

The “Core” of Designing for NEBS Compliance

BY DAVE LORUSSO

Most of you know NEBS has something to do with telecommunications. It's true; NEBS has a lot to do with telecommunications. NEBS is the premiere set of documents used to ensure telecommunications equipment perform at their highest level possible.

NEBS stands for “Network Equipment – Building System”. Breaking this down: “Network Equipment” is the hardware (and software?) that constitutes a telecommunications carrier's network. The network could be in a Central Office (CO) or part of an Outside Plant infrastructure. “Building System” emphasizes organization and structure, mainly around a Central Office. NEBS is primarily a series of tests meant to ensure that telecommunications equipment meets a vast array of safety, electromagnetic compatibility, and environmental requirements. NEBS indirectly describes the environment of a typical CO.

So, what is a Central Office environment like?

Typically, a CO is a large unobtrusive, windowless, secure building. There are approximately 35,000 COs in the

United States. There might even be one in your neighborhood. Since the U.S. telecommunications system is more than 100 years old, COs often occupy prime real estate. There are many older COs throughout the country with harsh environments inside. This is why you'll see tough requirements around temperature, humidity, vibration, illumination, fire resistance, and contaminants. Your product must conform to this environment.

Copper pairs from your home or business eventually find their way to a local Central Office building. They enter the CO underground via a cable vault and terminate in a distribution frame. There is a demarcation between Outside Plant (OSP), where the wires come from, and the central office pairs. Since OSP is exposed to many transient events (both destructive and non-destructive), protection must be provided. Typically, this is in the form

of a 5-pin Protector Module. This protection is taken into consideration when lightning and power cross criteria is presented to the copper pairs. Protected central office pairs then find their way to a CO switch that can switch calls locally or to long distance carrier phone offices.

For online virtual and pictorial tours of a CO, go to www.nebs-faq.com.

The core NEBS documents are available as a set from Telcordia: FD-NEBS-01, NEBS™ *Physical and Electrical Protection*, and include:

- GR-63-CORE, *NEBS™ Requirements: Physical Protection*
- GR-1089-CORE, *Electromagnetic Compatibility and Electrical Safety – Generic Criteria for Network Telecommunications Equipment*
- SR-3580, *NEBS Criteria Levels*

The above documents will set you back about \$2,500.00... expensive, but worth the investment. You need to understand what service providers require for their networks. But this is just the beginning. There are many more Telcordia documents you need to purchase to get a complete a understanding of NEBS.

GR-63-CORE

According to Telcordia's ROADMAP-TO-NEBS-1, Telcordia GR-63-CORE, *NEBS™ Requirements: Physical Protection, is considered the "backbone" of the NEBS program and identifies the minimum spatial and environmental criteria for all new*

telecommunications equipment systems used in a telecommunications network. Topics covered include temperature and humidity, fire resistance, spatial and vibration criteria, airborne contaminants, acoustic noise, and illumination.

Let's look at the spatial criteria. Equipment and cabling must be compatible with the vertical and horizontal space allocations in a Central Office. Floor loading limits must also be taken into consideration since equipment can be mounted on a second floor or above. Section 2 "Spatial Requirements" provides a broad overview of criteria

applicable to frames, distribution and interconnecting frames, dc power plant equipment, and cable distribution systems. Criteria is given right down to the hole pattern used to anchor a frame to the building floor (Figure 1).

An important area to understand is how frames are distributed in a typical Central Office (Figure 2). There is a Maintenance Aisle and a Wiring Aisle. This arrangement allows personnel to operate, maintain, and repair equipment from the front. Cables are in the back running upward to the overhead cable distribution tray. DC power is brought down to the equipment. Equipment is powered by -48 Vdc.

It's also important to understand how a typical central office is cooled. A typical cooling system is all-air usually using central fan rooms, overhead ducts, and diffusers to distribute air. The preferred cooling method for Network Equipment is for air to enter from the lower front and exit through the top rear (Figure 3). This results in a cold aisle (Maintenance) and a hot aisle (Wiring). The air supply to the cold aisle comes from ducting from top down. Hot air recovery from the hot aisle is generally done through ducting on top. GR-3028, "Thermal Management In Telecommunications Central Offices" is the guiding Telcordia document.

Section 4 is the meat of the document. This section addresses environmental criteria in a CO:

- temperature, humidity, and altitude
- fire resistance
- equipment handling
- earthquake, office vibration, and transportation vibration
- airborne contaminants
- acoustic noise
- illumination

Section 5 describes the Environmental Test Methods used to prove that your equipment meets Section 4.

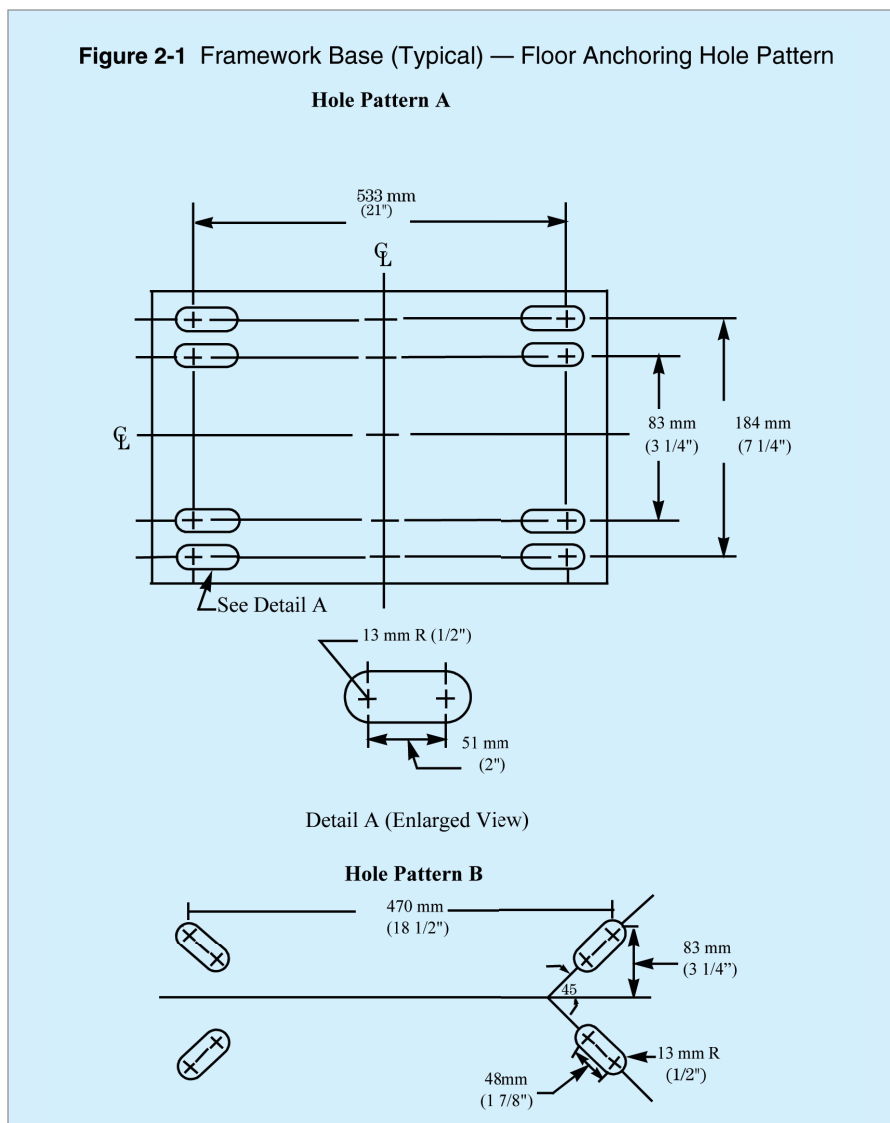


Figure 1: From Page 2-2 of GR-63-CORE, Issue 3, March 2006

All of the environmental criteria above are important, however, there is not enough room in this article to go into detail. Let's look at some key areas.

Temperature, Humidity, and Altitude

Key to this area is the short-term limits, short-term being defined as "a period of not more than 96 consecutive hours and a total of not more than 15 days in 1 year. (This refers to a total of 360 hours in any given year, but no more than 15 occurrences during that 1-year period.)". That's four long days of wicked hot temperatures! Your equipment needs to stay operational from -5°C to 50°C (23°F to 122°F) if it's sold at the frame level or -5°C to 55°C (23°F to 131°F) if it's a shelf level product.

Fire Resistance

Your product is going to get burned. Let me repeat that. YOUR PRODUCT IS GOING TO GET BURNED. You can't do a simulation – you have to burn it. This is not the same requirement you see in the 60950 safety standards. In 60950, there is a heavy reliance on the use of a Fire Enclosure to contain fire. You can have a compliant Fire Enclosure designed to 60950 and fail the NEBS Fire Resistance test. Material selection and construction techniques are emphasized in 60950. The risk of ignition is reduced by putting a limit on the maximum temperature of components under normal and single fault conditions; if there is ignition, the spread of flame is reduced by using flame retardant materials or by adequate separation. Using these proven practices will help, but not guarantee passing the NEBS Fire Resistance test. The best way to pass this test is to understand it.

In the early days of NEBS (circa 1985), a 5-3/4 inch diameter by 2-3/8 inch deep pan containing 200 ml of isopropyl alcohol was ignited 2 inches below the bottom of the lowest unit. Fire was not allowed to spread into adjacent equipment assemblies.

Figure 2-2 Typical 6-Lineup Floor Plan for Nominal 300 mm (12-in) Deep Frames

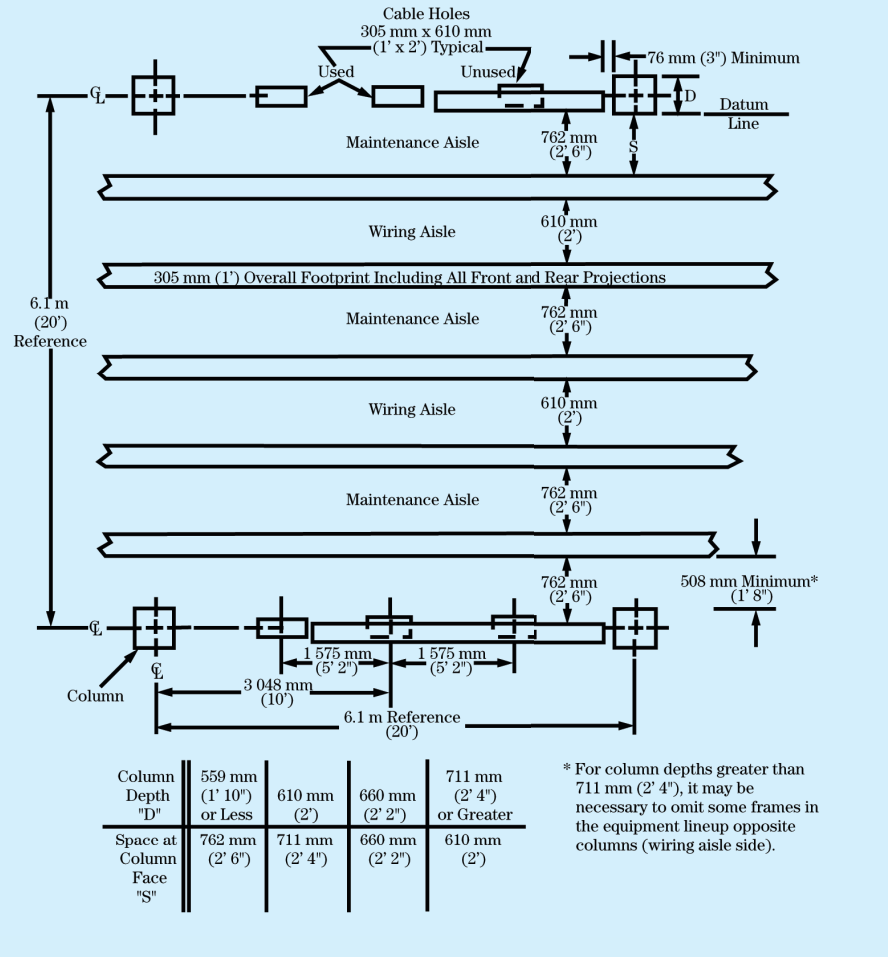


Figure 2: From Page 2-4 of GR-63-CORE, Issue 3, March 2006

Figure 4-2 Profile View of Conforming Equipment Airflow Schemes Dashed Method Is Preferred

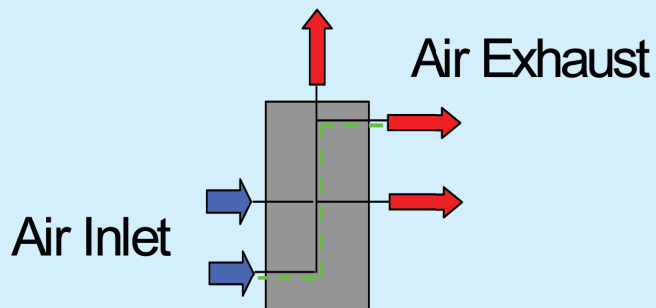


Figure 3: From Page 4-10 of GR-63-CORE, Issue 3, March 2006

NOTE:

GR-63-CORE is currently under review with an estimated completion date of December 2011. The new issue will be Issue 4. Some topics being addressed include:

- Spatial objectives with consideration of newer equipment environments, including wireless sites and telecom data centers.
- Evaluation of industry requirements for energy efficiency and thermal management, such as: target heat dissipation values on a per chassis basis, airflow management, cooling efficiency at the rack level, and proprietary requirements for product efficiency and cooling effectiveness.
- Fire spread and fire hazard characterization requirement review.
- Potential reduction of testing cost for some environmental tests, such as the office vibration test.
- Update of hydrosopic dust test method to reflect the latest methods in GR-1274, Generic Requirements for Reliability Qualification Testing of Printed Wiring Assemblies (PWAs) Exposed to Airborne Hygroscopic Dust.

Furthermore, 15 minutes after flame outbreak, a Class 5 B:C portable fire extinguisher must put out the fire. If one fire extinguisher didn't do the job, the number required was recorded. If you used internal fans, you had to do the test twice.

Bellcore Technical Advisory, TA-NWT-000063, Issue 2, December 1992 introduced the currently used methane line burner. The original test was deemed to be severe. The line burner would be based on burning characteristics of typical printed circuit board. Calorimetric techniques would be used to determine the flame size and duration. As time went on, this method also was deemed too severe as it was tougher on smaller line cards and easier on larger ones.

The test now follows ANSI T1.319-2002 "Equipment Assemblies – Fire Propagation Risk Assessment Criteria". A methane line burner (Figure 4) is inserted into the product and allowed to burn for 5½ minutes following a pre-defined gas flow profile. All nearby flammable material is ignited. This is a simplification. There are many variables, including: fuel load, air flow, compartments, fan use, size and shape of printed circuit boards, and exemptions.

Some design guidelines:

- Understand where and what the flames touch.
- Use metal wherever possible.
- Use the least flammable parts throughout.

- Watch out for flame exposure to printed circuit board edges, including daughter and memory cards.
- Watch your airflow. Fan position is key. Keep fans away from sources that may ignite; recess your fans if possible as being too close to the outside edge could result in flaming material leaving the enclosure.

Earthquake

Will your equipment work after an 8.2 earthquake? Only a seismic test will prove if it does. GR-63-CORE lists five earthquake zones in the continental United States: Zone 0, no ground acceleration, through Zone 4, 0.40g of ground acceleration. California, Nevada, and the junction of Idaho, Montana and Wyoming have the distinction of being in Zone 4. Even though the great majority of products pass this test the first time, it's best to do a thorough review of your mechanical design. Watch especially for cabling prior to the test due to the significant displacement the product will undergo.

GR-1089-CORE

The title of this Telcordia document is "Electromagnetic Compatibility (EMC) and Electrical Safety". As you can see from the list below, major areas of EMC are covered, as are some obvious and unique safety concerns:

- electrostatic discharge
- electromagnetic interference
- lightning and power fault
- steady-state power induction
- DC potential difference

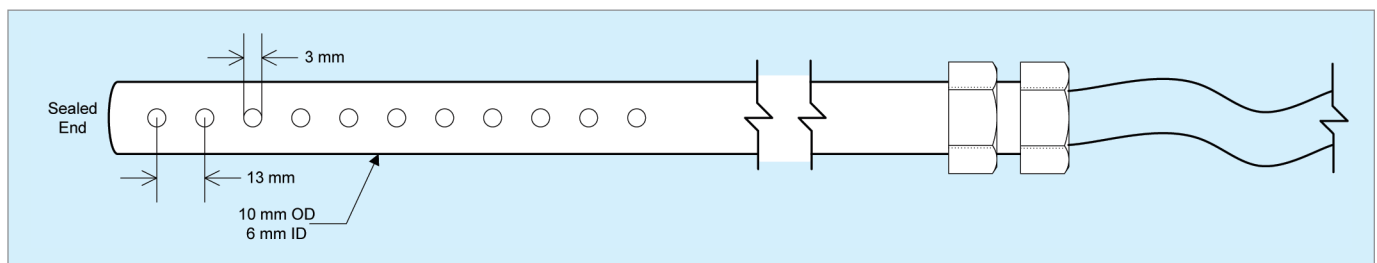


Figure 4

- electrical and optical safety
- corrosion
- bonding and grounding
- DC power port of telecommunications load equipment

Other NEBS related documents include:

- GR-78-CORE, *Generic Requirements for the Physical Design and Manufacture of Telecommunications Products and Equipment*
- GR-3160-CORE, *NEBS™ Requirements for Telecommunications Data Center Equipment and Spaces*
- GR-1217-CORE, *Generic Requirements for Separable Electrical Connectors Used in Telecommunications Hardware*
- GR-468-CORE, *Generic Reliability Assurance Requirements for Optoelectronic Devices Used in Telecommunications Equipment*
- GR-357-CORE, *Generic Requirements for Assuring the Reliability of Components Used in Telecommunications Equipment*
- GR-3028-CORE, *Thermal Management In Telecommunications Central Offices: Thermal GR-3028*
- GR-1221-CORE, *Generic Reliability Assurance Requirements for Passive Optical Components*
- GR-2930-CORE, *Network Equipment Building System NEBS(TM) Raised Floor Generic Requirements for Network and Data Centers*
- GR-2969-CORE, *Generic Requirements for the Design and Manufacture of Short-Life Information Handling Products and Equipment*

There's more to NEBS than physical and electrical protection. Network reliability is key. Emergency phone service depends on it. GR-78-CORE provides guidance on how to design and build reliable products for telecom network use. It applies to design, engineering, manufacturing, and workmanship.

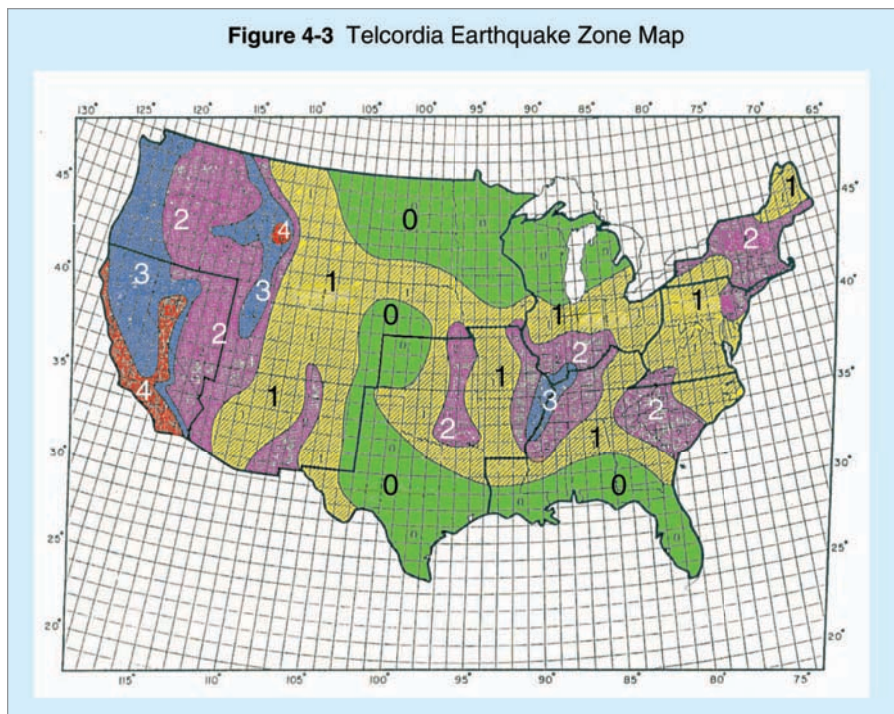


Figure 5: From Page 4-23 of GR-63-CORE, Issue 3, March 2006

But wait, there's more...

With 35,000 COs scattered across the country and tons of equipment from multiple vendors, order must come from chaos. Yes, another document: GR-485-CORE "COMMON LANGUAGE® Equipment Codes (CLEI™ Codes) – Generic Requirements for Processes Guidelines" (pronounced "klee-i"). CLEI Codes are 10-character, alpha-numeric codes having a one to one relationship with a product's part number. The codes are used to identify network equipment, including field replaceable units (FRUs). The largest carriers use CLEI Codes, and they have been adopted by other worldwide carriers. The use of these codes, in the form of a label on your product, help service providers manage their infrastructure and supply chain. There is a cost associated with each CLEI Code.

Even with high availability (99.999% or "5 nines"), something is going to break. COs tend to be lightly manned

so there has to be a method to notify personnel that there's a problem. Enter alarms. Telcordia document GR-474-CORE "Alarm and Control for Network Elements" provides guidance on network equipment maintenance. Your equipment must have a means of tying into the CO's Operations Center when a failure or transient condition occurs. There must be an indication on your product that there's a problem (local indication), a means must be provided to tie into the audible and visual indications that are available at various locations in the CO, and ultimately, trouble indication must find its way to the Operations Center. Contacts on the product are the typical method of notification.

TEAMWORK

It is next to impossible for one person to grasp all of these requirements. Expertise is required in many engineering fields: electromagnetic compatibility, product safety, electrical, mechanical, chemical, and reliability.

It takes a team approach to design, test, and qualify a product to NEBS. A good approach is to appoint a NEBS technical lead who has an excellent grasp of the requirements and can manage the program, or hire a NEBS consultant. ■

REFERENCES

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- Lorusso, D., *EMC Pre-testing Simplifies NEBS Compliance*, ITEM Publications' Interference Technology, May, 2008.
- Telcordia ROADMAP-TO-NEBS-1 *Telcordia Roadmap to NEBS™ Documents*.

- GR-63-CORE, *NEBS™ Requirements: Physical Protection*.
- GR-1089-CORE, *Electromagnetic Compatibility and Electrical Safety – Generic Criteria for Network Telecommunications Equipment*.
- SR-3580, *NEBS Criteria Levels*.
- GR-78-CORE, *Generic Requirements for the Physical Design and Manufacture of Telecommunications Products and Equipment*.
- GR-485-CORE, *COMMON LANGUAGE® Equipment Codes (CLEI™ Codes) – Generic Requirements for Processes Guidelines*.
- ANSI T1.319-2002, *Equipment Assemblies – Fire Propagation Risk Assessment Criteria*.
- IEC 60950, *Information Technology Equipment – Safety – Part 1: General Requirements*.

RESOURCES

- www.nebs-faq.com (Resource for NEBS Compliance information)
- www.telcordia.com (The creator and keeper of NEBS documents)
- www.verizonnebs.com (Verizon's NEBS Compliance Web Page)

(the author)

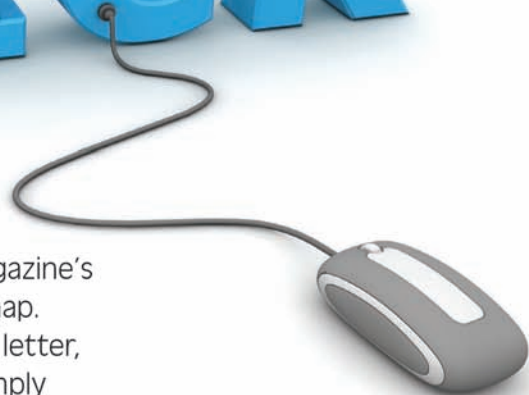
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