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To Whom it may concern

RE: Radio Frequency Hazard Exposure for Radio model E2-455

As per Section 1.1310 and Section 2.1091 certification of this transmitter is sought using the General Public / Uncontrolled exposure limits as detailed in OET Bulletin KDB 447498 D01 v06 section 7.1, as a power of up to 10 watts is to be used in a base / fixed environment.

In addition calculations have been made using the Occupational / Controlled Exposure limits as it is possible that this transmitter could be used during the course of employment.

In accordance with Section 1.1310 the following Maximum Permissible Exposure (MPE) power density limits have been applied:

- Occupational / Controlled Exposure of 1 mW/cm^2.
- General Population / Uncontrolled exposure of 0.2 mW/cm^2.

Table 1 from Section 1.1310 is reproduced here, with relevant points outlined in red.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f^2)	6
30–300	61.4	0.163	1.0	6
300–1500	.....	.....	f/300	6
1500–100,000	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f^2)	30
30–300	27.5	0.073	0.2	30
300–1500	.....	.....	f/1500	30
1500–100,000	.....	.....	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

The minimum distance from the antenna at which the MPE is met is calculated from the equation relating Maximum Permissible Exposure, transmit power in dBm, transmit antenna gain in dB, transmitter operating frequency in MHz and separation distance in centimeters. This is derived from the guidance in "KDB 447498 D01 general RF exposure guidance V06 section 7.1".

$$S = \left(\frac{EIRP}{4 \times \pi \times R^2}\right)$$

In the equations below:

- $EIRP$ is transmitter power (dBm) plus any gain from the antenna system (dBi).
- F_{op} is the operating frequency of the transmitter in MHz
- MPE is the Maximum Permissible Exposure field strength in mW/cm^2

- d_{min} is the minimum allowable distance

For Occupational / Controlled Exposure, MPE is 1 mW/cm^2 (Table 1(A))

$$d_{min} = \sqrt{\frac{10^{EIRP(dBm)/10}}{4 \times \pi \times 1}}\, cm$$

For General Public / Uncontrolled Exposure, MPE is 0.2 mW/cm^2 (Table 1(B))

$$d_{min} = \sqrt{\frac{10^{EIRP(dBm)/10}}{4 \times \pi \times 0.2}}\, cm$$

The following table shows the calculated d_{min} for offered antenna / cable combinations calculated at the maximum power level (+40dBm) and at worst case frequency (174MHz).

		Minimum Distance (m) at 174MHz	
Antenna / Coax	Gain (dBi)	Occupational / Controlled Exposure	General Public / Uncontrolled Exposure
UDP150-C	2	1.13	2.52
BU-3/150 + CC3 coax	4.5	1.50	3.35
BU-3/150	5	1.59	3.55
YU3/150 + CC3 coax	5.5	1.69	3.76
YU3/150	6	1.78	3.98
YU6/150 + CC3 coax	8.5	2.38	5.31
YU6/150	9	2.52	5.63

Yours sincerely,

John White
General Manager
ELPRO Technologies Pty. Ltd.

Exposure of humans to RF fields

As per FCC KDB 447498 D01 and Section 2.1091 radio frequency transmitters are required to be operated in a manner that ensures the public is not exposed to RF energy levels.

Calculations have been made using the General Public/Uncontrolled Exposure limits that are defined in Section 1.1310.

Minimum safe distances have been calculated below.

Power density, $mW/cm^2 = E^2/3770$

Limits for General Population / Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (E) (V/m)**	**Magnetic Field Strength (H) (A/m)**	**Power Density (S) (mW/ cm²)**	**Averaging Time |E|²,|H|² or S (minutes)**
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500			F/1500	30
1500-100,000			1.0	30
Note 1: f = frequency in MHz ; *Plane-wave equivalent power density Note 2: For the applicable limit, see FCC 1.1310				

- General Population / Uncontrolled exposure is (f/1500) mW/cm^2

As this radio can operate over the range of 148.0 to 174.0 MHz the lowest frequency of operation in the USA, which will give the worst case result, would be 150.0 MHz.

The power density at 150.0 MHz comes out to be 0.2 mW/cm^2.

For an Uncontrolled Environment

Power Density = 0.20 $mW/cm^2 = E^2/3770$

$E = \sqrt{0.20*3770}$

E = 27.5 V/m

The rated output power for FSK modulation is up to +40 dBm (10 W) transmit power.

For QAM modulation the rated power is up to +36 dBm (4 W) average transmit power.

The rated power of 10 Watts (+40 dBm) has been used in the safe distance calculations to give the worst case results.

A worst case scenario duty cycle of 100% has been used for the calculations.

The client has stated that the device can be connected to the antenna models listed below.

Antenna Models:

Model Number	Coax Kit	Net Gain in dB	Numeric gain
UDP150-C	none	2.0 dB	1.59
BU-3/150	none	5.0 dB	3.16
BU-3/150	CC3	4.5 dB	2.82
YU3/150	none	6.0 dB	3.98
YU3/150	CC3	5.5 dB	3.55
YU6/150	None	9.0 dB	7.94
YU6/150	CC3	8.5 dB	7.08

The minimum distance from the antenna at which the MPE is met is calculated from the following:

Field strength in V/m (FS)
Transmit power in watts (P)
Transmit antenna gain (G)
Transmitter duty cycle (DC)
Separation distance in metres (D)

The calculation is as follows:

$FS = (\sqrt{}(30 * P * G * DC)) / D$

Net Gain in dB	Numeric gain	Minimum safe distance (d) (cm)
2.0 dB	1.59	79.4
5.0 dB	3.16	112.0
4.5 dB	2.82	105.8
6.0 dB	3.98	125.7
5.5 dB	3.55	118.7
9.0 dB	7.94	177.5
8.5 dB	7.08	167.6

Sample calculation is given below

$D = (\sqrt{}(30 * P * G * DC)) / FS$

$D = (\sqrt{}(30 * 10 * 1.59 * 1)) / 27.5$

D = 0.794 m or 79.4 cm

Result: Complies if the safe distances defined for this environment is applied.