International Civil Aviation Organization

TENTH MEETING OF SPECTRUM REVIEW WORKING GROUP (SRWG/10)

Bangkok, Thailand, 04 – 06 February 2026

Agenda Item 5: Review of Frequency Lists in the Region

REVIEW OF FREQUENCY LISTS

(Presented by the Secretariat)

SUMMARY

This paper presents the status of Frequency Lists and the coordination on aeronautical frequency utilization for the region in 2025.

1. INTRODUCTION

1.1 The Third Asia/Pacific Regional Air Navigation Meeting (ASIA/PAC/3 RAN), held in Bangkok in 1993, agreed that the frequency lists prepared by the Asia and Pacific Regional Office would be the frequency planning documents for the Region.

1.2 States/Administrations are encouraged to coordinate with ICAO APAC Office for aeronautical services in the frequency bands of 190-526.5 kHz (NDB, Frequency List 1), 108-117.975 MHz, 960 – 1215 MHz (VOR, DME and ILS, Frequency List 2) and 117.975 to 137 MHz (VHF COM, Frequency List 3), as well as all others that may affect the use of aeronautical frequencies in other States/Administrations, e.g. frequencies for AM(OR) service.

1.3 This paper shares the status of the Frequency lists published and maintained by the ICAO APAC Office.

2. DISCUSSION

Management of Frequency List 2 and 3

2.1. The ICAO Asia and Pacific Office developed a standalone computer tool, **Frequency Manager**, to estimate, register assignments and generate the Frequency Lists 1, 2 and 3 in the past. Every year, the latest editions of the lists were issued. It was recommended that any errors or discrepancies should be communicated to the ICAO Asia and Pacific Regional Office.

2.2. In 2016, the frequency coordination for **VHF COM** at the APAC Regional Office was implemented with the Frequency Finder tool. The up-to-date database (equivalent to Frequency List No. 3 in the APAC region) was visible to all Frequency Finder users.

2.3. ICAO made continuous efforts to improve the Frequency Finder tool and encouraged States/Administrations to use the latest version of the Frequency Finder tool to enjoy the most benefits.

2.4. In 2024, after the adoption of the new **VHF COM allotment plan for APAC** by APANPIRG/35, the revised plan was incorporated into the Frequency Finder tool.

2.5. The Frequency Finder tool has incorporated the **VHF NAV** module since 2020. The ICAO APAC Regional Office introduced the (revised) frequency assignment planning criteria for NAV[1] facilities, review the status of the Frequency List No.2, in particular in light of the increased congestion and even saturation of this band for future ILS or VOR frequency assignments as well as the expected implementation of GBAS/VDB, in addition to ensure that the Frequency List 2 is correct, up-to-date and lists all NAV stations that are currently in operation or planned.

2.6. The purpose of the Frequency List is to provide comprehensive information for frequency planning. It should be emphasized that, for the Lists to be of real value for frequency planning, they must be up to date. To accomplish this, it is essential that States coordinate with the Regional Office on any change in assignment or on new frequency requirements prior to their use. The Regional Office updates the Lists regularly.

2.7. ICAO APAC Office synchronized all registered assignments of Frequency List 2 from Frequency Manager into Frequency Finder in 2022 and continues to use Frequency Finder for frequency assignments for NAV systems.

2.8. During SRWG/7, the Secretariat proposed to publish Frequency List 2 (36th edition) by Frequency Finder, which was supported by the meeting. ICAO hosted a Workshop on Frequency Finder at the ICAO Asia and Pacific (APAC) Regional Office on 9-13 October 2023. The workshop supported the **migration of Frequency List 2 to the Frequency Finder global database** (refer to WP07 of SRWG/8).

2.9. The CNS SG/28 endorsed the Draft Conclusion CNS SG/28/07 (SRWG/8/4) – *Transition from the regular publication of Frequency List 2 to the global database of frequencies included in the Frequency Finder,* which was adopted by APANPIRG/35 by **Conclusion APANPIRG/35/9**. As discussed in SRWG/8, after adopting the Draft Conclusion CNS SG/28/07 (SRWG/8/4), the ICAO APAC Regional Office stopped the regular publication of Frequency List 2. Therefore, no publication of Frequency List 2 was done in 2025.

2.10. Frequency List 2 and 3 can be accessed by the global database maintained in the Frequency Finder Tool. However, it is noted that, from August 2025, the Frequency Finder tool is undergoing a modernization process. The process was expected to be completed in 6 months; however, the process is still ongoing. This modernization process has resulted in an offline version of the Frequency Finder tool. As a result, the ICAO APAC Office faced issues conducting a simulation in the tool.

2.11. Nonetheless, the ICAO APAC Office has continued to coordinate frequency use with States, and all allocated frequencies have been saved in the local database. Once the tool is online, the local database is expected to be imported into the global database. However, it should be noted that after the Frequency Finder tool is online, some allocations may not be compatible. ICAO APAC Office will resolve such issues in coordination with affected States.

2.12. As the Frequency Finder tool is also used for SI/II code allocation, some requests were completed after August 2025 using the offline tool. However, it was observed that the SI/II code database has some missing entries from the past, and the allocated code was indeed not compatible. To resolve this issue and avoid allocating incompatible codes, currently, SI/II code allocations are not being made. The SI/II code allocation will start as soon as the issues in the current database are resolved.

Frequency List 1 Management issues

[1] In this paper NAV systems or NAV facilities refer to ILS (Localizer and Glide Path), VOR, DME and GBAS/VDB.

2.13. In SRWG/9 Meeting in 2025 by WP/12, the ICAO Secretariat informed that the Frequency Manager tool, used for NDB assignments and the maintenance of Frequency List 1, is installed on a very old configuration computer, as the frequency manager tool is not compatible with the latest configuration. The computer running Frequency Manager failed in January 2024. Even after recovery, the tool was intermittent, and it has become difficult to use. There is a risk that the tool may become unavailable in the near future. In such cases, it would be challenging to allocate NDB frequency to the APAC States/Administrations. SRWG/9 Meeting discussed the process for NDB assignments and the maintenance of Frequency List 1 (NDB) in the event of the Frequency Manager failing.

2.14. The SRWG/9 Meeting deliberated on the issue of NDB frequency assignment in case of unavailability of the frequency manager tool and shared the need for a dedicated tool for this purpose, as NDB has been an essential facility, since GNSS RFI occurrences are affecting the APAC region. It was agreed that other regions may also consider keeping NDB facilities or their enhancement in the future. Therefore, a tool to manage NDB frequency allocation was essential.

2.15. It was agreed that the best approach is to use the Frequency Finder tool to incorporate the NDB frequency/ident assignment facility. The Meeting requested that ICAO HQ incorporate the NDB frequency/identity assignment facility in the current FF tool. The Meeting requested that the ICAO Secretariat share this message with ICAO HQ and update the Meeting on the response, which resulted in ACTION ITEM 9-7**.**

2.16. It was also shared that if ICAO can help obtain detailed NDB frequency assignment criteria, APAC States/Administrations may explore alternative ways to perform such assignments in the future. The ICAO Secretariat was requested to coordinate with ICAO HQ and compile the resources that help understand NDB frequency/identity assignment criteria, resulting in ACTION ITEM 9-8

2.17. India suggested including NDB frequency assignment criteria in the Asia/Pacific Regional Frequency Management Manual, which led to Action Item 9-10 from SRWG/9.

2.18. Meanwhile, in 2025, the ICAO APAC Office published Frequency List 1 (39th edition) by State Letter Ref.: T 8/8.4: AP056/25 (CNS), dated 24 April 2025. The Frequency List 1 (39th edition) can also be accessed on the ICAO APAC e-Docs webpage. The next edition (40th edition) of the ICAO APAC Frequency List 1 is planned to be published in May 2026.

2.19. The ICAO APAC Office coordinated with ICAO Headquarters (HQ) to obtain relevant information. ICAO HQ informed that, other than the APAC region, NDB frequency assignment is not made by other regional offices, and there are no such requests to incorporate NDB frequency assignment features in the Frequency Finder Tool. As ICAO is upgrading the Frequency finder tool and plans to launch a web-based version in the future, adding NDB to the current tool is not a priority. Therefore, there is less hope that these allocations can be made by the Frequency Finder tool in the near future.

2.20. ICAO HQ advised that some technical parameters for NDBs can be found in Annex 10, Volume I. Furthermore, it was recommended to use the EUR Doc 011 (EUR Frequency Management Manual), which contains NDB planning criteria and other relevant details (provided in **Appendix A**), and may serve as a useful reference for APAC States.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper;

b) coordinate with the Regional Office for any change in assignment or requirement for new frequencies prior to their use;

c) discuss the way forward for the management of Frequency List 1 in case the current tool is unserviceable in the future;

d) draft NDB frequency and ident allocation criteria using references provided in the paper for potential inclusion of NDB-related content in the Asia/Pacific Regional Frequency Management Manual; and

e) discuss any relevant matter as appropriate.

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PART III RADIO NAVIGATION AID FREQUENCY ASSIGNMENT PLANNING CRITERIA

1 NDB and locator

1.1 General

1.1.1 A number of sub-bands in the range of 255 – 526.5 kHz (excluding 495 - 505 kHz) are allocated to aeronautical radio navigation with various status. Only the sub-band 325 - 405 kHz is allocated exclusively to the aeronautical radio navigation service, the other sub-bands being shared with other services.

1.1.1.1. As for the other users of the band, the sub-band 255 - 283.5 kHz is mainly used by broadcasting stations, while the sub-bands 283.5 - 315 kHz and 315 - 325 kHz are used by maritime beacons. The small segment 405 - 415 kHz is designated for radio direction-finding in the maritime radio navigation service, while the sub-bands in the range 415 - 526.5 kHz (excluding the segment 495 – 505 kHz) are used by the maritime mobile service, limited to radiotelegraphy.

1.1.1.2. It is noted additionally that Rradio frequency carrier systems are widely used for remote control or transmission of speech or data over segments of high-voltage overhead power lines. In some cases frequencies in the LF/MF bands are used and this has been proved to be able to affect ADF indications in aircraft at several nautical miles from the power lines.

1.1.2 Organization of Planning

1.1.2.1. In order to secure the international and the operational status of their assignments, States are required to apply the rules and procedures of the ITU Radio Regulations. This is particularly necessary for the shared sub-bands, since the ICAO EUR Table NAV is not supposed to include non-aeronautical assignments.

1.1.2.2. For assignments in the aeronautical radio navigation service, States are required to apply the ICAO EUR FMG rules and procedures.

Note 1: *Although in the shared sub-bands the FMG process is evidently partial and cannot result, if applied alone, in the required status, this process is necessary for the co-ordination of the identifications of the radio navigation aids.*

Note 2: *In the shared sub-bands, States are advised to avoid including assignments for non-aeronautical services (e.g. maritime services) in the FMG co-ordination process, as such assignments are not taken into account in compatibility assessments.*

1.1.3 References to documents:

- Annex 10, Volume I, Attachment C, paragraph 6.2.1.6
  (field strength);
- Annex 10, Volume V, paragraph 3.2
  (*general about protection, sharing and frequency congestion*);
- Annex 10, Attachment A to Volume V
  (*protection, receiver characteristics, filter attenuation*);
- European Region Air Navigation Plan (Doc 7754), Volume II, Part III.

1.1.4 The range can be from 10 NM (nautical miles) up to 100 NM (in some rare cases more) and the operational range is listed in the national AIP and the frequency assignment table. The maximum altitude is not specified. Co-channel separation between two transmitters shall be such that an unwanted signal is more than 15 dB below the wanted signal within the specified service area (DOC). This protection criterion is also included in the ITU Radio Regulations. The bandwidth characteristics of the airborne receiver need to be taken into account which require in principle that existing transmitters within ± 7 kHz from the frequency of the wanted station be considered.

1.1.5 In the band 325 - 405 kHz, aviation is the only user and new assignments should therefore preferably be made in this segment. Use of a segment where aeronautical radio navigation is secondary should only be considered in areas where the primary service is not used, like inland areas where the distance to any maritime station is sufficient.

1.1.6 The co-ordination of LF/MF radio navigation aids to be applied for aeronautical purposes above 526.5 kHz shall be carried out between national radio regulators, applying the relevant ITU procedures. The co-ordination of the identification of such a radio navigation aid shall be carried out between FMG members according to the rules in Part IV.

1.1.7 For normal coverage ranges (15 - 50 NM) co-ordination should, as an absolute minimum, be made with States within a radius of 300 - 400 NM. Co-ordination should also be made with the national authority responsible for protection of the maritime services if a shared band segment is to be used.

1.1.8 Information on the planning of identifications can be found in section 7.

1.2 Frequency Assignment Planning Principles

1.2.1 Wherever possible, frequencies at kHz points (i.e. integral multiples of 1 kHz) in the bands used for NDBs should be chosen to meet particular requirements. Frequency assignments at 0.5 kHz points may also be utilized, provided the full required protection can be ensured.

1.2.2 In the planning of frequency assignments, ADF receiver characteristics as specified in paragraph 3 of Attachment A to Annex 10, Volume V, should be assumed.

1.2.3 For the purpose of assessing the signal attenuation with distance, the LF/MF ground wave propagation curves agreed by the ITU-R should be used, taking into account the frequency of operation and the effect of mixed land/sea path where appropriate.

1.3 Frequency Assignment Planning Criteria

1.3.1 The protection of a NDB against interference from another NDB can be calculated using the propagation curves in Recommendation ITU-R P.368-9. These curves (known also as CCIR curves) represent the propagation characteristics of a transmitter (beacon) with an effective monopole radiated power (e.m.r.p.) of 1 kW. These curves can be adjusted to describe the propagation characteristics (field strength as a function of the distance from the beacon) of a beacon with a given coverage area. Such adjustment needs to ensure that the field strength at the edge of the coverage area is the minimum required. For aeronautical beacons this field strength is 70 µV/m or 36.9 dB (µV/m). (Ref.: Annex 10, Volume I, section 3.4 and ITU Radio Regulations Appendix 12).

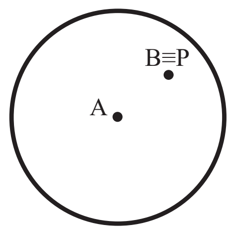
1.3.2 For frequency planning purposes, the CCIR curves for sea water and wet ground propagation are used, with the following characteristics:

Sea water:	σ = 5 S/m	Wet ground:	σ = 10^{-2} S/m
	ε = 70		ε = 30

1.3.3 The protection ratio has to be calculated at the point P where the interference is maximum. There are two cases to consider:

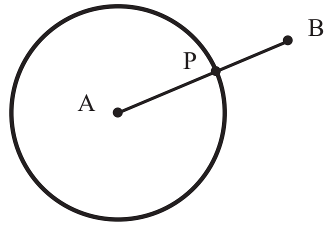
i) when the undesired beacon (B) is inside the coverage area of the desired beacon (A): at the location of that (undesired) beacon (see Figure 1)

Figure 1



ii) when the undesired beacon (B) is outside the coverage area of the desired beacon (A): at that point on the edge of the coverage area of the desired beacon closest to the undesired beacon (see Figure 2)

Figure 2



1.3.4 Calculation of the minimum protection ratio (D/U) shall ensure identification of the worst-case interference.

1.3.5 To ensure the compatibility of two beacons, it is necessary to consider successively the two cases where each of the beacons is treated as desired and the other one as undesired. In each case, the protection ratio needs to be calculated at the point of maximum interference. The lowest value of these two protection ratios is the value at risk and to be used in frequency planning.

1.3.6 Once the worst case protection ratio is known, the minimum frequency separation can be determined taking into account the ADF selectivity characteristics.

1.4 Description of the Calculations

1.4.1 As a first step, the ITU-R curves (see section 1.6) are adjusted to obtain field-strength values corresponding to the effective monopole radiated power of the beacon, necessary to obtain the minimum field strength required at the edge of coverage (36.9 dB µV/m).

Let *a* and *b* denote respectively the operational ranges of the beacons A and B.

The following symbols are additionally used:

$f(R)$	field strength at distance R, for e.m.r.p.= 1kW (from ITU-R curves).
$f^A(R)$	field strength for beacon A at distance R.
$f^B(R)$	field strength for beacon B at distance R.
$f(a)$	field strength $f(R)$ at $R = a$
$f(b)$	field strength $f(R)$ at $R = b$
$f^A(a)$; $f^B(b)$	field strengths $f^A(R)$ at $R = a$ and $f^B(R)$ at $R = b$ [normally 36.9 dB μV/m].
$f(1)$; $f^A(1)$; $f^B(1)$	field strengths $f(R)$, $f^A(R)$ and $f^B(R)$ at R = 1 km. $f(R)$ at R = 1 km is 109.5 dB μV/m. See also Recommendation ITU-R P.368-9.

The field strengths produced by beacons A and B at any distance R from the beacon satisfy:

$$f^A(R) = f(R) - [f(a) - 36.9] \qquad (1)$$

$$f^B(R) = f(R) - [f(b) - 36.9] \qquad (2)$$

Note: *In general the field strength ($f(R)$, $f^A(R)$ or $f^B(R)$) depends not only on the path distance R (this dependence being the only explicit in the notation), but also on the frequency as well as on the geological constitution of the radio-path (proportion of sea-path over the total path distance R).*

1.4.2 Determination of the field strengths $f(a)$ and $f(b)$

On considering each beacon separately, the first step is the identification of the radial along which the proportion *p* of sea-path over a total path distance equal to the range of the beacon is lowest.

On the basis of the lowest proportion *p*, the mixed-path calculation method (see section 1.5) is then applied for the determination of the quantity $f(a)$ or $f(b)$ and the consequent dimensioning of the output power of the beacon (see section 1.7).

1.4.3 Calculation of the protection ratio when the undesired beacon is inside the coverage area of the desired beacon (see paragraph 1.3.3 i) above). In this case the maximum level of the undesired signal that contributes to the interference of the desired signal is at the location of the transmitter of the undesired beacon.

If we assume A to be the desired beacon and B the undesired beacon, the maximum level of the undesired signal is:

$$E_U = f^B(1) = f(1) - [f(b) - 36.9]$$
$$= 109.5 - [f(b) - 36.9] \qquad (3)$$

The signal level of the desired facility A at this point of maximum interference is:

$$E_D = f^A(R_s) = f(R_s) - [f(a) - 36.9] \qquad 0<R_s<a \qquad (4)$$

R_s = separation distance between A and B.

The protection ratio D/U is: $E_D - E_U$ or $f^A(R_s) - f^B(1)$.

Substitution of (3) and (4) in this formula gives:

$$D/U = f(R_s) - f(a) + f(b) - 109.5 \qquad (5)$$

<u>Note</u>: *For the application of formula (5), the quantity $f(R_s)$ at the position of the undesired beacon is determined by the application of the mixed-path calculation method (see section 1.5).*

1.4.4 Calculation of the protection ratio when the undesired beacon is outside the coverage area of the desired beacon (see paragraph 1.3.3 ii) above). In this case the maximum level of the undesired signal that contributes to the interference of the desired signal is at the location of point P in Figure 2.

At this point the signal level of the desired facility A is:

(6)
$$E_D = f^A(a^*) = f(a^*) - [f(a) - 36.9]$$

($f^A(a^*)$, $f(a^*)$ denote respectively the adjusted and the non-adjusted (corresponding to e.m.r.p.=1kW) field strengths at the particular point P).

The signal level of the undesired facility B at this point is:

$$E_U = f^B(R_s - a)$$
$$= f(R_s - a) - [f(b) - 36.9], \qquad a<R_s, \qquad (7)$$

R_s = separation distance between beacon A and B.

The protection ratio D/U is: $E_D - E_U$ or $f^A(a^*) - f^B(R_s - a)$.

Substitution of (6) and (7) in this formula gives:

$$D/U = f(b) - f(R_s - a) + f(a^*) - f(a). \qquad (8)$$

<u>Note</u>: *For the application of formula (8), the quantities* $f(a^*)$ *and* $f(R_s-a)$ *are determined by the application of the mixed-path calculation method (see section 1.5),* $f(a^*)$ *corresponding to the propagation path AP*, *while* $f(R_s-a)$ *corresponding to propagation path BP (see Figure 2).*

1.4.5 Formulas (5) and (8) can be used to calculate the interference from beacon B (undesired) to beacon A (desired). When the outcome of the calculations shows that the D/U is equal or greater than 15 dB, the desired beacon is protected and the beacons can operate on the same frequency. When the outcome is less than 15 dB, a frequency separation between the frequencies assigned to these beacons has to be maintained.

The required frequency-separation depends upon the calculated D/U ratio and can be taken from the following table:

D/U(dB)	frequency-separation (kHz) between desired and undesired signal
≥ 15	0
< 15 to ≥ 9	1
< 9 to ≥ (-5)	2
< (- 5) to ≥ (-20)	3
< (-20) to ≥ (-35)	4
< (-35) to ≥ (-50)	5
< (-50) to ≥ (-65)	6
< -65	7

Table 1 – Required Frequency Separation

The above relation between the D/U ratio and the required frequency-separation corresponds to the ADF-receiver selectivity curve in Annex 10, Volume V, Attachment A, paragraph 3.

Since the D/U ratio, for a combination of beacons with a range of a and b respectively, is a function of the distance between these beacons and the required frequency separation is a function of the D/U ratio, the minimum required frequency separation is a complex function of the separation distance.

1.5 Mixed Path Calculations

1.5.1. The method described below pertains to a propagation path which contains both land and sea segments.

1.5.2. Although ITU-R is, for this purpose, recommending the Millington method (reference Recommendation ITU-R P.368-9, Annex 2), a simplified method was developed and recommended to be used in calculations when mixed path conditions exist.

1.5.3. In this simplified method the calculation of the signal-level of a beacon is based upon the following formula:

$$f(R)_M = f(R)_L + \{ f(R)_S - f(R)_L\}p \qquad (9)$$

where :

$f(R)_M$ = effective field strength of a beacon with EMRP=1kW at a point P, at distance R from the beacon

$f(R)_L$ =field strength at P if the total path were over land.

$f(R)_S$ =field strength at P if the total path were over sea.

R = total path length.

p = S/R where S is the total sea-path length.

1.6 ITU-R Propagation Curves

1.6.1 The ITU-R propagation curves (known also as CCIR curves) can be found in Recommendation ITU-R P.368-9. They were generated through the application of the computer program GRWAVE, which is made available by ITU-R.

1.6.2 The program GRWAVE was used as well for calculating the field strength values of Table 2 below for EMRP=1 kW. Field strength values at intermediate frequencies can be estimated by linear interpolation.

SEPARATION DISTANCE	BEACON RANGE	SEA 300 kHz	SEA 400 kHz	SEA 500 kHz	LAND 300 kHz	LAND 400 kHz	LAND 500 kHz
KM	NM	DB(UV/M)	DB(UV/M)	DB(UV/M)	DB(UV/M)	DB(UV/M)	DB(UV/M)
2		103.5	103.4	103.4	103.2	103	102.8
4		97.4	97.4	97.4	97.1	96.9	96.6
6		93.9	93.9	93.9	93.5	93.3	93
8		91.4	91.4	91.4	91	90.7	90.3
10		89.5	89.5	89.4	89	88.6	88.2
18.5	10	84.1	84.1	84.1	83.4	82.9	82.3
20		83.4	83.4	83.4	82.7	82.2	81.5
27.8	15	80.5	80.5	80.5	79.6	79	78.2
37	20	78	77.9	77.9	76.9	76.1	75.1
40		77.3	77.3	77.2	76.1	75.3	74.2
46.3	25	76	76	76	74.7	73.7	72.6

55.6	30	74.4	74.4	74.3	72.9	71.8	70.4
60		73.7	73.7	73.6	72.1	70.9	69.5
80		71.1	71	70.9	69.1	67.6	65.8
92.6	50	69.7	69.6	69.5	67.5	65.8	63.8
100		69	68.9	68.8	66.6	64.8	62.7
138.9	75	65.7	65.6	65.5	62.7	60.3	57.5
185.2	100	62.7	62.5	62.3	58.9	55.9	52.4
200		61.8	61.6	61.4	57.8	54.6	50.9
231.5	125	60.1	59.8	59.6	55.6	52	47.9
277.8	150	57.9	57.5	57.2	52.7	48.5	43.8
370.4	200	53.9	53.3	52.8	47.4	42.1	36.4
400		52.7	52.1	51.5	45.8	40.2	34.1
463	250	50.3	49.5	48.8	42.6	36.3	29.6
555.6	300	46.9	45.9	45	38.1	30.8	23.2
600		45.3	44.2	43.2	36	28.2	20.3
800		38.4	36.8	35.4	26.9	17.1	7.3
1000		31.8	29.7	28	18.2	6.2	-5.3
1200		25.4	22.8	20.7	9.6	-4.4	-17.8
1400		19.1	16	13.5	1.2	-14.9	-30.1
1600		12.9	9.3	6.4	-7.2	-25.3	-42.4
1800		6.7	2.7	-0.7	-15.5	-35.6	-54.5
2000		0.6	-3.9	-7.6	-23.7	-45.9	-66.6

Table 2 – 1 kW EMRP Field Strength at a Given Separation Distance

1.7 Effective Monopole Radiated Power (EMRP)

1.7.1 Pursuant to the ITU Radio Regulations (Article 28.23), the power radiated by each radio beacon shall be adjusted to the value necessary to produce the stipulated field strength (36.9 dB (μV/m)) at the limit of its operational range.

1.7.2 The EMRP is calculated not for frequency co-ordination purposes but for the determination of the transmitter output power P of the beacon which is required for the desired operational coverage. The quantities EMRP and P in dBW are related as follows:

$$P = EMRP + \text{cable and tuning losses} - Gv,$$

where Gv is the gain of the antenna with regard to a short vertical monopole. In most practical cases Gv=0dB. Cable and tuning losses, on the other hand, are usually not less than 10 dB (see also Attachment C to Annex 10, Volume I, paragraph 5 of section 6.3.2).

1.7.3 The EMRP in dBW can be calculated, using the ITU-R propagation curve for a 1 kW transmitter, as follows:

$$EMRP = 30 - [f(a) - 36.9] = 66.9 - f(a),$$

where

30 = term for the conversion of the ITU-R propagation curves from a 1 kW transmitter to a 1Watt transmitter in order to obtain an EMRP value in dB relative to 1 Watt.

36.9 = minimum field strength in dB(μV/m) required at the edge of the coverage.

f(*a*) = field strength in dB(μV/m) at the edge of the beacon's desired coverage calculated for an EMRP of 1kW as described in paragraph 1.4.2.

1.8 Treatment of Assignments over Polygonal Areas

1.8.1. In exceptional cases, frequency assignments can be co-ordinated over polygonal areas. In such a case :

1.8.1.1. Frequency protection is accorded over the co-ordinated polygonal area.

1.8.1.2. The envisaged distance (range) between receiver and transmitting beacon is specified at co-ordination in addition to the polygonal area. This range shall not exceed the length of the maximum diagonal of the polygonal area.

1.8.1.3. The transmitting beacon can be anywhere inside the polygonal area.

1.8.2. The following instructions are provided for the calculation of the required D/U ratio involving assignments over polygonal areas (referred to henceforth as area assignments) :

1.8.3. The field strength f(*a*) at the range of an area assignment is calculated by considering all possible paths of length *a* within the polygonal area and by identifying the lowest sea-path proportion among those paths.

1.8.4. Area assignment versus circular assignment.

1.8.4.1. Protection of the area assignment

1.8.4.1.1. If the centre of the circular assignment is inside the polygon of the area assignment, formula (5) is applicable with R_s being equal to the minimum of (i) the range *a* of the area assignment and (ii) the maximum distance between the centre of the circular assignment and the polygon. f(R_s) can be calculated by considering the radial with the lowest sea-path proportion among those radials of length R_s from the centre of the circular assignment which end up within the polygon.

<u>Note</u>: *When $R_s=a$, $f(R_s)\geq f(a)$. In general $R_s=a$ does not imply $f(R_s)=f(a)$ because the minimisation of the sea-path proportion is effected over different sets of possible paths of length a.*

1.8.4.1.2. If the centre of the circular assignment is outside the polygon of the area assignment, formula (8) is applicable with R_s-*a* being equal to the distance between the centre of the circular assignment and its closest point on the polygon. f(*a**) can be calculated by considering the radial with the lowest sea-path proportion among those radials which originate from the point on the polygon closest to the centre of the circular assignment, have length equal to the range *a* of the area assignment and end up within the polygon. If the distance of this point from any other point on the polygon is less than the range *a*, the length of the radial for the calculation of f(*a**) is reduced to the maximum value of this distance.

1.8.4.2. Protection of the circular assignment

1.8.4.2.1 If the polygon of the area assignment overlaps with the coverage area of the circular assignment, formula (5) is applicable with R_s being equal to the minimum of (i) the range *a* of the circular assignment and (ii) the maximum distance between the centre of the circular assignment and the polygon. f(R_s) can be calculated by considering the radial with the lowest sea-path proportion among those radials of length R_s from the centre of the circular assignment which end up within the polygon.

1.84.2.2 If the polygon of the area assignment does not overlap with the coverage area of the circular assignment, formula (8) is applicable with R_s being equal to distance between the centre of the circular assignment and its closest point on the polygon. In this case the situation is very similar to the compatibility between two circular assignments.

1.8.5. Area assignment versus area assignment

1.8.5.1 Protection of each area assignment

1.8.5.1.1 If the two polygonal areas overlap, formula (5) is applicable with R_s being equal to the minimum of (i) the range *a* of the area assignment to be protected and (ii) the maximum distance between any point in the intersection of the two polygonal areas and any other point on the polygon to be protected. $f(R_s)$ can be calculated by considering the path with the lowest sea-path proportion among all possible paths of length R_s which originate from points in the intersection of the two polygonal areas and end up within the polygon to be protected.

1.8.5.1.2 If the two polygonal areas do not overlap, formula (8) is applicable with R_s-*a* being equal to distance between the two polygons. f(*a**) can be calculated by considering the radial with the lowest sea-path proportion among those radials which originate from the point on the polygon to be protected closest to the opposite polygon, have length equal to the range *a* of the area assignment to be protected and end up within the polygon to be protected. If the distance of this point from any other point on the polygon to be protected is less than the range *a*, the length of the radial for the calculation of f(*a**) is reduced to the maximum value of this distance.