What Every Startup Needs To Know About NEBS

by Dave Lorusso, General Bandwidth

As a startup company, General Bandwidth knew that survival depended on getting our flagship product—the G6® Telecommunications Platform—to market as quickly as possible. With that as the goal, we were able to take the platform through an NRTL to achieve NEBS Plus in just two months. (G6 Block Diagram)

The G6 enables service providers to cost-effectively deploy voice over a broadband infrastructure to better use existing resources by efficiently aggregating access network traffic and provide a migration path to end-to-end packet networks. The rack-mounted electronics chassis functions as a multi-application platform product, permitting the translation of circuit to packet switched voice, data aggregation, and a migration from ATM to IP technologies.

Designed for the service providers' CO, the chassis measures 22.75" tall (13U) and 12" deep. The chassis card cage supports 18 front module slots, a fan tray, and an air filter tray. It can be either front- or mid-mounted in a 19" or 23" rack or cabinet. An EMI gasket is located on the right side of each of the modules.

NEBS Plus

NEBS Plus describes the requirements of RBOCs and other carriers that are over and above the traditional NEBS requirements. The four RBOCs as well as the IXC AT&T require full compliance to Telcordia GR-63-CORE and GR-1089-CORE. However, there are additional requirements/clarifications deemed necessary in their respective networks.

RBOC/IXC Specific Requirements

Verizon's SIT.NEBS.TE.NPI.2000.004 document provides clarification and details a few additional requirements:

- At 15 minutes into the fire-resistance test, flames shall be extinguished, and there shall be only minimal wisps of smoke from the equipment. The rationale for this criterion is that smoke causes more damage to telecommunications equipment than fire. COs have a sprinkler exemption. This exemption will stay in place as long as the RBOCs/IXCs minimize fire incidents.
- Verizon requires a specific cable configuration for EMC tests that mimics the cable trays in the COs. The RBOCs are exempt from FCC Part 15 as long as they self-police their networks. They do this by requiring an equipment vendor to meet radiated and immunity EMC from 10 kHz to 10 GHz. The FCC Part 15 range for radiated emissions is 30 MHz to 1 GHz and could be considered a subset of the GR-1089-CORE range.

SBC's TP76200MP physical design document details special DC power and seismic requirements:

- Proper equipment operation over a range of -42 VDC to -56.7 VDC.
- Transients of 0 V for 5 ms, -75 VDC for 10 ms, and DC noise immunity.
- Seismic requirements due to the location of some COs in earthquake-prone areas.

Qwest emphasizes altitude requirements up to 4,000 m, which in turn, directly impact thermal requirements. Heat-dissipation calculations are required for each shelf, individual cards, and scalable card options. Qwest plans to develop a NEBS checklist to assist equipment vendors.

AT&T has its own set of requirements called NEDS. Some additional requirements are:

- Systems exhausting more than 50 W/sq ft must exhaust the air vertically.
- Special considerations must be given to the use of OR-ing diodes that combine power feeders, such as appropriately sized over-current protection devices present in each power path to the unit, within the network element; diodes included in each power path return of the unit; and proper derating.
- Equipment must have the capability to automatically recover from the low input voltage shutdown.
- Equipment must withstand various overvoltage transients.
- If a fan is used, an airflow sensor is required to detect a clogged fan.

Spatial Requirements

The G6 was designed to meet the 12" depth NEBS spatial objective for deployment in established COs. If a vendor can design equipment to be 12" deep, it can be installed in existing available space with little or no facility modifications.

Management Commitment

Corporate goals cannot be achieved without management commitment. The founders of General Bandwidth made sure its commitment to NEBS Plus would be taken seriously: Achieving NEBS Plus was a stated corporate goal.

NEBS Plus has significant upfront costs. But the payback is a robust product that will provide years of trouble-free service.

Experienced engineers were needed with a background in the NEBS design process. In particular, a compliance manager was recruited to head up the program and had the authority to make compliance decisions for the company.

Test equipment was acquired for early prototype testing: a spectrum analyzer, an ESD simulator, an ESD ground plane, traffic simulators, and two 1,500-W room heaters (used as a load for the Second-Level Intrabuilding AC Power Fault Test).

Getting to market on time is crucial in a highly competitive industry such as telecommunications and especially crucial for a startup. Most startups have one shot at this to survive. For this reason, achieving NEBS Plus at the end of product development was critical to our success. Not having a specific RBOC/IXC as a customer, we had to design our product to NEBS Plus.

Early Involvement

Early compliance involvement is mandatory for a successful NEBS Plus program. We emphasized fire and EMC mitigation techniques to achieve a compliant design.

Fire

Even though the G6 mechanical design was developed with fire resistance in mind, problems arose. On May 31, 2000, during early fire testing on the first prototype, catastrophe struck. The back of our unit looked like a blowtorch after one minute and had to be put out after two minutes. We had no Plan B; our prototype was practically destroyed.

We decided it was better to burn now than later, so it was back to the drawing board. We investigated ways to use baffles, perforated panels, even a fancy infrared sensor. We also examined ways to stop the fan. We settled on letting the fans run and using the mechanical design plus a metal back module cover to solve the problem.

EMC

With the help of an EMC consultant, potential EMC problems were mitigated. We conducted an in-house Design for EMC Seminar as well as numerous EMC reviews as the design progressed. The results were astounding; we were almost FCC Class B during our first official NRTL EMC testing.

Good EMC design practice minimizes potential EMC problems. This was achieved by a combination of proper multilayer board stackup definition and component placement, signal-line filtering, and enclosure shielding. Each board was reviewed multiple times by EMC rule-based application software.

Planning

Nothing good happens without proper planning. We didn't want to rely on luck with our one shot at NEBS Plus. We listed our requirements for an ideal NRTL in order of importance:

- Customer acceptance.
- Competence.
- Working relationship.
- Schedule flexibility.
- Proximity.

We interviewed three NRTLs and, based on our requirements, chose SwRI in San Antonio, TX. Early meetings were held with SwRI to cover logistics. Once a final quote was obtained, our compliance manager and the SwRI senior project engineer hammered out a schedule four months prior to testing.

Five G6 units were presented for testing to reduce time. Multiple samples provided flexibility. Our schedule changed as testing progressed, but we were ready for any contingency.

For example, the one area we paid little attention to—equipment packaging—almost hurt us. The G6 chassis was damaged during the packaged drop test. Having extra units allowed us to redesign the packaging, retest, and pass.

We made it a point to have at least one of our engineers and/or technicians present during all tests. This strategy helped to provide a smooth test program. Questions were answered on the spot, and the schedule was maintained.

Cost

Yes, it's expensive, but worth it. Designing for NEBS Plus means reliability is designed into the product, which translates into lower warranty costs.

The incremental cost over a similar commercial product is about 7%. The incremental manufacturing cost is about 2%. Compared to

a commercial product, NEBS adds an extra 9% (see **Table 1** below).

Table 1. Incremental Product Cost

Criteria	Cost	Rationale
ESD	Free	Similar requirements for a commercial product
EMC	Free	FCC Class A is a subset of GR-1089-CORE; designing in EMC from 10 kHz to 10 GHz adds no significant cost
Surges	3.00%	With lines going to Outside Plant, GR-1089-CORE surge protection is required covering lightning, power cross, and steady-state power induction
Safety	Free	If designing to UL 60950, these requirements will be met, including bonding and grounding
Spatial	Free	When considered up front, designing for a 12" depth does not cost extra
T/H/A	3.00%	Some industrial-rated components are required to go from -5°C to 55°C
Fire	0.50%	Extra metal typically required to pass this test
Handling	Free	When the product is designed to pass Zone 4, it will handle handling tests; insignificant cost involved with the packaging
Seismic	0.50%	Surprisingly, little cost is added to meet this; use good mechanical engineering practice
Contaminants	Free	Proper selection of components and layout required
Acoustics	Free	Similar requirements for a commercial product
Illumination	Free	Proper finish selection required
Manufacturing	2%	For meeting GR-78-CORE requirements

Lessons Learned

- Test, test, and test some more as early as possible.
- Perform a burn test early, and perform it first during final testing.
- Have a Plan B.
- Hold compliance design reviews.
- Hire an EMC engineer/compliance engineer.
- Hire consultants to review paper designs and then physical designs.
- Use multiple samples; you reduce stress on the equipment and yourself.
- It’s expensive, but it’s worth it.

Conclusion

The upfront costs pay for themselves when you get to market early. Designing in NEBS adds insignificant cost to the product and results in a robust design. Once NEBS Plus is achieved, the process continues. Each product enhancement is looked at in the same methodical way.

Glossary

ATM	asynchronous transfer mode
CO	central office
IXC	interexchange carrier
IP	Internet Protocol
NEBS	network equipment building system
NEDS	network equipment development standards
NRTL	nationally recognized testing laboratory
RBOC	Regional Bell Operating Company (Verizon, SBC, Qwest, Bell South)
SwRI	Southwest Research Institute
T/H/A	temperature, humidity, altitude

References

AT&T MLID# 9069 *Network Equipment Development Standards (NEDS)*

SBC TP76200MP *Network Equipment Power, Grounding, Environmental, and Physical Design Requirements*

Telcordia GR-63-CORE *Network Equipment-Building System (NEBS) Requirements: Physical Protection*

Telcordia GR-78-CORE *Generic Requirements for the Physical Design and Manufacture of Telecommunications Products and Equipment*

Telcordia GR-1089-CORE *Electromagnetic Compatibility and Electrical Safety—Generic Criteria for Network Telecommunications Equipment*

Underwriters Laboratories, UL 60950 *Safety of Information Technology Equipment*

Verizon SIT.NEBS.TE.NPI.2000.004 *NEBS Compliance Checklist*

Resources

www.genband.com (Videos of the Seismic, Fire, and Packaging tests can be seen online, click on Media Center and view Technical Tests)

www.nebs.swri.org (Southwest Research Institute NEBS Testing)

www.verizonnebs.com (Verizon's NEBS Compliance Web Page)

www.nebs-faq.com (Resource for NEBS Compliance information)

www.telcordia.com (The creator and keeper of NEBS documents)

www.montrosecompliance.com (Montrose Compliance Services - EMC)

www.wwwilsonassoc.com (Product Safety Consulting Services)

www.pcb.cadence.com/product/simulation/specctraquest/ (Cadence's knowledge-based design rules checking for common EMI-related placement and routing issues)

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