

Rationalising the Tower of Babel: International Performance Specifications for CFLs

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Abstract

At Right Light 6 in Shanghai, June 2005, 80 delegates participated in the launch of the International CFL Harmonisation Initiative, with the aim of encourage the production of high quality, low cost CFLs worldwide. One of the stated objectives of this initiative is to make proposals regarding the global harmonisation of performance specifications. This paper charts the progress made on this issue and presents the participant's current thinking.

Compact Fluorescent Lamps (CFLs) have become a global commodity, and approximately 90% are now produced in China. However, this centralisation of manufacture has not been followed by a similar rationalisation of technical specifications. At present, are at least 38 different performance specifications and labelling requirements for CFLs in countries around the globe. Such a diversity of local requirements means that manufacturers are unable to maximise costs savings from large scale production, and this results in more expensive CFLs for consumers, as well as and higher costs for jurisdictions and programmes attempting to stimulate demand for these products.

This paper examines the most appropriate performance criteria that should be measured to enable the performance of CFLs to be rated and make proposals for a suite of *voluntary* performance thresholds for groups of these criteria that could be adopted by a range of market stakeholders across a number of jurisdictions.

Rationalising the Tower of Babel: International Performance Specifications for CFLs

The performance characteristics for compact fluorescent lamps (CFLs) which are important to consumers include more than just energy efficiency, and for this reason most programmes (MEPS, Labeling and Certification, Bulk Procurement, etc) include a set of criteria covering a range of performance characteristics (a performance specification) which must be met by a lamp to comply/qualify. Lamp life, lumen maintenance and start-up time are examples of these 'other' performance characteristics which are typically covered by specifications [LBNL 2005].

As documented elsewhere [du Pont 2005], there are now at least 38 energy efficiency programmes for CFLs around the world that have been developed over recent years. Some of these programs cover different performance characteristics, with varying thresholds for each characteristic; so that there now exist a large number of performance standards, many of which are similar but not exactly the same.

As the market for CFLs has expanded to become truly global, the presence of such a proliferation of specifications complicates the compliance tasks for CFL manufacturers and increases the final costs to consumers (as manufacturers are unable to capitalise on economies of scale and are have to cover the cost of compliance across the differing markets). A recent survey undertaken in seven Asia-Pacific countries and amongst 36 CFL manufacturers concluded that there was strong support for harmonization, and this would streamline the entire industry and result in significant benefits on cost structure [du Pont 2005].

While it is recognised that any jurisdiction has the right to set individual performance specifications, the benefits of reducing the costs of CFLs to consumers without sacrificing quality (and thereby increased penetration rates) is a compelling reason for rationalizing the number of different specifications. Further, it is likely that enforcement costs for authorities could also be reduced, or at least targeted more effectively.

Having a small number of clearly identified sets of performance specifications available to the international community may also appeal to jurisdictions which do not current run programmes to promote CFLs, and encourage them to launch new initiatives based on the limited number of

established performance specifications due to the associated reduced costs/skills required to establish a programme.

At the Shanghai launch of the International CFL Initiative, it was agreed that a working group should examine performance specifications for CFLs:

“Through 2005 and part of 2006, develop a number of performance specifications for self-ballasted CFLs of increasing stringency. This framework or scale facilitates any interested party (government, industry-operated voluntary scheme or other proponent) to select the performance requirements that best fit their particular needs (potentially as minimum performance requirements or to indicate better or even best-available technology). Any CFL scheme would still determine if and when any of these performance specifications should operate.” [ICHI 2005]

This paper discusses what is involved in setting performance specifications, highlights issues which require resolution and presents draft specifications for consideration.

Outline of proposal

Following the initial meeting in Shanghai, the working group prepared a discussion document in September 2005 (<http://www.apec-esis.org/cfl/www/index.php?pagelid=1050>) which outlined the conceptual framework for the harmonization of performance specifications, and highlighted issues to be resolved. This paper was presented at the second meeting in Seoul, Korea in November 2005. A performance specification comprises a set of thresholds for identified criteria. In view of the range of potential uses for performance specifications, such as minimum energy performance regulations, procurement policies, endorsement labeling, etc, and the range of users (from the most developed to newly emerging economies), delegates at the second meeting in Korea agreed that more than one set of performance specifications will be required.

Such a tiered performance system also enhances the capability of nations wanting to use a mix of both minimum performance standards and higher efficiency requirements for product endorsement, or a stepped labeling system.

The task of this working group has therefore been to propose several sets of specifications, which represent appropriately increasing levels of stringency. These can be conceived as follows:

- The lowest specification may represent a level suitable for adoption as a mandatory minimum performance threshold in the current market.
- A intermediate level may represent the requirements of an endorsement programme which aims to have a high number of compliant products.
- The most stringent level might be set to represent current best practice, met by only a small proportion of current models.

Further improvements in technology over time may warrant a higher stringency level than currently envisaged, and the system should facilitate the capacity to incorporate improvements in technologies into existing or new tiers over time.

It is intended that once these sets of performance specifications are agreed upon, they would be available for adoption by organisations responsible for deciding the specifications for individual energy efficiency programs anywhere in the world. The actual adoption of these performance specifications by an individual programme would be voluntary as outlined in the section below.

How will the rationalization of specifications occur?

The International CFL Harmonisation Initiative has no intention or ability to impose new specifications on jurisdictions who currently run energy efficiency programmes for CFLs, or on those that wish to do so in the future. The selection of specifications is entirely the responsibility of each individual jurisdiction, and the international harmonization project will not alter that in any way.

However, most energy efficiency programs for CFLs periodically revise their specifications every few years, and at this point there is the opportunity for each jurisdiction to consider whether to adopt one of the sets of internationally agreed performance specifications being proposed; thus reaping the cost benefits of mass produced products rather than the cost penalties of products produced for a small number of markets only.

Similarly, when a new programme is being established, the proponents could choose the set of internationally agreed specifications that best meets its requirements.

Core criteria

The range of criteria included in performance specifications are generally designed to address the concerns of consumers, who typically compare the performance of CFLs with that of incandescent lamps. For example, issues such as lamp lifetime are important to a consumers' assessment of value, since the higher capital cost of a CFL is only repaid by energy savings if longer lifetime claims are met.

Most existing programs include the following criteria in their performance specifications:

- Efficiency level
- Lumen Maintenance
- Lifetime
- Start-up and Run-up time
- Colour rendering
- Colour temperature

Some programmes also specify:

- Power Factor
- Starting temperature
- Cold start ability
- Lifetime under rapid cycle stress
- Variation of luminous flux with lamp orientation
- Marking requirements re: GLS equivalence, Correlated colour temperature and Lifetime (hours vs years)
- Mercury content of lamps
- Light distribution
- Noise

In addition, all programmes have requirements with respect to electromagnetic disturbance (EMC), total harmonic disturbance and safety requirements, however these are typically specified in safety standards or other national or international regulations. These may also be referenced in CFL programme specifications.

In discussions regarding the development of the test method a further criteria, called the "early failure rate", was considered to be a useful indicator and a means of differentiating products. Specifically, this shows the number of lamps from a sample which fail within the first 1,000 hours is also increasingly being considered. This 'new' criteria has been added to the list of potential criteria. In order to meet the objective of rationalizing the number of different performance specifications, the principle adopted is that for each tier there should be a set of 'core' criteria for which performance specifications are identified. This would enable any jurisdiction to add further criteria as required, on top of this list of core criteria.

The recommended approach for this project is that the following listing should form the core criteria to be included in harmonized performance specifications.

- Efficiency level
- Lumen maintenance
- Lifetime
- Early failure rate
- Start-up and Run-up time
- Colour rendering
- Colour temperature
- Power factor
- Mercury content of lamps

It should be noted that although general marking requirements eg. GLS equivalence, Colour temperature and Lifetime (hours vs years) were not considered as core criteria, some marking proposals have been developed as part of the compliance framework, and are considered core criteria. Further details of this proposal are available from the website: <http://www.apec-esis.org/cf> With respect to criteria relating to a rapid cycle stress test, this is not widely adopted, and where it is, there are differences between the cycle employed by different national programs. The major rationale for the rapid cycle criteria is that there is evidence that some users switch on and off their CFLs with a greater frequency than that used in current test method, and this behaviour has an impact on the

lamp lifetime. However, user behaviour differs widely depending upon a range of factors including geographical location, and hence this is a difficult issue to address internationally. Therefore at this stage it is not proposed that this forms one of the core criteria. Nevertheless, if there can be agreement that the current switching cycle does not generally reflect common practice, one future option is for the general lifetime tests to adopt a more frequent switching cycle, which may then avoid the need for the further rapid cycle test.

Electricity supply conditions

Currently CFLs are manufactured to operate at the voltage/frequency combinations in the target market, eg 240v/50Hz in EU, 110v/60Hz in North America, etc. While it is technically feasible to produce lamps which operate at all common voltage/frequency combination, this is not common practice.

It is likely that some of the performance characteristics of identical lamps would vary slightly under different electricity supply conditions (efficacy, for example). In other words, it may be technically more difficult to achieve a higher lamp specification for one market than another.

This raises the issue of whether the performance specifications need to be different for each voltage/frequency combination.

However, since the extent to which efficacy (and other performance aspects such as lifetime) vary with voltage/frequency for CFLs is not well known, it would be difficult to quantify equivalent performance requirements for each market. Further, considering that lamps currently meet high specifications in both Europe and the US, it is likely that the variations are in fact quite small. In any case, since the intention is to have several sets of performance specifications, it is still possible for a 240/50Hz country to use a different set of specifications to those adopted in the 115/60Hz country, this largely negates the need for equivalent specifications. Hence, it is currently proposed that there should be a single set of performance specifications which cover all voltage/frequency combinations.

Setting performance requirements

Table 1 below illustrates how the specifications will be set: for each 'Tier' there will be a defined minimum performance requirement for each of the 'core' criteria.

Table 1: Illustration of Performance Specifications

Criteria	Minimum Performance Requirements					
	Efficacy	Lifetime	Run-up time	Colour rendering	Mercury content	Other criteria
Tier 1	A ₁	B ₁	C ₁	D ₁	E ₁	F ₁
Tier 2	A ₂	B ₂	C ₂	D ₂	E ₂	F ₂

Overall, the requirements for Tier 2 will be more stringent than for Tier 1, however for some individual criteria the specifications may be the same. For example, A₂ and E₂ may be more stringent than A₁ and E₁ (efficacy and mercury content), although D₂ and D₁ (colour rendering) may have the same specification.

There has been considerable discussion on the number of levels which should be proposed, balancing the benefits of simplicity with providing sufficient delineation in the marketplace. Participants at the second International CFL Harmonisation workshop in Korea (November 2005) decided to proceed on the basis that it is possible to conceive of there being three levels which would serve the majority of purposes and which we could aspire to. In general the three levels are characterized as:

Tier 1: A mandatory minimum performance level

Tier 2: An endorsement label or procurement programme in a developing country

Tier 3: An endorsement label for the best products available currently

Considerable investment has been made by programme designers and manufacturers in the specifications used by existing programs, including those currently under revision. The intention of these proposed tiers is not to immediately supersede specification of existing programmes, but to provide a target to move towards over a period of time as programs are revised and updated.

In April 2006, at Light and Build Fair in Frankfurt, an initial set of draft performance criteria in three tiers was presented to a range of stakeholders, in particular European lighting manufacturers and

suppliers. This was also sent to selected interested parties not present in Frankfurt and posted on the public website in order to stimulate comments.

In establishing these performance specifications, the aim is to encourage the development of CFLs which have appropriate performance characteristics for their application, and which can be manufactured at the lowest cost. This requires the matching of consumer and technical requirements: a task which is complicated by the interrelationship between some of the performance criteria.

As a result of the comments received, some changes to that initial draft were made, and the current proposal is shown in Table 2 [ICHI 2006]. It should be noted that these specifications are still subject to discussion and agreement by the international community, however it is intended that these should be finalized by early 2007.

Table 2: Draft specification for bare bulb CFLs:

	Tier 1		Tier 2		Tier 3	
Starting Time	2.5 seconds		1.5 seconds		1.0 seconds	
Run-up Time	180 seconds		120 seconds		60 seconds (maybe longer for amalgam types)	
Initial Efficacy(without cover)	Input power(W)	Initial Luminous Efficacy	Input power(W)	Initial Luminous Efficacy	Input power(W)	Initial Luminous Efficacy
	<15 W:	≥ 45	<15 W:	≥ 45		Correlated Color Temperature (CCT)
	≥15 W	≥ 55	≥15 W	≥ 55		6500K,5000K 4000K,3500K,3000K,2700K
					≥ 5 to <10	46 50
					≥ 10 to <15	52 55
					≥ 15 to <25	57 60
					≥ 25 to < 60	62 65
Lumen Maintenance (2000 hours)	80%		80%		88%	
Premature Lamp Failure Rate (1000 hours)	≤ 5%		≤ 5%		≤ 5%	
Lifetime	Min 4000		Min 6000		Min 8000	
Power Factor	0.5		0.5		0.9	
Colour Appearance	Lamps must be marketed as one of the following: 2700K, 3000K, 3500K, 4100K, 5000K, or 6500K.	The color tolerance shall be within 5SDCM from the target values	Lamps must be marketed as one of the following: 2700K, 3000K, 3500K, 4100K, 5000K, or 6500K.	The color tolerance shall be within 5SDCM from the target values	Lamps must be marketed as one of the following: 2700K, 3000K, 3500K, 4100K, 5000K, or 6500K.	≥ 90% of sample must fall within 7-step ANSI MacAdam ellipse for that color temperature.
Colour Rendering Index	CRI > 75		CRI > 80		CRI > 80	
Maximum Mercury Content	10mg/lamp		5mg/lamp		5mg/lamp	
EMC	As per local requirements		As per local requirements		As per local requirements	
Safety	As per local requirements		As per local requirements		As per local requirements	

Transitional Arrangements

While some countries considering adopting specification for the first time may be able to adopt the one of the agreed international specifications imminently, it is recognised that this is impractical for many existing programmes. However, the purpose of discussing these now is to agree levels which individual programs could move towards over their next revision cycle.

In order to see how some of the key current programs fit with these proposals, several of commentators have requested that the number of tiers should be expanded. The organizers have therefore suggested that there should be additional tiers, up to six for existing programme specifications, and the three new specifications. These are shown in diagrammatic form in Table 3.

Table 3: Conceptual presentation of nine performance tiers

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6	Tier 7	Tier 8	Tier 9
Efficacy	Existing specification E1	Existing specification E2	New Specification N1	Existing specification E3	Existing specification E4	New specification N2	Existing specification E5	Existing specification E6	New specification N3
Lumen maintenance									
Lifetime									
Early failure rate									
Start-up and Run-up time									
Colour rendering & colour temperature									
Power factor									
Mercury content									
Lamp marking requirements									

It should be noted that when considering this number of specifications it is more difficult to rank them **overall** in terms of the degree of stringency, as some criteria may be more stringent in one specification than the other, but the reverse situation may be the case for another criteria. While it is possible to rank specifications for individual criteria, with many criteria in each specification, a comparative ranking could only be given if a weighting were ascribed to each criteria. This introduces a degree of subjectivity and has not been attempted.

As a result, the numbering of the tiers should be viewed as a means of identification, rather than indicating any ranking.

At this stage there has been little work on identifying which existing specifications, or indeed exactly how many, would be used as a basis for specifications E1 to E6.

As mentioned previously, over time it is intended that individual programme specifications will adopt the new specifications, as shown in Table 4.

Table 4: Intended transition of specifications over time

	Tier E1	Tier E2	Tier N1	Tier E3	Tier E4	Tier N2	Tier E5	Tier E6	Tier N3
Migration of specifications over time									

Conclusion

Since its launch in June 2005, the main foci of the International CFL Harmonisation Initiative to date has been on the development of the test protocol and gaining support and broader participation. An initial conceptual framework for the rationalization of performance specifications was presented in November 2005 at the second meeting in Seoul, Korea, where considerable stakeholder feedback was obtained. This provided the basis for more detailed proposals put forward in April 2006 at a stakeholder meeting in Frankfurt, and there has been considerable discussion of these subsequently. The specifications presented in this paper represent the latest set of proposals, which will be discussed in detail during the meeting prior to EEDAL in London. It is intended that international agreement will be reached by early 2007.

During the course of these discussions over the past twelve months, there appears to be growing support for the concept of rationalizing the numerous performance specifications that currently exist. While it is recognized that the International CFL Harmonisation Initiative has no ability to enforce specifications, most participants have stated that it would be useful to gain agreement on a few 'target' specifications, which represent reasonable performance requirements for a range of applications.

These specifications could be adopted by countries/agencies implementing new programmes, or by existing programmes at the time when their specifications are updated.

In the meantime, there is also support for the idea of a transitional arrangement which recognises the existing specifications from some of the key national programmes. A proposal, to be discussed at the meeting prior to EEDAL, presents three new 'target' specifications and up to six existing specifications, giving a total of up to nine tiers.

Further work will be required over the forthcoming months to gain agreement on the number and detailed specifications of the performance requirements for each of the tiers. Nevertheless there is sufficient support for the key elements of the proposal to suggest that the timetable for achieving agreement by early 2007 can be met.

References

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