RECOMMENDATION ITU-R M.1227-1

TECHNICAL AND OPERATIONAL CHARACTERISTICS OF WIND PROFILER RADARS IN BANDS IN THE VICINITY OF 1 000 MHz

(Question ITU-R 102/8)

(1997-2000)

The ITU Radiocommunication Assembly,

considering

a) that wind profiler radars (WPRs) are important meteorological systems used to measure wind direction and speed as a function of altitude;

b) that many administrations plan to deploy WPRs in operational networks in order to improve meteorological predictions and warnings, and support studies of the climate and increase the safety of navigation;

c) the need for frequency bands in the vicinity of 50, 400 and 1 000 MHz to permit the full performance capability of WPR operations, as requested by the World Meteorological Organization (WMO);

d) that wind profilers operating near 1 000 MHz may be installed at fixed locations or may be transportable, to support a variety of requirements including environmental emergencies, pollution monitoring, etc.;

e) that Resolution 217 (WRC-97) identified the frequency bands 904-928 MHz (Region 2), 1 270-1 295 MHz and 1 300-1 375 MHz for WPRs having due regard to the potential for incompatibility with other services;

f) that selection of a proper frequency band for a WPR depends upon height coverage user needs, local climate and interference conditions;

g) that, once designed and built, the WPRs could operate on centre frequencies over a range of ±1%;

h) that WPRs may have to share spectrum with other systems both current and future;

j) that it would be desirable to have a limited number of frequencies authorized worldwide, in order to minimize research and development investment in the design of components;

k) that technical standards would enhance compatibility with other systems within the same band,

recommends

1 that minimum requirements on system performance, as in Annex 1, should be adopted by administrations desiring to construct or operate WPRs in the bands near 1 000 MHz;

2 that the transmitter power should be limited to that necessary to obtain data at the maximum altitude for which the profiler was designed;

3 that the occupied bandwidth (see Note 1) should be as close to the necessary bandwidth (see Note 2) as is technically and economically feasible to provide the required range resolution, noting that reduced values of resolution are generally acceptable at higher altitudes. Values are given in Annex 1.

NOTE 1 – Occupied bandwidth: the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5% of the total mean power of the given emission.

NOTE 2 – Necessary bandwidth: for a given class of emission, the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specific conditions;

4 that the unwanted emissions from WPRs should be reduced as much as technically and economically feasible. Values are given in Annex 1;

5 that the antenna radiation pattern should minimize the levels of the sidelobes, especially those at or near the horizon. Representative values which have been achieved in one case of side-lobe gain and field strength are given in Annex 1;

6 that administrations may develop appropriate sharing criteria, such as frequency-distance (FD) separations in accordance with Recommendation ITU-R SM.337, for specific WPR designs sharing with other systems;

7 that the selection of WPR locations should take advantage of terrain and siting configuration to minimize the possibility of interaction with other systems; additional enhancements (e.g. fences, berms) and antenna orientation may improve compatibility;

8 that the frequency bands 904-928 MHz (Region 2), 1 270-1 295 MHz and 1 300-1 375 MHz should be chosen when compatibility is possible taking due account of the frequency dependence of performance over this frequency range as given in Annex 2.

ANNEX 1

Representative values and minimum requirements on system performance for WPRs in bands near 1 000 MHz

1 Introduction

The values given below are based on current knowledge and field measurements on pulse modulated systems.

2 Representative values for operational WPRs in bands near 1 000 MHz

TABLE 1

System parameter	Range of representative values(1)
Pulse peak power (kW)	0.5-5
Maximum transmitter average power (W)	50-500
Duty cycle (%)	0.5-10
Pulse repetition frequency (kHz)	1-50
Main beam antenna gain (dBi)	25-32
Beamwidth (degrees)	4-12
Tilt angle (degrees)	12-25
Antenna size (m^2)	3-15
Height range(2) (km)	0.05-3
Height resolution (m)	50-500

(1) Users of this table should exercise caution in using combinations of these values to represent a “typical” or “worst” case profiler. For example, a profiler operating with an average power of 500 W while using short pulses to yield a height resolution of 50 m would be an unusual system.

(2) The maximum operating height for a given range resolution depends upon the product: (mean power) × (antenna gain).

3 Minimum requirements on system performance

3.1 Emission bandwidth

TABLE 2

Pulse width (μs)	Necessary bandwidth (MHz)	Occupied/necessary bandwidth ratio
0.3-3	7.3-0.7	≤ 2.5(1)

(1) Values down to 1.5 MHz can be obtained at the expense of higher cost and somewhat inferior performance resulting from pulse shaping. The limit applies to the power and pulse width combination producing the highest power density in the signal sidebands.

3.2 Spurious emissions

Spurious emission levels should be measured at antenna input using the bandwidth values given below:

IF bandwidth ≤ $1/T$ for fixed-frequency, non-phase-coded pulsed radars, where T = pulse length. (E.g. if radar pulse length is 1 μs, then the measurement IF bandwidth should be ≤ 1/1 μs = 1 MHz)

≤ $1/t$ for fixed-frequency, phase-coded pulsed radars, where t = phase-chip length. (E.g. if radar transmits 26 μs pulses, each pulse consisting of 13 phase coded chips that are 2 μs in length, then the measurement IF bandwidth should be ≤ 1/2 μs = 500 kHz)

Video bandwidth ≥ Measurement system IF bandwidth

Suppression of spurious emission: > 55 dB.

3.3 Antenna side-lobe suppression for specified angles above the horizon

TABLE 3

Angle above the horizon (degrees)	Antenna side-lobe suppression (dB)	
	Median	Minimum
0-5	40	28
5-45	25	18
> 45	20	13

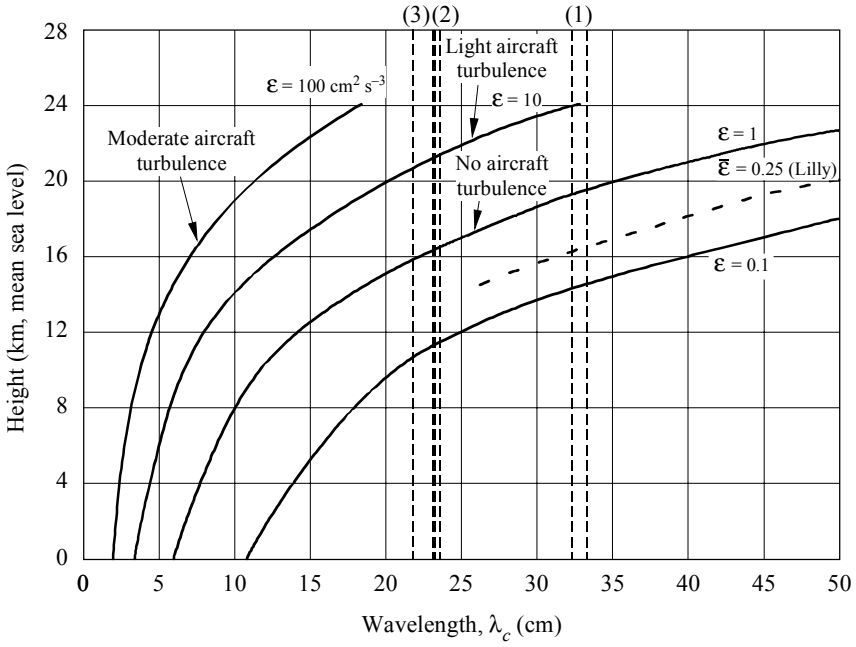
ANNEX 2

Frequency dependence of performance of a WPR

Frequency dependence of performance of a WPR is shown in Fig. 1 (see Fig. 12-2 in page 235 of "Radar Observation of Clear Air and Clouds", E. E. Gossard and R. G. Strauch, Elsevier, 1983).

FIGURE 1

Frequency dependence of performance of a WPR



Δ Lilly *et al.*

$\bar{\varepsilon}$ = 0.25 for North America
(14-21 km)

o Trout and Panolsky

Moderate aircraft turbulence	$\varepsilon = 85$
Light aircraft turbulence	$\varepsilon = 30$
No aircraft turbulence	$\varepsilon = 1.5$

(1) Wavelength for 904-928 MHz: 32.3-33.2 cm
(2) Wavelength for 1 270-1 295 MHz: 23.2-23.6 cm
(3) Wavelength for 1 300-1 375 MHz: 21.2-23.1 cm

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