Ecodesign performance requirements for high temperature process chillers and further consultation on walk in cold rooms

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Executive summary

High temperature process chillers

This study was carried out between December 2012 and April 2013 to assist the European commission in developing proposed minimum energy efficiency requirements for high-temperature industrial process chillers to be incorporated within an anticipated eco-design regulation. Process chillers were originally proposed under the product group referred to as DG ENTR Lot 1, but are now likely to be included along with DG ENTR/ENER Lot 6 Air Conditioning and Ventilation Systems. Proposals are already in place for minimum requirements for low temperature and medium temperature along with only information requirements for high-temperature chillers; each of those was the subject of a full impact assessment study during 2012. The Joint Industrial Expert Group[2] (JIEG) offered to assist the commission in development of standards for high temperature process chillers in late 2012. This study was initiated to develop a viable regulatory proposal through technical support from CLASP Europe.

There were two main aspects to the work: Firstly, gathering and analysing high-temperature chiller product performance data in order to derive proposed chiller performance energy efficiency requirement thresholds and other details of proposed requirements. Secondly, consulting with manufacturers and other stakeholders about the detailed proposals and assimilating results into a final proposal.

Product performance data on 53 different chillers was received from 8 different manufacturers and analysed to derive detailed proposals. The submitted data was judged to provide a fairly good representation of the market in terms of currently common compressor technologies and controls, refrigerant fluids and heat exchanger types. Some shortcomings in data coverage were compensated for by expert insight into the technology options combined with assessment of the much larger Eurovent certification scheme dataset of several thousand air conditioning chillers.

Proposals were then tested with all Lot 1 stakeholders via a consultation questionnaire with supporting explanatory documents during a three-week period in February/March 2013. In parallel, liaison was established with the impact assessment study on Lot 6 large air-conditioners to examine potential complementarity with this parallel regulation aimed at technically similar chillers (but with different applications). Additional consultation on proposals was carried out via two meetings held with the JIEG/EPEE, a telephone conference with an Italian SME chiller manufacturer, and direct correspondence with several stakeholders.

The analysis work and supporting technical discussions enabled development of proposed requirements that appear viable based on stakeholder feedback, assuming resolution of a range of associated issues that are summarised in the following paragraphs.

An acceptable basic definition of high temperature process chillers was concluded to be:

> *"A factory-built piece of refrigeration equipment which is primarily intended to cool down and maintain the temperature of a liquid (water or brine) using a vapour compression cycle within a refrigeration process, including at least a compressor and an evaporator within a "package". This is limited to chillers intended for process cooling applications, being those that are generally designed to operate all year round, including in ambient temperatures below approximately +10°C, and optimised for efficient operation at 80% loading and above and for which the load is generally independent of ambient conditions"*

[1] This lot was originally responsibility of DG ENTR but DG ENER was responsible for it in recent months.
[2] JIEG is composed of manufacturers of chillers, compressors and condensing units and meets under the auspices of EPEE in Brussels, see http://www.epeeglobal.org/ecodesign/ecodesign.

And for which 'High temperature' means that the chillers is intended to function at an operating temperature between +2°c and +15°c, with the reference point at +7°C This definition is proposed for use, but subject to further review for complementarity with the DG ENER Lot 6 Air Conditioning and Ventilation Systems chiller definitions and discussion with DG ENER.

Stakeholder feedback on the requirements resulted in the SEPR values shown in Table S1 being proposed for adoption, recognising that these are at a fairly demanding level for manufacturers, particularly for SMEs, but that these levels are economically highly favourable for almost all end users in terms of life cycle costs. Some significant changes would be required to existing chiller designs, with the traditional technologies of simple scroll and screw compressors being largely removed from the market, but the levels set enable retention of a reasonable range of improved technologies (including enhanced screw and scroll) to ensure sufficient supply of products to remain on the market. The timing of these Tiers must be carefully considered to ensure that economic impact on suppliers, particularly SMEs, is not punitive. Two years between entering into force and Tier 1 appears acceptable, whilst three years between the two tiers may ensure a suitable and economically acceptable transition for SMEs. But this must be coordinated with the proposed Lot 6 Air Conditioning and Ventilation Systems requirements for air conditioning chillers to ensure manageability. Benchmark levels of performance have been proposed and endorsed by stakeholder feedback, representing the best available technologies at 2012 and are shown in Table S2.

Table S1. Tier 1 and Tier 2 mandatory minimum requirements for Lot 1 high temperature process chillers as proposed for adoption following consultation feedback.

	Capacity range, kW	Tier 1 minimum performance SEPR	Tier 2 minimum performance SEPR
Air cooled	<400 kW	4,5	5,0
	>400 kW	5,0	5,5
Water cooled	<400 kW	6,5	7,0
	>400 & <1000 kW	7,5	8,0
	>1000 kW	8,0	8,5

Table S2. High-temperature industrial process chiller benchmark performance levels, as endorsed in the March 2013 consultation for high-temperature process chillers.

	Capacity range, kW	Benchmark SEPR level
Air cooled	<200 kW	6,5
	>200 & <400 kW	8,0
	>400 kW	8,0
Water cooled	<200 kW	8,5
	>200 & <400 kW	12,0
	>400 & <1000 kW	12,5
	>1000 kW	13,0

With regards to scope and included product types, stakeholder feedback suggested inclusion of evaporative condenser chillers but this must await development of a suitable harmonised test methodology that addresses their efficiency. Comparison of the scope of the first draft regulation and explanatory memorandum for DG ENTR/ENER Lot 6 Air Conditioning and Ventilation Systems exposed several specific issues on the scope of products that should be verified, including:

- Regarding the SEPR methodology itself, whilst half of stakeholder responses noted problems with it, no substantive arguments were presented to merit changes. Some clarifications and improvements to the SEPR documentation have been made by the JIEG but none that materially affected the proposed requirements.

- A review has been carried out of the Lot 6 proposals according to the March 2013 working document. The key differences regarding complementarity are that Lot 1 excludes sorption chillers and evaporative condensers, whereas these are included in Lot 6 - it is proposed to maintain this situation. The metrics used for energy performance are substantially different and not comparable between chillers under Lot 6 (Seasonal space cooling energy efficiency expressed as a percentage in primary energy terms) and Lot 1 (SEPR), but these differences are appropriate. Equally, there is no apparent reason to remove the slight mismatch in the capacity range of chillers included under Lot 6 versus Lot 1 (that Lot 6 is only up to 2 MW and Lot 1 unlimited). The most significant difference is regarding the estimated proportion of 2012 market that would be removed by the proposed tiers: The Lot 6 proposals equate to banning 90% of the 2012 market at Tier 1 and 95% at Tier 2, whereas Lot 1 targets 40% at Tier 1 and 60% at Tier 2. However, the technical stringency in terms of the engineering/technologies involved in compliant products is currently very similar (Lot 1 to Lot 6). Any changes in the relative stringency of requirements as a result of up-coming consultation must be reviewed to minimise the potential for exploitation by manufacturers by deeming products to be under the more lenient requirement. No remedy for that situation is apparent, but parallel relaxation of Lot 1 requirements to remove it would seem unjustified and counter-productive.

- The factors considered in this analysis provide a slight but not overwhelming logical preference for grouping high temperature process chillers with air conditioning chillers under the same regulation and, if necessary, separately to low and medium temperature process chillers. The regulation(s) should specify what manufacturers are to declare in their documentation about intended purpose to make it clear to enforcement authorities which regulation is relevant to any given product.

- Regarding the impact of proposed F-gas regulation, the viability of proposed performance requirements for high temperature process chillers relies upon continued availability of chillers using HFC refrigerants R410A and R134a. If the F-gas regulation results in, for example, a 2020 ban on HFCs in stationary air conditioners, then it would probably become necessary to verify the technical and economical feasibility the proposals, given the knock-on effects of such changes affecting the chiller market and this should be included at regulatory review if/as appropriate. No evidence has been identified to support inclusion of a GWP bonus for high-temperature process chillers (despite the 10% lower requirement being proposed under Lot 6 for chillers with refrigerant GWP less than 675).

Walk in cold rooms - executive summary

This work was carried out in December 2012 to support the Commission's management of a stakeholder consultation meeting on walk in cold rooms (WICR) held 13 December 2012. The meeting followed up on several issues that could not be resolved during the 2012 Impact Assessment study. The main issues were the scope of the harmonised standard being developed at that point by CEN TC44 WG4, stringency levels appropriate for insulation panel U-values, the issue of who takes eco-design responsibility in the supply chain and how regulation or other Commission action might help raise the quality of installation.

This work was not able to resolve all of the key issues facing this ecodesign regulation, but progress was made in identifying possible routes forward and in refining understanding of priorities and options. Key points arising included that:

- Further planning work between the Commission and TC44 WG4 is required to clarify what additional harmonised standards are required to establish full system performance metrics and test/calculation methodologies for cold rooms.
- An alternative metric of maximum heat flux per square metre (W/m^2) should be investigated as potentially a more satisfactory option than the simpler U-value.
- A final decision is required on whether the eco-design regulation should only apply to cold rooms of less than 100 m^3. If larger rooms were kept within scope then different thresholds and possibly different other requirements would be appropriate.
- A harmonised standard on good practice for installation of walk in cold rooms is a necessary first step towards raising the quality of installation work and a mandate should be drafted to cover this.
- Energy labelling of panels (such as A to G) is not appropriate for this market.
- Thermal efficiency requirements for panels should be set such that discontinuous panels are not removed from the market, at least until a whole system metric is developed that takes account of their overall performance in a complete enclosure. Their superior prefabricated joints are likely to more than compensate for any slight reduction in simple U-value, compared with continuous panels cut and joined on site.
- The eco-design regulation must be worded to cover both 'placing on the market' (to cover prefabricated kits) and ‘putting into service’ (to cover customised cold rooms).
- Evidence reviewed to date would suggest that the person in the supply chain with ecodesign responsibility for a customised (built on site) cold room is he who puts the cold room into service under his own name (or ‘on his own behalf’), thus taking on the responsibilities of a ‘manufacturer’, even if some or all work is subcontracted. The responsibilities of the assembler and installer will be limited to taking necessary measures that the cold room still complies with the requirements as a result of their role. This last point must be understood as being our initial opinion; legal advice should be employed to verify this point.

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Part 1: High temperature industrial process chillers

1 Background for high temperature industrial process chillers

An eco-design regulation is being developed to cover industrial process chillers under DG ENTR Lot 1. The impact assessment for this was concluded in September 2012 and covered proposals for minimum requirements affecting low-temperature and medium temperature industrial process chillers. The low and medium temperature market is only modest sized and projected energy savings are 4 TWh per year at 2030. Speculative minimum requirements for HT chillers modeled during the Lot 1 IA indicated *additional* savings at 2030 of around 11 TWh per year over those for low and medium temperature chillers only. Industry feedback indicated that more stringent minimum requirements than those assumed would probably be appropriate, further increasing the savings potential. In the working document of January 2012, high-temperature chillers were only proposed to be subject to information requirements due to absence of evidence of chiller performance, as well as some regulatory issues that first needed to be addressed. There was also at that time an assumption that such chillers could be covered under Lot 6 for air-conditioning applications. During industry consultation in February to May 2012 as part of the Impact Assessment study – the significant size of the high temperature process chiller market, combined with better insight into the different optimisation required for air conditioning chillers compared to industrial process chillers, increased determination to develop separate requirements for high temperature process chillers.

The Joint Industrial Expert Group (JIEG) offered to assist the commission in development of proposed standards in late 2012. With technical support from CLASP it was deemed possible to develop a viable regulatory proposal, subject to resolving several issues, including the following:

- How can high-temperature industrial process chillers be robustly distinguished under the regulation from air conditioning chillers, and how will this work in enforcement practice? (E.g. when interpreted by enforcement authorities)
- Are there any problems associated with having a product that could fall under either of two ecodesign regulations (other than the basic technical definition)
- Which is the most appropriate regulatory home for the HT process chillers – under Lot 1 or under Lot 6?
- What performance levels represent fair and appropriate requirements?

This report explains the process to address these and other issues to derive a viable regulatory proposal for high temperature industrial process chillers.

2 Project team

This work on high temperature chillers was carried out on behalf of CLASP Europe by Jeremy Tait of Tait Consulting Limited with expert technical support and analysis provided by Philippe Rivière of ARMINES, Paris.

Amongst other relevant experience, Tait Consulting was able to bring to bear its insight and data from carrying out the Lot 1 impact assessment study for DG ENTR between February and October 2012 that included both industrial process chillers and walk in cold rooms. ARMINES brought its experience and datasets from working on the DG ENTR/ENER Lot 6 Air Conditioning and Ventilation Systems preparatory study on large air conditioning systems between 2010 and July 2012.

3 Overview of work carried out

There were two main aspects to the chillers project as finally delivered:

A. Firstly, gathering and analysing high-temperature chiller product performance data in order to derive proposed chiller performance energy efficiency requirement thresholds and other details of proposed requirements.

B. Secondly, consulting with manufacturers and other stakeholders about the detailed proposals and assimilating results into a final proposal.

The work commenced in December 2012 with a meeting held with the Joint Industrial Expert Group (JIEG) of manufacturers, meeting under the auspices of EPEE (14 December) at which potential approaches to setting requirements were discussed. Product performance data was then requested from manufacturer members of the Eurovent chillers working group and this was analysed during January and February to derive detailed proposals for performance requirements.

The proposals and underlying evidence were summarised into a consultation document and questionnaire. The consultation was launched on 28 February 2013 by email to all Lot 1 stakeholders as well as via the consultation website used during the 2012 impact assessment. A three-week consultation period was allowed (given that outline proposals were subject to a 12 week consultation period during 2012 as part of the impact assessment study). A further explanatory meeting was held with the JIEG on 12 March in Brussels at which further details of the underlying evidence were discussed and queries addressed. The consultation closed on 18 March and results assimilated into final proposals. Impact on SME suppliers is a particular concern and so specific representative SME suppliers were sought out for follow-up consultation: a detailed discussion with one such supplier resulted, yielding additional insight and evidence to take into account.

In parallel, during this process, liaison was established with the Lot 6 large air-conditioners impact assessment study being carried out by VHK: ensuring complementarity with this parallel regulation aimed at technically similar chillers (but with different applications) is important to the final effectiveness of the joint regulations. Unfortunately a draft of the Lot 6 proposals was not made available until 5 March 2013 which severely limited the opportunity for comparison and review, in particular regarding the challenges for enforcement authorities, but a review of the Lot 6 document is included in this report.

Finally, key issues were identified for update of the 2012 impact assessment on eco-design regulation of industrial process chillers. The work was completed in April 2013.

4 Derivation of ecodesign requirement proposals for HT chillers

The mandatory minimum eco-design requirements for high-temperature chillers that were initially derived from this analysis, and as used in the March 2013 consultation are given in Table 1 (note that the requirement for the largest segment water cooled chillers was subsequently relaxed slightly – see section 5.2). The proposed benchmark performance levels used for the same purpose are given in Table 2. The capacity segments are as proposed by the manufacturers (JIEG) and reflect the technology types and consequent efficiency levels that dominate at the various capacity levels.

Table 1. Tier 1 and Tier 2 mandatory minimum requirements as proposed in the March 2013 consultation for high-temperature industrial process chillers – *NOT FINAL: see* Table 6.

	Capacity range, kW	Tier 1 minimum performance SEPR	Tier 2 minimum performance SEPR	*For comparison: Indicative average SEPR in 2012*
Air cooled	<400 kW	4,5	5,0	*4,7*
	>400 kW	5,0	5,5	*5,1*
Water cooled	<400 kW	6,5	7,0	*7,3*
	>400 & <1000 kW	7,5	8,0	*8,5*
	>1000 kW	8,0	9,0	*8,6*

Table 2. High-temperature industrial process chiller benchmark performance levels, as proposed in the March 2013 consultation for high-temperature industrial process chillers.

	Capacity range, kW	Benchmark SEPR level
Air cooled	<200 kW	6,5
	>200 & <400 kW	8,0
	>400 kW	8,0
Water cooled	<200 kW	8,5
	>200 & <400 kW	12,0
	>400 & <1000 kW	12,5
	>1000 kW	13,0

4.1 Approach to setting requirements

Initial proposed performance requirements for low and medium temperature industrial process chillers only were made in the Working Document of January 2012; these were superseded by proposals in the Impact Assessment study of September 2012. That study also made some speculative proposals for requirements for high temperature chillers, made purely to quantify the magnitude of consumption and possible savings for prioritising future development of requirements for high temperature process chillers. Since publication of that study, further research and evidence has become available to develop robust proposed requirements.

The process taken to derive these is described in overview in the document from the March 2013 consultation exercise called '*Stakeholder consultation on possible Ecodesign Requirements for DG ENTR Lot 1 Professional Refrigeration: High temperature industrial process chillers, ANNEX 3: Summary of supporting evidence*' which is included as Annex 1 to this report.

Further detail of the underpinning analysis of data, its comparison with the Eurovent database of chillers and also the consideration of technology options and their impact on efficiency and full details on the rationale for the proposed MEPS is provided in the report called '*Analysis of data received from manufacturers and comparison with Eurovent database to derive proposed minimum requirements, Version of 17 February 2013, ARMINES'.* This is included as Annex 2 of this report.

Section 5 Results of consultation process in endorsing and/or modifying proposals explains the further development of these requirements as a result of the consultation process.

4.2 Market coverage of collected data

Data on 53 different chillers (22 air cooled; 31 water cooled) was received from 8 different manufacturers as a result of a call for data sent out by the European commission in mid December 2012, sent mainly to the Eurovent chillers group but also made known to the wider Lot 1 process chillers stakeholder group. A data submission form was provided to make data analysis easier and most respondents did oblige with the use of that spreadsheet. This enabled SEPR performance figures to be calculated by ARMINES for 48 different chillers.

An overview of how the submitted products data was distributed across the various permutations of technologies is given in Table 5 of the document given in Annex 1 of this report. That table also indicates (by colour coding of the squares) which permutations of technologies and refrigerant are currently responsible for a significant proportion of the total market, and which permutations are deemed likely to become more significant in future (in expert opinion of ARMINES). The submitted data was judged to provide a fairly good representation of the market in terms of currently common compressor technologies and controls, refrigerant fluids and heat exchanger types. Weaknesses in coverage by technology are mainly lacking representation of R407C and propane refrigerants and with weak coverage of stepped capacity units. In addition, comparison with the Eurovent database showed a lack of coverage of high-efficiency chillers in the low capacity range (as explained in Annex 2).

These shortcomings in the available data were made up for by insight into the technology options and their impact on efficiency, combined with judgments based on the context of the wider Eurovent dataset.

5 Results of consultation process in endorsing and/or modifying proposals

The consultation events held during the course of this work are listed in Table 3. The first of these on 14 December 2012 informed the process of developing the proposed requirements and the meeting notes are given in Annex 3.

The full text of consultation questionnaire returns is included in Annex 6, with other feedback notes included in Annexes 3, 5 and 7. The sections following summarise together by each main issue in turn the responses from all sources (questionnaire, both JIEG meetings and Climaveneta discussion, plus some additional material during that period).

Table 3. Table consultation events held in the course of this work.

Consultation event	Consultees involved	Comments
Meeting with Joint Industry Expert Group (JIEG) 14 December 2012	5 manufacturers plus Eurovent and EPEE; European commission and study contractors.	See Annex 3 for meeting notes.
Consultation process 22 February to 18 March 2013	Consultation made available at http://www.taitconsulting.co.uk/Ecodesign_Consultation.html and notified by email to 272 Lot 1 stakeholders on 22 February 2013 with closing date of 18 March 2013. Thirteen responses received: 7 from manufacturers; 4 national authorities; 2 consultants, covering 10 different countries.	See Annex 4 for consultation questionnaire; Annex 6 for Summary of consultation replies.
Meeting with JIEG 12 March 2013	5 manufacturers plus Eurovent and EPEE; European commission and study contractors.	See Annex 5 for meeting notes.
Telephone conference with Climaveneta 25 March 2013	Telephone conference call between 3 managers from Climaveneta, J Tait and P Rivière regarding impact of the proposed requirements on SME manufacturers.	See Annex 7 for meeting notes.

5.1 Market average performance levels

For air cooled HT chillers there was good or very good agreement from the consultation with the estimated market average EER, best available EER and two of the three market average ESEER figures; the small segment market average ESEER was thought too high and was adjusted. For water-cooled HT chillers there was fairly good agreement with estimated market average EER (suggestion that they should be slightly lower); a slight majority disagreed with best available EER (suggestion that it should be lower) and most supported the typical ESEER estimates (suggestion from one expert respondent that these should be higher). The feedback is detailed in Annex 6 and has been assimilated and assumed market performance levels retained/adjusted as shown in Table 4 and Table 5.

Table 4. Air-cooled high-temperature process chillers, assumed market average performance levels for consultation and those adopted as a result of feedback.

Temperature range	Capacity range, kW	Assumed Market average capacity for that range, kW	Typical (market average) EER in consultation	Adopted market average EER	Best available EER today on the market* in consultation	Adopted best available EER	Typical (market average) ESEER in consultation	Adopted market average ESEER
High	<100 kW	40	2,7	**2,7**	3,4	**3,4**	3,8	**3,6**
	>100 & <400 kW	250	2,7	**2,7**	3,5	**3,5**	3.8	**3,8**
	>400 kW	1000	2,9	**2,9**	3,4	**3,4**	3.9	**3,9**

Table 5. Water-cooled high-temperature process chillers, assumed market average performance levels for consultation and those adopted as a result of feedback.

Temperature range	Capacity range, kW	Assumed Market average capacity for that range, kW	Typical (market average) EER in consultation	Adopted market average EER	Best available EER today on the market* in consultation	Adopted best available EER	Typical (market average) ESEER in consultation	Adopted market average ESEER
High	<400 kW	250	4,4	**4,4**	5,6	**5,6**	5,4	**5,2**
	>400 & <1000 kW	750	4,8	**4,8**	5,9	**5,9**	5,4	**5,4**
	>1000 kW	1600	4,9	**4,9**	6.3	**6,2**	5,7	**5,7**

5.2 Stringency of requirements

The stringency of requirements was initially designed to remove around the poorest performing one third of the 2012 market at Tier 1, with Tier 2 removing around two thirds of the 2012 market. A consultation question asked for stakeholder views on the proportion of the market removed at each tier for which seven stakeholders provided their estimates plus a couple of extra comments. The statistical average of responses for the market moved at Tier 1 was 40% (five said between 21%-40%;

2 said between 41%-60%; one said 61%-80%). Similarly, the average of responses for Tier 2 was 60% (three said 41%-60%; three said 61%-80% and one said over 81%).

In comments, one large manufacturer suggested that the Tier 2 SEPR requirements were too ambitious for water-cooled chillers above 1000 kW, suggesting an alternative figure of SEPR 8.5 (instead of 9.0). Another large manufacturer did not provide an answer to this question because of disagreement with some of the principles of how SEPR is determined (see following section). One smaller manufacturer suggested that the SEPR requirements across the board are very demanding. He had no great concerns about those for air cooled chillers, but considered that the requirements for large water-cooled chillers (those above 400 kW) were particularly demanding and would require significant changes to the product range offered. This supplier initially made a much less stringent proposal table for minimum requirements (see Annex 6) and later in discussion agreed that adjusting the SEPR requirements for water-cooled chillers above 1000 kW capacity to 8.5 (Instead of 9.0) would allow the better performing screw chillers to remain on the market and so enable additional technology/product range flexibility whilst also raising standards. This supplier felt that "*units with traditional technology (scroll and screw compressor) would suffer most*" – which is in line with expectations that significant and economically justified improvements in the product efficiency levels would require changes in technologies deployed.

An important aspect of justifying any given level of stringency is on the economic benefit to end users to energy savings offsetting the additional upfront investment. The consultation document suggested highly contrasting average annual usage hours between air conditioning chillers at 600 hours per year and industrial process chillers with typically 7000 hours per year. Several respondents picked up on this contrast being excessive, with some air-conditioning chillers used through most of the year (e.g. for hospitals and data centres) and some industrial processes being used only for eight or 16 hours per working day (corresponding to some 2000 or 4000 hours per year). It is important to note that all of the technology improvements noted in the Lot 6 Air Conditioning and Ventilation Systems preparatory study can easily be justified at only 2000 usage hours per year, many are justified at only 600 hours per year. Since the majority of those technologies are equally applicable to process chillers, the proposed minimum requirements are economically justified at far lower usage hours than were implied in the supporting documentation.

As a result of feedback, it is suggested that the Tier 2 requirement for water-cooled chillers above 1000 kW capacity should be reduced from 9.0 down to 8.5. In addition, consideration should be given to allow smaller manufacturers the time to respond by adjusting product range without excessive technical and economic burden. The requirements proposed for adoption as a result of consultation feedback are summarised in Table 6.

Table 6. Tier 1 and Tier 2 mandatory minimum requirements for Lot 1 high temperature process chillers as proposed for adoption following consultation feedback.

	Capacity range, kW	Tier 1 minimum performance SEPR	Tier 2 minimum performance SEPR
Air cooled	<400 kW	4,5	5,0
	>400 kW	5,0	5,5
Water cooled	<400 kW	6,5	7,0
	>400 & <1000 kW	7,5	8,0
	>1000 kW	8,0	8,5

5.3 Impact on particular regions or subsectors of the market

The only impact on a particular geographical region noted in responses was associated with the design of the SEPR methodology, rather than any skewed impact of the regulation itself (Scandinavia). See section 5.6 Acceptability of SEPR methodology.

One Swedish respondent noted that the regulation could affect supermarket refrigeration and ice rink chillers which are designed for partial load operation, resulting in products on the market that are not optimised for that partial load profile. Datacentre chillers were similarly identified by another respondent as not matching the assumed usage profile through having significant part load operation time. It is correct that there will remain many applications for which good part load performance will be required in applications that meet the description of 'industrial process cooling'. However, such products will continue to be usefully applied to air conditioning applications and so should not disappear from the market. Engineering judgment will still be required to select the most appropriate product and the proposed regulation does not prevent any given product being applied to any particular application (only sets minimum requirements for products primarily marketed for certain applications). In fact, it may make sense to use a cheaper air-conditioning chiller with better part load efficiency in combination with a more expensive but more efficient industrial process chiller for the base load – the regulations will not prevent this choice being made.

One respondent noted that traditional technologies (scroll and screw compressor types) would suffer most from the proposals. As noted above, it is in line with expectations that significant and economically justified improvements in the product efficiency levels would require changes in technologies deployed, hence this impact is anticipated and not perceived as a problem.

Whilst it was only one Italian SME supplier that raised specific concerns about the stringency of levels, also claiming to represent the views of other Italian SME suppliers, there is no evidence that this is an isolated regional or national problem. Anecdotal evidence and expert insight points to similar performance levels and technology usage with similar French and other country suppliers.

5.4 Impact on market profitability and economic impacts

Eighty percent of respondents agreed that the regulation would place market focus on better performing and that it would encourage investment in product development and innovation. Ninety percent of respondents agreed that there would continue to be an adequate supply of products that meet the requirements, although one particularly emphasised that product costs would rise. One respondent suggested that SME manufacturers "would suffer extreme regulatory burden", elaborating that the cost of testing is significant, especially when this has to be subcontracted to an expert independent test house. As discussed under Lot 1 impact assessment proposals for this and other product groups, enforcement authorities should expect a proportionate and economically rational approach by manufacturers to this challenge through use of representative models (i.e. performance levels of any particular model potentially calculated from tests on a similar or representative model). It would not be expected to have practical test results on every model of chiller. There is also the timing of requirements to be carefully considered here, allowing adequate time for a programme of testing to be rolled out through the product ranges.

Most respondents agreed that product costs would rise and several suggested that end-users are not interested in an economically justified investment involving higher initial cost. However, none disputed the economic justification that can be made and one described it as a win-win situation where justifiable additional investment by end users benefits manufacturers by selling higher value products. One smaller manufacturer in particular said there will remain demand for basic functional products, quoting a comparison with cars with demand for Ford/Fiat models by users who cannot or do not want to pay for the Mercedes/VW models (this is basically acknowledging that users may object to minimum requirements creating a price increase). However, the proposed performance levels are in close alignment with the least life cycle cost approach required to be applied for eco-design regulatory requirements and the longer-term economic case appears attractive from the end-users' perspective[3].

[3] Based upon evidence form both the Lot 6 and Lot 1 impact assessment analyses.

5.5 Scope of regulation

The only specific feedback suggesting change in the scope of regulation was that the regulation should include chillers making use of evaporative condensers. These were specifically excluded from the working document of the January 2012 consultation forum. This topic was also discussed at the 12 March 2013 meeting with the JIEG, concluding that there could be challenges in the testing of these, as they are not covered by EN 14825. It was also noted that use of evaporative condensers made particular sense for air conditioning (Lot 6 Air Conditioning and Ventilation Systems) applications which operate predominantly in higher ambient temperatures when the advantages of evaporative condensing would be much more attractive than over year-round operation. Hence there is particular attraction to including them within the scope of Lot 6. The consensus at 12 March meeting was that exclusion of evaporative condenser's remains appropriate, but this could usefully be investigated for inclusion in a mandate for future development of standards such as EN 14825.

Note: Performance of evaporative condensing chillers would generally be superior to that of conventional air cooled chillers and so such chillers would be expected to easily meet the minimum requirements. Due to the higher cost of the water management equipment for evaporative condensers, combined with their superior performance, this does not represent a loophole for the regulation. Investigation may be appropriate for the time of regulatory review into whether there are poor performing evaporative condensing chillers that could usefully be excluded from the market. At this stage, however, without further evidence it would seem appropriate to exclude them from the current regulation.

5.6 Acceptability of SEPR methodology

Attitudes to the acceptability of the SEPR methodology were split almost equally for and against, but with varied reasons for what should be improved:

- Firstly, regarding assumed ambient conditions: Two Scandinavian respondees noted the different average temperature and weather conditions in Scandinavia are significantly different to the average assumed for Europe. A third respondent suggested use of different climate zones across Europe, as used for the air conditioning energy label. In fact, minimum eco-design requirements for air conditioners have to be calculated only at the average heating season temperature profile when calculating COP for compliance (this applies to heating mode only – cooling mode has only one temperature profile for EER compliance). Performance under other temperature profiles may be provided on the energy label but the 'colder' and 'warmer' profiles are for user information only. There is no suggestion that energy labelling is appropriate for high-temperature industrial process chillers, but such information could conceivably be required to be published by suppliers. However, such an approach would add significant complexity to the regulation and technical burden on suppliers, but would still not result in a necessarily accurate assessment of the efficiency of that particular installation due to the many other variables in the set up and use. Also, the target audience for information made available through this regulation is an expert one of refrigeration design engineers and specifiers who can assess the suitability of a product with a full appreciation of the usage conditions, rather than less informed end users that would often be buying energy labelled air-conditioners. There is therefore little justification for adding the complication of different climatic zones for process chillers.

- Secondly, it was suggested by one major manufacturer that the SEPR usage profile was not in line with most industrial applications. The specific risk highlighted was that products could be optimised to perform well under SEPR testing but that this would result in sub optimal performance in the real world. The manufacturer had carried out some performance modelling and shown that some best performing products for some process applications were penalised under the proposed SEPR calculation method. It is accepted that the methodology will not cater best for all situations. However, the requirements will significantly improve market focus on efficiency and drive out of the market a significant proportion of products with very poor performance in these applications. As noted above, there will and should remain a focus on engineering expertise to specify the most appropriate product for any given application. The improved availability of performance information through this regulation should help

improve the effectiveness of these experts. Also, products performing efficiently at part load will continue to be available on the market for air conditioning applications and can be specified for use where appropriate.

- One further specific technical issue was raised: Head pressure control is required to operate some chillers at SEPR condition 'D' and for water-cooled chillers a field-installed valve or a VFD pump is required to control condensing temperature (some chillers can supply an analogue signal to control the valve/pump). In response, ARMINES pointed out that this is already the case at 18 °C for some air cooled chillers and there is no provision made in the EN14825 standard to explain how the units should be tested in that case. This additional enhancement could be considered in the transitional test method.

The JIEG worked on the details of the SEPR explanatory document and calculation tool during December 2012 to March 2013 and made a number of small but useful clarifications and enhancements. These included changing the default degradation coefficient definition and default value from Cd = 0.25 to Cc = 0.9 (i.e. change from a Cd to Cc factor, plus change of value - these were agreed as appropriate by ARMINES) and several other issues around use of degradation coefficients. The version as at 1 May 2013 is included as Annex 11.

5.7 Timing of tiers

Manufacturers at 12 March 2013 meeting stated a preference for tiers to come in December or January to align with product range and brochure releases. There was no specific dispute of the two-year period between the regulation coming into force and Tier 1 taking effect, but several felt that only two years following to the start of Tier 2 would be too little time to make the product adjustments required; this was especially strongly felt by the SME supplier. Another point made during consultation was the potential combined impact on engineering resources for manufacturers of adapting products and technical literature for compliance with both Lot 6 Air Conditioning and Ventilation Systems and Lot 1 regulations. This should be further discussed and agreed both between DG ENTR and DG ENER, and with further input from suppliers. There was a consensus that requirements and Tiers for both Lot 1 and Lot 6 should come into effect at the same time.

5.8 Draft definition of process chillers

Eight out of the 11 respondents to the question about adequacy of the proposed definition felt that improvements were necessary, but the problems identified, and a few possible solutions, were highly varied. Some of these responses are dealt with under section 5.11. Several aspects of the high temperature industrial process chiller definition were discussed at 12 March meeting with manufacturers, see Annex 5. It was stated by one manufacturer that the draft definition used in the consultation document was adequate for a manufacturer to decide on the appropriate categorisation, but refinements were agreed. The main points emerging from this and other responses were that:

a) There will inevitably have to be a degree of reliance on a declaration intended purpose by manufacturers in order to cater for the many grey areas and niche applications between air conditioning systems used 600 hours per year and less with variable load, compared with industrial process applications with almost continuous and high loading.

b) It would be appropriate to combine the 'all year operation' with a statement of a typical loading level being intended as 80% of full load and above.

c) Information requirements would have to be very specific to ensure surveillance and enforcement authorities had adequate information with which to ensure compliance.

The definition derived from feedback was reported in the meeting notes from 12th of March with no further refinements suggested by the manufacturers:

"A factory-built piece of refrigeration equipment which is primarily intended to cool down and maintain the temperature of a liquid (water or brine) using a vapour compression cycle within a refrigeration process, including at least a compressor and an evaporator within a "package". This is limited to chillers intended for process cooling applications, being those that are generally designed to operate all year round, including in ambient temperatures below approximately +10°C, and optimised for efficient operation at 80% loading and above and for which the load is generally independent of ambient conditions"

This definition is proposed for use, but subject to further review for complementarity with the Lot 6 Air Conditioning and Ventilation Systems chiller definitions and discussion with DG ENER (see section 5.12).

5.9 Definition of temperature ranges

A query was raised by one of the JIEG members about the definition of low, medium and high temperature ranges used in the working document, that they might not be logical. No previous queries had been raised about this, but the comments appeared logical and were investigated.

The definitions as used in the January 2012 working document at the consultation forum were:

- *'Low operating temperature' means that the chillers is intended to function at an operating temperature between -25°c and -8°c, with the reference point at -25°C*
- *'Medium operating temperature' means that the chillers is intended to function at an operating temperature between -12°c and +3°c, with the reference point at -8°C*
- *'High operating temperature' means that the chillers is intended to function at an operating temperature between +2°c and +15°c, with the reference point at +7°C*
  [Note: the reference point of +6°C used in the original working document was changed to +7°C by agreement with JIEG in January 2013 in order to align with that used in harmonised test methodologies]

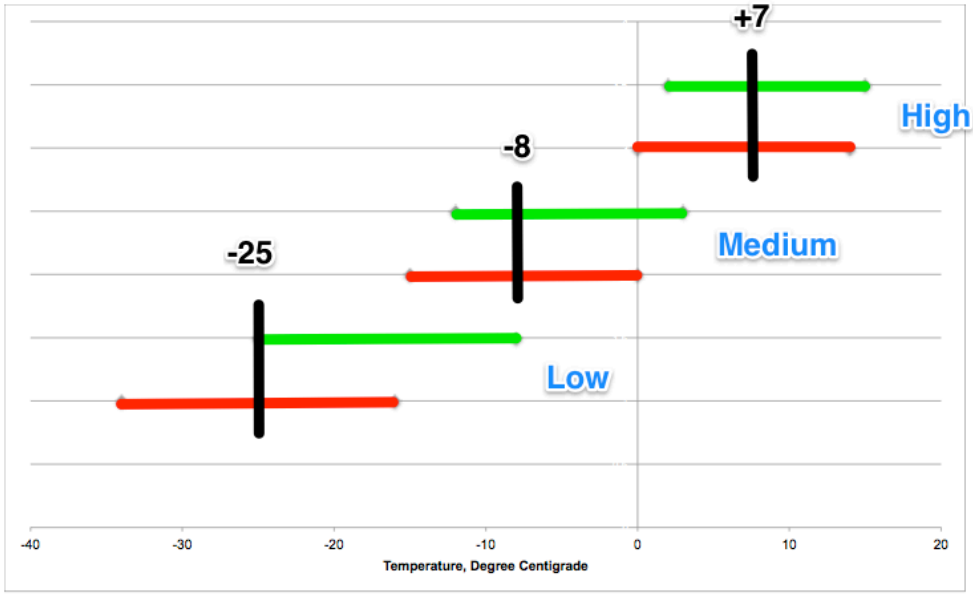
The suggestion made in March 2013 was that the temperature ranges should be symmetrically arranged around the reference temperatures and that there should be no overlapping of ranges between low and medium as follows:

- reference point for LT-industrial process Chillers (-25°C) being valid for application temperature range $t_{LT} \leq -16°C$
- reference point for MT-industrial process Chillers (-8°C) being valid for application temperature range $-16°C > t_{MT} \leq 0°C$
- reference point for HT-industrial process Chillers (+7°C) being valid for application temperature range $t_{HT} > 0°C$

Anecdotal evidence suggests that few products in the Eurovent programme are declared at low and medium temperatures and that these declared definitions are not widely used by manufacturers in their own literature – hence it should be possible to adjust them without major upheaval. (It would be highly complex to make any change to the reference temperatures at this late stage, as that would mean recalculation of performance levels etc. – but this is not being suggested).

It is proposed that these should be adopted for the regulation - subject to approval by the JIEG.

Figure 1. Proposed new temperature ranges (red, lower lines of each pair) with original temperature ranges as proposed in January 2012 working document (green, upper lines); reference temperatures are at the vertical black bars and common to both. Note overlap of original ranges.



Background notes on derivation of the original definition of ranges:

The temperature ranges for the January 2012 working document definitions (-25°C to -8°C etc.) are quoted from the Eurovent certification programme description for liquid chilling packages and heat pumps, which states that three applications are covered by the Eurovent Standard[4]:

- *low brine, with leaving brine temperature between - 8°C and - 25°C*
- *medium brine, with leaving brine temperature between + 3°C and - 12°C*
- *air conditioning, with leaving chilled water temperature between + 2°C and + 15°C*

The reference points quoted (-25°C, -8°C and +7°C) refer to the chilled liquid temperature as it leaves the evaporator heat exchanger.

[4] See http://www.eurovent-certification.com/en/Certification_Programmes/Programme_Descriptions.php?lg=en&rub=03&srub=01&select_prog=LCP-HP

5.10 Choice of Lot 6 or Lot 1 as 'home' for the high temperature process chiller requirements

Regarding how the products should be grouped between the regulations there are three possible options:

a) Grouping high-temperature process chillers with air conditioning chillers, and putting low and medium temperature chillers under a separate regulation (i.e. grouping by operating temperature)

b) Grouping high-temperature process chillers with low and medium temperature process chillers, and air conditioning chillers under a separate regulation (i.e. grouping all process chillers together and separately from air conditioning chillers)

c) Grouping all process chillers together with air conditioning chillers under the same regulation

There was virtually equal support for options a) and b) (three votes each); and two votes for option c).

Reasons for choices were not explained by most stakeholder respondees, although one did explain that b) was the most logical due to the significant differences between the requirements for process chillers versus air conditioning chillers, but this respondent also pointed out that if the requirements for Lot 1 and Lot 6 Air Conditioning and Ventilation Systems were better co-ordinated, then option a) becomes favourable.

Note that the choice of 'home' for the requirements should not necessarily of itself affect the scope, definitions, stringency etc. of any requirement. There is good reason to ensure (for example) that the definitions used are complementary and compatible anyway, as many manufacturers will have products that qualify for Lot 1 and Lot 6 – often using the same basic product for both but with differently optimised controls and/or special features.

There did seem to be consensus from manufacturers that high temperature chillers are materially different in construction and engineering to low and medium temperature chillers, and so the 'technical' logic for grouping low, medium and high temperature process chillers together is not compelling. Of more relevance is the fact that some manufacturers use the same chillers for both air conditioning and for high temperature process applications and so on that basis there is logic to grouping those two together. This logic holds even though one aim of the Lot 1 regulation is to establish a separation in markets between high temperature process chillers and air conditioning chillers because this principle can just as easily be established and rationalised with both types covered by a single regulation – the end result being that products are better optimised for the appropriate application.

The working title of Lot 6 is currently "…*with regard to ecodesign requirements for air heating products and cooling products*". The 'cooling' reference in that title is not in fact restricted to air-cooling only and so high temperature process chillers do indeed fit within the implied scope of that title. Whilst it could be argued that further complicating the already wide range of products under Lot 6 could be unwelcome, this is not a substantive point.

There is also the practical issue of how the grouping would affect the date at which requirements can be brought into effect. It is the author's understanding that a Consultation Forum for Lot 6 is anticipated for June 2013 leading to a vote at Regulatory Committee by the end of 2013 or early 2014. Since Lot 1 is being prepared for Inter-Service Consultation in April/May, it would appear that Lot 6 is around 6 months behind Lot 1 in the development process. Requirements for high temperature process chillers could therefore be slightly more quickly be implemented by keeping them with Lot 1, although the compatibility issues between Lot 1 and Lot 6 must still be sorted out and so Lot 1 could end up being delayed whilst that happens. Conversely, requirements for low and medium temperature process chillers (only 20% or so of the total process chillers energy savings) could be protected from delay by leaving high temperature chillers with Lot 6. The high temperature chillers should achieve far greater savings than combined low and medium temperature chillers and so effectiveness of the HT measure should not be put at risk for short-term opportunism. The difference of implementation date arising from this decision is unlikely to exceed one year, and so its consequences are only fairly short term, hence the factor of timing should not be allowed to unduly affect the product grouping decision.

On balance, whilst there is no overwhelming rationale to recommend any one of the options a), b) or c) over another – the factors considered in this analysis provide a logical preference for option a), i.e. grouping high temperature process chillers with air conditioning chillers and, if necessary, separately to low and medium temperature chillers.

5.11 Issues associated with a chiller that could be classed under two product categories with differing requirements

There are and will continue to be some applications for which the same chiller is designed to provide both space cooling and process cooling simultaneously. In such cases it could be disputed whether the product should meet Lot 6 Air Conditioning and Ventilation Systems and/or Lot 1 high temperature process chiller requirements. In addition, products are likely to persist on the market that could be used in either application. It must be made clear in the regulations that such products must comply with either Lot 1 or Lot 6, or both – and that absence of a specific intended use will not allow evasion of both requirements. This was discussed at the JIEG meeting of 12 March – see Annex 6.

As an attempt to rationalise this situation, it was decided to follow the logic of the Commission's Blue Guide[5] for the implementation of directives and consider its implications if it were to apply to ecodesign regulations. According to the Blue Guide it seems that it might be legally acceptable for all high temperature chillers to be within the scope of a Lot 6 regulation (and so Lot 6 would not require to have any statement of intended purpose), and a subset of those chillers (the high-temperature process ones) to be subject to a second and more specific regulation (Lot 1). The regulations could usefully specify what manufacturers are to declare in their documentation about intended purpose to make it clear to enforcement authorities which measure is relevant to any given product.

The Blue Guide states that:

> *Two or more directives can cover the same product or hazard. In such a case, the application of other directives is often limited by excluding certain products from the field of application of the other directives, or by giving preference to the more specific directive[6].*

The 'more specific' measure would be Lot 1. Requirements around this declaration in product literature could be drafted into both regulations/sets of requirements.

In effect, a supplier could be free to declare performance (and show conformity) under Lot 1 and/or Lot 6, but if the chiller meets the Lot 1 definition then it must (also) meet the Lot 1 requirements.

One downside of this is regarding potential costs for testing. Not every product would be required to be tested of course – calculation methods may be applied, and use of representative models etc. (see the Impact Assessment study report). But for those chillers that must be tested and that could be used under both regulations, the testing cost could be slightly reduced if, for example, there was at least one rating point common to both regulations/test methods (expected to be the full load standard condition). This would mean seven tests to cover both requirements, rather than eight. It was also noted that a test lab might not be able to perform both process and air conditioning tests at the same time if outdoor ambient conditions were not favorable to achieve this (problematic particularly for larger chillers).

[5] Guide to the implementation of directives based on the New Approach and the Global Approach, European Commission. Available from http://ec.europa.eu/enterprise/policies/single-market-goods/files/blue-guide/guidepublic_en.pdf.
[6] Section 2.2 Simultaneous application of directives, p16.

5.12 Complementarity of Lot 1 with Lot 6 proposals

The first draft working document for Lot 6 Air Conditioning and Ventilation Systems became available in March 2013[7]. This was reviewed in order to investigate the potential complementarity of Lot 1 and Lot 6 requirements, and to identify any potential issues to be harmonised. Table 7 compares and contrasts many aspects of the two regulatory proposals.

A key aspect is that of product definitions:

Definition of Lot 1 chillers:

> *"A factory-built piece of refrigeration equipment which is primarily intended to cool down and maintain the temperature of a liquid (water or brine) using a vapour compression cycle within a refrigeration process, including at least a compressor and an evaporator within a "package". This is limited to chillers intended for process cooling applications, being those that are generally designed to operate all year round, including in ambient temperatures below approximately +10°C, and optimised for efficient operation at 80% loading and above and for which the load is generally independent of ambient conditions"*

Definition of Lot 6 chillers:

The definition used is of a 'hierarchical' nature, by which it defines a cooling generator, then a cooling product (that incorporates a cooling generator), then a chiller (that is a type of cooling product); then types of chillers such as air to water; water/brine to water; sorption cycle chiller etc. The most pertinent here is the definition of a chiller:

> *"'Chiller' means a cooling product:*
> *a) of which the indoor heat exchanger (evaporator) extracts heat from a water-based cooling system (heat source), designed to operate at leaving chilled water temperatures between + 2°C and + 15°C or above 20oC;*
> *b) has a cooling generator that uses a vapour compression cycle or a sorption cycle,*
> *c) of which the outdoor heat exchanger (condenser) releases this heat to ambient air, water or ground heat sink(s)*
> *d) may or may not operate in reverse."*

Thus the approaches to defining a chiller are fundamentally different between Lot 1 and Lot 6. This need not cause a legal problem and may not necessarily cause problems for manufacturers, although it could result in confusion for products that can serve both space cooling and process cooling functions. This issue of contrasting definitions has not yet been specifically tested with stakeholders.

It seems logical that if high temperature process chillers were to be included under Lot 6, then the definitions should be harmonised; if they remain under separate regulations then the definitions must still be checked for legal and technical complementarity.

[7] Explanatory Memorandum to the Working Document on draft COMMISSION REGULATION (EU) No .../... Implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air heating products and cooling products (ENER Lot 21 central air heating products and ENTR lot 6 cooling products combined)', draft supplied by Martijn Van Elburg of VHK on 5 March 2013.

Table 7. Comparing elements of the draft regulatory proposals for Lot 1 and Lot 6.

Issue	Lot 1 approach	Lot 6 approach	Comments
Temperature range definition	Operating temperature above 0°C (see section 5.9) with the reference point at +7°C	Water leaving temperatures of 2°C to 15°C or >20°C	Lot 6 temperature range is under query, and may resolve to generally between 6°C and 15°C, plus some specific exceptions outside of that range. Justified differences could remain between Lot 6 and Lot 1.
Intended purpose	Limited to chillers intended for process cooling applications	Provides an intended purpose for air conditioners but not for chillers.	Process chillers are (potentially) included under scope of both Lot 6 and Lot 1 – see section 5.11.
Scope by capacity	No capacity limits.	Cooling products with a rated cooling output of up to 2 MW, with no minimum capacity relevant to chillers[8].	No specific problems with this identified.
Scope by type of chiller and exclusions	Covers vapour compression systems only (water and air cooled). Excluded are absorption chillers; those exclusively designed for evaporative condensers; all not factory-built.	Covers vapour compression chillers (water and air cooled); 'chillers and air conditioners outside the scope of REGULATION 206/2012' (ecodesign of air conditioners and comfort fans). Also includes evaporative condensers and those with ground heat sink (as well as air and water). Information requirements only for sorption chillers included (hence absorption and adsorption). Excludes chillers with leaving chilled water temperatures of less than +2°C. Draft text proposes to exclude products up to a certain date that are sold as direct replacements for identical products.	Justification for differences in treatment of evaporative condensers, sorption chillers and ground as heat sink should be reviewed, although no specific problem with these differences has been identified. Appropriateness of also under Lot 1 excluding products sold for replacement of identical products could be considered (although this has proven controversial in other product areas).

[8] A minimum capacity of 12kW is stated for products if the product is covered by Regulation No 206/2001 (room air conditioners) – but minimum of 0kW is stated for products outside of that regulation scope. Hence no lower limit for chillers is applicable.

Issue	Lot 1 approach	Lot 6 approach	Comments
% of 2012 market targeted for removal	Aims to remove 40% of the 2012 market at Tier 1; 60% of 2012 market at Tier 2. *Note that the technical stringency in terms of the engineering/technologies involved in compliant products is currently very similar (Lot 1 to Lot 6) - the proportion of market removal reflects the typically poorer average performance of Lot 6 type chillers.*	Proposal being modelled for impact assessment at March 2013 adopt the most stringent of the 3 scenarios proposed by the preparatory study. These target exclusion of 90% of 2012 market at Tier 1 and 95% at Tier 2[9].	Similar levels of stringency would minimise potential for exploitation by manufacturers by deeming products to be under the more lenient requirement. Note: The Lot 6 preparatory study scenario 1 (least stringent) is estimated to remove a similar market proportion to the Lot 1 proposals made in this document.
Segmentation of market by capacity for minimum requirements	Air cooled: <400kW; and >400kW Water cooled: <400kW; 400kW to 1000kW and >1000 kW	Air cooled: <400kW; and >400kW Water cooled: <400kW; and >400kW	Differences are assumed justified by the contrasting performance expected at the different capacity levels. No problems arising from differences between Lot 1 and lot 6 have been identified.
Low GWP refrigerants	No concession for low GWP refrigerants anticipated.	10% lower requirements for chillers using refrigerants with GWP less than 675.	Absence of concession for low GWP refrigerants under Lot 1 appears justified – see section 5.15.1.
Seasonal Efficiency metric	Seasonal Energy Performance Ratio (SEPR)	Seasonal space cooling energy efficiency[10], expressed as a percentage; in primary energy terms[11]	The stated differences in metrics are appropriate and justified.
Dates of coming into force	Likely OJ publication date if with LT and MT chillers: January 2014 (TBC) Tier 1: 2 years after publication Tier 2: 4 years after publication; proposal being considered for 5 years after publication	Likely OJ publication date June 2014 (TBC) Tier 1: 2 years after publication Tier 2: 4 years after publication	Consultation indicates manufacturers would prefer requirements for Lot 1 and Lot 6 to take effect at the same time.

[9] Estimate from Lot 6, Task 7 report, page 84.

[10] 'Seasonal space cooling energy efficiency' is the overall energy efficiency ratio of the air conditioner or chiller, representative for the whole cooling season, calculated as the 'reference annual cooling demand' divided by the 'annual electricity consumption for cooling'.

[11] To convert Seasonal space cooling energy efficiency as a percentage to an efficiency ratio SEER, multiply by 2.5, then add three percentage points to efficiency requirements (control factor); and then for water cooled chillers only add a further five percentage points to compensate for water pumping on condenser side.

Issue	Lot 1 approach	Lot 6 approach	Comments
Noise requirements	No noise requirement.	3 Tiers of maximum noise requirements for cooling only chillers non-ducted between 12kW and 70kW; and ducted chillers between 12kW and 740kW.	Noise requirements deemed unnecessary for process applications.

5.13 Relative stringency of proposed Lot 1 and Lot 6 requirements

Lot 6 requirements are expressed as seasonal space cooling energy efficiency, being the ratio between the space cooling demand pertaining to a designated cooling season provided by a cooling product, and the annual energy consumption required for its generation, expressed as a percentage[7] (see Table 8 and Table 9). These are directly equivalent to the levels recommended in the Lot 6 Preparatory study report (Task 7 of July 2012) that are shown in Table 10. Seasonal space cooling energy efficiency figures can also be converted to SEER values[12]. Lot 1 requirements are given as SEPR (see Table 6). However, SEER and SEPR are of course not directly equivalent as the annual usage patterns are different (combination of hours of use at certain loading levels). SEPR is based upon chillers used at high levels of loading (80% and above of full capacity) whereas SEER is based upon loading 21% up to 100%. The conditions and usage pattern used to calculate SEER generally give lower absolute values than those to calculate SEPR.

Thus the same chiller will achieve a lower SEER value than it will for the SEPR value. As shown in Table 11, the proposed Lot 1 SEPR values are numerically between 13% and 22% higher than the Lot 6 SEER figures (exceptionally 27% to 35% higher for small water-cooled). There is a reasonably close equivalence of technology measures used in chillers that meet the respective thresholds and thus the current Lot 1 and Lot 6 requirements are probably fairly closely aligned in relative stringency. There is, however, a significant difference in the proportion of the recent respective markets that would be removed by the proposed tiers: Tier 1 of Lot 6 (Prep study scenario 3, maximum stringency) targets removal of around 90% of the market, compared to around 40% for Lot 1; Tier 2 targets 95% for Lot 6 and 60% for Lot 1. Of course the proposed Lot 6 thresholds are yet to be reviewed by the Commission and other stakeholders. Similar levels of stringency between Lot 1 and Lot 6 would be consistent with minimising potential for exploitation by manufacturers by deeming products to be under the more lenient requirement. No remedy for manufacturers choosing a more lenient route for a given chiller is apparent, but parallel relaxation of Lot 1 requirements to remove the temptation would seem unjustified and counter-productive.

In terms of removal of market products, the Lot 6 preparatory study scenario 1 (least stringent) is closest to the Lot 1 proposals made in this document (see Table 7). However, under the Lot 6 proposals, products that qualify for the low GWP (<675) bonus are allowed to meet 10% less stringent energy efficiency (seasonal space cooling energy efficiency) requirements, which for qualifying chillers brings the requirements of scenario 3 much closer to the requirements of scenario 1 without the bonus[13]. Hence, if the move towards low and zero GWP refrigerants is accelerated by the F-gas regulation revision (see section 5.14) then the ambition levels of Lot 1 and Lot 6 requirements in terms of product removal from the market would then be much more closely aligned. The proportion of low GWP qualifying chillers is almost certain to rise significantly as the impact of F-gas proceeds.

Note: Air conditioning chillers should be optimised for typically 600 annual hours (in some applications much more) and SEER performance; industrial process chillers should be optimised for typically 7.500 annual hours (sometimes much less) and SEPR. As a result, their design features *should* be different (but in the 2012 market often are not different).

Table 12 and Table 13 compare the benchmark levels for high performing products under the two sets of analysis.

[12] To convert Seasonal space cooling energy efficiency as a percentage to an efficiency ratio SEER, multiply by 2.5, then add three percentage points to efficiency requirements (control factor); and then for water cooled chillers only add a further five percentage points to compensate for water pumping on condenser side.

[13] The numerical differences between the scenario 1 and scenario 3 proposals for MEPS in the Lot 6 preparatory study vary according to the product type and capacity, but range between around 7% and 20% with a majority around 15% (see Lot 6 ecodesign preparatory study final report for Task 7, table 7-9 to table 7-12, pages 47-50, ARMINES, July 2012).

Table 8. Lot 6 chillers proposed efficiency requirements for Tier 1 (image of relevant table from Lot 6 documentation).

(Note that the '<' and the '>' symbols regarding GWP numbers should be reversed in these tables, i.e. right hand column contains requirements for low GWP refrigerants; the percentage symbol is missing from the top 2 rows; highlighting shows the products relevant in this analysis).

Cooling product	**seasonal space cooling energy efficiency**	
	GWP of refrigerant (kg $CO_{2eq.}$/100 yr)	
	GWP ≤ 675	GWP > 675
Air-cooled Chiller, Prated < 400 kW	157	141
Air-cooled Chiller, Prated ≥ 400 kW	173	156
Water-cooled Chiller, Prated < 400 kW	196%	176%
Water-cooled Chiller, Prated ≥ 400 kW	256%	230%
Fuel driven chiller	142%	128%
Electric air conditioner	181%	163%
Fuel driven air conditioner	167%	150%

Table 9. Lot 6 chillers proposed efficiency requirements for Tier 2 (image of relevant table from Lot 6 documentation).

(Note that the '<' and the '>' symbols regarding GWP numbers should be reversed in these tables, i.e. right hand column contains requirements for low GWP refrigerants; highlighting shows the products relevant in this analysis).

Cooling product	**seasonal space cooling energy efficiency**	
	GWP of refrigerant (kg $CO_{2eq.}$/100 yr)	
	GWP ≤ 675	GWP > 675
Air-cooled Chiller, Prated < 400 kW	161%	145%
Air-cooled Chiller, Prated ≥ 400 kW	185%	167%
Water-cooled Chiller, Prated < 400 kW	200%	180%
Water-cooled Chiller, Prated ≥ 400 kW	272%	245%
Fuel driven chiller	147%	132%
Electric air conditioner	189%	170%
Fuel driven air conditioner	177%	159%

Table 10. Lot 6 requirements as SEER values.

(Taken directly from Lot 6 preparatory study, Task 7 Table 7-9 to 7-12, p47-50, taking the net SEER MEPS values for scenario 3 (highest stringency, as adopted for the Lot 6 Impact Assessment); low GWP values are calculated for this table at 10% less than high GWP values).

	SEER Tier 1		**SEER Tier 2**	
	GWP >675	GWP <=675	GWP >675	GWP <=675
Air-cooled Chiller, Prated < 400 kW	4,0	3,6	4,1	3,7
Air-cooled Chiller, Prated > 400 kW	4,4	4,0	4,7	4,2
Water-cooled Chiller, Prated < 400 kW	5,1	4,6	5,2	4,7
Water-cooled Chiller, Prated > 400 kW	6,6	5,9	7,0	6,3

Table 11. Comparison of numerical values of Lot 6 SEER with Lot 1 SEPR.

	Tier 1				Tier 2			
	Lot 6 SEER (Table 10)	Lot 1 SEPR (Table 6)	Difference in numerical value	Lot 1 % higher than Lot 6	Lot 6 SEER	Lot 1 SEPR	Difference in numerical value	Lot 1 % higher than Lot 6
	GWP >675				GWP >675			
Air-cooled Chiller, Prated < 400 kW	4.0	4.5	0.5	13%	4.1	5.0	0.9	22%
Air-cooled Chiller, P_{rated} > 400 kW	4.4	5.0	0.6	14%	4.7	5.5	0.8	17%
Water-cooled Chiller, P_{rated} < 400 kW	5.1	6.5	1.4	27%	5.2	7.0	1.8	35%
Water-cooled Chiller, P_{rated} > 400 kW (>400kW and <1000kW for Lot 1)the	6.6	7.5	0.9	14%	7.0	8.0	1.0	14%
Water cooled > 1000 kW (Lot 1 only)	6.6	8.0	1.4	21%	7.0	8.5	1.5	21%

Table 12. Benchmark performance levels for chillers under Lot 6.

	Capacity range, kW	Benchmark seasonal space cooling energy efficiency level[14]	Benchmark net SEER level (high SEER from Lot 6 Prep study)[15], Equivalent to seasonal space cooling energy efficiency
Air cooled	<200 kW	209%	5.3
	>200 kW	225%	5.7
Water cooled	<200 kW	272%	7.0
	>200 kW	352%	9.0

[14] From Explanatory Memorandum...on ecodesign requirements for air heating products and cooling products (ENER Lot 21 central air heating products and ENTR lot 6 cooling products combined)', draft supplied by Martijn Van Elburg of VHK on 5 March 2013, Annex VII page 75.

[15] From Lot 6: Air-conditioning and ventilation systems, Contract No. ENTR / 2009/ 035/ LOT6/ SI2.549494, Air conditioning systems, Final report of Task 7, Armines, July 2012, Table 7-15, page 54 using the High Benchmark figures for net SEER.

Table 13. Benchmark performance level for chillers under lot 1 and showing percentage difference with Lot 6 SEER values.
(Note that capacity ranges do not directly correspond between Lot 1 and Lot 6 but the closest equivalent was taken)

	Capacity range, kW	Benchmark SEPR level Lot 1[16]	% higher than Lot 6 SEER benchmarks
Air cooled	<200 kW	6,5	23%
	>200 & <400 kW	8,0	40%
	>400 kW	8,0	40%
Water cooled	<200 kW	8,5	21%
	>200 & <400 kW	12,0	33%
	>400 & <1000 kW	12,5	39%
	>1000 kW	13,0	44%

5.14 Impact of F-Gas regulations

The preparatory study on the F-gas revision showed it was cost efficient to reduce GHG emissions by limiting the use of HFC refrigerants in chillers. Three types of chillers were considered (< 350 kW, larger than 350 kW except centrifugal, and centrifugal chillers)[17]. The main refrigerant options discussed in the report for chillers are hydrocarbons, ammonia and HFOs, being either flammable or toxic. Average products were modeled but not best efficiency products.

In the ENTR Lot 6 Air Conditioning and Ventilation Systems study, it was concluded it was probably feasible to ban HFC refrigerants with a GWP superior to 675 for stationary air conditioners by 2020 (with a reserve that safety standards for refrigerants should be adapted to authorize "mildly" flammable refrigerants to be used in Europe). This is in line with alternative refrigerants being studied by the industry[18], which are mainly mixtures of HFO (1234yf and ze) and of HFC. Many combinations are being tested with a number of credible alternatives with GWP lower than 675.

In November 2012, the Commission proposed a first F-gas regulation draft[19], in which chillers were excluded from the list of bans of HFC use. However, HFC in stationary air conditioners would be limited by the global limitation of the volume of HFC refrigerants put on the market, which is to be reduced to 21 % of the levels sold in 2008–11 by 2030. This proposal thus leaves 15 years to progressively adapt chillers to refrigerant fluids with lower GWP, thus encouraging the development of lower GWP alternatives. This is the result of a compromise with the industry, which clearly limits the cost of the transition for stationary air conditioners.

The F-gas proposal is now (April 2013) being discussed at the European parliament. Proposed amendments that have been released in the specialized press[20] imply that requirements might be made more stringent: HFC (without GWP thresholds) could be banned for stationary air conditioning and refrigeration applications in 2020 (and in 2027 for centrifugal chillers).

The ban of all HFCs means the retention of only pure HFOs, ammonia or hydrocarbons, thus greatly restricting the range of refrigerant options. This restricted range is likely to force the complete redesign of many product ranges and so a significant economic burden for manufacturers between 2013 and 2020. Outside of this highly restricted range, there might be cost effective refrigerant options with low GWP and including some HFCs.

[16] From Annex II, Analysis of data received from manufacturers and comparison with Eurovent database to derive proposed minimum requirements, Version of 17 February 2013, ARMINES, page 36.

[17] Preparatory study for a review of Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases.

[18] http://www.ahrinet.org/ahri+low_gwp+alternative+refrigerants+evaluation+program.aspx

[19] COM(2012) 643 - Proposal for a regulation of the European Parliament and of the Council on fluorinated greenhouse gases

[20] See for instance www.r744.com ; DRAFT REPORT on the proposal for a regulation of the European Parliament and of the Council on fluorinated greenhouse gases (COM(2012)0643 – C7-0370/2012 – 2012/0305(COD)) Committee on the Environment, Public Health and Food Safety Rapporteur: Bas Eickhout.

The setting of stringency levels explained in this report and its appendices for Tiers 1 and 2 for high temperature process chillers relies on continued availability of HFC chillers (R410A and R134a). If a 2020 ban on HFCs in stationary air conditioners is indeed taken forward, then it would probably become necessary to verify the technical and economical feasibility the proposed Tier 2 MEPS levels for high temperature process chillers, given the authorized refrigerant fluids at 2020, because of inevitable knock-on effects impacting the chiller market. This should be considered at regulatory review.

5.15 Other issues

5.15.1 GWP efficiency bonus

The bonus awarded to products using low GWP refrigerants under Lot 6 Air Conditioning and Ventilation Systems was justified on the basis that the direct impact of the refrigerant as a proportion of the total direct and indirect impact is typically significant. Thus carbon savings made by means of low GWP refrigerants more than offset, in terms of TEWI, the lower energy savings due to the bonus. However, also within Lot 6 the bonus is not applicable for products in heating mode since for a typical product in heating mode the indirect impacts (energy consumption) are proportionally much more important and the emphasis for optimum carbon impact must remain on the energy efficiency. Similarly, due to very high loading and annual usage hours, the emphasis for Lot 1 must remain on energy efficiency (i.e. SEPR) and no bonus for low GWP refrigerants is appropriate.

5.15.2 Consideration of a bonus for free-cooling systems

A free-cooling system, or thermo-syphon operation, allows cooling to be delivered without operation of the compressor when external ambient temperatures are sufficiently low. Thus cooling is achieved at very low energy consumption for certain times of year and under certain operational conditions. This could provide benefit, for example, for process applications often during autumn, winter and spring seasons. Typical air conditioning systems rarely operate during times when free cooling would be an option and so this is not considered under Lot 6 (although some air conditioning systems such as at hospitals will operate all year and so could benefit).

The issue of free cooling has been discussed within the CEN TC113 working group 7 (regarding EN14825), including whether free cooling should be included or not in the evaluation of a seasonal performance ratio. This was of particular interest to rooftop chiller manufacturers (rooftop and air handling units being natural free cooling products). The challenge for standards writing is that there are several means at building level to perform free cooling: via the air handling unit, a chiller with thermosyphon, chiller with supplementary air/liquid coil, supplementary dry cooler independent from the chiller and other options. Overall, the best free cooling option needs to be evaluated by the building / system designer using application-specific data. For this reason, free cooling was not included in the SEER metrics as an option.

The same applies to heat recovery, which is highly dependent on the specific site and simultaneity of cooling/heating loads (from zero to 100 % depending on the situations).

In both cases, the Lot 6 study advised regulators to require specific information on free cooling and heat recovery products so that building designers may properly design the building/system for a specific site. It is thus not feasible to define a meaningful ‘typical situation’ enabling a bonus to be calculated. For example, if a chiller is selected with integral thermosyphon based upon its SEPR, it may be that a chiller with poorer SEPR but adapted with a different free cooling option may give a better overall cooling performance/efficiency over the year for that application.

The conclusion is therefore to not include any bonus for free cooling systems, but to make sure that building designers in due course have the necessary data about how chillers with free cooling perform, in order to make the best choices. Therefore a mandate should be considered to ensure that this free cooling performance information requirement is developed and built into the appropriate harmonised standards.

5.15.3 Multifunction chillers

Daikin raised the question of how the regulation would deal with multifunction chillers, and provided product data on the Conveni product (an example system is shown in Figure 2). This shows a condensing unit connected to refrigeration units and to heating/cooling indoor units by refrigerants pipework. Functionally, it combines space heating, space cooling and refrigeration service in one unit, for example as used for small shops or convenience stores that require space heating in Winter and cooling in Summer, plus refrigeration of display cabinets. This particular product does not meet the definition of a chiller and need not be considered here (but may require due consideration under Lot 6), but it does illustrate a possible category of multi-functional products, some of which could be used in process heating/cooling applications.

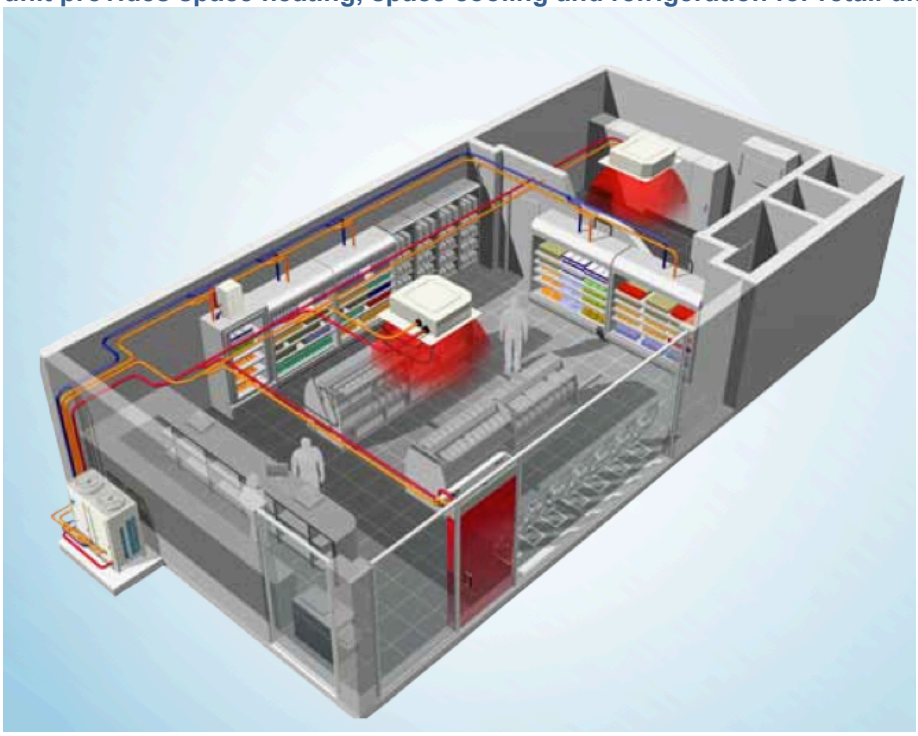
The only significant multi-functionality of relevance to high temperature process chillers is thought to be heat recovery. The performance of the chiller would not be significantly affected when heat recovery is not in operation.

It is understood that harmonised test methodologies do not currently cover such products but it is a growing issue for the HVAC&R sector. If the separate heating and cooling functions can be operated independently, then such products could be tested under conventional methods to be certified as compliant (and so not inadvertently excluded from the market), but this is unlikely to do justice to the energy savings potential of the technology and performance assessment (and regulatory requirements) could, in due course, take into account functional interaction and savings between modes.

At present, it is recommended that a suitable mandate be issued to begin development of appropriate test methods and performance data with a view to being included at a suitable future regulatory review. If such units for process applications were, for the interim, excluded from the regulation there is a risk that 'multi-functional' status could be used as a loophole to avoid requirements. This should also be discussed with DG ENER in the context of Lot 6 to ensure complementarity.

It is therefore recommended to include multi-functional chillers for process applications within scope of Lot 1 (chillers offering a heat recovery option, being the only multi functional product available at this time) with a requirement that their cooling function in isolation shall meet the cooling efficiency requirement. To do so, it is enough to mention chillers offering the heat recovery function in the scope product definition.

Figure 2. Example of a multi-functional chiller-heater system – the Daikin Conveni pack: One outdoor unit provides space heating, space cooling and refrigeration for retail display cabinets.



5.15.4 SEPR documentation updates

The JIEG worked on the explanatory documents and calculation tools for SEPR during January to March 2013; the update documents were made available on the consultation web site and should be transferred to the DG ENTR Lot 1 ecodesign web site as soon as is practicable.

5.15.5 Tolerances

ARMINES carried out a review of the tolerances suggested in Annex IV: *Verification procedure for market surveillance purposes* of the January 2012 working document for process chillers. Note that this is relevant to low, medium and high temperature chillers.

The conclusion was that allowed tolerances on the SEPR value could be limited to a maximum 6%, compared to 10% in the January 2012 document – and edits to the table are suggested as given in Table 14.

Table 14. Reproduction of Table 1 from Annex IV of the process chillers working document as published at January 2012, showing the proposed changes to tolerances.

Measured parameter	Verification tolerances
Cooling capacity (full load, +35°c ambient)	The measured value shall not be lower than the declared value by more than **5% *(was 10%)***
Power input (full load, +35°c ambient)	The measured value shall not be greater than the declared value by more than 5%
SEPR value	The measured value of SEPR at the declared capacity shall not be lower than the declared value by more than **6% *(was 10%)*** It shall not be lower than the minimum SEPR allowed in Annex 1 by **6% *(was 10%)***
Cooling capacity at reference points A, B, C, D	The measured value shall not be lower than the declared value by more than **5% *(was 10%)***
Power input at reference points A, B, C, D	The measured value shall not be greater than the declared value by more than **5% *(was 10%)***

6 Updates to Impact Assessment report for industrial process chillers

A final part of this work was to briefly review what changes this additional analysis on HT process chillers would make to the previously submitted Impact Assessment study report of October 2012. Aside from the substantially revised thresholds for energy performance, the main change is on the magnitude of savings that would be anticipated. Tait Consulting has carried out some *indicative* re-working of the models used in the original IA study to provide some context for the Commission when reviewing these revised proposals (this reports on modelling work not included under the project for CLASP). Tait Consulting has proposed Numbers and rationale for consideration and checking by the Lot 6 Air Conditioning and Ventilation Systems Impact Assessment contractor. These numbers suggest that the estimated energy savings at 2020 arising from HT chillers have risen from 3.2 TWh under previous (simplistic) assumptions, to 6.2 TWh under the revised proposals for HT chiller MEPS as detailed in this report. This could raise the savings potential of the original Lot 1 group of products from 12 TWh to 15 TWh at 2020. The difference arises almost exclusively from the more stringent MEPS levels for high temperature chillers, compared with the simplistic assumptions adopted for the impact analysis. Some key uncertainties underlie this estimate, including the estimation of average performance before and after MEPS. Assumptions of annual usage hours are identical and annual energy consumption by chiller market segment is very similar. Tier 1 was previously estimated to save around 3% per year of total stock consumption at 2020, and Tier 2 to save 7%; this revised analysis indicates that savings are around 4% for Tier 1 and 11% for Tier 2. These indicative results have been provided to DG ENTR and to the Lot 6 IA contractor but are not included with this report as they have not been verified.

7 List of issues suggested for discussion and resolution with DG ENER

Several points came to light that could usefully be reviewed by DG ENTR and/or DG ENER as appropriate to ensure complementarity of Lot 1 and Lot 6 requirements, in addition to finding the most appropriate home for the HT process chiller requirements:

a) Approach to defining the basic chiller products – ensuring technical compatibility even if not using the same approach.

b) Timing of requirements coming into force. Considerations include allowing time for SMEs to adapt; coincidence of Lot 6 and Lot 1 timing; timing with respect to LT and MT chiller requirements; entering into force in December or January.

c) Desirability of comparable levels of stringency, in particular to minimise use of selective attribution of the category of any particular chiller based on finding the most lenient requirements, rather than on real intended use.

d) Wording of mandatory declaration of intended use and technical documentation, with associated definitions being suitably proscriptive to minimise potential for abuse.

e) Possibility of adopting the revised definitions for temperature ranges.

f) Acceptability of differences between Lot 1 and Lot 6 regarding sorption chillers, maximum cooling capacity level, noise requirements and bonus for low GWP refrigerants.

g) Impact of changes to F-gas regulation regarding phase-out date for HFC refrigerants and the possible chiller exemption.

h) Coverage of multi-function chillers.

i) Exemption until a given date for chillers sold as identical replacements for previous chillers.

j) Tolerances to be allowed for market surveillance.

8 Conclusions and recommendations for high temperature process chillers

1. Proposals for minimum seasonal performance requirements (SEPR) for high-temperature chillers were derived based on product performance data supplied by manufacturers and cross compared with a substantial dataset provided by Eurovent. Performance thresholds were set in two tiers that aimed to remove 40% of the 2012 market at Tier 1 followed by 60% of the 2012 market at Tier 2. Consultation feedback resulted in a recommendation to relax only one of the SEPR values (that for water-cooled chillers above 1000 kW capacity at Tier 2). Proposed requirements are summarised in Table 15.

Table 15. Tier 1 and Tier 2 mandatory minimum requirements as proposed for adoption following consultation feedback (numbers are identical to those in Table 6).

	Capacity range, kW	Tier 1 minimum performance SEPR	Tier 2 minimum performance SEPR
Air cooled	<400 kW	4,5	5,0
	>400 kW	5,0	5,5
Water cooled	<400 kW	6,5	7,0
	>400 & <1000 kW	7,5	8,0
	>1000 kW	8,0	8,5

2. The proposed requirements for air-cooled chillers did not raise particular concern amongst stakeholders. Stakeholders felt that those for water-cooled chillers, particularly the larger ones, were particularly demanding and would require significant changes to the product range offered. However, requirements are economically and technically justifiable and do allow a range of good technologies to remain on the market. 90% of respondents agreed that they would continue to be an adequate supply of products that meet the requirements, although product costs would rise.

3. Benchmark levels of performance have been proposed and endorsed by stakeholder feedback, representing the best available technologies at 2012. These are reproduced in Table 16.

Table 16. High-temperature industrial process chiller benchmark performance levels, as proposed and endorsed in the March 2013 consultation for high-temperature process chillers.

	Capacity range, kW	Benchmark SEPR level
Air cooled	<200 kW	6,5
	>200 & <400 kW	8,0
	>400 kW	8,0
Water cooled	<200 kW	8,5
	>200 & <400 kW	12,0
	>400 & <1000 kW	12,5
	>1000 kW	13,0

4. No evidence has been identified suggesting any particular geographical skew to the impact of the regulation. SMEs in many countries would find the requirements challenging with substantial alteration necessary to the engineering of products.

5. Regarding the scope of the regulation, it was concluded that evaporative condensing chillers should continue to be excluded from the regulation until harmonised methodologies are in place to evaluate performance. Similarly, sorption technologies should continue to be excluded unless and until further evidence is available to define performance requirements appropriately.

6. Whilst half of stakeholder responses noted problems with the SEPR methodology as proposed, no substantive arguments were presented to merit changes. Some clarifications and improvements to the SEPR documentation have been made by the JIEG but none that materially affected the proposed requirements.

7. A preference has been expressed that Tiers should come into effect in December or January of any given year for convenience of marketing materials. There was no dispute of the initial two-year period between regulation coming into force and Tier 1 taking effect. Some feedback requested a longer period than two years before Tier 2 takes effect and this would be consistent with allowing SME manufacturers adequate time to react. A final decision on planning of Tiers must take into account also the timing under Lot 6, with a preference expressed that requirements should coincide.

8. Stakeholder feedback and discussions with the JIEG resulted in a proposed definition for high-temperature process chillers as follows, which should be further considered in consultation with DG ENER for compatibility with the definitions used in Lot 6:

> *"A factory-built piece of refrigeration equipment which is primarily intended to cool down and maintain the temperature of a liquid (water or brine) using a vapour compression cycle within a refrigeration process, including at least a compressor and an evaporator within a "package". This is limited to chillers intended for process cooling applications, being those that are generally designed to operate all year round, including in ambient temperatures below approximately +10°C, and optimised for efficient operation at 80% loading and above and for which the load is generally independent of ambient conditions"*

9. The definition proposed for air-conditioning chillers under Lot 6 is very different in its approach to making the definition, but no substantive technical differences have been identified.

10. A member of the JIEG proposed modified definitions for the temperature ranges under Lot 1. The reference temperatures are the same (including the alteration to use +7°C for high-temperature), but the operating temperature ranges are symmetrically set around the reference temperatures and do not overlap. The proposed definitions are as follows and proposed for use in the regulation, subject to final checks by JIEG:

- Reference point for LT-industrial process Chillers (-25°C) being valid for application temperature range $t_{LT} \leq$-16°C
- Reference point for MT-industrial process Chillers (-8°C) being valid for application temperature range -16°C > $t_{MT} \leq$ 0°C
- Reference point for HT-industrial process Chillers (+7°C) being valid for application temperature range t_{HT} > 0°C

11. Factors considered so far suggest no overwhelming rationale regarding the grouping of chillers under the regulations, but there is a logical preference to group high temperature process chillers with air conditioning chillers under the same regulation and, if necessary, separately to low and medium temperature chillers.

12. It appears legally acceptable (according to the Commission's Blue Guide) for all high-temperature chillers to be within the scope of a Lot 6 regulation (that would not require any statement intended purpose) and that a subset of those chillers (the process chillers) would be subject to more specific requirements that could be in a separate regulation if necessary.

13. In terms of compatibility, several material differences in approach have been identified between Lot 6 and Lot 1 according to the March 2013 working draft of the Lot 6 proposals:

    a. The most significant difference is regarding the estimated proportion of 2012 market that would be removed by the proposed tiers: According to the preparatory study, the current Lot 6 proposals equate to banning 90% of the 2012 market at Tier 1 and 95% at Tier 2. Whereas the Lot 1 proposals target 40% at Tier 1 and 60% at Tier 2. Note that the technology options applicable are similar in both of the current proposals, i.e. the technical stringency in terms of the engineering involved is currently very similar. The stakeholder consultation process should be monitored carefully for changes in the relative stringency of requirements. Similar levels of stringency between Lot 1 and Lot 6 would be consistent with minimising potential for exploitation by manufacturers by deeming products to be under the more lenient requirement.

    b. There is a slight mismatch in the capacity range of chillers included under Lot 6 versus Lot 1. Lot 1 has no exclusions by capacity; Lot 6 is only up to 2 MW. In practice, Lot 1 is only limited by the statement that chillers assembled on site are excluded (which tend to be the very largest), i.e. they must be factory made. No change is suggested to be necessary to this.

    c. Lot 1 excludes sorption chillers and evaporative condensers, whereas these are included in Lot 6. It is proposed to maintain this situation.

    d. The metrics used for energy performance are substantially different and not comparable between chillers under Lot 6 (seasonal space cooling energy efficiency) and Lot 1 (SEPR). These differences are appropriate.

14. Regarding the impact of proposed F-gas regulation, the setting of stringency levels explained in this report and its appendices for Tiers 1 and 2 for high temperature process chillers relies on continued availability of chillers using HFC refrigerants R410A and R134a. If changes are made to the proposed F-gas regulation that result in, for example, a 2020 ban on HFCs in stationary air conditioners, then it would probably become necessary to verify the technical and economical feasibility the proposed Tier 2 MEPS levels for high temperature process chillers, given the resulting authorized refrigerant fluids at 2020, because of inevitable knock-on effects impacting the chiller market.

15. No evidence has been identified to support inclusion of a GWP bonus for high-temperature process chillers. (A 10% lower requirement is set under Lot 6 for chillers with refrigerant GWP less than 675).

16. Consideration was given to whether a bonus should be allowed for free cooling systems, concluding that this was not justified, but a mandate should be considered to ensure that free cooling performance information is developed and built into the appropriate harmonised standards.

17. It is suggested that multifunction chillers (meaning those with heat recovery) should be mentioned in the scope section as being included for operation in their normal cooling mode.

18. Proposals are provided to reduce the size of tolerances quoted in the market surveillance annex to the regulation as quoted in the January 2012 working document (relevant to LT, MT and HT).

Part 2: Walk in cold rooms

9 Background and overview for walk in cold rooms

Walk in cold rooms are the second of the five product groups under Lot 1. The 2012 impact assessment study estimated an energy consumption of 18 TWh for the sector but only an indicative 4% savings (0.8 TWh) are accessible through the currently feasible measures on insulation U-value. These are based on the Preparatory study findings that are the only available source, and estimates appear reasonable. However, even on setting minimum U-values, there are issues to be addressed including the level of stringency that is feasible, given clear differences in typical current practice of southern Europe compared to northern Europe; whether a form of energy labeling for some panel types may be appropriate to help inform users; and in particular who in the supply chain should take on responsibility for ecodesign compliance. This modest additional piece of consultation aimed to address these main points and explore possible routes forward for walk in cold rooms through ecodesign regulation.

10 Project team

The work on walk in cold rooms was carried out on behalf of CLASP Europe by Jeremy Tait of Tait Consulting Limited. Amongst other relevant experience, Tait Consulting was able to bring to bear its insight and data from carrying out the Lot 1 impact assessment study for DG ENTR between February and October 2012 that included walk in cold rooms.

11 Overview of work carried out

The Commission hosted an industry consultation meeting on 13 December 2012 to address a range of issues regarding the regulation. Tait Consulting on behalf of CLASP provided preparatory input and management of that meeting, plus some follow up work on remaining issues, including a review of the Commission's Blue Guide regarding responsibility for compliance amongst supply chain players.

12 Key issues identified for consultation

The 2012 Impact Assessment study report for walk in cold rooms discussed many of the challenging issues associated with setting ecodesign requirements for these products. The key issues remaining at December 2012 are described in Annex 8 and these formed the basis of discussions on 13 December 2012 in Brussels with manufacturers and some other stakeholders. These are in summary:

i. Scope and aims of the proposed harmonised standard to support measures for U-value of the insulated enclosure.

ii. Insulation panel U-value stringency levels

iii. Who takes eco-design responsibility?

iv. Raising the quality of installation

v. Specific requirements for doors, joints and air infiltration

vi. Market development situation for blowing agents

13 Consultation results

The details of discussions at the 13 December 2012 meeting are described in Annex 9. Key points were as follows:

a) CEN TC44 working group 4 has held its first meeting towards developing a new harmonised test methodology for walk in cold rooms on November 16, 2012. The harmonised standard will address calculation and test methods (when possible) of thermal performance of the insulated envelope only, including thermal performance of panels, doors, construction elements such as corner joints and thermal bridges. It will not address any electricity consuming components. The concept is to provide cold room designers with calculation methods for the steady state thermal performance of their design, including rules of thumb to estimate performance of factory made joints as compared to on site constructed joints etc. Additional, separate standard(s) will have to address energy consumption of refrigeration equipment and electrical ancillaries which have not yet been initiated or planned but will fall under TC44 aiming to deliver by 2016. The need was noted to coordinate between TC44 and TC 128, TC113, TC89 and TC182, particularly regarding system performance. The CEN coordination group on eco-design measures should be involved in this process. The French standard NFP 75 401-1 (AFNOR Norme, October 2001, also known as DTU 45.1) was confirmed as a useful example of a standard aimed at raising the performance of cold rooms.

b) Regulation of U-value was acknowledged to be a pragmatic but not ideal interim metric, but aiming to positively influence energy performance until a suitable overall performance metric is in place. It was noted that maximum thermal transmission rates for insulated panels and floor in the form of maximum heat flux per square metre (W/m^2) was in use in France and Spain and could be considered as an alternative performance metric for EU regulation instead of U-value, although research would be needed to verify and develop this. U-value is a more straightforward property of a panel to determine and label; thermal flux changes with temperature differential, although it can be calculated for any given combination of panel and application. The potential need for rating according to the different climatic zones of Europe was briefly discussed but dismissed since the products under the potential regulation would most likely be only those constructed within other buildings. The consensus was that heat flux is a technically more satisfactory option but U-value should not be ruled out if heat flux would be too complex or take too long to develop.

c) Several delegates suggested that it might be appropriate to set different requirements for large and small cold rooms and thereby 'shelter' the smaller prefabricated market from stringent short-term panel-only requirements. This reinforced the need to consider whether separate requirements should be set for cold rooms with less than 100 m^3 internal volume and those with over 100 m^3. EPAQ re-asserted a suggestion they and a UK Institute of Refrigeration respondent made during consultation in March 2012 that the eco-design regulation should only apply to cold rooms of less than 100 m^3. (Any such decision should be based upon the technical feasibility and appropriateness of any performance requirements - this was discussed in the Lot 1 IA study report).

d) A harmonised standard on good practice for installation of walk in cold rooms was agreed as a useful and necessary first step towards raising the quality of installation work. This could be initiated via a mandate and the installation code/standard would be different for very large cold rooms compared to very small cold rooms. An industry challenge would be to establish a system for qualification and certification of suppliers/installers. A requirement that only qualified personnel are able to carry out the installation job could be considered for the future. EPAQ reported on a cooperative initiative with IFPS on developing good practice codes for installation of panels (in many applications, not just cold rooms) that may provide a useful precedent from which to build a specific initiative for cold rooms.

e) Energy labelling associated with thermal performance of panels was rejected through discussion as having limited benefit: there is no 'information failure' to be addressed. Existing test methodologies are perfectly adequate for designers / specifiers and end users rarely need to consider performance of panels alone.

f) The group agreed that stringency of thermal efficiency of panels should be set bearing in mind the risk of pushing prefabricated cold rooms and/or manufacturers of discontinuous panels out of the market at this interim stage: pure

performance of these panel components may be inferior to that of continuously produced panels (which can more easily and economically be made thicker) but when at a later stage metrics for the thermal performance of the whole envelope are introduced, the overall performance of prefabricated rooms with discontinuous panels may prove better than that from customised construction (mostly due to superior fit and performance of factory-made joints). There was consensus that a single tier of requirements for thermal performance of panels (set at the level previously assigned to the second tier) would be preferable to two tiers and would avoid the risk of backsliding under a less stringent first tier. It was agreed that previous impact assessment study judgements that Northern European widely used 'good practice' means 100mm for medium temperature and 150 mm for low temperature may not hold true for smaller cold rooms. (Note: This supports the later suggestion for splitting the requirements into small and medium stores but further work is desirable on the economics of insulation effectiveness to support any final decision, including the influence of typical door openings).

14 Taking responsibility in the supply chain

This item was discussed on 13 December 2012, but subsequent research from the Commission's Blue Guide[21] provided more useful insight as interpreted by the author (expert legal opinion should be employed to verify these initial opinions). This is described in Annex 10 but can be summarised as:

- Prefabricated WICR kits will be 'placed on the market'; customised cold rooms will be 'put into service'. The eco-design regulation must therefore be worded to also cover 'putting into service'.
- The person responsible is he who puts the cold room into service under his own name (or 'on his own behalf'), thus taking on the responsibilities of a 'manufacturer'. Those responsibilities remain his, even if some or all work is subcontracted and he is obliged to understand both the design and construction of the cold room to take responsibility for compliance.
- Technical documentation must be drawn up by 'the person in whose name the cold room is put into service' and that person must operate a quality control system. The documentation should contain information to demonstrate the conformity of the product to the applicable requirements.
- The responsibilities of the assembler and installer will be limited to taking necessary measures that the cold room still complies with the requirements as a result of their role (unless it is being put into service in their name, in which case they take full responsibility).

15 Conclusions and recommendations for WICR

This work was not able to resolve all of the key issues facing this ecodesign regulation, but progress was made in identifying possible routes forward and in refining understanding of priorities and options. The main conclusions and recommendations are:

1. Further planning work between the Commission and TC44 WG4 is required to clarify what additional harmonised standards are required to establish full system performance metrics and test/calculation methodologies for cold rooms. The CEN coordination group on eco-design measures should take a lead to ensure full coordination between the many relevant standards committees.

[21] Guide to the implementation of directives based on the New Approach and the Global Approach, 2000.

2. An alternative metric of maximum thermal transmission rates for insulated panels and floor in the form of maximum heat flux per square metre (W/m^2) should be investigated as potentially a more satisfactory option, but U-value should not be ruled out if heat flux would be too complex or take too long to develop.

3. A final decision is required on whether the eco-design regulation should only apply to cold rooms of less than 100 m^3, but if larger rooms are kept within scope then different thresholds and possibly different other requirements would be appropriate.

4. A harmonised standard on good practice for installation of walk in cold rooms is a necessary first step towards raising the quality of installation work and a mandate should be drafted to cover this.

5. Energy labelling of panels (such as A to G) is not appropriate for this market.

6. During any initial stage of setting thermal efficiency limits for panels, thresholds should be set bearing in mind the risk of pushing prefabricated cold rooms and/or manufacturers of discontinuous panels out of the market at that interim stage. This is because the thermal performance of a prefabricated enclosure (mostly using discontinuous panels) is likely to be superior to that of continuous panels cut and joined on site.

7. The eco-design regulation must be worded to cover both 'placing on the market' (to cover prefabricated kits) and ‘putting into service’ (to cover customised cold rooms).

8. Evidence reviewed so far indicates that the person in the supply chain with ecodesign responsibility for a customised (built on site) cold room is he who puts the cold room into service under his own name (or ‘on his own behalf’), thus taking on the responsibilities of a ‘manufacturer’. Those responsibilities remain his, even if some or all work is subcontracted and he is obliged to understand both the design and construction of the cold room to take responsibility for compliance. Technical documentation must be drawn up by that person, who must operate a quality control system. The documentation should contain information to demonstrate the conformity of the product to the applicable requirements. This is our initial opinion; legal advice should be employed to verify this point.

9. The responsibilities of the assembler and installer will be limited to taking necessary measures that the cold room still complies with the requirements as a result of their role (unless it is being put into service in their name, in which case they take full responsibility). Again, this is our initial opinion; legal advice should be employed to verify this point.

Annexes

Annex 1: March 2013 consultation document, summary of supporting evidence ('Annex 3' to the consultation documents of March 2013)

Annex 2: Analysis of data received from manufacturers and comparison with Eurovent database to derive proposed minimum requirements, Version of 17 February 2013, ARMINES'

Annex 3: Discussion of eco-design measures for high temperature chillers, Meeting notes for Friday 14 December 2012

Annex 4: Stakeholder consultation questionnaire on possible Ecodesign Requirements for DG ENTR Lot 1 Professional Refrigeration: High temperature industrial process Chillers

Annex 5: Discussion of evidence behind proposed eco-design measures for high temperature chillers, and any consultation queries, Meeting notes for Tuesday 12 March 2013

Annex 6: Summary of consultation returns for the stakeholder consultation on possible Ecodesign Requirements for DG ENTR Lot 1 Professional Refrigeration: High temperature industrial process Chillers

Annex 7: Telephone conference call discussion with Climaveneta (Italy) regarding proposed ecodesign requirements, Conference call notes for Monday 25 March 2013

Annex 8: Agenda and key issues summary for walk in cold rooms meeting of 13 December 2012

Annex 9: Meeting notes on walk in cold rooms for 13 December 2012

Annex 10: Notes arising from the 'Blue Guide' regarding ecodesign responsibilities in the supply chain for walk in cold rooms

Annex 11: Transitional method for determination of the SEPR (Seasonal Energy Performance Ratio) for chillers used for refrigeration and industrial applications (version of 1 May 2013)