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G.664

Amendment 1
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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Transmission media characteristics – Characteristics of optical components and subsystems

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Optical safety procedures and requirements for optical transport systems

Amendment 1

CAUTION !

PREPUBLISHED RECOMMENDATION

This prepublication is an unedited version of a recently approved Recommendation. It will be replaced by the published version after editing. Therefore, there will be differences between this prepublication and the published version.

FOREWORD

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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.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU [had/had not] received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

Amendment 1 to ITU-T Recommendation G.664

Optical safety procedures and requirements for optical transport systems

This amendment contains editorial and technical corrections to ITU-T Rec. G.664 (03/2003).

1) The Scope is modified as shown below:

1 Scope

This Recommendation provides guidelines and requirements for techniques to enable optically safe working conditions (for the human eye and skin and for ~~avoiding~~ keeping fibres damage-free~~ignition~~) on optical interfaces of the Optical Transport Network, including conventional SDH systems, for equipment in both restricted and controlled locations.

The actual definition and specification of optically safe levels are considered outside the scope of this Recommendation (they are provided by IEC).

The main fields of application are conventional SDH line systems with and without optical amplifiers and systems designed for the Optical Transport Network. In particular, some specific considerations are given for systems employing high-power Raman amplification techniques.

The impact of bidirectional transmission as described in ITU-T Rec. G.692 has also been considered.

Because of desired backwards compatibility with no longer existing Recommendations on the subject of optical safety, this Recommendation provides some descriptions for safety procedures in the case of single- and multichannel SDH systems with and without line amplifiers. A clarification is given as to why procedures employing restart pulses for Automatic Laser Shutdown (ALS) and Automatic Power Shutdown (APSD), defined in a previous version of this Recommendation, are no longer appropriate or necessary for applications given in ITU-T Recs G.691, G.693 and G.957.

The definition of optical safety procedures for the Optical Access Network is regarded as being outside the scope of this Recommendation.

2) The list of References is modified as shown below:

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.

– ITU-T Recommendation G.662 (1998), *Generic characteristics of optical fibre amplifier devices and subsystems*.

– ITU-T Recommendation G.691 (2000), *Optical interfaces for single channel STM-64, STM-256 and other SDH systems with optical amplifiers*.

– ITU-T Recommendation G.692 (1998), *Optical interfaces for multichannel systems with optical amplifiers*.

– ITU-T Recommendation G.693 (2001), *Optical interfaces for intra-office systems*.

– ITU-T Recommendation G.783 (2000), *Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks*.

– ITU-T Recommendation G.872 (2001), *Architecture of optical transport networks*.

– ITU-T Recommendation G.957 (1999), *Optical interfaces for equipments and systems relating to the synchronous digital hierarchy*.

– ITU-T Recommendation G.959.1 (2001), *Optical transport network physical layer interfaces*.

– IEC 60825-1 Edition 1.2 (2001), *Safety of laser products – Part 1: Equipment classification, requirements and user's guide*.

~~– IEC 60825-2 Second Edition (2000), *Safety of laser products – Part 2: Safety of optical fibre communication systems.*~~

~~– IEC 60825-2 Corr.I1 (2001), *Safety of laser products – Part 2: Safety of optical fibre communication systems – Interpretation sheet 1.*~~

– IEC 60825-2 Edition 3.0 (2004), *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS).*

– IEC TR 61292-4 (2004) *Optical amplifiers - Part 4: Maximum permissible optical power for the damage-free and safe use of optical amplifiers, including Raman amplifiers.*

3) Clause 5 is modified as shown below:

5 General optical safety considerations

5.1 Safety considerations for avoiding damage to the human eye and skin

IEC 60825-2 provides a clarification of the difference between Laser Class and Hazard Level. The text below is taken from IEC 60825-2.

"**Class**: The word "Class" refers to a scheme by which, based on emission levels, a product or internal emitter can be grouped with respect to its safety. These levels are described in the Accessible Emission Limit Tables in IEC 60825-1. Classes range from Class 1, which is safe under reasonably foreseeable conditions, to Class 4, which is potentially the most hazardous case. In IEC 60825-1, the classification of products is based on ~~normal~~ reasonably foreseeable operating conditions including single fault conditions."

"**Hazard Level**: "Hazard Level" is a term used in this standard which refers to the potential hazard from laser emissions at any location in an end-to-end fibre optic communication system that may be accessible during use or maintenance or in the event of a failure or fibre disconnection. The assessment of the hazard level uses the Class Accessible Emission Limit tables described in the IEC 60825-1."

"A whole optical fibre communication system will not be classified in the same way as required by IEC 60825-1. This is because, under intended operation, the optical radiation is totally enclosed, and it can be argued that a rigorous interpretation of IEC 60825-1 would give a Class 1 allocation to all systems, which may not reflect the potential hazard accurately."

"Based upon this statement, a complete optical fibre communications system can be regarded as a Class 1 laser product because, under normal conditions, the emissions are completely enclosed (like a laser printer) and no light should be emitting outside the ~~enclosure~~protective housing. It is not

until the fibre ~~breaks~~becomes broken~~,~~ or an optical connector is unplugged, that someone might be exposed to a level of optical radiation which is potentially hazardous ~~light level~~ (if the internal emitters or amplifiers are of high enough power)".

"Therefore, for each optical output port the Hazard Level must be assessed. The Hazard Level limits are dependent on the "dominant" wavelength range, taking into consideration that IEC 60825-1 defines different limits for different wavelength ranges. Details can be found in IEC 60825-1. Furthermore, this standard allows the use of Automatic Power Reduction (APR) techniques to achieve a lower (less hazardous) Hazard Level based on the normal power in the fibre and speed of automatic power reduction".

In this Recommendation, Automatic Laser Shutdown (ALS) techniques (in the case of SDH systems), which were originally designed for the same purpose, i.e., to provide safe working environments, are also described in Appendix III.

NOTE 1 – Over the past years the term Automatic Power Shutdown (APSD) has also been used for systems with optical amplifiers. Because the term ALS has been in use much longer, in this Recommendation the term ALS will be used, noting that in this context the term APSD is intended to be equivalent to the term ALS.

Actual details about the various Class and Hazard Level limits are provided by IEC 60825-1 and 60825-2 respectively. A further clarification on actual levels and power reduction times for the various safety categories is provided by IEC TR 61292-4.

It should furthermore be noted that, for the hazard level assessment, only those power levels should be considered which might occur under reasonably foreseeable conditions. IEC 60825-2 provides some description and guidance to define the meaning of "reasonably foreseeable".

For the purposes of this Recommendation, it is assumed that OTN equipment in general (including SDH equipment) will only be deployed in Controlled and Restricted locations. In IEC 60825-2 it is defined that the Hazard Level of equipment shall not exceed 1M in Restricted Locations and 3B in Controlled Locations. Additional requirements for Controlled Locations, which are outside the scope of this Recommendation, can be found in IEC 60825-2.

NOTE 2 – ~~In IEC 60825-1, a Class 1M has been defined instead of 3A. In IEC 60825-2 a Hazard Level 1M is, however, not yet defined. In order to make both IEC documents consistent, an Interpretation Sheet has been agreed by IEC (IEC 60825-2 Corr.I1 (2001)) in which the Hazard Level 1M is introduced, replacing Hazard Level 3A.~~In previous versions of IEC 60825-1 and 60825-2 a Class 3A and Hazard Level 3A were used respectively. In many systems deployed in the field a Hazard Level 3A might have been used. In the latest IEC 60825-1 and 60825-2 this 3A category has been replaced by a new category 1M. In particular, in the 1550 nm window, the 3A exposure limit was a fixed limit, in contrast to the 1M level, which is expressed by a formula and, as such, determined by several factors specified by IEC 60825-1 (e.g., exposure time, wavelength, fibre mode field diameter, measurement diameter and measurement distance). For the applications covered by this Recommendation, the Hazard Level 1M limit is generally higher than the previous Hazard Level 3A limit due to divergence of the beam from the optical fibre into free space. In this Recommendation, general reference is made to the new Hazard Level 1M instead of the previous Hazard Level 3A. In situations where the Hazard Level assessment is still 3A, it is suggested to use the guidelines applicable to Hazard Level 1M.

In systems which have an operational power in the fibre exceeding the potentially hazardous levels 1M or 3B in the case of Restricted or Controlled locations respectively, an APR or ALS capability shall be used to reliably reduce the operational power to a level below the safety level applicable for the type of location. More detailed requirements are defined in clause 6.

Furthermore IEC 60825-2 provides guidelines on the reliability of APR procedures.

5.2 Safety considerations to keep fibres damage-free~~Safety considerations to avoid ignition~~

IEC TR 61292-4 provides extensive guidance on the following topics:

- Fibre fuse and its propagation
- Loss-induced heating at connectors or splices
- Connector end-face damage induced by dust/contamination
- Fibre-coat burn/melt induced by tight fibre bending.

~~Awaiting publication of IEC documents giving details on the topic of safety to avoid ignition, this clause is for further study.~~