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Report On

RF Exposure Assessment of the
Nokia
Flexi Zone Micro Base Station

Document 75929282 Report 02 Issue 1

October 2015



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REPORT ON

RF Exposure Assessment of the
Nokia
Flexi Zone Micro Base Station

Document 75929282 Report 02 Issue 1

October 2015

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SECTION 1

REPORT SUMMARY

RF Exposure Assessment of the
Nokia
Flexi Zone Micro Base Station



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1.1 INTRODUCTION

The information contained in this report is intended to show verification of the RF Exposure Assessment of the Nokia Flexi Zone Micro Base Station to the requirements of the applied test specifications.

Objective	To perform RF Exposure Assessment to determine the Equipment Under Test's (EUT's) compliance of the applied rules.
Applicant	Nokia
Manufacturer	Nokia
Manufacturing Description	Base Station
Model Number(s)	Flexi Zone Micro
Test Specification/Issue/Date	EN 62311:2008 CFR 47 Pt1.1310 Health Canada Safety Code 6 ARPANSA Radiation Protection Series No.3



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1.2 REGIONAL REQUIREMENTS

The table below shows the regional requirements that are referenced in this test report. A full list of the requirements is shown in Annex A.

Report Reference	Regional Requirement
EU	EN 62311:2008
FCC	CFR 47 Pt1.1310
IC	Health Canada Safety Code 6
AUS	ARPANSA Radiation Protection Series No.3



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1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment under test was a Nokia Flexi Zone Micro Base Station. A full technical description can be found in the manufacturer's documentation.

All reported calculations were carried out on the relevant information supplied for the Flexi Zone Micro Base Station to demonstrate compliance with the applied test specification(s). The sample assessed was found to comply with the requirements of the applied rules.

1.3.2 Supported Features

The following radio access technologies and frequency bands are supported by the equipment under test.

Radio Access Technology	LTE TDD
	Bluetooth
Frequency Band	Band 41: 2496 - 2690
	Bluetooth: 2400 - 2480

1.3.3 Antennas

The following antennas are supported by the equipment under test.

No.	Model	Gain (dBi)
1	PCTEL MHO80617102NM	2
2	PCTEL MHO242703NM	2
3	Laird WXC2400SMRP-NS1	0

1.3.4 EUT Configurations

The EUT has two configurations as shown in the table below

Configuration	Antenna Port	RAT
Omni Configuration 1	1	LTE
	2	LTE
	3	Bluetooth
Omni Configuration 2	1	LTE
	2	LTE
	3	Bluetooth



Omni Configuration 1 and 2



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1.4 BRIEF SUMMARY OF RESULTS

The wireless device described within this report has been shown to be capable of compliance with the basic restrictions related to human exposure to electromagnetic fields for both General Public and Occupational. The calculations shown in this report were made in accordance the procedures specified in the applied test specification(s).

Configuration	Required Compliance Boundary (m)	
	Occupational	General Population
LTE TDD Band 41 Single Carrier	0.20	0.44
LTE TDD Band 41 2 Carrier + Bluetooth	0.36	0.88
Bluetooth	0.02	0.04

Table 1 – Compliance Boundary Results



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1.4.1 Configuration 1 - LTE TDD Band 41

Regional Requirement	Calculated RF exposure level at compliance boundary of 0.20 m					
	S Field (W/m ²)		E Field (V/m)		H Field (A/m)	
	Result	Limit	Result	Limit	Result	Limit
EU	23.7040	50.0000	133.6877	137.0000	0.3546	0.3630
FCC*	2.3704	5.0000	N/A	N/A	N/A	N/A
IC	23.7040	50.0000	133.6877	137.0000	0.3546	0.3640
AUS	23.7040	50.0000	133.6877	137.0000	0.3546	0.3640

* Requirement and Result in mW/cm²

Table 2 – Occupational Results

The calculations show that the EUT complies with the occupational exposure levels described in the EN 62311:2008, CFR 47 Pt1.1310, Health Canada Safety Code 6 and ARPANSA Radiation Protection Series No.3 at the point of investigation, 0.20 m.

Regional Requirement	Calculated RF exposure level at compliance boundary of 0.44 m					
	S Field (W/m ²)		E Field (V/m)		H Field (A/m)	
	Result	Limit	Result	Limit	Result	Limit
EU	4.8975	10.0000	60.7671	61.0000	0.1612	0.1620
FCC*	0.4898	1.0000	N/A	N/A	N/A	N/A
IC	4.8975	10.0000	60.7671	61.4000	0.1612	0.1630
AUS	4.8975	10.0000	60.7671	61.4000	0.1612	0.1630

* Requirement and Result in mW/cm²

Table 3 – General Population Results

The calculations show that the EUT complies with the occupational exposure levels described in the EN 62311:2008, CFR 47 Pt1.1310, Health Canada Safety Code 6 and ARPANSA Radiation Protection Series No.3 at the point of investigation, 0.44 m.



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1.4.2 Configuration 2 - LTE TDD Band 41 + Bluetooth

The tables below show the summed fractional results from the antenna port summary in section 2.2. Where the result is less than one, the EUT is deemed compliant.

Regional Requirement	Calculated RF exposure level at compliance boundary of 0.36 m as a Fraction of the Limit		
	S Field	E Field	H Field
EU	0.1479	0.8027	0.8036
FCC	0.1479	N/A	N/A
IC	0.2293	0.9977	0.9977
AUS	0.1479	0.8027	0.8014

Table 4 – Occupational Results

The calculations show that the EUT complies with the occupational exposure levels described in the EN 62311:2008, CFR 47 Pt1.1310, Health Canada Safety Code 6 and ARPANSA Radiation Protection Series No.3 at the point of investigation, 0.36 m.

Regional Requirement	Calculated RF exposure level at compliance boundary of 0.88 m as a Fraction of the Limit		
	S Field	E Field	H Field
EU	0.1238	0.7375	0.7366
FCC	0.1238	N/A	N/A
IC	0.2253	0.9892	0.9891
AUS	0.1238	0.7327	0.7321

Table 5 – General Population Results

The calculations show that the EUT complies with the general population exposure levels described in the EN 62311:2008, CFR 47 Pt1.1310, Health Canada Safety Code 6 and ARPANSA Radiation Protection Series No.3 at the point of investigation, 0.88 m.



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1.4.3 Configuration 3 - Bluetooth

Regional Requirement	Calculated RF exposure level at compliance boundary of 0.02 m					
	S Field (W/m ²)		E Field (V/m)		H Field (A/m)	
	Result	Limit	Result	Limit	Result	Limit
EU	19.8944	50.0000	86.6025	137.0000	0.2297	0.3630
FCC*	1.9894	5.0000	N/A	N/A	N/A	N/A
IC	19.8944	31.6361	86.6025	109.2114	0.2297	0.2897
AUS	19.8944	50.0000	86.6025	137.0000	0.2297	0.3640

* Requirement and Result in mW/cm²

Table 6 – Occupational Results

The calculations show that the EUT complies with the occupational exposure levels described in the EN 62311:2008, CFR 47 Pt1.1310, Health Canada Safety Code 6 and ARPANSA Radiation Protection Series No.3 at the point of investigation, 0.02 m.

Regional Requirement	Calculated RF exposure level at compliance boundary of 0.04 m					
	S Field (W/m ²)		E Field (V/m)		H Field (A/m)	
	Result	Limit	Result	Limit	Result	Limit
EU	4.9736	10.0000	43.3013	61.0000	0.1149	0.1620
FCC*	0.4974	1.0000	N/A	N/A	N/A	N/A
IC	4.9736	5.3508	43.3013	44.9105	0.1149	0.1191
AUS	4.9736	10.0000	43.3013	61.4000	0.1149	0.1630

* Requirement and Result in mW/cm²

Table 7 – General Population Results

The calculations show that the EUT complies with the occupational exposure levels described in the EN 62311:2008, CFR 47 Pt1.1310, Health Canada Safety Code 6 and ARPANSA Radiation Protection Series No.3 at the point of investigation, 0.04 m.



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SECTION 2

TEST DETAILS



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2.1 RATIONALE FOR ASSESSMENT OF THE RF EXPOSURE

The aim of the assessment report is to evaluate the compliance boundary for a set of given input power(s) according to the basic restrictions (directly or indirectly via compliance with reference levels) related to human exposure to radio frequency electromagnetic fields.

The chosen assessment method to establish the compliance boundary in the far-field region is the reference method as defined in the relevant specifications.

The RF exposure assessment is based upon the following criteria:

The Flexi Zone Micro Base Station operates with the following transmitters active on the antenna ports shown in Section 1.3.3. For each transmitter, the Radio Access Technology (RAT), EIRP inclusive of antenna gain and duty cycle, gain of the antenna and lowest frequency of operation are shown as they contribute to the calculation of S Field, E field and H field values according to the following formulas.

The power flux (S Field):

$$S = \frac{PG_{(\theta, \phi)}}{4\pi r^2}$$

The electric field strength (E Field):

$$E = \frac{\sqrt{30PG_{(\theta, \phi)}}}{r}$$

The magnetic field strength (H Field):

$$H = \frac{E}{\eta_0}$$

Where:

P = Average Power (W)

G = Antenna Gain (dBi)

r = Distance (cm) or (m)

$\eta_0 = 377$



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2.2 TEST RESULT DETAILS

The frequencies shown in the tables below have been chosen based on the lowest possible frequency that the EUT can transmit.

2.2.1 Configuration 1 - LTE TDD Band 41

Antenna Port	Tx No.	Ant No.	RAT	EIRP (W)	Duty Cycle (%)	Gain (dBi)	Frequency (MHz)	RF Exposure Level at compliance boundary of 0.20 m		
								S Field	E Field	H Field
1	1	2	LTE TDD	5.957	75	2	2496.7	11.8520	66.8438	0.1773
2	1	2	LTE TDD	5.957	75	2	2496.7	11.8520	66.8438	0.1773

Table 8 – Occupational Transmitter Summary

Antenna Port	Tx No.	Ant No.	RAT	EIRP (W)	Duty Cycle (%)	Gain (dBi)	Frequency (MHz)	RF Exposure Level at compliance boundary of 0.44 m		
								S Field	E Field	H Field
1	1	2	LTE TDD	5.957	75	2	2496.7	2.4488	30.3836	0.0806
2	1	2	LTE TDD	5.957	75	2	2496.7	2.4488	30.3836	0.0806

Table 9 – General Population Transmitter Summary



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2.2.2 Configuration 2 - LTE TDD Band 41 + Bluetooth

Antenna Port	Tx No.	Ant No.	RAT	EIRP (W)	Duty Cycle (%)	Gain (dBi)	Frequency (MHz)	RF Exposure Level at compliance boundary of 0.36 m		
								S Field	E Field	H Field
1	1	1	LTE TDD 2 carrier	2.986	75	2	2496.7	1.8334	26.2899	0.0697
	2	1	LTE TDD 2 carrier	2.986	75	2	2496.7	1.8334	26.2899	0.0697
2	1	2	LTE TDD 2 carrier	2.986	75	2	2496.7	1.8334	26.2899	0.0697
	2	2	LTE TDD 2 carrier	2.986	75	2	2496.7	1.8334	26.2899	0.0697
3	1	3	Bluetooth	0.100	100	0	2402	0.0614	4.8113	0.0128

Table 10 – Occupational Transmitter Summary

Antenna Port	Tx No.	Ant No.	RAT	EIRP (W)	Duty Cycle (%)	Gain (dBi)	Frequency (MHz)	RF Exposure Level at compliance boundary of 0.88 m		
								S Field	E Field	H Field
1	1	1	LTE TDD 2 carrier	2.986	75	2	2496.7	0.3068	10.7550	0.0285
	2	1	LTE TDD 2 carrier	2.986	75	2	2496.7	0.3068	10.7550	0.0285
2	1	2	LTE TDD 2 carrier	2.986	75	2	2496.7	0.3068	10.7550	0.0285
	2	2	LTE TDD 2 carrier	2.986	75	2	2496.7	0.3068	10.7550	0.0285
3	1	3	Bluetooth	0.100	100	0	2402	0.0103	1.9682	0.0052

Table 11 – General Population Transmitter Summary

The following tables show the regional requirements for the frequencies used in the RF exposure calculation. A full list of the requirements is shown in Annex A.

Frequency (MHz)	Occupational Limit			General Population Limit		
	S Field (W/m ²)	E Field (V/m)	H Field (A/m)	S Field (W/m ²)	E Field (V/m)	H Field (A/m)
2496.7	50.0000	137.0000	0.3630	10.0000	61.0000	0.1620
2402	50.0000	137.0000	0.3630	10.0000	61.0000	0.1620

Table 12 – EN 62311:2008 Limits

Frequency (MHz)	Occupational Limit			General Population Limit		
	S Field (mW/cm ²)	E Field (V/m)	H Field (A/m)	S Field (mW/cm ²)	E Field (V/m)	H Field (A/m)
2496.7	5.0000	-	-	1.0000	-	-
2402	5.0000	-	-	1.0000	-	-

Table 13 – CFR 47 Pt1.1310 Limits

Frequency (MHz)	Occupational Limit			General Population Limit		
	S Field (W/m ²)	E Field (V/m)	H Field (A/m)	S Field (W/m ²)	E Field (V/m)	H Field (A/m)
2496.7	32.2537	110.2722	0.2925	5.4941	45.5078	0.1207
2402	31.6361	109.2114	0.2897	5.3508	44.9105	0.1191

Table 14 – Health Canada Safety Code 6 Limits

Frequency (MHz)	Occupational Limit			General Population Limit		
	S Field (W/m ²)	E Field (V/m)	H Field (A/m)	S Field (W/m ²)	E Field (V/m)	H Field (A/m)
2496.7	50.0000	137.0000	0.3640	10.0000	61.4000	0.1630
2402	50.0000	137.0000	0.3640	10.0000	61.4000	0.1630

Table 15 – ARPANSA Radiation Protection Series No.3 Limits



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2.2.3 Configuration 3 - Bluetooth

Antenna Port	Tx No.	Ant No.	RAT	EIRP (W)	Duty Cycle (%)	Gain (dBi)	Frequency (MHz)	RF Exposure Level at compliance boundary of 0.02 m		
								S Field	E Field	H Field
1	1	3	Bluetooth	0.100	100	0	2402	19.8944	86.6025	0.2297

Table 16 – Occupational Transmitter Summary

Antenna Port	Tx No.	Ant No.	RAT	EIRP (W)	Duty Cycle (%)	Gain (dBi)	Frequency (MHz)	RF Exposure Level at compliance boundary of 0.04 m		
								S Field	E Field	H Field
1	1	3	Bluetooth	0.100	100	0	2402	4.9736	43.3013	0.1149

Table 17 – General Population Transmitter Summary

2.2.4 Configuration 1 - LTE TDD Band 41

The following tables show a summary of each antenna port and the summation of the RF exposure results and limit for each region.

Antenna Port	EIRP (W)	Regional Requirement	Calculated RF exposure level at compliance boundary of 0.20 m					
			S Field (W/m ²)		E Field (V/m)		H Field (A/m)	
			Result	Limit	Result	Limit	Result	Limit
1	5.957	EU	11.8520	50.0000	66.8438	137.0000	0.1773	0.3630
		FCC*	1.1852	5.0000	N/A	N/A	N/A	N/A
		IC	11.8520	50.0000	66.8438	137.0000	0.1773	0.3640
		AUS	11.8520	50.0000	66.8438	137.0000	0.1773	0.3640
2	5.957	EU	11.8520	50.0000	66.8438	137.0000	0.1773	0.3630
		FCC*	1.1852	5.0000	N/A	N/A	N/A	N/A
		IC	11.8520	50.0000	66.8438	137.0000	0.1773	0.3640
		AUS	11.8520	50.0000	66.8438	137.0000	0.1773	0.3640

* Requirement and Result in mW/cm²

Table 18 – Occupational Antenna Port Summary

Antenna Port	EIRP (W)	Regional Requirement	Calculated RF exposure level at compliance boundary of 0.44 m					
			S Field (W/m ²)		E Field (V/m)		H Field (A/m)	
			Result	Limit	Result	Limit	Result	Limit
1	5.957	EU	2.4488	10.0000	30.3836	61.0000	0.0806	0.1620
		FCC*	0.2449	1.0000	N/A	N/A	N/A	N/A
		IC	2.4488	10.0000	30.3836	61.4000	0.0806	0.1630
		AUS	2.4488	10.0000	30.3836	61.4000	0.0806	0.1630
2	5.957	EU	2.4488	10.0000	30.3836	61.0000	0.0806	0.1620
		FCC*	0.2449	1.0000	N/A	N/A	N/A	N/A
		IC	2.4488	10.0000	30.3836	61.4000	0.0806	0.1630
		AUS	2.4488	10.0000	30.3836	61.4000	0.0806	0.1630

* Requirement and Result in mW/cm²

Table 19 – General Population Antenna Port Summary



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2.2.5 Configuration 2 - LTE TDD Band 41 + Bluetooth

As the frequency of operation for each transmitter is not the same, in order to evaluate compliance with the limit which is dependent on frequency, the calculated RF exposure fields are divided by the limit to get a fractional exposure value. Any values less than one are compliant with the limit. Table 2 shows a summary of each antenna port and the summation of the fractional RF exposure results of each transmitter.

Antenna Port	EIRP (W)	Regional Requirement	Calculated RF exposure level at compliance boundary of 0.36 m as a Fraction of the Limit		
			S Field	E Field	H Field
1	5.972	EU	0.0733	0.3838	0.3842
		FCC	0.0733	N/A	N/A
		IC	0.1137	0.4768	0.4768
		AUS	0.0733	0.3838	0.3832
2	5.972	EU	0.0733	0.3838	0.3842
		FCC	0.0733	N/A	N/A
		IC	0.1137	0.4768	0.4768
		AUS	0.0733	0.3838	0.3832
3	0.100	EU	0.0012	0.0351	0.0352
		FCC	0.0012	N/A	N/A
		IC	0.0019	0.0441	0.0441
		AUS	0.0012	0.0351	0.0351

Table 20 – Occupational Antenna Port Summary

Antenna Port	EIRP (W)	Regional Requirement	Calculated RF exposure level at compliance boundary of 0.88 m as a Fraction of the Limit		
			S Field	E Field	H Field
1	5.972	EU	0.0614	0.3526	0.3522
		FCC	0.0614	N/A	N/A
		IC	0.1117	0.4727	0.4726
		AUS	0.0614	0.3503	0.3500
2	5.972	EU	0.0614	0.3526	0.3522
		FCC	0.0614	N/A	N/A
		IC	0.1117	0.4727	0.4726
		AUS	0.0614	0.3503	0.3500
3	0.100	EU	0.0010	0.0323	0.0322
		FCC	0.0010	N/A	N/A
		IC	0.0019	0.0438	0.0438
		AUS	0.0010	0.0321	0.0320

Table 21 – General Population Antenna Port Summary



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SECTION 3

DISCLAIMERS AND COPYRIGHT



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3.1 DISCLAIMERS AND COPYRIGHT

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ANNEX A

REGIONAL REQUIREMENTS



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Frequency Range (MHz)	Power Density (W/m ²)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.065 - 1	-	610/f	1.6/f
1 - 10	-	610/f	1.6/f
10 - 400	10	61	0.162
400 - 2000	f/40	3*f ^{0.5}	0.00796*f ^{0.5}
2000 - 300000	50	137	0.363

Table A.1 – EN 62311:2008 Occupational Limits

Frequency Range (MHz)	Power Density (W/m ²)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.003 - 0.15	-	87	5
0.15 - 1	-	87/f	0.73/f
1 - 10	-	87/f ^{0.5}	0.73/f
10 - 400	2	27	0.071
400 - 2000	f/200	1.375*f ^{0.5}	0.00364*f ^{0.5}
2000 - 300000	10	61	0.162

Table A.2 – EN 62311:2008 General Population Limits

Frequency Range (MHz)	S Field (mW/cm ²)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0 - 0.3	-	-	-
0.3 - 3	100	614	1.63
3 - 30	900/f ²	1842/f	4.89/f
30 - 300	1	61.4	0.163
300 - 1500	f/300	-	-
1500 - 100000	5	-	-

Table A.3 – CFR 47 Pt1.1310 Occupational Limits

Frequency Range (MHz)	S Field (mW/cm ²)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0 - 0.3	-	-	-
0.3 - 3	100	614	1.63
3 - 30	180/f ²	824/f	2.19/f
30 - 300	0.2	27.5	0.073
300 - 1500	f/1500	-	-
1500 - 100000	1	-	-

Table A.4 – CFR 47 Pt1.1310 General Population Limits

Frequency Range (MHz)	Power Density (W/m ²)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
10 - 20	10	61.4	0.163
20 - 48	44.72/f ^{0.5}	129.8/f ^{0.25}	0.3444/f ^{0.25}
48 - 100	6.455	49.33	0.1309
100 - 6000	0.6455*f ^{0.5}	15.60*f ^{0.25}	0.04138*f ^{0.25}
6000 - 150000	50	137	0.364

Table A.5 – Health Canada Safety Code 6 Occupational Limits



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Frequency Range (MHz)	Power Density (W/m ²)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
10 - 20	2	27.46	0.0728
20 - 48	$8.944/f^{0.5}$	$58.07/f^{0.25}$	$0.1540/f^{0.25}$
48 - 300	1.291	22.06	0.05852
300 - 6000	$0.02619*f^{0.6834}$	$3.142*f^{0.3417}$	$0.008335*f^{0.3417}$
6000 - 15000	10	61.4	0.163

Table A.6 – Health Canada Safety Code 6 General Population Limits

Frequency Range (MHz)	Power Density (W/m ²)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.1 - 1	-	614	$1.63/f$
1 - 10	$1000/f^2$	614	$1.63/f$
10 - 400	10	61.4	0.163
400 - 2000	$f/40$	$3.07*f^{0.5}$	$0.00814*f^{0.5}$
2000 - 300000	50	137	0.364

Table A.7 – ARPANSA Radiation Protection Series No.3 Occupational Limits

Frequency Range (MHz)	Power Density (W/m ²)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.1 - 0.15	-	86.8	4.86
0.15 - 1	-	86.8	$0.729/f$
1 - 10	-	$86.8/f^{0.5}$	$0.729/f$
10 - 400	2	27.4	0.0729
400 - 2000	$f/200$	$1.37*f^{0.5}$	$0.00364*f^{0.5}$
2000 - 300000	10	61.4	0.163

Table A.8 – ARPANSA Radiation Protection Series No.3 General Population Limits