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Re: GR-63 Altitude Criteria

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Dear User of NEBS Criteria:

Recently, service providers and equipment suppliers requested clear performance criteria and test methods for equipment operation at altitude. Criteria are provided in the current GR stating the product must operate at specific altitudes but no specific test method (time, temperature, rate of change) is given.

It has been our position in the past, substantiated by national standards, that explicit altitude testing is not required for equipment which conforms to the GR-63 operating temperature and humidity requirement, R4-7. This position was based on a Contribution made to ANSI Accredited Committee T1E1.8 for use in national standard ANSI T1.304 - 1997, *Ambient Temperature and Humidity Requirements for Network Equipment in Controlled Environments*, from which the NEBS Operating Temperature and Humidity Test Method was adopted:

> Air pressure/Altitude effects are not usually considered in the GR-63-CORE Operating Temperature and Humidity Test Method. Lower air pressures, associated with increased altitudes, result in reduced rates of convective heat transfer. For convective heat transfer across moderate temperatures differences, the effect is small for the pressure/altitude range of the NEBS criteria. For temperature differences up to about 10 °C, the magnitude of the pressure/altitude effect is less than the test tolerance on temperature specified for testing. For convection across higher temperature differences, the pressure/altitude effects may be significant.
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> To determine this significance, Telcordia examined the effects of altitude on peak outdoor temperatures. Studies of ASHRAE climatic data indicate a reduction in peak outdoor climatic temperature at altitudes above 1500 meters [4920 feet]. At these elevations, the use of outdoor air for emergency cooling can prevent the occurrence of extreme high temperature conditions. Therefore, reduced outdoor temperatures may

> effectively offset the altitude effect on heat transfer above 1500 meters. For convective heat transfer across temperatures differences up to 50 °C, altitude effects do not exceed the test tolerance until about 750 meters [2460 feet]. Between 750 and 1500 meters, some sites are susceptible to high temperatures and a significant altitude effect.

A key element in the position above was that the altitude effect is dependent upon the temperature difference across which convection occurs. The hotter the surface temperature of the devices being cooled, the more significant the effects of reduced air pressure caused by altitude. As a rough approximation, an increase in ambient air temperature of 1 °C per 1000 feet of altitude is often used.

As a result of the contribution to T1E1.8, an appendix was included in the ANSI T1.304 standard to summarize the pressure/altitude effects and the justification of ignoring them in the ANSI T1.304 test method. The appendix read as follows:

> For the purpose of this Standard the Working Group conjectures that equipment performing satisfactorily at sea level performs equally as well within the altitude range specified. This is because the impact of altitude on convective and radiative heat transfer is normally very small. Furthermore, at altitudes of 1500 meters (4921 feet) and greater, the ambient temperatures during summer are significantly lower than near sea level. The use of outdoor air for emergency cooling at higher altitudes reduces the risk of high temperatures occurring local to the telecommunications equipment addressed by the cited testing method.

Based on the findings of the contribution and the noted addition to the ANSI T1.304 national standard, we have not in the past insisted that equipment suppliers perform explicit altitude simulation when products are temperature tested over the short-term temperature range (50 °C) cited in GR-63-CORE, Section 4.1.2, R4-7. It has been our position that compliance to R4-7 at sea level is sufficient to demonstrate acceptable temperature performance over the cited altitude range of requirement R4-8.

Because of the assumptions regarding the temperature difference of convective heat transfer, and because some equipment may be susceptible to non-thermal (that is reduced pressure and mechanical) effects of altitude, an explicit altitude test based on the GR-63 criteria is now desired. In order to develop specific criteria and test methods that address the intent of the GR, the following background is provided.

Perspective:

Early versions of the NEBS document stated the altitude requirement as follows:

> All equipment shall remain operational when installed in COs located from 200 ft below sea level to 10,000 ft above sea level.

In Issue 3 of 1998, the Altitude requirement referenced the temperature and humidity limits as follows:

> All equipment shall be functional within the limits specified in Table 4.2-1 (up to 49 °C) when installed at elevations between 200 feet below sea level and 13,000 feet above sea

level. At elevations greater than 5000 feet above sea level it may be necessary to reduce allowable room temperatures, make special room air distribution arrangements, or provide standby power for short-term cooling as specified by the manufacturer of the equipment.

In this issue of the TR, the maximum altitude was increased to 13,000 feet. Note that in the reference back to the temperature tables, there was an anticipation that operation at combined high temperature and high altitude condition would not be practical.

In the current version of GR-63, the criteria read as follows:

> **R4-8 [74]** All equipment shall be functional within the limits specified in Table 4-4 (up to 50 °C) when installed at elevations between 60 m *(197 ft*) below sea level and 1800 m *(5905 ft)* above sea level.
>
> **O4-10 [76]** All equipment should be functional within the limits specified in Table 4-4 when installed at elevations between 1800 m *(5905 ft)* and 4000 m *(13,123 ft)* above sea level.

Recommendation

Operation at sea level and an aisle temperature from –5 °C to 50 °C is required. To clearly delineate the relation between temperature and altitude at other elevations, the following recommendation is proposed:

> From R4-8, operation at 6000 feet is required and was apparently intended to apply over the entire temperature range. From the earlier work at T1E1.8 on ANSI T1.307, the consensus was that the application of an altitude limit over the entire temperature range was too severe and unrealistic for most equipment installations. As an initial position, I propose that operation at 6000 ft be required up the maximum of the "normal temperature" of 40 °C. Operation at higher temperatures and 6000 ft is left as an objective.
>
> From O4-10, operation at 13,000 feet is an objective. For our purposes, I have considered operation at 13,000 feet and 30 °C as a requirement. This is slightly more stringent than the current GR position. Operation at 13,000 feet and higher temperatures is left as an objective. Note that the most severe case – 13,000 feet and 50 °C - is roughly equivalent to sea-level operation at 65 °C. This is the maximum temperature limit for loop electronics exposed to solar load and not air-conditioned. I feel it is unreasonable to expect indoor central office products to operate at this extreme, even short-term. While there may be applications for such a design criteria, I suggest that they are beyond the scope of GR-63 applications.

Tabulated, the criteria levels appear as follows:

	Temperature		
	30 °C	**40** °C	**50** °C
Sea-Level	**R**	**R**	**R**
6000 Feet	**R**	**R**	**O**
13,000 Feet	**R**	**O**	**-**

Proposed Test Format

In order to systematically determine conformance, the following test format is proposed. It is assumed the product under test already conforms to the operational temperature requirement for operation up to 50 °C at sea level.

Test in sequence, operation at the following conditions. Dwells of 8 hours at each condition should be adequate to demonstrate operation:

For Conformance to the Requirements:
Operation at 30 °C, 6000, and 13,000 feet.
Operation at 40 °C, 6000 feet

For Conformance to the Objectives:
Operation at 40 °C, 13,000 feet
Operation at 50 °C, 6000 feet

During testing, rates of temperature change and relative humidity limits should be maintained with the normal limits of GR-63. Temperature adjustments for shelf level products should also be made.

Closing

Feedback on these proposals is eagerly sought. In the first half of year 2000, I plan to perform some investigative testing on products to produce more detailed and formalized test methods. Prior to the start of that work, a consensus on the criteria amongst interested service providers and suppliers is desired.

Thank you for your continued interest and support of Telcordia's NEBS requirements. Please do not hesitate to call me at (973) 829-4669 or Rudi Schubert at (973) 829-2556 with any questions or comments.

Truly yours,

R.G. Kluge
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