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| U.S. Radiocommunications Sector  Fact Sheet | |
| **Working Party:** ITU-R WP5B | **Document No:** USWP5B24-03 |
| **Ref:**  Doc. 1A/8 (CIS/F/789/INF)   5B/498  IEC Guide 107 EMC | **Date:** 1 May 2020 |
| Document Title: ﻿Addressing the problem of interference from LED to maritime VHF in coordination with WP1A, WP4C and CISPR | |
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| **Purpose/Objective:** To address CISPR’s liaison response to WP5B and WP1A, to encourage sharing of critical information, and to ensure CISPR coordination and other requirements of IEC Guide 107 are met necessary to finally resolving the EMC problem. WP4C is included recognizing the current lack of EMC protection from unintentional emitters to mobile earth stations used on vehicles. | |
| **Abstract:** CISPR/F’s latest response to ITU-R’s liaison on this subject indicates an apparent lack of understanding of the problem, noting “*it is unclear what type of LED lighting equipment was exactly involved and to which standard this lighting equipment was tested and complied*” despite that information being provided in detail in an earlier liaison, and “...*it is concluded that the number of reported complaints is relatively low and therefore insignificant*” despite this being reported by ITU-R as a safety problem. Yet CISPR/F’s cooperation is necessary to prepare a relevant standard and resolve the problem. This paper is intended to clarify the matter in a reply liaison to CISPR/, addressing coordination requirements described in IEC Guide 107, and encouraging exchange of information necessary for resolving this international problem. | |

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| **Radiocommunication Study Groups** |  |
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| addressing the problem of Interference from LED lighting in coordination with WP1A, WP4C and CISPR   1. **Introduction**   This document is offered to support WP5B in continuing its work with WP1A to facilitate coordination with CISPR to develop suitable standards that protect aeronautical and maritime use, as proposed in 1A/399 last year.   1. **Background**   This issue was initially reported in Doc. 5B/498 14 May 2018), noting its seriousness and effect on safety (e.g. “Problem in traffic separation scheme, the MRCC did not manage to contact the ship, very poor AIS reception”). In addition, the document also reported that the LED navigation lights compliant with IEC 60945 were found to cause harmful interference, as were other LED lighting compliant with CISPR 15. The U.S. confirmed the existence of severe interference to shipboard VHF maritime radio and AIS from IEC 60945-complaint LED navigation lights installed near VHF antennas such as reported n document 5B/498. Consequently, WP5B reported this issue and relevant information in a liaison to CISPR F on 13 June 2018 (5B/TEMP/220), received by CISPR F on 22 June 2018) (CIS/F/742/INF).  On 19 June 2019, WP1A in document 5B/720 (CISPR/1425/INF), which is a new liaison statement, requested that CISPR develop “a specific proposal as to which existing standard(s) could be modified or new standard(s) be developed to address this problem in its entirety and also provides a timeline to complete this work”. CISPR F responded to this liaison on 11 October 2019 in Document 1A/8 (CIS/F/789/INF), noting that *“﻿it is unclear what type of LED lighting equipment was exactly involved and to which standard this lighting equipment was tested and complied”.* However France did identify the applicable EMC standards in the attachment to CIS/F/742/INF submitted previously by ITU-R. *“Hence, from the information provided, the real root cause of the reported interferences cannot be concluded. Furthermore, since there are worldwide numerous cases of such LED lighting equipment being applied near receiving antennas with maritime navigation and / or communication functions, it is concluded that the number of reported complaints is relatively low and therefore insignificant”*. CISPR/F therefore concluded and recommended “*that IEC 60945 is the most suitable standard that shall be applied for lighting equipment nearby receiving antennas of maritime radiocommunication systems. We recommend ITU- R WP 1A the following approach for follow-up:  a) To assess the reported complaints against the applicable emission requirements of IEC 60945 using test results of accredited laboratories;  b) In case, frequent and justified complaints are reported from lighting equipment complying with IEC 60945, then TC 80 shall be requested to revise the emission requirements in IEC 60945 in such a way to reach the required reduction of interference cases.”*   1. **Proposal**   It is proposed that WP5B submit a liaison statement to WP1A to aid them in their response to CISPR’s liaison Doc. 1A/8 (CIS/F/789/INF) addressing the issues discussed in the attached draft liaison. It is further proposed that WP4C also be informed noting the current lack of EMC protection from unintentional emitters to mobile earth stations used on vehicles, despite use not uncommon in areas outside areas of cellular coverage. The United States offers a draft liaison in the annex for the consideration of WP 5B. | |
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Annex

DRAFT LIAISON STATEMENT TO WP1A, WP4C AND CISPR

**Addressing the problem of interference from shipboard LED lighting**

1. ITU-R Working Party (WP) 5B, at its meeting on 20 to 30 July 2020, reviewed the liaison statement from Doc. 1A/8 (CIS/F/789/INF) to WP1A as well as standards work being undertaken by the Radio Technical Commission for Maritime Services (RTCM) in the United States addressing this problem. WP5B seeks to provide support to WP1A to aid them in responding to CISPR in this matter. Since a question regarding the apparent lack of protection of mobile satellite earth stations used on vehicles from unintentional emitters described in CISPR 25, WP4C has been included in this liaison.

2. In order to ensure that this problem is addressed efficiently and effectively, and in order to comply with the requirements of IEC Guide 107, continued coordination with CISPR F and WP1A will be important. This may especially be necessary recognizing the response by CISPR F in Doc. 1A/8 (CIS/F/789/INF) may misconstrued the problem, its effect on safety, and the 15m separation distance requirement assumed by IEC 60945. It is also especially important given IEC’s mandate that “*the assistance and advice of the EMC committees for any change in the emission limits and/or measurement requirements*”.

3.1 WP1A and CISPR are invited to note that:

1. EMC complaints have been confirmed from IEC 60945 and CISPR 15-compliant devices as reported by several administrations, and that the EMC interference impacts the safety of navigation of ships;
2. IEC 60945 was developed under the assumption that unintentional interferers would be separated by 15m or more from shipboard victim VHF based upon provisions of the Safety of Life at Sea (SOLAS) Convention, and that LED luminaires found to be causing interference are located well inside this 15m separation;
3. Rather than amend IEC 60945, TC80 decided that it would generate a new preliminary work item concerning these EMC requirements;
4. The Radio Technical Commission for Maritime Services (RTCM) has established a special committee to prepare an appropriate standard addressing unintentional emitters located within 15m of shipboard victim antennas, which when completed will be proposed to IEC TC80 as a new work item;

3.2 WP5B seeks guidance on technical issues from WP1A and CISPR, including bandwidth effects and relationship among average, peak and quasi-peak limits as described herein, taking into account IEC Guide 107. Additional explanatory information on this matter is contained in the attachment to this liaison statement.

3.3 WP4C is invited to note the current lack of EMC protection from unintentional emitters to mobile earth stations used on vehicles.

**Status:** For action

**Deadline:** May 2021

**Contact:** Mr Joseph Hersey **Email:** **joe@joecel.com**

**ATTACHMENT**

**EXPLANATORY INFORMATION**

1. **Background**

In Document 5B/498, France notified WP5B that navigation lights having “a MED {EU Marine Equipment Directive} certification under item A.1/6.1.” and meeting the “applicable standard for electromagnetic compatibility is for the conformity assessment, the IEC 60945 (2002) including IEC 60945 corrigendum 1 (2008)” was found to be the cause of “Serious problem regarding VHF reception when navigation lights are on. Confirmed by other ships. The ship cannot be contacted by VHF when the lights are on”. The problem reported by France was validated in the U.S., where for example a shipbuilder reported “The problem (using IEC 60945-compliant LED lighting) ...manifested itself as an inability to hear ships (over VHF) that were visible (but not close)….we have not found a manufacturer of lights for boats over 65' that we trust.” The problem was not due to use of luminaires failing to meet appropriate standards such as IEC 60945, nor due to the lack of certification by accredited laboratories, nor were they infrequent and therefore insignificant. Instead, the problem can clearly be attributed to IEC 60945 radiated emission limits at VHF being based upon unintentional emitters separated from shipboard VHF receiving antennas by 15m or more. IEC 60945 was never intended to cover that 15m gap where luminaires are commonly installed. The problem is one of safety, not one that can be resolved by further assessing the frequency and justification of complaints.

IEC TC80 in Doc. 5B/584 recognized that IEC 60945-compliant LED navigation lights were causing interference, noting that this was a “special case… due to their being in very close proximity to radio antennas”. Rather than amend IEC 60945, TC80 indicated it would “therefore generate a new preliminary work item concerning requirements for LED navigation lights and their installation to be developed in the committee and will keep WP 5B advised of progress”. TC80 reaffirmed this decision at its October 2019 Plenary. Recognizing that IEC 60945 EMC requirements and the 15m assumed separation from victim antennas are primarily based upon the Safety of Life at Sea (SOLAS) Convention Chapter V Regulation 17.1 which states that *“Administrations shall ensure that all electrical and electronic equipment on the bridge or in the vicinity of the bridge… is tested for electromagnetic compatibility taking into account the recommendations developed by the Organization”,* WP5B supports this decision by IEC TC80.

In May 2019 the US-based Radio Technical Commission for Maritime Services (RTCM) established Special Committee SC137 ﻿*Electromagnetic Compatibility Requirements for Light Emitting Diode (LED) Devices and other Unintentional Emitters Located Near Shipboard Antennas* to develop a technical standard addressing this problem. Recognizing that the VHF radiated emission limits of IEC 60945 are based upon “﻿a typical separation of 15 m between the bridge and the VHF antenna” (IEC 60945 Annex C Section C.2.2), RTCM SC137 is intended to apply only to shipboard electrical and electronic equipment installed within 15 meters of VHF antennas, including LED luminaires such as navigation lights as well as other devices installed near antennas capable of causing interference. Since shipboard LED luminaires installed near Global Navigation Satellite System (GNSS) receiving antennas have also been reported to cause interference, RTCM SC137 will consider including protection from unintentional emitters to L-band GNSS and to Global Maritime Distress and Safety System (GMDSS) ship earth stations operating in nearby spectrum as well. In accordance with its terms of reference, RTCM SC137 will “Provide input to the future work of IEC TC80 standards, including the possibility of offering to TC80 this RTCM standard as a Committee Draft for a new TC80 work item proposal, either prior to or upon completion of the standard, as agreed by the Committee”.

Since its establishment, RTCM SC137 has reviewed and compared existing EMC standards that might be adequate to address this problem and amended existing shipboard EMC installation guidelines in recognition of the problem. Besides IEC 60945, the most applicable EMC standard found is CISPR 25 *Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of on-board receivers*, although that standard is limited in application to vessels of length 15m and below and currently does not address protection from unintentional emitters to mobile satellite earth stations installed on vehicles. SC137 has just begun work on a preliminary committee draft standard.

1. **Planned demonstration test**

RTCM SC137 also developed a demonstration test plan intended to:

* Confirm that the LED EMC problem is real, that it is resolvable and that it affects IEC 60945-compliant LEDs; and that it affects both VHF (20 dB SINAD) and AIS (20% packet error rate (PER)) systems in accordance with IEC-specified receiver minimum sensitivity for these two systems.
* Measure effects of the radiated emission from LEDs within reactive near field of both 1.5m (AIS) and 2.5m (VHF radiotelephone) antennas commonly used on ships (how much deviation from 20 log distance curves). For example, what is the effective receive antenna gain at 1 m separation? Can we ease off on the 20 log d predicted radiated emission limits within the receive antennas reactive near field, or must we keep to those predicted radiated emission limits? Can the separation from antennas be reduced to as little as 0.3m?
* Compare average vs. quasi-peak vs. peak measurement values of various noisy LEDs at a fixed distance.
* Determine whether an LED purchased off the shelf and reported “interference free” by the manufacturer does or does not have an EMC problem with both VHF and AIS
* Gauge the urgency in addressing radiated emission from LEDs in the GNSS and GMDSS satellite bands.

Performance of these tests is subject to the availability of funds.

1. **Preliminary work of RTCM SC137 in the VHF maritime band**

RTCM SC137 in addressing this problem is considering the following technical issues:

* Radiated emission limits in the VHF maritime band. In order to protect victim receivers used on ships for safety purposes, RTCM SC137 is considering basing its recommended radiated emission limits, measured with a CISPR 16-defined average detector and assuming an ITU or IMO-defined victim receiver antenna, upon a carrier over noise plus interference (C/(N+I)) value of 10, where C = International Maritime Organization (IMO) or IEC-specified victim receiver sensitivity (i.e. -107 dBm). Typical shipboard AIS/VHF Data Exchange System (VDES) and VHF radiotelephone antennas would be assumed, similar to assumptions upon which IEC 60945 was based. Specifically, the radiated emission average limit would be based upon interference received such that PER is does not exceed 20% and SINAD is no less than 20 dB in accordance with these existing standards, when separated 1m or more from the victim antenna. That radiated emission average limit at 120 kHz would consequently be 10.3 dB µV/m. VHF radiated emission limits of 17.3 dB µV/m quasi-peak and 30.3 dB µV/m peak could be established, based upon average limits offset by 7 dB and 20 dB respectively, the same ratio adopted by CISPR 25. These values differ from those specified in CISPR 25 Class 5 by less than 5 dB.
* Conducted emission limits in the VHF maritime band. SC137 will also consider adopting CISPR 25 Class 5-specified VHF conducted emission limits of 4 µA peak, -9 µA quasi-peak and -16 µA average at 120 kHz. These calculated limits would be validated by the planned demonstration test.
* VHF band limits. Since the lowest VHF maritime channel 1060 (156.025 MHz) is located at the lower edge of the 156-165 MHz band to which special unintentional emission limits are specified by IEC 60945, RTCM SC137 plans to extend that band 1 MHz downwards in its standard, to 155-165 MHz, to ensure protection to those lower channels. Note the comparable band specified by CISPR 25 is 142-175 MHz.
* Quasi-peak measurements. Since most recognized EMC standards applicable to LED lighting and shipboards equipment, including IEC 60945 and CISPR 15, are measured using a CISPR 16-defined quasi-peak detector, RTCM SC137 is considering recommending a quasi-peak to average radiated emission limit ratio of 7 dB, similar to that established by CISPR 25. Radiated emission average, quasi-peak and peak limits would, like those of CISPR 25, be recommended for the maritime VHF band (i.e. for 155-165 MHz).
* Bandwidth. IEC 60945 established a radiated emission quasi peak limit of 24 dB µV/m in the VHF maritime band based upon IMO radiotelephone performance requirements: “﻿For the VHF band IMO requires a receiver sensitivity of 2 µV e.m.f which equates to a field strength of 3 µV/m at the antenna. For a typical separation of 15 m between the bridge and the VHF antenna, the free-space field strength at 3 m is 15 µV/m (23,5 dB µV/m) to give 3µV/m at the antenna.”[[1]](#footnote-1) IEC 60945 based this 23.5 dB µV/m value on a C/(N+I) value of 1 measured in quasi-peak and at a bandwidth of 9 kHz, approximately one half[[2]](#footnote-2) that of the VHF radiotelephone receiver upon which the limit was based. On the other hand, nearly all other relevant EMC standards specify emission limits based upon a bandwidth of 120 kHz in this band, as does IEC 60945 in the bands adjacent to the maritime VHF band. Yet the effects of bandwidth upon measured radiated emission results are uncertain. 10 log (120kHz/9kHz) should describe the difference in average measurement assuming Gaussian interference, but others[[3]](#footnote-3) have shown the quasi-peak measurement to differ 16-20 dB between these bandwidths for most interfering signals in the VHF maritime band.
* IEC 60945’s assumption of 15 m separation. IEC 60945 decision to base quasi-peak measured limit based upon a C/(N+I) value of 1, measured at a bandwidth about one half that of the victim receiver, could affect[[4]](#footnote-4) the assumed 15 m separation between victim antenna and unintentional emitter. If quasi-peak measurements do indeed differ 16-20 dB between bandwidths of 9 and 120 kHz at VHF, then IEC 60945’s equivalent radiated emission limit in the maritime VHF band is 40 to 44 dB µV/m at 3m and 120 kHz, slightly less strict than the 40 dB µV/m required by CISPR 15 at 3m. IEC 60945-compliant devices consequently may require more than 15m separation from victim VHF antennas in order to provide their necessary protection.

1. **IEC Guide 107**

IEC in its Guide 107 ﻿(*Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications)* mandates IEC product committees follow certain requirements when developing EMC standards. Those requirements include the necessity of seeking “*the assistance and advice of the EMC committees for any change in the emission limits and/or measurement requirements”*, of referring “*to the basic EMC standards for instrumentation, measurement and/or test methods, and test set-ups; and if a deviation from the generic standards is needed in exceptional cases, a justification shall be given in the product family EMC standard, e.g. in an informative annex of the standard.*”. In addition, “*Where a product family/product EMC standard specifies less stringent test values/levels for a phenomenon or if a phenomenon is only partially covered (e.g. the product family/product EMC standard only covers a subset of the recommended frequency range), either a justification or a reference to the relevant requirement in another EMC standard shall be given in the product family/product EMC standard.*” Although IEC Guide 107 does not apply to RTCM, it will likely apply to IEC TC80. For this reason, RTCM SC137 plans to follow IEC Guide 107 to the extent practicable and seeks to continue liaison with CISPR through WP5B.

1. **Planned approach for bands other than VHF and guidance sought**

RTCM SC137 does seek ITU-R and CISPR guidance in the developing of emission limits. Note that this standard would only apply to equipment installed on ships within 15m of receiving antennas of well-defined systems used for safety purposes. Consequently, the criteria specified in CISPR 16-4-4 *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-4 Uncertainties, statistics and limit modeling – Statistics of complaints and a model for the calculation of limits for the protection of radio services* would not appear to apply in this particular situation. In developing emission limits in bands other than VHF, RTCM SC137 plans instead consider the following criteria.

* 30 MHz and below  
  + IEC 60945 indicated that “﻿..due to ever increasing cosmic and atmospheric noise. It is thus possible to relax the limit at these lower frequencies..” RTCM SC137 will review existing IEC 60945 and CISPR 25 limits in relation to Recommendation ITU-R P.372-14 atmospheric, cosmic and median city noise. Initial indications show that IEC 60945 limits may be significantly higher than cosmic and atmospheric noise expected on board ship, particularly if NAVDAT installations become widespread. CISPR 25 specified MF and HF band radiated emission limits are about 10-20 dB less than those of IEC 60945, and may be a useful comparison.
* 1 – 2 GHz:
  + Global navigation satellite system (GNSS). RTCM SC137 will consider radiated emission limits in light of the requirements of Recommendations ITU-R M.1903-1 and M.1902-1 as well as CISPR 25 Class 5 limits for GPS and GLONASS, including proposed CISPR 25 Edition 5 Class 5 committee draft proposed limits for BDS (Beidou).

* + Global Maritime Distress & Safety System (GMDSS) ship earth stations in the bands ﻿1518 – 1544 MHz (Inmarsat) and 1616 – 1626.5 MHz (Iridium). RTCM SC137 will consider CISPR 25 Ed.5 Class 5 committee draft 4G limits proposed for the band 1525-1559 MHz used by Inmarsat. No CISPR 25 limits appear to apply to the band 1616-1626.5 MHz. RTCM will further consider receiver sensitivity specifications from IEC 60945 Annex C (Inmarsat) and from information from GMDSS satellite providers. No CISPR 25 limits appear to apply to the bands used by mobile satellite services such as 1616-1626.5 MHz despite the fact that mobile satellite earth stations are used on vehicles, particularly vehicles operating outside of cellular telephone service.
* The need to protect wireless signals such as those prescribed in CISPR 25 Edition 5 Class 5, navigation radar and other shipboard systems operating in the 2 to 8 GHz bands from unintentional emitters will also be considered, possibly in a future edition of the standard.

1. IEC 60945 Annex C §C.2.2 Radiated emissions. [↑](#footnote-ref-1)
2. VHF radiotelephone receiver necessary bandwidth is 16 kHz. The necessary bandwidth of AIS equipment of similar specified receiver sensitivity, operating in the same band and similarly used for safety purposes is 18 kHz. [↑](#footnote-ref-2)
3. H. Jin, W. Yang, F. Yu and Z. Wang, "A novel EBG structure with spiral line bridges for radiation suppression in marine VHF band," in IEEE Electromagnetic Compatibility Magazine, vol. 8, no. 4, pp. 56-61, 4th Quarter 2019 [↑](#footnote-ref-3)
4. For example, basing C/(N+I) = 1 (0dB) would create a difference of approximately 3 dB from that assumed in §3.1 if the assumed 7 dB ratio between average and quasi-peak were correct. An additional approximate 3 dB difference could be incurred due to the difference between the measurement and victim receiver bandwidths. [↑](#footnote-ref-4)