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SERIES L: ENVIRONMENT AND ICTS, CLIMATE
CHANGE, E-WASTE, ENERGY EFFICIENCY;
CONSTRUCTION, INSTALLATION AND PROTECTION
OF CABLES AND OTHER ELEMENTS OF OUTSIDE
PLANT

Power feeding and energy storage

**Evaluation method of safety operations and
energy saving for power supply systems in
telecommunication rooms or buildings**

Recommendation ITU-T L.1240

ITU-T L-SERIES RECOMMENDATIONS

ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

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Recommendation ITU-T L.1240

Evaluation method of safety operations and energy saving for power supply systems in telecommunication rooms or buildings

Summary

Recommendation ITU-T L.1240 specifies, for telecommunication rooms or buildings, the overall evaluation framework, classification, reliability grading, evaluation items and evaluation methods for power supply systems. Recommendation ITU-T L.1240 applies to the evaluation of power supply systems, maintenance capability, safety operations and energy saving of various telecommunication rooms or buildings.

History

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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Recommendation ITU-T L.1240

Evaluation method of safety operations and energy saving for power supply systems in telecommunication rooms or buildings

1 Scope

This Recommendation establishes evaluation methods of safety operations and energy saving for power supply systems in telecommunication rooms or buildings.

This Recommendation specifies:

- overall safety operations evaluation;
- energy-saving evaluation;
- classification of telecommunication rooms or buildings;
- reliability grading;
- evaluation methods for power supply system in telecommunication rooms or buildings.

This Recommendation applies to the evaluation of power supply systems, maintenance capability, safety operations and energy saving of various telecommunication room or building configurations.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

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| [ITU-T L.1210] | Recommendation ITU-T L.1210 (2019), <i>Sustainable power-feeding solutions for 5G networks</i> . |
| [ITU-T L.1320] | Recommendation ITU-T L.1320 (2014), <i>Energy efficiency metrics and measurement for power and cooling equipment for telecommunications and data centres</i> . |
| [ITU-T L.1350] | Recommendation ITU-T L.1350 (2016), <i>Energy efficiency metrics of a base station site</i> . |
| [ITU-T L.1380] | Recommendation ITU-T L.1380 (2019), <i>Smart energy solution for telecom sites</i> . |
| [ITU-T L.1381] | Recommendation ITU-T L.1381 (2020), <i>Smart energy solutions for data centres</i> . |
| [ITU-T L.1382] | Recommendation ITU-T L.1382 (2020), <i>Smart energy solution for telecommunication rooms</i> . |
| [ITU-T L.1383] | Recommendation ITU-T L.1383 (2021), <i>Smart energy solutions for city and home applications</i> . |
| [ETSI EN 300 019-2-4] | ETSI EN 300 019-2-4 V2.5.1 (2018), <i>Environmental engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 2-4: Specification of environmental tests; Stationary use at non-weather protected locations</i> . |



[IEC 60068-2-11]	IEC 60068-2-11:2021, <i>Environmental testing – Part 2-11: Tests – Test Ka: Salt mist.</i>
[IEC 60529]	IEC 60529:2013, <i>Degrees of protection provided by enclosures (IP code).</i>
[IEC 61000-4-2]	IEC 61000-4-2:2008, <i>Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test.</i>
[IEC 61000-4-5]	IEC 61000-4-5:2017, <i>Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test.</i>
[IEC 62619]	IEC 62619:2022, <i>Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications.</i>
[IEC CISPR 32]	IEC CISPR 32 (2019), <i>Electromagnetic compatibility of multimedia equipment – Emission requirements.</i>
[ISO 10289]	ISO 10289:1999, <i>Methods for corrosion testing of metallic and other inorganic coatings on metallic substrates — Rating of test specimens and manufactured articles subjected to corrosion tests.</i>
[ISO 16750-4]	ISO 16750-4:2010, <i>Road vehicles – Environmental conditions and testing for electrical and electronic equipment – Part 4: Climatic loads.</i>

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 energy [b-ISO 80000-5]: Ability of a system to do work.

NOTE – In telecommunication systems, the primary source is electrical energy, which is measured in joules or watt hours.

3.1.2 energy savings [b-ISO/IEC 13273-1]: Reduction of energy consumption following implementation of an energy performance improvement action.

NOTE – See [b-ITU-T L.1315] for a complete discussion on energy efficiency terms.

3.1.3 functional unit [b-ITU-T L.1310]: A performance representation of the system under analysis. For example, for transport equipment, the functional unit is the amount of information transmitted, the distance over which it is transported and its rate in Gbit/s. Sometimes the term is used to indicate useful output or work.

NOTE – This definition is based on that in ISO 14040.

3.1.4 idle mode [b-ITU-T L.1310]: A network element with no user data traffic (it is not zero traffic, as service and protocol supporting traffic are present) being used, although it is ready to be used.

3.1.5 low power (sleep) mode [b-ITU-T L.1310]: For small networking equipment, this means a state that happens after the device detects no user activity for a certain period of time and reduces energy consumption. For this state, no user-facing LAN ports are connected; the Wi-Fi is active but no clients are connected. The WAN port may be inactive. The device will reactivate on detecting a connection from a user port or device.

3.1.6 reliability [b-ITU-T Y.3514]: The ability of a system, product or component to perform and maintain under stated conditions as required for a specified period of time.

3.1.7 small networking device [b-ITU-T L.1315]: A networking device with fixed hardware configuration, designed for home/domestic or small office use, with less than 12 wired ports. This device can have wireless functionality implemented. Wireless functionality is not considered a port.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 active mode of small networking equipment: Operational mode where all ports (wide access network and local area network) are connected, with at least one wireless fidelity (Wi-Fi) connection, if a Wi-Fi function is available.

3.2.2 useful output: The useful work carried out by the equipment, e.g., delivered bits or output energy from wireless equipment.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC	Alternating Current
BMS	Battery Management System
DC	Direct Current
ESD	Electrostatic Discharge
HSL	Hazard Safety Level
ICT	Information and Communication Technology
SOC	State Of Charge
UPS	Uninterruptible Power Supply
Wi-Fi	Wireless Fidelity

5 Conventions

In this Recommendation, safety operations mean maintenance of system reliability at the initial designed level.

The symbol I_{10} A (the equivalent in industry is C_{10}) is used for the current rate for 10 h of backup equivalent to one-10th of nominal capacity.

6 Introduction

There are many problems in current urban energy management. Smart energy solves existing problems of urban energy management through clean, regional, intelligent and Internet-based urban energy. Smart solutions can promote the conversion of all kinds of energy, especially electrical. For energy, smart solutions increase the proportion of that which is clean, as well as promoting its development and utilization, optimize urban structure, and improve utilization efficiency, to implement green and environmentally friendly management at local and national government levels. Solutions based on smart power developed in [ITU-T L.1210], [ITU-T L.1380], [ITU-T L.1381], [ITU-T L.1382] and [ITU-T L.1383] shall be considered.

6.1 Classification of telecommunication rooms or buildings

Telecommunication installations in a network can be classified in different ways and called by different names, such as central office, primary site and aggregation site, depending on the country.

Telecommunication rooms or building are classified based on the service and interconnection types derived from [b-CCSA-YD/T 1051] with some adjustment.

All telecommunication rooms or buildings are classified into classes I to IV:.

- class I: with international and national network services, which provide services and support for the entire country, with large-sized data centre computer rooms, etc;
- class II: with local network service room, centralized service room and support room for local network, medium-sized data centre, etc;
- class III: local telecommunication rooms or buildings with regional services and support in local network, small data centre, etc;
- class IV: computer room, base station, indoor distribution telecommunication room and other telecommunication rooms or buildings with network terminal access services.

6.2 Reliability grading of power supply system

There are four levels of potential power supply reliability risk, which are determined by the importance of its system installation and the degree of damage caused to its entire system and to information and communication technology (ICT) load when faults occur.

Table 1 lists descriptions and grading criteria for reliability risk levels.

Table 1 – Descriptions and grading criteria for reliability risk levels

Graded	Description	Grading criteria
Level 1	The reliability of the power supply system and communications has been or will be jeopardized and should be handled as soon as possible.	Faults occur frequently or have occurred and affect the power supply system and communication reliability.
Level 2	The power supply system may be out of service or operating performance deterioration, affecting equipment and communication reliability.	In violation of system requirements, equipment and communication reliability may be affected if a fault occurs.
Level 3	Equipment component failure in the power supply system may affect the system and communication reliability but does not affect the overall system performance.	If a fault occurs, the equipment and communication reliability may be affected. If the fault is not handled, the fault would become a level 1 or level 2 risk.
Level 4	General hidden troubles that do not affect the normal operation of the power supply system.	If a fault occurs, it will not affect the power supply of the system and will not be upgraded if the fault is not handled.

6.3 Necessity of evaluation for reliability not impacting operations and energy saving

The power supply system is the foundation of a telecommunication network and quality guarantee of the whole network. With the rapid development of the communication business and the continuous expansion of network scale, the capacity and structure complexity of power supply systems in telecommunication buildings are increasing, and the requirements of reliability need to be improved.

However, in recent years, power supply interruptions caused by improper design, construction and maintenance of the power supply system occur from time to time, which affect the availability and the operation time of telecommunication systems that are susceptible to influence from the power supply system.

Comprehensive, objective and effective evaluation of the power supply system of the whole network in telecommunication buildings from the aspects of external power supply, medium- and low-voltage

power distribution, generator sets, uninterruptible power supply (UPS), switching power supply and battery strings is the focus of maintenance and management for power supply systems.

Statistical analysis of power supply system failure in recent years has identified the causes as follows.

- a) The importance of power supply system is not well understood. Reliable operation of the power supply system is the basis of ensuring network reliability. Due to lack of attention and effective management methods, the maintenance and management of a power supply system is relatively passive, and its operation is not optimized. Problems such as capacity expansion, non-synchronous monitoring, insufficient redundancy, equipment aging failure, equipment operation with faults and insufficient emergency capacity directly affect network reliability.
- b) The maintenance and management methodology of power supply systems need to be improved. At present, there is no effective method suitable for functionality and system health condition inspection of power supply systems in telecommunication buildings. In addition, there is no reliability evaluation standard for power supply systems, which leads to inadequate evaluation of operation management and implementation of key performance indicators of power supply in telecommunication buildings.
- c) There are potential reliability hazards in the operation and maintenance of power supply systems. There are many types of power equipment in telecommunication centres, which have a wide range of technologies, involve complicated maintenance work and difficult management. With continuous expansion of network scale, maintenance problems of power supply systems are becoming more prominent. Work on power supply reliability is lagging behind. Surge interference, harmonic interference, unreliable equipment quality, improper installation and use, inadequate equipment protection, mismatching of breaker capacity, poor protection selectivity and other hidden dangers threaten the safe operation of telecommunication systems.
- d) Insufficiently trained personnel, employed for maintenance, lack basic theoretical knowledge and practical operation experience on site. In addition, engineering and original data are incomplete, which causes difficulties in equipment maintenance and fault analysis. The supporting management system is imperfect, which causes loss of operational data.

Energy saving and efficiency of power supply systems is an important aspect to be considered in future implementation and modernization of actual telecommunication rooms or buildings. The efficiency requirements specified in [ITU-T L.1210], [ITU-T L.1350], [ITU-T L.1380], [ITU-T L.1381], [ITU-T L.1382] and [ITU-T L.1383] need to be considered in the design of power systems. The measurement methodology for the energy efficiency of power system is specified in [ITU-T L.1320].

6.4 Battery hazard safety level description

Table 2 lists hazard safety levels (HSLs) of cell and battery systems. If any of the criteria are met, the test or failure is assigned to the corresponding HSL.

Table 2 – Safety and reliability risk level description

Hazard safety level	Description	Criteria
HSL0	Intrinsic safety without functional impairment	1) Test samples are not affected in the environmental reliability test and functions are normal. 2) The target cell of battery system is not thermal runaway. 3) The box of the unit under test is free of deformation, liquid leakage (Note 1). There is no gas leakage, smoke, fire, crack or explosion. 4) The maximum temperature of the tested unit ($T_{\max}$) is less than or equal to the upper limit of the operating temperature (T_{up}) (except for the thermal diffusion test).
HSL1	Reversible function failure or reversible protection action, thermal runaway without diffusion	1) Reversible function failure in the environmental reliability test (including action of recoverable protection device). 2) The thermal diffusion test does not extend to cells adjacent to the target cell. 3) The box of the tested unit has no deformation, leakage of liquid or gas, smoke, crack, fire or explosion. 4) $T_{\max}$ is less than or equal to T_{up} (except for the thermal diffusion test).
HSL2	Irreversible function failure, thermal runaway without expansion, slight gas leakage, slight smoke	1) The environment reliability test shows that the irreversible function fails (including activation of a passive protection device or functional component damage). 2) Slight liquid leakage from the tested unit (Note 2). Gas leakage, slight smoke or white smoke (Note 3). 3) The thermal diffusion test does not extend to cells adjacent to the target cell. 4) $T_{\max}$ is greater than T_{up} (except for the thermal diffusion test). 5) The tested unit has no deformation, ignition, carbonization, cracking and explosion.
HSL3	Carbonization, thermal runaway expansion in the battery, serious liquid leakage or gas leakage, and a large amount of smoke	1) Serious liquid leakage from the tested unit (Note 4). Gas leakage, serious smoke (black or grey) emission. 2) In the thermal diffusion test, the target cell is triggered by thermal runaway, which extends to adjacent cells. However, the whole test sample is not subject to thermal runaway. 3) The carbonized area of structural or electrical components in the tested unit is $\leq 20\%$, and no ignition occurs. 4) The box in the unit under test is slightly deformed (Note 5). There is no crack or no explosion.
HSL4	Ruptured	1) The case of the tested unit is severely deformed, cracked and free of explosion. 2) The unit under test catches fire, and the surface temperature of the epoxy resin plate 100 mm away from the unit under test undergoes a rise δT exceeding 97°C for more than 3 s. 3) Thermal diffusion test: The cell is subject to thermal runaway, as well as the unit; however, it does not extend to the adjacent battery system.

Table 2 – Safety and reliability risk level description

Hazard safety level	Description	Criteria
HSL5	Fire, battery thermal runaway	1) The battery system of the tested unit is on fire. 2) Thermal diffusion test: The cell and battery under test are subject to thermal runaway. 3) The box in the tested unit is severely deformed (Note 6). Slightly cracked, no solid matter or debris are ejected, and no explosion. 4) The surface temperature of the epoxy resin board 100 mm away from the tested unit rises $\delta T > 97^{\circ}\text{C}$ for more than 3 s.
HSL6	Explosions	1) Thermal runaway explosion of the unit under test. 2) Thermal diffusion test: The tested cell and battery system are subject to thermal runaway, which extends to the adjacent battery system.
NOTE 1 – Except for the pre-set air leakage device, the battery module or battery system shell is mechanically damaged and cracked. NOTE 2 – Slight leakage: volume loss before and after the test of the unit under test $\leq 50\%$ of the total liquid injected. NOTE 3 – Smoke: guidance is contained in [b-UL9540A] smoke release rate test method. NOTE 4 – Serious liquid leakage: The volume loss before and after the test of the unit is greater than 50% of the total liquid injected. NOTE 5 – Slight deformation: the maximum deformation of the unit under test in any direction is $< 15\%$, and no structural damage is found. NOTE 6 – Severe deformation: the maximum deformation in any direction of the unit under test is $\geq 15\%$ or the shell structure is cracked.		

7 Evaluation of reliability and correct operations of power supply items

This evaluation shall include maintenance management, external power supply, medium-voltage power supply system, transformer, low-voltage power supply system, battery backup system, UPS power supply system (including storage battery), related evaluation methods are derived from [b-CCSA-YD/T 3569].

The main purposes of establishing the power supply reliability evaluation method for telecommunication rooms are: use as an evaluation tool; means for systematic, comprehensive and effective inspection of the power supply system of existing telecommunication rooms or buildings to expose hidden dangers, and propose improvements in the power supply reliability of telecommunication rooms or buildings. In this Recommendation, the power supply reliability evaluation items are classified into different categories. Each category is divided into several evaluation items based on the system composition and key indicators.

7.1 External alternating current mains power reliability evaluation

The reliability evaluation of the alternating current (AC) power supply system in telecommunication rooms includes its category and capacity. AC power system capacity should meet the existing power demand of telecommunication rooms or buildings.

The evaluation of AC power supply categories are shown in Table 3.

Table 3 – Evaluation of the supply categories and system capacity of alternating current power

Evaluation item	Evaluation criteria	Key indicators	Evaluation method	Risk level
External AC mains power	In principle, class I telecommunication rooms or buildings shall employ class I AC mains power. Class II telecommunication rooms or buildings shall employ in class II AC mains power, when the external AC power conditions are met and the investment growth is under control, class I AC mains power shall be considered. Class III telecommunication rooms or buildings shall employ in class II mains power when the conditions are met; and class III AC mains power can be used when the conditions are not met. Reliable 380 V or 220 V power supply can be used for class IV local telecommunication rooms or buildings.	AC power supply category	The category of external AC mains power shall meet the requirements of various telecommunication rooms or buildings, and the power supply mode shall meet standard requirements. Check the completion acceptance report of external AC mains power according to the power supply scheme signed with the power supply department.	Level 2
External mains unavailability	The unavailability key indicators of external mains depend on various telecommunication room or building requirements.	AC power supply category	The unavailability of mains power refers to the ratio of the time of mains power failure in the statistical period to the time of the statistical period (not less than 1 year).	Level 2
AC main connection modality	Two medium-voltage cables shall not enter telecommunication rooms or buildings at the same point.	AC power supply category	Check the completion acceptance report of the external AC mains power according to the power supply scheme signed with the power supply responsible department.	Level 4

Table 3 – Evaluation of the supply categories and system capacity of alternating current power

Evaluation item	Evaluation criteria	Key indicators	Evaluation method	Risk level
Whether power demand is met	1) The introduction capacity of class I AC mains power to two AC mains power (or two mains power not meeting class I AC mains power capacity) shall meet maximum working load demand of all telecommunication rooms and ICT loads. 2) For the communication machine room introducing one circuit of external mains power, the introduction capacity of external mains power shall meet maximum working load demand of all telecommunication rooms and ICT loads.	AC power system capacity	1) Check the power capacity of one or two AC mains power in the existing communication room, and the input power capacity shall be subject to the power supply scheme signed with the power supply department. 2) If the power input capacity of two mains power (standby for each other) is inconsistent, the input power capacity of one mains power with smaller input power capacity must meet the "maximum working load" demand of telecommunication rooms and ICT loads.	Level 1

7.2 Medium-voltage power supply system reliability evaluation

7.2.1 Medium-voltage distribution system

The reliability evaluation of the medium-voltage distribution system in the communication room includes two main contents: equipment performance and equipment configuration (switching capacity, distribution level, standby automatic switching, and switch interlocking relay protection and detection report). The evaluation contents are shown in Table 4.