The Aerospace Corporation
Experimental License Application
File No.: 1884-EX-CN-2023

Explanation of Experiment

The Aerospace Corporation ("Aerospace") is a non-profit federally funded research and development corporation (FFRDC) which has, as part of its mission, the obligation to support experimentation in space. Aerospace is filing this application as part of its contractual support for the US Space Force, under contract number FA8802-14-C-0001, in its in-space technology demonstrations. This application is filed for the operation of ***radios that are owned, operated, and controlled by Aerospace***. Those radios will be hosted by two Paladin satellites that belong to the US Space Force. The radios will be used by Aerospace for testing and demonstration of the radio performance so that Aerospace can evaluate its radio operations while they are hosted on the in-orbit technology demonstrations of US Space Force Paladin satellites. As part of the contracting effort for this demonstration, Aerospace is responsible to provide US Space Force with a report on the performance of the radio and how the radio will function in communicating with ground stations from the elliptical orbit throughout the demonstration period.

Paladin satellites will be owned, operated, and controlled by US Space Force. The AF will seek NTIA approval for operating Paladin satellites.

The radios (listed in this application), hosted by US Space Force Paladin satellites, will be owned, operated, and controlled by Aerospace. Aerospace will be using its own ground station network for communications with its radios. As such, an FCC experimental application is appropriate for these operations/radios.

Technical Synopsis

Spectrum needed:	914.7 MHz
Emission Designator:	1M09F1D
Time of Use:	five minutes every three days
Areas of Operation:	Hosted Payload operates only over ground stations described below
Power level and ERP:	1.3 W, 2.79 dBi gain, ERP: 1.51 W – downlink information
	9 W, 21.9 dBi gain, ERP: 755.5 W – uplink information
DoD Contract:	FA8802-14-C-0001

Description of Operations

Aerospace was asked to install its custom-designed radio on the Space Force's Paladin satellites (2 of them.) Because of the special design of the Aerospace radio, Paladin will be hosting the Aerospace radio as a hosted payload, with Aerospace owning, operating, and controlling its radios throughout the Paladin mission. The radios are there to experiment with their use in geosynchronous transfer orbit (GTO).

The Aerospace radio has flight heritage – it has been shown to work effectively in other on-orbit satellites – however, it has never been used in GTO previously. The experiment will look at the

performance of the radio throughout the life of the satellite, and it will give Aerospace, and its customers in the Space Force, an opportunity to determine how the radio will function in communicating with ground stations from a highly elliptical orbit.

The Paladin satellites will be owned and controlled by the Space Force. The Space Force will have its own, primary, communications systems for the operation of the Paladin satellites. The Space Force will be submitting a DD 1494 and a request for radio frequency authorization through AFSMO for its operations. The Space Force has submitted a letter in support of this application. See Attachment A.

The Space Force will not own nor operate the Aerospace radio. Aerospace will. The Space Force has consulted with Air Force Spectrum Management and the NDD regarding the proposed satellite operations and hosted payload that is owned and operated by Aerospace. AFSMO and the NDD have determined that the Aerospace hosted payload should be licensed by the FCC because the radios are owned, operated, and controlled by Aerospace, which is not a governmental entity.

Spectrum Requested

Aerospace is requesting authorization to use 914.7 MHz for these operations. The contract specifies the use of the radio that operates on the specified frequency. This is a radio that Aerospace has designed and tested during other on-orbit operations. The proposed testing and demonstration operations that are the subject of this application propose a new operational challenge for the radio, which requires experimentation. The demonstration and report due to the Space Force after this mission are essential to national security. Because the Aerospace owned radio has flight heritage, it has been asked to test and demonstrate the same radio for this new application. To meet its customer's needs and its contractual requirements, Aerospace cannot change the radio frequency for this proposed operation. Aerospace is aware that future operations may require use of different frequencies.

DoD Contract FA8802-14-C-0001

Aerospace is filing this application for the operation of its hosted payload radio. Aerospace was advised to note: "This request supports a DoD Space Systems Command launch mission requirement under contract number FA8802-14-C-0001, Govt Contract POC: Col. Joseph Roth for Project Paladin." Aerospace is attaching a memo in support of this application that the Space Force has provided. See Attachment A.

Aerospace will be using its own ground station network for communications with its radio. Details regarding the ground stations are below.

The Space Force's satellite operations will be working through KSAT's ground station network for the operations of Paladin's embedded radio communications. Those communications are being authorized by the Space Force through NTIA. Those operations are separate from Aerospace's wholly owned radio operations, which Aerospace will control.

Orbital Parameters

The Paladin satellites will be operating in a geosynchronous transfer orbit. The purpose of the orbit is to allow the satellites to transfer between low earth orbit and the geosynchronous orbit to transfer information amongst satellites at different orbital elevations. The orbit is depicted in *Figure 1* below. The orbit apogee is 36101 km; the orbit perigee is 205 km.

The orbital period is 630 minutes (10.5 hours). This is an extremely elliptical orbit. As a consequence, the satellites will pass over the Aerospace ground stations very rarely.

The Aerospace radios will only operate when the satellite is approaching the orbital perigee of 205 km. When a Paladin satellite is both at the orbital perigee and over one of the Aerospace ground stations, the radio may be in use for five minutes. That is expected to happen once every three days.

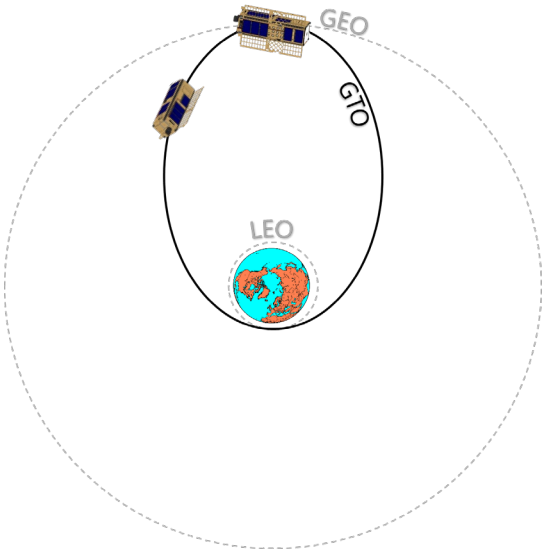


Figure 1. Diagram of Aerospace Hosted Payloads on satellites in GTO Orbit (satellites are not to scale)

Ground Station Network and Area of Operations

There are eight ground station locations that Aerospace will operate to communicate with its radio hosted on Paladin. Each station operates with the same technical parameters, summarized in *Table 1*, below.

Ground Stations - AeroGS Network			
Item	**Data Field**	**Entry**	**Comment**
21	Location	Bryan, Texas (Brazos county)	
22	Latitude, deg	30.6431	
23	Longitude, deg	-96.4725	
24	Antenna Type	Parabolic	
25	Size, m	1.8	
26	Antenna Height, m	2.1	
27	Peak Antenna Gain, dB	21.9 dBi	
28	Input Power, W	3.98 e-15 W (-114 dBm)	Depends on satellite position
29	Half Power Beamwidth, deg	12.3	
30	System Noise Temperature, K	288	
31	Antenna Pointing	TLE tracking	
32	Minimum Elevation Angle, deg	2	
33	Antenna Gain Pattern		

Table 1. Ground Station Technical Data

Ground Stations Locations

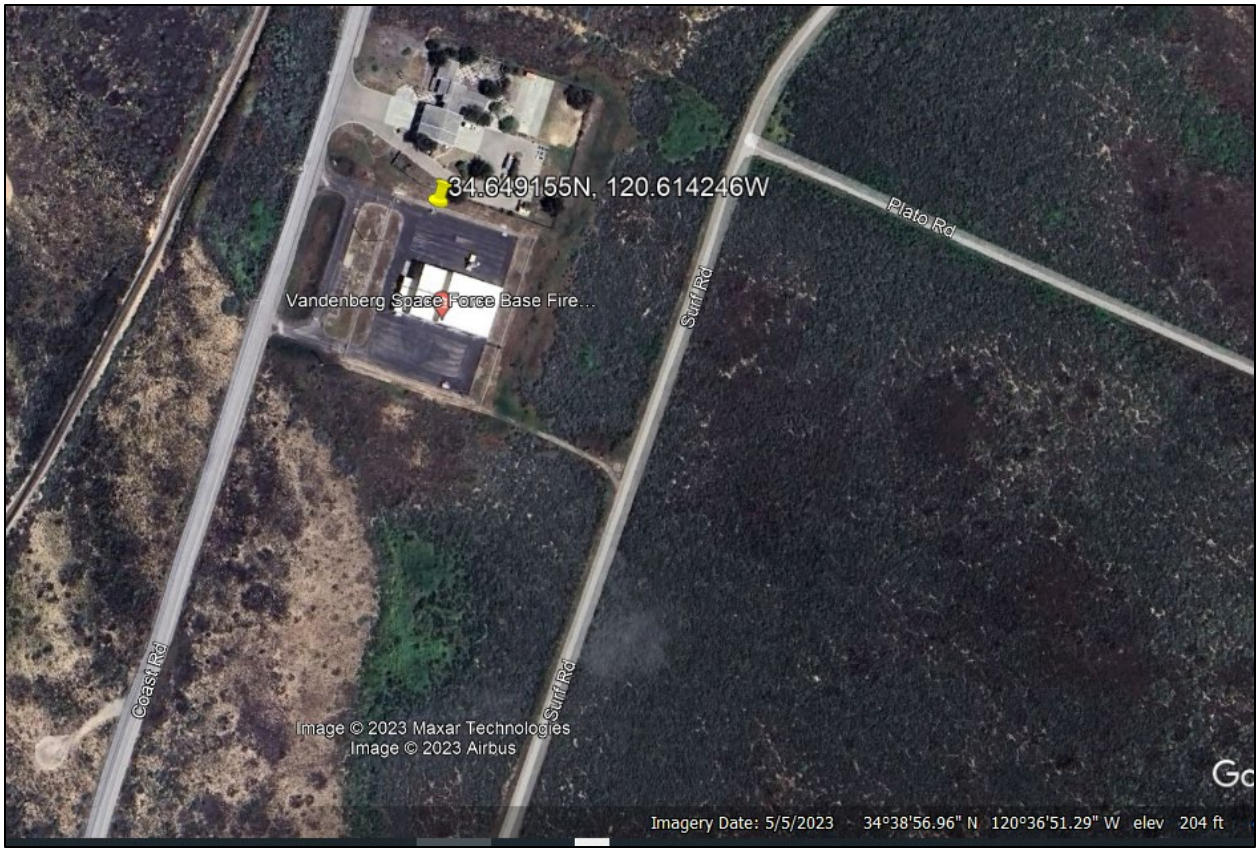
Location	Latitude	Longitude	Site Elevation
Bryan, TX	30-38-35 N	96-28-21 W	265 ft
Vandenberg AFB, CA	34-38-55 N	120-36-51 W	204 ft
Edwards AFB, CA	34-49-01 N	117-53-33 W	2300 ft
Ash River, MN	48-22-45 N	92-49-56 W	1230 ft
Limestone, ME	46-56-28 N	67-53-58 W	707 ft
Spokane, WA	47-38-05 N	117-37-58 W	2427 ft
Guayama, PR	17-57-55 N	66-06-28 W	94 ft
Gainesville, FL	29-37-37 N	82-21-39 W	78 ft

Table 2. Ground Station Location Information

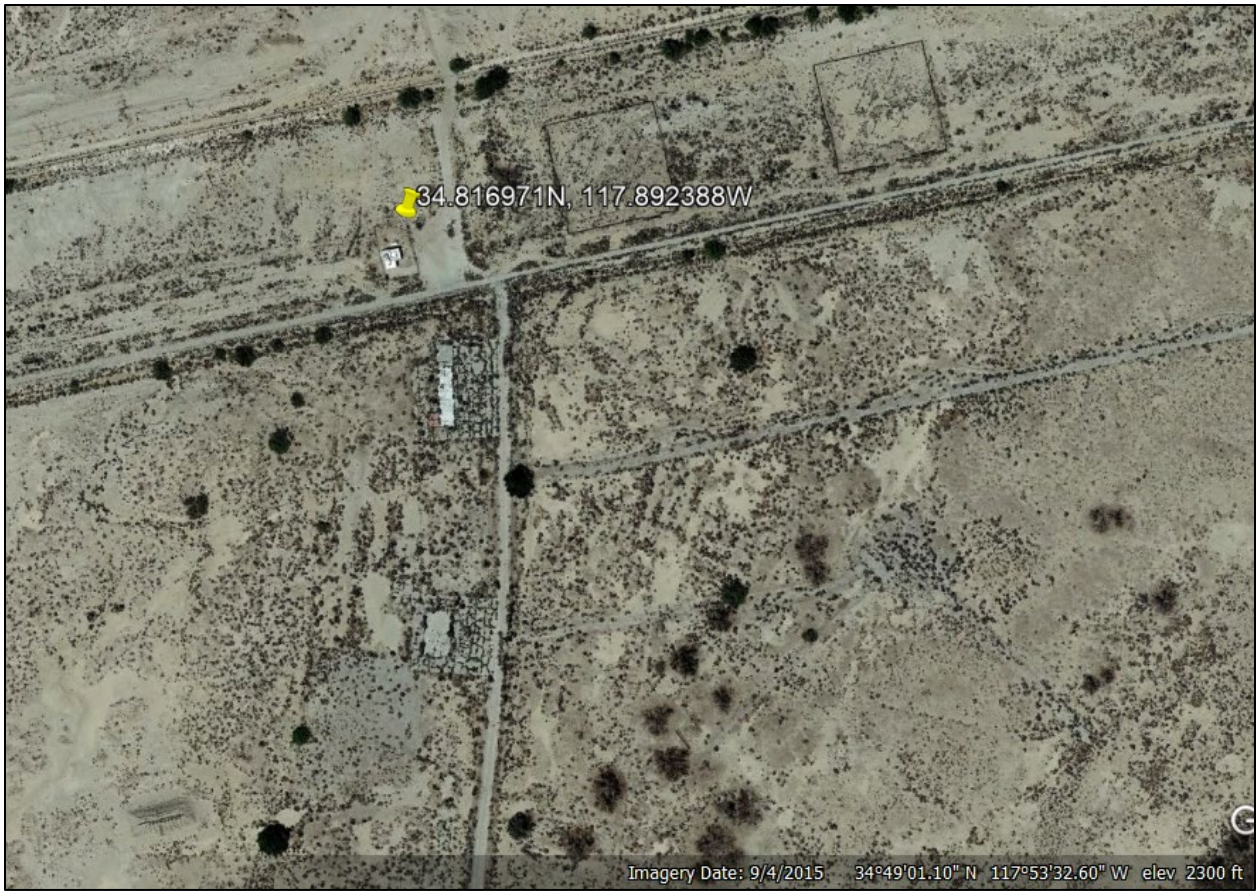
Images of each ground station site are shown below. The Guayama and Edwards AFB sites are not yet built, so the images do not show the actual antennas.

Bryan, TX:

Vandenberg SFB:


34.649155N, 120.614246W
Vandenberg Space Force Base Fire...
Plato Rd
Surf Rd
Coast Rd
Surf Rd
Image © 2023 Maxar Technologies
Image © 2023 Airbus
Imagery Date: 5/5/2023 34°38'56.96" N 120°36'51.29" W elev 204 ft

Edwards AFB:

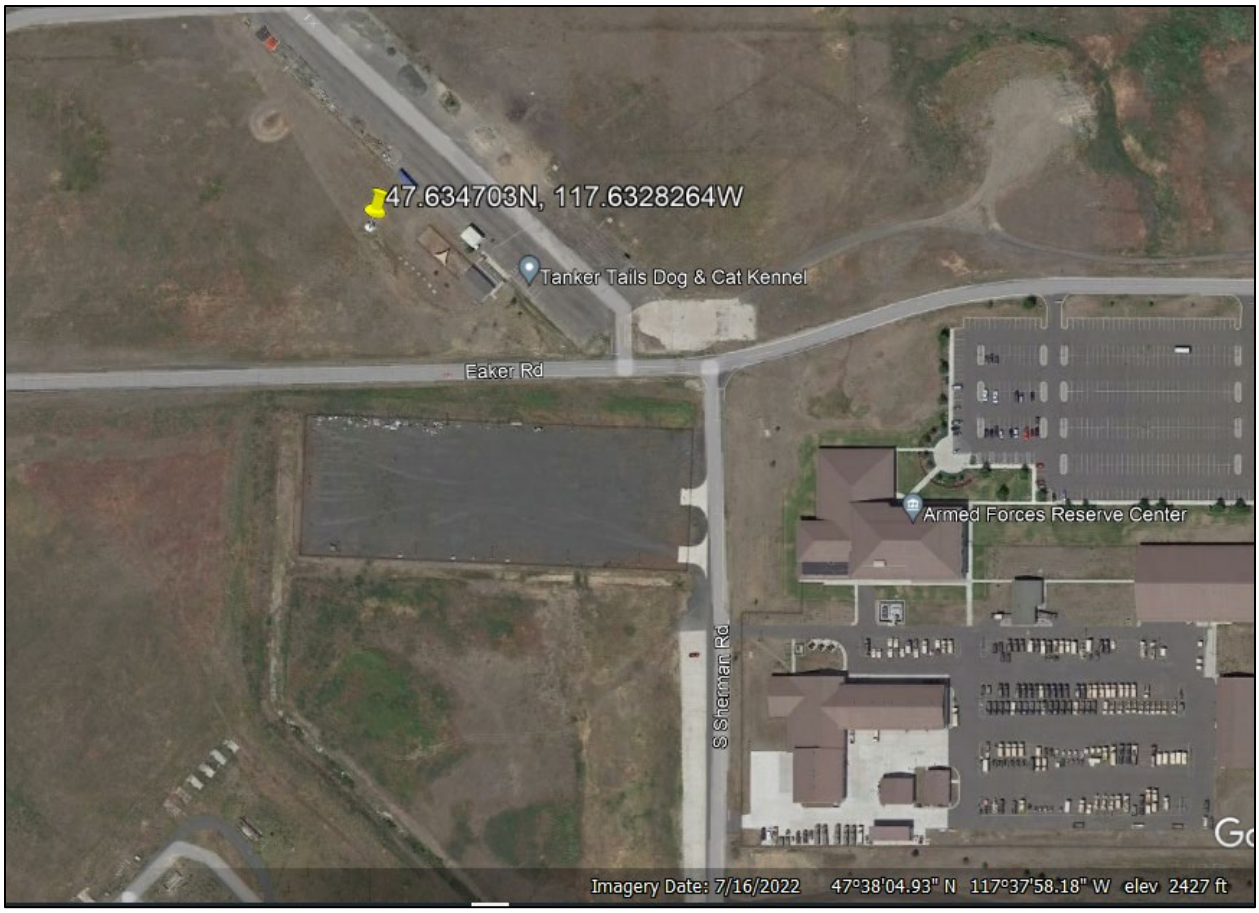

34.816971N, 117.892388W
Imagery Date: 9/4/2015 34°49'01.10" N 117°53'32.60" W elev 2300 ft

Ash River, MN:

Limestone, ME:

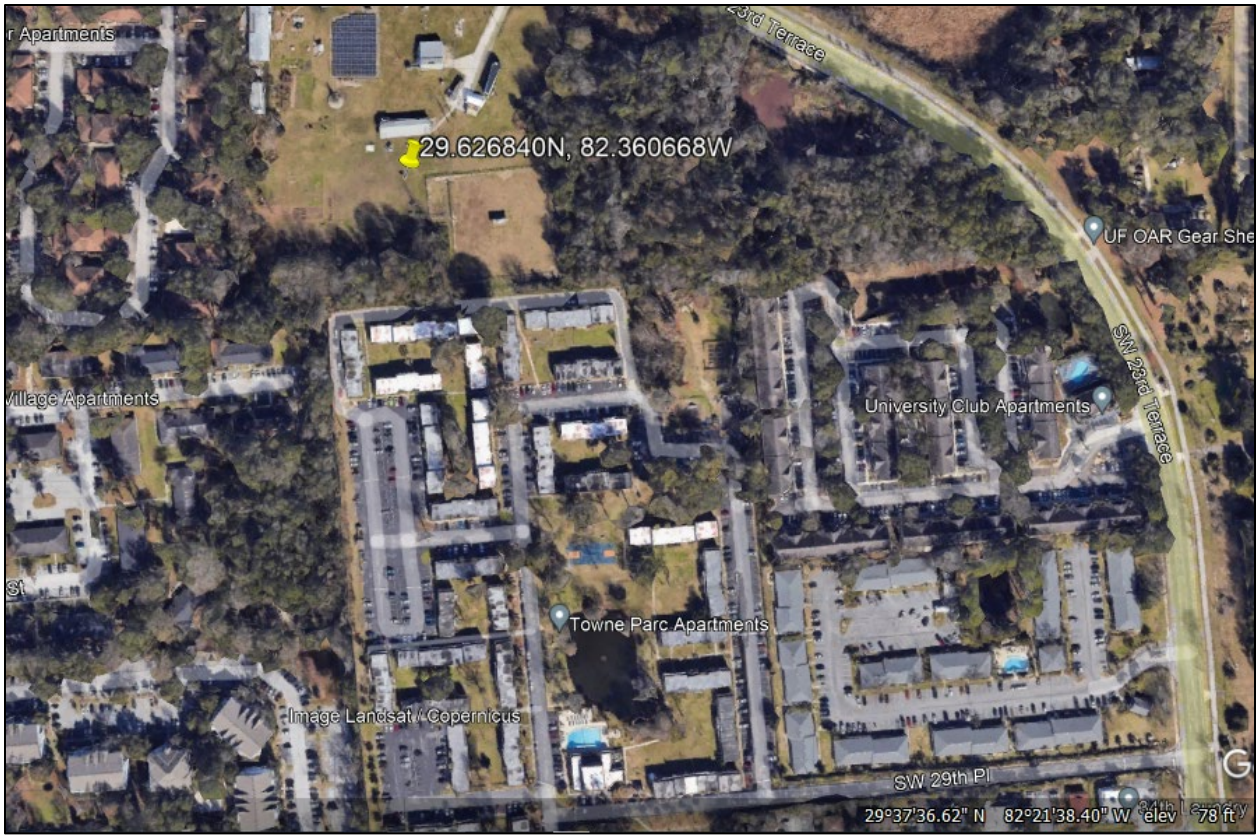

Loring Development Authority
46.940853N, 67.899384W
Georgia Rd
Georgia Rd
Alabama Pl
Pennsylvania Rd
Arizona Rd
Florida Rd
Montana Rd
Imagery Date: 10/5/2022 46°56'27.07" N 67°53'57.78" W elev 707 ft

Spokane, WA:


47.634703N, 117.6328264W
Tanker Tails Dog & Cat Kennel
Eaker Rd
Armed Forces Reserve Center
S Sherman Rd
Imagery Date: 7/16/2022 47°38'04.93" N 117°37'58.18" W elev 2427 ft

Guayama, Puerto Rico:

Gainesville, FL:



Time of Use

Radios listen for a ground station signal, and they turn on when they are passing over a ground station where they "hear" the ground station signal. With a maximum rate of ground contacts at 5 minutes every 3 days, the radio utilization is only about 0.1%.

Power levels Proposed

The program has been designed to use the minimum power possible to achieve effective communication from the satellite to the ground station. The 1.51 W ERP is expected to achieve the mission goals without draining resources of the satellite.

The ground station network has been used for other operations, and it uses only the power necessary to communicate with the satellites.

No Likelihood of Harmful Interference

With the limited amount of use of the signals, it is not expected that there will be harmful interference to other operations. The signal will only be over a ground station and transmitting for 5 minutes every three days, and that will not be the same ground station each time the satellite passes.

The signal level expected at the surface of the earth for transmissions at the orbital perigee is estimated as -104 dBm.

Other experimentation with this radio, flown on other cubesats by Aerospace, has not caused any interference to existing operations on the ground.

These ground stations have not caused interference to other operations since they have been in use.

Stop Buzzer POC

Garrett Kinum
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Office: 310-336-2280
Cell: 424-423-8186

ITU Cost Recovery Letter

In keeping with the FCC's requirements regarding its licensing of radio operations from space, Aerospace is submitting an ITU Cost Recovery letter.

SpaceCap

To allow the FCC to submit this application to the ITU for Advanced Publication, along with the application, Aerospace is submitting a SpaceCap API file as an attachment to the application in ELS.

NTIA Space Record Data

Aerospace has prepared and submitted an NTIA Space Record Data Sheet for the proposed operations of the radios it will have hosted on Paladin. This information is submitted as an attachment to the application in ELS.

Debris Assessment and Conjunction Warnings

Aerospace does not have authority over the space crafts, only over its payload which will be hosted aboard the Paladin satellites.

It is customary for federal satellite systems to undergo a space debris assessment analysis. Aerospace has confirmed that the Space Force will complete the SDAR, which includes the Aerospace radio payload in the report. Paladin's satellites will comply with all NASA DAS requirements. The SDAR and mission plan for Paladin will be reviewed by Space Systems Command prior to Paladin receiving approval for launch. This review will assure Paladin's compliance with AFI 91-202 and the federal United States Government's Orbital Debris Mitigation Standard Practices.

Conjunction warnings: As explained above, Aerospace does not control or operate the Paladin satellites. The Space Force does. The Space Force has developed and will follow a conjunction

warning response plan that meets its mission requirements, including the protection of spacecraft on orbit.

Conclusion

Aerospace is seeking an experimental license from the FCC to operate two radios that it owns, operates, and controls as payloads that will be hosted on the Paladin satellites belonging to the US Space Force. Because Aerospace owns, operates, and controls the radios, it is appropriate that Aerospace is the licensee. Because Aerospace is working on an experiment to test and demonstrate these radios under a contract with the US Space Force, an experimental license is appropriate.

Should there be any questions regarding this application, please contact Anne Cortez, Counsel to Aerospace, anne@washingtonfederalstrategies.com or 520-360-0925.

Attachment A

Memorandum from US Space Force in Support of Aerospace Experimental License Application For Hosted Payloads on its Satellites

(see next page)

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE SYSTEMS COMMAND (USSF)
LOS ANGELES AIR FORCE BASE, CALIFORNIA

MEMORANDUM FOR Federal Communications Commission (FCC)
45 L. Street NE
Washington DC 20554

FROM: Space Domain Awareness and Combat Power
SSC/SZ-BC SMO
483 N. Aviation Blvd. Bldg. 270
El Segundo, CA 90245-2808

SUBJECT: Paladin FCC License

I am writing on behalf of the Paladin Satellite Program within the United States Space Force to confirm that Aerospace Corporation has a contract number FA8802-19-C0001 with a period of performance that ends 30 September 2028, to provide a communications link. The communications link will be owned and operated by Aerospace Corporation. The link is essential to the Paladin program, and we hope that the review process will result in a favorable decision on the Aerospace application for the proposed operations.

The Paladin Satellite Program Spectrum Points of Contact are listed below.

Name: Dr. Geleta Smith
Phone: (505) 917-1580
E-mail: geleta.smith@spaceforce.mil

Name: Mr. Thomas Fagan
Phone: (571) 599-5363
E-Mail: thomas.fagan.ctr@spaceforce.mil

Please address spectrum questions to the above persons and any contractual questions to me at (310) 653-7308, or at austin.sheeley.3@spaceforce.mil.

AUSTIN SHEELEY, Major, USAF
Section Chief, Space Control Advanced
Technology Transition Branch
Paladin Satellite Program Manager

cc: Spectrum POCs