SCTE · ISBE

STANDARDS

Energy Management Subcommittee

AMERICAN NATIONAL STANDARD

ANSI/SCTE 186 2021

Product Physical, Environmental, Electrical, Sustainability, and Quality Requirements for Cable Telecommunications

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1. Introduction

1.1. Executive Summary

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

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.

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.

1.3. Benefits

SCTE 186 provides cable operators a single reference point that defines energy savings and sustainability requirements for inside plant cable equipment. This standard provides cable operators means to implement and require more energy and environmentally friendly equipment. Cable operators should see financial operating energy savings as a result of implementing SCTE 186.

1.4. Intended Audience

Cable operator procurement and equipment engineering teams and inside plant equipment manufacturers will benefit from leveraging this standard.

1.5. Areas for Further Investigation or to be Added in Future Versions

None at time of 2020 update.

2. Normative References

The following documents contain provisions, which, through reference in this text, constitute provisions of this document. At the time of Subcommittee approval, the editions indicated were valid. All documents are subject to revision; and while parties to any agreement based on this document are encouraged to investigate the possibility of applying the most recent editions of the documents listed below, they are reminded that newer editions of those documents might not be compatible with the referenced version.

2.1. SCTE References

- ANSI/SCTE 46-2016, Test Methods for AC to DC Power Supplies
- ANSI/SCTE 81-2018, Surge Withstand Test Procedure
- ANSI/SCTE 129-2017, Drop Passives, Bonding Blocks (Without Surge Protection)

- ANSI/SCTE 158-2016, Recommended Environmental Condition Ranges for Broadband Communications Equipment
- SCTE 184 2015, Facilities Energy Managment and Recommended Practices 2011

2.2. Standards from Other Organizations

- ANSI T1.336-2009, Engineering Requirements for a Universal Telecom Framework
- ANSI/UL60950-1-2011, 2nd Edition, 2011-12-19, Information Technology Equipment-Safety-Part 1, General Requirements
- ANSI Z535.4-2007 American National Standard for Product and Safety Signs
- ANSI Z136.1-2014, American National Standard for Safe Use of Lasers
- ANSI Z136.2-2012, American National Standard; Safe Use of Optical Fiber Communications Systems Utilizing Laser Diode and LED Sources
- ANSI C63.4-2014, American National Standard Methods for Measurement of Radio-Noise Emissions for Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
- ANSI T1.307-2007, Fire Resistance Criteria – Ignitability Requirements for Equipment Assemblies, Ancillary Non-Metallic Apparatus, and Fire Spread Requirements for Wire and Cable
- ANSI T1.319-2002, Equipment Assemblies – Fire Propagation Risk Assessment Criteria. 2002.
- ANSI T1.319-2002, Telecom Equipment Assemblies – Fire Propagation Risk Assessment Criteria
- ASHRAE-2015, Thermal Guidelines for Data Processing Environments, Fourth Edition. 2015.
- ASHRAE-2009, Design Considerations for Datacom Equipment Centers, Second Edition. ISBN 9781933742489, 2009
- ASHRAE-2009, Best Practices for Data Center Facility Energy Efficiency, 2nd Edition, ISBN 978-1-933742-27-4, 2009
- ASHRAE Standard 52.1-1992, Gravimetric and Dust-Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter
- ASHRAE Standard 52.2 Addenda a, b and d-2015, Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size, 2015
- ASHRAE TC 9.9-2011, Thermal Guidelines for Data Processing Environments – Expanded Data Center Classes and Usage Guidance
- ATIS 060004-2006, Equipment Surface Temperature
- ATIS 0600005-2006, Acoustic Noise
- ATIS 0600010.02-2012, Equipment Handling, Transportation Vibration and Rail Car Shock Requirements for Network Telecommunications Equipment
- ATIS 060015-2013, 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 0600015.02-2014, Energy Efficiency for Telecommunication Equipment, Methodology for Measurement and Reporting - Transport Requirements

- ATIS 0600015.03-2013, 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 0600307-2014, Fire Resistance Criteria – Ignitability requirements for Equipment Assemblies, Ancillary Non-Metallic Apparatus, and Fire Spread Requirements for Wire and Cable
- ATIS 0600333-2013-07, Grounding and Bonding of Telecommunications Equipment
- ATIS 0600329-2014 Edition: Network Equipment Earthquake Resistance.
- CEA-556-C-2005, Outer Shipping Container Label Standard.
- CEA-624-A-2002, Product Package Bar Code Label Standard for Non-Retail Applications
- 21CFR910, "OCCUPATIONAL SAFETY AND HEALTH STANDARDS", Code of Federal Regulations, Title 29-Labor, Chapter XVII-Occupational Safety and Health Administrations, Department of Labor, Part 1920, 21CFR1910
- 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
- 29CFR1910.05, "Occupational Noise Exposure", Code of Federal Regulations, Title 29, Part 1910, Subpart 95 (1910.95), U.S. Department of Labor, Occupational Saftey and Health Administration (OSHA), 29 CFR1910.05
- 47CFR15, "RADIO FREQUENCY DEVICES", --Telecommunication, Chapter 1-Federal Communications Commission, Part 15-Radio Frequency Device, 47CFR15
- DIRECTIVE 2003/10/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of the of February, 2003 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents, noise.
- 47eCFR15-2016-02, Electronic Code of Federal Regulations (e-CFR), Title 47, Telecommunication, Part 15 – Radio Frequency Devices
- 47eCFR68-2016-02, Electronic Code of Federal Regulations (e-CFR), Title 47, Telecommunication, Part 68 – Connection of Terminal Equipment to the Telephone Network
- ECMA-109-2012, Declared Noise Emission Values of Information Technology and Telecommunications Equipment, 6th edition (December 2012)
- ECMA-74-2015, Measurement of Airborne Noise Emitted by Information Techology and Telecommunications Equipment, 13th Edition (June 2015)
- ECMA-341-2010, Environmental Design Consideration for ICT and CE Products, 4th Edition (December 2010)
- ECMA-370-2015, TED-The Echo Declaration, 5th Edition (June 2015)
- EIA-471-1996, Symbol and Label for Eelctrostatic Sensitive Devices
- EIA/ECA-310-E-2005, Cabinets, Racks, Panels, and Associated Equipment
- EN 300 119-1, V2.1.1-2004-2009, Environmental Engineering (EE); European telecommunications standard for equipment practice; Part 1, Introduction and terminology
- 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
- EN 300 119-5, V1.2.2-2004-12, Environmental Engineering (EE); European telecommunications standard for equipment practice; Part 5, Thermal Management
- ENERGY STAR®, Generalized Test Protocol for Calculating the Energy Efficiency of Internal AC-DC and DC-DC Power Supplies, Revison 6.6 (April 2012)
- ENERGY STAR®, Program Requirements for Computers. Version 6.0. October 2013
- ENERGY STAR®, Program Requirements for Computer Servers. Version 1.0. 2009
- ENERGY STAR®, Program Requirements for Computer Servers. Version 2.0. October 2013
- ENERGY STAR®, Program Requirements Product Specification for Uninterruptible Power Supplies (UPSs), Version 1.0. 2012
- Environmental Profile, Central Offices and Network Data Centers, Version 1.0 May 5, 2008, SCOPE Alliance
- ETR 100 035-February 2004, Equipment Engineering (EE); Environmental Engineering; Guidance and Terminology
- ETSI EN 300 019-1-0, V 2.1.2-2003-09, Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-0, Classification of environmental conditions; Introduction
- ETSI EN 300-019-1-1 V2.1.4-2003-2004, Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment, Part 1-1, Classification of environmental conditions; Storage
- 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
- ETSI EN 300 019-1-3, v2.3.2-2009-11, Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3, Classification of environmental conditions; Stationary use at weatherprotected locations
- ETSI EN 300 019-2-0, V 2.1.2-2003-09, Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 2-0, Specification of environmental tests; Introduction
- ETSI EN 300 019-2-1, V 2.1.6-2014-06, Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 2-1, Specification of environmental tests; Storage
- ETSI EN 300 019-2-2, V 2.1.2-2011-1, Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 2-2, Specification of environmental tests; Transportation
- ETSI EN 300 019-2-3, V 2.3.7-2015-09, Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 2-3, Specification of environmental tests; Stationary use at weatherprotected locations
- ETSI 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 300 386, V1.4.1-2007-10, Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Telecommunications Network Equipment; ElectroMagnetic Compatibility (EMC) Requirements
- ETSI ES 201 468 V1.5.1-2005-08, Additional Electromagnetic Compatibility (EMC) requirements and resistibility requirements for telecommunications equipment for enhanced availability of service in specific applications
- ETSI ETR 127-March 1994, Equipment Engineering (EE); Electrostatic environment and mitigation measures for Public Telecommunications Network (PTN)
- ETSI ETR 300 753 V1.2.1-2009-03, Equipment Engineering (EE); Acoustic noise emitted by telecommunications equipment
- ETSI TR 102 489, V1.1.1-2004-06, Environmental Engineering (EE); European telecommunications standard for equipment practice; Thermal Management Guidance for equipment and its deployment
- IEC CISPR 22 6th edition-2008-09
- IEC 60068-2-2 5th edition-2007-07, Environmental testing - Part 2, Tests
- IEC 60068-2-27 4th edition-2008-02, Environmental testing – Part 2-27, Tests – Ea and guidance, Shock
- IEC 60721-3-3 2.2nd edition-2002, Classification of environmental parameters and their severities - Stationary use of weather-protected locations
- IEC 60825-1 3rd edition-2014, Safety of laser products - Part 1, Equipment classification and requirement
- IEC 60950-1,2005+AMD1,2009+AMD2,2013, 2nd edition, 2013-05, Safety of information technology equipment including electrical business equipment
- IEC 61000-3-2 4th edition-2014-05, Electromagnetic Compatibility (EMC) – Part 3-2, Limits – Limits for harmonic current emissions (equipment input current <=16A per phase)
- IEC 61000-3-3,2013 3rd edition-2013-05, (EMC) – Part 3-3, Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current <=16A per phase and not subject to conditional connection
- IEC 61000-4-2,2008 2nd edition-2008-12, Electromagnetic Compatibility (EMC) – Part 4-2, Testing and measurement techniques – Electrostatic discharge immunity test
- IEC 61000-4-3, 3.2nd edition-2010-04, Electromagnetic Compatibility (EMC) – Part 4-3, Testing and measurement techniques – radiated, radio-frequency, electromagnetic field immunity test
- IEC 61000-4-4,2012 RLV 3rd edition-2012-04, Electromagnetic Compatibility (EMC) – Part 4-4, Testing and measurement techniques – Electrical fast transient/burst immunity test
- IEC 61000-4-5,2014 3rd edition-2014-05, Electromagnetic Compatibility (EMC) – Part 4-5, Testing and measurement techniques – Surge immunity test
- IEC 61000-4-6,2013 4th edition-2013-10, Electromagnetic Compatibility (EMC) – Part 4-6, Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields
- IEC 61000-4-8,2009 RLV 2nd edition-2009-09, Electromagnetic Compatibility (EMC) – Part 4-8, Testing and measurement techniques – Power frequency magnetic field immunity test

- IEC 61000-4-11 2nd edition-2004-03, Electromagnetic Compatibility (EMC) – Part 4-11, Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests
- IEC CISPR 24 2.1nd edition-2015: Information Technology Equipment - Immunity Characteristics - Limit and Methods of Measurement Table 4 conducted RF limits are identical.
- IEEE C62.41.1 2nd edition-2008, Guide on the Surge Environment in Low-Voltage (1000V and less) AC power circuits
- ISO/IEC DIS 2836 3rd edition 2016-02, Information Technology – Office Equipment – Determination of Chemical Emission Rates from Electronic Equipment
- JESD-471-2009, Symbol and Label for Electrostatic Sensitive Devices
- MIL-STD 810d, method 507.2 Procedure III-Aggravated
- NGAA Converged Multiservice Access Platform Product Specification, August 2010, Hardware & Functional Specification
- (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)
- SR-332 Issue 3, January 2011, Updated February 2011, Reliability Prediction Procedure for Electrical Equipment
- UL 2416 Edition 1, March 2015, Standard for Standard for Audio / Video, Information and Communication Technology Equipment Cabinet, Enclosures and Rack Systems
- UL 60950-1 Information Technology Equipment – Safety, March 2007, Updated December 2011
- (WEEE) DIRECTIVE 2002/96/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 January 2003 on waste electrical and electronic equipment (WEEE) (and latest associated amendments)
- UL 2416 STANDARD FOR SAFETY Audio/Video, Information and Communication Technology Equipment Cabinet, Enclosure and Rack Systems, March 11,2015

2.3. Published Materials

- No normative references are applicable.

3. Informative References

The following documents might provide valuable information to the reader but are not required when complying with this document.

3.1. SCTE References

- ANSI/SCTE 210 2015 Performance Metrics for Energy Efficiency & Functional Density of Cable Data Generation, Storage, Routing, and Transport Equipment.
- ANSI/SCTE 231 2016 General Test Procedures for Evaluation of Energy Efficiency Metrics and in Support of Functional Density Metrics
- ANSI/SCTE 232 2016 Key Performance Metrics: Energy Efficiency & Functional Density of CMTS, CCAP, and Time Server Equipment.

3.2. Standards from Other Organizations

- ANSI/TIA 942-2015: Telecommunications Infrastructure Standard for Network Data Center.
- ANSI/TIA-968-B-2009: Telecommunications - Telephone Terminal Equipment – Technical Requirements for Connection of Terminal Equipment to the Telephone Network.
- ANSI Z535.4-2011 (R2017) American National Standard for Product and Safety Signs and Labels
- ASHRAE: Datacom Equipment Power Trends and Cooling Applications, Second Edition, ISBN 9781936504282 2012
- ASHRAE: Design Considerations for Datacom Equipment Centers, Second Edition, ISBN 9781933742489, 2009
- ASHRAE: Liquid Cooling Guidelines for Datacom Equipment Centers, ,Second Edition ISBN 9781936504671, 2013
- ASHRAE: Structural and Vibration Guidelines for Datacom Equipment Centers, ISBN 9781933742205,2008
- ATIS-0600319.2014-2014: Equipment Assemblies -- Fire Propagation Risk Assessment Criteria.
- ATIS-PP-0600315.2013: Voltage Levels for DC-Powered Equipment Used in the Telecommunications Environment
- CAN/CSA-Z321-96 (R2006), Signs and Symbols for the Workplace
- DIRECTIVE 2006/95/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 December 2006 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (and 2008/C 28/01 for harmonized stand)
- (EMC) DIRECTIVE 2004/108/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility
- EN 300 119-4 V2.1.1-2004-09: Environmental Engineering (EE); European telecommunications standard for equipment practice; Part 4: Engineering requirements for subracks in miscellaneous racks and cabinets
- ETSI EN 300 132-2 V2.4.6-2011-10: Power supply interface at the input to the telecommunications and datacom (ICT) equipment; Part 2: Operated by -48V direct current
- ETSI EN 300 132-3 V2.1.1-2011-10: Environmental Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 3: Operated by rectified current source, alternating current source or direct current source up to 400V
- ETSI EN 300 253 V2.2.1-2015-06: Equipment Engineering (EE); Earthing and bonding of telecommunications equipment in telecommunication centres
- TIA-569-B-2004: Commercial Building Standard for Telecommunications Pathways and Spaces

3.3. Published Materials

- “Information technology equipment including electrical business equipment”: European Norm, European Committee for Electrotechnical Standardsization (CENELEC)
- Recommendations for Measuring and Report Overall Data Center Efficiency
- SCOPE AdvancedTCA™ HW Profile, Version 2.0-2007
- SCOPE MicroTCA™ HW Profile, Version 1.0-2007

- SCOPE Services and Support Profile Service Availability, Version 1.0-2007
- SCOPE Services and Support Profile Long Life Cycle Support, Version 1.0-2007
- Usage and Public Reporting Guidelines for PUE/DCiE – WP #2-2009
- VZ.TPR.9205 Issue 5-2011-10: Verizon Technical Purchasing Requirements

4. Compliance Notation

shall	This word or the adjective "***required***" means that the item is an absolute requirement of this document.
shall not	This phrase means that the item is an absolute prohibition of this document.
forbidden	This word means the value specified shall never be used.
should	This word or the adjective "*recommended*" means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighted 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.
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5. Abbreviations and Definitions

5.1. Abbreviations

AC	alternating current
ADM	add-drop multiplexer
ASTM	American Society for Testing and Materials
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
CENELEC	European Committee for Electrotechnical Standardization
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

DIMM	Dual In-line Memory Module
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
EMI	electromagnetic interference
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
IP	Internet protocol
ISDN	Integrated Services Digital Network
IT	information technology
ITE	information technology equipment
ITU	International Telecommunication Union
MPEG	Motion Picture Experts Group
MSO	multiple system operator
PDA	personal digital assistant
PSTN	Public Switched Telephone Network
OEM	original equipment manufacturer
OS	operating system
OSHA	Occupational Safety and Health Administration (US Dept. of Labor)
OSP	outside plant
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
TCG	telecommunications carrier group
TEER	telecommunications energy efficiency ratio
TIA	Telecommunications Industry Association
U	unit, short for rack-unit, measure of vertical rack space, 1U=1.75” (44.45mm)
USB	universal serial bus
UPS	uninterruptible power supply
WDM	wavelength-division multiplexer

6. Physical Requirements

6.1. Frame and Cabinet

1. Equipment frames and cabinets *should* comply with international standards for uniform frameworks.
2. Safety for equipment and frames should comply with UL 60950-1 Information Technology Equipment – Safety and UL 2416 Edition 1, March 2015, Standard for Standard for Audio / Video, Information and Communication Technology Equipment Cabinet, Enclosures and Rack Systems.
3. Open racks *should* comply with EIA/ECA-310-E-2005: Cabinets, Racks, Panels, and Associated Equipment.
4. Recommended open rack dimensions are:
   - 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
5. 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 0600329-2014 Edition:** *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 0600333-2013-07,** *Grounding and Bonding of Telecommunications Equipment*.
6. No protrusions ***shall*** extend beyond a cabinet front or rear.
7. Frames ***shall*** provide holes in a horizontal surface at the base of the frame to allow anchoring to the floor.
8. Shelf 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 1.

Table 1 - Example Cabinet Dimensions

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
23.6	42.3	89.6	49	Cabinet
27.16	43.37	84.5	45	Cabinet
27.5	36	89.6	49	Cabinet
27.5	42	89.6	49	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	42.3	89.6	49	Cabinet
31.5	46.5	84	45	Cabinet
31.5	48	95	51	Cabinet
32	36	89.6	49	Cabinet
32	42	89.6	49	Cabinet

6.2. 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.

Static Load tests shall be applied as close as possible to the top of the enclosure and equal to two times the total weight of the loaded system. This will include he weight of the system itself, the maximum rated load and rated cable weight.

6.3. Impact Force Resistance

Note Section 9.1.5 of UL 2416 has different requirement, eg, enclosure with a voumue of 8 ft^3 the impact is to be 13.6J, (10 ft lbs) produced by dropping a steel sphere etc.

For an enclosure having a volume of 8 ft3 or more the impact is to be 136J (100 ft-pds) produced by dropping a hard rubber ball (such as a bowling ball) etc..

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.

6.4. Microphonic 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.

6.5. 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.

6.6. 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 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.
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.
9. 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 Title 21 CFR1040.10 and/or the clause of IEC 60825-1 Ed.3. Labels should comply with ANSI Z535.4-2007 American National Standard for Product and Safety Signs.

6.6.1. Packaging and Shipping Labels

1. Equipment package barcode ***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 barcodes indicating its contents placed on the front upright surface.
3. Equipment packaging ***shall*** comply with **CEA-556-C-2005,** *Outer Shipping Container Label Standard*.
4. Equipment packaging ***shall*** comply with **CEA-624-A-2002, Product** *Package Bar Code Label Standard for Non-Retail Applications*.

6.6.2. ESD Labels and Documentation

1. Equipment ***shall*** be labeled in compliance with **JESD-471-2009:** *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.

Review ANSI Z535.3/CAN/CSA-Z321 to ensure visibility?

6.7. 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, polybrominated biphenyls (PBB) or polybrominated diphenyl (PBDE) from electronic and electrical products.

6.8. 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. (Reference **SCTE 184 2015,** *Facilities Energy Managment and Recommended Practices* 2011

6.9. 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 websites to compute product weight based on equipment configuration.

7. 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 earthquake resistance are specified.

7.1. Climate

7.1.1. 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 conditions, 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 2.
2. Packaged equipment ***shall not*** be damaged or deteriorate in operational performance after exposure to the High Temperature conditions specified in the Table 2.
3. Packaged equipment ***shall not*** be damaged or deteriorate in operational performance after exposure to the High Humidity criteria specified in Table 2.
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 2 - 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.)	

7.1.1.1. Thermal Shock (non-powered)

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

Table 3 - 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

7.1.1.2. Humidity Shock (non-powered)

1. Equipment *may* comply with high humidity criteria specified in Table 4. 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 4, 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".[1] 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

ed in a survey of racks and

Table 4 - 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] Reference MIL-STD 810d, method 507.2 Procedure III-Aggravated					

7.1.2. Operating Temperature and Humidity

Equipment ***shall*** meet the operating temperature and humidity criteria specified in Table 5.

Table 5 - 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 **IEC CISPR 22 6th edition-2008-09** [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 that. 1-year period.)[2]							

7.1.3. 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 50°C (32° 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° 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.

cabinets in facilities of one major North American MSO.
March 2006: Page 4-4.

7.1.4. Operating Internal Temperature Margin

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

1. The equipment vendor *should* provide detailed information regarding equipment internal temperature above ambient at 0ºC, 25ºC, and 50ºC.
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 the 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.

7.1.5. 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.
6. Equipment operating instructions ***shall*** document fan or fan bank replacement procedures.
7. Equipment manufacturers ***shall*** document any fan software control features.

7.1.6. Equipment Surface Temperature

1. Equipment touchable surfaces ***shall not*** exceed limits specified in Table 6.
2. For ambient temperature up to 50ºC, 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 6 - ATIS-060004.2006 Touchable Equipment Surface Temperature Limits[3]

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] Uncoated metals *may* be plated and/or have a conversion coating. Conversion coatings are assumed to be thermally conductive.
[2] Contact: Incidental contact *may* be accidental and is very short in duration: 1 second or less.
[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] Prolonged use is anywhere between 10 seconds and 10 minutes. Examples *may* include surfaces handled during more extensive maintenance and repair procedures.

7.2. Shock and Vibration

Equipment undergoing commercial transportation can be subject to complex low-level vibrations of randomly distributed frequencies and transient peaks. Equipment can also be subject to drops and mechanical shock during transportation, storage, and installation. While 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.

7.2.1. 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.

7.2.1.1. Equipment < 100 kg

Equipment weighing < 100 kg (220.5 lbs.) 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 7.[4]

Table 7 - Free Fall Drop Limits

Gross Mass	Drop Height
< 15 kg (< 33.1 lbs.)	1.0 m (39.6 in)
< 20 kg (< 44.1 lbs.)	0.8 m (31.5 in)
< 30 kg (< 66.2 lbs.)	0.6 m (23.6 in)
< 40 kg (< 88.2 lbs.)	0.5 m (19.7 in)
< 50 kg (< 110.2 lbs.)	0.4 m (15.8 in)
< 100 kg (< 220.5 lbs.)	0.3 m (11.8 in)

[3] **ATIS-060004.2006:** *Equipment Surface Temperature*, Table 1.
[4] Data is from Class T 2.3 free fall drop limits specified in Table 7 of ETSI EN 300 019-2-2, V 2.1.2-2011-1.

7.2.1.2. Equipment ≥ 100 kg

Palletized equipment weighing ≥ 100 kg (220.5 lbs.) 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.).

7.2.2. Unpacked Equipment Free Fall Drop

When unpackaged, the device ***shall not*** be physically damaged and ***shall*** operate normally without performance degradation after exposure to free fall drop limits specified in Table 8.

Table 8 - Unpacked Equipment Free Fall Drop[5]

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

7.2.3. 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 9.

Table 9 - Transportation Mechanical Shock[6]

Mechanical Shock Spectrum Type	I	II
Duration	11 ms	6 ms
Peak Acceleration (m/s^2) (g)	 100 m/s^2 10.2 g	 300 m/s^2 30.6 g
Notes: **Reference** IEC 60068-2-27 4th edition-2008-02 **for shock spectrum definitions.** **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.**		

7.2.4. 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 10.

[5] Data is from Table 6 of **ATIS-0600010.02.2009:** *Equipment Handling, Transportation Vibration and Rail Car Shock Requirements for Network Telecommunications Equipment.*
[6] Class 2.3 transportation mechanical shock criteria from Table 5 of **ETSI EN 300-019-1-2, V2.1.4, 2003-04.**

Table 10 - Transportation Mechanical Vibration

Random Vibration			**Notes**
Acceleration spectral density (ASD) (m^2/s^3) (g^2/Hz)	 1 .01	 0.3 .003	
Frequency range (Hz)	10 to 200	200 to 2000	
Notes: **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** **ASD in units of m^2/s^3 = 96 x [ASD in units of g^2/Hz]**			

7.2.5. Operating Mechanical Vibration

Equipment resistance to office vibrations ***shall*** be tested:

- Swept Sine – Subject the equipment to a swept sine survey at an acceleration amplitude of 0.981 m/sec^2 (0.1g) from 5 to 100 Hz and back to 5 Hz at a rate of 0.1 octave/minute. The duration of this sweep is approximately 90 minutes.

  Repeat the swept sine for each of the 3 mutually perpendicular framework axis (X, Y, and Z).

7.2.6. Operating Mechanical Shock

Equipment ***shall*** operate when subjected to a maximum mechanical shock to the equipment chassis of equipment weight based breakdown of:

- ≤ 50 pounds = 63g
- 50 to ≤ 100 pounds = 53 g
- 100 + to 200 pounds = 43 g
- 200 + pounds = 33 g

(all half-sine shock levels are of 2 ms duration) on a half-sine shock pulse of 2 milliseconds duration to the equipment surface front, back, top, bottom, left side and right side.

7.2.7. Earthquake Resistance

Mission critical equipment *should* withstand high risk zone earthquake resistance criteria specified in **ATIS 0600329-Edition 2014:** *Network Equipment – Earthquake Resistance.* **ATIS 0600329** requirements for seismic vibration endurance include parts from GR-63-CORE and ETSI with IEC based test methods.[7] Earthquake resistance evaluation is based on the required response spectra simulation test response waveform and simulation methods established in the 1970s by Bell Labs.

[7] **ATIS 0600329-2014 Edition**, Annex B.

7.3. 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.

7.3.1. Equipment Airborne Contaminant Resistance

7.3.2. Solvent Resistance

1. Equipment ***shall not*** be deformed, disfigured, discolored or marred when exposed to common household and industrial cleaning solvents, to nonabrasive cleaners or to waxes.
2. Equipment solvent resistances ***shall*** include, but ***shall not*** be 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.

7.4. Equipment Safety

7.4.1. 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.*

7.4.2. 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.*
2. **ANSI Z136.1-2014,** *American National Standard for Safe Use of Lasers*.
3. **ANSI Z136.2-2012, *American*** *National Standard; Safe Use of Optical Fiber Communications Systems Utilizing Laser Diode and LED Sources*.

7.4.3. Fire Safety

Equipment *should* comply with **ATIS 0600329-2014 Edition:** *Network Equipment - Earthquake Resistance.*REF _ATI09

7.4.4. 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 7.1.5; points 2 and 3.)
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.

8. Electrical Requirements

8.1. Electromagnetic compatibility (EMC)

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

8.1.1. 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 Part 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. The need to further reduce equipment radiated emissions is emphasized by some operators by requiring equipment to 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.

8.1.2. 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 6th edition-2008-09**.

8.1.2.1. 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.

8.1.2.2. 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 6th edition-2008-09** Class A emissions limits.
2. Equipment *should* comply with **IEC CISPR 22 6th edition-2008-09** Class-B radiated emissions limits.

8.1.3. Conducted Emissions

8.1.3.1. Power-On Spurious Emissions

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

8.1.3.2. Conducted Emissions

1. Equipment conducted emissions ***shall*** meet or surpass applicable FCC rules and regulations.
2. Equipment *should* meet or exceed FCC Part 15 Class B compliance specifications.

8.1.3.3. DC ports Conducted Emissions

For equipment with DC power ports, the Class A limits specified in **IEC CISPR 22 6th edition-2008-09** ***shall*** apply.

8.1.3.4. Conducted Emissions – Telecommunications/Network Ports

This specification uses the **IEC CISPR 22 6th edition-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 6th edition-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 6th edition-2008-09**.

8.1.4. Immunity Criteria

8.1.4.1. Enclosure

8.1.4.1.1. 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 11

Table 11 - 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	
Notes: Reference: IEC 61000-4-3, 3.2nd edition-2010-04: Electromagnetic Compatibility (EMC) – Part 4-3: Testing and measurement techniques – radiated, radio-frequency, electromagnetic field immunity test..			

8.1.4.1.2. 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 insulated equipment surface.
3. Electrostatic discharges ***shall*** be attempted over and around equipment interface ports but ***shall not*** be performed inside the interface ports. [8]

8.1.4.2. AC Power Port

8.1.4.3. 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 12.

Table 12 - 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	
Notes: IEC CISPR 24 2.1nd edition-2015: Information Technology Equipment - Immunity Characteristics - Limit and Methods of Measurement Table 4 conducted RF limits are identical. IEC 61000-4-6 4th edition-2013-10: Electromagnetic Compatibility (EMC) – Part 4-6: Testing and Measurement Techniques-Immunity to Conducted Disturbances, Induced by Radio Frequency Fields.			

8.1.4.3.1. Surge Immunity – AC Power Port

Equipment ***shall*** operate without performance impairment after its AC power port is exposed to surges specified in Table 13.

Table 13 - 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: Reference IEC 61000-4-6,2013 4th edition-2013-10, Electromagnetic *Compatibility (EMC) – Part 4-6*. Surge waveform is per IEEE C62.41.1 2nd edition-2008, Guide on the Surge *Environment in Low-Voltage (1000V and less) AC power circuits* Reference ANSI/SCTE 81-2012: Surge Withstand Test Procedure.			

8.1.4.3.2. 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 14.

[8] Reference **IEC 61000-4-2:2008 2nd Edition-2008-12:** *Electromagnetic Compatibility (EMC) – Part 4-2.Testing and measurement techniques – Electrostatic discharge immunity test.*

Table 14 - 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

8.1.4.3.3. 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 15.
2. Equipment using 3-phase AC power ***shall not*** operate on loss of one or more power phase inputs.

Table 15 - AC Voltage Dips

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

8.1.4.3.4. 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 16.
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 16 - AC Voltage Interruptions

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

8.1.4.4. DC Power Port

8.1.4.4.1. 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 17.

Table 17 - 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	

8.1.4.4.2. 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 specified in Table 18.

Table 18 - 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	

8.1.4.4.3. DC Voltage Fluctuation – DC Power Port

1. Equipment ***shall*** withstand < 30 second duration voltage fluctuations that exceed 75 VDC or less 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.

8.1.4.5. Telecommunications/Network Port

8.1.4.5.1. 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 19.

Table 19 - 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	

Notes:
1. IEC CISPR 24 2.1nd edition-2015: Information Technology Equipment - Immunity Characteristics - Limit and Methods of Measurement Table 2 conducted RF limits are identical.2.
2. Applies when the cable length between the EUT and other active equipment *may* be greater than 3 meters.

8.1.4.5.2. 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 20.

Table 20 - 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	
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	
Differential mode (Metallic) surge applied to ports using unshielded nonsymmetrical cables.	T_r/T_h µs kV peak	1.2./50 (8/20) 1	

8.1.4.5.3. 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 21.

Table 21 - Telecommunications/Network Ports Electronic Fast Transients

Parameter	Unit	Limit	Notes
Fast Transients	T_r/T_h ns kV peak kV peak Rep. Frequency kHz	5/50 0.5 for indoor 1 for outdoor 5	

8.2. 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 affixed 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.

9. 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-341-2010, *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.

9.1. 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-341-2010, *Environmental Design Consideration for ICT and CE Products*. ECMA-341 provides 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*"[9]

3. Equipment providers ***shall*** document product environmental design decisions using a design checklist covering environmental aspects.
4. **ECMA-341-2010,** *Environmental Design Consideration for ICT and CE Products*, *Annex A* is an example checklist.
5. Equipment provider companies ***shall*** document the Company Environmental Profile and the Product Environmental Attribute (for each product) specified in **ECMA-370-2015, TED-The Echo Declaration**.
6. Equipment providers *should* develop a Corporate Responsibility Report and a Global Reporting Initiative (GRI) Corporate Responsibility Report.
7. Life Cycle Thinking[10]

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.

9.1.1. 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.

9.1.2. 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.

[9] ECMA-341-2010: Environmental Design Consideration for ICT and CE Products, *Section 1: Scope.*
[10] ECMA-341-2010: Environmental Design Consideration for ICT and CE Products, *Section 5: Life Cycle Thinking* and *Section 4: Terms and Definitions.*

9.2. Product Operation

9.2.1. Airflow

Every kW of heat load typically require 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). 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 criteria guidelines should include:

1. Direction of air flow within the equipment should be front to rear. If the airflow is side to side, a deflector should be provided to direct airflow to the rear.
2. Cubic-feet-per-minute (CFM) airflow from fans directing air to specific locations.
3. Information about software-controlled features of fans.
4. Spacing/ clearance limit requirements and/or recommendations.

9.2.2 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 52.1-1992**-1992 and **ASHRAE Standard 52.2** Addenda a, b and d-2015, Addendum a, b, and d-2015, 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 given size range. Standard 52.2-1999 measures particle size efficiency expressed as a minimum efficiency reporting value (MERV) between 1 and 20*."[11]

1. Fan cooled cable equipment ***shall*** use filters compliant with **ASHRAE Standard 52.1-1992** and **ASHRAE Standard 52.2 Addenda a, b and d-2015**.
2. Equipment with vertical rack space greater than 2U ***shall*** have minimum dust arrestance of 80% or a MERV rating of 4 per **ASHRAE Standard 52.2 Addenda a, b and d-2015**.
3. Equipment with vertical rack space less than or equal to 2U ***shall*** have minimum dust arrestance of 65% per **ASHRAE Standard 52.1-1992** or a MERV rating of 2 per **ASHRAE Standard 52.2 Addenda a, b and d-2015**
4. Filters *should* be disposable 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 replacement.

9.2.2. 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-2015, *Thermal*** *Guidelines for Data Processing Environments, Fourth* Edition.

[11] **ASHRAE:** *Design Considerations for Datacom Equipment Centers*.

4. Recorded heat release values ***shall*** be based on the following operating conditions:[12]
    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 2015, *Facilities Energy Managment and Recommended Practices 2011* recommends rack level power dissipation 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 with the use of blanking panels to help minimize mixing of warm and cold air through the 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.

9.2.3. Energy Efficiency

Strain is placed upon communication facilities capabilities and increases operating expenses due to increasing equipment sophistication, power density, and heat dissipation. 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.
- Compliance 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.
- 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

[12] **ASHRAE-2015:** *Thermal Guidelines for Data Processing Environments,Fourth Edition*.

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.

9.2.3.1. 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 final draft 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 060015-2013: 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 0600015.02-2014: Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting - Transport Requirements.

4. Router and Ethernet Switch
ATIS 0600015.03-2013: 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.

9.2.3.2. 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 document section *should* comply with the general requirements for equipment energy efficiency as specified in Section 9.2.4.3.
3. Equipment types itemized in this document 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 that meet the qualifying criteria specific to a TEER or ENERGY STAR® specification referenced in this document *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 Issue 5-2011-10: Verizon Technical Purchasing Requirements.***

General Requirements for Equipment Energy Efficiency

1. Equipment ***shall*** measure and report energy/internal power supply efficiency in accordance with ENERGY STAR®: Generalized Test Protocol for Calculating the Energy Efficiency of Internal AC-DC and DC-DC Power Supplies, Revision 6.6 (April 2012).
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.

9.2.3.3. Computer Energy Efficiency

ENERGY STAR®: Program Requirements for Computers. Version 6.0. October 2013 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*." [13]

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

9.2.3.4. Computer Server Energy Efficiency

ENERGY STAR®: Program Requirements for Computer Servers. Version 1.0. 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"*[14]

9.2.3.4.1. ENERGY STAR® Computer Server

1. Computer server category equipment *should* comply with ENERGY STAR®: Program Requirements for Computer Servers. Version 1.0. 2009. OEMs *should* specify the release edition for which equipment qualifies.

[13] **ENERGY STAR®** Program Requirements for Computers Version 6.0. 2013, page 5.
[14] **ENERGY STAR®** *Version 1.0: Program Requirements for Computer Servers. 2009.*

9.2.3.4.2. ATIS Server TEER[15]

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%, 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 22 and Table 23.

Table 22 - 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 23 - 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

9.2.3.5. Transport Equipment Energy Efficiency

ATIS 0600015.02-2014: 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,

[15] 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.

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)"*[16]

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 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 a Certified TEER equipment configuration.

9.2.3.6. Router and Ethernet Switch Efficiency

1. Providers of router and Ethernet switch category equipment *should* comply with *ATIS 0600015.03-2013: 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.

[16] ***ATIS 0600015.02-2009:*** *Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting - Transport Requirements,* section 4.1

9.2.4. Emissions

9.2.4.1. Chemical Emission

If a product uses an electrostatic process, equipment providers ***shall*** document emission rates according to **ISO/IEC DIS 2836 3rd edition 2016-02,** Information *Technology – Office Equipment – Determination of Chemical Emission Rates from Electronic Equipment*

JESD-471-2009, Symbol and Label for Electrostatic Sensitive Devices

9.2.4.2. Acoustic Emissions

Equipment ***shall*** comply with acoustic noise limits specified in **ATIS 0600005-2006:** *Acoustic Measurement.* See Table 24.

Table 24 - 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

9.3. Equipment Metrics for ASHRAE Expanded Data Center Operating Envelopes

Operators *may* use guidelines recommended by ASHRAE[17] 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 15ºC, 20ºC, 25ºC, 30ºC, and 35ºC. 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-74-2015,** *Measurement of Airborne Noise Emitted by Information Techology and Telecommunications Equipment, 13th Edition (June 2015)*and using declaration in a uniform fashion as specified in **ECMA-109-2012,** *Declared Noise Emission Values of Information Technology and Telecommunications Equipment, 6th edition (December 2012)*. Criteria *should* be provided at 15ºC, 20ºC, 25ºC, 30ºC, and 35ºC. 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.

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

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.

9.4. 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.

10. Quality Requirements

10.1. 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.

10.2. Highly Accelerated Life Testing (HALT)

1. Equipment vendors *should* submit one fully loaded sample of the product with all applicable modules and components to a full and complete HALT regimen.
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 regimen ***shall*** be monitored and reported. All faults or performance anomalies ***shall*** be recorded. A Root Cause Analysis report for each anomaly ***shall*** be generated.

10.3. Service Life Predictions

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