SUPPLEMENTAL NARRATIVE STATEMENT[1]

The Boeing Company ("Boeing") requests that the Commission modify Boeing's existing experimental authorization (Call Sign WC2XVE, File No. 0032-EX-ML-2002) to permit Boeing to operate within the United States up to two (2) of its ten previously authorized mobile earth stations with phased array antennas installed on a High-Mobility Multipurpose Wheeled Vehicle ("HMMWV") (the U.S. military vehicle commonly referred to as the "Humvee" or "Hummer") for experimentation and demonstration purposes, and to fulfill a contract with the United States Government. The experiments are consistent with the existing U.S. secondary Land-Mobile-Satellite Service "(LMSS") allocation in the 14.0-14.5 GHz band, and are critical to further the development of advanced combat communications systems for the United States military. Thus, modifying Boeing's current authorization to permit these experimental operations would strongly serve the public interest.

I. BACKGROUND

On March 29, 2002, Boeing was authorized by the Commission to operate in the 14-14.5 GHz band, on an experimental basis, up to ten (10) technically identical mobile earth stations with phased array antennas aboard U.S. aircraft communicating with ALSAT Ku-band satellites (*i.e.*, U.S. licensed satellites and those foreign-licensed satellites on the Permitted Space Station list) over CONUS, plus Alaska and Hawaii, in support of the Connexion by Boeing[SM]

---

[1] Boeing respectfully requests that this Supplemental Narrative Statement be associated with experimental modification application File No. 0038-EX-ML-2003 (filed June 13, 2003), which requested FCC authority to add ten (10) mobile earth stations with reflector antennas and to make other minor changes to its experimental authorization.

("Connexion") system.[2] On October 3, 2002, the Commission modified Boeing's experimental authorization to add the Eutelsat Atlantic Bird 2 and Eutelsat II-F4 satellites as authorized points of communication, and to add international airspace to Boeing's authorized service area.[3] Boeing also holds regular Commission authority to operate up to 800 transmit-receive phased array antenna mobile earth stations within the United States.[4]

Since grant of its original authorizations, Boeing has conducted additional research regarding other potential applications for the Connexion system. Boeing believes that the Connexion system can be successfully utilized in an LMSS application. Specifically, a U.S. military vehicle equipped with a Connexion earth station could serve as a mobile satellite communications station and, if connected to remote terminals using wireless LAN or other technologies, as a network distribution center for battlefield communications and other important applications. Boeing seeks to test and demonstrate this capability to U.S. Department of Defense

---

[2] *See The Boeing Company,* Experimental Radio Station Construction Permit and License, Call Sign WC2XVE, File No. 0145-EX-PL-2001 (effective March 29, 2002).

[3] *See The Boeing Company,* Experimental Radio Station Construction Permit and License, Call Sign WC2XVE, File No. 0032-EX-ML-2002 (effective October 3, 2002) ("*Boeing Experimental Authorization*").

[4] *See* Radio Station Authorization, Call Sign E000723, File No. SES-MOD-20020308-00429; *see also The Boeing Company,* Order and Authorization, 16 FCC Rcd. 22645 (Int'l Bur./OET 2001) ("*Transmit-Receive Order*"). This order expanded Boeing's previously licensed receive-only AMSS service by adding transmit-receive authority. *See The Boeing Company,* Order and Authorization, 16 FCC Rcd. 5864 (Int'l Bur./OET 2001).

and other U.S. Government personnel using its currently authorized phased array antenna at various locations within the United States.

Boeing also has entered into research and development Contract No. DAB07-01-C-L845 (Topic No. S0102) issued by Commander U.S. Army Communications-Electronics Command ("CECOM") to perform on-the-move wideband satellite communications link blockage mitigation and quick-recovery protocol development. The focus of this research effort is the use of commercial-off-the-shelf ("COTS") products for mitigating the effects of satellite signal disruption, with an emphasis on link-level improvement and transport-level enhancements to account for high bit error rate environments. The effort includes laboratory testing and development, as well as stationary and in-motion vehicle testing and demonstrations. Boeing seeks Commission authority to employ the currently authorized Connexion phased array antenna mounted on a customized HMMWV Mobile Wideband Testbed ("MWT") to conduct the vehicle testing and demonstrations required under the contract. Boeing has outfitted one HMMWV MWT with a Connexion phased array antenna, and seeks experimental authority to operate two HMMWV MWT vehicles.

II. PERMITTING BOEING TO CONDUCT EXPERIMENTS USING THE HMMWV MWT WOULD FURTHER IMPORTANT PUBLIC INTEREST OBJECTIVES

The experimental operations proposed by Boeing would help foster a novel and innovative use of the Connexion system -- advanced broadband LMSS services in support of U.S. military communications; and would assist in the development of technologies to ensure more robust and reliable satellite communications links in U.S. military communications applications. In view of the importance of developing new and more effective satellite communications systems for the U.S. military, and given that the experimental operations proposed herein would not adversely affect other spectrum users, grant of Boeing's experimental modification application plainly would serve the public interest.

A. Description of the HMMWV MWT and Proposed Experimental Operations

1. Boeing's HMMWV MWT

The HMMWV MWT is a Boeing-owned vehicle licensed in the state of Washington that is used as a testbed and demonstration platform for various systems. In the context of the experiments described herein, Connexion phased array antennas are mounted on top of a customized S710 aluminum/rigid-foam shelter attached to the HMMWV MWT.

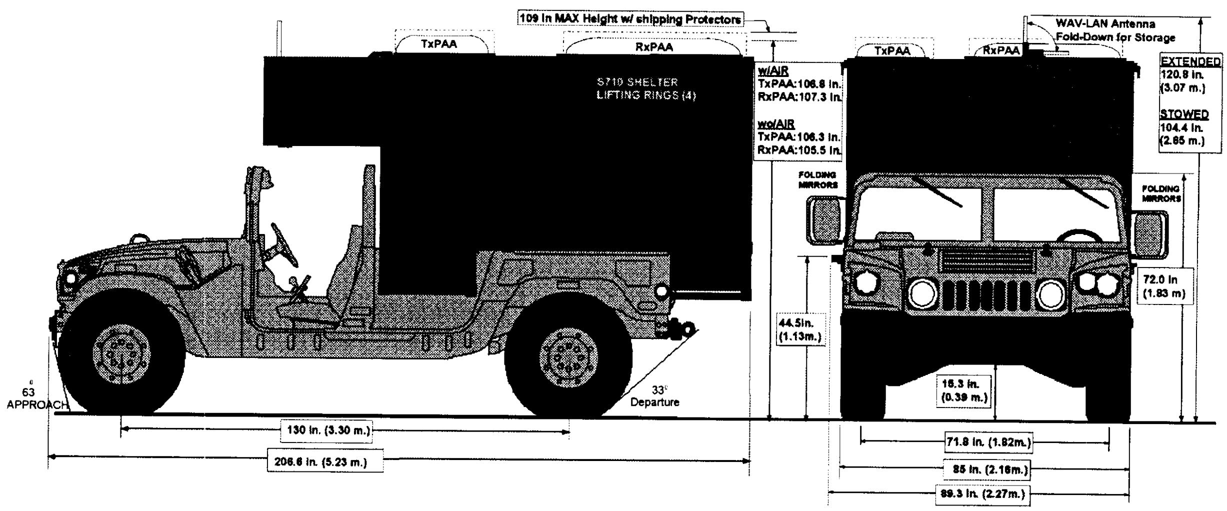

Figure 1. Boeing Phased Array Antenna mounted on the HMMWV MWT

The phased array antennas are installed on top of the shelter 8.8 feet above ground level as shown in Figure 1. To communicate with satellites, the antennas point upwards and electronically scan towards the serving satellite at elevation angles above 27° (the maximum scan angle of the phased array antenna is 63°).

2. Stationary and In-Motion Testing and Demonstrations

For stationary experimental operations, the HMMWV MWT will demonstrate broadband communications capabilities (*e.g.*, remote network access, two-way broadband connectivity, etc.) via the Connexion system to observers using laptop computers or similar equipment connected to the HMMWV MWT via cables or a 802.11b wireless LAN. During such demonstrations, the HMMWV MWT will be situated so as to have an unobstructed view towards the serving satellite and will be no less than 50 feet from a demonstration tent or building where observers are located. Access to the HMMWV MWT will be controlled during stationary operations, but Boeing employees and observers may be located at ground level around the HMMWV MWT and in the passenger compartment and/or the S710 shelter.[5] Stationary testing and demonstrations will be conducted at Boeing's testing facility in Kent, Washington, or other locations in the United States as requested by potential U.S. Government customers.

During in-motion testing and demonstrations conducted under the U.S. Government blockage mitigation contract, there will be no observers in close proximity to the HMMWV MWT, but Boeing or U.S. Government personnel will be located within the vehicle's passenger compartment and within the S710 shelter to monitor link performance, blockage and recovery. In-motion testing will be conducted principally at Boeing's testing facility in Kent, Washington

---

[5] At all times Boeing personnel and observers will be located either at ground level or within the HMMWV or S710 shelter, and thus will never be above the plane of the antenna during transmit operations.

or at U.S. Army facilities in Fort Lewis, Washington; with final demonstrations to be performed at Fort Monmouth, New Jersey or another location as requested by the customer.[6]

B. The Technical Conditions Contained in Boeing's Existing Experimental Authorization Are Sufficient To Avoid the Possibility of Harmful Interference from the Requested Operations

In lieu of specifying frequency tolerance in Boeing's experimental authorization, the Commission imposed occupied bandwidth and power limitations to avoid the possibility of harmful interference from Boeing's experimental operations.[7] Boeing recognizes and accepts that the operational conditions set forth in its existing experimental authorization will apply to its experimental LMSS operations in the United States. These conditions will enable Boeing's experimental operations to proceed without causing any harmful interference to other authorized stations operating in the 14.0-14.5 GHz band.

Moreover, unlike Boeing's existing experimental and regularly authorized mobile earth station operations, which are conducted on a non-conforming use basis in the 14.0-14.5 GHz uplink band, the experiments proposed herein are fully consistent with the existing secondary LMSS allocation in the 14.0-14.5 GHz band.[8] That said, Boeing confirms that it will continue to

---

[6] At all times Boeing personnel and observers will be located either at ground level or within the HMMWV or S710 shelter, and thus will never be above the plane of the antenna during transmit operations.

[7] *Boeing Experimental Authorization* at 1 and Special Condition 1.

[8] Downlink operations would continue to be performed on an unprotected, non-harmful interference basis as a non-conforming use of the 11.7-12.2 GHz downlink band.

meet the stated criteria necessary to protect NASA's TDRSS operations, as well as Radio Astronomy stations observing in the 14 GHz band, as set forth in the applicable agreement and letter referenced in the *Transmit-Receive Order*.[9] Boeing also will accept the existing condition in its experimental authorization that its operations will not cause harmful interference to, and shall not claim protection from, any other authorized station operating in accordance with the provisions of the ITU Constitution, ITU Convention and the ITU Radio Regulations.[10] Furthermore, Boeing will continue to operate within the parameters notified to adjacent satellites as documented in previous filings, so this modification will not adversely affect adjacent satellite operators.

C. Authorizing Boeing To Conduct Experiments To Fulfill a Contractual Agreement with the Unites States Government Would Serve the Public Interest

Pursuant to Sections 5.3(b) and 5.63(b) of the Rules, Boeing requests a modification of its existing authorization to encompass limited experimental LMSS operations that will be conducted pursuant to a government contract. Boeing has entered into a research and development with Commander, U.S. Army Communications-Electronics Command ("CECOM") (Contract No. DAB07-01-C-L845, Topic No. S0102) to provide, among other things, stationary and in-motion vehicle testing and demonstrations of techniques to mitigate the effects of satellite communications signal disruption in a military operational environment.

---

9 *See Transmit-Receive Order* at n.20, 21.

10 *See Boeing Experimental Authorization* at Special Condition 4.

The Commission has authorized experimental operations in fulfillment of government contracts on countless occasions, necessarily finding that such experimental operations would serve the public interest.[11] In this case, the direct and substantial public benefits would result from the services provided under the CECOM research and development contract. Boeing's experimental operations would help develop techniques for mitigating satellite signal disruption in military operational environments. In addition, Boeing's experiments would help validate the use of broadband satellite communications services to support battlefield and other critical military communications, and further the development of future combat communications systems. Thus, authorizing Boeing's experimental operations to provide research and development of advanced satellite services pursuant to a contract with the U.S. Government to support U.S. military communications needs plainly would serve the public interest.

III. CONCLUSION

For all of the foregoing reasons, Boeing respectfully requests that the Commission modify Boeing's experimental authorization to permit the operation of up to two HMMWV

---

[11] *See, e.g.,* Woods Hole Oceanographic Institution, Experimental Radio Station Construction Permit and License, Call Sign WA2XVB, File No. 6290-EX-PL-1998 (effective Dec. 21, 1998) (authorizing mobile satellite earth station operations required by National Science Foundation, an independent agency of the United States Government); AT&T Corp., Call Sign WA2XFW (1997) (new experiment to test point-to-point communications between ships at sea to fulfill U.S. Navy contract); Lockheed Martin Corp., Call Sign WA2XGJ (1997) (new experiment to support U.S. Army contract); Westinghouse Comm. Services, Inc., Call Sign KG2XLV (1995) (new experimental for fulfillment of U.S. Navy contract).

MWTs equipped with previously authorized, phased array antenna mobile earth stations for experimentation and demonstration purposes within the United States.

Non-Ionizing RF Radiation Hazard Assessment for the Boeing Ku-Band Transmit Antenna Mounted on a HMMWV Mobile Wideband Testbed

June 2003

1 INTRODUCTION

This analysis assesses the compliance of The Boeing Company ("Boeing") phased array antenna installed on a High-Mobility Multipurpose Wheeled Vehicle ("HMMWV") testbed vehicle with the limits for human exposure to radiofrequency ("RF") fields adopted by the Federal Communication Commission ("FCC"). The Boeing transmit antenna under consideration, shown in Figure 1, is a Ku-band, 873-element electronically scanned array with a truncated circular aperture. This is the same antenna licensed for use aboard aeronautical platforms by the Connexion by Boeing℠ ("Connexion") system.

The antenna is installed on the top of a customized S710 aluminum/rigid-foam shelter mounted on a Boeing-owned HMMWV Mobile Wideband Testbed ("MWT"). The transmit phased array antenna is installed on top of the shelter 8.8 feet above ground level as shown in Figure 2. To communicate with satellites the antenna points upwards and electronically scans towards the serving satellite at elevation angles above 27^{o} from locations in the continental United States (the maximum scan angle of the phased array antenna is 63^{o}). This scan angle limitation reduces the RF radiation hazard below the antenna near the vehicle to negligible levels.

The HMMWV MWT vehicle is licensed in the state of Washington and is used as a testbed and demonstration platform for various systems. For the stationary experimental operations described in this application, the HMMWV MWT will demonstrate broadband connectivity via the Connexion system to observers using laptop computers or similar equipment connected to the HMMWV MWT via cables or a wireless LAN. During such demonstrations, the HMMWV MWT will be situated so as to have an unobstructed view towards the southern sky and no less than 50 feet from a demonstration tent or building where observers are located. During in-motion testing, there will be no observers in proximity to the HMMWV MWT, but Boeing or U.S. Government personnel will be located within the HMMWV MWT's passenger compartment and within the S710 shelter.

Access to the HMMWV MWT will be controlled during stationary testing and demonstrations, but Boeing employees and observers may be located in or near the passenger compartment and/or in the S710 shelter while the antenna is operating.[1] Accordingly, an analysis was done to determine the RF radiation levels near the antenna and to define any procedures necessary to ensure that recommended limits for safe exposure of human beings to RF energy are not exceeded.

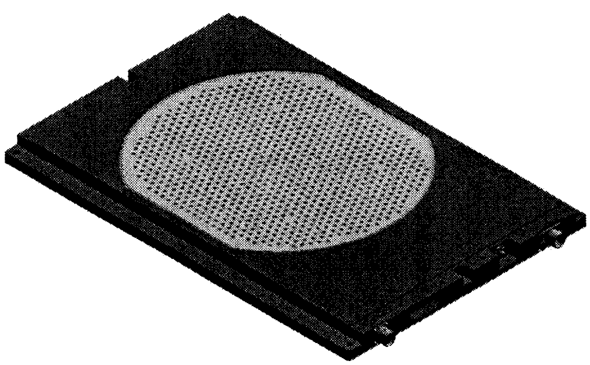

Figure 1. 873 Element Electronically Scanned Phased Array Antenna

[1] However, at all times Boeing personnel and observers will be located either at ground level or within the HMMWV passenger compartment or S710 shelter, and thus will never be above the plane of the antenna.

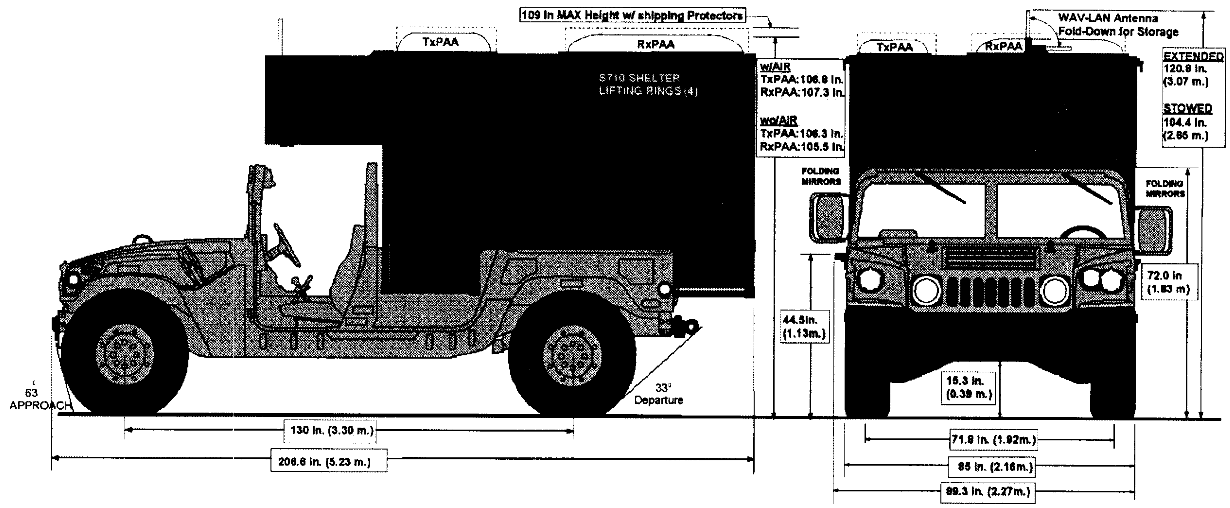

Figure 2 Boeing Phased Array Antenna mounted on top of a HMMWV

2 RF RADIATION EXPOSURE LIMITS

Researchers have considered the biologic effects of radiofrequency ("RF") energy for over 40 years. Various organizations and countries have developed recommended safe exposure standards for RF and microwave energy. In the United States, the FCC guidelines for human exposure to RF electromagnetic fields were derived from the recommendations of two expert organizations, the Institute of Electrical and Electronic Engineers ("IEEE") [1] and the National Council on Radiation Protection and Measurements ("NCRP") [2].

Expert scientists and engineers developed both the NCRP and the IEEE exposure standards after extensive reviews of the scientific literature related to biologic effects of human exposure to RF electromagnetic fields. The exposure guidelines are based on thresholds for known adverse effects, and they incorporate appropriate margins of safety. The potential hazards associated with RF electromagnetic fields are discussed in OET Bulletin No. 56, "Questions and Answers About the Biological Effects and Potential Hazards of Radiofrequency Electromagnetic Fields."

For radios operating above 1.5 GHz, the RF exposure limits for the general public developed by the above mentioned expert groups specify a maximum power density of 10 W/m^2, averaged over a thirty-minute period. Exposure up to this level is considered safe for an unlimited time. Power density levels higher than 10 W/m^2 are permitted if the average exposure over a thirty-minute period does not exceed the limit. For example two times the power density limit is safe for fifteen minutes if the person is not exposed at all in the preceding or following 15 minutes. It is normally not possible to control the exposure times of the general public to the extent that averaging times can be applied and the worst-case continuous exposure is usually assumed when determining compliance with RF Safety guidelines.

3. ANTENNA PARAMETERS

3.1 Antenna Specifications

The phased array antenna specifications are given in Table 1. The maximum EIRP permitted under the experimental license (FCC File No. 0032-EX-ML-2002) is 45.9 dBW.

Table 1 – Phased Array Antenna System Parameters

1	Antenna diameter in longest dimension, D,	0.3704 m
2	Wavelength at 14.25 GHz, λ,	0.0210 m
3	Antenna Beamwidths at zenith	3.3° x 3.5°
4	Bore-sight gain	34.86 dBi
5	Maximum EIRP	45.9 dBW

3.2 Phased Array Patterns

The scan angle limitations and narrow beamwidth of the phased array antenna reduce the RF radiation hazard in the vicinity of the MWT vehicle when tests are conducted. The 63° maximum scan angle of the electronically scanned antenna keeps RF radiation levels below the horizontal plane of the antenna to very low levels. Because of the highly directional nature of this antenna, only a very small area within the narrow transmit beam contains harmful RF radiation. The narrow beamwidth of the phased array antenna at 14.25 GHz at a scan angle of 0° is shown in Figure 3. This pattern shows that 2^0 from the antenna pointing angle the power is 5 dB below the on-axis level, and 6^0 away the power is at least 15 dB, or 97% lower, than in the main-beam. The beamwidth of electronically scanned phased array antennas increases as the scan angle increases. At a 63^0 scan angle, shown in Figure 4, the –3 dB beamwidth increases from 4^0 to 8^0. Figure 4 also shows the higher side lobes that occur at high scan angles, but at angles greater than 10^0 from the main beam they still are at least 15 dB below the power levels in the main beam.

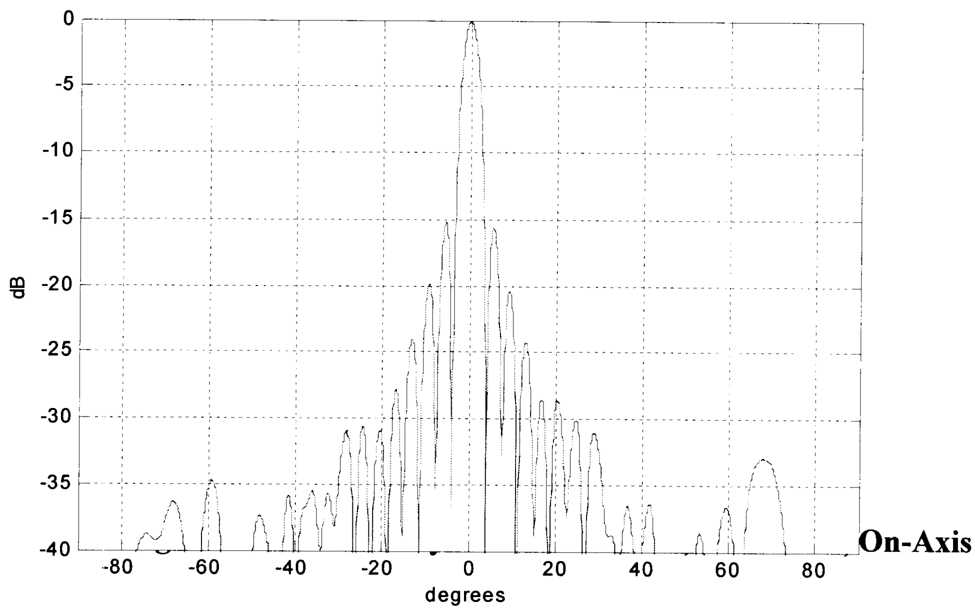

Figure 3. Phased Array Antenna Pattern, 14.25 GHz, On-Axis

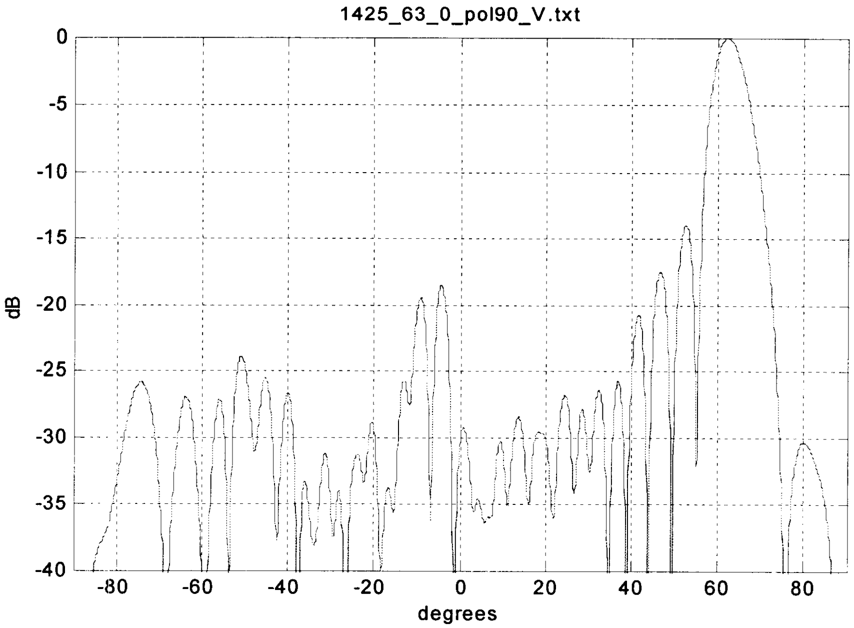

Figure 4. Phased Array Antenna Pattern, 14.25 GHz, 63^0 Scan Angle

4 CALCULATION OF RADIATED POWER LEVELS

The following regions characterize the RF field in front of the antenna:

Near-Field Region: A region in general proximity to an antenna in which the electric and magnetic fields do not necessarily decrease with distance away from the antenna, and do not approximate a plane-wave character, but vary considerably at equidistant points from the antenna. In this region the energy is essentially confined to a cylindrical pattern having the same diameter as the antenna.

Far-Field Region: The region of the field of an antenna where the angular field distribution is essentially independent of the distance from the antenna. In this region the field has a predominantly plane-wave nature; *i.e.*, locally uniform distribution of electric field strength and magnetic field strength in planes transverse to the direction of propagation.

In the literature of antenna theory, the distance from the antenna to the far-field zone is generally taken to be on the order of $2D^2/\lambda$, where D is the greatest dimension of the antenna and λ is the wavelength. This distance can be greater or smaller depending on the parameter of interest, for example, minimizing the phase difference from equidistant points from the antenna so that the electromagnetic waves approximate a plane wave. In the case of radiation hazard assessment however, a shorter distance defining the beginning of the far-field zone is acceptable because it is the magnitude of the power levels that are of interest rather than the angle of the vector at each point.

From references [1] and [3], a realistic practical distance from a large antenna, *i.e.*, an antenna diameter larger than a wavelength of its operating frequency, where the far-field zone begins is:

$$R_f = 0.5\, D^2/\lambda \qquad (1)$$

where R_f = distance to the far-field region, in meters (m)
D = diameter of antenna in longest dimension, in meters (m)
= 0.37 meters
λ = transmitter wavelength, 0.0210 meters at 14.25 GHz

Therefore,

$$R_f = 0.5\, D^2/\lambda$$
$$= 0.5\,(0.3704)^2/0.0210 = 3.27 \text{ meters}$$

4.1 Power Density Levels in the Near Field

The electromagnetic field in the near field is extremely complex and calculation of field strength at each point in the near field requires numerical integration methods. The energy in the near-field region is largely confined to a cylinder of diameter equal to the antenna diameter, extending upwards from the antenna. Computer analysis of the electrical fields in the area immediately above the phased array antenna at a power level of 46 dBW has shown the maximum power density is approximately 1000 W/m^2. This is two orders of magnitude greater than the general public exposure limits of 10 W/m^2, therefore the entire near-field area for all scan angles is considered a hazardous area.

However, the antenna is mounted approximately nine feet above ground level on an aluminum structure on top of the HMMWV MWT as shown in Figure 2, which protects anyone inside the vehicle and restricts personnel access to the hazardous region above the antenna. In addition, actual measurements in the HMMWV MWT passenger compartment, S710 shelter and a 360° area around the vehicle below the plane of the antenna confirm that RF radiation levels during transmit operations are well below unacceptable levels.

4.2 Power Density Levels in the Far Field

Power density levels in the far field of the antenna are more predictable than in the near field, and are easily calculated from the standard range equation:

$$\text{Power Density} = \text{EIRP}/\ 4\pi r^2 \qquad \textbf{(2)}$$

Where EIRP (dBWi) = total power radiated from the antenna
r (meters) = distance from the antenna

The distance to the near field/ far field boundary was calculated using equation (1) as 3.27 meters. The maximum transmit power is limited to 45.9 dBW ($10^{4.59}$ W). Inserting these values in equation (2) gives the power densities at the beginning of the far field region, 3.3 meters above the antenna:

$$PD = 10^{4.59} / 4\pi(3.3)^2 = 284 \text{ W/m}^2$$

These values exceed the 10 W/m^2 maximum exposure level for the general public.

The minimum distance, r_{min}, from the antenna where the exposure level does not exceed this maximum exposure level can be calculated by rearranging equation (2) and inserting a 10 W/m^2 power density for the MPE_{limit}:

$$\begin{aligned} r_{min} &= [\text{EIRP}/4\pi * MPE_{limit}]^{0.5} \\ &= [10^{4.59} / 4\pi * 10]^{0.5} \\ &= 17.6 \text{ meters} \end{aligned} \qquad \textbf{(3)}$$

This distance is in the far-field zone of the antenna, and therefore the use of equation (3) to calculate power density levels is valid.

The 17.6-meter distance applies when the antenna is pointed directly upward. Scan angles when pointing to a satellite on the geostationary arc range from 61.5° in Seattle, Washington to 48° in Washington, D.C. Due to the nature of the phased array antenna, which scans electronically, the radiated power decreases approximately as $\cos(\theta)$, where θ is the angle from the zenith point directly above the antenna. Antenna range measurements have shown that the antenna gain and therefore the EIRP decreases approximately with $\cos^{1.2}(\theta)$, where θ is the antenna scan angle from boresight. When the antenna beam is scanned to θ = 61.5°, the hazardous distance from the antenna is reduced from 17.6 meters to 11.3 meters.

Therefore, the potential hazardous area of this antenna is within the 3.5° wide main transmit beam in an area 17.6 m directly above the antenna. At the maximum 63° scan angle, the 3 dB beamwidth increases to 8°, but the output power is reduced so that the minimum safe distance from the antenna decreases to 11 meters. At a 63° scan angle, the hazardous area is only within in a conical-shaped zone that extends upwards from the antenna in the direction of transmission (elevation angle and azimuth) and ends in an area located 9.8 meters (approximately 32 feet) away in the horizontal direction and 5 meters (approximately 16 feet) above the plane of the antenna. Given that the hazardous area extends upwards above the plane of the antenna and no personnel will have access to this area while the antenna is transmitting, there is no danger of potentially hazardous RF exposure.

In areas other than the conical-shaped hazardous zone described above, the hazardous distance is significantly smaller. The power level at the horizon with the antenna scanned to the maximum scan angle can be seen at 90 degrees on Figure 4, where the power level is at least 40 dB below the main beam level. Reducing the 45.9 dBW EIRP by 40 dB in equation

(3) gives a minimum safe distance on the horizon from the antenna at the maximum scan angle of 63° of 0.12 meters (approximately 5 inches).

4.3 Calculation of Far-Field Power Impinging Upon Nearby Structures

Stationary tests and demonstrations are not conducted within 50 feet of demonstration areas or other structures, and the HMMWV MWT is always positioned so that it has a clear field of view towards the serving satellite. Thus, there is no possibility of harmful RF exposure to occupants of any nearby structures. Even assuming that the transmitter remains at full power and is pointed at an intervening structure, however, people with the structures will not be exposed to hazardous levels of RF radiation.

First, it is extremely unlikely that a person would be exposed to the mainbeam of the antenna for a sufficiently long period of time to cause an RF exposure concern. To raise such a concern, a person must be located near the antenna (*i.e.*, within 9.8 meters), have an unobstructed line-of-sight to the antenna, experience no attenuation of the signal through the building, and remain stationary for longer than the thirty-minute averaging time of the FCC exposure guidelines.[2] Second, microwave energy at 5.2 GHz is attenuated an average 12 dB when passing horizontally through a building wall [4]. Microwave energy at 14 GHz is attenuated more than energy at 5 GHz, which gives an additional margin of safety. Lastly, if either the transmit or receive signal path from the vehicle to the satellite is blocked by a structure, the transmitter is automatically shut down within a few seconds. Thus, if a person inside a building is within the main beam of the antenna, transmissions would cease automatically and the potential exposure to RF radiation would be eliminated. For these reasons, it is concluded that there is no RF radiation hazard to people inside a building next to the vehicle.

---

[2] The beam-width of the phased array antenna is less than 2 meters wide at this point.

5 CONCLUSION

Based on this analysis, it is concluded there is no RF and microwave radiation hazard to Boeing operators or other people that could be located near the HMMWV MWT vehicle while testing is being performed. In order to further ensure that no person would be within the RF exposure zone during experimental operations, appropriate training will be conducted and access to the area above the plane of the antenna will be controlled.

6 REFERENCES

1. IEEE C95.1, *IEEE Standards for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, 1999.*
2. International Commission on Non-Ionizing Radiation Protection. *Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields (up to 300 GHz)*, Health Physics, 1998.
3. *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields,* Federal Communications Commission Office of Engineering and Technology, Bulletin 65, August 1997.
4. ETSI EN 300 328 V1.4.1: “Electromagnetic compatibility and Radio Spectrum Matters (ERM); Wideband Transmission Systems; Data transmission equipment operating in the 2.4 GHz ISM band and using spread spectrum modulation techniques”, November, 2002.
5. World Health Organization. *Environmental Health Criteria 137: Electromagnetic Fields (300 Hz – 300 GHz)*, 1993.