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How to Apply ASHRAE Temperature Guidelines to Evaluate Air-Based Cooling Systems in Data Centers

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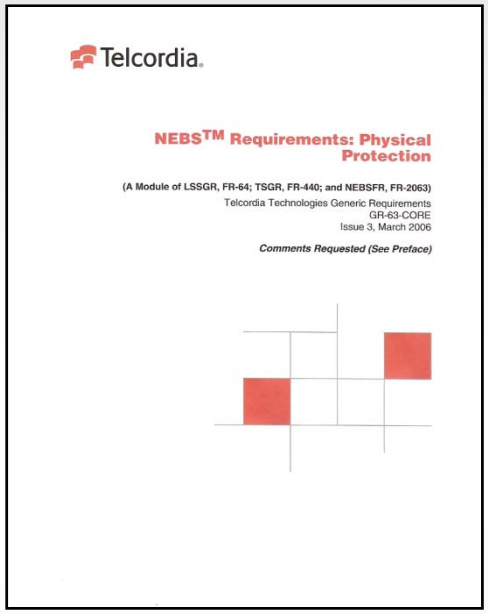
Advanced Indoor Environmental and Energy Solutions for Mission-Critical Facilities

Learning Objectives

- Recognize Leading Industry Environmental Guidelines
  - ✓ ASHRAE
  - ✓ NEBS
- Importance of Complying with the Guidelines
- Learn About the Rack Cooling Index (RCI)
- Quickly Apply the Index to Show Compliance

NEBS

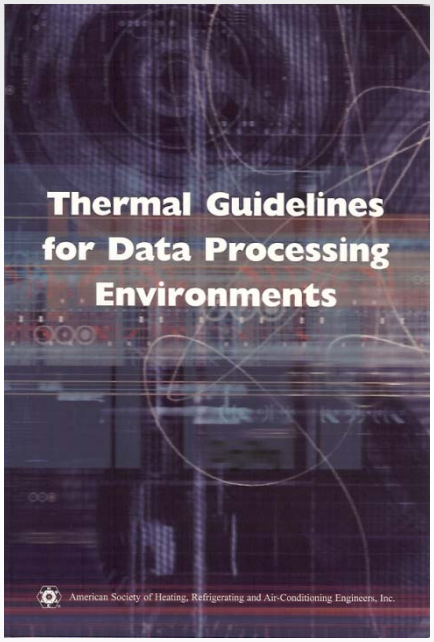


NEBS is the de-facto standard for telecom equipment and facilities;
END USER CENTRIC

Telcordia. 2001. (Herrlin, M.) Generic Requirements GR-3028-CORE, *Thermal Management in Telecommunications Central Offices*, Issue 1, December 2001, Telcordia Technologies, Inc., Piscataway, NJ.

Telcordia. 2006. (Kluge, R.) Generic Requirements NEBS GR-63-CORE, *NEBS Requirements: Physical Protection*, Issue 3, March 2006, Telcordia Technologies, Inc., Piscataway, NJ.

ASHRAE



Many concepts taken
from NEBS GR-63/3028

The ASHRAE guideline is primarily for
data-center equipment and facilities;
EQUIPMENT VENDOR CENTRIC

ASHRAE. 2004 & 2008. Special Publication, *Thermal Guidelines for Data Processing Environments,* American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA.

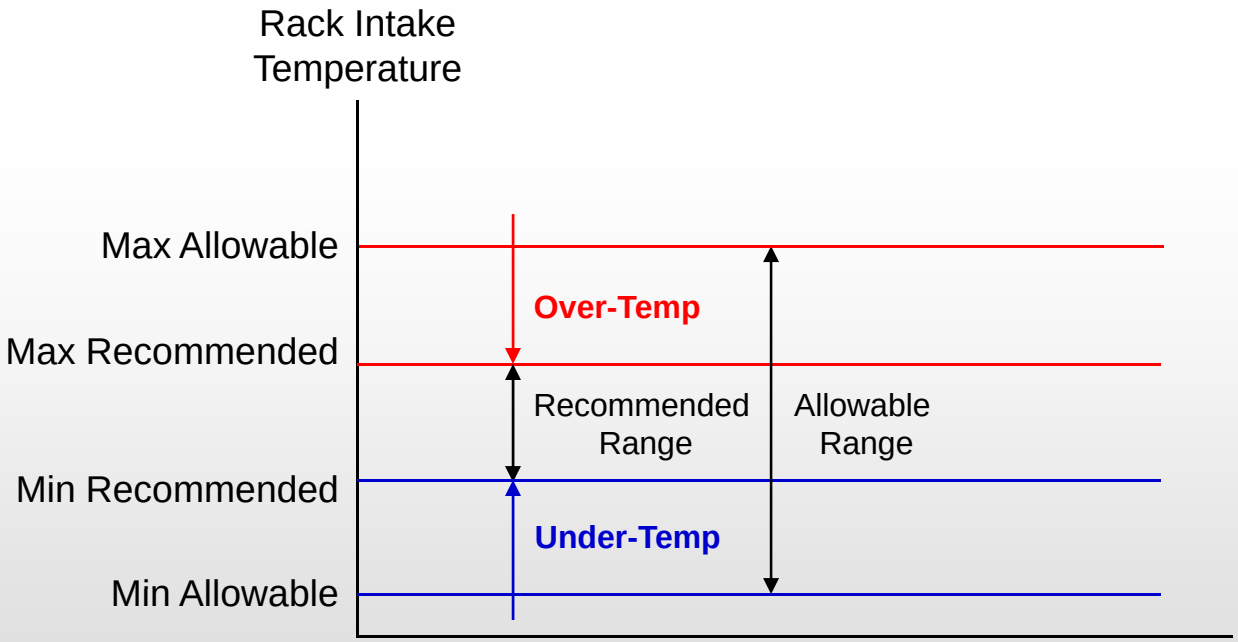
Key Nomenclature

Recommended range (statement of reliability)

Preferred facility operation; most values should be within this range.

Allowable range (statement of functionality)

Robustness of equipment; no values should be outside this range.



Why a Recommended Range?

It Takes Real-World Conditions into Consideration

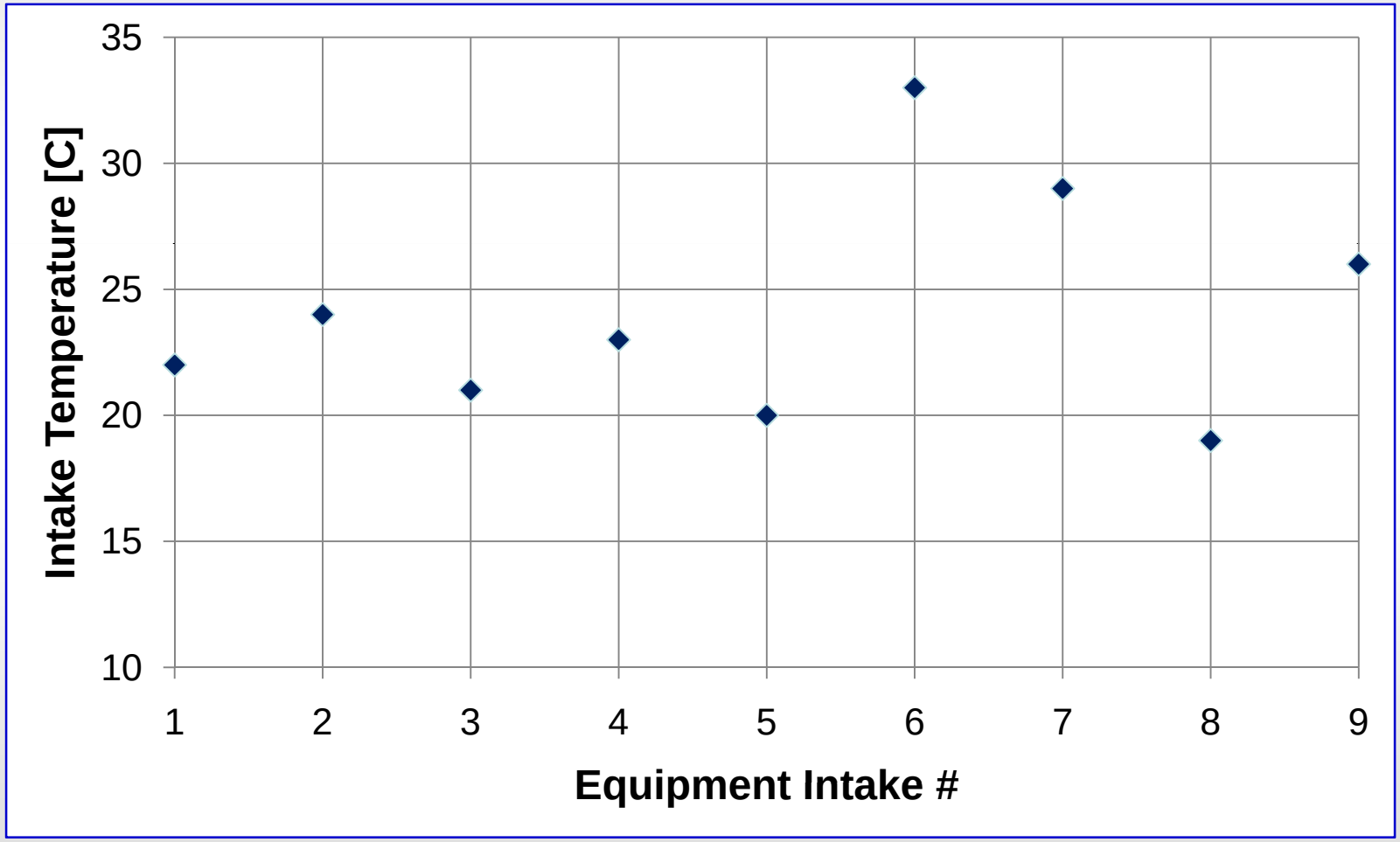
- Diverse equipment stock
- Soiled equipment
- Spatial and temporal variations
- Human activity
- Energy consumption

Temperature Specifications [°C]

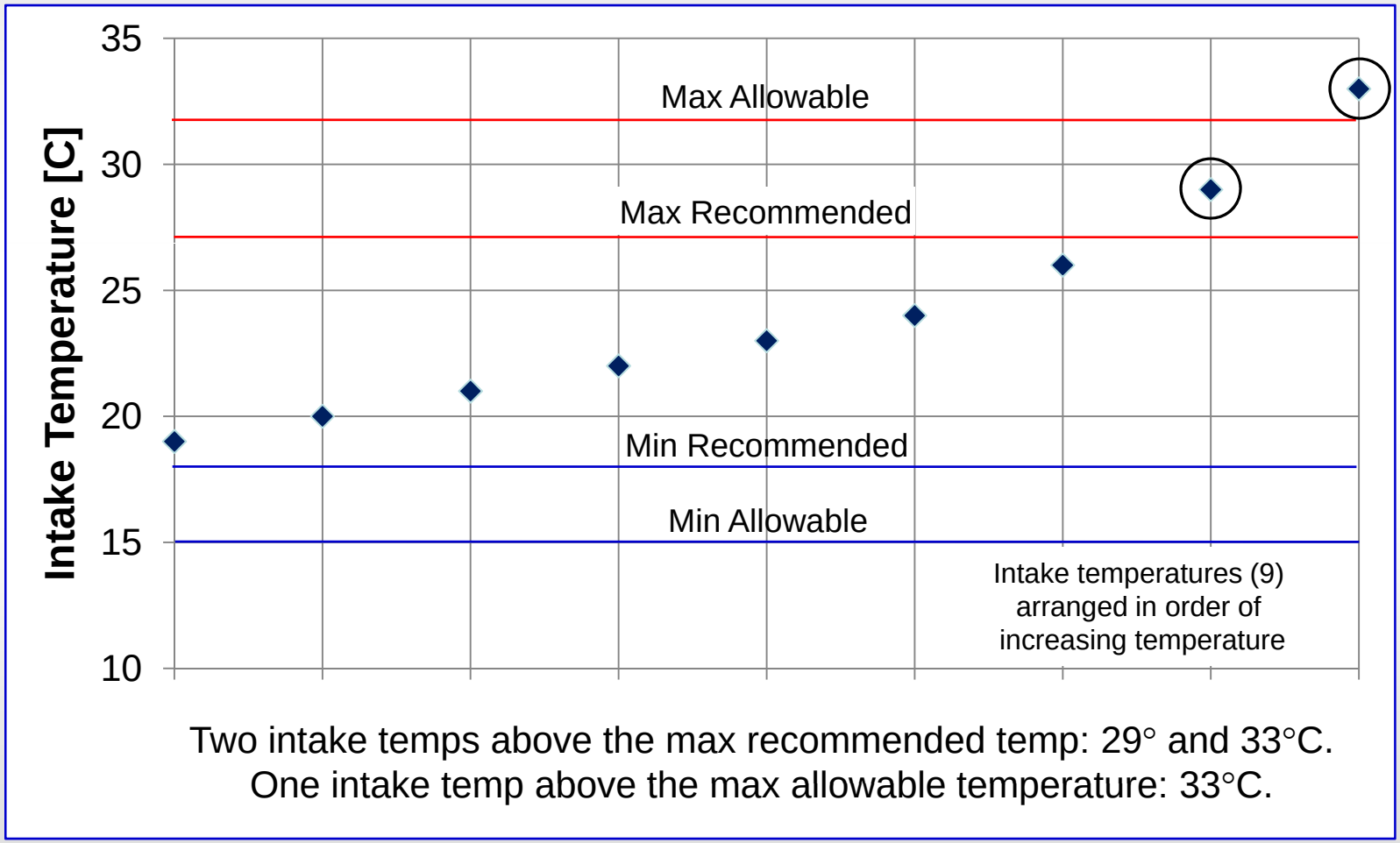
(@ Equipment Intake)	**Recommended** (Facility)	**Allowable** (Equipment)
Data Centers		
ASHRAE (2004)	20° – 25°	15° – 32°
ASHRAE (2008)	18° – 27°	15° – 32°
Telecom Centers		
NEBS (2001, 2006)	18° – 27°	5° – 40°

Convergence between ASHRAE and NEBS.

Example: Intake Temperatures



Intake Temperatures + Specifications



Two intake temps above the max recommended temp: 29° and 33°C.
One intake temp above the max allowable temperature: 33°C.

Determining the Compliance

Thermal specifications become truly useful when there is an objective way of determining the compliance; the Rack Cooling Index (RCI) "compresses" the intake temps into RCI_{HI} and RCI_{LO}.

- **RCI_{HI} = 100%** **No over-temperatures**
- **RCI_{LO}= 100%** **No under-temperatures**
- **Both = 100%** **Absolute compliance**

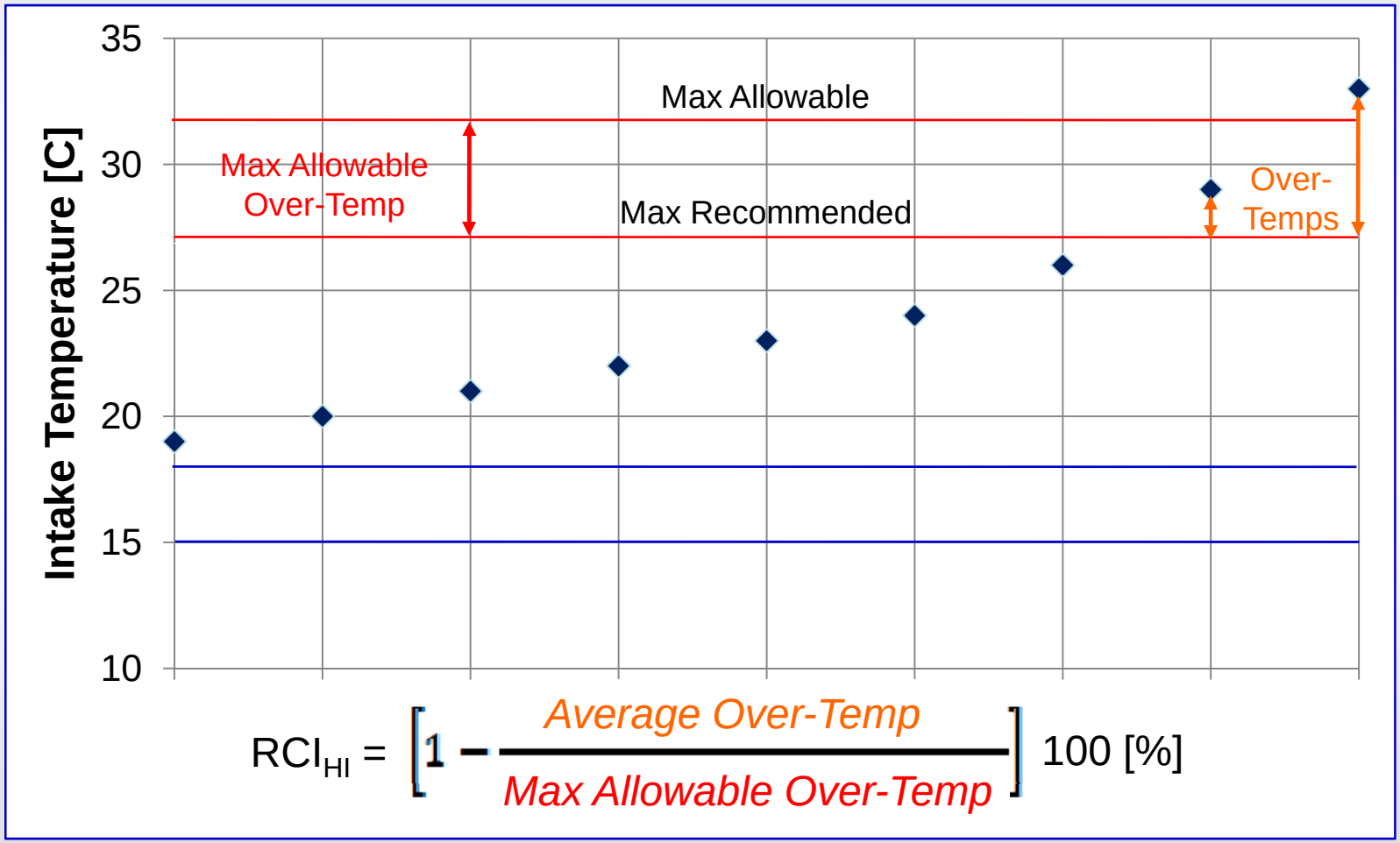
Based on modeling, a well-designed data center should have an RCI of 90% or higher. Benchmarking is in progress at LBNL.

Herrlin, M. K. 2005. *Rack Cooling Effectiveness in Data Centers and Telecom Central Offices: The Rack Cooling Index (RCI)*. ASHRAE Transactions, Volume 111, Part 2. (free download at www.ancis.us)

ASHRAE. 2008. Special Publication, *Thermal Guidelines for Data Processing Environments,* American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA.

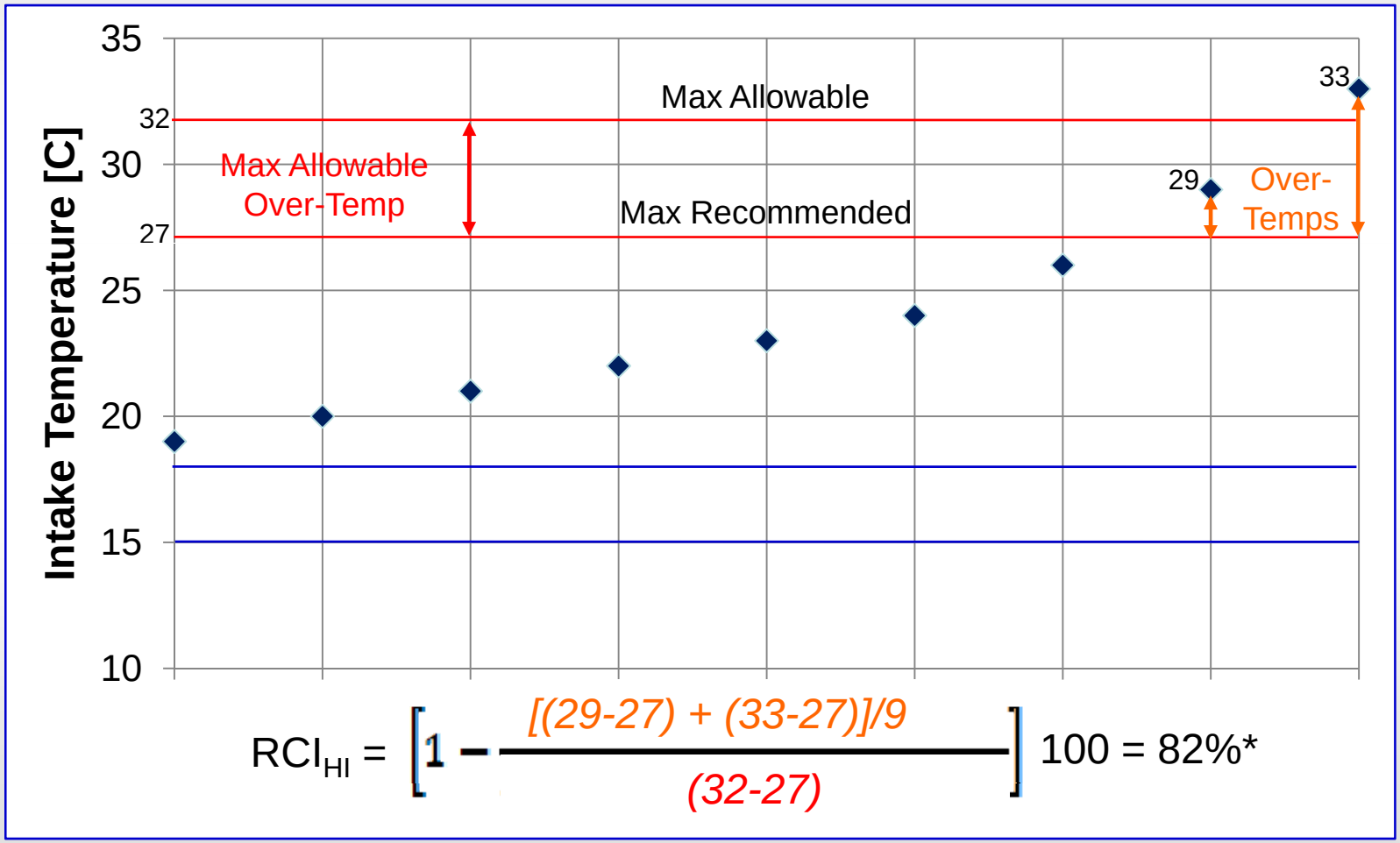
Definition of RCI_{HI}

RCI_{LO} is defined in an analogous way

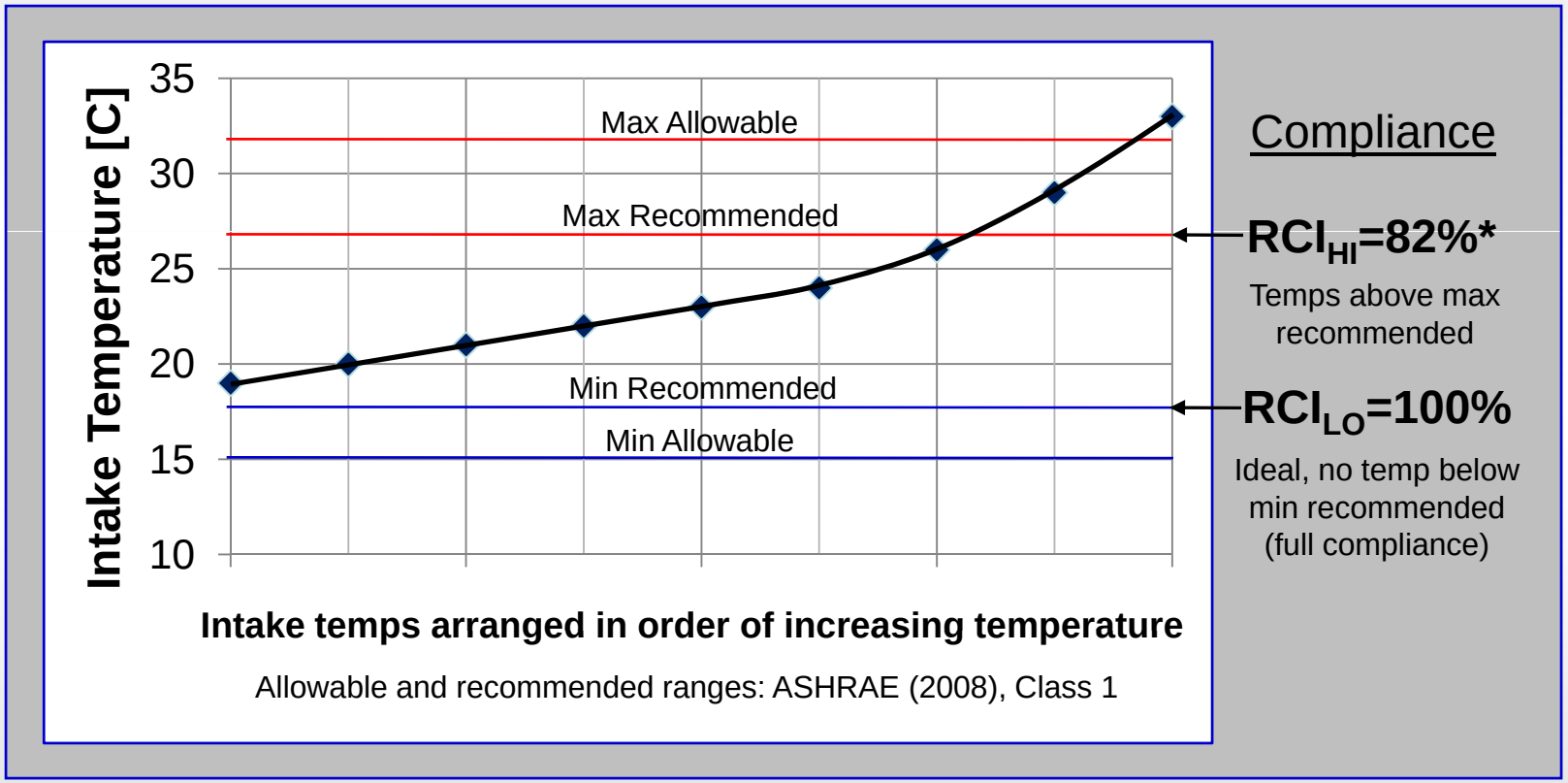


$$RCI_{HI} = \left[1 - \frac{\textit{Average Over-Temp}}{\textit{Max Allowable Over-Temp}}\right] 100\ [\%]$$

Calculation of RCI_{HI}



Proposed Compliance Chart

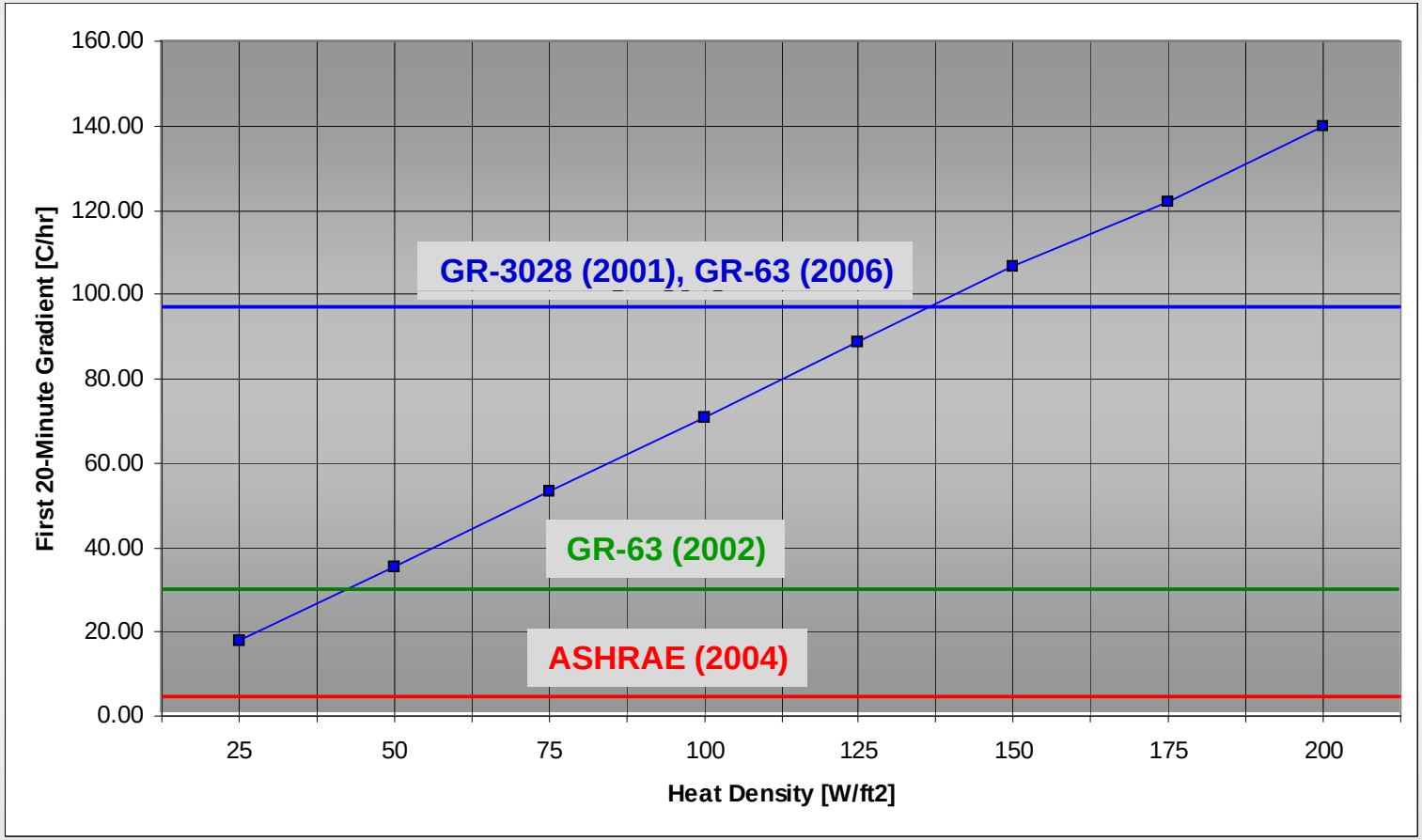


Gradient Specifications [°C/hr]

(@ Equipment Intake)	**Maximum**
Data Centers	
ASHRAE (2004)	5°C/hr
ASHRAE (2008)	?°C/hr
Telecom Centers	
NEBS (2002)	30°C/hr
NEBS (2001, 2006)	96°C/hr

These large discrepancies call for further study.

Modeled Gradients



Humidity Specifications [%RH]

(@ Equipment Intake)	**Recommended** (Facility)	**Allowable** (Equipment)
Data Centers		
ASHRAE (2004)	40 – 55%	20 – 80%
ASHRAE (2008)	25 – 60%	20 – 80%
Telecom Centers		
NEBS (2001, 2006)	Max 55%	5 – 85%

Convergence and divergence between ASHRAE and NEBS.

Summary

ASHRAE Guideline and NEBS GR-63/3028 provide guidance on environmental conditions for equipment and equipment spaces.

Convergence is occurring in some areas (recommended temps.) whereas large discrepancies remain in others (temp. gradients).

Thermal specifications become truly useful when there is an objective way of determining the compliance (compliance chart).

The RCI “compresses” unwieldy data to understandable and objective numbers; standardized way of specifying and reporting.

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Questions

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