1. Introduction

This analysis predicts the radiation levels in and around the developmental lab for the referenced radar system at the Linthicum, MD Northrop Grumman facility, and the safety mitigation steps required. This report is developed in accordance with the predication methods contained in OET Bulletin No. 65, and Sections 1.1307 and 1.1310 of the FCC rules. For the frequency band used under this license, per section 1.1310 and the IEEE C95.1-2019 standard the maximum level of non-ionizing radiation to which people may be exposed is limited to 5 milliwatts per square centimeter(5mW/cm^2) over any 6 minute period in a controlled environment and 1 mW/cm^2 for the general public.

Northrop Grumman Mission Systems follows an established procedure to ensure the safety of both the hardware and personnel for our radiating labs. Procedure K200-312-MSM requires a transmit readiness review (TxRR) for all labs, with involvement from systems engineering to ensure proper hardware safeguards are in place (interlocked power and cooling as an example). Industrial Health and Safety leads the team review to ensure proper RF safety procedures are followed and that the proper license is in place for use. Figure 1 provides the pertinent information regarding this procedure and its relation to safe operations.

Due to the nature of the test environment, the Northrop Grumman policy is to limit occupied areas impacted by radiating systems to not exceed the general public levels, or 1 mW/cm^2 exposure. Any area that exceeds this limit is physically blocked off with a barrier (chain or locked access) and with signage warning people of the potential for RF hazard and to stay out of the restricted area.

NORTHROP GRUMMAN

Mission Systems (MS) Manual

K200-312-MSM

Subject
Radio Frequency Transmit Readiness Review

Effective Date
5/18/2022

Page
1 of 3

Document Details & Contact Information

Document Owner	Supersedes	Date Last Authorized
Oconnor, Kevin (safety) [US] (MS)	K200-312-MSM dated 12/3/2019	Click Here

Defined Terms None

Purpose

This document defines the elements needed to complete a Transmit Readiness Review (TxRR) before radiating Radio Frequency (RF) energy.

This document does not pertain to Class B Federal Communications Commission (FCC) approved devices, commercial devices used as intended by the manufacturer with no modifications or other devices having documentation that shows they meet Institute of Electrical and Electronics Engineers (IEEE) C95.1, IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz- to 300 GHz, standards for the general public. Devices having FCC approval but have attached warning statements identifying specific operating conditions to prevent RF exposure must adhere to this procedure. Programs/projects that are doing receive only testing using test equipment (signal generators) are not required to conduct a TxRR.

Requirements and Procedure

TxRR

This document provides the minimum requirements that a TxRR must address to ensure the safety of both personnel and Northrop Grumman assets.

If outdoor transmission testing is going to be performed, refer to E260-MSM, Requirements for Radio Frequency Spectrum Management and Licensing, and K200-306-MSM, Radiation Protection Program.

To avoid situations where there is a chance of exceeding the power rating of the RF absorber, exposing personnel to harmful RF levels, or damaging Northrop Grumman assets; a systematic review of the operating procedures and safeguards is essential. The method developed to accomplish this review is with the use of a TxRR.

The following identifies the topics that shall be addressed at a minimum in the TxRR Template or equivalent:

- Overview of testing objectives.
- Review of test procedures that will be performed for safety hazards and applicable site documents.
- Review of potential hazards expected during testing.
- Review of system safeguards, i.e.:
  - Emergency shutdowns (locations, speed of shutdown, etc.).
  - Software (if applicable)

Figure 1. Excerpt from Northrop Grumman TxRR Safety Procedure.

2. Referenced Radar System Parameters

Frequency: 420MHz – 450 MHz
Transmitter Type: Torch 2.0 Demo FED
Antenna: Passive
Length: 2.65 meters
Scanning: Broad elevation beam scanned electronically over +/-70^{o} in azimuth. Airborne operation will have a 360 degree azimuth scan.
Total EIRP: 179 KW
Total ERP: 109 KW
Max Duty Cycle: 50%

3. Safe Distance Calculations

IEEE C95.1-2019 and FCC Bulletin 65 establish the Radio Frequency Power Specific Density (RF PSD) for unwarned personnel / general public at 1 mW/cm^2 (10 W/m^2) for the frequencies used by the subject radar.

The Fraunhofer distance for this antenna is 2D^2/lambda; approximately 21 meters or about 69 feet.

The near-field region exceeds human safe values:

$$S=16P/Pi*D^2 = 16*9600/(3.14*2.65^2) = 69.62 \text{ KW/m}^2$$

The time-averaged far-field minimum safe distance for the main beam of the subject radar for the general public (10 W/m^2 or 1 mW/cm^2) is given by:

$$R= SQRT[(EIRP (W)*duty cycle)/(4*pi* 10 W/m^2)]$$

$$= SQRT[(179000 W * 0.5)/(4*3.14*10)] = 27.3 \text{ meters} \sim 90 \text{ feet}$$

Without any mitigating power reductions, personnel will not be allowed in the areas noted above; at the face of the antenna, in the near field region, or in the far field region to the hazard limit distance (90 feet).

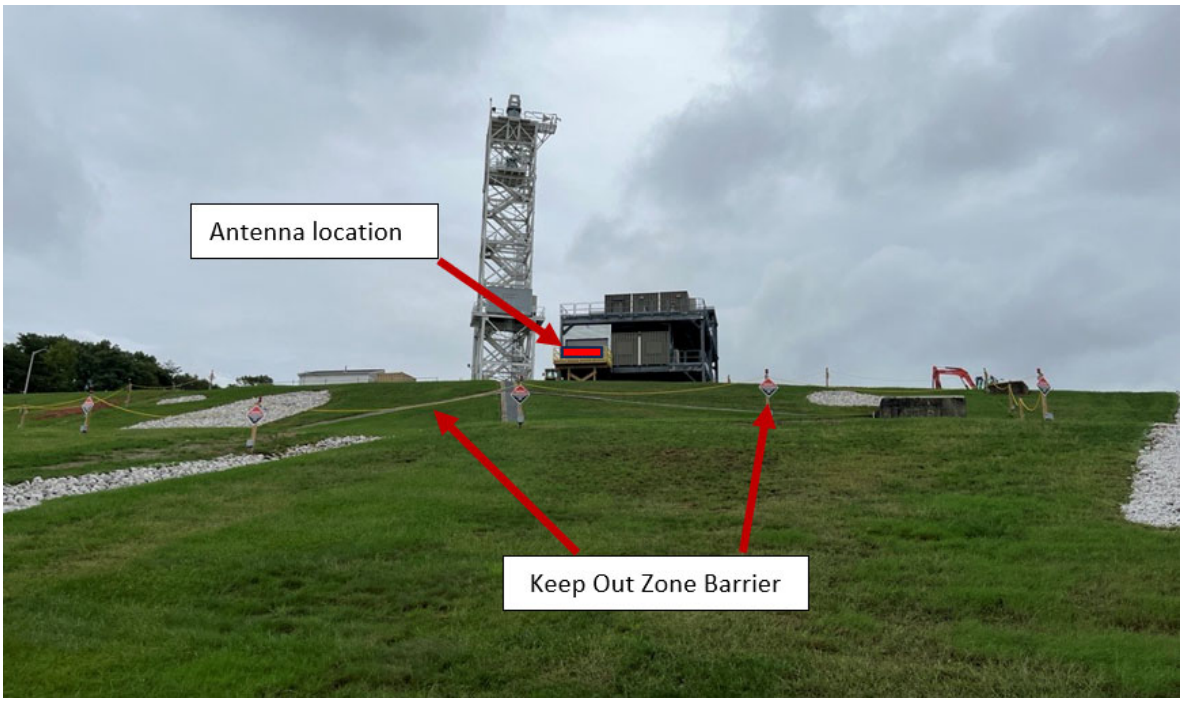

Figure 2. Antenna Location and Keep Out Barrier

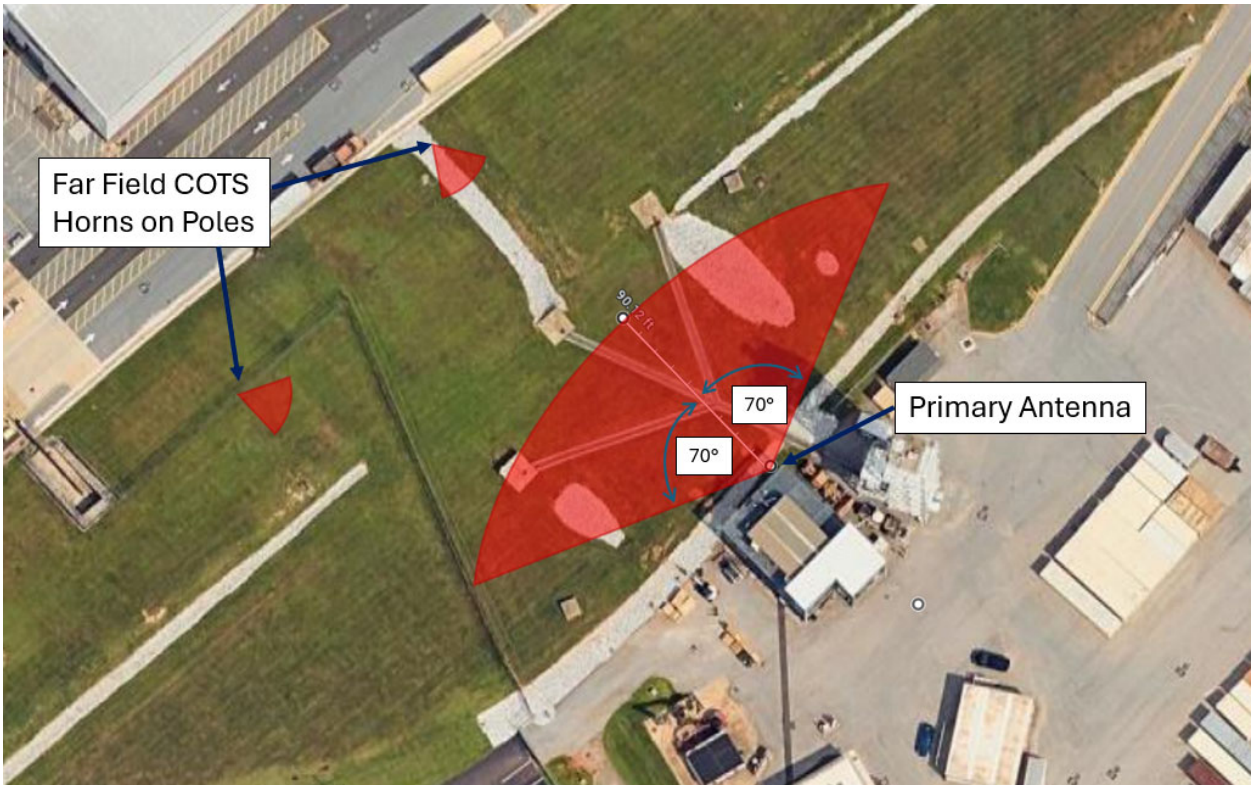

Figure 3. Illustration of Minimum Safe Distance of 27.3 Meters / 90' in Red

In addition to the high power antenna there are two far field horns located ~60' above the ground to provide a low power signal from test equipment towards the primary antenna. The far field horns will transmit a maximum of 50W towards the primary antenna, the illustration shows their orientation but there is no required keep out area for those locations due to their power level and height above the ground.

4. Physical Safety Precautions

Northrop Grumman Mission Systems implements numerous safety controls in all of its radiating labs in accordance with Procedure K200-312-MSM. The TxRR reviews all the calculations of the predicted hazard areas. Physical barriers (chains/ropes/curtains) with signs are installed to keep people out of the hazard areas. The radar antenna electronically scans over the field of regard to the front of the antenna and the outside roof area of the lab. Due to the scanning nature of the antenna, the area to the front of the radar is physically cordoned off for human safety assuming main-beam power levels are present throughout the field of regard.

Personnel are not allowed to the immediate front or sides of the installed radar when it is capable of transmitting. In accordance with K200-312, the NGMS Industrial Health and Safety office conducts an RF safety survey in the lab using a calibrated RF field density meter to ensure there are no hazardous reflections or emissions in the lab, or that the areas are properly marked off. This includes the areas outside of the lab. Based on the calculated field strengths at distance, the area on the ground where personnel may congregate will be blocked off with signage to notify and keep people out of the potentially hazardous area. The area to the immediate front of the antenna will be closed.

5. Summary

The safety systems put in place for all Northrop Grumman radiating labs, to include subject radar lab, protect unwarned and untrained personnel from accessing the hazard zones around the radiating system. The areas inside and outside of the lab with RF PSD values above the unwarned human safe limit (10 W/m^2) will be blocked off from access.

Testing is planned to begin around January 2025 and the TxRR process will be completed prior to radiating to ensure there is no risk to Northrop Grumman personnel, BWI operations, or personnel working in the construction site area.

Prepared by:
Jean Torchenot
Northrop Grumman Mission Systems
Spectrum Management