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Product Environmental Requirements for Cable Telecommunications Facilities

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1 Introduction

This specification provides physical, environmental, electrical and sustainability requirements for equipment deployed in mission critical cable system headends, hub sites and data centers.

1.1 Purpose

The specification purpose is to define product environmental and sustainability requirements 1) by referencing existing international standards, 2) by using requirements from cable operator specifications, and 3) by adding cable system specific requirements as needed. It is not the intent of this document to replace existing standards or cable operator requirements.

1.2 Scope

This specification defines product physical, environmental, electrical, and sustainability requirements during transportation, storage, operation, and disposal. The specification is limited to indoor shelf, frame, rack, and cabinet level mission critical cable systems equipment. Facilities for which this specification generally applies are network data centers and cable headends. This specification also applies to unmanned or remotely monitored distribution hubs where hub location, construction, and HVAC capabilities can result in less tightly controlled ambient operating climates and longer duration environmental stresses. The specification does not address requirements for outside cable plant equipment.

1.3 Target Equipment

Example equipment includes CMTSs, receivers, modulators, video encoders, multimedia gateways, servers, routers, switches, network equipment, network storage units, edge routers, add-drop multiplexors and edge QAMs. Uninterruptable Power Supplies are not in scope for this document.

1.4 Requirements Syntax

Throughout this document, specific words are used to define the requirements significance. These words are:

“shall"	This word means that the item is an absolute requirement of this specification.
"shall not"	This phrase means that the item is an absolute prohibition of this specification.
"should"	This word means that there may be valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighed before choosing a different course.
"should not"	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
"may"	This word means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.

1.5 Document Structure

This document is structure is provided in Table 1-1.

Table 1-1: Document Structure

Section #	Section Title	Description
1	Introduction	This section defines the document purpose, scope, targeted equipment and requirements syntax. It also provides a summary of the content for each top level document section.
2	Physical Requirements	This section describes the equipment physical requirements. It identifies applicable frame and cabinet physical criteria, equipment labels, and cable routing criteria.
3	Environmental Requirements	This section specifies environmental requirements. This includes requirements for equipment storage, transportation, handling, operation and safety. Requirements for equipment climate, vibration, shock, earthquake resistance and contamination resistance are specified.
4	Electrical Requirements	This section specifies equipment Electrical Static Discharge (ESD), Electromagnetic Compatibility (EMC), and grounding/bonding requirements. EMC criteria include radiated emissions, conducted RF emissions, RF immunity, Electronic Fast Transient (EFT) immunity and surge immunity.
5	Sustainability Requirements	This section addresses equipment energy efficiency, energy monitoring, and equipment ecology. Methods to evaluate equipment efficiency, to monitor power consumption, to monitor equipment temperature and to configure equipment efficiency are included. Equipment ecology provides guidelines for environmentally conscious equipment design, manufacturing, and disposal. This includes product life cycle management, material selection, hazardous waste material handling, and material recycling requirements. The ecology section also specifies equipment airflow, heat release, and acoustic emissions.
6	Quality Requirements	This section addresses requirements to assess product quality and reliability.
	Appendices	Appendices list normative and informative references used in this document.

1.6 Acronyms

Table 1-2: Acronyms

AC	Alternating Current
ANSI	American National Standards Institute
ASD	Acceleration Spectral Density
ASHRAE	American Society of Heating, Refrigerating and Air-conditioning
ATIS	Alliance for Telecommunications Industry Solutions
BER	Bit Error Rate
BOB	Buffered on Board
CFM	Cubic Foot per Minute
CFR	Code of Federal Regulations (US)
CE	Consumer Electronics
CISPR	Special International Committee on Radio Interference
DC	Direct Current
DCS	Digital Cross Connect Systems
eCFR	Electronic Code of Federal Regulations (US)
EC	European Community
ECC	Error-correcting Code
ECMA	Ecma International® *(formally European Computer Manufacturers Association)*
EFT	Electronic Fast Transient
EIA	Electronic Industries Alliance
EMC	Electromagnetic Compatibility
ETSI	European Telecommunications Standards Institute
EUT	Equipment Under Test
ICT	Information and Communication Technology
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
ISDN	Integrated Services Digital Network
IT	Information Technology
ITE	Information Technology Equipment
MPEG	Motion Picture Experts Group
PDA	Personal Digital Assistant
PSTN	Public Switched Telephone Network
OEM	Original Equipment Manufacturer
OS	Operating System
QAM	Quadrature Amplitude Modulation
RAM	Random-access Memory
ROADM	Reconfigurable Optical Add-drop Multiplexer
RoHS	Restriction of Hazardous Substances
SCTE	Society of Cable Telecommunications Engineers
SDH	Synchronous Digital Hierarchy
SONET	Synchronous Optical Network
SMS	Sustainability Management Subcommittee
SPEC	Standard Performance Evaluation Corporation
TEER	Telecommunications Energy Efficiency Ratio
U	Unit, Short for Rack-Unit, Measure of vertical rack space, 1U=1.75” (44.45mm)
USB	Universal Serial Bus
WDM	Wavelength-division Multiplexer

2 Physical Requirements

2.1 Frame and Cabinet

1. Equipment frames and cabinets should comply with international standards for uniform frameworks.
2. Open racks should comply with ***EIA/ECA-310-E-2005****: Cabinets, Racks, Panels, and Associated Equipment* Recommended open rack dimensions are:[1]
    - Height: 2130 mm *(84 in)*
    - Width: 560 mm *(23 in)* for 19-inch equipment
      660 mm *(26 in)* for 23-inch equipment
    - Depth: 300 *(12 in)* with extenders to support wider depth equipment as needed
3. Closed frames, cabinets and equivalent frameworks should comply with ***ANSI T1.336-2009****, Engineering Requirements for a Universal Telecom Framework.* Noteworthy criteria specified in ANSI T1.336-2009 includes:
    - Cabinet outer dimensions based on ***EN 300 119-2, V2.1.2, 2009-12;*** *Environmental Engineering (EE); European telecommunications standard for equipment practice; Part 2: Engineering requirements for racks and cabinets* and ***EN 300 119-3, V2.1.2, 2009-12****; Environmental Engineering (EE); European telecommunications standard for equipment practice; Part 3: Engineering requirements for miscellaneous racks and cabinets*
        - Widths: 600, 750, 900 mm (23.62, 29.52, 35.43 inches)
        - Depths: 600, 750, 900 mm (23.62, 29.52, 35.43 inches)
        - Heights: 2130 mm (84.0 inches)
    - Three recommended minimum rated equipment loads of 441, 882, and 1323 pounds
    - Required static load tests with a maximum deflection point of 50 mm (2 inches) when subjected to a static force twice the rated load capacity.
    - Dynamic load tests per ***ATIS 0600329, Edition 8 2008****, Network Equipment Earthquake Resistance*
    - Fire resistant compliant with ***ANSI T1.307-2007****: Fire Resistance Criteria – Ignitability Requirements for Equipment Assemblies, Ancillary Non-Metallic Apparatus, and Fire Spread Requirements for Wire and Cable*
    - Ground bonding between frames per **ATIS-0600333.2007,** *Grounding and Bonding of Telecommunications Equipment*
4. No protrusions shall extend beyond a cabinet front or rear.
5. Frames shall provide holes in a horizontal surface at the base of the frame to allow anchoring to the floor.
6. **S**helf level equipment shall provide brackets (or equivalent methods) that support equipment mounting to a variety of cabinet widths and depths. Dimensions that should be supported are provided in Table 2-1.

[1] These are the open rack dimensions recommended in GR-63-CORE for central offices and equivalent facilities.

Table 2-1: Example Cabinet Dimensions[2]

Width (inches)	Depth (inches)	Height (height)	U	TYPE
19	16.5	84	45	Open rack
19	24.289	83.72	45	Open rack
21.063	32.063	85.875	45	Cabinet
23.62	42.13	78.39	42	Cabinet
23.62	42.13	88.9	48	Cabinet
27.16	43.37	84.5	45	Cabinet
27.6	43.3	78.5	42	Cabinet
29.53	42.13	78.39	42	Cabinet
29.53	42.13	88.9	48	Cabinet
31.5	46.5	84	45	Cabinet
31.5	48	95	51	Cabinet

2.2 Equipment Static Load

No mechanical damages or visible deformation shall occur when the equipment housing is subjected to a static load of 25 lbs. for a period of one (1) minute. This equipment shall withstand the static load when applied to the top, bottom, right side, and left side of the equipment both when it is free standing and when it is housed in a rack or cabinet using the OEM supplied mounting brackets.

2.3 Impact Force Resistance

After impact force of 5.0 ft-lbs. by free fall of a 2 inch diameter, 1.18 lb. solid smooth steel sphere on all chassis surfaces except surfaces housing electronics or connectors, the equipment:

1. Shall not be distorted in any manner such that wire-to-ground or wire-to-chassis spacing is reduced below the following values:
    a. For Vrms peak <= 50: 1/16”
    b. For 50 < Vrms peak <= 150: 1/4"
    c. For 150 < Vrms peak <= 600: 1/2"
2. Shall not be distorted such that the chassis contacts any non-insulated high voltage surfaces or components.
3. Shall not cause any open exposures to non-insulated parts.

2.4 Microphonics Emissions

Mechanical shocks or vibrations to operating equipment with a minimum impact energy of 0.7 joules (Newton/meters) shall not cause output port spurious signals, electrical noise, signal interruptions, or signal discontinuities.

2.5 Dissimilar Metals – Galvanic Compatibility

Galvanic Compatibility is defined as the differential in Anodic Index Voltage between the various metals at the junction. The maximum Anodic Index (V) differential limit for equipment shall not be greater than +/-0.50 Volt.

2.6 Equipment labels and markings

1. Equipment vendor and product identification shall be visible when the unit is installed.
2. Labels for equipment user panels, connectors, controls, and power connections shall be shall be visible when unit is installed and shall be located near their intended function.
3. Equipment certifications, compliances, approvals, and warning labels shall be visible when the unit is installed and shall be provided in the equipment user documentation.
4. Labels that display serial numbers, MAC addresses and similar information shall be visible when the equipment is installed.
5. Labels shall be implemented in sufficient contrast to assure legibility in non-optimum lighting.

[2] These rack dimensions were identified in a survey of racks and cabinets in facilities of one major North American MSO.

6. Labels shall not peel, wear, crack, fade or blister in the environmental conditions in which the equipment will operate.
7. Shelf level equipment labels should not be placed on the top, bottom, or side.
8. Equipment should provide an area to affix a MSO placed equipment barcode or equivalent label.

Laser light emitting ports shall be capped or shuttered, and equipment containing laser outputs of Class 2 or higher shall contain Warning, Explanatory and Aperture labels and documentation in accordance with ***21CFR1040****;"PERFORMANCE STANDARDS FOR LIGHT EMITTING PRODUCTS", Code of Federal Regulations, Title 21—Food and Drugs, Chapter 1-Food and Drug Administration, Department of Health and Human Services, Subchapter J-Radiological Health, Part 1040, 21CFG1040.10* and/or ***IEC 60825-1, Edition 2.0,*** *Safety of Laser Products – Part 1: Equipment Classification and Requirements.*

2.6.1 Packaging and Shipping Labels

1. Equipment package bar code shall be placed such that it can be read and/or scanned without removing the equipment from its package or wrapping material.
2. Equipment shipping package shall have bar codes indicating its contents placed on the front upright surface.
3. Equipment packaging shall comply with **CEA-556-C**, *Outer Shipping Container Label Standard*.
4. Equipment packaging shall comply with **CEA-624-A,** *Product Package Bar Code Label Standard for Non-Retail Applications.*

2.6.2 ESD Labels and Documentation

1. Equipment shall be labeled in compliance with **EIA-471-1996,** *Symbol and Label for Electrostatic Sensitive Devices*.
2. The ESD label should be located on the equipment front. Alternative locations may be used if there is no room for a front of equipment label.
3. Equipment documentation shall specify any ESD sensitivity issues.
4. Instructions and procedures to prevent ESD problems shall be provided in the equipment user documentation.

2.7 Agency Compliance

1. Equipment shall comply with applicable international, national, and local compliance agencies. Examples include FCC Part 15, FCC Part 76, UL 60950-1 (or IEC/EN 60950-1), and IEC 60065.
2. Equipment should comply with ***(RoHS)*** *Directive 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast).* This directive set criteria to eliminate the use of hazardous materials such as lead, mercury, cadmium, hexavalent chromium, poly-biphenlysi (PBB) or polybrominated diphenyl (PBDE) from electronic and electrical products.

2.8 Equipment Cable Routing

Equipment that requires large amounts of cabling should support methods to facilitate cable routing to cable conduits in a manner that eliminates or minimizes the interference to equipment cooling airflow intake and exhaust ports. Example methods included cable trays, routing strap attachments, cable routing brackets, etc.

2.9 Floor Loading

1. Equipment vendors shall include accurate product weight in kilograms (grams) and pounds in the product documentation.
2. Modular equipment with numerous configuration options shall include accurate weight of plug-in modules as well as instructions or web sites to compute product weight based on equipment configuration.

3 Environmental Requirements

This section documents equipment transportation, storage, and operating environmental requirements. Criteria in this section is based on 1) requirements commonly used when developing carrier grade products; 2) requirements currently included in operator proprietary specifications; and 3) requirements specifically requested by operators. Limits relating to climate, contamination, mechanical shock, mechanical vibration, and earth quake resistance are specified.

3.1 Climate

3.1.1 Transportation/Storage Temperature and Humidity

During transportation or storage, equipment can be exposed to extremes in ambient temperature and humidity. The criteria in this section apply to equipment in its public transportation shipping container. After the equipment is exposed to the given environment, it is returned to ambient, unpackaged and operated. Conformance is based on the equipment's ability to operate as intended when returned to ambient conditions.

1. Packaged equipment shall not be damaged or deteriorate in operational performance after exposure to the Low Temperature conditions specified in the Table 3-1.
2. Packaged equipment shall not be damaged or deteriorate in operational performance after exposure to the High Temperature conditions specified in the Table 3-1.
3. Packaged equipment shall not be damaged or deteriorate in operational performance after exposure to the High Humidity criteria specified in Table 3-1.
4. Equipment providers shall document performance limitations and/or special operating requirements within the operating climate specified in this section for which the equipment will not function without performance degradation or impairment.

Table 3-1: Transportation/Storage Temperature and Humidity Criteria

Parameter		% Relative Humidity	Temperature	Transition / Rate of Change	Soak Duration
Low Temperature	Ramp	Not Controlled	23°Cto -40°C (73°F to -40°F)	30°C/Hr (54°F/hr)	---
	Soak		-40°C (-40°F)	---	72 Hrs
	Shock		-40°C to 23°C (-40°F to 73°F)	≤ 5 minutes	---
High Temperature	Ramp	Not Controlled	23°Cto 70°C (73°F to 158°F)	30°C/Hr (54°F/hr)	---
	Soak		70°C (158°F)	---	72 Hrs
	Shock		70°C to 23°C (158°F to 73°F)	≤ 5 minutes	---
High Humidity	Temperature Change	50% RH	23°C to 40°C (73°F to 104°F)	30°C/Hr (54°F/hr)	---
	Humidity Change	50% to 93% RH	40°C (104°F)	< 2 Hrs	
	Soak	93% RH	40°C (104°F)		96 Hr
	Humidity Change	93% to 50% RH	40°C (104°F)	< 2 Hrs	--
	Temperature Change	50% RH	40°C to 23°C (104°F to 73°F)	30°C/Hr (54°F/hr)	

3.1.1.1 Thermal Shock (non-powered)

1. Equipment may comply with three cycles of the thermal shock criteria specified in Table 3-2. These limits are required by at least one operator for headend equipment.

Table 3-2 : Thermal Shock Tests (Non-powered)

Parameter		% Relative Humidity	Temperature	Transition / Rate of Change	Soak Duration
Thermal Shock (Not Powered)	Soak 1	Not Controlled	-40°C (-40°F)		30 minutes
	Shock 1		-40°C to 25°C (-40°F to 77°F)	≤ 5 minutes	
	Soak 2		25°C (77°F)		10 minutes
	Shock 2		25°C to 60°C (77°F to 140°F)	≤ 5 minutes	
	Soak 3		60°C (140°F)		30 minutes
	Shock 3		60°C to 25°C (140°F to 77°F)	≤ 5 minutes	
	Soak 4		25°C (77°F)		10 minutes

3.1.1.2 Humidity Shock (non-powered)

1. Equipment may comply with high humidity criteria specified in Table 3-3. Compliance with the criteria, which is based on MIL-STD-810d, Method 507.2, Procedure III-Aggravated, is required by at least one operator for headend equipment.
2. For this procedure, equipment shall be tested outside of its shipping encasement.
3. After exposure to 10 cycles of the criteria specified in Table 3-3, complying equipment shall be fully operational and meet all specifications.

Method 507.2 "exposes the test item to extreme temperature and humidity levels not found in nature but for shorter durations. It is used to reduce the time and cost of testing. This procedure helps identify potential problem areas, and the test levels are, for all practical purposes, fixed"[3]. Example problem areas that might be identified using this procedure include:

- Corrosion
- De-lamination of composite materials
- Quality control deficiencies
- Dimensional changes due to bowing or swelling of fibrous materials
- PCB surface resistivity changes
- PCB laminates out-gassing
- PCB manufacturing defects or impurities
- PCB electrolytic corrosion and electrical shorts
- Connector corrosion, electrical opens, and electrical shorts
- Brittle plastics
- Electrostatic susceptibility

Table 3-3: Aggravated Thermal Shock and Humidity Test Criteria

Parameter		% Relative Humidity	Temperature	Transition / Rate of Change	Soak Duration
High Humidity[1]	Temp and Humidity Change	85% to 95% RH	30°C to 60°C (86°F to 140°F)	2 hours	
	High Temp Soak	95% +/- 5% RH	60°C (140°F)		6 Hrs
	Temp Change	Maintain 85% to 95% RH	60°C to 30°C (140°F to 86°F)	8 hours	---
	Low Temp Soak	95% +/- 5% RH	30°C (86°F)		8 Hrs

Notes:
[1] Mil-Std 810d, method 507.2 Procedure III-Aggravated

3.1.2 Operating Temperature and Humidity

Equipments shall meet the operating temperature and humidity criteria specified in Table 3-4.

[3] MIL-STD-810D, Page 117.

Table 3-4: Operating Temperature and Humidity

Parameter	Temperature			% Relative Humidity[1]			
	Minimum	Nominal	High	Low	Nominal[2]	High	Condensing
Normal Operating	0°C (32°F)	21°C ±1°C (70°C±2°C)	50°C (122°F)	5%	45%±5%	95%	Non
Shelf Equipment-Short Term Operating[3]	-5°C (23°F)	---	55°C (131°F)	5%	---	90 %	Non

Notes:

[1] Humidity Ratio not to exceed 24 g water/kg of dry air.

[2] Nominal temperature and humidity in this table are the objective data center values recommended on page 2-13 of **GR-3160-CORE Issue 1, November 2008;** *NEBS™ Requirements for Telecommunications Data Center Equipment and Spaces*

[3] Short-term refers to 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 that1-year period.)[4]

3.1.3 Operating Altitude

1. For altitudes from -61 m to 3048 m (-200 ft to 10000 ft), equipment shall operate within the temperature range of 0 to 50C (32°F to 122°F).
2. For altitudes between 3048 m to 4000 m (10000 ft to 13000 ft), equipment should function without impairment with normal operating ambient aisle temperatures between 0° and 40°C (32°F to 104°F).
3. Equipment manufacturers shall document performance limitations and/or special operating requirements within the operating climate specified in this section for which the equipment will not function without performance degradation or impairment.

3.1.4 Operating Internal Temperature Margin

At least one operator requires vendors supply the following equipment operating internal temperature margin criteria:

1. The equipment vendor should provide detailed information regarding equipment internal temperature rise above ambient at 0°C, 25°C, and 50°C.
2. The equipment vendor should provide detailed information in pictorial and chart format pinpointing and identifying temperature of all major equipment components.
3. The equipment vendor should provide detailed information relating to the maximum safe operating temperature for each major component. This data should be provided in tabular format and include manufacturer's specified critical component data including ThetaJA, ThetaJC, maximum power dissipation, maximum case temperature, maximum junction temperature and ambient temperature around each component.
4. The equipment vendor should supply data corresponding to any heat sinks, thermal compounds, and CFM of airflow directed at specific locations. This data should include sufficient thermal characterization information to determine design overhead to maximum critical junction temperatures.

3.1.5 Equipment Cooling Fans

1. Equipment with multiple fans shall operate normally on a single fan failure.
2. Equipment shall signal loss of a fan or fan bank.
3. The loss of fan or fan bank signal should include front panel status lights and remote element management or operational support protocol event reporting.
4. Equipment with fan modules shall support fan or fan bank replacement without disrupting equipment operation.
5. Equipment with fans should support trained operator fan or fan bank replacement.

[4] ***GR-63-CORE, Issue 3, March 2006****; NEBS Requirements: Physical Protection*

6. Equipment operating instructions shall document fan or fan bank replacement procedures.
7. Equipment manufacturers shall document any fan software-control features.

3.1.6 Equipment Surface Temperature

1. Equipment touchable surfaces shall not exceed limits specified in Table 3-5.
2. For ambient temperature up to 50°C, equipment surface to ambient temperature difference to all touchable surfaces should be ≤ 15° C above the ambient temperature.
3. Equipment vendors shall document any deviations to the equipment surface temperature requirements specified in this section.

Table 3-5: ATIS-060004.2006 Touchable Equipment Surface Temperature Limits[5]

Specification Criteria				**Notes**
Maximum Surface Temperature at ambient temperature at 23°C				
Type	**Contact °C (°F)**	**Periods in Normal Use °C (°F)**	**Prolonged Use °C (°F)**	**[1], [2], [3], [4]**
Uncoated Metal	65 (149)	55 (131)	48 (118)	
Coated Metals	74 (165)	56 (133)	48 (118)	
Plastics	85 (185)	70 (158)	48 (118)	

Notes:
1. **[1] Uncoated metals** may be plated and/or have a conversion coating. Conversion coatings are assumed to be thermally conductive
2. **[2] Contact:** Incidental contact may be accidental and is very short in duration: 1 second or less
3. **[3]** Parts held in **normal use**, are expected to be held up to 10 seconds. Examples may include extractor taps, handles, knobs, and grips. Examples may also include surfaces handled during maintenance, repair, or upgrade.
4. **[4] Prolonged use** is anywhere between 10 seconds and 10 minutes. Examples may include surfaces handled during more extensive maintenance and repair procedures.

3.2 Shock and Vibration

Equipment undergoing commercial transportation can be subjected to complex low-level vibrations of randomly distributed frequencies and transient peaks. Equipment can also be subjected to drops and mechanical shock during transportation, storage, and installation. Operating, equipment can be subject to normal office vibrations from sources such as vibrations from nearby equipment, nearby vehicles, close proximity construction work, and hurricanes. Operating equipment can also encounter extreme shock such as that caused by an earthquake.

3.2.1 Packaged Equipment Free Fall Drop

The free fall drop criteria specified in this section is segmented into equipment weighing less than 100 kg (220.5 lbs) and equipment weighing 100 kg (220.5 lbs) or greater.

3.2.1.1 Equipment < 100 kg

Equipment weighing < 100 kg (220.5 lb) packaged by the vendor for public transportation shall not be physically damaged and shall operate normally without performance degradation after exposure to free fall drop limits specified in Table 3-6.[6]

[5] ***ATIS-060004.2006,*** *Equipment Surface Temperature*, Table 1

[6] Data is from Class T 2.3 free fall drop limits specified in Table 7 of ***EN 300 019-2-2, V 2.1.2, 1999-09****; Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 2-2: Specification of environmental tests; Transportation*

Table 3-6: Free Fall Drop Limits

Gross Mass	Drop Height
< 15 kg (< 33.1 lb)	1.0 m (39.6 in)
< 20 kg (< 44.1 lb)	0.8 m (31.5 in)
< 30 kg (< 66.2 lb)	0.6 m (23.6 in)
< 40 kg (< 88,2 lb)	0.5 m (19.7 in)
< 50 kg (< 110.2 lb)	0.4 m (15.8 in)
< 100 kg (< 220.5 lb)	0.3 m (11.8 in)

3.2.1.2 Equipment ≥ 100 kg

Palletized equipment weighing ≥ 100 kg (220.5 lb) packaged by the vendor for public transportation shall not be physically damaged and shall operate normally without performance degradation after exposure to free fall drop height of 100 mm (3.9 in).

3.2.2 Unpacked Equipment Free Fall Drop

Equipment packaged by the vendor for public transportation shall not be physically damaged and shall operate normally without performance degradation after exposure to free fall drop limits specified in Table 3-7.

Table 3-7: Unpacked Equipment Free Fall Drop[7]

Gross Mass	Drop Height
0 to < 10 kg (0 to < 22 lb)	100 mm (3.9 in)
10 to < 25 kg (22 to < 55.1 lb)	75 mm (3 in)
25 to < 50 kg (55.1 to < 110.2 lb)	50 mm (2 in)
≥ 50 kg (≥ 110.2 lb)	25 mm (1in)

3.2.3 Transportation Mechanical Shock

Equipment packaged for public transportation shall not be damaged and shall operate normally without performance degradation after exposure to mechanical shock limits specified in Table 3-8.

Table 3-8: Transportation Mechanical Shock[8]

Mechanical Shock Spectrum Type	I	II
Duration	11 ms	6 ms
Peak Acceleration (See Note [1]) **(m/s^2)** **(g)**	 100 m/s^2 10.2 g	 300 m/s^2 30.6 g

.

[7] Data is from Table 4-9 of ***GR-63-CORE, Issue 3, March 2006****; NEBS Requirements: Physical Protection*

[8] Class 2.3 transportation mechanical shock criteria from Table 5 ***EN 300 019-2-2, V 2.1.2, 1999-09****; Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 2-2: Specification of environmental tests; Transportation*

Notes:

[1] **The unit of measure** of acceleration in the International System of Units (SI) is m/s^2. In North America, the unit g is often used - the acceleration due to gravity at the earth's surface; it can be written g, *g*, or G. More accurately, it is the standard gravity (symbol: g_n), defined as 9.80665 m/s^2 **(32.2 ft/s^2), or equivalently 9.80665 newtons** of force per kilogram of mass

3.2.4 Transportation Mechanical Vibration

Equipment packaged for public transportation shall not be damaged and shall operate normally without performance degradation after exposure to random vibration limits specified in Table 3-9.

Table 3-9: Transportation Mechanical Vibration

Random Vibration			**Notes**
Acceleration spectral density (ASD) **(m^2/s^3)** **(g^2/Hz)**	 1 .01	 0.3 .003	[1], [2]
Frequency range (Hz)	10 to 200	200 to 2000	

Notes:

[1] The unit of measure of acceleration in the International System of Units (SI) is m/s^2. In North America, the unit g is often used - the acceleration due to gravity at the earth's surface; it can be written g, *g*, or G. More accurately, it is the standard gravity (symbol: g_n), defined as 9.80665 m/s^2 **(32.2 ft/s^2), or equivalently 9.80665 Newtons** of force per kilogram of mass

[2] ASD in units of m^2/s^3 = 96 x [ASD in units of g^2/Hz]

3.2.5 Operating Mechanical Vibration

Equipment resistance to office vibrations shall be tested. Recommended test methods can be found in ***GR-63-CORE, Issue 3, March 2006****; NEBS Requirements: Physical Protection*; Section 5.4.2.

3.2.6 Operating Mechanical Shock

Equipment shall operate when subjected to a maximum mechanical shock to the equipment chassis of 63g based on a half-sine shock pulse of 2 milliseconds duration to the equipment surface front, back, top, bottom, left side and right side.

3.2.7 Earthquake resistance

Mission critical equipment should withstand high risk zone earthquake resistance criteria specified in ***ATIS 0600329, Edition 8 2008***, *Network Equipment – Earthquake Resistance.* ***ATIS 0600329, Edition 8 2008*** requirements for seismic vibration endurance include parts from GR-63-CORE and ETSI with IEC based test methods.[9] Earthquake resistance evaluation is based on the required response spectra simulation test response waveform and simulation methods established in the 1970's by Bell Labs.

3.3 Contaminant Resistance

Equipment contamination sources include outdoor pollutions and facility generated contaminants. Contaminants come in the form of gases, solids, and liquids and are influenced by equipment location, weather, outdoor pollutant levels, facility construction, facility/equipment filtration, and facility/equipment maintenance practices.

3.3.1 Equipment Airborne Contaminant Resistance

Recommended methods to evaluate equipment resistance to airborne contaminants are provided in ***GR-63-CORE, Issue 3, March 2006****; NEBS Requirements: Physical Protection*; Section 5.5.

[9] ***ATIS 0600329****, Edition 8 2008*, Annex B

3.3.2 Solvent Resistance

1. Equipment shall not be deformed, disfigured, discolored or marred when exposed to common household and industrial cleaning solvents, to non abrasive cleaners or to waxes.
2. Equipment solvent resistance shall include, but is not limited to, cleaning products based in alcohol, ammonia, baking soda, soap, detergent, vinegar, lemon, powdered borax, bleach or other common cleaning agents that can be applied with a damp cloth.
3. All equipment contactable surface areas shall be solvent resistant including surface mounted labels and decorative artwork.

3.4 Equipment Safety

3.4.1 Safety of Information Technology equipment

Equipment shall comply with ***ANSI/UL60950-1-2011, 2nd Edition, 2011-12-19****, "Information Technology Equipment-Safety-Part 1: General Requirements*

3.4.2 Laser safety

Equipment with laser components shall comply with safety, classification and labeling requirements specified in the following standards:

1. ***21CFR1040****;"PERFORMANCE STANDARDS FOR LIGHT EMITTING PRODUCTS", Code of Federal Regulations, Title 21—Food and Drugs, Chapter 1-Food and Drug Administration, Department of Health and Human Services, Subchapter J-Radiological Health, Part 1040, 21CFG1040.10*
2. ***ANSI Z136-2007*** *American National Standard for Safe Use of Lasers*
3. ***ANSI Z136.2 (1997)****: American National Standard; Safe Use of Optical Fiber Communications Systems Utilizing Laser Diode and LED Sources*

3.4.3 Fire safety

Equipment should comply with ***ANSI T1.307-2007****: Fire Resistance Criteria – Ignitability Requirements for Equipment Assemblies, Ancillary Non-Metallic Apparatus, and Fire Spread Requirements for Wire and Cable.*

3.4.4 Equipment Alarms and Automatic Shut Down

1. Equipment shall alarm and power down when the temperature of any internal component or compartment within the unit reaches a level that may appreciably reduce the life of or damage the unit.
2. Equipment should have two independent temperature sensors. It is preferred that one sensor is located to measure air intake temperature and the second is located to measure outtake temperature. Dual sensors should be designed to allow redundant temperature readings to prevent false alarms from shutting down the unit.
3. Equipment shall alarm on loss of a fan or fan bank. The alarm indicator shall be locally generated in the form of status lights reported remotely if the equipment supports remote element management. (See Section 3.1.5)
4. Equipment shall alarm on loss of a power supply or on loss of one or more power rails for a multi-output power supply. The alarm indicator shall be locally generated in the form of status lights and by remote event reporting when feasible.

4 Electrical Requirements

4.1 Electromagnetic compatibility (EMC)

This section addresses electromagnetic emission and immunity requirements for cable telecommunications products deployed in mission critical cable facilities.

4.1.1 Radiated Emissions

This specification uses ***47CFR15****; "RADIO FREQUENCY DEVICES", --Telecommunication, Chapter 1-Federal Communications Commission, Part 15-Radio Frequency Device*, e.g., FCC Part 15, for equipment radiated and conducted emissions. FCC Par 15 allowable radiated emissions criteria are based on whether the equipment is designed to meet Class-A or Class-B limits. The less strict Class-A limits have traditionally been used in telecommunications facilities. Some operators are emphasizing the need to further reduce equipment radiated emissions by requiring equipment meet the Class-B limits. Others still accept Class-A limits. This specification addresses this trend by specifying FCC Part 15 Class A compliance as "shall" and FCC Part Class B compliance as "should". Vendors are encouraged to recognize the transition toward Class-B limits and develop their equipment accordingly. FCC Part 15 Definitions and Clauses.

Definitions and clauses provided in FCC Part 15 Subpart B that are significant to this specification include:

1. *"Digital Device: An unintentional radiator (device or system) that generates and uses timing signals or pulses at a rate in excess of 9,000 pulses (cycles) per second and uses digital techniques; inclusive of telephone equipment that uses digital techniques or any device or system that generates and uses radio frequency energy for the purpose of performing data processing functions, such as electronic computations, operations, transformations, recording, filing, sorting, storage, retrieval, or transfer. A radio frequency device that is specifically subject to an emanation requirement in any other FCC Rule part or an intentional radiator subject to subpart C of this part that contains a digital device is not subject to the standards for digital devices, provided the digital device is used only to enable operation of the radio frequency device and the digital device does not control additional functions or capabilities."*
2. *"Class A digital device: A digital device that is marketed for use in a commercial, industrial or business environment, exclusive of a device which is marketed for use by the general public or is intended to be used in the home."*
3. *"Class B digital device: A digital device that is marketed for use in a residential environment notwithstanding use in commercial, business and industrial environments. Examples of such devices include, but are not limited to, personal computers, calculators, and similar electronic devices that are marketed for use by the general public:*

   Note: The responsible party may also qualify a device intended to be marketed in a commercial, business or industrial environment as a Class B device, and in fact is encouraged to do so, provided the device complies with the technical specifications for a Class B digital device. In the event that a particular type of device has been found to repeatedly cause harmful interference to radio communications, the Commission may classify such a digital device as a Class B digital device, regardless of its intended use."

4. *Alternative CISPR Pub 22 Method: FCC Part 15, paragraph (g): As an alternative to the radiated emission limits shown in paragraphs (a) and (b) of this section, digital devices may be shown to comply with the standards contained in Third Edition of the International Special Committee on Radio Interference (CISPR), Pub. 22, "Information Technology Equipment—Radio Disturbance Characteristics—Limits and Methods of Measurement" (incorporated by reference, see §15.38).*

For this specification, if the CISPR 22 alternative method is used, the equipment shall use the alternative radiated emissions limits specified in **IEC CISPR 22 Edition 6.0 2008-09**.

4.1.1.1 Radiated Emissions Limits – Unintentional Radiators

1. Equipment shall comply with FCC Part 15 Class A emissions limits.
2. Equipment should comply with FCC Part 15 Class B radiated emissions limits.

4.1.1.2 Radiated Emissions Limits – Unintentional Radiators per CISPR Publication 22

For this specification, equipment compliant with FCC Part 15.109 paragraph (g) shall be an acceptable alternate method to comply with FCC Part 15 Class-A enclosure radiated emissions. FCC Part 15.109 paragraph (g) allows compliance with CISPR Publication 22 limits for a portion of the RF spectrum. For the CISPR Publication 22 criteria, the following criteria apply:

1. Equipment shall comply with ***IEC CISPR 22 Edition 6.0 2008-09*** Class A emissions limits.
2. Equipment should comply with ***IEC CISPR 22 Edition 6.0 2008-09*** Class B radiated emissions limits.

4.1.2 Conducted Emissions

4.1.2.1 Power-On Spurious Emissions

During system power-on and initialization, equipment shall not emit spurious interference from any ports including, but not limited, to power, telecommunications, and coaxial ports.

4.1.2.2 Conducted Emissions

1. Equipment conducted emissions shall meet or exceed FCC Part 15 Class A compliance specifications.
2. Equipment should meet or exceed FCC Part 15 Class B compliance specifications.

4.1.2.3 DC ports Conducted Emissions

For equipment with DC power ports, the Class A limits specified in ***IEC CISPR 22 Edition 6.0 2008-09*** shall apply.

4.1.2.4 Conducted Emissions – Telecommunications/Network Ports

This specification uses the ***IEC CISPR 22 Edition 6.0 2008-09*** definition of a telecommunications/Network port:

"Point of connection for voice, data, and signaling transfers intended to interconnect widely dispersed systems via such means as direct connection to multi-user telecommunications networks (e.g. public, switched telecommunications networks (PSTN), integrated services digital networks (ISDN), x-type digital subscriber lines (xDSL), etc.), local area networks (e.g. Ethernet, Token Ring, etc.) and similar networks

Note: A port generally intended for interconnection of components of an ITE system under tests (e.g. RS-232, IEEE Standard 1284 (parallel printer), Universal Serial Bus (USB), IEEE Standard 1286 ("Fire Wire"), etc.) and used in accordance with its functional specifications (e.g. for the maximum length of cable connected to it), is not considered to be a telecommunications/network port under this definition."

1. Equipment telecommunications/network port longitudinal (common mode) conducted emissions shall not exceed Class A limits specified in ***IEC CISPR 22 Edition 6.0 2008-09***.
2. Equipment telecommunications/network port longitudinal (common mode) conducted emissions limits should not exceed the Class B limits specified in ***IEC CISPR 22 Edition 6.0 2008-09***.

4.1.3 Immunity Criteria

4.1.3.1 Enclosure

4.1.3.1.1 Radiated Immunity

1. Equipment shall be able to operate without impairment in an imposed reference RF field of 10 V/m from 80 MHz to 6 GHz. Verification of operation without impairment shall include 1) verifying no signal flow errors as determined by direct measurement of BER, MPEG stream errors, 2) by observation of no disruption of video/audio signals, 3) and/or by MPEG data stream analysis.
2. Any device which uses an input tuner shall be tested at three to five (3 to 5) discrete frequencies within the tuner operating spectrum as deemed applicable by the evaluating organization. These interfering carriers shall be stepped in 25 KHz increments ranging from 150 KHz below to 150 KHz above the carrier center frequency (f_C = ±150 KHz).

Table 4-1: Equipment Enclosure Radiated Immunity

Parameter	Unit	Limit	Notes
Radio frequency electromagnetic field amplitude modulated	MHz V/m % AM (1 kHz)	80 to 6000 10 80	[1]

Notes:
[1] ***IEC 61000-4-3, Ed 3.2, 2010-04****; Electromagnetic Compatibility (EMC) – Part 4-3: Testing and measurement techniques – radiated, radio-frequency, electromagnetic field immunity test.*

4.1.3.1.2 Electrostatic Discharge (ESD)

1. Equipment shall operate continuously without performance interruption or impairment when exposed to a minimum of 20 direct contact discharges at Test level 4 (±8kV) on any equipment conductive surface.
2. Equipment shall operate without performance interruption or impairment when exposed to a minimum of 20 air discharges at Test level 2 (±4kV) and Test level 4 (±15kV) on any non-conductive equipment surface.
3. Electrostatic discharges shall be attempted over and around equipment interface ports but shall not be per performed inside the interface ports.

4.1.3.2 AC Power Port

4.1.3.2.1 Conducted RF Immunity – AC Power Port

Equipment shall operate without performance impairment when AC power ports are subjected to the continuous conducted radio frequency criteria specified in Table 4-2.

Table 4-2: AC Power Port Conducted RF Immunity

Parameter	Unit	Limit	Notes
Radio frequency continuous conducted	MHz V % AM (1 kHz) Source impedance Ω	0.15 to 80 3 80 150	[1],[2]

Notes:
[1] ***IEC CISPR 24, Edition 2.0 2010****; Information Technology Equipment - Immunity Characteristics - Limit and Methods of Measurement* Table 4 conducted RF limits are identical
[2] ***IEC 61000-4-6 ed 3.0, 2008****; Electromagnetic Compatibility (EMC) – Part 4-6: Testing and Measurement Techniques-Immunity to Conducted Disturbances, Induced by Radio Frequency Fields*

4.1.3.2.2 Surge Immunity – AC Power Port

Equipment shall operate without performance impairment after its AC power port is exposed to surges specified in Table 4-3.

Table 4-3: AC Power Port Surge Immunity

Parameter	Unit	Limit	Notes
Surges (line-to-line) (line-to-ground)	T_r/T_h µs kV peak kV peak	1.2./50 (8/20) 1 2	[1], [2], [3]

Notes:

[1] Reference **IEC 61000-4-5, Edition 2.2, 2006-05**; *Electromagnetic Compatibility (EMC) – Part 4-6.*

[2] Surge waveform is per **IEEE C62.41.1, Edition 2, 12/10/08;** *Guide on the Surge Environment in Low-Voltage (1000V and less) AC power circuits*

[3] Reference **ANSI/SCTE 81 2007,** *Surge Withstand Test Procedure*

4.1.3.2.3 Electronic Fast Transients – AC Power Port

Equipment shall operate without impairment during and after exposure of AC power ports to electronic fast transients specified in Table 4-4.

Table 4-4: AC Power Port Electronic Fast Transients

Parameter	Unit	Limit	Notes
Fast Transients	T_r/T_h ns kV peak Rep. Frequency kHz	5/50 1 5	[1]

Notes:

[1] Reference ***IEC 61000-4-4, Second Edition, 2004-07***; *Electromagnetic Compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

4.1.3.2.4 Voltage Dips – AC Power Port

1. Equipment shall operate without performance impairment during and after exposure to AC power port voltage dips specified in Table 4-5.
2. Equipment using 3-phase AC power shall not operate on loss of one or more power phase inputs.

Table 4-5: AC Voltage Dips

Parameter	Unit	Limit	Notes
AC Voltage Dips	% Reduction Period	>95 1	
	% Reduction Period	>95 0.5	
	% Reduction Period	30 25	

4.1.3.2.5 Voltage Interruptions – AC Power Port

1. Equipment non-volatile memory shall not be corrupted on an AC power input voltage interruption as specified in Table 4-6
2. Equipment shall return to last operator saved configuration after restart(s) caused by one or more voltage interruptions including multiple voltage interruptions occurring in rapid succession.

Table 4-6: AC Voltage Interruptions

Parameter	Unit	Limit	Notes
AC Voltage Dips	% Reduction Period	>95 300	

4.1.3.3 DC Power Port

4.1.3.3.1 Conducted RF Immunity – DC Power Port

Equipment shall operate without performance impairment when DC power ports are subjected to the continuous conducted radio frequency criteria specified in Table 4-7.

Table 4-7: DC Power Port Conducted RF Immunity

Parameter	Unit	Limit	Notes
Radio frequency continuous conducted	MHz V % AM (1 kHz) Source impedance Ω	0.15 to 80 3 80 150	[1]

Notes:
[1] Reference ***IEC 61000-4-6 ed 3.0, 2008****; Electromagnetic Compatibility (EMC) – Part 4-6: Testing and Measurement Techniques-Immunity to Conducted Disturbances, Induced by Radio Frequency Fields*

4.1.3.3.2 Electronic Fast Transients – DC Power Port

Equipment with DC power ports that use cables greater than 3 meters shall operate without impairment during and after exposure of the ports to electronic fast transients as specified in Table 4-8.

Table 4-8: DC Power Port Electronic Fast Transients

Parameter	Unit	Limit	Notes
Fast Transients	T_r/T_h ns kV peak Rep. Frequency kHz	5/50 1 5	[1]

Notes:
[1] Reference ***IEC 61000-4-4, Second Edition, 2004-07****; Electromagnetic Compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test.*

4.1.3.3.3 DC Voltage Fluctuation – DC Power Port

1. Equipment shall withstand < 30 second duration voltage fluctuations that exceed 2 times the nominal DC input voltage or that drop to 0 VDC.
2. Equipment shall withstand short-term (30 seconds minimum) voltage fluctuations of 1.1 times the maximum specified DC input voltage without disruption to any service or signal flow.

4.1.3.4 Telecommunications/Network Port

4.1.3.4.1 Conducted RF Immunity – Telecommunications/Network Port

Equipment shall operate without performance impairment when telecommunications/networks ports are subjected to the continuous conducted radio frequency criteria specified in Table 4-9.

Table 4-9: Telecommunications/Network Port Conducted RF Immunity

Parameter	Unit	Limit	Notes
Radio frequency continuous conducted	MHz V % AM (1 kHz) Source impedance Ω	0.15 to 80 3 80 150	[1], [2], [3]

Notes:

[1] ***IEC CISPR 24, Edition 2.0 2010****; Information Technology Equipment - Immunity Characteristics - Limit and Methods of Measurement* Table 2 conducted RF limits are identical.

[2] Reference ***IEC 61000-4-6 ed 3.0, 2008****; Electromagnetic Compatibility (EMC) – Part 4-6: Testing and Measurement Techniques-Immunity to Conducted Disturbances, Induced by Radio Frequency Fields*

[3] Applies when the cable length between the EUT and other active equipment may be greater than 3 meters.

4.1.3.4.2 Surge Immunity – Telecommunications/Network Ports

Equipment with telecommunications/network ports and interfaces that connect to cables that can exceed 30 meters shall operate without impairment after exposure of the ports to 5 positive and 5 negative polarity surges (10 in total) as specified in Table 4-10.

Table 4-10: Telecommunications/Network Ports Surge Immunity

Parameter	Unit	Limit	Notes
Common mode (Longitudinal) surge applied to ports using balanced symmetrical unshielded cables	T_r/T_h µs kV peak	1.2./50 (8/20) 1	[1]
Common mode (Longitudinal) surge applied to ports using shielded cables. Examples are coax cables and shielded Ethernet cables	T_r/T_h µs kV peak	1.2./50 (8/20) 1	[1]
Differential mode (Metallic) surge applied to ports using unshielded nonsymmetrical cables.	T_r/T_h µs kV peak	1.2./50 (8/20) 1	[1]

Notes:

[1] Surge waveform is the combination wave specified in ***IEC 61000-4-5, Second Edition, 2005-11****; Electromagnetic Compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

4.1.3.4.3 Electronic Fast Transients - Telecommunications/Network Ports

Equipment with telecommunications/network ports using cables greater than 3 meters shall operate without impairment during and after exposure of the ports to electronic fast transients specified in Table 4-11.

Table 4-11: Telecommunications/Network Ports Electronic Fast Transients

Parameter	Unit	Limit	Notes
Fast Transients	T_r/T_h ns kV peak kV peak	5/50 0.5 for indoor 1 for outdoor	[1], [2]

	Rep. Frequency kHz	5	

Notes:
[1] Reference ***IEC 61000-4-4, Second Edition, 2004-07****; Electromagnetic Compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*.
[2] Applies when the cable length between the EUT and other active equipment may be greater than 3 meters.

4.2 Grounding and Bonding

1. Equipment shall employ a bonding connection or terminal.
2. The grounding connection/terminal shall be clearly labeled, and in a location that is readily accessible to the installer at the rear of the chassis.
3. Equipment shall use an anti-rotational methodology such as a terminal a fixed with a star washer for ground connection.
4. Two-hole compression type lugs should be provided for bond connection.
5. Torque specifications for the bond connection shall be provided.
6. Equipment shall not rely upon incidental bond paths such as those that may exist between the chassis and the equipment rack or frame.
7. Nonconductive coatings such as paint or enamel shall be removed from threads and other contact surfaces to assure electrical continuity.
8. All exposed conductive surfaces shall be bonded to the equipment chassis.
9. Equipment electrically conductive doors shall be bonded with an appropriate gauge stranded wire or copper braid and attached with an anti-rotational connection means such as a star washer. The conductor may be insulated or non-insulated.
10. Equipment shall not use aluminum conductors for grounding or bonding purposes.
11. Equipment, subassemblies and modules that plug into the main equipment chassis shall be bonded to the chassis grounding system by metal-to-metal contact or by wires, PCB traces, appropriate backplane connectors, etc.
12. Equipment fastening hardware shall be compatible with the materials being joined and shall preclude loosening, deterioration and electrochemical corrosion of the hardware and the joined materials.
13. Equipment shall not use multiple connections to join to a single bolt assembly.

5 Sustainability Requirements

This section addresses product sustainability. The term 'product sustainability' is subjective and can include a variety of economic, social, and environmental considerations. In this specification, product sustainability addresses requirements and objectives that minimize the impact of a product on the environment during all phases of the product life cycle. During product development and manufacturing, design practices, material selection, hazardous materials treatment and manufacturing waste management are important criteria. During operation, equipment heat release, airflow management, energy efficiency, chemical emissions and noise emissions have an economic, social and environmental impact. At the end of its life, product recycling and disposal are important criteria to consider.

Key definitions from ***ECMA-341, 4th edition December 2010****, Environmental Design Consideration for ICT and CE Products* that apply in this section are:

- Environmental aspect: Element of an organization's activities, products or services that can interact with the environment.
- Environmental impact: Any change to the environment (adverse or beneficial) wholly or partially resulting from an organization's environmental aspects.
- Life Cycle: Consecutive and interlinked stages of a product, from raw material acquisition or generation of natural resources to the final disposal

5.1 Product Development

1. Equipment vendors shall design products to applicable governmental environmental legal requirements and shall include conformance documentation or statements in the product documentation.
2. Equipment providers shall comply with and be able to provide supporting documentation of compliance with ***ECMA-341, 4th edition December 2010****, Environmental Design Consideration for ICT and CE Products*. ECMA-341provides requirements and objectives "*for the design of environmentally sound products regarding:*

    - *Life Cycle Thinking aspects*
    - *Material efficiency*
    - *Energy efficiency*
    - *Consumable and batteries*
    - *Chemical and noise emissions*
    - *Extension of product lifetime*
    - *End of life*
    - *Hazardous substances/preparations*
    - *Product packaging*"[10]

3. Equipment providers shall document product environmental design decisions using a design checklist covering environmental aspects. ***ECMA-341,*** *4th edition December 2010, Environmental Design Consideration for ICT and CE Products*, Annex A is an example checklist.
4. Equipment provider companies shall document the Company Environmental profile and the Product Environmental Attribute (for each product) specified in ***ECMA-370****, 4th Edition June 2009, TED-The Echo Declaration*.
5. Equipment providers should develop a Corporate Responsibility Report and a Global Reporting Initiative (GRI) – Corporate Responsibility Report.

[10]***ECMA-341,*** *4th edition December 2010, Environmental Design Consideration for ICT and CE Products*, section 1 - Scope

5.1.1 Life Cycle Thinking[11]

1. Equipment shall be based on the concept of life cycle thinking (LCT) which requires consideration of the environmental aspects of a product in all life cycle stages. Key life cycle thinking practices for equipment vendors are:
    a. The product shall be developed to minimize its overall adverse environmental impact at all product life stages.
    b. The product's environmental aspects shall be identified, quantified (if possible), qualified, and documented.
    c. The product's design shall consider the trade-offs between environmental aspects and life cycle stages.

5.1.2 Material Efficiency

1. Equipment should minimize material variety and amount of material used so that the lowest possible product weight is achieved while still meeting required equipment physical, climate, mechanical vibration, mechanical shock and earthquake resistance criteria.
2. Equipment should use environmentally conscious materials that can be recycled.
3. Equipment should use material that has a lower adverse environmental aspect.
4. Equipment material selection shall take into account hazardous material treatment for all aspects of a product life cycle especially with respect to product manufacturing, operation, and disposal.

5.1.3 Consumables and Batteries

1. Products shall take into account recycling, reuse, and end of life disposal of any consumables used by the product.
2. Equipment batteries shall comply with all applicable restrictions for hazardous substance preparation, use and disposal.
3. Equipment providers should use batteries with low adverse environmental impact whenever feasible.
4. Equipment batteries shall be easily identifiable and replaceable.
5. Equipment documentation shall provide instructions for battery replacement, handling, and disposal.
6. Equipment design methods should prolong the battery life and durability.
7. Equipment providers shall document the equipment materials that can cause an adverse environmental impact.

5.2 Product Operation

5.2.1 Airflow

IT server equipment typically requires an air flow of 150-200 cubic feet per minute to remove enough heat to raise the exhaust air temperature by 8.3-11°C (15-20°F). [12] To assure such air flow is effective in removing equipment exhaust heat, this specification assumes cooling air is supplied to the equipment front (the cold aisle) and that hot exhaust air is extracted from the equipment rear (the hot aisle). Equipment airflow criteria to assist with facility airflow best practices include:

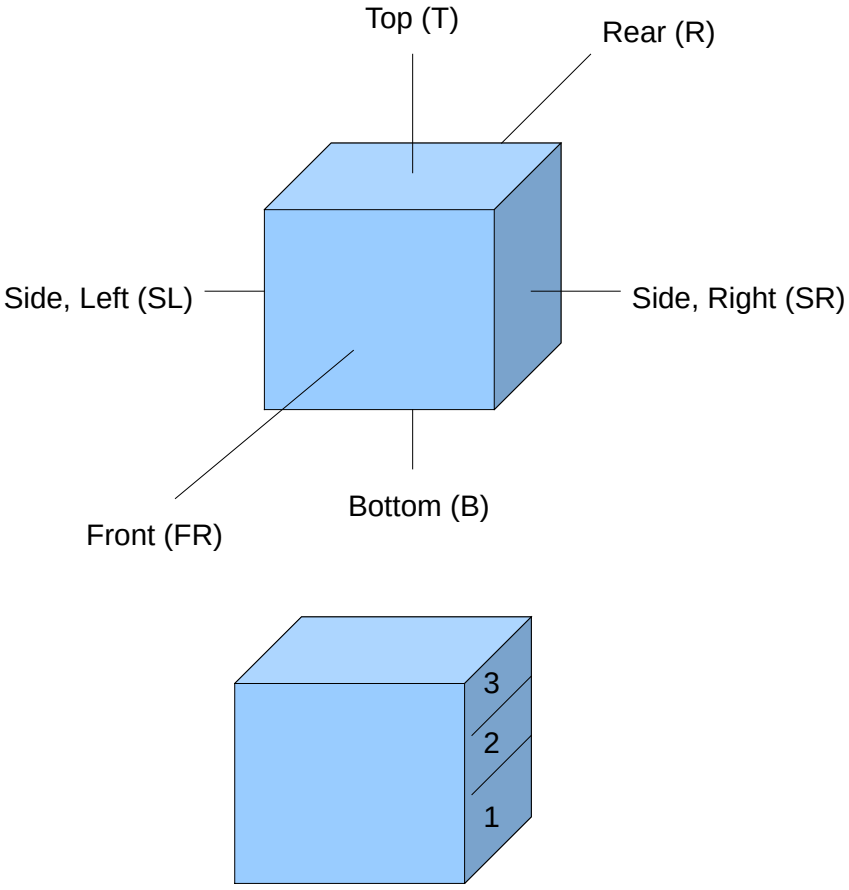
1. Equipment air flow patterns shall be documented using nomenclature originally defined by Telecordia™. Figure 1 illustrates this nomenclature. It is based on the use of six equipment surfaces: Front, Side Left, Side Right, Rear, Bottom and Top. The vertical space is further sub-divided into zones 1, 2, and 3. Airflow pattern is represented with this nomenclature in terms of air intake position(s) followed by air exhaust position(s).
2. Equipment using forced air for heat dissipation shall use front-to-back airflow. Airflow patterns that shall be acceptable include:
    a. Bottom-front to top-rear airflow (F1-R3) (Preferred Airflow)

[11] ***ECMA-341, 4th edition December 2010***, *Environmental Design Consideration for ICT and CE Products*, Section 5: Life Cycle Thinking and Section 4: Terms and Definitions
[12] APC White Paper 119, Page 5-6

b. Mid-front to mid-rear (F2-R2)
c. Mid-front to top-rear (F2-R3)

4. Equipment using forced air for heat dissipation shall not use intake or exhaust airflow from equipment Sides (SL and SR), Top (T), and Bottom (B).

Figure 1: Telcordia Equipment Cooling Class Nomenclature[13]



5.2.2 Air filters

ASHRAE provides guidelines for data center air filtration and maintenance to prevent dust accumulation from impeding heat removal as well as to prevent corrosive gases from damaging equipment. **ASHRAE Standard 52.1** and **ASHRAE Standard 52.2** provides methods to rate filter collection efficiency, pressure drop, and particulate holding capacity. *"ASHRAE 52.1-1992 measures arrestance, dust spot efficiency and dust holding capacity. Arrestance is a measure of a filter's ability to capture a mass fraction of coarse dust. Dust Spot efficiency is the ability to capture particles within a give size range. Standard 52.2-1999 measures particle size efficiency expressed as a minimum efficiency reporting value (MERV) between 1 and 20."*[14]

1. Fan cooled cable equipment shall use filters compliant with **ASHRAE Standard 52.1** and **ASHRAE Standard 52.2**.
2. Equipment with vertical rack space greater than 2U shall have minimum dust arrestance of 80% per **ASHRAE Standard 52.1** or a MERV rating of 4 per **ASHRAE Standard 52.2**.

[13] (SCO5 Environmental Profile), Figure 7.3.7
[14] ***ASHRAE Design Considerations for Datacom Equipment Centers,*** *ISBN 1-931862-94-X, 2005,* Section 8.4.8

3. Equipment with vertical rack space less than or equal to 2U shall have minimum dust arrestance of 65% per **ASHRAE Standard 52.1** or a MERV rating of 2 per **ASHRAE Standard 52.2**[15]
4. Filters should be disposal type only.
5. Filters shall be replaceable while equipment is operating.
6. Filter-to-equipment mechanical fit shall assure unfiltered air does not pass through the equipment.
7. Vendors shall provide recommended filter maintenance schedules and practices.
8. Equipment should support a filter replacement alarm capability that indicates when filters need replaced.

5.2.3 Heat Release

1. Equipment heat release and method of cooling shall be documented in total watts, watts per square meter (W/m^2) and watts per square foot (W/ft^2).
2. Shelf equipment heat release values shall be based on heat dissipation per meter (or per foot) of frame vertical height.
3. Floor mounted equipment (Cabinets, etc.) shall be based on floor area used.
   Equipment manufacturers shall provide heat and airflow reports as specified in Chapter 5 of ***ASHRAE*** *Thermal Guidelines for Data Processing Environments.* 2nd edition.
4. Recorded heat release values shall be based on the following operating conditions:[16]
   a. Equipment operating at steady state using nominal input power voltage
   b. User controls or programs shall be set to a utilization rate that maximizes the number of simultaneous components, devices, and subsystems that are active
   c. Ambient room temperature shall be between 18°C and 27°C (64.4°F and 80.6°F)
   d. Air moving devices shall be operating at nominal speed

SCTE 184, *Facilities Energy Managment and Recommended Practices 2011* recommends rack level power dissipation to not exceed 20kW. Adherence to this 20kW maximum per rack limit requires accurate equipment power consumption and heat release reporting as well as due diligence by equipment operators when installing and operating equipment. Practices equipment operators may use to achieve the 20kW per rack limit include:

1. Reduction of equipment installation density as needed, e.g., adding empty space in racks.
2. Selecting the most energy efficient equipment with capabilities to reduce power by programmable configuration or element management.
3. Using embedded rack level cooling including liquid cooled racks when necessary.
4. Use supplemental cooling when needed.

5.2.4 Energy Efficiency

Increasing equipment sophistication, power density, and heat dissipation is straining communication facilities capabilities and increasing operating expenses. Equipment providers can help operators address these constraints by complying with energy efficiency criteria recommended in this section.

Criteria OEMs should implement in their equipment include:

- ENERGY STAR® program conformance for equipment that meets the 'identifying criteria' to earn an ENERGY STAR® label for a published ENERGY STAR® program requirement.
- Complying with applicable ATIS Telecommunications Energy Efficiency Ratio (TEER) specifications as a means to measure and report equipment energy efficiency. Reports generated from these standards allow uniform metrics for operators to evaluate equipment. TEER can also be used to estimate and analyze energy efficiency options for planned network configurations.

[15] ***GR-63-CORE, Issue 3, March 2006****; NEBS Requirements: Physical Protection,*page 4-33.
[16] ***ASHRAE*** *Thermal Guidelines for Data Processing Environments.* 2nd edition

- Equipment features that include integrated power consumption and temperature instrumentation with real time remote reporting through element management and operational support protocols. Intake and outflow temperature and air flow monitoring is recommended for all products that use forced air cooling. Analysis of data collected from equipment instrumentation and from strategically placed sub-meters 1) will support ongoing activities to improve facility Power Utilization Efficiency (PUE), 2) will assist in Rack Cooling Index (RCI) analysis and 3) will support facility energy efficiency management and practices.
- Equipment designs with variable speed fans and real time reporting of fan speeds through element management and/or operational support protocols.
- Equipment designed with configurable and automatic power management capabilities to support advanced facility load management practices based on real-time conditions and corporate objectives. These capabilities can also be used to establish emergency response equipment configurations and best practices.
- Equipment designed with advanced energy management features which can be enabled or disabled by element management protocols. Example features include capabilities 1) to idle equipment and/or power down equipment components dynamically; 2) to support equipment virtualization; 3) and to support automated energy management. Specific methods for implementation are beyond the scope of this specification.

5.2.4.1 Efficiency Standards & Equipment Types

This document specifies general energy efficiency requirements as well as requirements for specific equipment types. For the equipment types requirements, ENERGY STAR® and/or the ATIS Telecommunications Energy Efficiency Ratio (TEER) documents have released or "work in progress" documents that specify 1) equipment efficiency limits, 2) equipment functional requirements and 3) efficiency measurement and calculation methods applicable to the given product type.

ENERGY STAR® has final draft or "work in progress" specifications for the following equipment types:

1. Computer
2. Computer Server
3. Transport Equipment
4. Router and Ethernet Switch
5. Power Category Equipment
6. Storage Equipment

The TEER specification suite defines methods for vendors and third party independent laboratories to use in the formation of a telecommunication energy efficiency ratio (TEER). This document suite consists of a base standard that sets the general requirements for TEER and supplemental standards that address a range of equipment types. Additional supplemental standards may be developed for other equipment types or technologies. ATIS TEER specifications that are currently available include:

1. General
   ***ATIS 060015: 2009**, Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting - General Requirements*
2. Server
   ***ATIS 060015.01.2009**, Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting - Server Requirements*
3. Transport Equipment
   ***ATIS 0600015.02.2009**, Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting - Transport Requirements*
4. Router and Ethernet Switch
   ***ATIS 0600015.03; 2009**, Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting for Router and Ethernet Switch Products*
5. Power Category Equipment

***ATIS 0600015.04.2010**, Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting DC Power Plant – Rectifier Requirements*

5.2.4.2 Future SCTE Energy Efficiency Standards and Channel Density Metrics

SCTE is developing energy efficiency standards and channel density metrics to address the unique characteristics of broadband /video equipment being deployed in mission critical cable telecommunications facilities. Equipment targeted for these future SCTE standard(s) includes but is not limited to the following equipment types:

- CMTS
- Edge QAM
- Video Server
- Video Encoder
- Video Transcoder
- Video Statistical Multiplexor
- Video Add Insertion equipment

1. OEMs should monitor SCTE energy efficiency standards releases and should design future generation equipment to comply with these standards.
2. The equipment types itemized in this section should comply with the general requirements for equipment energy efficiency as specified in Section 5.2.4.3.
3. Equipment types itemized in this section may be unique to cable system networks and thus do not need to comply with Energy Star or TEER specifications referenced in the following sections of this document. (Future SCTE specification(s) are planned to address these equipment types.)
4. Mission critical cable system equipment referenced in this document section that meet the qualifying criteria specific to a TEER or Energy Star specifications referenced in later sections should comply with the energy efficiency criteria of the designate TEER or Energy Star specification(s). In general, products that fit this category are ITE and CE types common to enterprise data centers and office/corporate environments that do not have physical layer and/or data link layer functionality unique to cable system video or broadband data distribution.

Note: Verizon is using TEER metrics quantification for its networks. An example of equipment types Verizon qualifies with TEER metrics for these networks can be found in **VZ.TPR.9205** *Verizon Technical Purchasing Requirements, Issue 4, August 2009*

5.2.4.3 General Requirements for Equipment Energy Efficiency

1. Equipment shall measure and report energy/internal power supply efficiency in accordance with *Generalized Test Protocol for Calculating the Energy Efficiency of Internal AC-DC and DC-DC Power Supplies, Revison 6.5.*
2. Equipment AC-to-DC power supply performance shall be characterized in accordance with **ANSI/SCTE 46 2007**, *Test Methods for AC to DC Power Supplies*.
3. Equipment DC-to-DC power supply performance shall be characterized in accordance with **ANSI/SCTE 46 2007**, *Test Methods for AC to DC Power Supplies*, modified as needed to cover DC rather than AC input.
4. Equipment providers shall identify the specific energy modes in which the product operates and shall document the energy consumption for each operating mode.
5. Equipment providers should provide configuration and/or element management options to control equipment energy efficiency.
6. Equipment should support power management features that permit sleep modes, reduced power modes and nap modes when the operating loads allow. Processors RAM, network cards, and hard disk drives are well suited for power management.

7. Equipment should support remote monitoring and event reporting of sleep modes, reduced power modes, and nap modes.

5.2.4.4 Computer Energy Efficiency

ENERGY STAR® *Program Requirements for Computers Version 5.0.* 2008 defines a computer as "*a device which performs logical operations and processes data. Computers are composed of, at a minimum: (1) a central processing unit (CPU) to perform operations; (2) user input devices such as a keyboard, mouse, digitizer or game controller; and (3) a computer display screen to output information. For the purposes of this specification, computers include both stationary and portable units, including desktop computers, gaming consoles, integrated desktop computers, notebook computers, small-scale servers, thin clients, and workstations. Although computers must be capable of using input devices and computer displays, as noted in numbers 2 and 3 above, computer systems do not need to include these devices on shipment to meet this definition*." [17]

1. Computer category equipment shall comply with the most recent final draft of the Energy Star® Program Requirements for Computers specification.

5.2.4.5 Computer Server Energy Efficiency

ENERGY STAR® *Version 1.0 Program Requirements for Computer Servers.* 2009 defines a computer server as "*a computer that provides services and manages networked resources for client devices, e.g., desktop computers, notebook computers, thin clients, wireless devices, PDAs, IP telephones, other Computer Servers and other networked devices. Computer Servers are sold through enterprise channels for use in data centers and office/corporate environments. Computer Servers are designed to respond to requests and are primarily accessed via network connections, and not through direct user input devices such as a keyboard, mouse, etc. In addition, Computer Servers must have all of the following characteristics:*

a. Marketed and sold as a Computer Server;
b. Designed for and listed as supporting Computer Server Operating Systems (OS) and/or hypervisors, and targeted to run user-installed enterprise applications;
c. Support for error-correcting code (ECC) and/or buffered memory (including both buffered DIMMs and buffered on board (BOB) configurations);
d. Packaged and sold with one or more AC-DC or DC-DC power supply(s);
e. Includes at least one installed hard drive able to store and boot a local operating system or hypervisor;
f. *All processors have access to shared system memory and are independently visible to a single OS or hypervisor"* [18]

5.2.4.5.1 ENERGY STAR® Computer Server

1. Computer server category equipment should comply with Energy Star® Program Requirements for Computer Servers. OEMs should specify the release edition for which it equipment qualifies.

5.2.4.5.2 ATIS Server TEER [19]

1. Equipment providers should provide server TEER data compliant with ***ATIS 060015.01.2009***, *Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting - Server Requirements*.

   ATIS 060015.01.2009 specification uses the Standard Performance Evaluation Corporation (SPEC) organization SPECpower_ssj2008 power efficiency metric to measure the performance of servers for a variety of server operating modes. This benchmark measures server side Java performance and automatically produces a report for benchmark runs. See <www.spec.org> for details on the SPECpower_ssj2008 benchmark. This benchmark computes and generates a report for the average power consumption of the server at 100%, 90%,

[17] *ENERGY STAR® Program Requirements for Computers Version 5.0.* 2008, page 5
[18] *ENERGY STAR® Version 1.0 Program Requirements for Computer Servers.* 2009
[19] Reference ***ATIS 060015.01.2009***, *Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting - Server Requirements* for complete details to calculate, test, and report server TEER.

80%, 70%, 60%, 50%, 40%, 30%, 20%, 10%, and "Active Idle" load levels. In addition to reporting the power consumption and work performed at each load level, the benchmark generates an overall SPECpower_ssj2008 value that is the sum of the work performed at each load level divided by the sum of the average power consumption at each level.

2. Equipment that does not qualify for the ENERGY STAR® program but which fits the general operating functionality of the computer server product category should comply with the energy efficiency requirements specified in the ENERGY STAR® Computer Server specification. Specifically, these products should comply with Power supply efficiency and power supply power factor limits specified in Table 5-1 and Table 5-2.

Table 5-1: Computer Server Equipment Power Supply Efficiency Requirements

Power Supply Type	Rate Output Power	10% Load	20% Load	50% Load	100% Load
Multi-output (AC-DC & DC-DC)	All Output Levels	N/A	85%	88%	85%
Single-output (AD-DC & DC-DC)	All Output Levels	80%	88%	92%	88%

Table 5-2: Computer Server Equipment Power Supply Power Factor Requirements

Power Supply Type	Rate Output Power	10% Load	20% Load	50% Load	100% Load
DC-DC (All)	All Output Levels	N/A	0.80	N/A	N/A
AC-DC Multi-output	All Output Levels	N/A	0.80	0.90	0.95
AC-DC Single-output	Output Rating ≤ 500 W	N/A	0.80	0.90	0.95
	Output Rating > 500W and ≤ 1000 W	0.65	0.80	0.90	0.95
	Output Rating > 1000 W	0.80	0.90	0.90	0.95

5.2.4.6 Transport Equipment Energy Efficiency

ATIS 0600015.02.2009*, Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting - Transport Requirements* defines transport equipment as "*products which provide connectivity across a local, metro, or long haul area. Transport products may perform electrical, optical, or point-to-point wireless transmission; the multiplexing or aggregation of lower rate circuits or flows into higher rate circuits or flows; or cross-connection of circuits or flows. Transport category equipment may be located in a central office, co-location area, outside plant cabinet, controlled environment vault, customer located telecommunications closet, customer located indoor cabinet, or any similar location. In all cases, Transport category equipment is owned by the carrier. Examples of Transport category equipment include, but are not limited to:*

- *SONET/SDH ADMs, MSPP, and similar equipment.*
- *"OTN" (Optical Transport Network) equipment.*
- *Digital Cross Connect Systems (DCS).*
- *ROADM/WDM and similar equipment.*
- *Video transport equipment.*
- *Storage area networking equipment.*
- *Free space optics.*
- *Point-to-point wireless transport (e.g., Microwave)"*[20]

1. Providers of transport category equipment should be able to provide Declared TEER reports for a cable operator requested system configuration according to ***ATIS 0600015.02.2009****, Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting - Transport Requirements*. Declared TEER reports

[20] ***ATIS 0600015.02.2009,*** *Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting - Transport Requirements*, section 4.1

require equipment providers maintain a database of module-level power consumption data. To generate a Declared TEER report, a detailed system application description must be available. The equipment provider uses the description to engineer a solution to the description and then uses the database to calculate a Declared TEER for the recommended system configuration.

2. For modular transport equipment, it is not practical to implement independent third party TEER (Certified TEER) reports on all possible transport equipment system configurations. To address this issue, equipment providers should implement Certified TEER reports for of a subset of system configurations and provide them to an operator on request.
3. Equipment vendors should be able to report the percentage of power included in a Declared TEER calculation that is contributed by modules which have been used in an Certified TEER equipment configuration.

5.2.4.7 Router and Ethernet Switch Efficiency

1. Providers of router and Ethernet switch category equipment should comply with ***ATIS 0600015.03; 2009***, *Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting for Router and Ethernet Switch Products*.
2. As it is not practical to provide independent third party TEER reports on all possible combinations for a module based router or Ethernet switch, equipment providers should have independent third party power consumption reports of a subset of system configurations that can be provided to an operator on request.
3. Equipment vendors should be able to report, on request, the percentage of power included in a Declared TEER calculation that is contributed by modules which have been used in an independently certified configuration.

5.2.5 Emissions

5.2.5.1 Chemical Emission

If a product uses an electrostatic process, equipment providers shall document emission rates according to **ISO/IEC DIS 2836, Edition 11 January 2011**; *Information Technology – Office Equipment – Determination of Chemical Emission Rates from Electronic Equipment*

5.2.5.2 Acoustic emissions

Equipment shall comply with acoustic noise limits specified in **ATIS-0600005.2006**, *Acoustic Noise.*

Table 5-3: Equipment Acoustical Noise Emission Limits

Environmental Parameters	Declared Sound Power Level L_{WAd} (dB)	Temperature (ºC)
Equipment in attended telecommunications room	75	27
Equipment in unattended telecommunications room	75	27
Equipment in power room	83	27

5.3 Equipment Metrics for ASHRAE Expanded Data Center Operating Envelopes

Operators may use guidelines recommended by ASHRAE[21] to implement customized data center operating environments. OEMS should provide the following metrics to assist operators to evaluate equipment performance when operating in alternative operating envelopes:

1. OEMs should provide equipment heat release criteria in total watts, watts per square meter (W/m^2) and watts per square foot (W/ft^2) at 15°C, 20°C, 25°C, 30°C, and 35°C. If equipment is modular, OEMs should provide such metrics for typical system configurations or should provide data per module type to allow operators to estimate overall equipment heat release.
2. OEMs should provide equipment acoustical noise emission levels using measurement methods specified in ***ECMA-74*** *Measurement of Airborne Noise Emiitted by Informatin Techology and Telecommunications Equipment* and using declaration in a uniform fashion as specified in ***ECMA-109****, December 2010; Declared Noise Emission Values of Information Technology and Telecommunications Equipment, 5th edition (December 2010)*. Criteria should be provided at 15°C, 20°C, 25°C, 30°C, and 35°C. If equipment is modular, OEMs should provide such metrics for typical system configurations or should provide data per module type to allow operators to estimate overall equipment heat release.
3. OEMs should provide equipment reliability estimates based on equipment operation at 15°C, 20°C, 25°C, 30°C, and 35°C. If equipment is modular, OEMs should provide such metrics for typical system configurations or should provide data per module type to allow operators to estimate overall equipment heat release.

5.4 Product Disposal

1. Equipment installation and maintenance documentation shall provide specific direction not to discard the equipment with residential or commercial waste.
2. Equipment installation and maintenance documentation should provide instruction(s) and/or direction(s) for equipment provider take-back or recycling initiatives.

[21] ***ASHRAE TC 9.9 2011*** *Thermal Guidelines for Data Processing Environments – Expanded Data Center Classes and Usage Guidance*

6 Quality Requirements

6.1 Reliability

1. Equipment vendors shall provide product reliability predictions based on SR-332. (Reference ***SR-332 Issue 3, January 2011, Updated February 2011****; Reliability Prediction Procedure for Electrical Equipment*)
2. All reliability prediction reports shall state the SR-332 standard version used.
3. If the equipment has configuration options that substantially affect the reliability predictions, they shall be documented as options or shall be provided in separate reliability prediction report with instructions to combine predictions to get reliability of the resulting assembly.
4. Baseline reliability prediction values shall be stated at reference component ambient temperature of 40°C and 50°C using the SR-332 "Method I-D Black-Box Technique".
5. Manufacturers shall state the reliability model, the manufacturer data, and/or the field performance data from which the component reliability data is based.

6.2 Highly Accelerated Life Testing (HALT)

1. Equipment vendors should submit one fully loaded sample of the product with all applicable modules and component to a full and complete HALT regime.
2. The vendor shall document the equipment configuration and operating state during the HALT regimen.
3. The equipment configuration and operating state tested shall represent the highest performance capability of the equipment.
4. The testing shall include extreme variations of temperature, humidity and vibration to some extent outside of the normal operational ranges of these parameters.
5. The test process shall include a number of rapid transitions between the upper and lower test ranges of the designated parameters as well as extended periods at the extremes of these ranges
6. The equipment operating performance during the HALT regime shall be monitored and reported. All faults or performance anomalies shall be recorded. A Root Cause Analysis report for each anomaly shall be generated.

6.3 Service life predictions

Equipment vendors shall provide equipment and module sub-assembly service life prediction reports.

Appendix A – Normative References

The following documents contain provisions, which, through references in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

***ANSI/UL60950-1-2011, 2nd Edition, 2011-12-19**, "Information Technology Equipment-Safety-Part 1: General Requirements*

***ANSI Z136-2007** American National Standard for Safe Use of Lasers*

***ANSI Z136.2 (1997)**: American National Standard; Safe Use of Optical Fiber Communications Systems Utilizing Laser Diode and LED Sources*

ANSI/SCTE 46 2007, *Test Methods for AC to DC Power Supplies*

ANSI/SCTE 81 2007, *Surge Withstand Test Procedure*

***ASHRAE** Thermal Guidelines for Data Processing Environments.* 2nd edition, ISBN 1-931862-43-5, 2009

ASHRAE Standard 52.1, *Gravimetric and Dust-Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter*, 1992

ASHRAE Standard 52.2, *Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size*, 1999

***ATIS-0600005.2006**, Acoustic Noise*

***ATIS-060004.2006,** Equipment Surface Temperature*

CEA-556-C, *Outer Shipping Container Label Standard*

CEA-624-A, *Product Package Bar Code Label Standard for Non-Retail Applications*

***21CFR1040**;"PERFORMANCE STANDARDS FOR LIGHT EMITTING PRODUCTS", Code of Federal Regulations, Title 21—Food and Drugs, Chapter 1-Food and Drug Administration, Department of Health and Human Services, Subchapter J-Radiological Health, Part 1040, 21CFG1040.10.*

***47CFR15**; "RADIO FREQUENCY DEVICES", --Telecommunication, Chapter 1-Federal Communications Commission, Part 15-Radio Frequency Device, 47CFR15.*

***ECMA-370**, 4th Edition June 2009, TED-The Echo Declaration*

EIA-471-1996, *Symbol and Label for Eelctrostatic Sensitive Devices*

***GR-63-CORE, Issue 3, March 2006**; NEBS Requirements: Physical Protection*

***IEC 60825-1, Edition 2.0,** Safety of Laser Products – Part 1: Equipment Classification and Requirements*

***IEC 61000-4-3, Ed 3.2, 2010-0**4; Electromagnetic Compatibility (EMC) – Part 4-3: Testing and measurement techniques – radiated, radio-frequency, electromagnetic field immunity test*

***IEC 61000-4-4, Second Edition, 2004-07**; Electromagnetic Compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

***IEC 61000-4-5, Second Edition, 2005-11**; Electromagnetic Compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

***IEC 61000-4-5, Edition 2.2, 2006-05**; Electromagnetic Compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields.* 2006.

***IEC 61000-4-6 ed 3.0, 2008**; Electromagnetic Compatibility (EMC) – Part 4-6: Testing and Measurement Techniques-Immunity to Conducted Disturbances, Induced by Radio Frequency Fields*

***IEC CISPR 22 Edition 6.0 2008-09**; International Technology Equipment - Radio Disturbance Characteristics - Limits and Methods of Measurement*

***IEC CISPR 24, Edition 2.0 2010**; Information Technology Equipment - Immunity Characteristics - Limit and Methods of Measurement*

IEEE C62.41.1, Edition 2, 12/10/08; *Guide on the Surge Environment in Low-Voltage (1000V and less) AC power circuits*

ISO/IEC DIS 2836, Edition 11 January 2011; *Information Technology – Office Equipment – Determination of Chemical Emission Rates from Electronic Equipment*

SR-332 Issue 3, January 2011, Updated February 2011*; Reliability Prediction Procedure for Electrical Equipment*

Appendix B – Informative References

The folowing documents may provide valuable information to the reader but are not required when complying with this standard.

ANSI T1.336-2009: *Engineering Requirements for a Universal Telecom Framework*
ANSI T1.307-2007*: Fire Resistance Criteria – Ignitability Requirements for Equipment Assemblies, Ancillary Non-Metallic Apparatus, and Fire Spread Requirements for Wire and Cable*
ASHRAE Design Considerations for Datacom Equipment Centers, *ISBN 1-931862-94-X, 2005*
ASHRAE TC 9.9 2011 *Thermal Guidelines for Data Processing Environments – Expanded Data Center Classes and Usage Guidance*
ATIS 060015: 2009*, Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting - General Requirements*
ATIS 060015.01.2009*, Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting - Server Requirements*
ATIS 0600015.02.2009*, Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting - Transport Requirements*
ATIS 0600015.03; 2009*, Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting for Router and Ethernet Switch Products*
ATIS 0600015.04.2010*, Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting DC Power Plant – Rectifier Requirements.*
ATIS 0600329, Edition 8 2008*, Network Equipment - Earthquake Resistance*
ATIS-0600333.2007, *Grounding and Bonding of Telecommunications Equipment*
ECMA-74 *Measurement of Airborne Noise Emiitted by Informatin Techology and Telecommunications Equipment.*
ECMA-109*, December 2010; Declared Noise Emission Values of Information Technology and Telecommunications Equipment, 5th edition (December 2010).* ECMA
ECMA-341, 4th edition December 2010*, Environmental Design Consideration for ICT and CE Products*
47eCFR68*, Electronic Code of Federal Regulations (e-CFR), Title 47: Telecommunication, Part 68 – Connection of Terminal Equipment to the Telephone Network.*
EIA/ECA-310-E-2005*: Cabinets, Racks, Panels, and Associated Equipment*
EN 300 119-2, V2.1.2, 2009-12; *Environmental Engineering (EE); European telecommunications standard for equipment practice; Part 2: Engineering requirements for racks and cabinets*
EN 300 119-3, V2.1.2, 2009-12*; Environmental Engineering (EE); European telecommunications standard for equipment practice; Part 3: Engineering requirements for miscellaneous racks and cabinets*
ENERGY STAR® Version 1.0 Program Requirements for Computer Servers. 2009.
ENERGY STAR® Version 2.0, Draft 1 Program Requirements for Computer Servers
EN 300 253, V2.1.1, ETSI 2002-04*; Equipment Engineering (EE); Earthing and bonding of telecommunications equipment in telecommunication centres*
EN 300 019-2-2, V 2.1.2, 1999-09*; Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 2-2: Specification of environmental tests; Transportation*
EN 300 132-1, September 1996*; Environmental Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 1: Operated by alternating current (ac) derived from direct current (dc) sources*
ETSI EN 300-019-1-2, V2.1.4, 2003-04*; Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment, Part 1-2: Classification of environmental conditions; Transportation equipment*
ENERGY STAR® Program Requirements for Computers Version 5.0. 2008.
Mil-Std 810d, method 507.2 Procedure III-Aggravated

(RoHS) *DIRECTIVE 2002/95/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011 on the restriction of the use of certain hazardous Substances in electrical and electronic equipment (recast)*

SCTE 184 2012, *Facilities Energy Managment and Recommended Practices 2012*

Generalized Test Protocol for Calculating the Energy Efficiency of Internal AC-DC and DC-DC Power Supplies, Revison 6.5.

VZ.TPR.9205 *Verizon Technical Purchasing Requirements, Issue 4, August 2009*

GR-3160-CORE Issue 1, November 2008; *NEBS™ Requirements for Telecommunications Data Center Equipment and Spaces*

Environmental Profile*: Central Offices and Network Data Centers, Version 1.0 May 5, 2008, SCOPE Alliance*