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| **COMMISSION FOR BASIC SYSTEMS** |  | | | |
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| **Steering Group on Radio Frequency  Coordination (SG-RFC)**  **Geneva, 24-27 January 2017**  **Submitted by : P. TRISTANT (EUMETNET)** | | **Document SG-RFC/2017-Doc06.4 Agenda Item 2.4** | | |
|  | | **5 January 2017** | | |
|  | | **English only** | | |
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|  | | **Restricted access required?** | **N** |  |
| WRC-19 Agenda Item 9.1.5 | | | | |

**1 Introduction**

A EUMETNET contribution to the recent CPG/PTD (Helsinki 10-12 January) is given in attachment 1. It provides an analysis of the relevant DFS detection by WAS/RLAN comparing the meteorological radars described in Recommendations ITU-R M.1638 and M.1849-1. It concludes that:

* adding a new reference to Recommendation ITU‑R M.1849‑1 to footnotes Nos [5.447F](file:///C:/Users/TRISTANT/Documents/A-TRAVAIL/WRC-19/Agenda/5.447F.docx) and [5.450A](file:///C:/Users/TRISTANT/Documents/A-TRAVAIL/WRC-19/CPG/CPG-PTD/PTD-2%20(Helsinki%20Janv%202017)/Contribution%20EUMETNET/5.450A.docx) will not impact the services referred in these footnotes, in particular RLAN/WAS and will keep unchanged the protection of meteorological radars.
* a reference to Recommendation ITU-R M.1849-1 would provide a much clearer picture of the situation, since it provides a detailed description of meteorological radars specificities (radar equation, emission schemes, operational scenarios, ….) that were taken into account when deriving the up-to-date DFS specifications, in particular in ETSI EN 301 893, and that are currently missing in Recommendation ITU-R M.1638-0.

For completeness, Attachment 2 provides similar analysis for the new radars proposed by Japan to be included in a revised version of Recommendation ITU-R M.1849 (see Document 5B/195 annex 14).

**2. Action (by SG-RFC) Proposed**

To be taken into account when drawing WMO preliminary position on agenda item 9.1.5.

**3. Recommended text**

None.

**Attachment 1**

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|  | | Doc. CPG-PTD(17)xxx |
| 2nd meeting of CPG Project team D | | |
| Helsinki, Finland, 10th – 12th January 2017 | | |
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| Date issued: | 3 January 2017 | |
| Source: | EUMETNET | |
| Subject: | Agenda item 9.1.5 | |
|  | | |
| Summary: | | |
| One of the issue to be considered under Agenda Item 9.1.5 (WRC-19) is “to investigate the technical and regulatory impacts on the services referred to in Nos [5.447F](file:///C:/Users/TRISTANT/Documents/A-TRAVAIL/WRC-19/Agenda/5.447F.docx) and [5.450A](file:///C:/Users/TRISTANT/Documents/A-TRAVAIL/WRC-19/CPG/CPG-PTD/PTD-2%20(Helsinki%20Janv%202017)/Contribution%20EUMETNET/5.450A.docx) that would result from adding a new reference to Recommendation ITU‑R M.1849‑1 to these footnotes, while ensuring that no undue constraints are imposed on the services referenced in these footnotes” (see *resolves to invite the ITU Radiocommunication Sector* N°2 of Resolution 764 (WRC-15)).  This document provides an analysis of the relevant DFS detection by WAS/RLAN comparing the meteorological radars described in Recommendations ITU-R M.1338 and M.1849-1. | | |
| Proposal: | | |
| It is proposed to CPG/PTD to consider the elements developed in this contribution to further elaborate the CEPT Brief on agenda item 9.1.5. | | |

1. **introduction**

One of the issue to be considered under Agenda Item 9.1.5 (WRC-19) is “to investigate the technical and regulatory impacts on the services referred to in Nos [5.447F](file:///C:/Users/TRISTANT/Documents/A-TRAVAIL/WRC-19/Agenda/5.447F.docx) and [5.450A](file:///C:/Users/TRISTANT/Documents/A-TRAVAIL/WRC-19/CPG/CPG-PTD/PTD-2%20(Helsinki%20Janv%202017)/Contribution%20EUMETNET/5.450A.docx) that would result from adding a new reference to Recommendation ITU‑R M.1849‑1 to these footnotes, while ensuring that no undue constraints are imposed on the services referenced in these footnotes” (see resolves to invite the ITU Radiocommunication Sector N°2 of Resolution 764 (WRC-15)).

This issue deals with the way to refer to ground based meteorological radars in those footnotes and the following points are to be considered:

* The protection of meteorological radars from WAS/RLAN in the 5 GHz range is based on the implementation by WAS/RLAN of the DFS mitigation technique, specified in Recommendation ITU-R M.1652, in particular the DFS detection threshold.
* Technical parameters on ground based meteorological radars were previously given in Recommendation ITU-R M.1638-0 and have been since then transferred into Recommendation ITU-R M.1849-1. In addition to those technical parameters, it should be noted that Recommendation ITU-R M.1849-1 also provides a detailed description of meteorological radars specificities (radar equation, emission schemes, operational scenarios, ….) that were taken into account when deriving the up-to-date DFS specifications, in particular in ETSI EN 301 893.

This document provides an analysis of the relevant DFS detection by WAS/RLAN comparing the meteorological radars described in Recommendations ITU-R M.1638-0 and M.1849-1.

1. **RLAN DFS equation**

The RLAN DFS equation is based on the two propagation paths, i.e. the radar emitted signal received at the RLAN receiver (equation 1 below) and the RLAN emitted signal received at the radar receiver (equation 2 below), assuming that the propagation conditions are symmetric.

**Equation 1 (Radar to RLAN path):**

Srec = Prad +Grad - A +GRLAN (1)

With Srec = signal level received at RLAN receiver (dBm)

Prad = Radar Power level (dBm)

Grad = Radar antenna gain (dBi)

A = Path Attenuation (dB)

GRLAN = RLAN antenna gain (dBi)

At the limit of detection, the signal level received at RLAN receiver is equal to the DFS detection threshold (SDFS) and one can derive the maximum Path Attenuation (Amax) as:

Amax = Prad +Grad - SDFS +GRLAN (1bis)

**Equation 2 (RLAN to Radar path):**

I = PRLAN +GRLAN - A +Grad -10log(BWRLAN/BWrad) (2)

With I = interference signal received at Radar receiver (dBm)

PRLAN = RLAN Power level (dBm)

GRLAN = RLAN antenna gain (dBi)

BWRLAN = RLAN bandwidth (Hz)

A = Path Attenuation (dB)

Grad = Radar antenna gain (dBi)

BWrad = Radar bandwidth (Hz)

On the principle that the path attenuation is symmetric, we then have:

I = PRLAN +GRLAN – (Prad +Grad - SDFS +GRLAN) +Grad -10log(BWRLAN/BWrad)

I = PRLAN – Prad + SDFS -10log(BWRLAN)+10log(BWrad) (3)

**DFS Equation**

The DFS will be efficient to ensure protection of the radar if the level of I (equation (3)) is lower than the maximum level of interference Imax expressed as (in dBm) (with I/N=-10 dB):

Imax= kTBF + I/N

Imax= -228.6 +10log(290) + 10log(BWrad) +NFrad +30 -10 (4)

In other terms, it is hence possible to calculate the DFS margin given as:

MDFS = Imax – I

MDFS = -228.6 +10log(290) + 10log(BWrad) +NFrad +30 -10 – (PRLAN – Prad + SDFS -10log(BWRLAN)+10log(BWrad))

**MDFS = Prad – PRLAN +NFrad +10log(BWRLAN) - SDFS -208.6 +10log(290) (5)**

With Prad = Radar Power level (dBm)

PRLAN = RLAN Power level (dBm)

NFrad = Radar noise figure (dB)

BWRLAN = RLAN bandwidth (Hz)

SDFS = DFS threshold (dBm)

It is here interesting to note that the DFS equation is independent from the antenna gain of both radar and RLAN, the radar bandwidth (assuming that the radar BW is smaller than the RLAN BW) and the distance between the radar and the RLAN.

1. **Application to the radar described in Recommendation ITU-R M.1849-1**

The following Table 1 provides the calculation of the DFS margin for all C-Band radars described in Recommendation ITU-R M.1849-1 (even for radar 14 although it is only operated in the 5350-5470 MHz band, i.e. not covered by agenda item 9.1.5). Relevant parameters have been taken from Table 8 in Annex 2, noting that for the NFrad figure, the minimum value has been considered (representing a worst case).

Concerning RLAN, it is easy to show that the worst case margin calculation is given with the following parameters :

* Power = 30 dBm (i.e. considering a 0 dBi antenna)
* Bandwidth = 20 MHz
* DFS threshold = -64 dBm

**Table 1**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Meteorological radars** | | |  |  | **RLAN** |  |  |  |
| **M.1849** | **M.1638** | **Peak Power** | **Peak Power** | **NF** | **Power** | **Bandwidth** | **DFS threshold** | **DFS Margin** |
| **Radar Nb** | **Radar** | **kW** | **dBm** | **dB** | **dBm** | **MHz** | **dBm** | **dB** |
| **1** | A | 250 | 84.0 | 7 | 30 | 20 | -64 | **14.0** |
| **2** | C | 250 | 84.0 | 4 | 30 | 20 | -64 | **11.0** |
| **3** | E | 250 | 84.0 | 2.3 | 30 | 20 | -64 | **9.3** |
| **4** | F | 250 | 84.0 | 3 | 30 | 20 | -64 | **10.0** |
| **5** | G | 250 | 84.0 | 3 | 30 | 20 | -64 | **10.0** |
| **6** | H | 250 | 84.0 | 3.5 | 30 | 20 | -64 | **10.5** |
| **7** | I | 250 | 84.0 | 1.5 | 30 | 20 | -64 | **8.5** |
| **8** | J | 2.25 | 63.5 | 3 | 30 | 20 | -64 | **-10.4** |
| **9** |  | 250 | 84.0 | 3 | 30 | 20 | -64 | **10.0** |
| **10** |  | 250 | 84.0 | 3 | 30 | 20 | -64 | **10.0** |
| **11** |  | 250 | 84.0 | 1.2 | 30 | 20 | -64 | **8.2** |
| **12** |  | 250 | 84.0 | 1.9 | 30 | 20 | -64 | **8.9** |
| **13** |  | 200 | 83.0 | 1 | 30 | 20 | -64 | **7.0** |
| **14** |  | 250 | 84.0 | 1.8 | 30 | 20 | -64 | **8.8** |

These calculations show that considering parameters of radars given in Recommendation M.1849-1, the DFS is efficient to ensure protection of meteorological radars with current DFS threshold (-64 dBm), with the exception of radar 8 that presents a negative DFS margin.

Considering the characteristics of the wave form (pulse width and PRF) of these radars, it can also be seen that they are consistent with current specifications as in EN 301 893, with the exception of radars 2 and 8 depicting minimum pulse width of 0.05 µs and 0.1 µs, respectively.

Hence, for radars 1, 3 to 7 and 9 to 14, a reference to Recommendation M.1849-1 does not have any impact on RLAN operations compared to a reference to Recommendation M.1638-0.

In addition, although in theory radars 2 and 8 may have some impact on RLAN operations, it should be noted that they were already described in Recommendation M.1638-0 as radars C and J, respectively. The situation is hence unchanged.

1. **Conclusion**

This document shows that there is actually no difference in terms of radar characteristics comparing Recommendation M.1849-1 and Recommendation M.1638-0.

In can therefore be concluded that adding a new reference to Recommendation ITU‑R M.1849‑1 to footnotes Nos [5.447F](file:///C:/Users/TRISTANT/Documents/A-TRAVAIL/WRC-19/Agenda/5.447F.docx) and [5.450A](file:///C:/Users/TRISTANT/Documents/A-TRAVAIL/WRC-19/CPG/CPG-PTD/PTD-2%20(Helsinki%20Janv%202017)/Contribution%20EUMETNET/5.450A.docx) will not impact the services referred in these footnotes, in particular RLAN/WAS and will keep unchanged the protection of meteorological radars.

On the other hand, a reference to Recommendation ITU-R M.1849-1 would provide a much clearer picture of the situation, since it provides a detailed description of meteorological radars specificities (radar equation, emission schemes, operational scenarios, ….) that were taken into account when deriving the up-to-date DFS specifications, in particular in ETSI EN 301 893, and that are currently missing in Recommendation ITU-R M.1638-0.

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**Attachment 2**

**Application to the radar described in the working document toward a PDRR Recommendation ITU-R M.1849-1 (see document 5B/195 Annex 14)**

Similarly with the calculations presented in attachment 1, the following Table provides similar analysis for the new radars 15 to 20 proposed by Japan to be included in the revised version of Recommendation ITU-R M.1849 (see Document 5B/195 annex 14).

**Table**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Meteorological radars** | | |  |  | **RLAN** |  |  |  |
| **M.1849** |  | **Peak Power** | **Peak Power** | **NF** | **Power** | **Bandwidth** | **DFS threshold** | **DFS Margin** |
| **Radar Nb** |  | **kW** | **dBm** | **dB** | **dBm** | **MHz** | **dBm** | **dB** |
| **15** |  | 6 | 67.8 | 2.5 | 30 | 20 | -64 | **-6.7** |
| **16** |  | 6 | 67.8 | 2.5 | 30 | 20 | -64 | **-6.7** |
| **17** |  | 6 | 67.8 | 2.5 | 30 | 20 | -64 | **-6.7** |
| **18** |  | 4 | 66.0 | 3 | 30 | 20 | -64 | **-7.9** |
| **19** |  | 6 | 67.8 | 2 | 30 | 20 | -64 | **-7.2** |
| **20** |  | 4 | 66.0 | 3 | 30 | 20 | -64 | **-7.9** |

These calculations show that considering parameters of the new radars proposed by Japan, the DFS is not efficient to ensure protection of meteorological radars with current DFS threshold (-64 dBm).

In addition, considering the characteristics of the wave form (pulse width and PRF) described for these radars, the maximum pulse widths described (ranging 200 to 256 µs) and some of the PRF (up to 20000 Hz in one case) are far from being within the current ranges of RLAN DFS specification.

Hence, on all aspects, the characteristics of the new radars proposed for inclusion in Recommendation ITU-R M.1849-1 do not allow for their detection by RLAN and thus their protection.

This issue will require careful consideration.