# Radar Development and Testing on Government Contract

RE: Antenna Registration Q4: Directional Antenna Information, Exhibit
File Number: 0548-EX-CN-2019
Confirmation Number: EL178088
Date: July 10, 2019

## Experiment Overview

Systems & Technology Research (STR) is developing leading technology in airborne SAR and GMTI RADAR systems for supporting government (DoD and other) uses. One of those development efforts is the SERVAL radar system.

In concurrence with the DARPA RadarNet program, STR is continuing development of the SERVAL radar system, and will require airborne testing of the system that will occur utilizing Internal Research and Development (IRAD) funding, rather than that of the AFRL contract(s) supported by WJ2XXY.

To help calibrate our radar systems, we will deploy one Moving Target Simulator (MTS) at various positions on the ground. It is a battery powered, stationary unit mounted on a tripod that extends no more than 6 feet off the ground. It is used to simulate both moving and stationary targets for radar systems. It is a non-triggered repeater that will amplify a signal within its receive bandwidth by a fixed gain and repeat it back. It will temporarily be placed at various locations within the permitted ring to support various aircraft profiles and missions, then removed once the mission of the day is complete. This device currently operates under license WJ2XYB when supporting the AFRL contract effort(s).

This will involve performance testing of our system, requiring a large footprint in the Boston, MA area that is the same as under our existing Experimental Licenses (WJ2XXY for the airborne radars, and WJ2XYB for the MTS). Please see 0935-EX-CN-2018 and 0940-EX-CN-2018 for detailed specifics.

A maximum of two aircraft will be outfitted with SERVAL systems and simultaneously operating in the same region with identical radar equipment. Both systems will employ identically constructed phased array antennas. Both airborne systems will conduct missions using the MTS (WJ2XYB) as a calibrated ground target simulation instrument in various locations within the same region.

Aircraft altitudes will still be constrained to < 10,000 ft, using the same antenna systems as previously used. The same instantaneous bandwidth (800 MHz) and operating area will be required to be tested, hence the same 9.2 - 10.2 GHz band as that granted in the respective WJ2XXY and WJ2XYB licenses is being requested in the Boston area.

This effort will be expected to begin in July, 2019, and extend for up to 36 months.

For all computations we consider the highest desired bandwidth and ERP of the systems.

## SERVAL (Airborne Radar) Antenna Parameters:

The SERVAL antenna is an electronically steered directional rectangular antenna with a 3dB azimuth beamwidth of 2.4 degrees and a 3dB elevation beamwidth of 10 degrees using the full array. In certain configurations we may have a wider beam, but the ERP will be reduced as a result.

The antenna can radiate in either horizontal or vertical polarizations at any given time, but not simultaneously.

The antenna has an effective scan limit of 60 degrees off boresight.

## SERVAL Power Parameters:

The radar transmits with a 10.5% duty cycle with pulses no longer than 100 microseconds. The peak transmit power is 1135 Watts. With the 10.5% duty cycle, the average transmit power is 120 Watts. The maximum antenna transmit gain is 31.34 dB, or a factor of 1361. So the peak ERP is 1135 * 1361 = 1.55 MW. The average ERP is 120 * 1360 = 163 kW.

## SERVAL Operations / Flight Routes:

Flights are currently planned for the Boston, MA area primarily near Lawrence, MA (KWLM) but at times extending south to operations near Cape Cod CGAS (KFMH) and north to Portsmouth Intl (KPSM). These locations will be where a majority of the flight operations will occur, not continuously, but rather as discrete test events during the development phase.

A nominal flight altitude of 8500 ft MSL is planned but could vary from 4500 ft to 9,000 ft MSL depending on weather conditions and VMC minimum requirements.

## MTS Antenna Parameters:

The MTS has 2 identical antennas: one for receive and the other for transmit. Both are 10 dBi standard gain horns that operate over X-band. The specifications for the horns are shown in Figure 1.

A-INFO

LB-90-10
8.2 – 12.4GHz Standard Gain Horn Antenna

**Technical Specification**

| | | |
|---|---|---|
| Frequency Range(GHz) | 8.2 – 12.4 | |
| Waveguide | WR90 | |
| Gain(dBi) | 10 Typ. | |
| Polarization | Linear | |
| 3dB Beamwidth(deg) | 55 Typ. | |
| Cross Pol. Isolation(dB) | 30 Typ. | |
| VSWR | A Type: | 1.15:1 Typ. |
| | C Type: | 1.25:1 Typ. |
| Output | A Type: | FBP100(UBR100) |
| | C Type: | N/ SMA/3.5mm/TNC/7mm |
| Material | Al | |
| Size(mm) | A Type: | 42 x 41.4 x 75 |
| | C Type: | 42 x 49.6 x 113 |
| Net Weight(Kg) | A Type: | 0.05 Around |
| | C Type: | 0.10 Around |

Figure 1: MTS Antenna

These antennas can be physically rotated by the user allowing them to operate in any linear polarization (vertical, horizontal, slant). They are directional antennas and both point in the same direction, which will nominally be at the aircraft.

Additionally, the MTS can employ interchangeable filters to further narrow the frequency response of the system. We intend to filter between 8.1 – 10.2 GHz to support SERVAL radar wideband performance testing and can further employ notch or bandpass filters as required. The filter details are specified below:

| | |
|---|---|
| Vendor | Micro-Tronics |
| Passband | 8 – 10 GHz |
| Passband Insertion Loss | 1.0 dB maximum |
| Rejection | 60 dB minimum from 0 – 6.8 GHz and 10.8 – 13.2 GHz |

## MTS Power Parameters:

The radar transmits with a 10.5% duty cycle with pulses no longer than 100 microseconds. Since the MTS only responds to external stimulus, its expected duty cycle is the same. The peak transmit power is 63.1 milliwatts. With the 10.5% duty cycle, the average transmit power is 6.6 milliwatts. The maximum antenna transmit gain is 10 dBi, or a factor of 10. The peak ERP is 63.1 * 10 = 631 milliwatts. The average ERP is 6.6 * 10 = 66 milliwatts.

## MTS Operations / Flight Routes:

The physical location and orientation of the ground-based MTS may change experiment to experiment as it is dependent upon the position of the aircraft it is supporting. This is why we desire the same test area as that in file number: 0935-EX-CN-2018.