Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

COMPATIBILITY BETWEEN NARROWBAND DIGITAL PMR/PAMR AND TACTICAL RADIO RELAY IN THE 900 MHz BAND

Cavtat, May 2003

EXECUTIVE SUMMARY

This report considers sharing between digital PMR/PAMR and tactical radio relay links (TRR) in the 870-876 / 915-921 MHz band.

Specifically this report sets out:

1) to define the necessary geographical separation if systems operate in different areas (e.g. TRR operating in rural areas and Digital PMR/PAMR in urban);
2) to define the figure of necessary frequency separation if systems would operate in the same geographical area.

This Report focusses on PMR/PAMR digital narrowband systems (e.g. TETRA and TETRAPOL). Studies related to wider band Digital PMR/PAMR systems (200 kHz and above) will be presented in another Report.

The sharing possibilities have been studied within a set of selected scenarios (detailed in Section 3.2), obviously these do not constitute an exhaustive list of scenarios covering potential use in all countries.

The two methods used in this study are complementary to each other:

- The MCL method provides the necessary attenuation required between the systems to enable interference free operation under specified condition.
- The SEAMCAT method calculates the probability of interference, which gives the extent of the problem. This has been expanded in two ways :
    - ➢ The Two-Step Approach calculates the probability of interference and investigates the necessary separation in distance or frequency between the two systems for the cases where interference occurs.
    - ➢ The application of SEAMCAT to geographically separated areas in order to reflect some operational scenarios.

For the scenarios investigated there is a good degree of correlation between the results of the different methods applied.

The MCL method indicates that for the scenarios investigated the potential of interference exists at very large distances when the frequency used is shared and no mitigation techniques are applied.
However, the need for very large separation distances would severely limit the required mobility of both systems.

From the results of MCL and two-step approach, it can be seen that for the situation with systems within the same geographical area, a frequency separation in the order of 2 MHz between the centre frequencies will be required. The main reason for this frequency separation is the 1.5 MHz receiver bandwidth of the TRR.

From the extension of SEAMCAT in the case of geographical separation it can be seen that, without any mitigation, separation distances around 150 km are required for some scenarios in order to protect the Digital PMR base stations. The use of co-ordination and mitigation techniques as described in section 7 would reduce the required minimum gap between the separated geographical service areas around 40 km for these scenarios.

In order to facilitate sharing, there are several mitigation techniques that can be applied, some of which will require some degree of co-ordination and others requiring good engineering practices. These techniques are mainly applicable where there is a geographical separation between Digital PMR/PAMR and the Tactical Radio Relay systems and are:

- Use of directional antennas for Digital PMR/PAMR base stations pointing away from known military exercise areas (see section 5.3 for the impact on scenarios 10 and 11).
- Optimise, when practicable, the alignment of the TRR antennas to minimise interference but at the same time maintain the wanted link. However, this may imply reduction of the TRR operational capabilities.
- Using the power setting of the TRR to increase the wanted link signal level in case of interference from PMR. The same limitations as above apply. However, it will also increase the interference from TRR to PMR.
- The use in the PMR/PAMR systems of quasi-synchronous and voting techniques, based on diversity, is a general means to decrease the effect of interference to PMR/PAMR.
- The use of direct contact to the PMR/PAMR operator to switch off a particular PMR/PAMR base station (This implies regulatory measures such as license requirements).

It should be noted that, since the band 870 - 871 paired with 915 - 916 MHz is foreseen as a guard band between Digital PMR/PAMR and GSM (ref ECC Report no. 5), the use of this band by TRR will minimise the effect of interference on both TRR and PMR.

If a degree of co-ordination was introduced between the operators, solutions could be found for cases where the two systems are not overlapping geographically, such as specific military exercise areas, if directional antennas are used for nearby PMR/PAMR coverage.

This study only considers situations where both systems operate continuously within the defined areas. It should be noted that the study has not taken into account any activity factor of the TRRs.

INDEX TABLE

1 INTRODUCTION 5

2 BASIC PARAMETERS FOR THE SYSTEMS UNDER CONSIDERATION 5

2.1 TRR 5
2.2 TETRA 7
2.3 TETRAPOL 8

3 APPROACH TO THE PROBLEM 9

3.1.1 Minimum Coupling Loss 9
3.1.2 Monte-Carlo and SEAMCAT 9
3.1.2.1 Standard SEAMCAT simulation 10
3.1.2.2 Two-Step approach 10
3.1.2.3 SEAMCAT extended to geographically separated operational areas 10
3.2 DEFINITION OF SCENARIOS 11
3.3 PROPAGATION MODEL 12

4 RESULTS USING MCL METHOD 12

4.1 UPPER BAND (915-921 MHZ) 12
4.2 LOWER BAND (870-876 MHZ) 13

5 RESULTS USING MONTE-CARLO METHOD (SEAMCAT) 13

5.1 RESULTS OF THE STANDARD SEAMCAT SIMULATION 13
5.2 RESULTS OF THE STUDY USING THE TWO-STEP APPROACH 14
5.2.1 Summary 14
5.2.2 Scenario 3 14
5.2.3 Scenario 7A 15
5.2.4 Scenario 15 15
5.3 RESULTS OF THE SEAMCAT STUDY EXTENDED TO GEOGRAPHICALLY SEPARATED OPERATIONAL AREAS 16

6 DISCUSSION OF THE RESULTS – COMPARISON BETWEEN THE DIFFERENT APPROACHES 17

7 MITIGATIONS TECHNIQUES 18

8 CONCLUSIONS 18

9 REFERENCES 19

ANNEX 1: RESULTS OF THE MCL STUDY 20

ANNEX 2: SEAMCAT INPUT DATA 33

ANNEX 3: STANDARD SEAMCAT SIMULATION REPORT 43

ANNEX 4 : DEFINITION OF THE TWO-STEP APPROACH 49

ANNEX 5: PRINCIPLES ON THE USE OF SEAMCAT EXTENDED TO GEOGRAPHICALLY SEPARATED OPERATIONAL AREAS 51

ANNEX 6 : RESULTS OF THE SEAMCAT STUDY EXTENDED TO GEOGRAPHICALLY SEPARATED OPERATIONAL AREAS 55

COMPATIBILITY BETWEEN NARROWBAND DIGITAL PMR/PAMR and TACTICAL RADIO RELAY IN THE 900 MHz BAND

1 INTRODUCTION

Following the results of DSI Phase 3, the need for strategic replanning of the 900 MHz band was recognised. One of the most important elements suggested is a joint use of Digital PMR and conventional Military Tactical Radio Relay Links equipment in the same band. Therefore, it is necessary to study the possibilities for sharing between Digital PMR and Military TRRL in the 870-876 MHz and 915-921 MHz bands before taking final decision on the strategic plan for the 900 MHz band.

The purpose of this Report is :

1) to define the figure of necessary geographical separation if systems would operate distantly (e.g. Military TRRL operating in rural areas and Digital PMR in urban);
2) to define the figure of necessary frequency separation if systems would operate co-located in the same area.

Concerning the digital PMR, this Report is focussing on narrowband systems (e.g. TETRA and TETRAPOL).

Studies related to wider band Digital PMR systems (e.g. 200 kHz) will be presented in an other Report.

2 BASIC PARAMETERS FOR THE SYSTEMS UNDER CONSIDERATION

2.1 TRR

TRR parameters are coming from the NATO recommendation [5], and were confirmed or completed with data from some real systems from The Netherlands and France.

TX Power	5 W
Antenna Gain	16 dBi (main lobe) ; -8 dBi (at 90° - from diagram below)
EIRP	53 dBm (= 37 dBm + 16) – consistent with 50 dBm ERP in [5]
Antenna Height	25 m (for P.1546, an effective height of 15 m will be used in the urban case, and 25 m for open areas)
Bandwidth	750 kHz
Noise Factor	7 dB
Protection Ratio	15 dB

ΔF (MHz)	0	±0.375	±1.5
Tx spectrum (dBc)	0	0	-80

Table 2.1.1 : Tactical Radio Relay transmitter spectrum

ΔF (MHz)	0	±0.750	±2	±5	±8
Rx selectivity (dB)	0	0	65	85	110

Table 2.1.2 : Tactical Radio Relay receiver selectivity

The Rx selectivity as defined in the table 2.1.2 and figure 2.1.2 has been checked against a real French TRR. The measured selectivity is also shown as the dotted curve in the figure A1.11 of Annex 1.

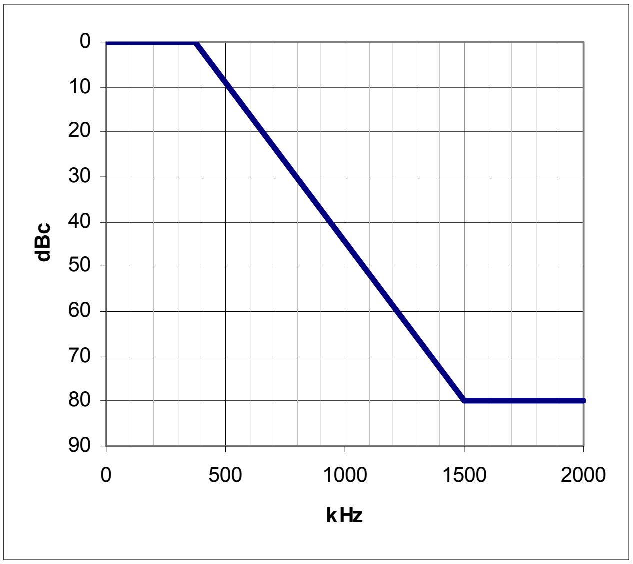


Figure 2.1.1 : TRR TX spectrum

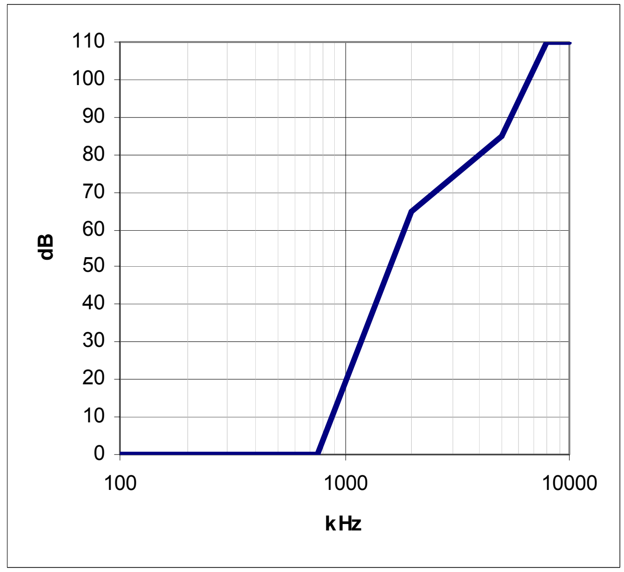


Figure 2.1.2: TRR RX selectivity

The following figure represents an antenna diagram measured on a Dutch TRR by the FEL-TNO institute:

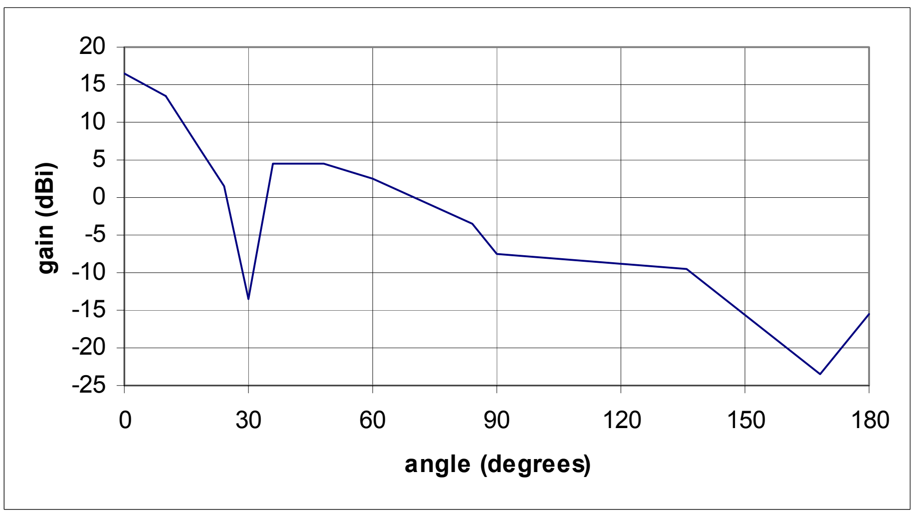


Figure 2.1.3 : Dutch TRR Antenna

In addition the TRR sensitivity was derived, using:

n = kTo.B.f   or   N = 10.Log10(kTo) + 10.Log10(B) + F

S = N + PR

with

N= noise floor of the receiver (dBm)
10.Log10(kTo) = -174 dBm/Hz
B = receiver bandwidth (Hz)
F = noise factor (dB)
S = sensitivity (dBm)
PR = protection ratio (dB)
TRR noise = -108 dBm (= -174 dBm/Hz + 59 dBHz + 7 dB)
TRR sensitivity = -93 dBm (= -108 + 15)

Note on the use of TRR Networks: Each Nation use their own tools to plan the deployment of a network. As a general rule, the links are established using the smallest power setting necessary to have a good quality link; the margin is a condition of the power settings available on the equipment, the terrain configuration, and the type of manoeuvre/operation conducted. Therefore, the margin can be any value from 0 dB to 13 dB. In the scope of this study, it seems a fair approach to consider an “average” margin of 6 dB. This margin has been implemented in the MCL study. For the Monte-Carlo simulations, the TRR is assumed to operate at its full power.

2.2 TETRA

The TETRA parameters have been discussed and agreed for the purpose of this study. Some numbers are coming from [9] but the characteristics are coming from [3].

Base EIRP	20 to 140 W (typical 40 to 100 W)
Base Antenna	20 to 100 m (typical 20 to 60 m) , 2 to 6 dBi for omni, 10 to 14 dBi for sectorised.
Mobile EIRP	0.5 W (handheld) to 40 W (van-mounted)
Mobile Antenna	omnidirectional , 1.50 m
Rx Bandwidth	18 kHz
Sensitivity	-103 dBm (MS) , -106 dBm (BS)
Protection Ratio	19 dB (BS + MS)

Type	class	power	Antenna / Effective Height for P-1546
BS High	2	25 W	6 dBi, 60m / Open=60 – urban=40
BS Low	6	5 W	6 dBi, 20m / Open=20 – urban=10
MS High	2	10 W	6 dBi, 1.5m
MS Low	3	3 W	6 dBi, 1.5m
Handheld	4	1 W	-3 dBi (body loss included), 1.5m

Table 2.2.1 : Type of TETRA stations considered in the study

ΔF (kHz)		±25	±50	±75	±(100-250)	±(250-500)	±(>500)
Transmitter spectrum (dBc)	BS High	-55	-65	-70	-80	-85	-90
	BS Low	-55	-65	-65	-74	-80	-85
	MS High + Low	-55	-65	-65	-74	-80	-85
	HandHeld	-55	-65	-65	-74	-80	-80

Table 2.2.2 : Transmitter spectrum of TETRA stations

ΔF (kHz)	±(8.5-16)	±(16-50)	±(50-100)	±(100-200)	±(200-500)	±(>500)
Rx blocking (dBm)	-90	-55	-40	-35	-30	-25
Selectivity BS (dBc)	35	70	85	90	95	100
Selectivity MS (dBc)	32	67	82	87	92	97

Table 2.2.3 : Receiver blocking and selectivity of TETRA stations

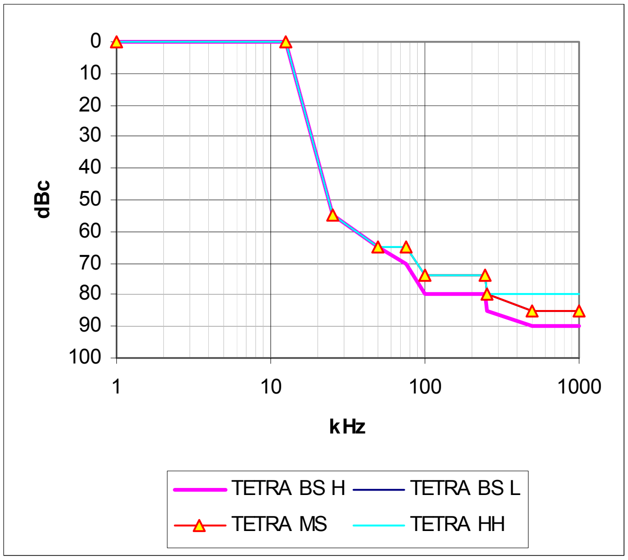


Figure 2.2.1 : TETRA TX spectrum

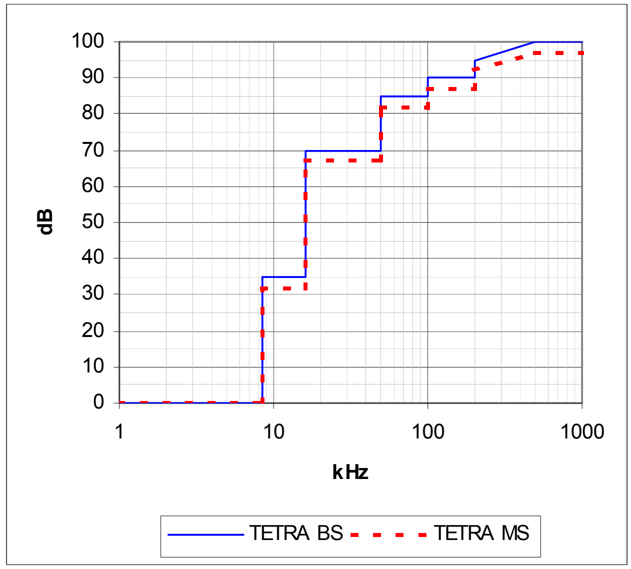


Figure 2.2.2 : TETRA RX selectivity

2.3 TETRAPOL

The TETRAPOL parameters are coming from [4] and [9].

Base EIRP	1 to 100 W
Base Antenna	omnidirectional - 20 to 100 m (typical 20 to 60m)
Mobile EIRP	1 to 10 W
Mobile Antenna	omnidirectional – 1.50 m
Rx Bandwidth	8 kHz
Sensitivity	-111 dBm (MS), -113 dBm (BS)
Protection Ratio	15 dB (BS + MS)

ΔF (kHz)	±(25-40)	±(40-100)	±(100-150)	±(150-500)	±(>500)
BS (dBc)	-70	-75	-85	-95	-105
MS (dBc)	-70	-75	-85	-90	-100

Table 2.3.1 : TETRAPOL Transmitter spectrum

channel spacing	10 kHz	12.5 kHz
1st adjacent	-36 dBc	-60 dBc
2nd adjacent	-60 dBc	-70 dBc

Table 2.3.2 : TETRAPOL Transmitter spectrum for the 2 first adjacent channels

ΔF (kHz)	±(13.5-25)	±(25-40)	±(40-100)	±(100-150)	±(150-500)	±(>500)
Rx blocking (dBm)	-65	-55	-50	-40	-35	-25
Selectivity BS (dBc)	63	73	78	88	93	103
Selectivity MS (dBc)	61	71	76	86	91	101

Table 2.3.3 : TETRAPOL receiver blocking and selectivity

Some assumptions had to be made to complement these parameters:

BS antenna	60 m, 6 dBi
BS power	25 W (giving EIRP = 44 dBm + 6 dBi = 50 dBm)
MS power	1 W and antenna = 0 dBi

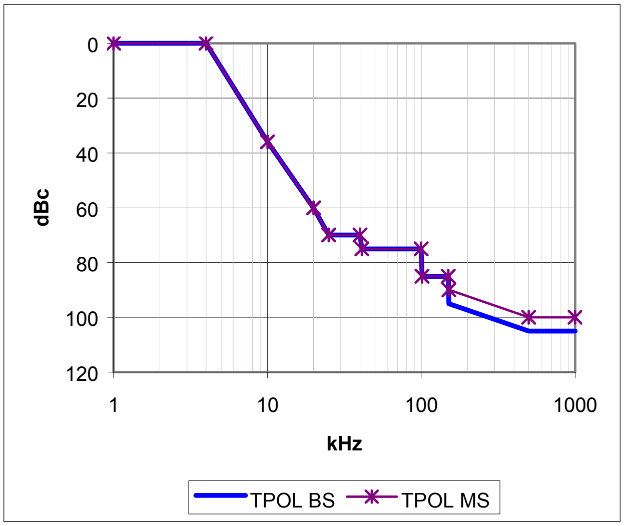


Figure 2.3.1 : TETRAPOL TX spectrum

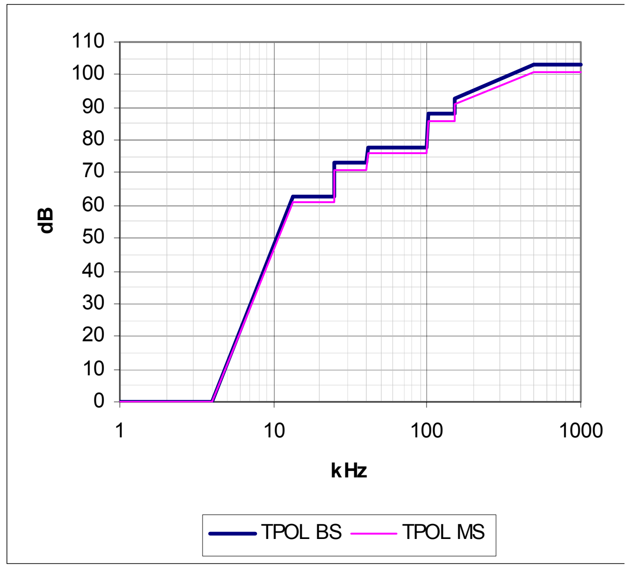


Figure 2.3.2 : TETRAPOL RX selectivity

3 APPROACH TO THE PROBLEM

Description of the Methods

3.1.1 Minimum Coupling Loss

The Minimum Coupling Loss (MCL) method calculates the isolation required between interferer and victim to ensure that there is no interference. The method is simple to use and does not require a computer for implementation.

Within the context of the study, the victim receiver is assumed to be continually operating at a minimum fixed level above reference sensitivity. Interference must be limited to maintain the victim's protection ratio. A path loss formula must be chosen to determine how much isolation can be attained through physical separation . The median path loss is used and no account has been taken of fading. There is also no statistical distribution of interferers used by the method.

Two MCL equations are used for the scenarios considered in this report. These include the interference effects of :

- unwanted emissions
- receiver blocking.

See reference [2] for more details.

3.1.2 Monte-Carlo and SEAMCAT

A Monte Carlo simulation as used in this report is a statistical technique based upon the consideration of many independent instants in time and locations in space. For each instant, or simulation trial, a scenario is built up using a number of different random variables i.e. where the interferers are with respect to the victim, how strong the victim's wanted signal strength is, which channels the victim and interferer are using etc. If a sufficient number of simulation trials are considered, then the probability of a certain event occurring can be evaluated with a high level of accuracy.

Simulations were carried out using SEAMCAT version 2 and the three following variations have been used :

- Standard SEAMCAT simulation (version 2.0),
- Two step approach (version 2.0),
- SEAMCAT extended to geographically separated operational areas (version 2.1).

3.1.2.1 Standard SEAMCAT simulation

The Monte-Carlo simulation method is based upon the principle of taking samples of random variables from their defined probability density functions (also called distributions). The user inputs distributions of possible values of the parameters, and the software uses them to extract samples (also called trial or snapshot). Then, for each trial SEAMCAT calculates the strength of the interfering and the desired signal and stores them as arrays.

The software derives the probability of interference taking into account the quality of the receiver in a known environment, and the calculated signals.

The Monte Carlo method can address virtually all radio-interference scenarios, like e.g. sharing or compatibility studies. This flexibility is achieved by the way the system parameters are defined. Each random parameter (antenna pattern, radiated power, propagation path, etc) is input as a statistical distribution function. It is therefore possible to model even very complex situations by relatively simple elementary functions.

3.1.2.2 Two-Step approach

The Two-Step approach has been used to assist with the interpretation of the probability of interference given by SEAMCAT in terms of frequency or distance separations. It has been shown in ERC Report 101 that we can obtain a relation between density of interferes, probability of interference (MC result) and estimation of separation distance. In a second step, it is possible to refine that approach using SEAMCAT to estimate the probability of interference as a function of the distance between the victim and one interferer.

This method is a refinement of the use of SEAMCAT.

In a first step, the overall probability of interference (P_1) is given, using the representative density of interferers (d) with a relatively large number of active transmitters (N) to allow the Monte-Carlo method to stabilise. In this paper, the simulation was run for N=1 and N=10. Then, we compute for each P_1 an estimation of the separation distance R_i as:

$$R_i = \sqrt{\frac{P_1}{\pi d}}$$

In the second step, SEAMCAT is used to compute an estimation of the probability of interference $P_2(R_s)$ when the distance between the victim and one interferer is less than R_s. As R_s can not be entered directly, we compute the corresponding density of interferer (d) with N=1 as:

$$d = \frac{1}{\pi R_s^2}$$

3.1.2.3 SEAMCAT extended to geographically separated operational areas

The study will cover a large rural area with a low population density and use the following characteristics:

1) Population pockets at the border area.
2) Population pockets separated by 5 km from the border area.
3) Population pockets separated by 10 km from the border area.
4) Population pockets separated by 30 km from the border area.
5) Population pockets separated by 150 km from the border area.

It is believed that these studies are representative of some practical situations in the determination of the sharing between Digital PMR and Tactical Radio Relay.

In this scenario, which is typical of the situation in some countries including the UK, TRRs are being used by the military in certain areas, which are usually rural and either sparsely populated or unpopulated. TETRA uses the same spectrum in a populated area nearby (population pocket), which is geographically separated from the area where the TRRs are used. This situation is illustrated in Figure 3.1 below.

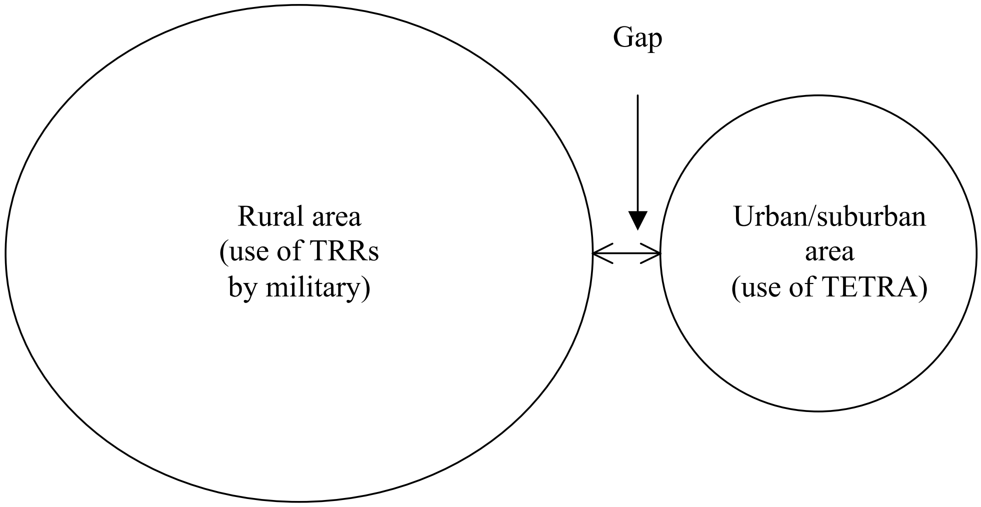


Figure 3.1 : Separated areas of deployment for TRR and digital PMR

3.2 Definition of scenarios

Various interference scenarios that may exist are detailed below in Table 3.1.

Attached in Annex 2 are the parameters for a limited number of the TRR and TETRA interfering scenarios given below.

It was agreed to focus on scenarios number 2, 3, 6, 7, 10, 11, 14 and 15 since they would cover most situations and therefore, only these are described in Annexes. Clearly, the selected set of scenarios does not constitute an exhaustive list of scenarios covering potential use in all countries.

Additionally some scenarios have an “A” placed after the number, these are the scenarios that will also use the P.1546 propagation model to perform the simulation (see section 3.3).

Scenario	Interferer	Victim
1	TRR	TETRA-MS (HH) served by HP BS
2	TRR	TETRA-MS (HH) served by LP BS
3	TRR	TETRA-MS (VM) served by HP BS
4	TRR	TETRA-MS (VM) served by LP BS
5	TETRA-BS (HP) serving HH Terminal	TRR
6	TETRA-BS (LP) serving HH Terminal	TRR
6A	TETRA-BS (LP) serving HH Terminal	TRR
7	TETRA-BS (HP) serving VM Terminal	TRR
7A	TETRA-BS (HP) serving VM Terminal	TRR
8	TETRA-BS (LP) serving VM Terminal	TRR
9	TRR	TETRA-BS (HP) serving HH Terminal
10	TRR	TETRA-BS (LP) serving HH Terminal
10A	TRR	TETRA-BS (LP) serving HH Terminal
11	TRR	TETRA-BS (HP) serving VM Terminal
11A	TRR	TETRA-BS (HP) serving VM Terminal
12	TRR	TETRA-BS (LP) serving VM Terminal
13	TETRA-MS (HH) served by HP BS	TRR
14	TETRA-MS (HH) served by LP BS	TRR
15	TETRA-MS (VM) served by HP BS	TRR
16	TETRA-MS (VM) served by LP BS	TRR

Table 3.1 : sharing scenarios

3.3 Propagation model

Two models are used in this study: modified Hata model (SE21) and ITU-R P.1546:

- The modified Hata model (agreed by SE21) will be used for all propagation paths between PMR and TRR (both directions). All formulas are taken from [7] and [8]. The antenna heights taken into account are the heights above ground level.
- For comparison purposes, the ITU-R P.1546 model [10] has been used for propagation between PMR base station and TRR (both directions). The curve used for the study is the land 50%. Formulas are taken from [10], including correction factors for frequency (interpolation between 600 and 2000 MHz curves) and receiving antenna heights (heights above ground level). The transmitter antenna heights taken into account are effective heights above clutter as listed in sections 2.2, 2.3 and 2.4.

4 RESULTS USING MCL METHOD

In this section, the results of the calculations using the MCL method are presented. A more detailed set of results containing additional information is contained in Annex 1.

The propagation model used is in general the modified Hata model as implemented in SEAMCAT in order to be able to make direct comparison between MCL and MC. However, the separation distances for TRR to PMR BS exceed the operational limits of the model, so in this case the Rec. ITU-R P.1546 was used.

The full report describes a lot of possible cases in terms of powers and antenna heights. However, the group decided to focus on the following cases:

- Rural area: High power (50 dBm eirp), higher antenna height (60 m) PMR BS serving a Vehicle Mounted MS (46 dBm eirp, 1.5 m)
- Urban area: Low power (43 dBm eirp), lower antenna height (20 m) PMR BS serving a Handheld MS (27 dBm eirp, 1.5 m)

In the summary below, for TRR, only the main lobe is considered. However results for the side lobe situation can be found in Annex 1.

4.1 Upper band (915-921 MHz)

For the upper band (915-921 MHz), the interference may occur from TRR to PMR Mobile Stations and from PMR Base Stations to TRR. The results can be summarised as follows (separation distances are given as a function of frequency separation between carriers):

<u>Rural case:</u>

Freq Sep (kHz)	Dist (km) TRR to vehicle MS[1]	Dist (km) BS to TRR[2]
0	39.4	66.5
1000	2.7	40.8
2000	0.3	2.9

Table 4.1 : Separations distance in rural case

<u>Urban case:</u>

Freq Sep (kHz)	Dist (km) TRR to handheld MS[1]	Dist (km) BS to TRR[2]
0	4.3	13.3
1000	0.2	7.3
2000	0.1	0.4

Table 4.2 : Separations distance in urban case

Notes:

1: Modified Hata model
2: Rec. ITU-R P.1546

4.2 Lower band (870-876 MHz)

For the lower band (870-876 MHz), the interference may occur from TRR to PMR Base Stations and from PMR Mobile Stations to TRR. The results can be summarised as follows:

Rural case:

Freq Sep (kHz)	Dist (km) TRR to BS[2]	Dist (km) vehicle MS to TRR[1]
0	51	61.9
1000	6.6	35.9
2000	0.4	1.7

Table 4.3 : Separations distance in rural case

Urban case:

Freq Sep (kHz)	Dist (km) TRR to BS[2]	Dist (km) handheld MS to TRR[1]
0	8.3	4.5
1000	0.5	1.9
2000	0.0	0.1

Table 4.4 : Separations distance in rural case

Notes:

1: Modified Hata model
2: Rec. ITU-R P.1546.

5 RESULTS USING MONTE-CARLO METHOD (SEAMCAT)

Since the MCL method showed some similar results for TETRA and TETRAPOL, the studies applying Monte-Carlo method have been done only with TETRA systems.

This study only considers situations where both systems operate continuously within the defined areas. It should be noted that the study has not taken into account any activity factor of the TRRs.

5.1 Results of the Standard SEAMCAT simulation

In order to limit the amount of calculations, a set of 8 scenarios representing the most realistic cases were developed (see Annex 2).

A first approach was to use SEAMCAT with a frequency separation between victim and interferer uniformly distributed between 0 and 3 MHz.

The Table 5.1 below summarises the results obtained for this simulation. Full results can be found in Annex 3.

In Table 5.1,
P1 is the raw output of SEAMCAT (probability of interference)
Rs is the radius of the simulation computed by SEAMCAT
d is the input density of interferers
Ri is a rough estimation of the necessary separation distance calculated as $\sqrt{(P_1 / \pi.d)}$ (see [2]).

Scenario	Description	P1 (%)	Rs (km)	d (1/km^2)	Ri (km)
2	TRR into TETRA-MS (HH) served by LP BS	4.12	6.51	0.0075	1.322
3	TRR into TETRA-MS (VM) served by HP BS	10.27	6.51	0.0075	2.088
6	TETRA-BS (LP) serving HH into TRR	46.19	1.56	0.13	1.063
6A	TETRA-BS (LP) serving HH into TRR	56.36	1.56	0.13	1.175
7	TETRA-BS (HP) serving VM into TRR	51.71	11.06	0.0026	7.957
7A	TETRA-BS (HP) serving VM into TRR	52.64	11.06	0.0026	8.028
10	TRR into TETRA-BS (LP) served by HH	26.40	6.51	0.0075	3.089
10A	TRR into TETRA-BS (LP) served by HH	60.00	6.51	0.0075	4.120
11	TRR into TETRA-BS (HP) served by VM	23.75	6.51	0.0075	3.175
11A	TRR into TETRA-BS (HP) served by VM	31.27	6.51	0.0075	3.643
14	TETRA-MS (HH) served by LP BS into TRR	10.52	2.52	0.05	0.818
15	TETRA-MS (VM) served by HP BS into TRR	54.18	2.52	0.05	1.857

Table 5.1 : Summary of results for standard SEAMCAT simulations

5.2 Results of the Study using the two-step approach

5.2.1 Summary

Three scenarios from the ones defined in section 3.2 have been implemented in the SEAMCAT version 2.0.7.
The "two-step approach" described in Annex 4 has been followed.
The antenna diagram for TRR as described in Section 2 was used in all cases.
These scenarios have been selected in order to further investigate these critical scenarios.

Scenario no	Title
7A	TETRA HP BS interfering TRR (open area)
15	TETRA VM MS interfering TRR (open area)
3	TRR interfering TETRA VM MS (open area)

Table 5.2.1 : Scenarios used for the Two-Step approach

For the purpose of comparison within this study, 5% is taken to be an acceptable degradation to TRR.

5.2.2 Scenario 3

The scenario 3 is the case where the TRR is interfering into a TETRA mobile station, vehicule mounted, served by a high power base station, in an open area.

Step 1: overall probability of interference P1

d=0.0075	N=1		N=10	
DF MHz	P1 %	Ri km	P1 %	Ri km
0.00	27.6	34.225	34.0	37.987
0.25	25.7	33.026	31.3	36.447
0.50	10.8	21.409	13.1	23.579
0.75	1.4	7.708	1.2	7.136
1.00	0.0	0.000	0.0	0.000

Table 5.2.2 : results of the step 1 for the Two-step approach applied to scenario 3

Step 2:

DF (MHz)/Rs (d)*	1 km (0.318)	2 km (0.08)	5 km (0.013)	10 km (0.003)	20 km (0.0008)
0.00	83.0	71.7	37.0	12.5	4.2
0.25	74.4	62.9	35.2	11.9	
0.50	63.8	40.8	16.2	4.8	
0.75	22.6	8.5	2.0	0.4	
1.00	1.0	0.6	0.0	0.0	

Table 5.2.3 : results of the step 2 for the Two-step approach applied to scenario 3
*d is the value of density corresponding to one interferer within the simulation radius.

The results in Table 5.2.3 above are in line with those provided with MCL calculations. For comparison, the MCL results for scenario 3 are summarised in Table 5.2.4.

DF MHz	Dist km
0.0	39.4
1.0	2.7
1.2	1.1
2.0	0.3

Table 5.2.4 : Results of the corresponding MCL scenario

5.2.3 Scenario 7A

The scenario 7A is the case where the TETRA base station, serving a vehicle mounted mobile terminal, is interfering into a TRR, in an open area.

Step 1: overall probability of interference P1

d=0.0026	N=1		N=10	
DF MHz	P1 %	Ri km	P1 %	Ri km
0.0	98.4	10.976	99.8	11.054
1.0	75.9	9.640	89.3	10.456
1.2	48.2	7.682	66.7	9.037
1.5	18.9	4.810	20.0	4.948
2.0	2.1	1.603	1.9	1.525
3.0	0.0	0.000	0.0	0.000

Table 5.2.5 : results of the step 1 for the Two-step approach applied to scenario 7A

The parameters d, N and Ri are defined in 3.1.

Step 2: calculation of P2 (%)

DF (MHz)/Rs (d)*	1 km (0.318)	2 km (0.08)	5 km (0.013)	10 km (0.003)	20 km (0.0008)
0.0	100.0	100.0	99.9	99.7	94.1
1.0	100.0	96.6	92.8	79.7	
1.2	100.0	91.2	77.7	59.2	24.5
1.5	100.0	64.6	47.2	21.2	9.1
2.0	46.4	13.6	3.1	1.1	
3.0	11.8	6.3	2.5	0.3	

Table 5.2.6 : results of the step 2for the Two-step approach applied to scenario 7A

*d is the value of density corresponding to one interferer within the simulation radius.

So for example at a 2 MHz frequency separation, a separation distance in the order of 5 km would be necessary to come to an acceptable degradation (3.1 %). Any frequency separations lower than 2 MHz would produce interference up to very large distances.

The results in table 5.2.6 above are in line with those provided with MCL calculations. For comparison, the MCL results for scenario 7A are summarised in Table 5.2.7.

DF MHz	Dist km
0.0	66.5
1.0	40.8
1.2	26.6
1.5	13.8
2.0	3

Table 5.2.7 : Results of the corresponding MCL scenario

5.2.4 Scenario 15

The scenario 15 is the case where the TETRA mobile station, vehicle mounted, is interfering into a TRR, in an open area.

Step 1: overall probability of interference P1

D=0.05	N=1		N=10	
DF MHz	P1 %	Ri km	P1 %	Ri km
0.0	94.0	2.446	99.4	2.516
1.0	47.5	1.739	71.1	2.128
1.2	24.8	1.257	34.7	1.486
1.5	5.7	0.602	5.2	0.575
2.0	0.0	0.000	0.0	0.000

Table 5.2.8 : results of the step 1 for the Two-step approach applied to scenario 15

Step 2: calculation of P2 (%)

DF (MHz)/Rs (d)*	1 km (0.318)	2 km (0.08)	5 km (0.013)	10 km (0.003)
0.0	100.0	98.2	77.9	48.7
1.0	100.0	56.1	21.8	8.9
1.2	34.3	27.4	7.3	1.6
1.5	20.3	6.1	1.1	0.0
2.0	0.0	0.0	0.0	

Table 5.2.9 : results of the step 1 for the Two-step approach applied to scenario 15

*d is the value of density corresponding to one interferer within the simulation radius.

So for example at a 1.5 MHz frequency separation, a separation distance in the order of 5 km would be necessary to come to an acceptable degradation (1.1 %).

The results in table 5.2.9 above are in line with those provided with MCL calculations. For comparison, the MCL results for scenario 15 are summarised in Table 5.2.10.

DF MHz	Dist km
0.0	51.4
1.0	28.7
1.2	16.0
1.4	8.1
2.0	1.3

Table 5.2.10 : Results of the corresponding MCL scenario

5.3 Results of the SEAMCAT study extended to geographically separated operational areas

The complete set of results from the geographically separated model are shown in Annex 6. The following extracts some typical results from these tables to illustrate the interference problems which might be encountered if these systems were deployed adjacent to each other. For the purpose of this study an interference probability of 5% was deemed to be operationally acceptable by both systems.

The following Table 5.3.1 summarises the results for the scenarios studied

Scenario	Interferer	Victim	Necessary gap**	Associated probability	Environment
2	TRR	TETRA-MS (HH) served by LP BS	0 30 km	<2 % < 7%	Urban Rural
3	TRR	TETRA-MS (VM) served by HP BS	0	<3 %	rural
6	TETRA-BS (LP) serving HH Terminal	TRR	10 km 0 km	<2 % <0.2 %	TRR Urban TRR Rural
7	TETRA-BS (HP) serving VM Terminal	TRR	30 km	~5% for 0.001 AID*	Rural
10	TRR	TETRA-BS (LP) serving HH Terminal	150 km > 150 km	≤ 5%	TRR urban TRR rural
11	TRR	TETRA-BS (HP) serving VM Terminal	150 km	< 5% for 0.003 AID 10% for 0.0075 AID	Rural

14	TETRA-MS (HH) served by LP BS	TRR	0 km	< 1 %	TRR urban and rural
15	TETRA-MS (VM) served by HP BS	TRR	0 km	< 4%	TRR Urban and Rural

* It should be noted that, in some cases, this study considers Active Interferer Density (AID) values and TETRA cell radius slightly different from the ones given in Annex 2 since it was found that these figures were more appropriate to reflect the scenarios considered.
** The gap is defined as the separation distance between the border of the two areas. See figure 3.1 and annex 5 for details

In the scenarios 10 and 11, where an element of the TETRA system is the victim, the results indicate that a separation distance of more than 150km will be required between the Geographic Areas. It is recommended that the TETRA system planner avoids these scenarios where possible.

However, in these scenarios, the separation distance may be significantly reduced by the mitigation techniques as described in section 7 albeit at a cost to the operator.

Additional simulations have been performed to assess the effect of the mitigation by the use of a directional antenna in the TETRA Base Station pointing away from the TRR operational area.

With mitigation techniques, the separation distances are reduced from 150 km to less than 40 km for urban cases in scenario 10 and for scenario 11.

6 DISCUSSION OF THE RESULTS – COMPARISON BETWEEN THE DIFFERENT APPROACHES

The two methods used in this study are complementary to each other:

- The MCL method provides the necessary attenuation required between the systems to enable interference free operation under specified condition.
- The SEAMCAT method calculates the probability of interference, which gives the extent of the problem. This has been expanded in two ways :
  - The Two-Step Approach calculates the probability of interference and investigates the necessary separation in distance or frequency between the two systems for the cases where interference occurs. The process of selecting the distance to be less than R_s will yield very similar results to those obtained by the MCL approach.
  - The application of SEAMCAT to geographically separated areas in order to reflect some operational scenarios.

For the scenarios investigated there is a good degree of correlation between the results of the different methods applied.

From the results of the scenarios investigated it is clear that sharing between Digital PMR/PAMR and Tactical Radio Relays would be difficult if co-ordination was not undertaken .

Furthermore, the results demonstrate that the large bandwidth specified for the tactical radio relay receivers severely limit the effect that could be achieved by frequency separation used as a sharing mechanism.

7 MITIGATIONS TECHNIQUES

If a sharing is wanted there are several mitigation techniques that can be applied, some of which require some degree of co-ordination and others that are mainly good engineering practices. These techniques are mainly applicable where there is a geographical separation between Digital PMR/PAMR and the Tactical Radio Relay systems and are:

- Use of directional antennas for Digital PMR/PAMR base stations pointing away from known military exercise areas (see section 5.3 for the impact on scenarios 10 and 11).
- Optimise, when practicable, the alignment of the TRR antennas to minimise interference but at the same time maintain the wanted link. However, this may imply reduction of the TRR operational capabilities.
- Using the power setting of the TRR to increase the wanted link signal level in case of interference from PMR. The same limitations as above apply. However, it will also increase the interference from TRR to PMR.
- The use in the PMR/PAMR systems of quasi-synchronous and voting techniques, based on diversity, is a general means to decrease the effect of interference to PMR/PAMR.
- The use of direct contact to the PMR/PAMR operator for switching down a particular PMR/PAMR base station (This implies regulatory measures such as license requirements).

It should also be noted that, since the band 870 - 871 paired with 915 - 916 MHz is foreseen as a guard band between Digital PMR/PAMR and GSM (ref ECC Report no. 5), the use of this band by TRR will minimise the effect of interference on both TRR and PMR.

If a degree of co-ordination was introduced between the operators, solutions could be found for cases where the two systems are not overlapping geographically, such as specific military exercise areas, if directional antennas are used for nearby PMR/PAMR coverage.

8 CONCLUSIONS

The MCL method indicates that for the scenarios investigated the potential of interference exists at very large distances when the frequency used is shared and no mitigation techniques are applied. This sharing analysis also confirms that, when a narrow-band and a wide-band system are involved, the interference is determined in both directions by the bandwidth of the wider system.

In this study, the SEAMCAT simulations provide the overall probability of interference in an uncoordinated approach. It shows the extent of the problem.

The Two-Step approach gives results which are consistent with those of the MCL, for the scenarios studied. This is because the method investigates distances where interference is likely to occur.

From the results of MCL and two-step approach, it can be seen that for the situation with systems within the same geographical area, a frequency separation in the order of 2 MHz between the centre frequencies will be required. The main reason for this frequency separation is the 1.5 MHz receiver bandwidth of the TRR.

From the extension of SEAMCAT in the case of geographical separation it can be seen that, without any mitigation, separation distances around 150 km are required for some scenarios in order to protect the Digital PMR base stations. The use of co-ordination and mitigation techniques as described in section 7 would reduce the required minimum gap between the separated geographical service areas to around 40 km for these scenarios. However, the need for very large separation distances would severely limit the required mobility of both systems.

This study only considers situations where both systems operate continuously within the defined areas. It should be noted that the study has not taken into account any activity factor of the TRRs.

9 REFERENCES

[1] Recommendation ITU-R P.370-7 (VHF and UHF propagation curves for the frequency range from 30 to1000 MHz)
[2] ERC Report 101, May 1999 (Comparison of MCL, EMCL and MC simulation)
[3] ETSI EN 300 392-2 V2.3.2 March 2001 (TETRA)
[4] TETRAPOL PAS version3, 10 November 1999
[5] STANAG 4212 (TRR)
[6] ETS 300 133 January 92 (definition of equipment parameters)
[7] ERC Report 68, September 1999 (MC methodology)
[8] SEAMCAT User Documentation, Sep 2000
[9] ERC Report 103 on TETRA/TETRAPOL study using SEAMCAT
[10] Recommendation ITU-R P.1546
[11] ECC Report 5.

ANNEX 1: RESULTS OF THE MCL STUDY

1 Introduction

This part of the study was based on the documents referenced below. The input parameters are described in the main body of the report and are not repeated here. This annex summarises the study contained in document SE27(01)31Rev2, where more details can be found, e.g. the implementation of propagation models and MCL calculations.

Notes:
This study took into account *typical* values (e.g. PMR antenna height of 20 to 60 m, EIRP from 20 to100 W) and therefore does not represent worst cases separation distances.
This paper only reflects the TRR equipment used by NATO countries. Other European countries may use TRR equipment with different characteristics.

1 Sharing study

1.1 Interference thresholds

The interference threshold taken into account in this study is a signal producing the same power as the internal noise of the receiver, thus producing an increase of 3 dB of the N+I, as described in Minimum Coupling Loss methodology [2].

In the present set of calculations, a link margin M was also added on the victim receiver as described in the E-MCL method (see [2] and formulas used in the study in appendix B).

Note: The interference level considered here has been relaxed from previous NATO/FMB studies where the maximum increase in N+I was to remain under 1 dB. This is to align this study with other CEPT-SE studies using the E-MCL method.

1.2 TRR victim of TETRA

The results give the interfering power I in dBm (convolution of the 2 filters), the minimum coupling loss L in dB, and the minimum separation distance D_{min} in km, first when the PMR is in the main lobe of the TRR (for 3 and 6 dB margins), then when the PMR is in the side lobe at –8 dBi (90°) (for 6 dB margin). Each table below gives the separation distances for a type of interferer.

df (kHz)	**BS HIGH**						**BS Low**					
	M = 3 dB		M = 6 dB		6dB, sidelobe		M = 3 dB		M = 6 dB		6 dB, sidelobe	
	Open	Urban	Open	Urban	Open	Urban	Open	Urban	Open	Urban	Open	Urban
0	230.2	102.3	204.1	86.9	101.2	32.7	142.9	53.4	123.6	43.7	52.8	12.0
700	230.2	102.3	204.1	86.9	101.2	32.7	142.9	53.4	123.6	43.7	52.8	12.0
750	229.5	101.6	203.4	86.7	100.9	32.4	142.2	53.0	123.2	43.4	52.4	11.9
800	215.8	93.8	190.6	79.4	92.9	28.7	132.2	48.0	113.9	39.0	47.4	10.1
900	188.6	78.3	165.5	65.5	77.4	21.7	112.4	38.3	95.9	30.6	37.8	7.2
1000	163.5	64.5	142.6	53.2	63.8	15.6	94.6	29.9	80.1	23.6	29.6	5.1
1200	120.3	41.9	103.4	33.6	33.0	7.6	65.1	17.0	54.1	12.4	14.7	2.6
1400	85.5	25.3	72.0	19.4	10.0	3.7	42.6	8.6	34.5	6.3	4.5	1.3
1800	25.2	6.4	14.6	4.6	0.9	0.9	11.5	2.3	6.7	1.7	0.4	0.3
2000	8.5	3.4	4.9	2.4	0.3	0.3	4.6	1.3	2.6	1.0	0.2	0.2

Table A1.1 : TETRA Base Stations interfering TRR receiver

df (kHz)	MS High						MS Low					
	M = 3 dB		M = 6 dB		6dB, sidelobe		M = 3 dB		M = 6 dB		6 dB, sidelobe	
	Open	Urban	Open	Urban	Open	Urban	Open	Urban	Open	Urban	Open	Urban
0	61.9	15.6	51.4	11.5	15.3	2.4	50.2	11.1	41.1	8.1	10.9	1.7
700	61.9	15.6	51.4	11.5	15.3	2.4	50.2	11.1	41.1	8.1	10.9	1.7
750	61.8	15.5	51.0	11.3	15.2	2.4	50.1	11.0	40.8	8.1	10.8	1.7
800	56.1	13.1	46.1	9.6	13.0	2.0	45.1	9.4	36.5	6.9	9.2	1.4
900	45.3	9.4	36.7	6.9	9.2	1.4	35.9	6.6	28.6	4.9	6.5	1.0
1000	35.9	6.7	28.7	4.9	6.6	1.0	27.9	4.8	21.9	3.5	4.7	0.7
1200	21.4	3.4	16.0	2.5	3.3	0.5	15.5	2.4	11.3	1.8	2.4	0.4
1400	11.0	1.7	8.1	1.3	1.7	0.3	7.9	1.2	5.8	0.9	1.2	0.2
1800	2.9	0.5	2.1	0.3	0.4	0.1	2.1	0.3	1.5	0.2	0.3	0.1
2000	1.7	0.3	1.3	0.2	0.2	0.1	1.2	0.2	0.9	0.1	0.1	0.1

Table A1.2 : TETRA Mobile Stations interfering TRR receiver

Df	Handheld					
	M = 3 dB		M = 6 dB		M=6dB sidelobe	
	Open	Urban	Open	Urban	Open	Urban
0	26.9	4.5	21.0	3.3	4.4	0.7
700	26.9	4.5	21.0	3.3	4.4	0.7
750	26.7	4.5	20.9	3.3	4.4	0.7
800	23.6	3.8	18.0	2.8	3.7	0.6
900	17.4	2.7	12.8	2.0	2.7	0.4
1000	12.5	1.9	9.1	1.4	1.9	0.3
1200	6.3	1.0	4.6	0.7	1.0	0.2
1400	3.2	0.5	2.3	0.4	0.5	0.1
1800	0.9	0.1	0.6	0.1	0.1	0.1
2000	0.6	0.1	0.4	0.1	0.0	0.0

Table A1.3 : TETRA handheld interfering TRR receiver

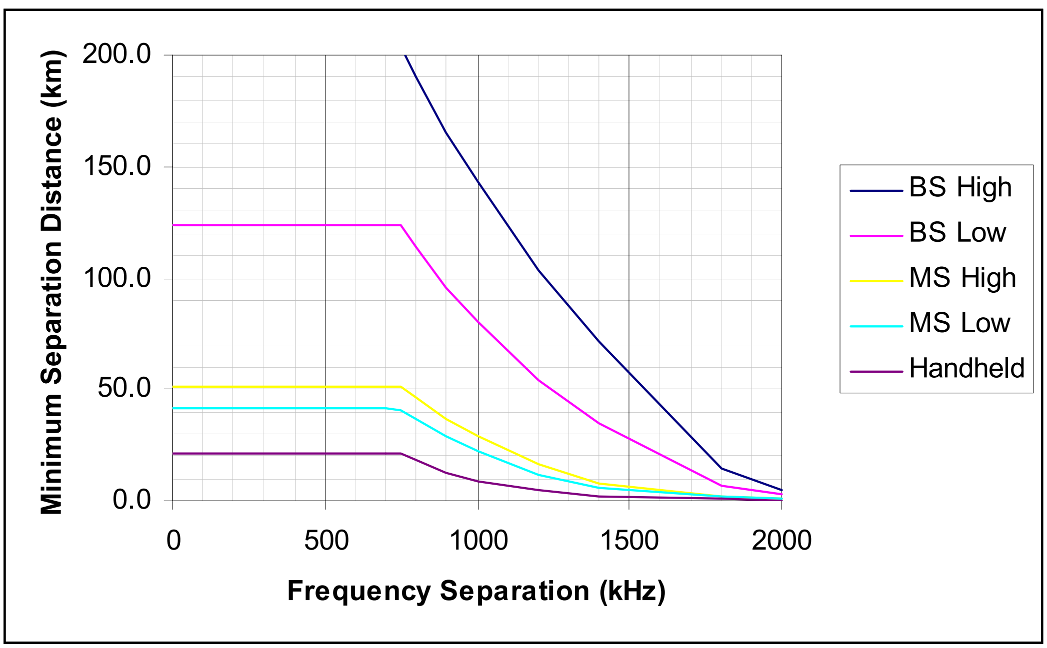


Figure A1.1 : TRR victim of TETRA , margin 6 dB, Open Area

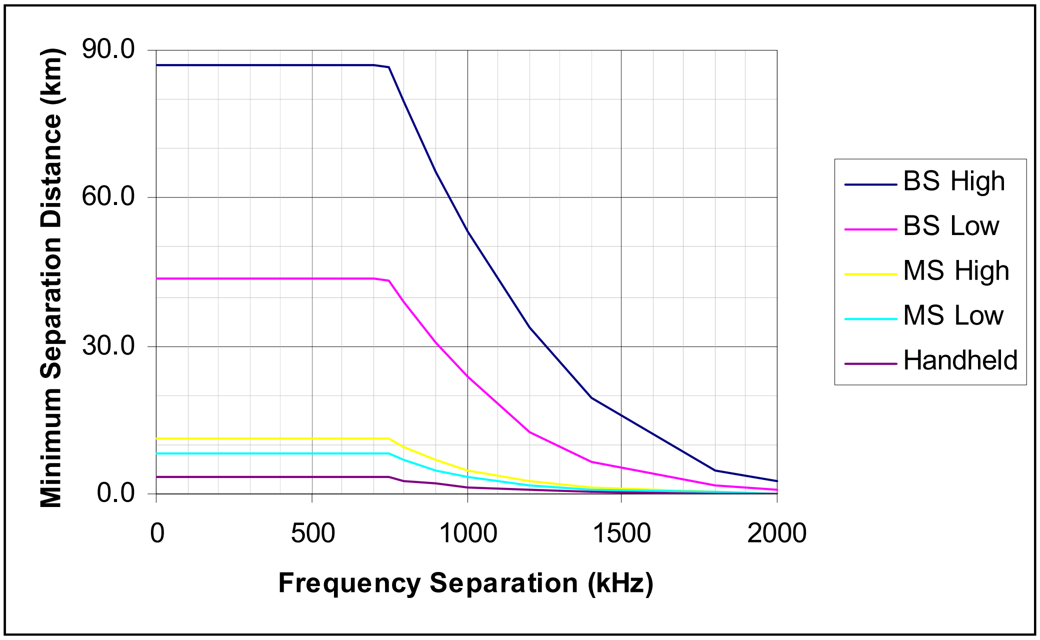


Figure A1.2 : TRR victim of TETRA , margin 6 dB, Urban Area

2.3 TRR victim of TETRAPOL

df (kHz)	BS High						BS Low					
	M = 3 dB		M = 6 dB		6dB, sidelobe		M = 3 dB		M = 6 dB		6 dB, sidelobe	
	Open	Urban	Open	Urban	Open	Urban	Open	Urban	Open	Urban	Open	Urban
0	230.3	102.3	204.1	86.9	101.2	32.7	142.9	53.4	123.6	43.7	52.8	12.0
700	230.3	102.3	204.1	86.9	101.2	32.7	142.9	53.4	123.6	43.7	52.8	12.0
750	230.0	102.0	203.9	86.7	101.3	32.6	142.6	53.2	123.6	43.6	52.6	11.9
800	216.0	93.7	190.4	79.3	93.0	28.7	132.0	47.9	114.0	38.9	47.4	10.1
900	188.4	78.2	165.3	65.4	77.3	21.7	112.3	38.3	96.0	30.6	37.8	7.2
1000	163.6	64.5	142.4	53.4	63.7	15.5	94.5	29.9	80.3	23.6	29.5	5.1
1200	120.2	41.9	103.3	33.6	32.9	7.6	65.3	16.9	54.1	12.5	14.7	2.6
1400	85.4	25.3	71.9	19.4	10.0	3.7	42.7	8.6	34.4	6.3	4.5	1.3
1800	24.9	6.4	14.4	4.6	0.9	0.9	11.1	2.2	6.4	1.6	0.4	0.3
2000	7.6	3.1	4.4	2.3	0.3	0.3	3.4	1.1	2.0	0.8	0.1	0.1

Table A1.4 : TETRAPOL Base Stations interfering TRR receiver

df (kHz)	MS High						MS Low					
	M = 3 dB		M = 6 dB		6dB, sidelobe		M = 3 dB		M = 6 dB		6 dB, sidelobe	
	Open	Urban	Open	Urban	Open	Urban	Open	Urban	Open	Urban	Open	Urban
0	61.9	15.6	51.4	11.5	15.3	2.4	50.3	11.1	41.1	8.1	10.9	1.7
700	61.9	15.6	51.4	11.5	15.3	2.4	50.3	11.1	41.1	8.1	10.9	1.7
750	61.8	15.5	51.2	11.4	15.3	2.4	50.3	11.0	41.0	8.1	10.9	1.7
800	56.0	13.1	46.0	9.6	13.0	2.0	45.1	9.4	36.6	6.9	9.2	1.4
900	45.2	9.4	36.6	6.9	9.2	1.4	35.8	6.7	28.5	4.9	6.5	1.0
1000	35.8	6.7	28.6	4.9	6.6	1.0	27.9	4.8	21.9	3.5	4.7	0.7
1200	21.5	3.4	16.0	2.5	3.3	0.5	15.5	2.4	11.4	1.8	2.4	0.4
1400	11.0	1.7	8.1	1.3	1.7	0.3	7.9	1.2	5.7	0.9	1.2	0.2
1800	2.8	0.4	2.1	0.3	0.4	0.1	2.0	0.3	1.5	0.2	0.3	0.1
2000	1.5	0.2	1.1	0.2	0.2	0.1	1.0	0.2	0.8	0.1	0.1	0.1

Table A1.5 : TETRAPOL Mobile Stations interfering TRR receiver

df (kHz)	Handheld					
	M = 3 dB		M = 6 dB		6dB, sidelobe	
	Open	Urban	Open	Urban	Open	Urban
0	26.9	4.5	21.0	3.3	4.4	0.7
700	26.9	4.5	21.0	3.3	4.4	0.7
750	26.8	4.5	20.9	3.3	4.4	0.7
800	23.6	3.8	17.9	2.8	3.7	0.6
900	17.4	2.7	12.8	2.0	2.7	0.4
1000	12.4	1.9	9.1	1.4	1.9	0.3
1200	6.3	1.0	4.6	0.7	1.0	0.2
1400	3.2	0.5	2.3	0.4	0.5	0.1
1800	0.8	0.1	0.6	0.1	0.1	0.0
2000	0.4	0.1	0.3	0.1	0.0	0.0

Table A1.6 : TETRAPOL Handheld interfering TRR receiver

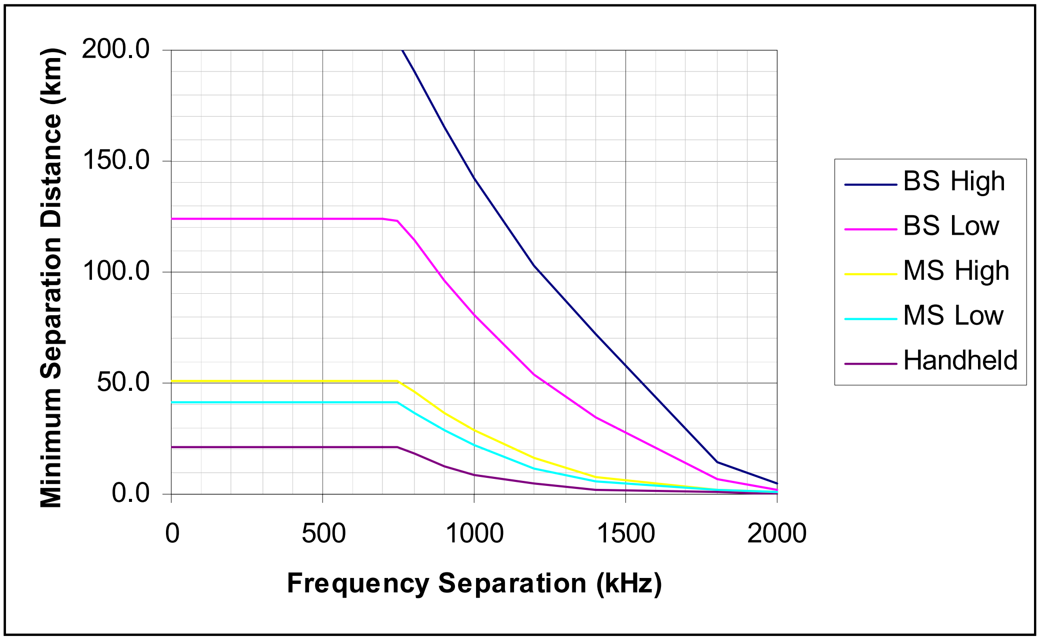


Figure A1.3 : TRR victim of TETRAPOL, Margin 6dB, Open Area

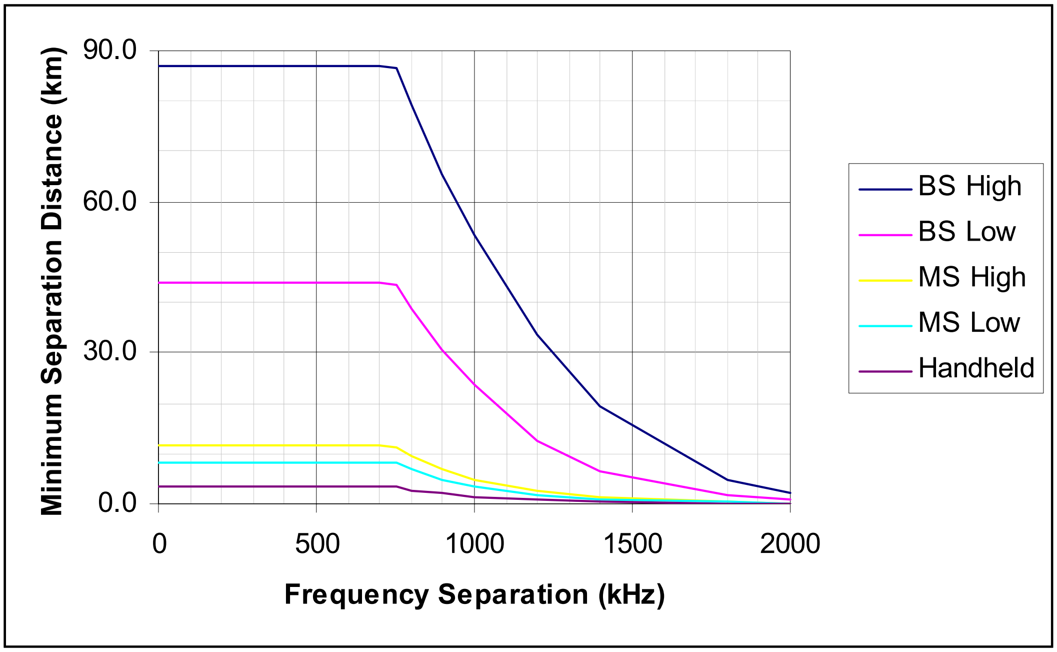


Figure A1.4 : TRR victim of TETRAPOL, Margin 6dB, Urban Area

2.4 TETRA victim of TRR

For this direction, only the situation with a 6-dB margin on the PMR receiver has been studied. The TETRA system is assumed to be in the TRR main lobe.

df (kHz)	**TETRA BS High**		**TETRA BS Low**	
	Open	Urban	Open	Urban
0	168.4	67.1	123.1	43.5
350	168.4	67.1	123.1	43.5
375	167.9	66.8	122.7	43.1
400	160.6	62.8	116.4	40.2
450	144.9	54.6	103.9	34.2
500	130.4	46.9	92.2	28.9
700	81.8	23.7	54.6	12.6
800	62.9	15.2	40.4	7.9
900	46.3	9.3	29.0	5.0
1000	20.4	5.7	20.1	3.1
1200	4.0	2.1	4.0	1.2
1400	0.8	0.8	0.8	0.5
1800	0.4	0.4	0.4	0.3
2000	0.4	0.4	0.4	0.3

Table A1.7 : TRR transmitter interfering TETRA BS

The TETRA MS High and Low configurations have the same receiving characteristics, therefore they form only one case for this direction.

df (kHz)	**TETRA MS**		**TETRA Handheld**	
	Open	Urban	Open	Urban
0	39.4	7.7	25.7	4.3
350	39.4	7.7	25.7	4.3
375	39.3	7.6	25.5	4.2
400	36.5	6.8	23.5	3.8
450	30.8	5.4	19.4	3.0
500	25.9	4.3	15.3	2.4
700	10.9	1.7	6.0	0.9
800	6.9	1.1	3.8	0.6
900	4.3	0.7	2.4	0.4
1000	2.7	0.4	1.5	0.2
1200	1.1	0.2	0.6	0.1
1400	0.4	0.1	0.2	0.1
1800	0.3	0.1	0.1	0.1
2000	0.3	0.1	0.1	0.1

Table A1.8 : TRR transmitter interfering TETRA MS and handheld

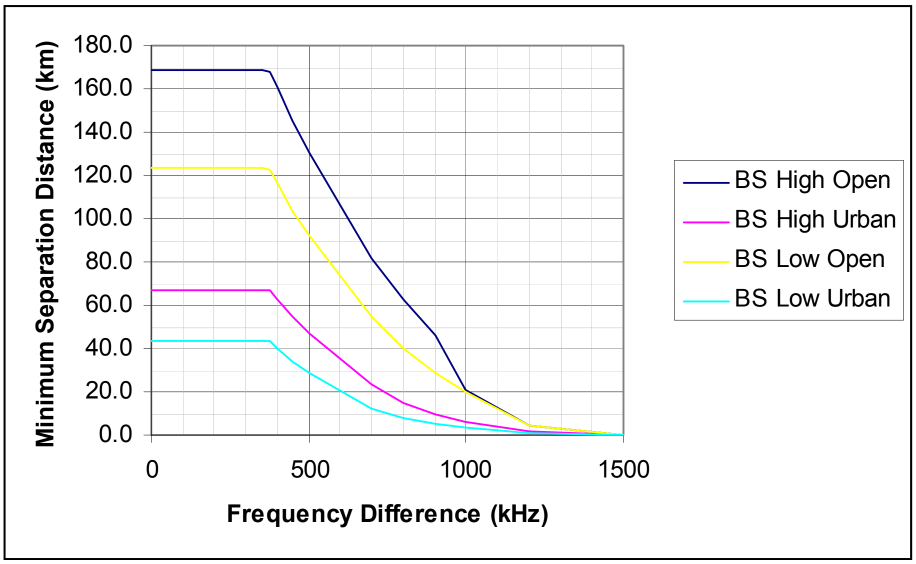


Figure A1.5 : TETRA BS victim of TRR

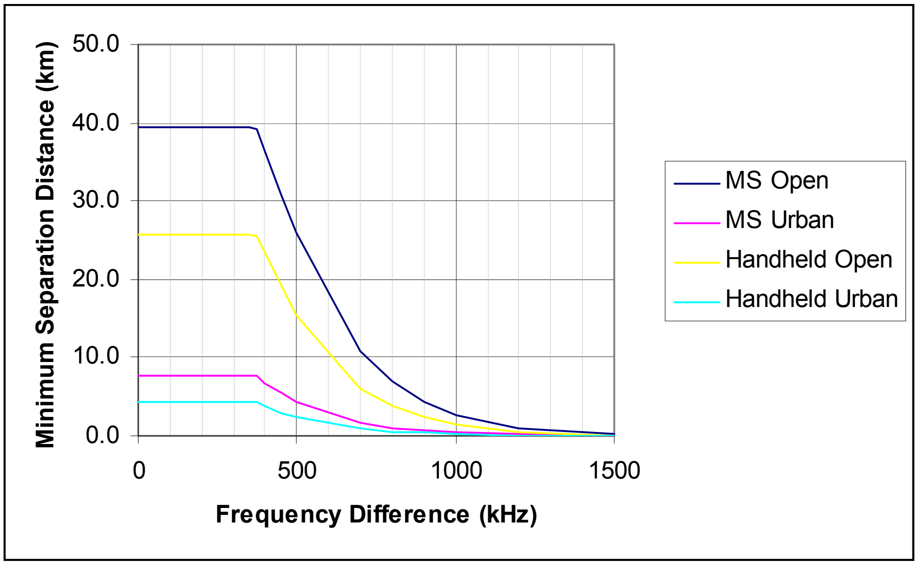


Figure A1.6 : TETRA MS victim of TRR

2.5 TETRAPOL victim of TRR

The TETRAPOL system is assumed to be in the TRR main lobe.

df (kHz)	TETRAPOL BS High		TETRAPOL BS Low	
	Open	Urban	Open	Urban
0	170.7	68.3	124.7	44.3
350	170.7	68.3	124.7	44.3
375	170.0	67.9	124.2	44.1
400	162.5	63.9	117.9	40.9
450	146.8	55.5	105.2	34.8
500	132.2	47.8	93.3	29.4
700	83.0	24.2	55.3	12.9
800	64.0	15.7	41.1	8.1
900	47.9	9.6	29.5	5.1
1000	21.4	5.8	20.5	3.2
1200	4.2	2.2	4.2	1.3
1400	0.8	0.8	0.9	0.5
1800	0.4	0.4	0.4	0.4
2000	0.4	0.4	0.4	0.4

Table A1.9 : TRR transmitter interfering TETRAPOL BS

df (kHz)	TETRAPOL MS		TETRAPOL Handheld	
	Open	Urban	Open	Urban
0	42.0	8.4	27.6	4.7
350	42.0	8.4	27.6	4.7
375	41.9	8.4	27.4	4.7
400	38.8	7.5	25.3	4.2
450	33.0	5.9	21.0	3.3
500	27.8	4.7	16.9	2.6
700	11.9	1.9	6.6	1.0
800	7.5	1.2	4.2	0.7
900	4.7	0.7	2.6	0.4
1000	3.0	0.5	1.7	0.3
1200	1.2	0.2	0.7	0.1
1400	0.5	0.1	0.2	0.1
1800	0.3	0.1	0.1	0.1
2000	0.3	0.1	0.1	0.1

Table A1.10 : TRR transmitter interfering TETRAPOL MS and Handheld

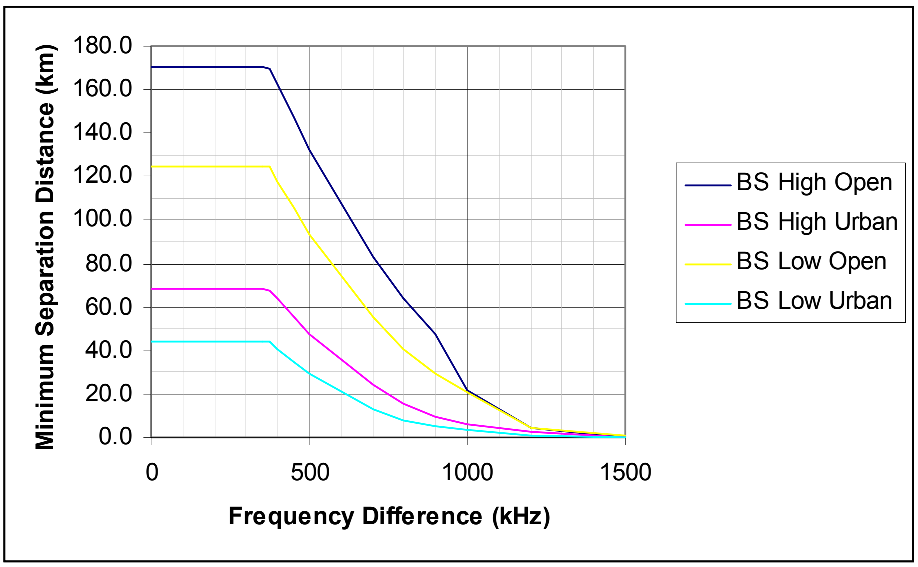


Figure A1.7 : TETRAPOL BS victim of TRR

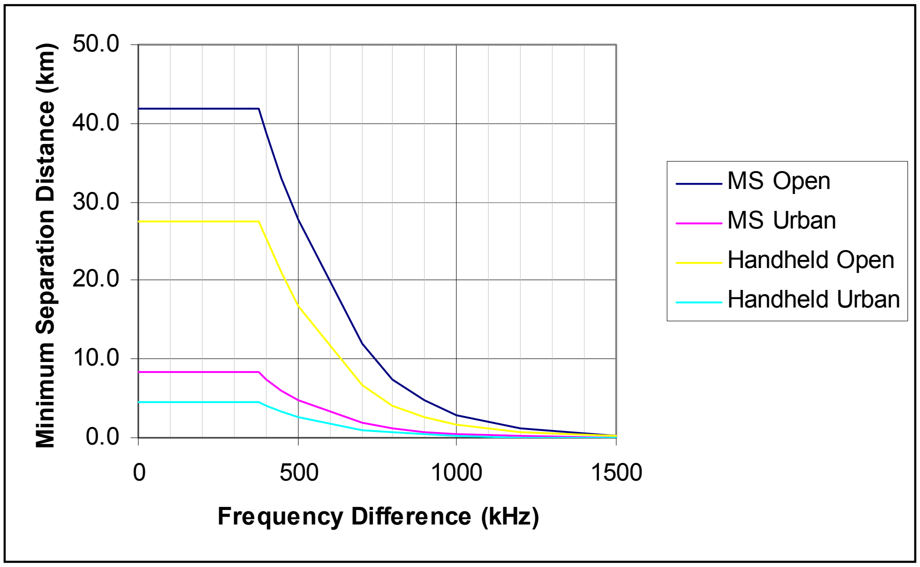


Figure A1.8 : TETRAPOL MS victim of TRR

Appendix A. PMR BS – TRR Separation Distances using ITU-R P.1546

In this part of the study, the "dense urban" case has been used for the ITU-R P.1546 propagation model (representative clutter height = 30 m).

df (kHz)	Dmin (km) for TETRA interference				Dmin (km) for TETRAPOL interference			
	TETRA High		TETRA Low		TETRAPOL High		TETRAPOL Low	
	Open	Urban	Open	Urban	Open	Urban	Open	Urban
0	66.5	23.4	34.6	8.3	66.5	23.4	34.6	8.3
700	66.5	23.4	34.6	8.3	66.5	23.4	34.6	8.3
750	66.3	23.2	34.3	8.3	66.6	23.3	34.5	8.3
800	60.5	20.8	30.7	7.3	60.4	20.8	30.6	7.3
900	49.7	16.4	24.2	5.6	49.6	16.4	24.2	5.6
1000	40.8	12.8	19.0	4.3	40.7	12.8	19.0	4.3
1200	26.6	7.3	11.8	2.3	26.6	7.3	11.8	2.3
1400	16.6	3.9	7.2	1.1	16.6	3.9	7.2	1.1
1800	5.5	0.9	2.3	0.3	5.5	0.9	2.2	0.3
2000	3.0	0.5	1.3	0.1	2.8	0.5	1.1	0.1

Table A1.11 : TRR victim of TETRA / TETRAPOL BS

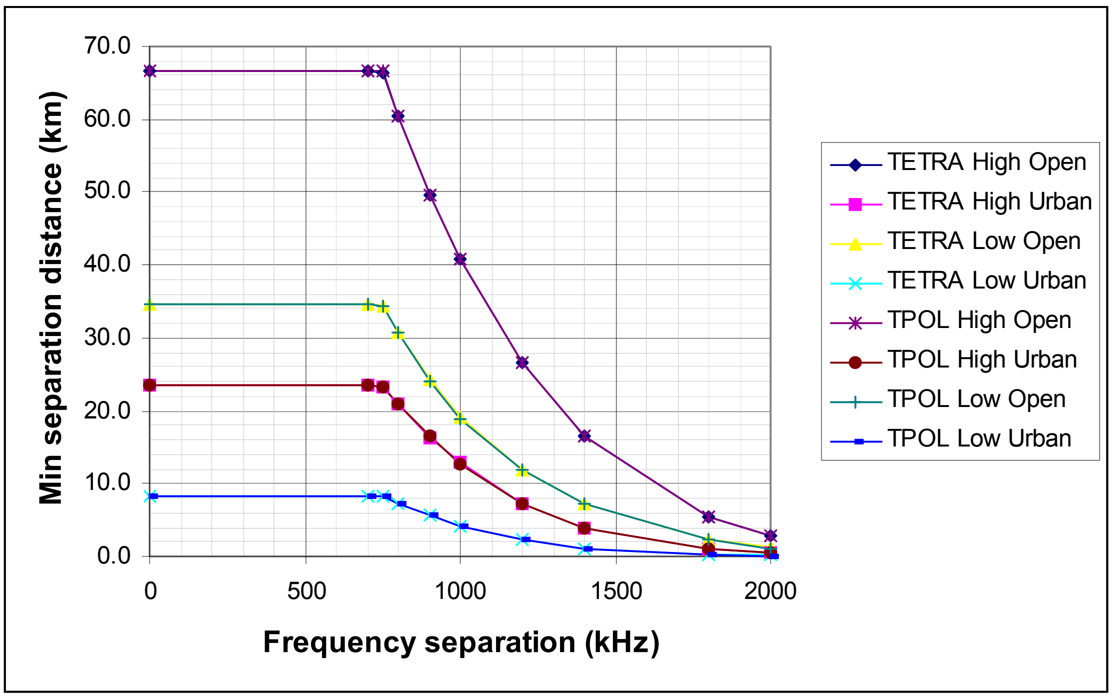


Figure A1.9 : TRR victim of TETRA/TETRAPOL, margin 6 dB, P.1546 Model

df (kHz)	Dmin for TETRA BS victim				Dmin for TETRAPOL BS victim			
	BS High		BS Low		High		Low	
	Open	Urban	Open	Urban	Open	Urban	Open	Urban
0	50.9	16.9	34.4	8.3	51.8	17.2	35.0	8.4
350	50.9	16.9	34.4	8.3	51.8	17.2	35.0	8.4
375	50.7	16.8	34.1	8.2	51.5	17.2	34.8	8.4
400	47.7	15.6	31.7	7.6	48.4	15.9	32.2	7.7
450	41.6	13.1	26.9	6.3	42.3	13.4	27.4	6.5
500	36.2	11.0	22.8	5.3	36.7	11.2	23.2	5.4
700	19.6	4.8	11.9	2.3	20.0	4.9	12.1	2.4
800	14.0	3.0	8.5	1.4	14.3	3.1	8.7	1.5
900	9.8	1.9	6.0	0.9	10.0	1.9	6.1	0.9
1000	6.6	1.1	4.1	0.5	6.8	1.2	4.2	0.6
1200	2.6	0.4	1.7	0.2	2.7	0.4	1.7	0.2
1400	0.8	0.2	0.7	0.1	0.8	0.2	0.7	0.1
1800	0.4	0.1	0.4	0.0	0.4	0.2	0.4	0.0
2000	0.4	0.1	0.4	0.0	0.4	0.2	0.4	0.0

Table A1.12 : TETRA / TETRAPOL BS victim of TRR

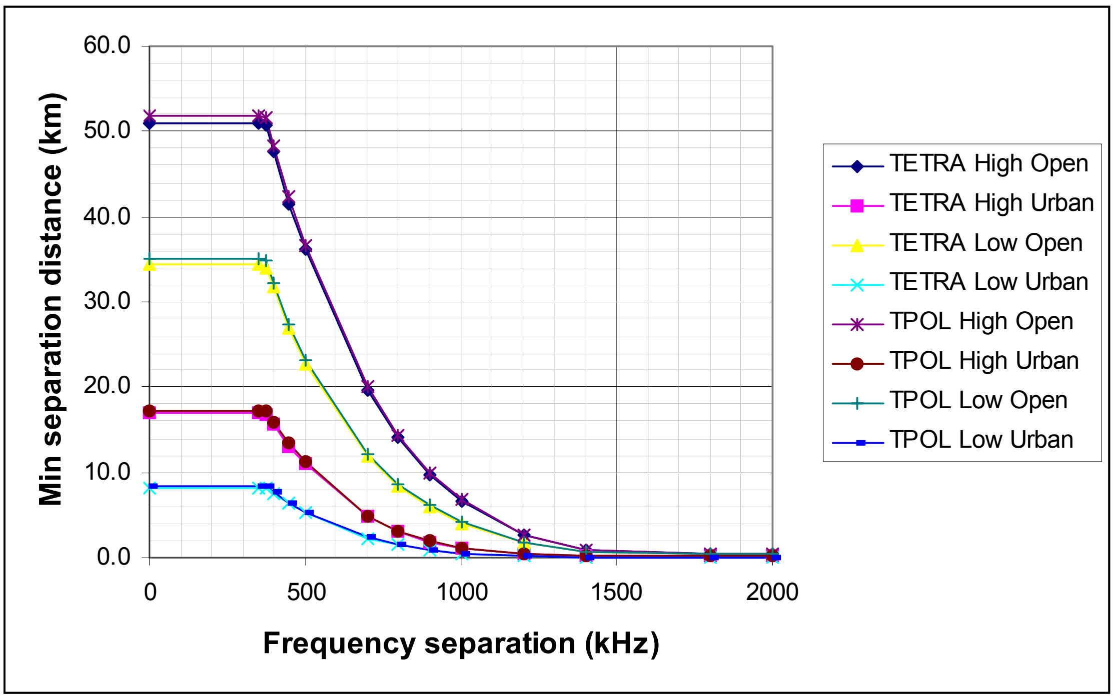


Figure A1.10 : TETRA/TETRAPOL victim of TRR, P.1546 Model

APPENDIX A. FRENCH TRR EXAMPLE (VICTIM)

The French MoD provided the selectivity curve measured on a real TRR equipment. The measurement stops at 42 dB, which was considered as a limitation of the measurement. For the MCL study, the measured curve has been extrapolated to the STANAG limit of 110 dB at 8 MHz.

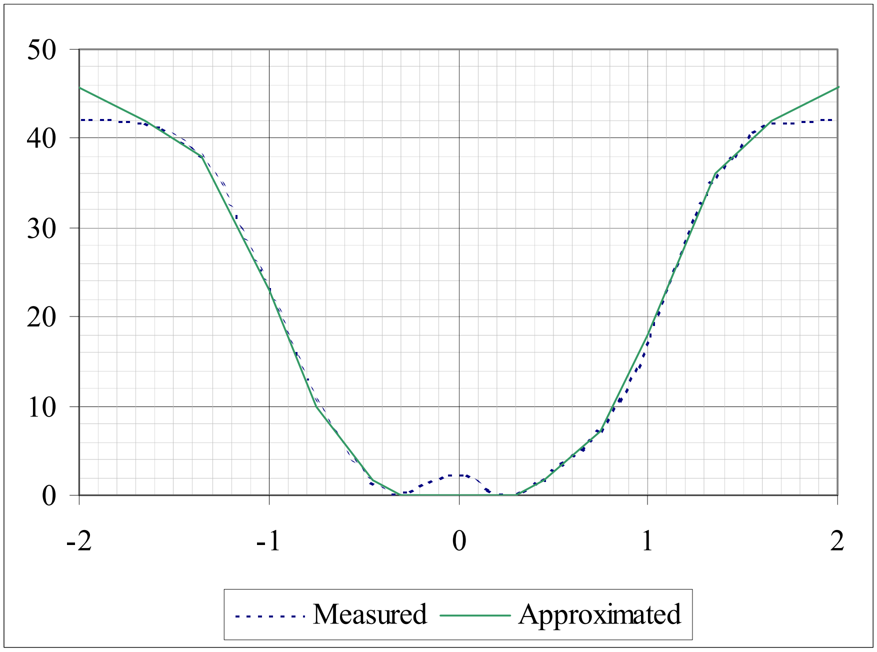


Figure A1.11 : French TRR Selectivity curve

The following results (TRR victim of TETRA) should be compared to the tables in paragraph 2.2 of this Annex 1.

df (kHz)	Dmin for TETRA interference to TRR, Open area, 6dB margin				
	BS High	BS Low	MS High	MS Low	HH
0.0	204.1	123.6	51.4	41.1	21.0
700.0	172.5	101.2	39.2	30.7	14.1
750.0	167.9	97.9	37.5	29.4	13.3
800.0	158.3	90.9	34.1	26.5	11.6
900.0	139.7	78.2	27.7	21.1	8.7
1000.0	122.5	66.8	22.1	16.1	6.5
1200.0	87.7	44.1	11.6	8.3	3.4
1400.0	63.7	29.6	6.6	4.7	1.9
1800.0	48.8	21.1	4.3	3.0	1.2
2000.0	39.9	17.9	3.7	2.6	1.1

Table A1.13 : TRR victim of TETRA

The following results (TRR victim of TETRAPOL) should be compared to the tables in paragraph 2.3 of this Annex 1.

df (kHz)	Dmin for TETRAPOL interference to TRR, Open area, 6dB margin				
	BS High	BS Low	MS High	MS Low	HH
0.0	204.1	123.6	51.4	41.1	21.0
700.0	172.4	101.2	39.1	30.7	14.1
750.0	168.2	97.8	37.5	29.4	13.3
800.0	158.5	91.2	34.1	26.5	11.6
900.0	139.9	78.2	27.6	21.1	8.7
1000.0	122.5	66.8	22.1	16.1	6.5
1200.0	87.6	44.1	11.6	8.3	3.4
1400.0	63.7	29.5	6.6	4.7	1.9
1800.0	48.8	21.0	4.3	3.0	1.2
2000.0	39.8	17.8	3.7	2.6	1.1

Table A1.14 : TRR victim of TETRAPOL

ANNEX 2: SEAMCAT INPUT DATA

INTRODUCTION

A limited number of the TRR and TETRA interfering scenarios are given in Table A2.1 below, it was agreed that scenarios number 2, 3, 6, 7, 10, 11, 14 and 15 would cover most of the requirements and only these have been included within the Annex. Additionally some scenarios have an “A” placed after the number, when those scenarios additionally used ITU-R Rec. P.1546 model in performing the simulation. The annex contains the input parameters in detail for these scenarios that have been used in the SEAMCAT simulations.

The various interference scenarios that may exist are detailed below in Table A2.1.

Scenario	**Interferer**	Victim
1	**TRR**	TETRA-MS (HH) served by HP BS
2	**TRR**	TETRA-MS (HH) served by LP BS
3	**TRR**	TETRA-MS (VM) served by HP BS
4	**TRR**	TETRA-MS (VM) served by LP BS
5	TETRA-BS (HP) serving HH Terminal	**TRR**
6	TETRA-BS (LP) serving HH Terminal	**TRR**
6A	TETRA-BS (LP) serving HH Terminal	**TRR**
7	TETRA-BS (HP) serving VM Terminal	**TRR**
7A	TETRA-BS (HP) serving VM Terminal	**TRR**
8	TETRA-BS (LP) serving VM Terminal	**TRR**
5	**TRR**	TETRA-BS (HP) serving HH Terminal
10	**TRR**	TETRA-BS (LP) serving HH Terminal
10A	**TRR**	TETRA-BS (LP) serving HH Terminal
11	**TRR**	TETRA-BS (HP) serving VM Terminal
11A	**TRR**	TETRA-BS (HP) serving VM Terminal
12	**TRR**	TETRA-BS (LP) serving VM Terminal
13	TETRA-MS (HH) served by HP BS	**TRR**
14	TETRA-MS (HH) served by LP BS	**TRR**
15	TETRA-MS (VM) served by HP BS	**TRR**
16	TETRA-MS (VM) served by LP BS	**TRR**

Table A2.1

PROCEDURE

Prior to building the scenarios in SEAMCAT, the details of the all the transceivers and antennas should be entered into the SEAMCAT library. These will then be used as required in the various scenarios.

The scenarios that can be built as detailed in Appendix 1 and 2.

APPENDIX 1 OF ANNEX 2

Scenario	2	3	10	10A	11	11A
X.1: Victim link						
Reference:	TETRA-MS (HH)	TETRA-MS (VM)	TETRA-BS (LP)	TETRA-BS (LP)	TETRA-BS (HP)	TETRA-BS (HP)
Frequency:	918 MHz	918 MHz	873 MHz	873 MHz	873 MHz	873 MHz
Use wanted transmitter:	Yes	Yes	Yes	Yes	Yes	Yes
X.1.1: Victim Receiver						
Reference:	TETRA-MS (HH)	TETRA-MS (VM)	TETRA-BS (LP)	TETRA-BS (LP)	TETRA-BS (LP)	TETRA-BS (LP)
C/I:	19 dB	19 dB	19 dB	19 dB	19 dB	19 dB
C/(I+N):	19 dB	19 dB	19 dB	19 dB	19 dB	19 dB
(N+I)/N:	0	0	0	0	0	0
Noise floor:	-122 dBm	-122 dBm	-125 dBm	-125 dBm	-125 dBm	-125 dBm
Blocking response:	Library	Library	Library	Library	Library	Library
Blocking mode:	Sensitivity	Sensitivity	Sensitivity	Sensitivity	Sensitivity	Sensitivity
Sensitivity:	-103 dBm	-103 dBm	-106 dBm	-106 dBm	-106 dBm	-106 dBm
Bandwidth receiver:	18 khz	18 khz	18 khz	18 khz	18 khz	18 khz
Antenna height:	1.5 m	1.5 m	10 m	10 m	60 m	60 m
Antenna azimuth:	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform
Antenna elevation:	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant
X.1.1.1: Antenna						
Reference:	TETRA-MS (HH)	TETRA-MS (VM)	TETRA-BS	TETRA-BS	TETRA-BS	TETRA-BS
Description:	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Maximum gain:	-3 dBi	6 dBi	6 dBi	6 dBi	6 dBi	6 dBi
X.1.2: Wanted Transmitter						
Reference:	TETRA-BS (LP)	TETRA-BS (HP)	TETRA-MS (HH)	TETRA-MS (HH)	TETRA-MS (VM)	TETRA-MS (VM)
Power:	37 dBm	44 dBm	30 dBm	30 dBm	40 dBm	40 dBm
Antenna height:	20 m	60 m	1.5 m	1.5 m	1.5 m	1.5 m
Antenna azimuth:	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform
Antenna elevation:	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant
X.1.2.1: Antenna						
Reference:	TETRA-BS	TETRA-BS	TETRA-MS (HH)	TETRA-MS (HH)	TETRA-MS (VM)	TETRA-MS (VM)
Description:	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Maximum gain:	6 dBi	6 dBi	-3 dBi	-3 dBi	6 dBi	6 dBi

X.1.3: WTx-VRx path						
Computation of the cell radius:	User defined radius	User defined radius	User defined radius	User defined radius	User defined radius	User defined radius
Fixed radius:	3.25 km	15 km	3.25 km	3.25 km	15 km	15 km
Correlation:	No	No	No	No	No	No
Radio path length:	Uniform polar	Uniform polar	Uniform polar	Uniform polar	Uniform polar	Uniform polar
Path Azimuth VR:	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform
X.1.3.1: Propagation model						
Model:	Hata	Hata	Hata	P.1546	Hata	P.1546
Median Loss:	Yes	Yes	Yes	Yes	Yes	Yes
Variation:	Yes	Yes	Yes	Yes	Yes	Yes
Environment:	Urban	Rural	Urban	Urban	Rural	Rural
...at WT:	Outdoor	Outdoor	Outdoor	Outdoor	Outdoor	Outdoor
...at VR:	Outdoor	Outdoor	Outdoor	Outdoor	Outdoor	Outdoor
Propagation:	Above Roof	Above Roof	Above Roof	Above Roof	Above Roof	Above Roof
X.2: Interfering link 1						
Reference:	TRR-TETRA –MS (HH)-ILK1	TRR-TETRA-MS (VM)-ILK1	TRR-TETRA-BS (LP)-ILK1	TRR-TETRA-BS (LP)-ILK1	TRR-TETRA-BS (HP)-ILK1	TRR-TETRA-BS (HP)-ILK1
Frequency:	918 MHz, 0.5 MHz steps to 3 MHz	918 MHz, 0.5 MHz steps to 3 MHz	873 MHz, 0.5 MHz steps to 3 MHz	873 MHz, 0.5 MHz steps to 3 MHz	873 MHz, 0.5 MHz steps to 3 MHz	873 MHz, 0.5 MHz steps to 3 MHz
X.2.1: Interfering Transmitter						
Reference:	TRR	TRR	TRR	TRR	TRR	TRR
Transmitting power:	37 dBm	37 dBm	37 dBm	37 dBm	37 dBm	37 dBm
Unwanted mask:	Library	Library	Library	Library	Library	Library
Unwanted emission floor:	No	No	No	No	No	No
Transmitting bandwidth:	750 kHz	750 kHz	750 kHz	750 kHz	750 kHz	750 kHz
Reference bandwidth:	750 kHz	750 kHz	750 kHz	750 kHz	750 kHz	750 kHz
Power Control:	No	No	No	No	No	No
PC-Step:	----	----	----	----	----	----
Minimal received power:	----	----	----	----	----	----
Maximum received power:	----	----	----	----	----	----
Antenna height:	25 m	25 m	25 m	25 m	25 m	25 m
Antenna azimuth:	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform
Antenna elevation:	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant

X.2.1.1: Antenna						
Reference:	TRR	TRR	TRR	TRR	TRR	TRR
Description:	Directional	Directional	Directional	Directional	Directional	Directional
Maximum gain:	16 dBi	16 dBi	16 dBi	16 dBi	16 dBi	16 dBi
X.2.2: Wanted Receiver						
(only for power control)						
Reference:	TRR	TRR	TRR	TRR	TRR	TRR
Antenna height:	25 m	25 m	25 m	25 m	25 m	25 m
Antenna azimuth:	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform
Antenna elevation:	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant
X.2.2.1: Antenna						
Reference:	TRR	TRR	TRR	TRR	TRR	TRR
Description:	Directional	Directional	Directional	Directional	Directional	Directional
Maximum gain:	16 dBi	16 dBi	16 dBi	16 dBi	16 dBi	16 dBi
X.2.2.2: ITx-VRx path						
Computation of the simulation radius						
Active interferers:	1	1	1	1	1	1
Density of active interferers:	0.0075 users/km^2	0.0075 users/km^2	0.0075 users/km^2	0.0075 users/km^2	0.0075 users/km^2	0.0075 users/km^2
Probability of transmission:	1	1	1	1	1	1
Activity per hour:	1	1	1	1	1	1
Correlation:	None	None	None	None	None	None
Radio path length:	uniform polar	uniform polar	uniform polar	uniform polar	uniform polar	uniform polar
Path Azimuth:	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform
X.2.2.3: Propagation model						
see X.1.3.1						
X.2.2.4: ITx WRx path						
Computation of the radio coverage of the interferer						
Mode:	Traffic limited	Traffic limited	Traffic limited	Traffic limited	Traffic limited	Traffic limited
Density of interferers:	0.0075 users/km^2	0.0075 users/km^2	0.0075 users/km^2	0.0075 users/km^2	0.0075 users/km^2	0.0075 users/km^2
Number of channels:	1	1	1	1	1	1
User per channel:	1	1	1	1	1	1
Frequency cluster:	1	1	1	1	1	1

Correlation:	None	None	None	None	None	None
Radio path length:	uniform polar	uniform polar	uniform polar	uniform polar	uniform polar	uniform polar
Path Azimuth:	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform
X.2.2.5: Propagation model						
see X.1.3.1						
X.3: Simulation control						
X.3.1: Event generation						
Number of samples:	20000	20000	20000	20000	20000	20000
Stop of simulation:	Number of events	Number of events	Number of events	Number of events	Number of events	Number of events
X.3.2: Distribution evaluation						
This evaluation is used to test the distribution to Gaussian and/or to stop the calculation, if a sufficient reliability of the results are given in the case of DEE-Mode.						
X.3.3: Test of the simulation						
X.3.3.1: Calculated radius						
Cell radius of the wanted system:						
…interfering system 1:						
…simulation radius 1:						
X.3.3.2: Generated Signals						
dRSS: mean:						
iRSS unwanted: mean:						
iRSS blocking: mean:						
X.3.3.3 : Correlation Exceptions						
X.4: Interference calculation						
X.4.1: ICE calculation						
Algorithms:	Quick	Quick	Quick	Quick	Quick	Quick
Number of samples:	2000	2000	2000	2000	2000	2000
Compatibility mode:	0	0	0	0	0	0
Unwanted emissions:	Yes	Yes	Yes	Yes	Yes	Yes
Blocking"	Yes	Yes	Yes	Yes	Yes	Yes
X.4.2: Result						
Probability:						

APPENDIX 2 OF ANNEX 2

Scenario	**6**	**6A**	**7**	**7A**	**14**	**15**
X.1: Victim Link						
Reference:	TRR	TRR	TRR	TRR	TRR	TRR
Frequency:	918 MHz	918 MHz	918 MHz	918 MHz	873 MHz	873 MHz
Use wanted transmitter:	Yes	Yes	Yes	Yes	Yes	Yes
X.1.1: Victim Receiver						
Reference:	TRR	TRR	TRR	TRR	TRR	TRR
C/I:	15 dB	15 dB	15 dB	15 dB	15 dB	15 dB
C/(I+N):	15 dB	15 dB	15 dB	15 dB	15 dB	15 dB
(N+I)/N:	0	0	0	0	0	0
Noise floor:	-108 dBm	-108 dBm	-108 dBm	-108 dBm	-108 dBm	-108 dBm
Blocking response:	Library	Library	Library	Library	Library	Library
Blocking mode:	Sensitivity	Sensitivity	Sensitivity	Sensitivity	Sensitivity	Sensitivity
Sensitivity:	-93 dBm	-93 dBm	-93 dBm	-93 dBm	-93 dBm	-93 dBm
Bandwidth receiver:	750 khz	750 khz	750 khz	750 khz	750 khz	750 khz
Antenna height:	25 m	25 m	25 m	25 m	25 m	25 m
Antenna azimuth:	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform
Antenna elevation:	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant
X.1.1.1: Antenna						
Reference:	TRR	TRR	TRR	TRR	TRR	TRR
Description:	Directional	Directional	Directional	Directional	Directional	Directional
Maximum gain:	16 dBi	16 dBi	16 dBi	16 dBi	16 dBi	16 dBi
X.1.2: Wanted Transmitter						
Reference:	TRR	TRR	TRR	TRR	TRR	TRR
Power:	37 dBm	37 dBm	37 dBm	37 dBm	37 dBm	37 dBm
Antenna height:	25 m	25 m	25 m	25 m	25 m	25 m
Antenna azimuth:	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform
Antenna elevation:	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant
X.1.2.1: Antenna						
Reference:	TRR	TRR	TRR	TRR	TRR	TRR

Description:	Directional	Directional	Directional	Directional	Directional	Directional
Maximum gain:	16 dBi	16 dBi	16 dBi	16 dBi	16 dBi	16 dBi
X.1.3: WTx-VRx path						
Computation of the cell radius:	User defined radius	User defined radius	User defined radius	User defined radius	User defined radius	User defined radius
Fixed radius:	50 km	50 km	50 km	50 km	50 km	50 km
Correlation:	No	No	No	No	No	No
Radio path length:	Uniform polar	Uniform polar	Uniform polar	Uniform polar	Uniform polar	Uniform polar
Path Azimuth VR:	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform
X.1.3.1: Propagation model						
Model:	Hata	P.1546	Hata	P.1546	Hata	Hata
Median Loss:	Yes	Yes	Yes	Yes	Yes	Yes
Variation:	Yes	Yes	Yes	Yes	Yes	Yes
Environment:	Urban	Urban	Rural	Rural	Urban	Rural
...at WT:	Outdoor	Outdoor	Outdoor	Outdoor	Outdoor	Outdoor
...at VR:	Outdoor	Outdoor	Outdoor	Outdoor	Outdoor	Outdoor
Propagation:	Above Roof	Above Roof	Above Roof	Above Roof	Above Roof	Above Roof
X.2: Interfering link 1						
Reference:	TETRA–BS (LP)-TRR-ILK1	TETRA–BS (LP)-TRR-ILK1	TETRA–BS (HP)-TRR-ILK1	TETRA–BS (HP)-TRR-ILK1	TETRA–MS (HH)-TRR-ILK1	TETRA–MS (VM)-TRR-ILK1
Frequency:	918 MHz, 0.25 MHz steps to 3 MHz	918 MHz, 0.25 MHz steps to 3 MHz	918 MHz, 0.25 MHz steps to 3 MHz	918 MHz, 0.25 MHz steps to 3 MHz	873 MHz, 0.25 MHz steps to 3 MHz	873 MHz, 0.25 MHz steps to 3 MHz
X.2.1: Interfering Transmitter						
Reference:	TETRA-BS (LP)	TETRA-BS (LP)	TETRA-BS (HP)	TETRA-BS (HP)	TETRA-MS (HH)	TETRA-MS (VM)
Transmitting power:	37 dBm	37 dBm	44 dBm	44 dBm	30 dBm	40 dBm
Unwanted mask:	Library	Library	Library	Library	Library	Library
Unwanted emission floor:	No	No	No	No	No	No
Transmitting bandwidth:	25 kHz	25 kHz	25 kHz	25 kHz	25 kHz	25 kHz
Reference bandwidth:	25 kHz	25 kHz	25 kHz	25 kHz	25 kHz	25 kHz
Power Control:	No	No	No	No	No	No
PC-Step:	----	----	----	----	----	----
Minimal received power:	----	----	----	----	----	----
Maximum received power:	----	----	----	----	----	----

Antenna height:	10 m	10 m	60 m	60 m	1.5 m	1.5 m
Antenna azimuth:	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform
Antenna elevation:	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant
X.2.1.1: Antenna						
Reference:	TETRA (BS)	TETRA (BS)	TETRA (BS)	TETRA (BS)	TETRA-MS (HH)	TETRA-MS (VM)
Description:	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Maximum gain:	6 dBi	6 dBi	6 dBi	6 dBi	-3 dBi	6 dBi
X.2.2: Wanted Receiver						
(only for power control)						
Reference:	TETRA-MS (HH)	TETRA-MS (HH)	TETRA-MS (VM)	TETRA-MS (VM)	TETRA-BS (LP)	TETRA-BS (HP)
Antenna height:	1.5 m	1.5 m	1.5 m	1.5 m	20 m	60 m
Antenna azimuth:	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform
Antenna elevation:	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant	0 Grad, constant
X.2.2.1: Antenna						
Reference:	TETRA-MS (HH)	TETRA-MS (HH)	TETRA-MS (VM)	TETRA-MS (VM)	TETRA (BS)	TETRA (BS)
Description:	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Maximum gain:	-3 dBi	-3 dBi	6 dBi	6 dBi	6 dBi	6 dBi
X.2.2.2: ITx-VRx path						
Computation of the simulation radius						
Active interferers:	1	1	1	1	1	1
Density of active interferers:	0.13 users/km^2	0.13 users/km^2	0.0026 users/km^2	0.0026 users/km^2	0.05 users/km^2	0.05 users/km^2
Probability of transmission:	1	1	1	1	1	1
Activity per hour:	1	1	1	1	1	1
Correlation:	None	None	None	None	None	None
Radio path length:	uniform polar	uniform polar	Uniform polar	uniform polar	uniform polar	uniform polar
Path Azimuth:	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform
X.2.2.3: Propagation model						
see X.1.3.1						
X.2.2.4: ITx WRx path						
Computation of the radio coverage of the interferer						
Mode:	Traffic limited	Traffic limited	Traffic limited	Traffic limited	Traffic limited	Traffic limited

Density of interferers:	0.13 users/km^2	0.13 users/km^2	0.0026 users/km^2	0.0026 users/km^2	0.05 users/km^2	0.05 users/km^2
Number of channels:	1	1	1	1	1	1
User per channel:	1	1	1	1	1	1
Frequency cluster:	1	1	1	1	1	1
Correlation:	None	None	None	None	None	None
Radio path length:	uniform polar	uniform polar	uniform polar	uniform polar	uniform polar	uniform polar
Path Azimuth:	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform	0-360 Grad, uniform
X.2.2.5: Propagation model						
see X.1.3.1						
X.3: Simulation control						
X.3.1: Event generation						
Number of samples:	20000	20000	20000	20000	20000	20000
Stop of simulation:	Number of events	Number of events	Number of events	Number of events	Number of events	Number of events
X.3.2: Distribution evaluation						
This evaluation is used to test the distribution to Gaussian and/or to stop the calculation, if a sufficient reliability of the results are given in the case of DEE-Mode.						
X.3.3: Test of the simulation						
X.3.3.1: Calculated radius						
Cell radius of the wanted system:						
…interfering system 1:						
…simulation radius 1:						
X.3.3.2: Generated Signals						
dRSS: mean:						
iRSS unwanted: mean:						
iRSS blocking: mean:						
X.3.3.3 : Correlation Exceptions						
X**.4: Interference calculation**						

X.4.1: ICE calculation						
Algorithms:	Quick	Quick	Quick	Quick	Quick	Quick
Number of samples:	2000	2000	2000	2000	2000	2000
Compatibility mode:	0	0	0	0	0	0
Unwanted emissions:	Yes	Yes	Yes	Yes	Yes	Yes
Blocking"	Yes	Yes	Yes	Yes	Yes	Yes
X.4.2: Result						
Probability:						

ANNEX 3: STANDARD SEAMCAT SIMULATION REPORT

INTRODUCTION

This annex contains the results of the SEAMCAT simulations for the scenarios as discribed in Annex 2.

Table A3.1 provides a summary of the results.

Table A3.1

Scenario	Interferer	Victim	Probability	Wanted Tx coverage radius	Interfering Tx coverage radius	Interfering simulation radius
2	TRR	TETRA-MS (HH) served by LP BS	4.12%	3.25	6.51	6.51
3	TRR	TETRA-MS (VM) served by HP BS	10.27%	15	6.51	6.51
6	TETRA-BS (LP) serving HH Terminal	TRR	46.19%	50	1.56	1.56
6A	TETRA-BS (LP) serving HH Terminal	TRR	56.36%	50	1.56	1.56
7	TETRA-BS (HP) serving VM Terminal	TRR	51.71%	50	11.06	11.06
7A	TETRA-BS (HP) serving VM Terminal	TRR	52.64%	50	11.06	11.06
10	TRR	TETRA-BS (LP) serving HH Terminal	26.40%	3.25	6.51	6.51
10A	TRR	TETRA-BS (LP) serving HH Terminal	60.00%	3.25	6.51	6.51
11	TRR	TETRA-BS (HP) serving VM Terminal	23.75%	15	6.51	6.51
11A	TRR	TETRA-BS (HP) serving VM Terminal	31.27%	15	6.51	6.51
14	TETRA-MS (HH) served by LP BS	TRR	10.52%	50	2.52	2.52
15	TETRA-MS (VM) served by HP BS	TRR	54.18%	50	2.52	2.52

SEAMCAT RESULTS FOR SCENARIO OF ANNEX 2 APPENDIX 1

Scenario	**2**	**3**	**10**	**10A**	**11**	**11A**
Event generation						
EGE Number of events :	20000	20000	20000	20000	20000	20000
EGE Expected duration :	1 min	1 min	1 min	1 min	1 min	1 min
EGE Termination condition :	Number of events	Number of events	Number of events	Number of events	Number of events	Number of events
Distribution evaluation						
DEE incremental number of events :	2000	2000	2000	2000	2000	2000
DEE stability threshold :	0.8	0.8	0.8	0.8	0.8	0.8
DEE identification threshold :	0.2	0.2	0.2	0.2	0.2	0.2
DEE correlation threshold :	0.8	0.8	0.8	0.8	0.8	0.8
Calculated radius						
Wanted transmitter coverage radius :	3.25 Km	15 Km	3.25 Km	3.25 Km	15 Km	15 Km
Interfering transmitter coverage radius 1 :	6.51470015870539 Km	6.51470015870539 Km	6.51470015870539 Km	6.51470015870539 Km	6.51470015870539 Km	6.51470015870539 Km
Interfering transmitter simulation radius 1 :	6.51470015870539 Km	6.51470015870539 Km	6.51470015870539 Km	6.51470015870539 Km	6.51470015870539 Km	6.51470015870539 Km
Generated signals						
dRSS						
dRSS vector :	Array(20000)	Array(20000)	Array(20000)	Array(17655)	Array(20000)	Array(19446)
Standard deviation :	12.0	11.5	11.9	8.7	11.5	10.7
Mean :	-100.7	-69.9	-113.1	-131.5	-73.7	-92.7
iRSS Unwanted						
iRSS Unwanted 1 :	Array(20000)	Array(20000)	Array(20000)	Array(17655)	Array(20000)	Array(19446)
Standard deviation :	34.4	34.6	34.7	34.2	33.9	34.1
Mean :	-177.4	-139.7	-146.2	-168.5	-121.8	-126.4
Unwanted Summation vector :	Array(20000)	Array(20000)	Array(20000)	Array(17655)	Array(20000)	Array(19446)
Standard deviation :	34.4	34.6	34.7	34.2	33.9	34.1
Mean :	-177.4	-139.7	-146.2	-168.5	-121.8	-126.4

iRSS Blocking						
iRSS Blocking 1 :	Array(20000)	Array(20000)	Array(20000)	Array(17655)	Array(20000)	Array(19446)
Standard deviation :	15.5	15.4	16.5	15.1	14.1	14.5
Mean :	-217.0	-179.4	-188.0	-210.4	-165.0	-169.5
Blocking Summation vector :	Array(20000)	Array(20000)	Array(20000)	Array(17655)	Array(20000)	Array(19446)
Standard deviation :	15.5	15.4	16.5	15.1	14.1	14.5
Mean :	-217.0	-179.4	-188.0	-210.4	-165.0	-169.5
iRSS Intermodulation						
Correlation						
Exception						
Propagation models :	0	0	0	2345	0	554
Pattern :	0	0	0	0	0	0
Random variables :	0	0	0	0	0	0
Masks :	0	0	0	0	0	0
Signal summation :	0	0	0	0	0	0
Geometric calculations :	0	0	0	0	0	0
Interference calculation						
ICE calculation 0						
ICE algorithm:	Quick	Quick	Quick	Quick	Quick	Quick
ICE samples number:	2000	2000	2000	2000	2000	2000
Interference criteria:	0	0	0	0	0	0
ICE compatibility mode:	0	0	0	0	0	0
Use unwanted signal type:	Yes	Yes	Yes	Yes	Yes	Yes
Use blocking signal type:	Yes	Yes	Yes	Yes	Yes	Yes
Use intermodulation signal type:	No	No	No	No	No	No
Probability result:	Constant(0.0412)	Constant(0.1027)	Constant(0.2640)	Constant(0.6000)	Constant(0.2375)	Constant(0.3127)

SEAMCAT RESULTS FOR SCENARIO OF ANNEX 2 APPENDIX 2

Scenario	**6**	**6A**	**7**	**7A**	**14**	**15**
Event generation						
EGE Number of events :	20000	20000	20000	20000	20000	20000
EGE Expected duration :	1 min	1 min	1 min	1 min	1 min	1 min
EGE Termination condition :	Number of events	Number of events	Number of events	Number of events	Number of events	Number of events
Distribution evaluation						
DEE incremental number of events :	2000	2000	2000	2000	2000	2000
DEE stability threshold :	0.8	0.8	0.8	0.8	0.8	0.8
DEE identification threshold :	0.2	0.2	0.2	0.2	0.2	0.2
DEE correlation threshold :	0.8	0.8	0.8	0.8	0.8	0.8
Calculated radius						
Wanted transmitter coverage radius :	50 Km	50 Km	50 Km	50 Km	50 Km	50 Km
Interfering transmitter coverage radius 1 :	1.5647803635108 Km	1.5647803635108 Km	11.0646680610604 Km	11.0646680610604 Km	2.52313252202008 Km	2.52313252202008 Km
Interfering transmitter simulation radius 1 :	1.5647803635108 Km	1.5647803635108 Km	11.0646680610604 Km	11.0646680610604 Km	2.52313252202008 Km	2.52313252202008 Km
Generated signals						
dRSS						
dRSS vector :	Array(20000)	Array(11779)	Array(20000)	Array(19849)	Array(20000)	Array(20000)
Standard deviation :	23.4	23.0	22.8	19.2	18.9	18.1
Mean :	-127.4	-137.8	-99.6	-131.3	-127.2	-99.6
iRSS Unwanted						
iRSS Unwanted 1 :	Array(20000)	Array(11779)	Array(20000)	Array(19849)	Array(20000)	Array(20000)
Standard deviation :	30.2	28.5	30.9	31.4	28.6	29.8
Mean :	-126.8	-128.2	-126.3	-136.7	-167.1	-123.8
Unwanted Summation vector :	Array(20000)	Array(11779)	Array(20000)	Array(19849)	Array(20000)	Array(20000)
Standard deviation :	30.2	28.5	30.9	31.4	28.6	29.8
Mean :	-126.8	-128.2	-126.3	-136.7	-167.1	-123.8

iRSS Blocking						
iRSS Blocking 1 :	Array(20000)	Array(11779)	Array(20000)	Array(19849)	Array(20000)	Array(20000)
Standard deviation :	32.6	31.1	31.6	32.2	32.6	32.4
Mean :	-104.7	-106.1	-99.9	-110.6	-148.9	-101.6
Blocking Summation vector :	Array(20000)	Array(11779)	Array(20000)	Array(19849)	Array(20000)	Array(20000)
Standard deviation :	32.6	31.1	31.6	32.2	32.6	32.4
Mean :	-104.7	-106.1	-99.9	-110.6	-148.9	-101.6
iRSS Intermodulation						
Correlation						
Exception						
Propagation models :	0	8221	0	151	0	0
Pattern :	0	0	0	0	0	0
Random variables :	0	0	0	0	0	0
Masks :	0	0	0	0	0	0
Signal summation :	0	0	0	0	0	0
Geometric calculations :	0	0	0	0	0	0
Interference calculation						
ICE calculation 0						
ICE algorithm :	Quick	Quick	Quick	Quick	Quick	Quick
ICE samples number :	2000	2000	2000	2000	2000	2000
Interference criteria :	0	0	0	0	0	0
ICE compatibility mode :	0	0	0	0	0	0
Use unwanted signal type :	Yes	Yes	Yes	Yes	Yes	Yes
Use blocking signal type :	Yes	Yes	Yes	Yes	Yes	Yes
Use intermodulation signal type:	No	No	No	No	No	No
Probability result :	Constant(0.4619)	Constant(0.5636)	Constant(0.5171)	Constant(0.5264)	Constant(0.1052)	Constant(0.5418)

ANNEX 4 : DEFINITION OF THE TWO-STEP APPROACH

1st STEP = « overall » scenario =

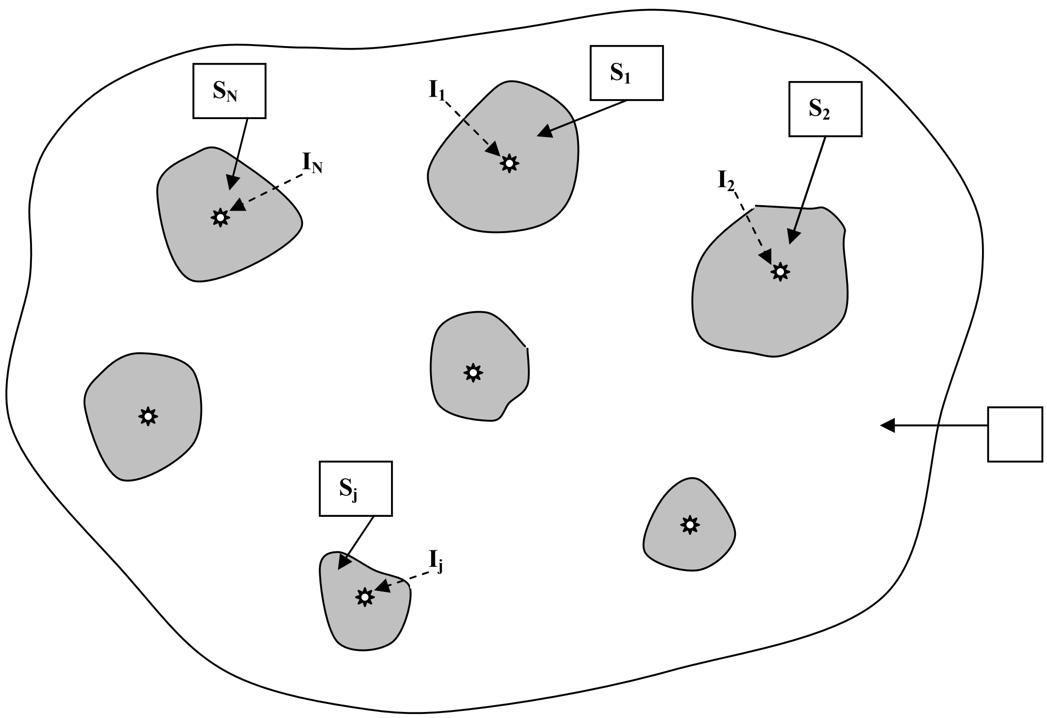
- d= interferers density
  = actual density (for exemple in the case of T.R.R.= 0.0025km^{-2})
- N= interferers number = to be choosen large enough, for exemple 5<N<20

So $R_{simu} = \sqrt{(N/\pi d)}$

Result1.1 =

P_1 = overall probability of interference

« What is the geographical meaning of P_1 ? »



With : S = overall area of the scenario
$I_1, I_2, \ldots I_j, \ldots I_N$ = interferers
S_j = individual interfering area around each I_j such as =

- If the victim stays within one S_j, interference occurs
- If the victim stays outside, no interference occurs

Therefore : $P1 = (S1 + S2 + \ldots\ldots Sj + \ldots\ldots.. SN) / S$

$= N.aver(S_I) / S$ (aver(S_I) being the mean of S_1, S_2 … S_j,……..S_N)

$= N\pi R_I^2 / S$ (aver(S_I) being considered as a circle)

Considering also: S = N / d,

We obtain : $\mathbf{P_1 = d\pi R_I^2}$

R_I being a rough estimation of the seraration distance

Result 1.2 =

R_I = estimation of the seraration distance = $\sqrt{}$ (P_1 / π.d)

(see ERC report 101 §2.4)

2nd STEP = « risky » scenario =

« What happens more precisely, when the victim is close to one I_j ?»

To answer the Seamcat scenario to be used in that case is=

- **1 interferer only**
- **R_{simu} = to be choosen** around RI above (for exemple between 0.5 and 2.0 RI)

The density of interferers has therefore to be equal to = 1 / π Rsimu2

The result of the simulation is P_2 as a function of Rsimu with =

Result 2 =

$P_2(R_{simu})$ = Probability of interference when the distance between the victim and one interferer is less than R_{simu}

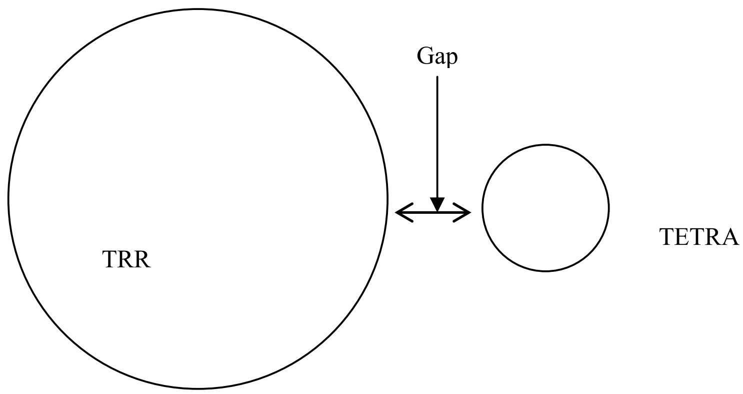
So the risk of interference can be estimated as a function of the geographical separation between victim and interferer.

ANNEX 5: PRINCIPLES ON THE USE OF SEAMCAT EXTENDED TO GEOGRAPHICALLY SEPARATED OPERATIONAL AREAS

1 DESCRIPTION OF THE PROBLEM

For this study, it was requested that SEAMCAT should simulate the interference from a military Tactical Radio Relay to a private mobile radio cell which would be employing TETRA technology. It was assumed that each of these technologies would be in geographically separated areas although the possibility that they might overlap was to be considered. It was decided that, for the convenience of calculation, the TETRA cell and the military training area would be represented as circles of coverage. The radius of the TETRA cell would vary to represent the environments which might be expected in practice. The radius of the military training area would be approximately 55 kilometres. This radius is larger than is likely to be encountered in practice.

The scenario might be depicted approximately as follows:



2 DESCRIPTION OF THE SOLUTION

In order to solve this problem a decision was made that it would be necessary to employ the feature within SEAMCAT which permits the operator to enter the distance between the interferer and the victim as a distribution. It was evident that three separate steps would be needed in order to use this process. These include:

i. Derive the distribution

ii. Determine a method of operation which would permit the accuracy to be validated

iii. Execute the calculations using SEAMCAT, correcting any errors revealed by the process of validation.

2.1 Deriving the Distribution

It was decided that Monte Carlo modelling should be used to construct the distribution. It was assumed that the users would be evenly distributed both throughout the cell and through the area of use of the Tactical Radio Relay:

i. A uniform polar distribution was used to simulate the even distribution of victims and interferers. The same method is available in SEAMCAT

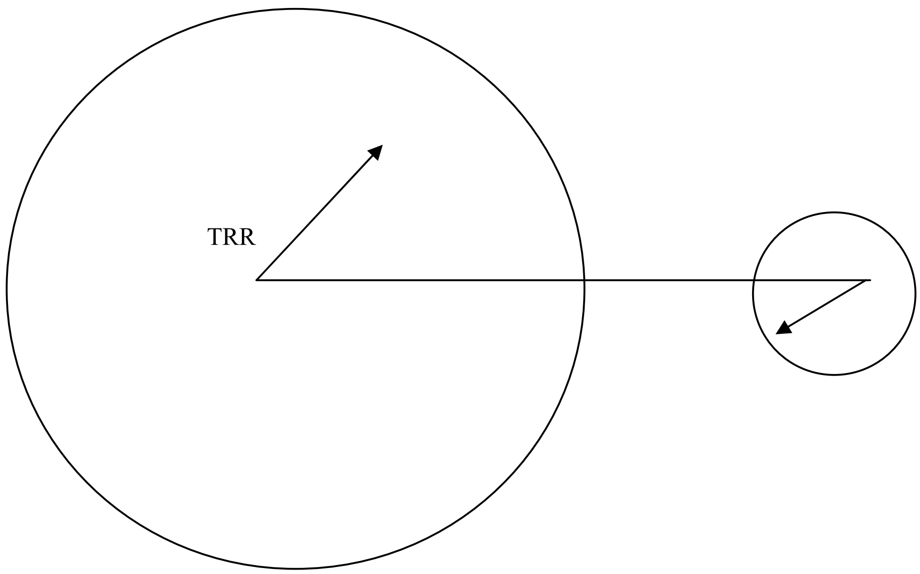
ii. The maximum simulation radius would be the maximum distance at which an interferer might be found. This would ensure that the number of interferers remained the product of the area of the Tactical Radio Relay cell and the user density.

iii. When the victim was the TETRA base station the radius over which the victim could be distributed should be set to zero.

A computer program was developed which calculated the distribution using conventional mathematical methods. It also calculated the simulation radius. This computer program has been supplied to the SEAMCAT management committee.

2.1.1 Mathematical Processes

The scenario described included a TETRA cell which would be located close to a military training area in which Tactical Radio Relays can be used:



In mathematical terms this may be represented as two central points separated by a configurable distance in which the users may be distributed radially around these two points, thus:

The distance between the two users would be the distance between the heads of the arrows. This distance may be easily calculated as follows:

i. Polar mathematics is used to define the positions of the interferer and the victim

ii. The radial angle is randomly distributed between 0 and 360 degrees (0 and 2π radians)

iii. The distance is distributed according to the maximum radius of the cell or area multiplied by the square root of a random number. This process has been demonstrated to randomly distribute users/interferers by area within a circle when polar mathematics is in use. It is one of the methods used for this purpose by SEAMCAT. In SEAMCAT it is referred to as the Uniform Polar Distribution.

iv. The polar co-ordinates are then converted to orthogonal co-ordinates relative to the line between the two centres

v. The distance between them is calculated using Pythagoras's method

vi. The distance found is loaded to a histogram by incrementing the total number of events within the bar of the histogram which encompasses that distance

vii. This process is carried out many 1,000s of times to yield a distribution

viii. The distribution is converted to a percentage.

2.1.1 Proving the Mathematical Process

In order to test the mathematical process for developing the distribution, the radii were reduced and the distances were stretched such that the comparison of the histogram generated with that which should be statistically expected was relatively easy. The radii were then increased and the manner in which the distribution became skewed was confirmed against the manner in which this should be forecast to occur. Finally the distance between the areas was reduced to close to zero and one radius was also reduced to nearly zero to confirm that the distribution would match that which may be determined using the uniform polar distribution.

When the model was updated to use a logarithmic basis for the histogram it became impossible to use visual inspection of the histogram to confirm the accuracy but the cumulative figures were checked against the cumulative figures produced by the previous version. This earlier version was checked as described in the previous paragraph.

2.2 Validating the Accuracy

It was noted that the radius of the area in which Tactical Radio Relays would be deployed was much greater than the radius of the TETRA cell. It was realised that if the calculations were carried out with the TETRA cell very far inside the area of use of Tactical Radio Relays this would be very close to the scenario in which the TRRs would be uniformly distributed around the TETRA victim. A comparison could be made between the proposed method and the standard method used within SEAMCAT.

When the technique had been proved the victim could be moved out of the area of use of TRRs in order to match the scenario which had been requested.

The detailed procedure used included:

i. The model was reduced to a single frequency instead of using the band which had been specified. The purpose of this was to reduce the number of variables. The model would be converted back to the full band when the assumptions had been proved.

ii. The method for assessing a single interferer within a TETRA cell within SEAMCAT has been proved in the past using mathematics and paper based calculations. If a large area of TRRs was assumed and the TETRA cell was placed within this area then the level of interference should be approximately the same using the calculated distribution as would occur using the established techniques.

iii. When tests were run using both a single interferer and multiple interferers, the models used were Uniform by Area and Uniform Polar. It was found that the results diverged as the number of interferers was increased. In order to establish which of these options was correct a Monte Carlo model was devised to reveal the RSS for the distribution of interferers which would occur in practise. It was found that Uniform Polar matched the performance of this model whilst Uniform by Area diverged as the number of interferers increased. The Uniform Polar distribution was selected as the basis for future testing.

iv. The number of interferers and the simulation radius were raised using the Uniform Polar distribution whilst the TETRA cell was still enclosed in the area of TRRs. This was then matched against the number of interferers and the simulation characteristics derived from the distribution which had been calculated using the Monte Carlo model. As a result of this process the Monte Carlo model was amended to reduce the granularity in those distances which are closest to the victim.

v. Following the successful proving of the method the single frequency was converted to the full band and the distance between the TETRA cell and the TRR area was increased such that it represented the layout which was to be tested.

2.3 Executing the SEAMCAT Model

The SEAMCAT model was applied to the process of validation which has been described above:

i. It was learnt that the standard distribution of interferers within SEAMCAT which most closely met the requirement to distribute the TRRs was the uniform polar distribution.

ii. It was learnt that the increments used for the distribution of users against distance were not small enough in the region closest to the victim. The method of distribution of the increments was changed from a uniform distribution to a logarithmic distribution in order to overcome this problem.

Following the process of validation the model was used with SEAMCAT to assess the interference between TETRA and the Tactical Radio Relays.

3 USING THE SOFTWARE TOOL

Copies of the software which was used to model the distribution of tactical radio relays are available from UK RA. Both the source code and instructions for its use are included. The software tool needs to be configured to permit it to represent the range of interference scenarios which were studied. The methods of configuration include:

TRR to TETRA mobile
- enter figures for both the TETRA cell and the TRR area

TRR to TETRA base station
- set the TETRA cell radius to zero and enter the figure for the TRR area

TETRA Base Station to TRR
- set the TETRA cell radius to zero and enter the figure for the TRR area

TETRA Mobile to TRR
- enter figures for both the TETRA cell and the TRR area

ANNEX 6 : RESULTS OF THE SEAMCAT STUDY EXTENDED TO GEOGRAPHICALLY SEPARATED OPERATIONAL AREAS

The tables show the results from the execution of the SEAMCAT model with a range of distances between the operational areas for the two technologies. The primary purpose of the test was to reveal the interference between geographically separated areas but, as is explained in Annex 5, it was necessary to demonstrate that the results obtained were consistent with Standard SEAMCAT by starting within the area of coverage and progressively separating the two areas of operation.

The distances which are entitled Gap 0, 10, 20, 30, 150 describe the separated operational areas with a gap between them which varies from just touching for "Gap 0" to 150 kilometres for "Gap 150".
The remaining descriptions have the meanings shown below. It should be noted that the operational area of the TRRs has a much greater diameter than that of the TETRA cell:

- "All In" – describes the operational area for the TETRA cell which is completely surrounded by the operational area of the TRRs and there is a significant distance between the edge of the TETRA cell and the edge of the operational area of the TRRs.
- "Just In" – describes the occasions when the TETRA cell is completely surrounded by the operational area of the TRRs but the edge of the TETRA cell touches the edge of the operational area for the TRRs.
- "On" – describes a situation in which the TETRA base station is located on the edge of the operational area for the TRRs.

For each of the scenarios provided below, it was considered not necessary to run simulations in all cases. These are marked with NR (not required).

Scenario 2
Interferer **TRR**
Victim **TETRA-MS (HH) served by LP BS**

TRR Environment		**Rural**	**Rural**	**Urban**	**Urban**
AID		**0.003**	**0.0075**	**0.003**	**0.0075**
Name					
All in		27.93%	52.22%	2.66%	6.49%
Just in		23.25%	44.93%	2.24%	5.42%
On		19.26%	39.63%	1.51%	3.62%
Gap0		16.38%	33.03%	0.65%	1.95%
Gap5		12.12%	25.88%	0.41%	0.90%
Gap10		9.10%	19.89%	0.22%	0.65%
Gap20		5.04%	12.23%	0.14%	0.31%
Gap30		2.82%	6.85%	0.08%	0.25%

Scenario 3
Interferer **TRR**
Victim **TETRA-MS (VM) served by HP BS**

AID		**0.003**	**0.0075**
Name			
All in		7.81%	18.68%
Just in		7.48%	17.40%
On		4.33%	10.27%
Gap0		1.07%	2.53%
Gap5		0.75%	1.83%
Gap10		0.62%	1.66%
Gap20		0.46%	1.20%
Gap30		0.39%	0.87%

Scenario 6
Interferer **TETRA-BS (LP) serving HH Terminal**
Victim **TRR**

TRR Environment		**Urban**	**Urban**	**Rural**	**Rural**
TETRA Cell Radius (km)		**3.25**	**5**	**3.25**	**5**
AID		**0.03**	**0.013**	**0.03**	**0.013**
Name					
All in		4.72%	6.63%	0.45%	0.51%
Just in		4.04%	4.15%	0.29%	0.37%
On		3.35%	3.17%	0.23%	0.26%
Gap0		3.33%	2.75%	0.18%	0.17%
Gap5		2.42%	2.23%	0.10%	0.10%
Gap10		1.88%	1.68%	0.08%	0.08%
Gap20		1.16%	1.09%	0.06%	0.06%
Gap30		0.77%	0.72%	0.02%	0.02%
Gap100		NR	NR	NR	NR
Gap150		0.06%	0.07%	0.01%	0.01%

Scenario 7
Interferer **TETRA-BS (HP) serving VM Terminal**
Victim **TRR**

AID		**0.001**
Name		
All in		18.10%
Just in		16.63%
On		13.55%
Gap0		10.26%
Gap5		9.52%
Gap10		8.42%
Gap20		6.74%
Gap30		5.28%
Gap150		0.63%

Scenario 10
Interferer **TRR**
Victim **TETRA-BS (LP) serving HH Terminal**

TRR Environment		**Urban**	**Urban**	**Urban**	**Urban**	**Rural**	**Rural**	**Rural**	**Rural**
TETRA Cell Radius (km)		**3.25**	**3.25**	**5**	**5**	**3.25**	**3.25**	**5**	**5**
AID		**0.003**	**0.0075**	**0.003**	**0.0075**	**0.003**	**0.0075**	**0.003**	**0.0075**
Name									
All in		NR	NR	NR	NR	NR	NR	NR	NR
Just in		NR	NR	NR	NR	NR	NR	NR	NR
On		NR	NR	NR	NR	NR	NR	NR	NR
Gap0		NR	NR	NR	NR	NR	NR	NR	NR
Gap5		NR	NR	NR	NR	NR	NR	NR	NR
Gap10		NR	NR	NR	NR	NR	NR	NR	NR
Gap20		NR	NR	NR	NR	NR	NR	NR	NR
Gap30		17.55%	34.81%	29.16%	51.86%	79.35%	93.51%	88.22%	97.02%
Gap 40		12.67%	26.81%	22.05%	41.33%	73.58%	90.19%	84.01%	95.36%
Gap 40 *		0.85%	2.27%	2.35%	5.86%	29.66%	52.66%	40.87%	64.72%
Gap150		1.25%	3.28%	1.97%	5.01%	14.66%	30.98%	25.74%	46.48%
Gap 150 *		0.00%	0.00%	0.00%	0.01%	0.67%	1.70%	1.67%	4.14%

*These simulations take into account mitigation brought by the use of directive antennas for TETRA BS pointing away from the TRR area.

Note : the values related to 5 km TETRA cell radius are provided here for consistency with the assumptions given in Annex 2. Due to link budget considerations, the figures related to 3.25 km TETRA cell radius are more realistic.

Scenario 11
Interferer **TRR**
Victim **TETRA-BS (HP) serving VM Terminal**

AID		**0.003**	**0.0075**
Name			
All in		68.17%	87.04%
Just in		61.25%	83.09%
On		51.85%	76.19%
Gap0		41.16%	66.12%
Gap5		37.55%	62.37%
Gap10		33.60%	58.44%
Gap20		27.50%	50.45%
Gap30		21.57%	41.85%
Gap40		17.64%	35.54%
Gap40*		0.29%	0.62%
Gap150		4.17%	10.27%
Gap 150 *		0.00%	0.00%
Gap250		2.63%	7.19%
Gap350		2.08%	4.92%
Gap500		1.59%	4.12%

*These simulations take into account mitigation brought by the use of directive antennas for TETRA BS pointing away from the TRR area.

Scenario 14

Interferer **TETRA-MS (HH) served by LP BS**
Victim **TRR**

TRR Environment		Urban	Urban	Rural	Rural
AID		**0.1**	**0.5**	**0.1**	**0.5**
Name					
All in		0.57%	2.82%	0.08%	0.26%
Just in		0.44%	2.22%	0.05%	0.27%
On		0.33%	1.98%	0.03%	0.21%
Gap0		0.15%	0.80%	0.01%	0.03%
Gap5		0.07%	0.44%	0.01%	0.03%
Gap10		0.07%	0.26%	0.01%	0.03%
Gap20		0.02%	0.15%	0.00%	0.01%
Gap30		0.01%	0.10%	0.00%	0.01%
Gap60		NR	NR	NR	NR

Scenario 15
Interferer **TETRA-MS (VM) served by HP BS**
Victim **TRR**

AID		0.02	0.004
Name			
All in		18.12%	4.42%
Just in		17.57%	4.01%
On		10.29%	2.38%
Gap0		3.61%	0.74%
Gap5		2.66%	0.56%
Gap10		2.05%	0.40%
Gap20		1.29%	0.29%
Gap30		0.97%	0.21%
Gap150		0.27%	0.06%