METHODOLOGY FOR MEASURING INTERMODULATION PRODUCTS OF TYPE "A1", OCCURRING DURING THE OPERATION OF CLOSELY SITUATED VHF-FM RADIO BROADCASTING STATIONS

(in conformity with item 2.5 of Appendix 1 to the Technical Requirements for Operation of Electronic Communications Networks of the Broadcasting Service and the Related Equipment)

Section I

General Information

1.1. This methodology concerns the measurement of suppression of intermodulation products (IMP) type "A1", occurring in result of infiltration of signal from one UHF-FM transmitter in the output signal of other transmitters and vice versa when more than one transmitters operate from one site or in close vicinity.
IMP are new frequency components resulting from the interaction in a nonlinear element of two or more main frequency components, forming a linear combination of the main frequencies and their harmonic frequencies.

1.2. The methodology defines the obligatory operations which guarantee reliable results of measurements and screening control of the electromagnetic compatibility of the VHF-FM broadcasting service and the aeronautical radio service.

1.3. Two protocols must be drawn pursuant to this Methodology: "Protocol of findings" concerning the on-site situation before making the measurements for "A1" IMP and "Protocol of measurements of "A1" IMP".

1.4. The Communications Regulation Commission (CRC), taking into account:
- Its authority stipulated in Section 32, item 4 and item 7 of the Electronic Communications Act;

- That the VHF-FM broadcasting stations operating in the range 87.5 – 108.0 MHz and located on one and the same site can be the source of unwanted emissions created by the mutual intermodulation products which, on their part, can be a serious threat for the radio facilities of the aeronautical service in the range 108.0 - 128.5 MHz.

- The need to guarantee protection of the radio facilities of the aeronautical service from unwanted products of the intermodulation type and ensuring control of the electromagnetic environment; on the basis of the following documents:

- Rec. ITU-R SM.1009-9 and LEGBAC group – BAC01; BAC04; BAC12; BAC13; BAC24; BAC32; BAC33; BAC34;
- ITU-R REC. 1446 – Measuring of intermodulation products
- BD SETS 300384: VHF-FM broadcasting radio transmitters
- ITU-R REC. SM 329-6; ECC/ERC REC. 74-01: Spurious emissions
- EBU ETR 132; „Radio transmitting centers. Engineering methods."
- Software product of ITU-R and ICAO – „LEGBAC"

and the meaning of the text: (ITU-R REC.SM1009-9, Annex 2 (GAM) т.3.2.4) – 'In the cases where the suppression of "A1" IMP of a broadcasting transmitter is known, the same value should be applied in calculating the compatibility", drafted and approved this Methodology.

1.5. This Methodology is meant to serve as manual for practical measuring of "A1" IMP in real operation conditions. Further, the Methodology aims at avoiding errors by standardizing the conditions during measuring and also to guarantee objectivity, repeatability and comparability of measured results , as well as to serve as an instrument for practical verification of hypotheses and methods for calculation of the suppression of intermodulation products and for monitoring checks during operation with respect to conformity with ITU-R, REC.SM1009-9.

1.6. Two approaches for use of the measurement results are applicable:

- The measured values of suppression of "A1" IMP (see column 9 in Table 1 herein) are used instead of the values in Table 1 of REC. SM1009-9 in calculating the electromagnetic compatibility according to item 3.2.4, Annex 2 of REC.SM1009-9.
- The measured values are compared to the suppression values calculated by use of the software products LEGBAC or AIRNAV for possible IMP during the study of the electromagnetic compatibility (EMC) with the aeronautical radio service, in which case the EMC is satisfactory if the measured value of suppression is higher that the calculated value for the respective IMP.

The method of measuring "A1" IMP is independent of the selected approach for use of the results.

1.7. This Methodology is used for measuring of intermodulation products of the "A1" type, category three – with two and three signals, i.e. products resulting from the interaction of the main frequencies (signals) of two or three VHF-FM transmitters. Subject of the study are only products above 108.0 MHz as only such products fall in the endangered frequency band (108.0 - 128.5 MHz), allocated for the aeronautical radio service (radio navigation and radio communication):
$2f_1 - f_2$ two-signal IMP; $f_1 > f_2$ $f_1 + f_2 - f_3$ three-signal IMP; $f_1 > f_2 > f_3$

Section II

Procedure and conditions for performing a measurement

The measurement of the level of "A1" IMP shall be performed after the output point of the combining device (filter-multiplexer) and before the feeder and the antenna system. The following measuring setting is used (fig. 1):

Fig. 1

For directive coupler: In – input, Out – output, F – output of direct wave, R – output of back wave.

The diagram shows three transmitters, but this number can be different (n=2 or n=3), depending on whether the measuring involves two-signal or three signal "A1" IMP and possibly other transmitters connected to the same filter-multiplexer (combiner) which are not part of the measured product and may be left out of consideration. In addition, some products can result from the interaction of, for example, of two or three radio transmission stations operating on two or three different combiners. In this case the measurement of one "A1" IMP should be performed in succession at the outputs of the two or three combiners, and the number of transmitters in a combiner will be (n=1 or n=2).
The suppression related to each of the transmitter signals, involved in the creation of the "A1" product (partial suppression) is defined as a correlation:

$A_{ni} = 10 \ln\{ P_n / („A1” \text{ IMP})_i \}$ A_{ni} [dB]; P_n , „A1” IMP [W], (1)

A_{ni} – partial suppression of the "n" transmitter (n = 1, 2 or 3) in relation to the "i" "A1" IMP, where "i" means the position "i" "A1" IMP (i of l to k) measured in the "m" combiner (m = 1, 2 or 3) and correlated to the power of the "n" transmitter.

The measuring process requires use of directive couplers, selective band filters and spectral analyzer (or selective microvolt meter), instrument for measuring the output power and equivalent loads as per the specification given in the end of this Methodology. The parameters of non-standard equipment (filters and directive couplers) are measured with use of circuit analyzer. The parameters of non-standard equipment should be in conformity with the

specific requirements for the particular case as defined in the description of each procedure and as described in the appendices for non-standard measuring instruments and non-standard equipment (7.1; 7.2).

The directional coupler diverts a proportional part (with precisely known factor 26-40 dB) of the energy output from the transmitter to the antenna and additionally suppresses with 30 to 40 dB the input energy from external sources from the antenna to the transmitter – for example from a VOR transmitter, to increase the precision of operation (direction of the directional coupler). The latter should have outputs for direct and back wave.

The band filter should be adjusted on the frequency of "A1" IMP (defined by the software as incompatible) which corresponds to the frequency of the respective VOR, ILS or COM channel being the object of measurement /$(2f_1 - f2)$ or $(f_1 + f_2 - f_3)$/. The filter suppresses the main emission of the transmitters to achieve the dynamics needed for measurement, which should be more than 100 dB. The attenuator serves to protect the input of the spectral analyzer from receiving a high level of signals which may cause damage to the input or create IMP from the input stage of the spectrum analyzer itself.

The suppression of "A1" IMP is calculated by adding to the relative difference between the levels of a radio transmitter and an "A1" IMP, shown on the screen of the spectral analyzer, the correction factors of attenuation from the filter and directional coupler A for the operative frequencies of the respective transmitters.

The spectral analyzer may be replaced by a selective microvolt meter capable of functioning as spectral analyzer.

The following procedure should be applied:
The "A1" IMP are calculated by use of software (LEGBAC; AIRWAV) for EMC between VHF-FM radio transmitters and the aeronautical radio service and then only the products which exceed the admissible levels are selected.

The minimum value of suppression of "A1" product shall be determined, necessary for each transmitter involved in the creation of the product exceeding the admissible levels:

$$A_{Ln} = A_{T1n} + A_{Mn} \quad (2)$$

A_{Ln} – minimum suppression value (Limit) [dB]
A_{T1n} – suppression value in relation to the maximum E.R.P. according to Table 1 of REC. IS 1009-9 [dB]
A_{Mn} – insufficient suppression (margin), calculated with the software [dB]
Note: All values are relevant for the "n" transmitter.

The next step is adjustment and calibration of the elements (see Section 3) of the setting (Fig. 1) for a particular "A1" IMP and then the result is recorded. The correction factors of the filter and directional coupler are added to the recorded result reading. The final result for the measured suppression should be higher than the one calculated by formula 2.

The measurements should be performed separately for each product and the adjustment and calibration operations should be repeated for each product, because the process is frequency dependent.

Section III

Preparations for measuring

3.1. Calculations are performed by use of LEGBAC or AIRNAV software to determine the radio transmitters which are incompatible with respect to "A1" IMP. Further measurements are performed only for those products or any part of them in order to minimize the period until shut down of the transmitters. The results must be printed out and attached to the protocol of measuring the "A1" IMP.

3.2. This is followed by an administrative procedure for coordination with the undertakings with respect to the scheme of shutting down of their transmitters, as well as with the Air Traffic Control service with respect to shutting down of technical operations facilities of the aeronautical administration, should this be necessary.

3.3. The technical specifications (or the updated database, used for calculation with LEGBAC) serve as basis for definition of the output power of each radio transmitting station in conformity with E.R.P., which has been subjected to calculation by use of the software and has shown incompatibility with respect to "A1" IMP. Such data must be recorded in the Protocol of Findings.

3.4. Prior to performing the measuring procedure, a check and record must be made of inputs and outputs of the combiners (filter-multiplexes) connected to each radio transmitter and the antennas connected to each combiner. The connections should be compatible with the database for the site used for calculations with LEGBAC. These connections must be recorded in the Protocol of Findings.

3.5. Connect the setting shown in Fig. 1. It is recommended to connect simultaneously as many settings as the intended filter-multiplexers (combiners) for measuring for incompatible "A1" IMP. To measure the output power of each radio transmitter, it is necessary to have directional couplers installed between the output port of each transmitter and the respective input port of the filter-multiplexer /combiner/ (directional couplers 1,2,3 – fig. 1). It is possible, if there are not enough directional couplers and filters, the setting in Fig. 1 to be moved from one filter-multiplexer to another, which should be recorded in the protocol.

The spectral analyzer maybe replaced by a selective microvolt meter with capacity of a spectral analyzer in conformity with the user manual for the instrument. In this case, the measuring is for absolute values and the suppression is represented by the relation between the values of "A1" IMP and the signal of the respective transmitter.

3.6. After the measurement output F of each directional coupler connected to the measuring set up a semiconductor power limiter (Limiter) for 20-100 mW (not shown in Fig.1) is connected, followed by an attenuator 10dB/2W for ensuring a safe level of the signal to the measuring equipment.

3.7. Using a suitable power measuring instrument, measure the output power of each radio transmitter involved in the creation of the measured "A1" IMP. The measuring is effected by use of a directional coupler connected between the output of each transmitter and the respective input of the filter-multiplexer (taps 1, 2, 3 – Fig. 1) or by separation of the transmitter from the filter-multiplexer and redirecting it to an equivalent load for the required scattered power. The respective output powers should conform to the powers shown in item 3.3. All non-conformities shall be recorded in a separate protocol of findings and, before measuring the "A1" IMP, the output power is established in conformity with item 3.3 and recorded in the protocols.

3.8. Follows a measuring for presence of on-air signal received by the antenna with the frequency of the measured VOR, ILS or COM. Connect the setting shown in Fig. 1 and all transmitters operating through the respective filter-multiplexer, including those not involved in the "A1" IMP, are replaced by equivalent loads of 50 Ω for power exceeding 1/1000 of the combined power of all radio transmitters operating on the site. The spectrogram of received signals is to be studied by performance of two measurements – one at the output for direct wave and a second at the output for back wave from the directional coupler. A record is made for the measurements showing higher values (direct wave for signals coming from the antenna – output R). A record is made also of the attenuator fading and the readings of the spectral analyzer screen. The measurement is done in the range 87.5 - 128.5 MHz. The results for all products found are recorded and attached to the protocol of "A1" IMP measurements.

3.9. When the measurement stipulated in item 3.8 establishes presence of signal on the VOR, ILS or COM frequency, a further investigation should be performed with respect to the parameters of this signal at the output F of the directional coupler in real operation conditions.

Connect the setting shown in Fig. 1 and, while at least one of the transmitters producing the measured intermodulation products is shut down, the readings are taken of the reviewed signal level of "A1" IMP resulting from reception of the emission of the respective VOR, ILS or COM through the antenna, which may corrupt the measurement result. In this case, during measuring of "A1" IMP (section IV, item 4.7) the respective VOR, ILS or COM should be shut down for the period of examination or, if this is not possible, the readings should be considered as a sum of incoherent signals (see item 4.7). If all transmitters, forming an intermodulation product, are connected

to a single filter-multiplexer and there is penetration of external signal with the frequency of IMP, the measurement required in item 4.7 can be done with equivalent antenna replacing the antenna shown in fig. 1.

The measurements are done in the range 108.0 - 128.5 MHz. The values of the level of penetrating air signal with frequency of IMP are to be recorded, printed and attached to the protocol of measuring of “A1” IMP.

3.10. In order to discover undesirable penetrations in the measuring setting as per fig. 1 of electromagnetic fields in the room where the setting is located, the following measurements should be performed:

Make the setting as shown in fig. 1. The measurement is done in the range 108.0 - 128.5 MHz. The cable to the band filter is disconnected (separated) from the output of the directional coupler (fig. 1) by unscrewing the connector. The cable section connecting the directional coupler and the selective filter remains connected to the filter and its blank end is loaded with equivalent load of 50 Ω. The information on the screen of the spectral analyzer must be recorded and possible presence of undesirable penetration is to be checked. If such penetrations are discovered, they should be recorded in the protocol and taken into account during the measuring procedure. The results must be recorded, printed out and attached to the protocol of measuring the “A1” IMP.

3.11. Determine the correction factors of the band filters: The role of selective filter as per fig. 1 is played by a double-circuit band penetrable filter with high quality factor for circuits – over 500, and inter-circuit connection factor κ=0,7-1.
The loss in the penetration band should not exceed 1 dB.
The fading of frequencies +/- 1,5 MHz (in relation to the adjusted frequency) should be higher than 20 dB, and for frequencies +/-2 MHz—higher than 25 dB.

The operating power of the filter should be more than 1W. It is possible to use a filter for higher output.

The measurements are done in the range 87.5 - 128.5 MHz.

The parameters of the band filter must be taken down for measuring the correction factors for the operational frequencies of radio transmitters creating “A1” IMP. The filter is to be adjusted to the frequency of the "A1" IMP. The adjusted band filter is to be connected to the circuit analyzer and measurements of S11, S12, S21, S22 are taken. The results are recorded and printed. The amplitude/frequency parameters (AFP) serve for definition of the correction factors of the filter for each frequency involved in the measurement.

The measurement can also be done by use of a tracking generator and spectral analyzer. In this case the filter is connected between the tracking generator and the input of the spectral analyzer. The AFP is measured and recorded in accordance with the manual for use of the range analyzer. Using the AFP, the difference between the fading of the “A1” IMP frequency and the frequency of each radio transmitter forming “A1” IMP is recorded. These values are used in further alterations as correction factors of the selective filter for the level of the main signal of each transmitter and the undesirable “A1” IMP.

The results, showing the correction factors for each frequency, should be recorded in column 7 of the protocol – Fig. 3. Note: If the band filters are accompanied by manufacturer’s specifications allowing calculation of relevant factors, measurements are not necessary.

3.12. Determine the correction factors of the directional couplers:

The A directional coupler is to be selected for operational power equal to the sum of the powers of all transmitters connected to a particular filter-multiplexer, plus a reserve of at least 50%, in order to avoid possible damage to filters and the spectral analyzer due to transfer of energy from high SWR in the main tract or to discharge in the directional coupler. The factors of transmission, direction, SWR and AFP of the directional coupler for each output, related to the main tract, are defined by use of circuit analyzer (S11, S12, S21, S22) and the correction factors for each concerned frequency are recorded. The parameters of transmission and AFP of the directional coupler may also be taken down by use of tracking generator and spectral analyzer in accordance with their operation manuals.

The frequency of “A1” IMP is selected as a basis. A record is made of the correction factors (differences) for the frequencies of transmitters forming “A1” IMP, compared to the basis frequency, and the latter are to be entered in column 6 of the protocol for measuring “A1” IMP shown in Fig. 3.

The directional couplers 1, 2, 3 are selected for power corresponding to the power of the transmitter to which they are connected. The correction factors are taken in the same way as for directional coupler A.

Note: If the directional couplers are accompanied by manufacturer’s specifications allowing calculation of relevant factors, measurements are not necessary.

3.13. A check is to be performed to test the intermodulation resistance of the spectral analyzer:

Disconnect the attenuator at the spectral analyzer input. Using two signal generators and band filters set to the respective operational frequencies, feed equal amplitude signals to the input port of the spectral analyzer through a passive summator with input difference of minimum 26 dB and level of the spectral analyzer -10 dBm and frequencies 100 MHz и 105 MHz. Measure the intrinsic IMP in the range between 95 MHz and 110 MHz, which should be lower than 66 dBc. Further measuring should involve control of the level of signals at the output port of the spectral analyzer for the principal frequencies where this level should not be higher than -10 dBm. The results must be recorded, printed out and attached to the protocol of measuring the “A1” IMP.

Section IV

Measuring of “A1” IMP and the suppression level

The measuring is performed with switched off modulation of all radio transmitters involved in the measured product. If the “A1” IMP level is lower than the noise and can not be defined, the ratio "carrier signal / noise" is recorded.

4.1. Measuring is performed for each “A1” IMP for which the examination with LEGBEC (AIRNAV) software has indicated a level of the product which is higher that the admissible and can potentially cause incompatibility.

A separate measuring is admissible for only one or several "A1" IMP. For measuring any further "A1" IMP, the procedure described in 3.9, 3.11, 3.12 must be repeated.

4.2. The spectral analyzer, the directional coupler and the band filter are connected as shown in the diagram in Fig. 1.

The spectral analyzer must be adjusted so that its screen would allow viewing the frequencies of the radio transmitters which form the “A1” IMP and the frequency of the “A1” IMP itself in the band above 108.0 MHz. The attenuator at the input of the spectral analyzer (and any additional attenuators if needed) should be adjusted so that the instrument is not overloaded by the level of signals from the radio transmitters (level – 10 dBm) but not less, in order to achieve the maximum possible dynamic range (with the defined fading) to ensure the possibility of reading on the screen the expected "A1" IMP together with the signal of the transmitter, i.e. dynamics not less than 100 dBc (including the suppression of intermodulating transmitters' carrier frequencies in the selective band filter).

4.3. The resolution bandwidth (RBW) of the spectral analyzer should be set to 100 kHz. (To increase sensitivity, 10 kHz or 1 kHz are allowed with switched off modulation of transmitters).

4.4. The frequency of the tested signal should correspond to the adjustment of the spectral analyzer +/- 1 kHz and the modulated signal should not digress from the bandwidth (RBW).

4.5. Calibrate the spectral analyzer in accordance with the instrument’s user manual.

4.6. Mark the frequencies to be measured – of the two or three transmitters creating “A1” IMP and the product itself in the band above 108.0 MHz.

4.7. The screen of the spectral analyzer shows the signals of interfering transmitters and the "A1" IMP in the band above 108.0 MHz. Measurements are to be taken of the difference between the signal level within the frequency of each transmitter which produces "A1" IMP and the level at the frequency of the "A1" IMP – [dBc].

Following the formula (1) the partial suppressions are found for each transmitter creating a "A1" IMP. The results, after adding the fading in the band filter D_{lf}, are to be recorded in column 8 of the protocol – fig. 3.

The results at points 3.8 and 3.9 should be taken into account in the measuring of each "A1" IMP if there is external signal from the measured VOR. If the VOR can not be switched off, using the measured level of signal at point 3.9 - $V_{3.9}$ and the signal level measured with all transmitters working and creating the product measured at 4.7 - $V_{4.7}$, the level in question is calculated by the following formula:

$V_{A1} = \sqrt{(V_{(4.7)})^2 - (V_{(3.9)})^2}$ (3) or
$P_{A1} = (P_{(4.7)}) - (P_{(3.9)})$ (3.1)
depending on the method of measuring, where P_{A1}; $(P_{(4.7)})$; $(P_{(3.9)})$ are the required and actually measured output powers at the respective points.

Note: When only a quality check is needed for presence of "A1" IMP products weaker than the sensitivity level of the spectral analyzer, a communication receiver with optimized sensitivity for the range 108.0 - 128.5 MHz is to be used.

For this purpose, the communication receiver must conform with the following requirements:

- to have four-circuit band filter at the input;
- to have a frequency synthesizer for the heterodyne which does not create unwanted frequencies in the range 108.0 - 128.5 MHz and allows adjustment at intervals of 1 kHz;
- in order to avoid unwanted mirror signals, the first intermediate frequency should be higher than 140 MHz;
- to have a switchable band by intermediate frequency – 1 kHz; 10 kHz; 100 kHz;
- detectors – AM and FM broad band; narrow band and DC output of the detectors; mean quadratic output (by power); S-meter (RSSI).
- input sensitivity – higher than -120 dBm/10kHz, 12 dB SINAD, corresponding to 0.224 μV over 50 Ω; and sensitivity higher than dBm/ 300 kHz; 26 dB S/N for FM;
- unsteady sensitivity within the range 108-128.5 MHz – less than 1 dB;
- the detector's output should be controlled by an indicator with linear scale and speakerphone;
- the receiver must have a RSSI indicator with logarithmic-linear scale with range of minimum 90 dB and permissible error within the entire range less than 3 dB.

Such a check should be performed always during control of interference of communication signals (COM) when interference of IMP has been found. The RSSI indicator of the receiver may be used for low precision measurement of a product, instead of using a microvolt meter.

4.8. The radio transmitters, which create "A1" IMP, may be connected to only one filter-multiplexer (combiner) or to different filter-multiplexers. In the case when one "A1" IMP is produced by transmitters connected to different filter-multiplexers, the directional coupler A should be repositioned (when only one directional coupler A is used) at the output of every following filter-multiplexer and the procedure remains the same until all radio transmitters creating IMP are measured – (2 or 3). The setting may be arranged by use of two or three A directional couplers, connected respectively to the filter-multiplexers concerned.

4.9. Measurements are made for the distance (suppression) between the signal levels of a transmitter and the resulting "A1" IMP. If a product is not readable, the noise level on its frequency is to be recorded.

4.10. The value of suppression is added to the value of fading in the filter from column 2 for the frequency of the “A1” IMP and the sum is recorded in column 8.

4.11. For the purpose of defining the actual suppression between “A1” IMP and the carrier frequency, the value in column 8 is summed with the correction factors of the respective directional coupler - column 6, and the selective band filter - column 7. This sum is to be recorded into column 9 of the protocol of measuring an “A1” IMP.

4.12. The result in column 9 - is used for calculation of compatibility by use of the formulas in item 3.2.4, Annex 2 (GAM) of REC.SM1009-9 instead of the values in Table 1;
or
- for comparison with the respective value of the calculated required suppression of “A1” IMP which would ensure absence of interference with the respective aeronautical radio service (VOR, ILS, COM). These values (margin) are recorded in a special graph reflecting the evaluation of EMC to the aeronautical radio service with AIRNAV software, and only the highest suppression value is input in the LEGBAC software, and this value should be lower than the reading in column 9 of Table 2 in order to ensure EMC with the aeronautical service.

Section V

Content of the protocols

5.1. Protocol of findings
Requisite information:

- Transmitters on the site;
- Frequencies of the transmitters;
- Power of transmitters – output and E.R.P.;
- Filters and filter-multiplexers with inputs and outputs, and transmitters connected to each input.
- Antennas and connections to filters and filter-multiplexers;
- Table 1 with the results as per the form shown in Fig. 2

Table 1 for Site “…….”

Radio station name	Transmission frequency	Power / E.R.P.	Filter-multiplexer	Input No.	Antenna	Inconformities

Fig. 2

5.2. Protocol of measuring "A1” IMP
Requisite information:

- Calculations made with EMC software - LEGBAC, AIRNAV, including output power of transmitters and E.R.P. – the data used for the calculation must conform to the actual state and database;
- Electromagnetic environment of the site;
- signals received by the antennas on the site on the measured frequencies (item 3.8);
- electromagnetic influence of internal electromagnetic fields (item 3.9);

- Parameters of the transmitters creating a product - frequency, power (output and E.R.P.), antenna, filter-multiplexer and connection input;
- Information about the preparations covered by Section III;
- Table 2 with the results as per the form shown in Fig. 3;
- Appendices:
- Analytical results from the EMC examination of the site by LEGBAC, AIRNAV;
- Protocol of findings in accordance with item 5.1;
- Measuring equipment setting;
- Spectral diagrams established by measuring of the electromagnetic environment;
- Measured parameters of the band filters for each f;
- Measured parameters of the directional couplers;
- Spectral diagrams of the measured "A1" IMP

Table 2 for Site "……."

IMP f [MHz]	[dB]		Multi	TX (2or3) Frequency/	Correction of	Correction of band	Suppression of "A1" IMP	
	$D_{l.f.}$ =	Antenna	plexer type	Power	directional coupler "A" to f_{imp} [dB]	filter to f_{imp} [dB]	Value measured [dB] + $D_{l.f.}$	Actual value [dB] (6+7+8)
1	2	3	4	5	6	7	8	9
				f_1 MHz/P kW				
				f_2 MHz/PkW				
				f_3 MHz/PkW				
				f_1 MHz/P kW				
				f_2 MHz/PkW				
				f_3 MHz/PkW				
				f_1MHz/P kW				
				f_2 MHz/PkW				
				f_3 MHz/PkW				
				f_1 MHz/P kW				
				f_2 MHz/PkW				
				f_3 MHz/PkW				

Note: In the case of two-signal product, the cells are shown in two rows, and with three-signal product – in three rows (as shown in the table). All measured values are considered as positive when fading (suppression) related to the product basic frequency is concerned (fig. 3).

Note: The preliminary assessment covered by Section III, item 3.11, item 3.12 and item 3.13 may be performed in laboratory environment before the on-site measuring if ready filters are available for each studied frequency and on-site adjustment is not necessary.

Such measurements are not necessary if manufacturer's specifications with relevant information are available.

Section VI

Terms, definitions and abbreviations

For the purposes of this Methodology:

- “intermodulation product (IMP)” is the result of non-linear interaction of signals from two or three VHF-FM radio transmitters;
- “A1” IMP is a type “A1” product according to the definition by ITU-R, i.e. a product, resulting from the mutual penetration in the outputs of transmitters of output power from other closely located transmitters, which is transmitted by the radio transmitters antennas;

- “ Measurement dynamics” is the correlation between the level of the signal from an intermodulating transmitter and the level of the “A1” IMP. Dynamics higher than 100 dB should be ensured for the purpose of this measurement.

- “Filter-multiplexer” is a combining device with n-inputs (with band-admitting feature and maximum one frequency independent input) and a common output. Radio transmitters are connected to the input ports, and the output port is connected to the antenna. Filter-multiplexers can be two types – “summators with directional couplers” and “star center summators”. The summators (combiners) with directional couplers have one broadband input port to which a radio transmitter can be connected only through an additional band filter;

- E.R.P. – effective radiated power;

- Resolution Bandwidth (RBW) – the frequency band in which the spectral analyzer measures the products;

- RSSI – indicator of the received signal strength in a receiver;

$D_{l.f.}$ – suppression of the band-pass filter in the passband;

- “Correction” (correction factors) – the suppression in dB made by the band-pass filter and the directional coupler to signals with the frequency of the examined transmitters compared to the frequency of the examined product.

Section VII

Required measuring instruments and non-standard equipment:

7.1. Measuring instruments:

1. Spectral analyzer and tracking generator for frequencies up to at least 240 MHz;

2. Power measuring instrument for frequencies of at least 240 MHz. (Maximum power according to the measurement specification and method of measuring); Precision up to 3%.

3. Selective microvolt meter (instead of spectral analyzer);

4. Network analyzer for frequencies of at least 240 MHz;

5. Signal generator for frequencies at least 240 MHz, output level 0 dBm (as per item 3.5) – 2 units;

6. Passive broadband summator (combiner) – 2 inputs, 1 output / 0.5W (as per item 3.5);

7. Directional coupler for forward and reverse travelling wave - 50 Ω; 87.5 - 128.5 MHz; 20 κW; transmission factor - 40 dB, directivity better than 30 dB. (Only in cases when a transmitter with such power is to be measured);

8. Directional coupler for forward and reverse travelling wave - 50 Ω; 87.5 - 128.5 MHz; 3 κW; transmission factor - 30 dB, directivity better than 30 dB. (Only in cases when a transmitter with such power is to be measured);

9. Directional coupler for forward and reverse travelling wave - 50 Ω; 87.5 - 128.5 MHz; 1 κW; transmission factor - 26 dB, directivity better than 30 dB;

10. Directional couplers 1,2,3 for forward and reverse travelling wave (depending on the transmitter power) - 50 Ω; 87.5 - 128.5 MHz; transmission factor - 26 dB, directivity better than 30 dB;

11. Attenuators - 10dB, 20dB/2W; adjustable attenuator 20dB/2W; SWF < 1.05 for frequencies not lower than 128.5 MHz;

12. Equivalent loads 50 Ω/2 W; 50 Ω/10 W; SWF < 1.05 for frequencies not lower than 128.5 MHz;

13. Equivalent antenna 50 Ω with respective output – 100W - 10 kW (as required) SWR < 1.05 for frequencies not lower than 128.5 MHz;

7.2. Non-standard equipment:

1. Selective band-pass filter – adjustable between 87.5 - 108.0 MHz, for output power 0.5 - 1,0 W as per item 3.12. - 1 unit; double circuit, critical connection; Q > 200; bandwidth of the passband at level -3 dB less than 500 kHz, selectivity better than – 26 dB at +/- 2MHz from the carrier frequency.

2. Double circuit band-pass filters for frequencies 100 MHz and 105 MHz, bandwidth of the passband at -3dB less than 500 kHz, for power up to 100 mW (as per item 3.5). Selectivity higher than -26 dB at +/- 2 MHz from the carrier frequency;

3. Communication receiver – 108.0 – 128.5 MHz (if required).

7.3. Notes:

1. The number of directive couplers, attenuators and loads is determined in accordance with the particular specification of measuring and should be considered carefully while planning the operation. The power of directive couplers and the equivalent antenna depends on the power of transmitters at the measured site. The need of equivalent antenna should be considered during planning the measuring.

2. Pursuant to the ‘Technical Requirements for Operation of Electronic Communications Networks by the Broadcasting Service and Any Related Facilities' all VHF-FM stations should be equipped with directive couplers and filters/filter-multiplexers as per Fig. 1.