techUK Data Centres Technical Committee

Briefing Note: ASHRAE and EcoDesign Lot9

March 2017

Introduction

The data that powers and enables our digital economy is processed, stored and managed by computer servers, which may be consolidated together into purpose built facilities (data centres) remote from the businesses they support, or located in-house in server rooms and cupboards ("Distributed IT"). Servers generate heat when they are working and data centre environments have to be cooled to ensure that this equipment does not overheat. Humidity can also be problematic for electronic equipment. Older servers used to be maintained within narrow temperature ranges (eg 18-22˚C) which made a big demand on air conditioning and hence on energy. However, this is changing thanks to ASHRAE.

What is ASHRAE?

ASHRAE (the American Society of Heating, Refrigeration and Air Conditioning Engineers) has defined, in consultation with server manufacturers, ranges (or "operating envelopes") of temperature and humidity within which servers will work reliably and their warranties are not compromised. The first such envelope was defined in 2004 and over time the ranges of both temperature and humidity have expanded as server technology has evolved. The advantage of servers that work reliably at higher temperatures and humidity is that environmental conditions can be optimised, thus improving data centre efficiency. For new IT equipment being placed on the market there are now four classes defined under ASHRAE, A1, A2, A3 and A4. While class A3 and A4 servers can operate reliably at very wide temperature and humidity ranges[1], industry standards suggest class A2 as a maximum because experts recognise that above this level there are diminishing returns in terms of energy savings: modern servers may be able to operate at high temperature and humidity but the supporting infrastructure may not[2], and the replacement cycle for other equipment may be longer than for servers.

How does this relate to EcoDesign?

The European Commission is legislating to improve server efficiency. The proposals, under the EcoDesign Directive[3], include several references to ASHRAE. techUK's Data Centre Technical Committee is concerned by these references and makes the following observations:

- The references to ASHRAE in the legislative proposals demonstrate a misunderstanding of the ASHRAE standard and its application, a failure to recognise that data centres are complex environments that require a system approach to operate efficiently, and methodological errors in calculating projected savings.
- The proposal to require idle testing at higher boundary temperatures is impractical, burdensome and will deliver no policy benefit (see technical notes in Box 1). However, manufacturers could be required to provide the fan power to temperature curves for the server product to enable data centre operators to calculate idle power at higher temperatures.

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[1] A1 equipment operates from 15 to 32˚C at 20% to 80% relative humidity, A2 equipment operates from 10 to 35 ˚C at 20% to 80% relative humidity, A3 equipment operates from 5 to 40˚C at 8% to 85% relative humidity, A4 equipment operates from 5 to 45 ˚C at 8% to 90% relative humidity

[2] The technical committee of the EU Code of Conduct for Data Centres agreed in 2016 not to advise that new servers should be ASHRAE class A3 on the basis that this would add cost but only marginal (if any) environmental benefit, and could compromise other components and infrastructure.

[3] The EcoDesign Directive aims to improve the energy performance of a range of devices, grouped by product type into different lots. Servers and storage are being addressed by DG GROW through Lot 9).

- The relationship between energy savings and ASHRAE classes (widening the ASHRAE envelope) is not linear. Once certain thresholds are reached, the servers themselves will start using more power, eroding or even negating savings from reduced cooling. This has been recognised and addressed by the industry. A typical operator commented: *"This is a juggling act as increasing temperature may actually promote higher energy consumption, so a holistic approach is required to strike a balance on across the whole system, chiller plants may work less but the cooling pumps may counteract the savings by working harder and vice versa, in that there is a point where even the server fans will work harder as they attempt to ensure regulate air flow and required temperature delta across a server chassis – sadly it's never black and white…"*
- Operating within ASHRAE Recommended ranges of temperature and humidity allows data centres to minimise or avoid mechanical cooling and reduce net energy use. The wider Allowable ranges enable operators to deal with temporary temperature and humidity fluctuations associated with exceptional circumstances. Expanding the envelope to allowable ranges will not necessarily deliver energy savings and may have the opposite effect.
- The inclusion of A3 and A4 class equipment as benchmarks (Table 8 in the working document) demonstrates a misunderstanding of these classes and how they are applied in a data centre environment. They tend to apply to a subset of equipment and mandating these classes could reduce, rather than improve, efficiency.
- The reference to ASHRAE (Annexe 2 of the working document) is incorrect and needs to be modified to show the recommended and allowable temperature range for each class and include the relevant technical notes. The inclusion of the table should also reference the ASHRAE standard as the source.
- Manufacturers accept that the ASHRAE environmental class should be declared for servers.

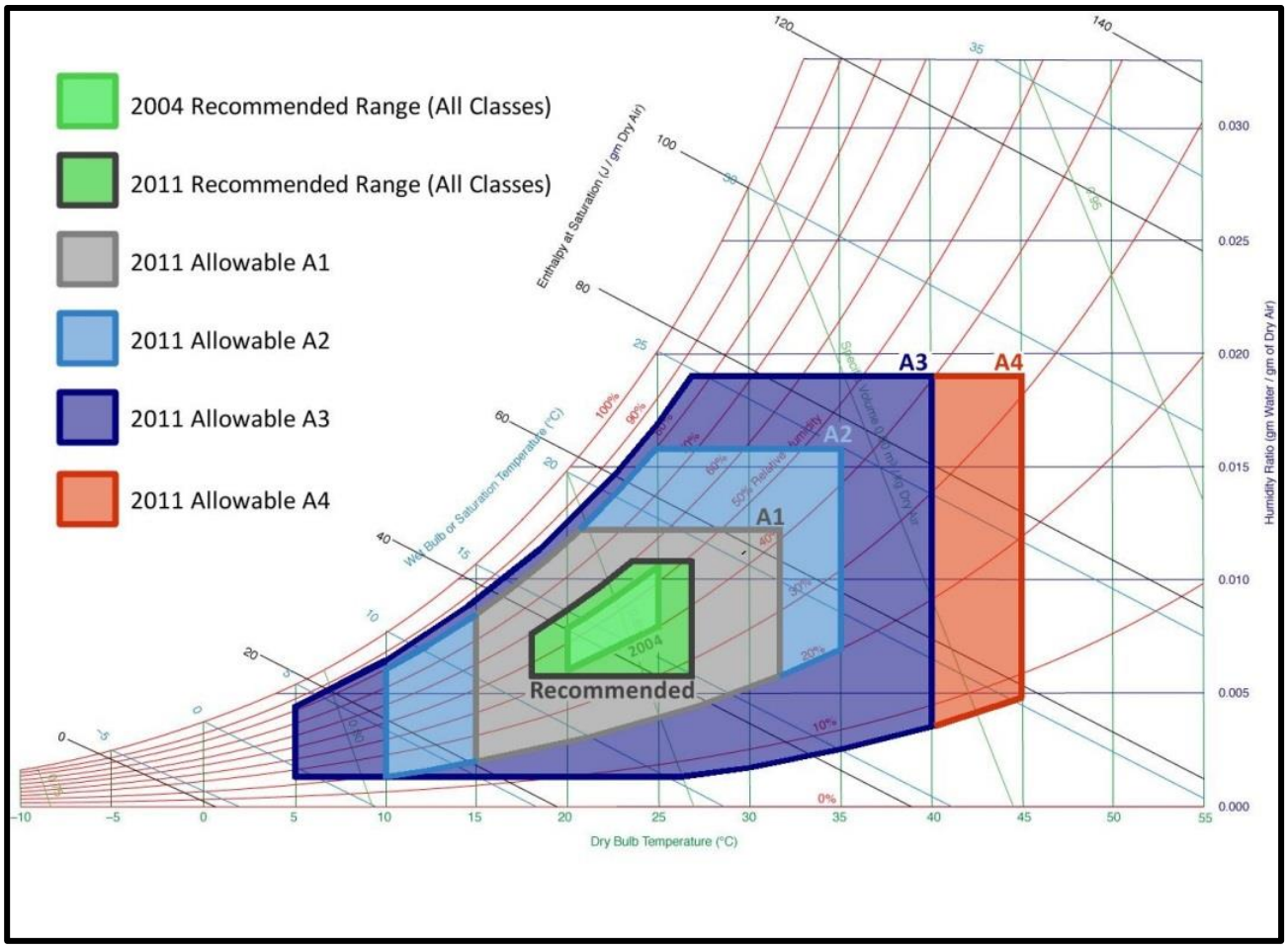

Figure 1: ASHRAE environmental classes for data centres (source ASHRAE)

Box 1 Idle Testing at Elevated Temperatures:
Idle testing at a higher boundary temperature (explanatory document 7.1.4) requires extra testing cost without providing meaningful, additional information about a server's energy use or performance. Performing the active efficiency and idle tests at higher temperatures is unreasonably expensive as it requires the testing to occur in highly specialized environmental chambers. In addition, servers will not be operating at the higher allowable ASHRAE temperature range for an appreciable period of time. As the industry reiterated during past engagements and comments, the ASHRAE temperature classifications involve a recommended temperature range of 18˚C to 27˚C, which is where the server will typically operate, and an allowable temperature range (up to 35˚C for the A2 classification) where a server can operate for limited durations of time without a significant loss in reliability. Measuring idle power at the allowable range offers no meaningful data for the following reasons:

1. The intent of the higher allowable operating range is to enable data center operators to extend the time available for free cooling. Using the most extreme condition of direct air free cooling, a server would be operating in the allowable range during the hottest periods of the day – which would likely occur from 2 pm to 6 pm. In turn, this is likely to be the period of highest server use during the day with the server experiencing little, if any, idle time. Idle periods are most likely to occur in the late evening and early morning when ambient temperatures are in the recommended temperature range.
2. Server idle power in the allowable range will increase because the cooling fans will be running at higher speeds to ensure the server is adequately cooled. In most products, a point will be reached where the extra power required to run the fans will eclipse the reduction in energy required to cool the data center. There is little, if any, energy reduction benefit to be gained by running in the higher allowable temperature range for an extended period of time. As discussed in (1) above, that will not be the operating profile even in a data center with direct air free cooling.
3. Operating at elevated temperatures for the time required to complete an active efficiency test (2.5 hours) or an idle test (30 minutes) is not a sufficient length of time to validate the ability of a server to stabilize its operation at that temperature.
4. Server idle power, excluding the fan power, will not vary appreciably over the recommended and allowed temperature ranges. The difference in server power use at higher temperatures will be a direct result of the higher fan speeds required to keep server operating temperatures within the allowable tolerances of the various system components. If it is desired to know the additional idle power driven by the fan speed, manufacturers can provide a curve of fan power to server operating temperature. Idle power at elevated temperatures can be calculated by adding the idle power at the test temperature and the additional fan power required between the test temperature and the operating temperature of interest to find the idle power at higher operating temperatures. This reasonably accurate and much more practical way to provide power use values at higher operating temperatures.

About techUK's Data Centres Technical Committee

techUK's Data Centres Technical Committee was originally established to advise techUK's Data Centres Council and provide expert technical input to policy responses, publications and other communications. However, the Committee's expertise is increasingly being sought during dialogue between industry and external stakeholders (predominantly government) for objective advice about the technical and market characteristics of the sector. Members collectively possess a wide spectrum of technical expertise, and while the core focus is on engineering and technology, some specialise in business processes, others cover operational aspects and some are experts on market trends, policy or legislation. The Committee includes external observers to ensure objectivity. Formal Terms of Reference provide governance for the group and a list of members is available. The Chairman is Professor Ian Bitterlin and the Vice Chair is Mark Acton.

Further information: These notes are only intended to provide a brief rule-of-thumb. The Technical Committee is on hand to provide further detail on the contents of this communication.

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