NEBS Standards

and Testing Criteria

The NEBS standard was developed by Bell Labs in the 1970s to standardize equipment that would be installed in a central office. The objective was to make it easier for a vendor to design equipment compatible with a typical regional Bell operating company central office, resulting in lower development costs and easing the equipment's introduction into the network. Telcordia now manages the NEBS specifications. The four largest US Telecommunications companies (AT&T, Verizon, BellSouth, and Qwest) created the Telecommunications Carrier Group (TCG), a group formed to synchronize NEBS standards across the industry in the US. The TCG checklist specifies the individual NEBS requirements of each of its members in a matrix, making it simple to compare them.

Figure 1 - Environmentally Controlled Chamber for NEBS Testing [1]

NEBS Thermal Criteria

The purposes of the NEBS criteria are personnel safety, protection of property and operational continuity. Although NEBS standards are unique in focusing on the US telecommunications facility environment, they are largely based on national/international standards of FCC requirements. The NEBS standard's thermal criteria require equipment to operate normally after being subjected to various thermal conditions. For example, after exposure to extreme ambient temperatures and humidity, the equipment needs to operate as intended when returned to normal ambient conditions. Testing for NEBS thermal criteria is done in specialized, thermally controlled environments, as shown in Figure 1 and 2. In addition to thermal requirements, the NEBS standard also cover various physical and electrical criteria.

Figure 2 - Thermally Controlled Chamber [1]

Extreme Temperature Exposure and Thermal Shock

One of the thermal criteria of the NEBS standard is extreme temperature exposure and thermal shock. The packaged equipment cannot sustain any damage or functional deterioration after it has been stored in an extreme temperature environment. For this testing, the equipment functionalities are initially tested under normal operating conditions.

Then it will be subject to the temperature profiles shown in figure 3 for low extreme temperature and figure 4 for high extreme temperature. After the thermal soaks, a post- test equipment functionality test is performed once the equipment has recovered to normal operating conditions.

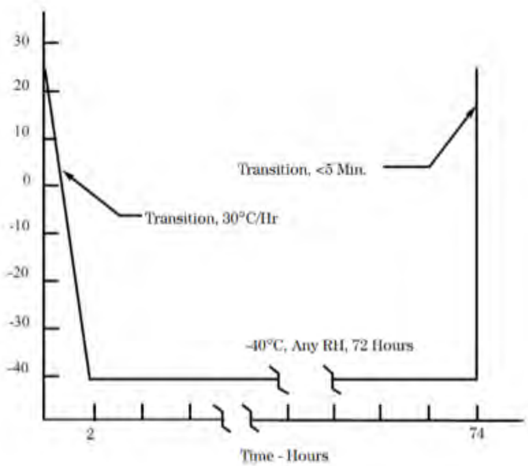


Figure 3 - Extreme Low Temperature Testing Profile [2]

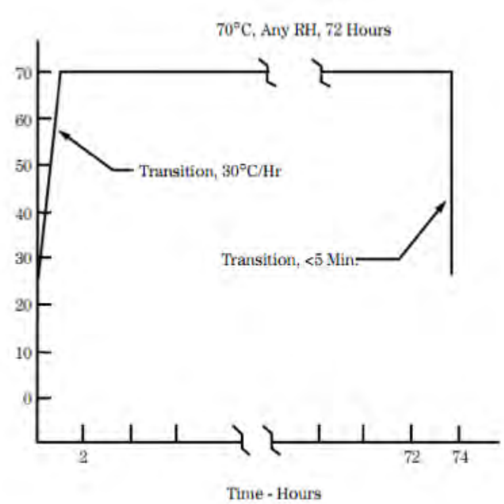


Figure 4 - Extreme High Temperature Testing Profile [2]

High Relative Humidity Exposure

The packaged equipment cannot sustain any damage or functional deterioration after it has been exposed to the high relative humidity environment. As in extreme temperature exposure testing, functionality testing is initially conducted under normal operating conditions. Then the equipment is packaged and placed into a test chamber at 23ºC and 50% RH. At 40ºC, increase the chamber's RH to 93% within two (2) hours and maintain for more than ninety six (96) hours. Transition the chamber's RH back to 50% at 40ºC within two (2) hours. Figure 5 shows the criterion's temperature/relative humidity profile. A post- test equipment functionality test is performed, once the equipment has recovered to normal operating conditions.

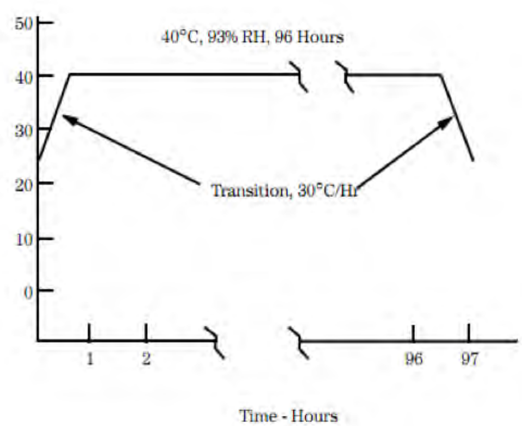
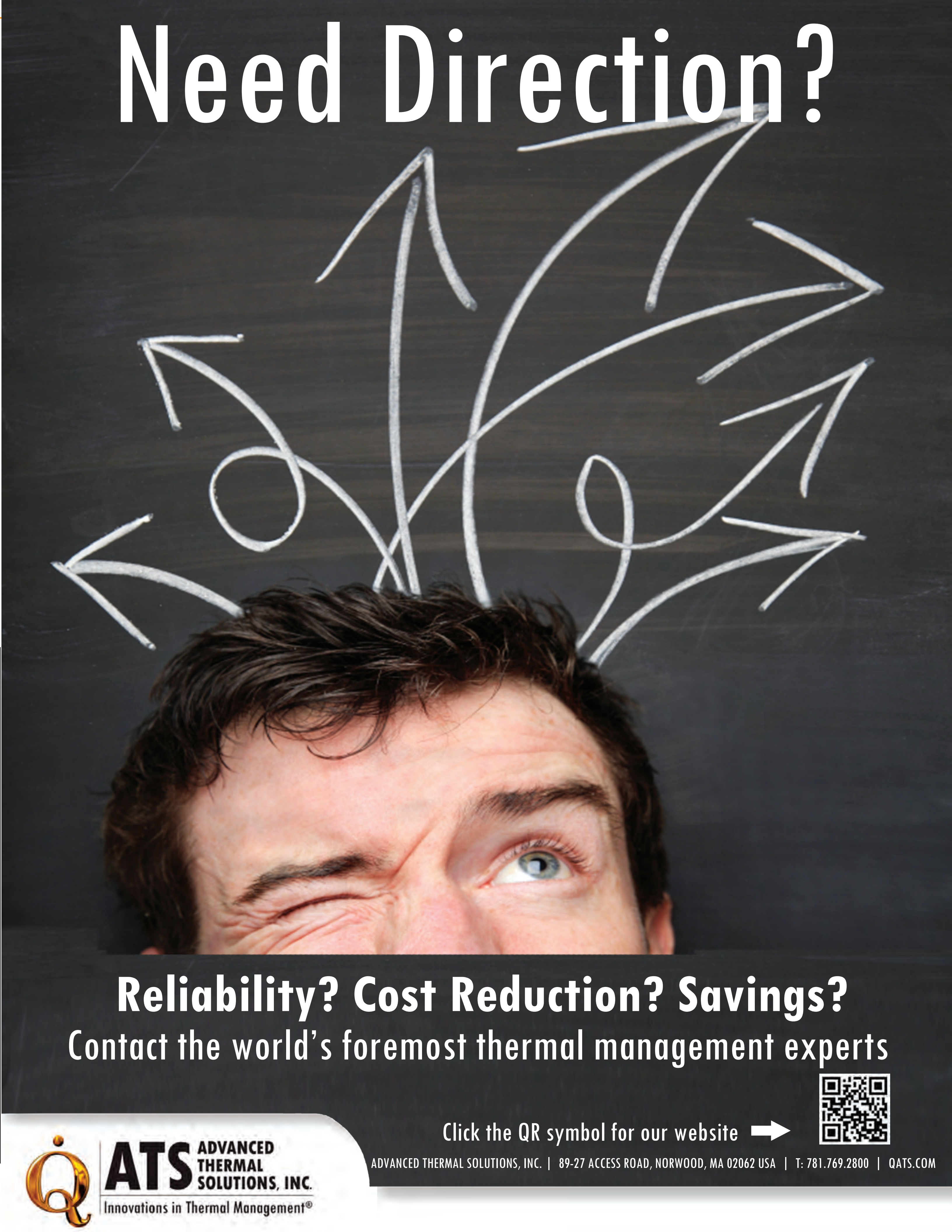


Figure 5 - High Relative Humidity Testing Profile [2]

Operating Temperature and Humidity

In order to ensure continuous equipment operation, the equipment cannot sustain any damage or functional deterioration when operating at the ambient environment stated in the operating temperature and humidity criterion. The control temperature and humidity sensor must be placed 1.5m (59in) from ground and 380 mm from the front of the equipment, as shown in Figure 6. The equipment must operate at 23ºC and at an RH level of 50% for at least four (4) hours to achieve steady state operation. Once steady state operation is achieved, the equipment needs to be subject to the temperature and RH profile shown in Figures 7 and 8. For shelf-level equipment, the maximum temperature



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must be 55ºC instead of 50ºC. If the product encounters a functional anomaly which requires a hardware replacement, a Root Cause Analysis shall be performed and the test will be repeated in full.

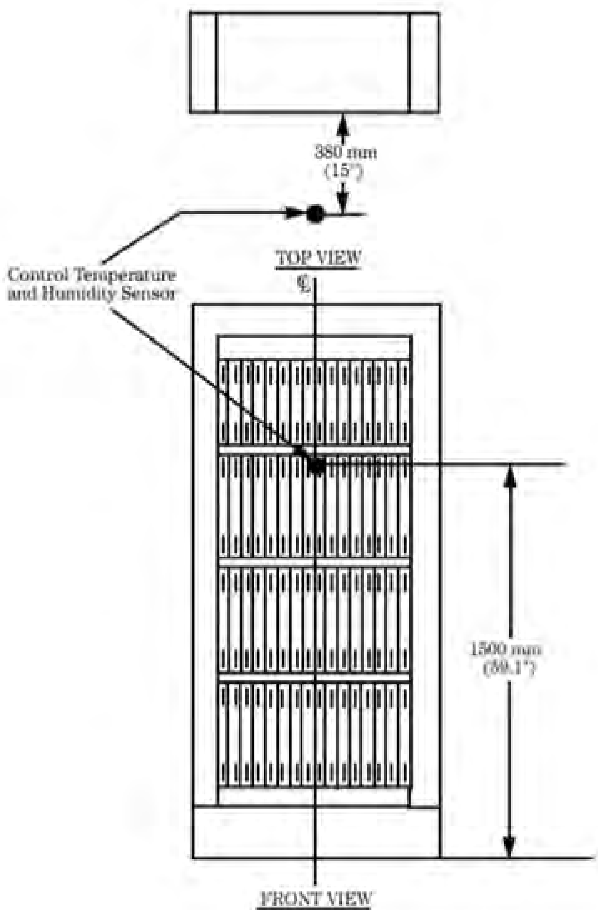

Figure 6 - Temperature and Humidity Measurement Location [2]

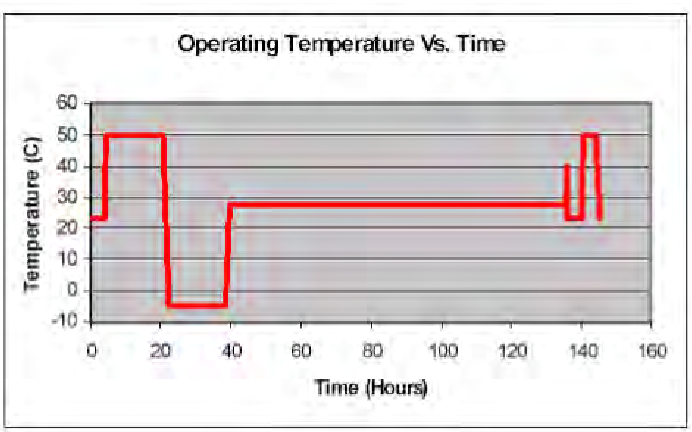

Figure 7 - Temperature Profile for Operating Temperature and Humidity Criterion Testing [2]

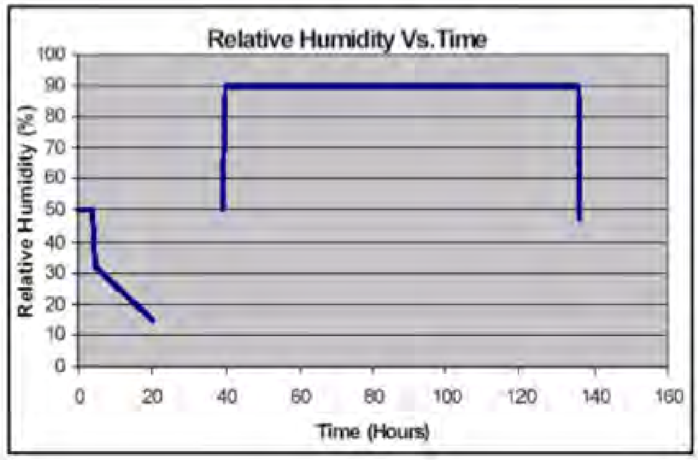

Figure 8 - Relative Humidity Profile for Operating Temperature and Humidity Criterion Testing [2]

Temperature Margin Evaluation

In addition to high and low operating temperature requirements and humidity criterion, the NEBS standard requires one to determine the equipment response to temperatures up to 10ºC above the short-term extreme temperature. The threshold temperature of the functional deterioration shall be reported. The equipment does not have to function normally under these conditions. This is only for informational purposes. In order to determine the threshold temperature, the equipment needs to achieve steady state operation at 23ºC and RH levels of 50% for at least four (4) hours. Then, the ambient temperature is to be increased to 50ºC for frame-level equipment (55ºC for shelf equipment), at a rate of 30ºC/hr, and maintained for 1 hour. The chamber temperature is then increased by 5ºC at a rate of 30ºC/hr and maintained. If there are performance changes, the temperature and the performance changes should be noted. If there are no performance changes, the chamber temperature increase of 5ºC must be repeated.

Altitude

The packaged equipment needs to be functional at different altitude ranges. For equipment installed above 1800m, the product documentation shall provide special requirements, if any. After the equipment reaches steady state operation at an ambient temperature of 25ºC and ambient pressure, the testing chamber's temperature is increased to 40ºC at a rate of 30ºC/hr. Then, it is further increased to 50ºC at a rate of 5ºC/hr. The chamber's pressure is then decreased to 80kPa at a rate of 15kPa/hr. NEBS standards require the condition of 50ºC and 80kPa to be maintained for eight (8) hours. Then, the chamber's temperature is decreased to 30ºC at a rate of 5ºC/hr, while decreasing the chamber's pressure to 60kPa at a rate of 15kPa/hr. The condition of 30ºC and 60kPa is maintained for eight (8) hours. The chamber's temperature is increased to 40ºC at a rate of 30ºC/hr and maintained at 40ºC and 60kPa for right (8) hours. Finally, the chamber's pressure is increased back to ambient at a rate of 15kPa/hr and the chamber's temperature is decreased to 25ºC at a rate of 5ºC/hr.

Fan Cooled Equipment

Equipment cooled by forced convection cannot sustain any damages or deterioration in functional performance when operated with a single fan failure at a 40ºC ambient temperature for a short period up to ninety six (96) hours. The equipment is required to have a remote alarm notification of a fan failure. The product documentation shall have replacement procedures for fans and cooling units. An estimated time of replacement is required if service interruption is needed for cooling unit replacement. In order to test fan failure, one of the fans that would most likely cause the greatest temperature increase in the system is de-energized, after equipment steady state is achieved. This condition is maintained for eight (8) hours and the equipment functionality is recorded. The test is complete if no other fans are to be tested. Otherwise, test must be repeated with each additional fan.

Surface Temperature

In order to protect maintenance personnel, equipment surfaces that face the aisle or upon which normal maintenance is anticipated shall not exceed 48ºC, when the equipment is operating in a room with an ambient air temperature of 23ºC. Passive equipment, where no heat is generated, is exempted from testing. Locations of the maximum temperature, and any temperature over 48ºC on the front surface of the equipment, need to be recorded after twenty four (24) hours of normal operation. The same procedure needs to be conducted for any surfaces to which a person may be exposed. The measured surfaces need to be described by part description/location and whether the part is a short term or long term exposure surface.

Heat Dissipation

NEBS standards require maximum heat release and the method of cooling to be documented. The heat release is to be specified as Watts and as W/m^2 or W/ft^2. The equipment heat release should not be greater than the values in Figure 9. If so, the heat release shall be clearly identified in the product documentation, along with a note indicating that special equipment room cooling may be required.

Individual Frame	
Natural Convection	1450 W/m^2 *(134.7 W/ft^2)*
Forced-Air Fans	1950 W/m^2 *(181.2 W/ft^2)*
Multi-Frame	
Entire System	860 W/m^2 *(79.9 W/ft^2)* *
Any 6.1-m × 6.1-m (20-ft × 20-ft) square area within a larger system	1075 W/m^2 *(99.9 W/ft^2)* *
Shelf	
Natural Convection	740 W/m^2 per meter *(20.9 W/ft^2/ft)* of vertical frame space the equipment uses.
Forced-Air Fans	995 W/m^2 per meter *(27.9 W/ft^2/ft)* of vertical frame space the equipment uses.

* Systems totally comprised of forced-air cooled equipment may increase these levels to 1075 W/m^2 *(99.9 W/ft^2)* and 1290 W/m^2 *(119.8 W/ft^2)*.

Figure 9 - Equipment Area Heat Release Limits [2]

References:

1. Environmental Engineering & Assessment, website http://www.swri.org/3pubs/brochure/d01/EEA/home.htm

2. Telcordia Technologies Generic Requirements GR-63-CORE Issue 3, March 2006