Radiation Hazard Study – Item 28

Comtech Mobile Datacom Corporation
Mobile Earth Station Terminal
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Introduction

Comtech Mobile Datacom Corporation ("CMDC") designs, manufactures, and is licensed to operate Mobile Earth Station Terminals ("MESs") in spectrum allocated to the Mobile Satellite Service under the Federal Communications Commission guidelines of Part 25, Title 47 of the Code of Federal Regulations. This Radiation Hazard Study demonstrates that CMDC's MESs meet FCC guidelines for RF exposure.

Background

Completion of a routine environmental analysis for RF exposure (as described in Federal Communications Commission Office of Engineering and Technology Bulletin 65 ("Bulletin 65")) due to emissions from the MES is one of the requirements to modify the existing blanket license.

Bulletin 65 identifies two parameters relating to equipment type and usage that determine the appropriate testing methods and limits.

First, devices may be classified as either Mobile or Portable. A Mobile device is intended for use in other than fixed locations and should be separated from the user or bystanders by at least 20 centimeters. Portable devices are intended to be operated within 20 centimeters of the user or bystander.

Second, the exposure must be deemed Occupational/Controlled Exposure or General Population/Uncontrolled Exposure. Occupational/Controlled Exposure applies where persons are exposed due to their employment or when they have been made aware of the potential for exposure and are able to exercise control over their exposure. Cases where the general public is exposed or where workers are not fully aware of the potential for exposure or are unable to exercise control over the amount of their exposure fall into the General Population/Uncontrolled Exposure category.

CMDC MESs fit into the Mobile and General Population/Uncontrolled Exposure categories. As such, the permissible radiation level may be determined using either Maximum Permissible Exposure or Specific Absorption Rate techniques. CMDC elects to use a Maximum Permissible Exposure analysis using the limits for General Population/Uncontrolled Exposure for frequencies above 1500 MHz shown in section B of the table below.

FCC LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

(A) Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
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

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	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^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

Analysis Method

A Maximum Permissible Exposure analysis will be done using the methods described in Bulletin 65 and the source-based time-averaging methods described in Title 47 of the Code of Federal Regulations Part 2.1091.

The source-based averaging allows scaling of the exposure level based on the inherent duty cycle of the MES. CMDC's MESs are limited to a maximum transmission duty cycle of 52% (a 1.552 second transmission burst every 3.0 seconds).

Bulletin 65 offers several methods for calculating the RF Power Density. Three of these methods seem appropriate for this analysis.

First, the equations below will predict the power density in the antenna far field and will overstate the density in the near field.

$$S = \frac{PG}{4\pi R^2} \qquad (3)$$

where: S = power density (in appropriate units, e.g. mW/cm²)
P = power input to the antenna (in appropriate units, e.g., mW)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

or:

$$S = \frac{EIRP}{4\pi R^2} \qquad (4)$$

where: EIRP = equivalent (or effective) isotropically radiated power

Second, the power density may be determined for an antenna close to a ground plane. The following equation provides this result based on 100% reflection from the ground plane. The power density determined by this method will be four times that of the density determined in the far field.

$$S = \frac{(2)^2 PG}{4\pi R^2} = \frac{PG}{\pi R^2} = \frac{EIRP}{\pi R^2} \qquad (6)$$

Third, the Environmental Protection Agency has recommended a more realistic approximation of those results in a power density increase of 2.56 above the far field case.

$$S = \frac{2.56\ EIRP}{4\pi R^2} = \frac{0.64\ EIRP}{\pi R^2}$$

This method seems most representative of the typical operating conditions for CMDC's MESs and is the method adopted for this analysis.

Analysis

The separation distance required to produce an RF power density less than one milliwatt per square centimeter will be calculated for all possible antennas. The calculations will be done for the maximum antenna input power of 6 dBW and for a maximum duty cycle of 52 %. The antennas that are available for use are characterized in the table below.

Antenna ID	Type	Antenna Size (meters)	Antenna Gain (dBi)
1-2010/INT	Quadrafilar Helix	0.15	2.9
2-2010/EXT	Quadrafilar Helix	0.15	4.8
2-2011/EXT	Quadrafilar Helix	0.15	4.8
3-2010/EXT	Patch	0.06	4.0
4-2010/INT	Quadrafilar Helix	0.15	5.0
5-202/EXT	Quadrafilar Helix	0.27	3.9
5-203/EXT	Quadrafilar Helix	0.27	3.9
5-2011/EXT	Quadrafilar Helix	0.27	3.9
5-2012/EXT	Quadrafilar Helix	0.27	3.9
6-2011/INT	Patch	0.18	3.7
6-2012/INT	Patch	0.18	3.7
6-203/INT	Patch	0.18	3.7
7-2011/INT	Patch	0.18	6
7-2012/INT	Patch	0.18	6
8-203/EXT	Patch	0.19	3.7
9-ASDR/INT	Quadrafilar Helix Array	0.315	11
10-ASDO/INT	Patch	0.047	2.5
11-C50/INT	Circular Patch	0.1524	4.5

Using the maximum power into the antenna of 6 dBW, a duty cycle of 52% and the antenna gains from the table above; the minimum separations to achieve one milliwatt per square centimeter power densities are calculated and listed in Table B below.

Antenna ID	Type	Separation distance for 1 mW per square centimeter Power Density (cm)
1-2010/INT	Quadrafilar Helix	29
2-2010/EXT	Quadrafilar Helix	36
2-2011/EXT	Quadrafilar Helix	36
3-2010/EXT	Patch	33
4-2010/INT	Quadrafilar Helix	37
5-202/EXT	Quadrafilar Helix	32
5-203/EXT	Quadrafilar Helix	32
5-2011/EXT	Quadrafilar Helix	32
5-2012/EXT	Quadrafilar Helix	32
6-2011/INT	Patch	31
6-2012/INT	Patch	31
6-203/INT	Patch	31
7-2011/INT	Patch	41
7-2012/INT	Patch	41
8-203/EXT	Patch	31
9-ASDR/INT	Quadrafilar Helix Array	58
10-ASDO/INT	Patch	28
11-C50/INT	Circular Patch	41

The typical CMDC MES is installed on the top surface of a land vehicle, ship, or aircraft. Distances to operating personnel and the general population will be greater than the separation distances calculated above.

The table below indicates the typical CMDC MES mounting location for various applications and the minimum distance necessary to prevent a hazard to operators and the general population.

Application	Typical minimum installation separation from people (cm)	Minimum distance necessary to prevent hazard (cm) for 9-ASDR/INT	Minimum distance necessary to prevent hazard (cm) for 10-ASDO/INT
Trucking	90	58	28
Rail	300	58	28
Container	200	58	28
Boats	>300	58	28
Aviation	75	58	28

Application	Typical minimum installation separation from people (cm)	Minimum distance necessary to prevent hazard (cm) for all other antennas
Trucking	90	41
Rail	300	41
Container	200	41
Boats	>300	41
Aviation	75	41

Conclusion

The preceding analysis shows that the CMDC MESs meet the Federal Communications Commission guidelines for RF exposure.