UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH

Report: GPS-HA-TECHDESC-26

RAF GPS Re-Radiator Technical Description, Hangars A & B

Revision: 03

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Revision Record

Rev	Date	Description of Changes	Pages	Approval
01	2026-02-11	Initial Release	All	J.Carnes
02	2026-02-25	Eliminated L2-band support. L1-band-only system.	5,6,7	J.Carnes
03	2026-04-22	Added intent for installation and description of second re-radiator system in RAF Hangar-B.	All	J.Carnes

Contents

Motivation and Purpose

The Earth Observing Laboratory (EOL) Research Aviation Facility (RAF) at the National Center for Atmospheric Research (NCAR), managed by the University Corporation for Atmospheric Research (UCAR), maintains, operates, and re-configures aircraft owned by the National Science Foundation (NSF) and deploys the aircraft on airborne research campaigns with custom payloads, internationally. The aircraft include a Gulfstream V (Tail# N677F, Figure 1) and C-130 Hercules (Tail# N130AR, Figure 2).

Recording GPS data is a critical mission requirement for research campaigns and reception of GPS signal is essential for research system integration during re-configuration of the aircraft payloads within a hangar environment. To support testing of research system development and systems integration within RAF's Hangar-A, a GPS signal re-radiator is needed. The use of a GPS signal re-radiator is appropriate for the following reasons:

- RAF tests GPS receiver systems as part of the development and test of aircraft, systems, and experimental payloads.
- The aircraft and payloads are frequently unable to be moved outside the hangar during ground test and integration operations.
- The use of "real" GPS signals (as opposed to simulated signals) is essential to identify integration issues with experimental aircraft payloads prior to deployment within a limited integration time window.
- The complexity of operations within the RAF hangar environment results in high risk of damage to hard-wired GPS solutions like GPS "hoods" or antenna couplers, making those solutions impractical.

The purpose of this document is to provide a technical overview of two GPS re-radiator installations to support the request for authorization by the FCC to operate the installations described herein, within RAF's Hangar-A and Hangar-B located at 10802 Airport Ct, Broomfield, CO 80021. The RAF facility is located adjacent to the Rocky Mountain Metropolitan Airport (RMMA, KBJC).

Figure 1 NSF NCAR RAF Gulfstream-V Aircraft

Figure 2 NSF NCAR RAF C-130 Hercules Aircraft

Requirements and Compliance

The RAF Hangar-A and Hangar-B re-radiator installations will comply with all requirements stated in section 8.3.28 of the NTIA “Manual of Regulations and Procedures for Federal Radio Frequency Management (Redbook)” Jan 2021 edition: Use of Fixed Devices That Re-Radiate Signals Received from the Global Positioning System. The requirements and evidence of compliance are listed below.

Requirement	**Compliance**
8.3.28(a): Individual authorization is for indoor use only and is required for each device at a specific site. …	Operation will only be conducted indoors at the RAF Hangar-A and Hangar-B locations identified herein. RAF will comply with obtaining the required authorization for any subsequent GPS re-radiator installations with a separate authorization request.
8.3.28(b): Applications for frequency assignment should be applied for as an XT station class with a note indicating the device is to be used as an "Experimental RNSS Test Equipment for the purpose of testing GPS receivers" and describing how the device will be used.	RAF is applying for authorization as an XT class with the appropriate note. The description is provided in the “System Use” section.
8.3.28(c): Approved applications for frequency assignment will be entered in the GMF.	RAF acknowledges the entry in the GMF.
8.3.28(d): The maximum length of the assignment will be two years, with possible renewal.	RAF acknowledges the maximum assignment length and intends to regularly renew the authorization.
8.3.28(e): The area of potential interference to GPS reception has to be under the control of the user. Areas beyond the range for potential interference are protected by the maximum power calculation described in f. below …	RAF’s Hangar-A and Hangar-B are under the control of NCAR RAF, the users of the Hangars. The analysis provided in “System Signal Strength Analysis” section demonstrates compliance with the maximum transmitted power beyond the facility.
8.3.28(f): The EIRP must be such that the emissions are no greater than -140 dBm/24 MHz as received by an isotropic antenna at a distance of 100 feet (30 meters) from the building where the test is being conducted. …	The “System Signal Strength Analysis” section demonstrates compliance with the maximum transmitted power beyond the facility.
8.3.28(g): Applications requesting consideration of non-zero building attenuation …	No additional attenuation is assumed nor requested in the analysis to meet the maximum transmitted power requirement.
8.3.28(h): GPS users in the area of potential interference to GPS reception must be notified that GPS information may be impacted for periods of time.	RAF will comply with this requirement.
8.3.28(i): The use is limited to activity for the purpose of testing RNSS equipment/systems.	RAF confirms that the GPS Re-radiator use is limited to testing aircraft payloads utilizing RNSS receiver equipment and signals. The system shall be otherwise de-energized.
8.3.28(j): A "Stop Buzzer" point of contact for the authorized device must be identified and available at all times during these re-radiator operations.	Points of contact for this purpose are listed in section “Contacts”.

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System Use

These re-radiator systems will be powered and operated only when GPS equipment testing is being performed. The illuminated wall-mounted power switches for each system will be activated by a technician or engineer conducting the test and will be deactivated when the testing is complete. The switch illumination helps remind the technicians and engineers that the system is in operation.

System Technical Description

RAF will use two GPS Source 'METRO Smart Amplifier Kit' installations to re-radiate GPS L1-band signal *only inside* the Hangar-A and Hangar-B structures, respectively. The overall signal path and re-radiating antenna has a channel passband of 1575 +/-15 MHz. As an emitter of the GPS L1-band signals within the 30MHz signal path bandwidth, the FCC emission designator for these systems is 30M0G1D. The re-radiating transmit antennas will be located on the ceiling of the hangars, in the center of the structures. The distance from the re-radiator to the nearest external wall (north-west) of Hangar-A is 64 feet, as shown in Figure 3. The distance to the nearest external wall (south-east) of Hangar-B is 80 feet, shown in Figure 4.

The GLI-METRO "Smart" Amplifier in these installations have automatic gain control that automatically adjusts the signal path to set the amplified output power to a configured level, which ensures that the system complies with the NTIA 8.3.28(f) Maximum EIRP limit requirement. Additionally, the amplifier has built-in test features that detect oscillation conditions, component failure and other failure modes that improve the reliability of the system.

RAF Hangar-A is located at latitude 39.91296, longitude -105.11863 and RAF Hangar-B is located nearby at latitude 39.913419, longitude -105.117647. Both hangars are adjacent to Taxiway A of the Rocky Mountain Metropolitan Airport (RMMA, KBJC), as shown in Figure 5. The distance from the Hangar-A structure to the nearest airport runway is more than 650 ft.

The GPS Re-Radiator Installations are comprised of the components listed in Table 1.

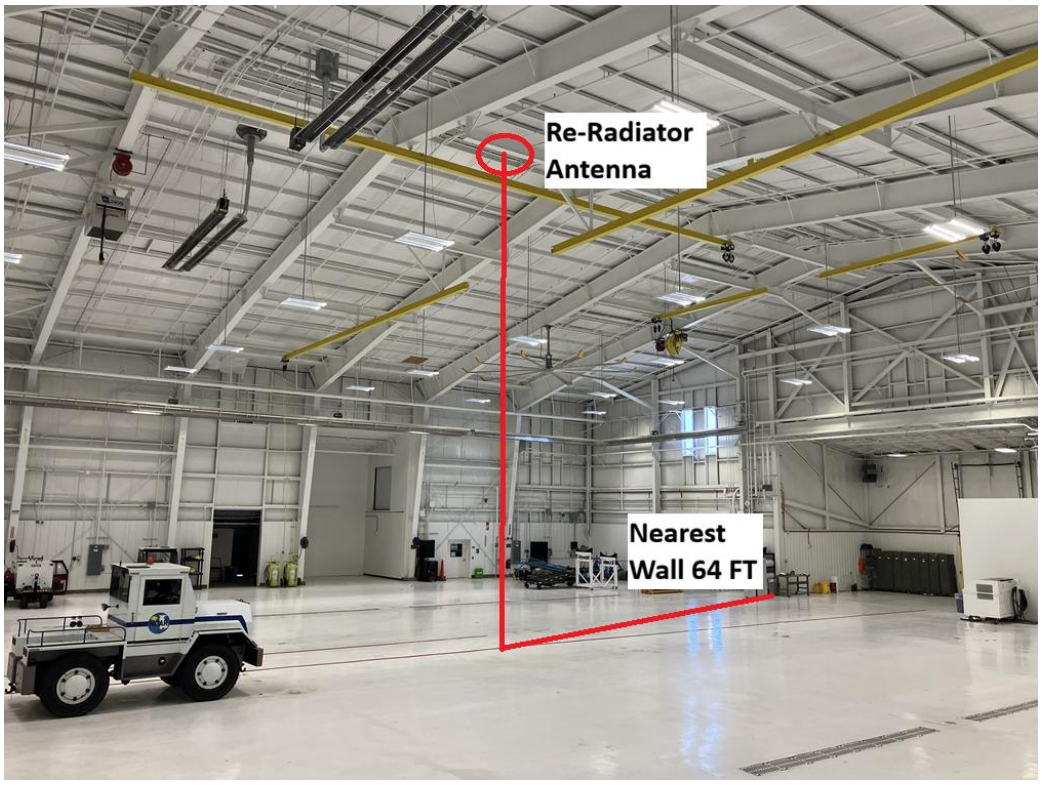

*Figure 3 NSF NCAR RAF Facility **Hangar-A** Layout and Distance to Nearest Wall*

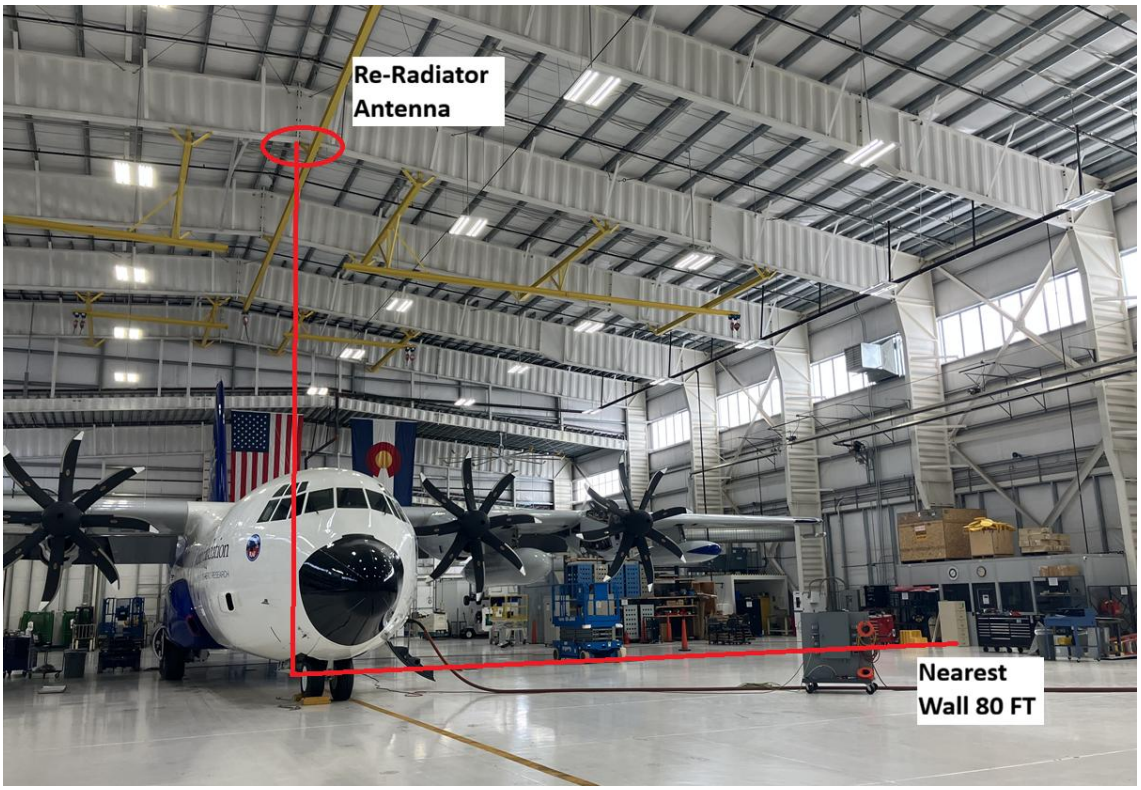

*Figure 4 NSF NCAR RAF Facility **Hangar-B** Layout and Distance to Nearest Wall*

Figure 5 Location of the NSF NCAR RAF Hangar-A and Hangar-B Structures at the KBJC Airport

Component	Part Number	Installation Location
Roof-Mounted Active Receive Antenna	GPS Source L1P-PL-NF	Hangar-A roof (external), center
GPS Signal Amplifier and Power Supply	GPS Source METRO-M-P110/6.8-NF	Hangar-A overhead ceiling structure (internal), center
GPS Passive Transmit Antenna	GPS Source L1A-PM-NF	Hangar-A overhead ceiling structure (internal), center
Lightning Arrestor	DGXZ+15NFNF-A	Hangar-A overhead ceiling structure (internal), center
Coaxial Feedline Cables	LMR-240 Standard RF Cable	Hangar-A roof (external) to overhead ceiling structure (internal), center
Wall-Mounted Power Pilot Switch with Red Indicator	HBL1221PL	Hangar-A, NE side wall

Table 1 GPS Re-Radiator System Components

System Signal Strength Analysis and Maximum EIRP

From the equation specified in NTIA requirement 8.3.28(f), the allowed maximum re-radiated transmit power (EIRP) is calculated below, assuming the distance d=19.5 meters (64 feet) between the transmit antenna and the nearest Hangar-A exterior wall, as shown in Figure 3.

$$P_{Tmax} = P_R + 20 \cdot \log_{10} f + 20 \cdot \log_{10}(30 + d) - 27.55$$

$$L1(f = 1575.42):\ P_{Tmax} = -140 + 63.95 + 20 \cdot \log_{10}(30 + 19.5) - 27.55 = -69.71\ dBm$$

The signal link budget analysis for the system composed of the components in Table 1 is shown in Figure 6. The GLI-METRO "Smart" Amplifier in this installation has automatic gain control that automatically adjusts the GPS amplifier gain to achieve the configured output power value of -74 dBm, regardless of the signal input power.

This analysis demonstrates that the signal strength at a location 100 ft outside the nearest facility wall does not exceed -140 dBm for the L1 band, and the maximum re-radiated EIRP does not exceed the values calculated above, with margin. The GLI-METRO Amplifier will be configured to -74 dBm output and permanently installed with that configuration to meet the 8.3.28(f) EIRP signal limit requirements at the distance 100 feet from the nearest external building wall (164 feet from the re-radiating antenna). Otherwise, no other attenuation (i.e. building path loss or directionality) is assumed. If the antenna directionality was considered, the signal strength outside the facility walls will be at least ~3dB lower than the Figure 6 values because of the permanently downward pointing antenna orientation and antenna beam shape.

The distance from the antenna to nearest exterior wall for Hangar-B (80 feet) is greater than Hangar-A (64 feet), therefore the analysis also demonstrates 8.3.28(f) compliance for Hangar-B.

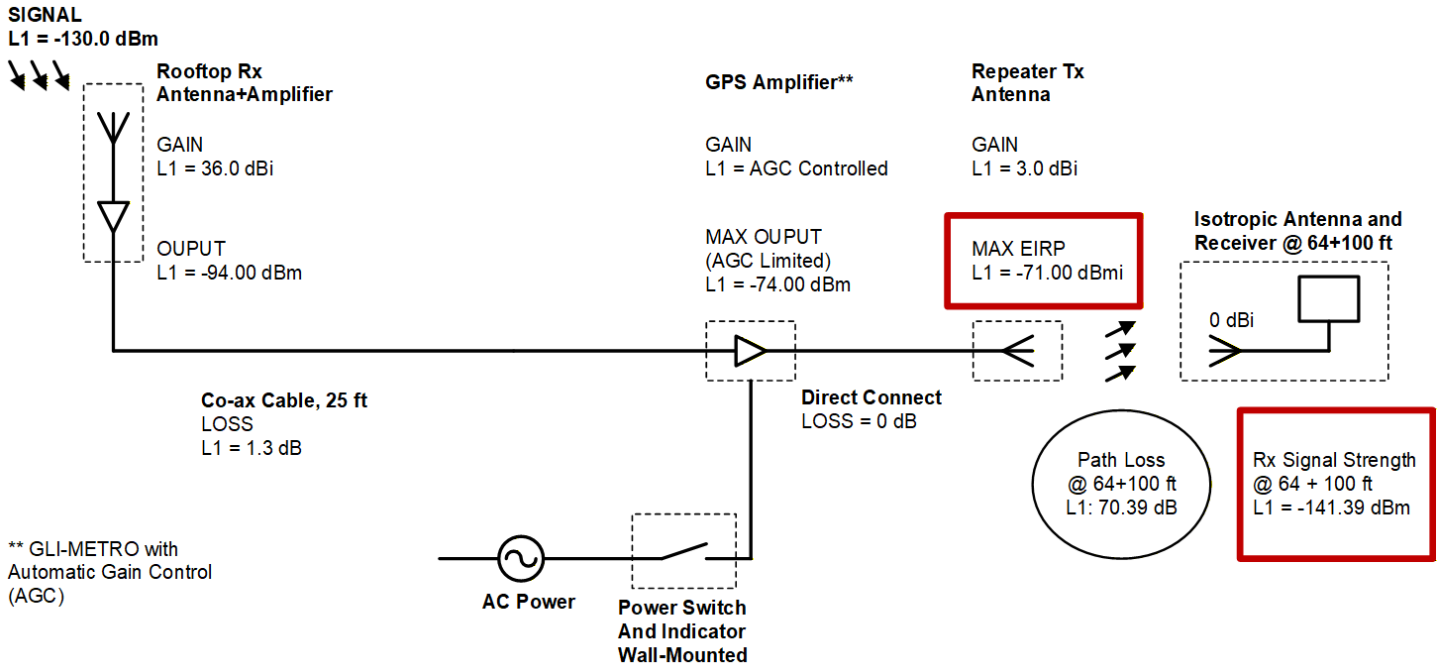

Figure 6 GPS Re-Radiator RF Signal Link Budget Analysis

Contacts

https://ncar.ucar.edu/
https://www.eol.ucar.edu/who-we-are/eol-organization/research-aviation-facility-raf

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Definitions/Acronyms

NSF	National Science Foundation
NCAR	National Center for Atmospheric Research
EOL	Earth Observing Laboratory
RAF	Research Aviation Facility
UCAR	University Center for Atmospheric Research

Document References

Document Number or File Name	Document Name or Description
IS-GPS-200 Rev. N	NAVSTAR GPS Space Segment/Navigation User Segment Interfaces
IS-GPS-800 Rev. J	NAVSTAR GPS Space Segment/ User Segment L1C Interfaces
LINK_BUDGET_FCC_REVG.xlsx	GPS Network Link Budget Tool. Downloaded ONLINE 12/29/2025. https://www.gpsnetworking.com/linkbudget Utilized as a link budget analysis reference tool.