Moses Lake Technical Information Manual and Installation Package

For LAAS/GBAS Ground Based Performance Monitor

(GBPM)

October 10th 2012 – May 3th, 2013

Department of Transportation

Federal Aviation Administration

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Table of Contents

SECTION 1.0 Ground Based Performance Monitor (GBPM)

1.1 Introduction

This package was developed to document the installation, support, and hardware details of the Grant County International Airport GBAS Ground Based Performance Monitor (GBPM). The documentation includes a materials (rack hardware) list as well as full wiring schematics for the GBPM. These diagrams include rack dimensions, power distribution, shelf configuration, Ethernet and serial connections, as well as network and T1 line details. This package also includes other related information such as GBPM infrastructure, service, and needs as well site specific information such as installation images and particulars.

Although it is not part of the GBAS/LGF, the GBPM is best described as a static 24/7, isolated, user platform with network capability. The system uses VHF Data Broadcast (VDB) corrections from DGPS positioning of the LAAS Ground Facility (LGF), along with raw GPS data in order to compute the accurate position of the monitor station (Precision Surveyed GPS Antenna). The position calculated from this data is compared to the position of the precision-surveyed GBAS grade GPS antenna, which can accurately identify positioning errors.

The GBPM is installed in the RTR Shelter, located at position 47°11'56.60"N 119°19'10.30"W (NAD 83).

Appendix A includes images and hardware placement determined from the on-site survey.

Appendix B includes line art and performance plots for the BAE Single Element DGPS Array/Reference Antenna.

Appendix C includes Keyboard, Video, and Mouse Interface (KVM) Code Screens for CAT I.

Appendix D includes KVM Code Screens for CAT III.

1.2 Title Terminology

The FAA's Local Area Augmentation System (LAAS) is also referred to as a GPS Ground Based Augmentation System (GBAS), in the international standards documents. To keep a consistent terminology, the term GBAS will be used in this document. The FAA developed a non-Federal Specification (non-Fed Spec) for the system – the specification uses the term LAAS.

The international terminology is GBAS, the terms are interchangeable.

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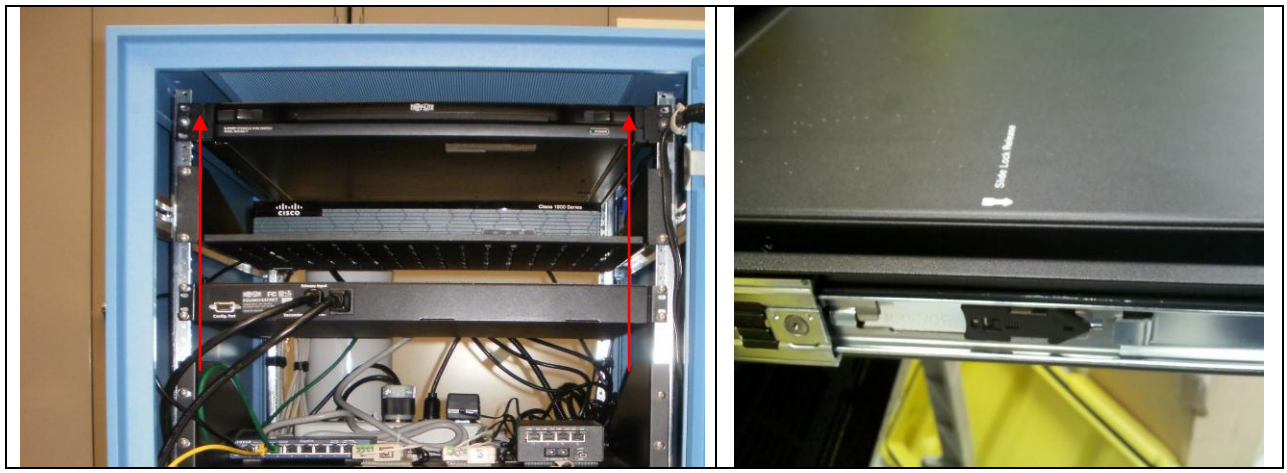
1.3 Boot-up, System Operation, and Data Collection

1.3.1 Boot-up Procedure

Upon installation, the GBAS monitoring station will run continuously unless the power is interrupted. For nominal interruptions, the UPS will keep the station up for at least one hour. Anything greater will result in a loss of service. The monitor is designed to power on after the disturbance and the software will start the boot-up procedure automatically. If for any reason it does not, FAA GBAS personnel will contact someone on-site to follow these simple steps:

- Assuming the GBPM is **off**, open front cabinet door and turn the UPS to the **on** state by pressing the power button located in the front of the unit
- Pull out Monitor and Keyboard (KVM) by grasping tab(s) underneath on device's left and right sides, pull outwards (shown below)*



- Flip open (pull upwards) KVM, if monitor is not powered **on** (LED not lit), hit the power button (circle with slash) on the left-hand corner of the device
- Flip open the KVM and press **enter** twice when prompted to enter a username and password, as there is none at this step, then press F5 to skip
- Press **enter** at the command prompt and type **root** to login to the QNX console
- Type **cd /MonitorSoftware** then press **enter**
- Type **./go 6** then press **enter**

*See section 1.5 Rack Hardware for additional images

1.3.2 Checking System Operation

The System Code* automatically runs from computer boot-up/startup on main console screen (Main Console #1). The System has 9 main screens useful in analyzing GPS performance, for example:

- Pressing **1 (Channels 1-8)** and **q (Channels 9-16)** show basic information on all GPS satellites tracked by the GPS receiver

- Pressing **2** shows the Azimuth and Elevation of the tracked SVs, as well as calculated Protection Limits for GPS and WAAS

- Pressing **5** shows corrected position information and GPS corrections based on the Type-1 message from GBAS VDB broadcast

If Login Prompt is displayed with a flashing cursor, type **root** followed by pressing the **enter** key.

* Please refer to Appendix C and D for detailed descriptions of the available screens (1 – 9) for CAT I and CAT III respectively.

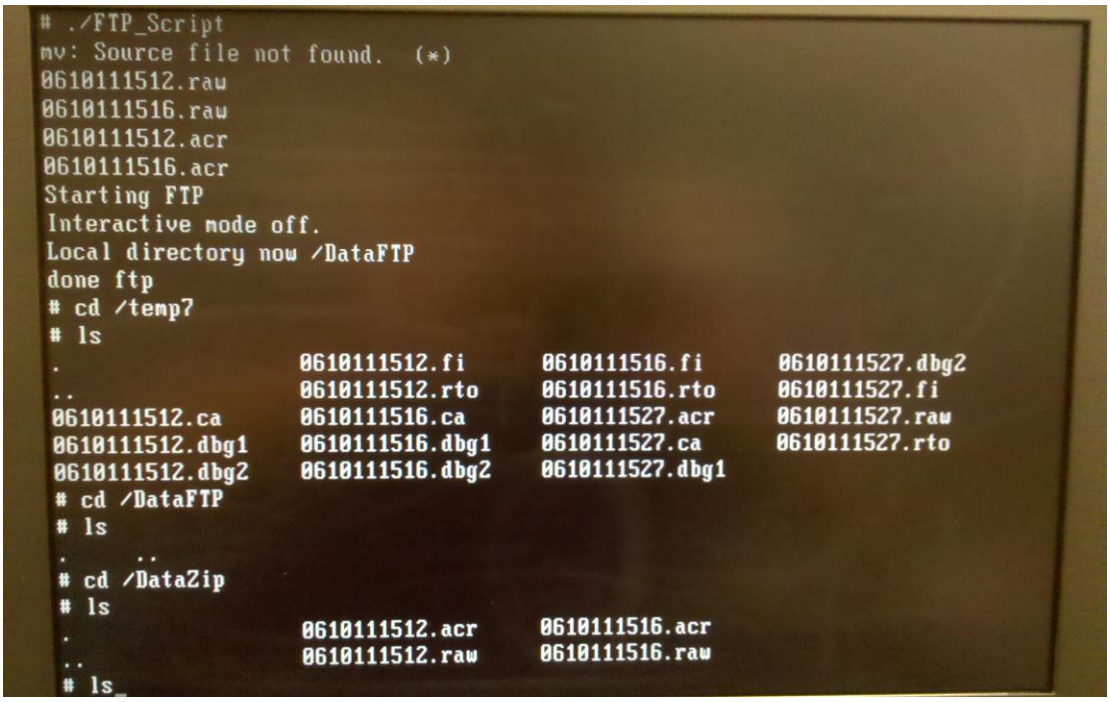
1.3.3 On-site Data Collection via Network Drive

All data collection is designed to be transferred via T1 line to the WJHTC in Atlantic City. A network drive may be provided as a temporary solution if said line is not installed prior to site installation.

- Using a standard Cat5/5e cable, plug in the network hard drive into the 8-port network switch and verify power by observing indicators on front of device
- Flip open the KVM and press **enter** twice when prompted to enter a username and password, as there is none at this step
- Switch to a blank console by pressing **Ctrl-Alt-#** (console 2 – 6 may be used, 1 is for system code)
- Press **enter** at the command prompt and type **cd /** (FTP script is stored in the **root** directory)
- To run script, type **./GBPM_FTP_Script** and press **enter**
    - Files to be copied will be displayed when process starts. If desired, write down these filenames for verification at a later time

  NOTE: The FTP Script will only copy files that are not currently running

When the script is completed, a **Done FTP** message is displayed along with **#** prompt. A screenshot of the "running" script is provided below.



After the script has finished running, it is important to verify that the desired files are copied to the Network/External Drive by following these simple steps:

- At the command prompt, type '**ftp 192.168.6.60**' then press **enter**
- At the command prompt, type **moses** then press **enter**
- For the password, type **mwhGBPM** then press **enter** (the display should read "Login Successful")
- At the command prompt, type **cd moses** then press **enter** (the display should read "Directory Successfully Changed")

- At the command prompt, type **dir** then press **enter** (files displayed in “moses” folder)
    - Verify that the files copied during runtime of **GBPM_FTP_Script** are being displayed
- At the command prompt, type **quit** then press **enter**

To re-display System Operation, the user must revert back to Main Console #1 (System Code) by pressing **Ctrl-Alt-1**.

1.3.4 Closing Monitor and Keyboard (KVM)

After inspecting rack (i.e. performing routine maintenance), follow these steps to return KVM to cabinet enclosure:

- Turn off the monitor and keyboard (KVM) by pressing down the power button
- Pull down monitor until it is flat against the keyboard
- Locate the two black slide-lock release tabs on the side rails of the KVM (pictures in Section 1.3.1 Boot-Up Procedure)
- Pull slide-lock release tabs forward while slowly sliding the KVM into the cabinet (effort may be required)
- Close cabinet door and lock with included key set (will be attached to the upper right-hand side of cabinet frame work)

1.3.5 Network Drive Removal and Replacement

Should the existing network drive fail or reach full capacity (and needs to be mailed to WJHTC personnel), it will need to be replaced. To replace existing network drive with a new device, please follow these steps:

- Locate white (rubber) power button next to Ethernet port to remove HDD that is turned **on**
- Press and hold power button until LED Indicator lights on opposite side are fully illuminated, then release the button
- When the LED lights turn off, unplug power and Ethernet cables then carefully remove HDD (device may be attached with Velcro or locking tape, some effort is required to remove)

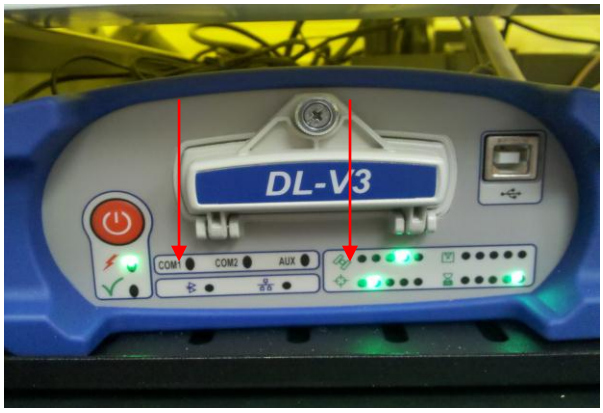
Follow these additional steps to install a replacement network drive:

- Install replacement network drive and insert power and Ethernet cables into new device
- LED indicator lights will turn on, then after approximately 20 seconds, they will turn off
- Press and hold white (rubberized) power button for about 3 seconds, or until LED indicator lights turn back on, then release the button

1.3.6 Checking GPS Receiver Status Lights

To verify that the NovAtel GPS Receiver is tracking GPS satellites, please refer to the reference guide provided below:

- View LED lights next to the **Satellite** icon to reference the number of satellites being tracked
  - 1st LED next to icon (red): <=3 SVs
  - 2nd LED next to icon (amber): 4 or 5 SVs
  - 3rd LED next to icon (green): 6 or 7 SVs
  - 4th LED next to icon (green): 8 or 9 SVs
  - 5th LED next to icon (green) : >= 10 SVs



- Verify receiver is outputting data on **COM1** (LED light to the right of COM1 should be blinking)

1.3.7 GBPM IP-Address List

Please use the chart below as a quick-reference guide in the event that an IP Address is required (For additional network concerns please contact Shawn Casler at 609-485-6914).

Device	IP Address
QNX CPU	192.168.6.21
CISCO Router	192.168.6.232
Power Distribution Unit (PDU)	192.168.6.100
Network Hard Drive	192.168.6.60 (may be provided)

1.4 Materials

The chart below is a complete list of all hardware used in construction/installation of the GBPM. This list does not include miscellaneous hardware such as HP power cords, RG-400 cable runs, various RF connectors or adapters, and other similar pieces of equipment.

GBPM:

Description	Specifications	Part Number
1U 12" Vented Component Shelf		1906-3-221-01 (V)
2U 12" Vented Component Shelf (x2)		1906-3-221-02 (V)
3U 12" Component Shelf		1906-3-221-03
8-port Console KVM and Switch	100-240 VAC ~ 50-60 Hz 1.0 AMP	B020-008-17
AccelePort 8r 920-PCI DB25 Card / Cable		(1P) 70001362
APC Smart UPS	120 VAC ~ 50-60 Hz 12 AMP	1500 1440VA 980W
Becker VDB Receiver RS 4909 A	VDB Freq: 114.075 MHz	PO 002781
CISCO HWIC Interface / Network Card		HWIC-1DSU-T1
CISCO Systems 1900 Series Integrated Service Router	100-240 VAC ~ 50-60 Hz 1.0 AMP	CISCO1921
Citel POE Surge Protector	120 VAC ~ 60 Hz 15 AMP	MJ8-POE-A
GlobTek AC Power Adapter (x2)	100-240 VAC 0.5 AMP Max 50-60 Hz	Part: TR9CE1250LCP-Y-UED GTM21089-1512-T3

	Output: 12 VDC @ 1.25 AMP	
GlobTek AC Power Adapter (NovAtel Only)	100-240 VAC 1-6 AMP Max 50-60 Hz Output: 24 VDC @ 2.1 AMP	Part: TR9C12100LCRY GTM-21097-5024
GPS Networking Incorporated T-Splitter		LDCB51X2
Islatrol, Inc. Isolation Transformer	120 VAC 15 AMP	LRI-115
Mini-Circuits Bias-Tee RF-Splitter	10-4200 MHz	Part: ZFBT-4R2G RUU16001132
Netgear ProSafe 8-Port Gigabit Switch		GS108
Network Enabled Power Distribution Unit	120 VAC ~ 60 HZ 15 AMP	PDUMH15ATNET
NovAtel GPS Receiver / WAAS		DL-V3-L1L2
QVS Surge Protected Power Strip	120 VAC ~ 60 Hz 15 AMP	112 0190
RS232-RS485 Converter (x2) Note: 2 separate units for Data and 1 PPS	2000 V Isolated	IC-485SI
RS232-RS485 Converter Power Adapter (x2)	120 VAC ~ 60 Hz, 5W Output: 9 VDC @ 300 mAMP	AD-0930M
Sunon Impedance Protected Exterior Mounted Cooling Fans (x4)	115 VAC ~ 50-60 HZ 0.21 / 0.18 AMP	SP101A 1123HST.GN
Super Logics QNX Central Processing Unit		SL-2V-AT-945GC-BA
Transition Networks 4XT1E1 to Fiber 1300 NM MM ST MUX		S4TEF1011-120-NA
TrippLite 12 Outlet un-UPS Power Strip	120 VAC 15 AMP	RS-1215-RA AGIP120V61PRM

GPS Antenna:

Description	Specifications	Part Number
BAE Single Element DGPS Antenna	Single Element	ARL-1900 S
Gas Discharge Tube Lightning Suppressor (Antenna) - OPTIONAL	Protection Voltage: 90 V Max Transient: 50 kA Multi-strike: 20 kA 10 Times	PTRONFONF09S
GPS Lightning Suppressor (Antenna and RTR Shelter J-Box)	Protection Voltage: 18 V Response Time: 10 ns Max transient: 30 kA 1 Time Multi-strike: 20 kA 10 Times	FPLNFNFBP12
GPS Accessories WR Incorporated GPS Filter	L1 / L2	#F
JCA Pre-Amplifier	RF Output: +12.6 V	JCA12-4189T Serial: F96810

Very-High Frequency Data Broadcast (VDB):

Description	Specifications	Part Number
Laird Mobile-to-Base Converter for 800 / 900 MHz w/ N (x6)		MBC800
Laird VHF ¼ Wave 66-174 MHz Unity Gain Antenna 51" NMO (x6)	114.075 MHz	B66
Polyphasor VHF (VDB) Lightning Arrestor, Broadband DC Blocked Protector (N Female to N Female) (Shelter J-Box)	Freq: 1.5 MHz to 700 MHz 600 Vdc +- 20% VHF 375 W, UHF 125 W	IS-B50LN-C0
VHF RF "Can" Filter	Frequency: 63-125 MHz Insertion: 1.3 dB max	5BT-63/125-5-N/N

MUX Shelf:

Description	Specifications	Part Number
1U 12" Component Shelf (Located in Fiber Rack 2, ATCT)		1906-3-221-01

Citel POE Surge Protector	120 VAC ~ 60 Hz 15 AMP	MJ8-POE-A
GlobTek AC Power Adapter	100-240 VAC 0.5 AMP Max 50-60 Hz Output: 12 VDC @ 1.25 AMP	Part: TR9CE1250LCP-Y-UED GTM21089-1512-T3
QVS Surge Protected Power Strip	120 VAC ~ 60 Hz 15 AMP	112 0190
Transition Networks 4XT1E1 to Fiber 1300 NM MM ST MUX		S4TEF1011-120-NA

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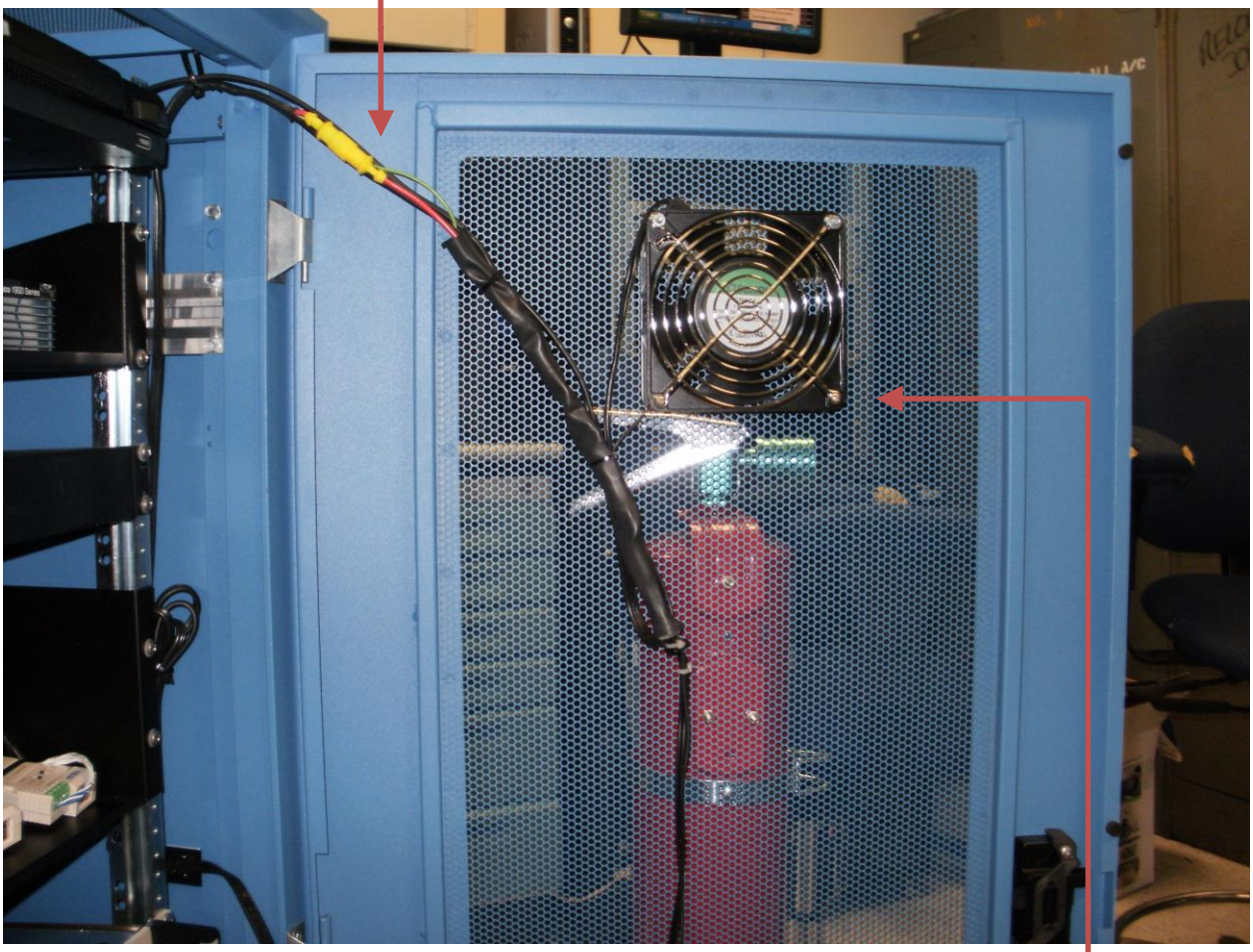
1.5 Hardware

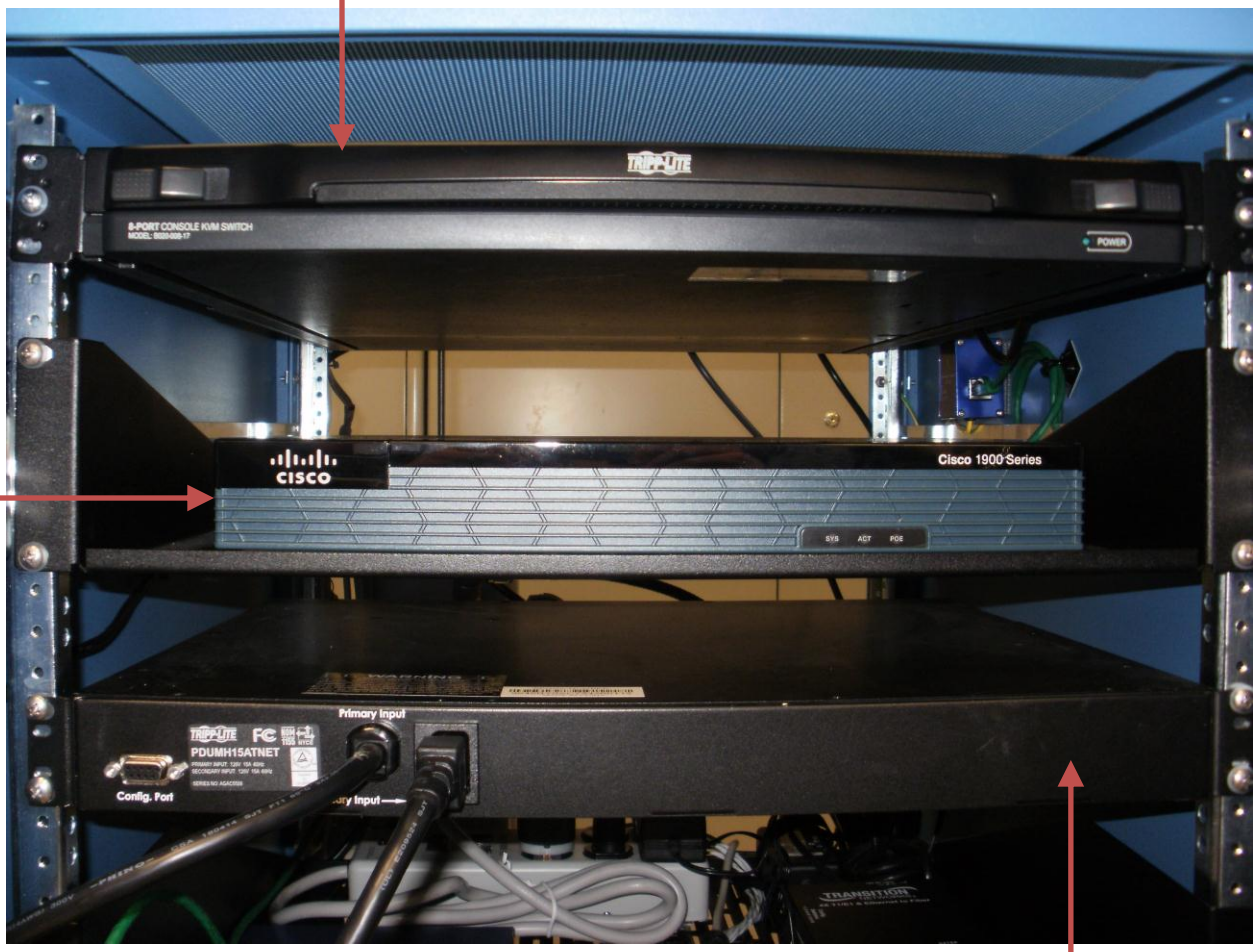
The following section features the front and rear layouts for the GBPM. Please refer image set.

In-Line Fuse



Cooling Fan/Housing

8-Port Console KVM and Switch

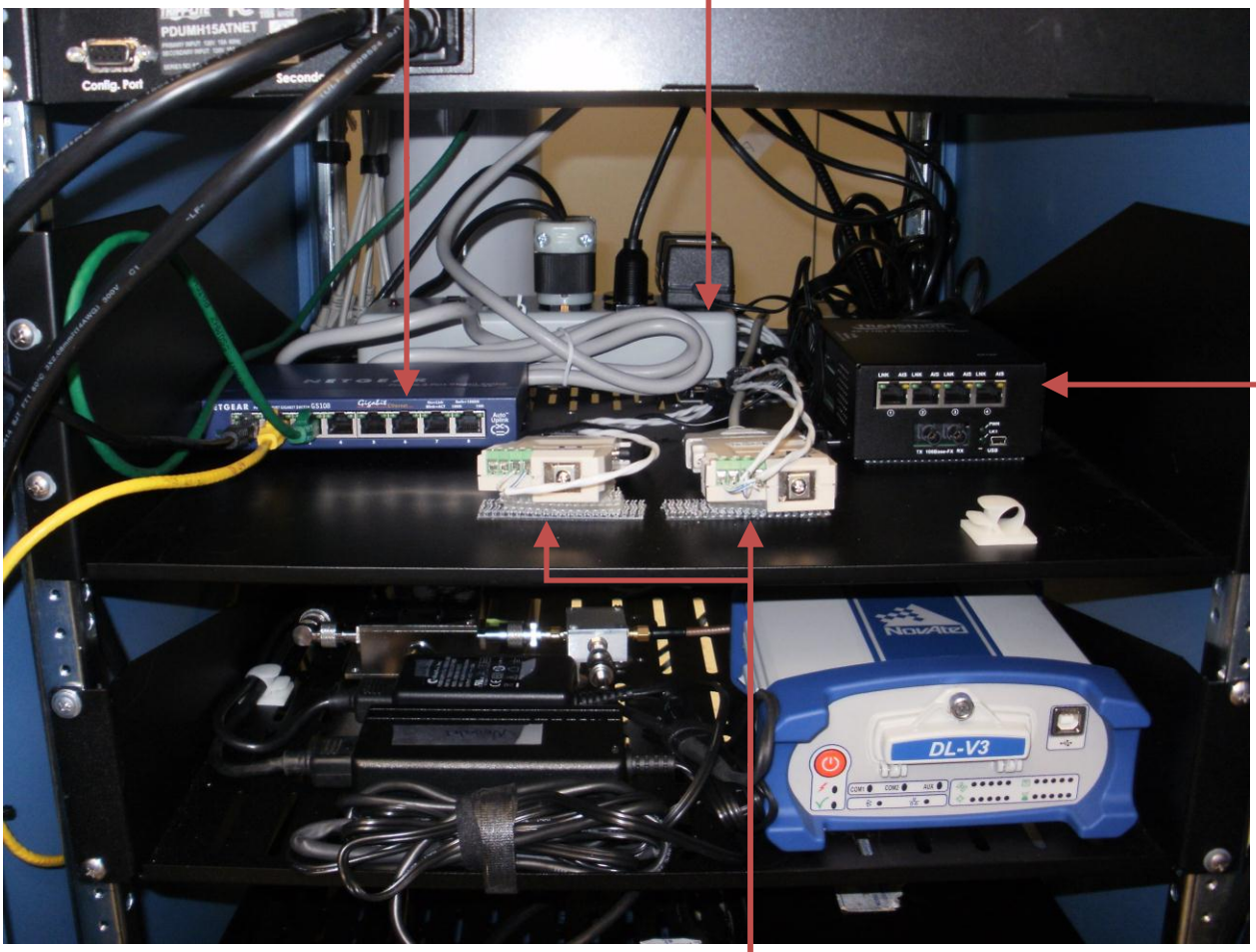


CISCO 1900 Series Router

Network Enabled PDU

Netgear ProSafe 8-Port Gigabit Switch

QVS Surge Protected Power Strip

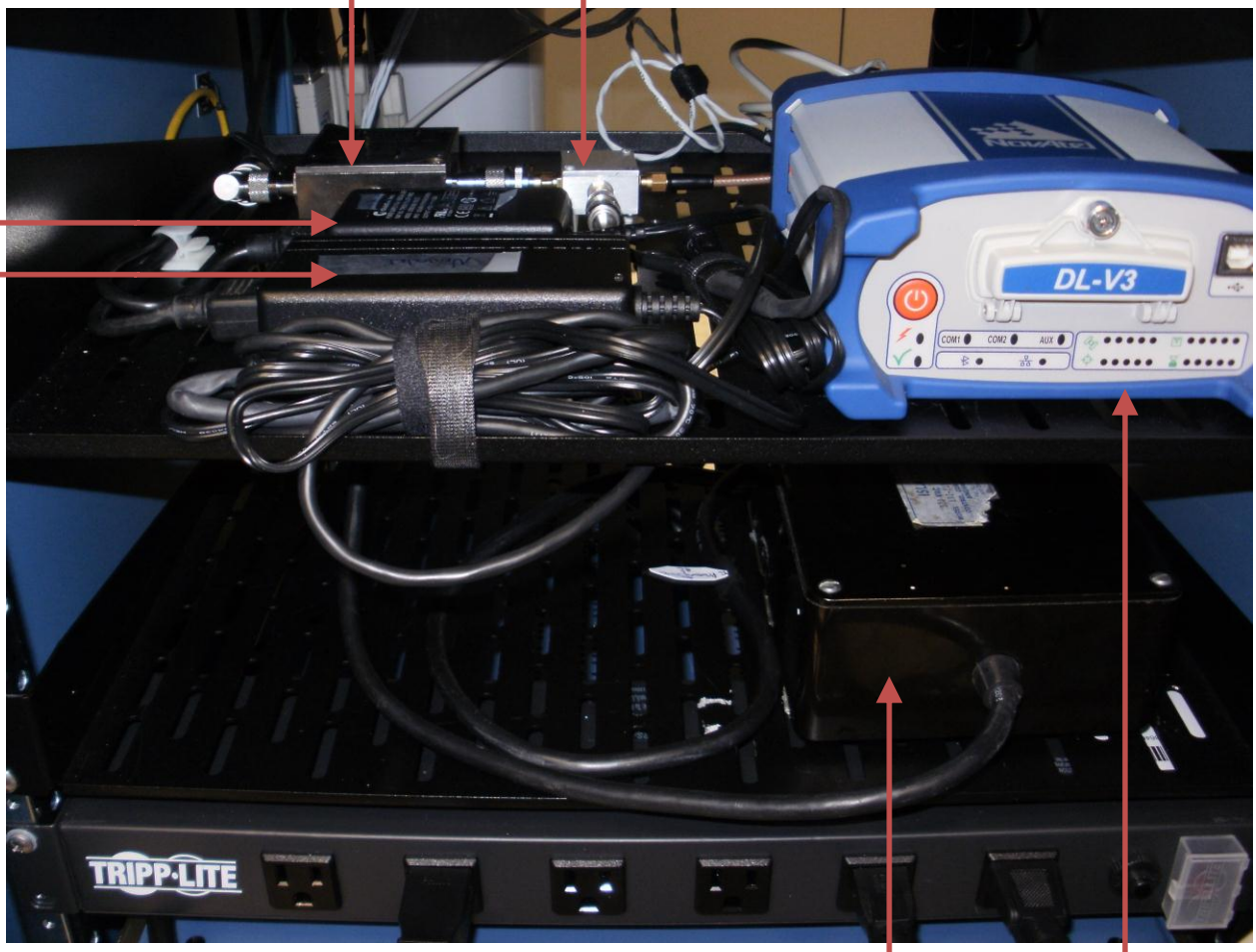


RS232/RS485 Media Converters

4XT1 Ethernet to Fiber MUX

GPS T-Splitter

Bias-T / RF Splitter



GlobTek 100-240 VAC Power Adapters for NovAtel and Bias-T (Labeled)

Islatrol, Inc. Isolation Transformer

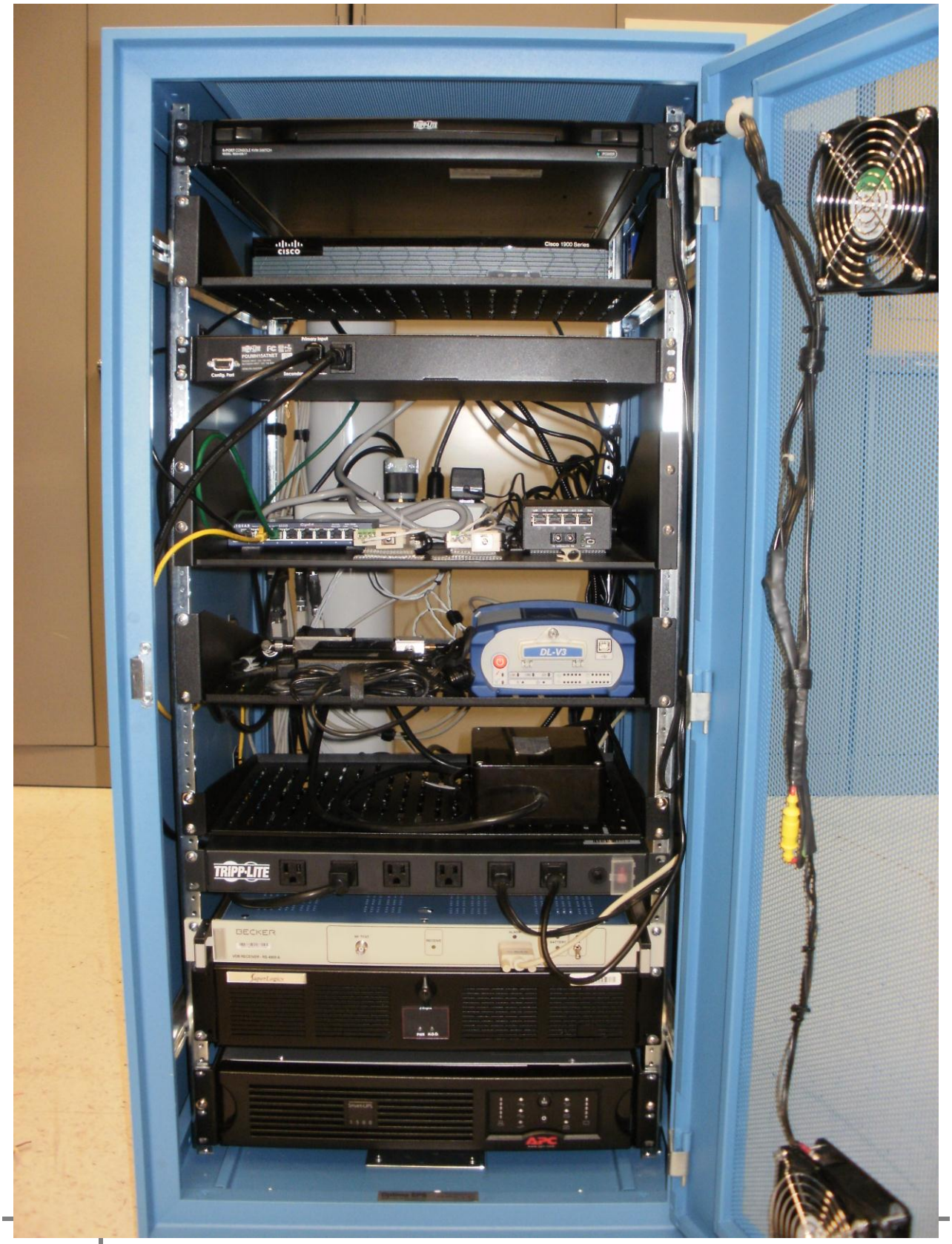
NovAtel GPS Receiver / WAAS

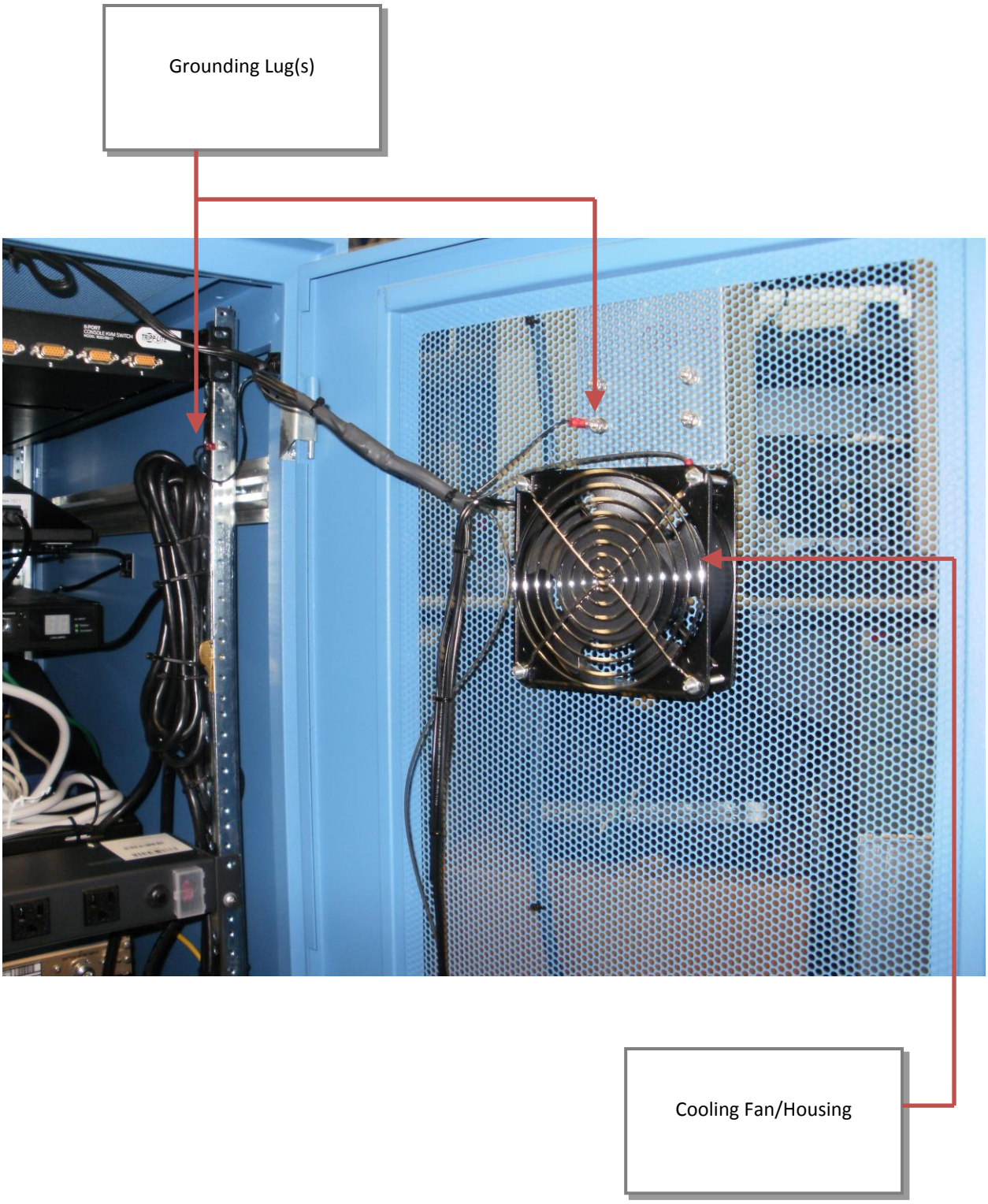
TrippLite 12 Outlet Power Strip

Becker VDB Receiver RS 4909 A

APC Smart UPS

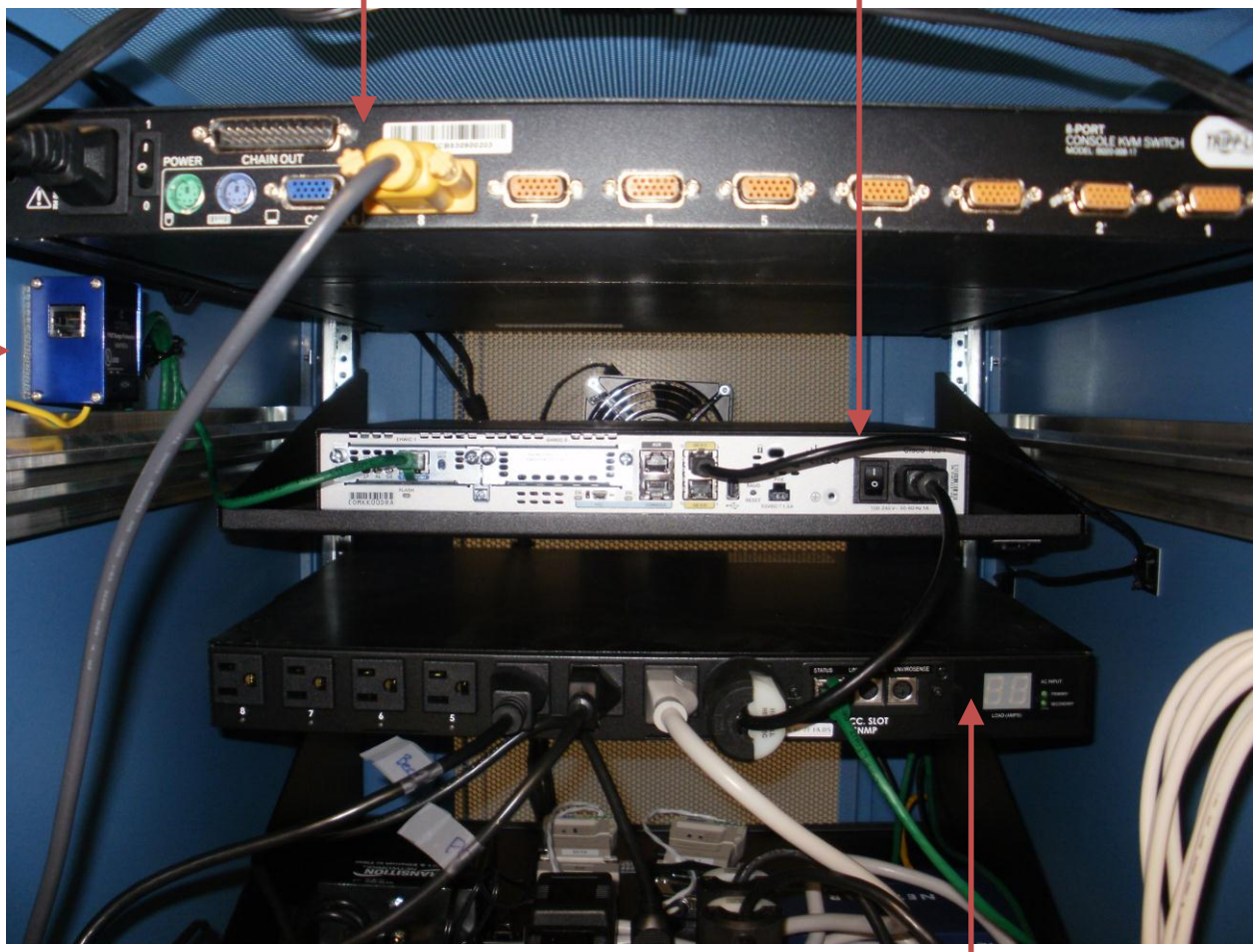
Super Logics QNX Central Processing Unit


TRIPP-LITE
CISCO
Cisco 1900 Series
DL-V3
TRIPP-LITE
BECKER
APC


Grounding Lug(s)
Cooling Fan/Housing

8-Port Console KVM and Switch

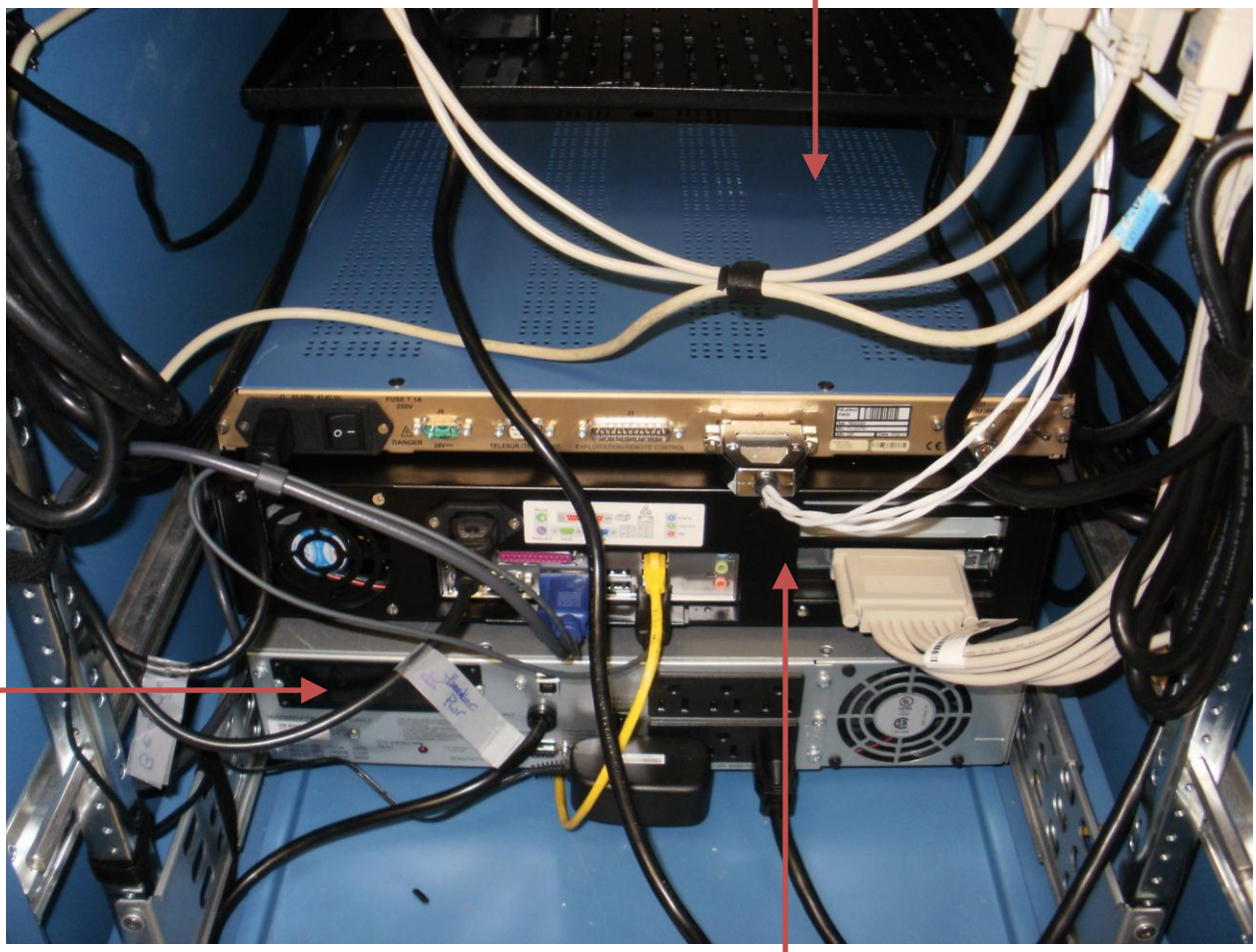
CISCO 1900 Series Router



Citel POE Surge Protector

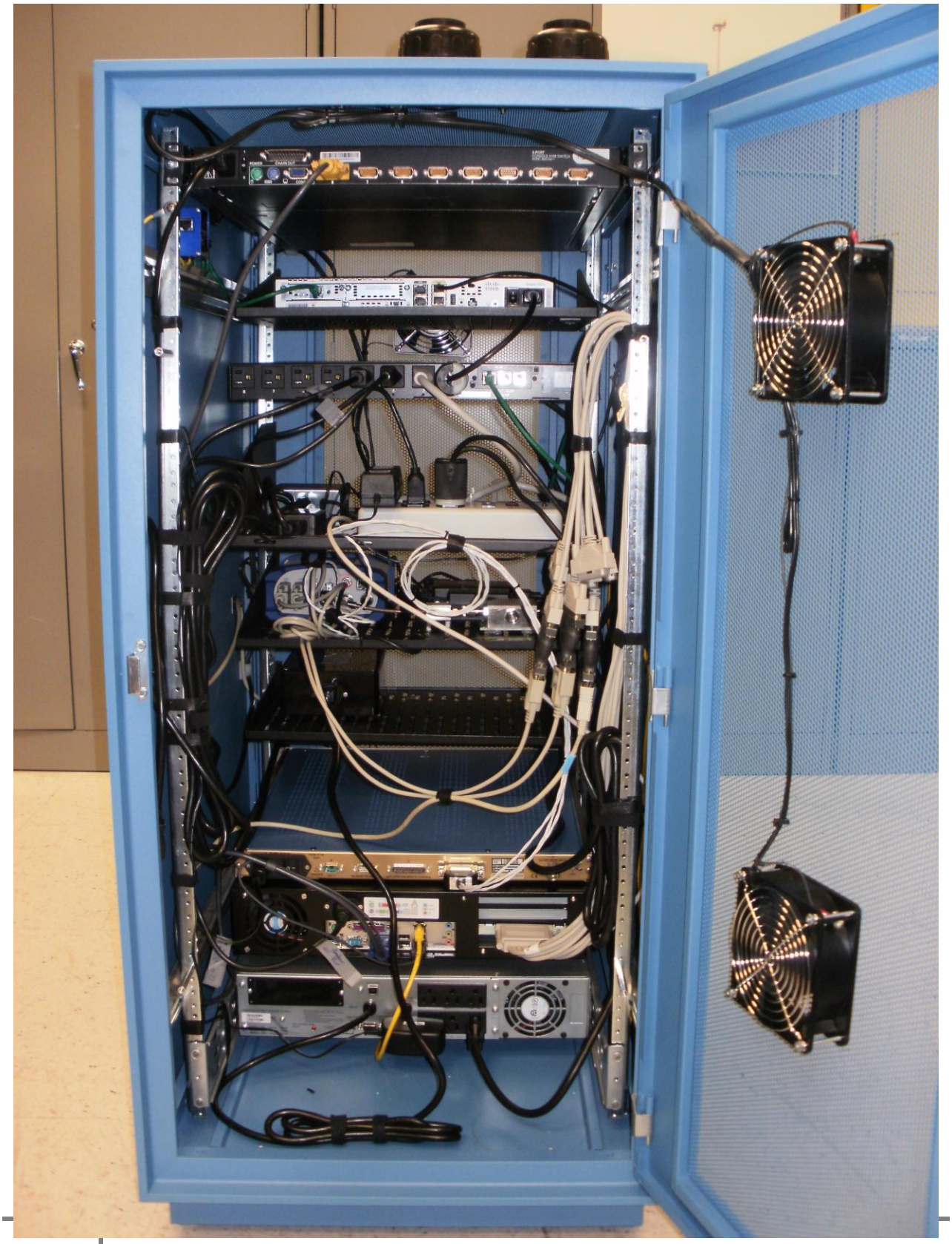
Network Enabled PDU

Becker VDB Receiver
RS 4909 A



APC Smart UPS

Super Logics QNX Central Processing Unit



1.6 Maintenance

The FAA Technical Center staff will have a dedicated T1 line in-place for remote system ops verification and data retrieval. There are three types of limited maintenance that may be required: Regular, As-Requested, and As-Needed.

Regular (every 3 months):

- ☐ **Observe cooling fan operation, if excessive dust is present within fan housing then un-mount housing from door frame and wipe with a soft cloth. Be sure to power down cooling fans before attempting this.**
- ☐ **Wipe clean excessive dust from rack-mounted equipment with a soft cloth.**
- ☐ **Verify power distribution within rack enclosure. Observe PDU indicator LEDS and verify that all mounted power strips are turned on and functioning correctly.**
- ☐ **Verify network connectivity within rack enclosure. Observe network switch indicator LEDS and validate that device configuration is satisfactory.**

As-Requested:

Any troubleshooting of rack-mounted equipment or network failures should be considered "As-Requested" because the FAA Technical Center GBAS staff will most likely become aware of such faults and replacement components/instruction can be shipped immediately. In regards to this matter, please do not hesitate to contact the GBAS staff at the earliest convenience.

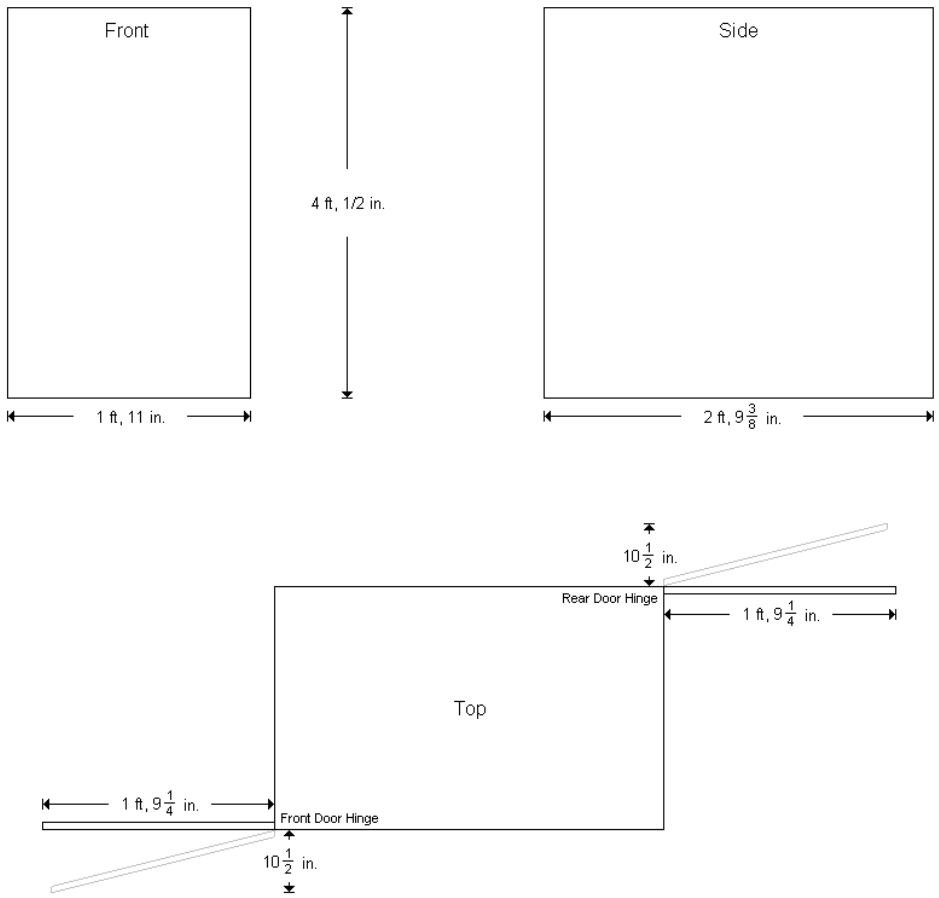
- ☐ **In the event of a network disruption - Verify that the GBPM is functioning correctly by pulling out KVM and observing data feed. If GBPM is not receiving GPS data then recycle power and await data capture. Contact information will be included with this package if further assistance is required.**

As-Needed:

Any unforeseen/abnormal component behavior with rack-mounted equipment should be considered "As-Needed" because the FAA Technical Center GBAS staff may not immediately become aware of the behavior. Abnormal behavior should be classified as alarms, smells, or visual cues. In regards to this matter, please do not hesitate to contact the GBAS staff at the earliest convenience.

- ☐ **If UPS is running on backup battery, be sure to push and hold the *1 Test* button (located on the rear of the device) for 3 seconds or until beeping stops. If beeping does not cease then this could indicate a building wiring fault, in which case immediate attention should be given to resolving the issue. As stated above, please contact if further assistance is required.**

1.7 Dimensions



The Buckeye Fire Equipment Extinguisher (5H 5A HALOTRON 1) is mounted to the *front* hinged door of the GBPM. This adds $5^{1/4}$ inches to the overall length (side view) of the GBPM and needs to be accounted for when positioning the GBPM.

As shown above, the installation team should allow clearances needed for maximum door swing (w/ fire extinguisher), which is roughly $10^{1/2}$ inches in either direction from center position (180°).

NOTE: The Fire Equipment Extinguisher w/ Smoke Sensor is an optional package and may or may not be included with the GBPM. This will depend on the contract agreement between the parties involved.

1.8 RF and Rack Power Cable Runs

Two LDF4-50 ½" Semi-Rigid Heliax cable runs were installed on-site at the RTR Shelter. These cable runs provide RF for the VHF and GPS Antennas and were ran from the GBPM enclosure, up roughly 6 ft. to the cable tray (via Heyco Flextube) and through the north wall penetration to the RTR Shelter J-Box (Port 9 for GPS, Port 10 for VHF). An RF pigtail was used to convert the GPS cable run (double white) into LDF1-50 ¼" Semi-Rigid Heliax in order to connect to the port labeled "Antenna" on the GPS Splitter.

The VHF Antenna cable run (double green) is connected to the input side of the VHF RF Filter, which has been tuned to 114.075 MHz. A second LDF1-50 ¼" Semi-Rigid Heliax cable run bridges the VHF RF Filter output side to the Becker VDB Receiver input.

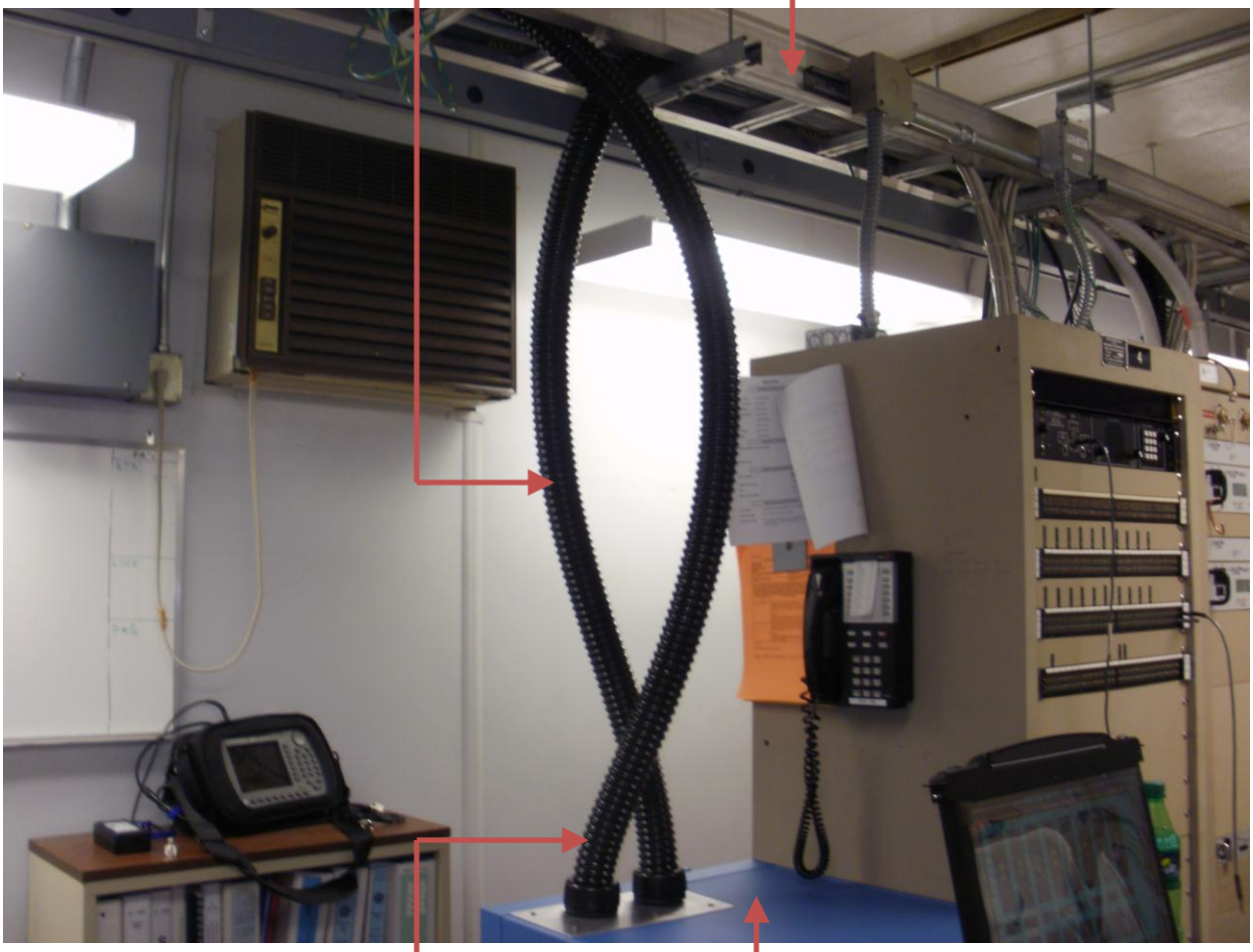
A second Heyco Flextube was used to house the Power and Fiber-optic cable runs. Two standard HP power cords were ran to Power Rack 4 and plugged into existing outlets to provide the necessary 120 VAC power for the GBPM. The standard HP power cords were terminated with 15 AMP NEMA male plugs. For detailed information regarding the fiber-optic cable run, please refer to *Section 4.1 T1 Network Cloud and ATCT Layout*.

Heyco FlexTube

(**Fiber and AC Power**)

Overhead Tray

Fiber and RF Cable Runs

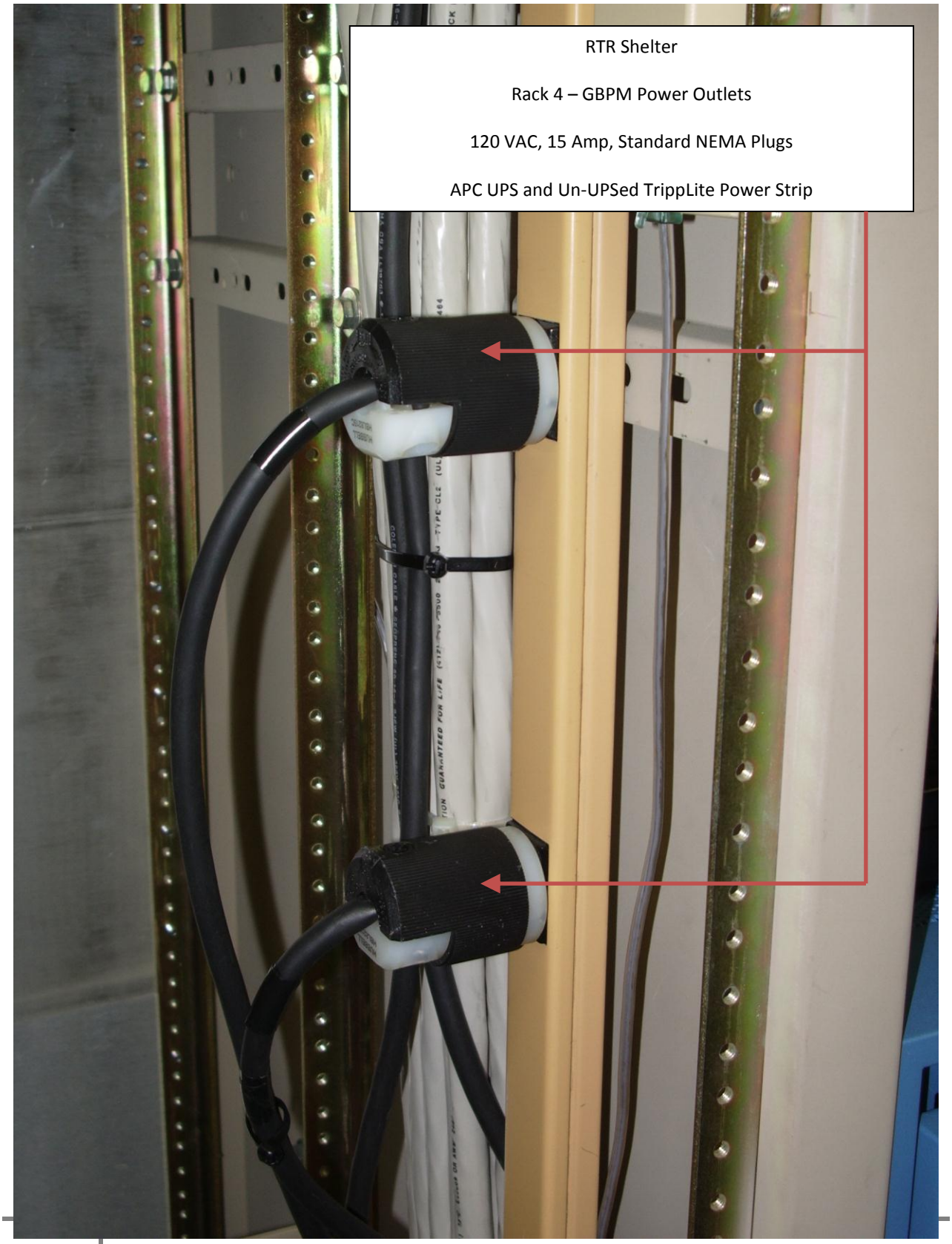


Heyco FlexTube

(**GPS & VHF Whip Antenna RF**)

GBPM

Adjacent to Power Rack 4


RTR Shelter
Rack 4 – GBPM Power Outlets
120 VAC, 15 Amp, Standard NEMA Plugs
APC UPS and Un-UPSed TrippLite Power Strip

Heyco FlexTube

(**Fiber and AC Power**)

LDF4-50 ½" Semi Rigid Heliax Cable Runs (x2)

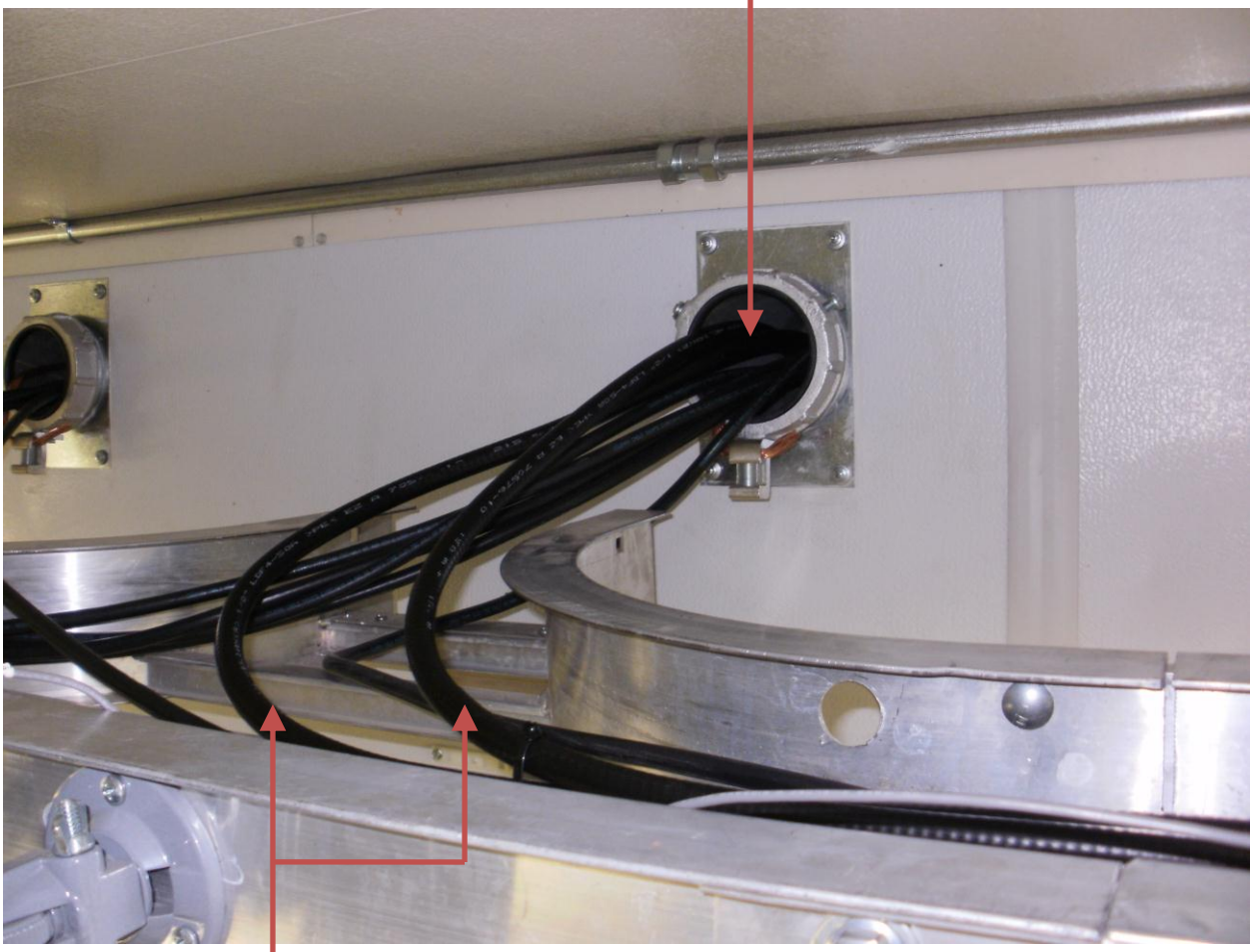
(**GPS & VHF Whip Antenna RF**)

Heyco FlexTube

(**GPS & VHF Whip Antenna RF**)

RTR Shelter Penetration – North Wall

To Exterior RTR Shelter J-Box



LDF4-50 ½" Semi Rigid Heliax Cable Runs (x2)

(**GPS & VHF Whip Antenna RF**)

LDF4-50 ½" Semi Rigid Heliax

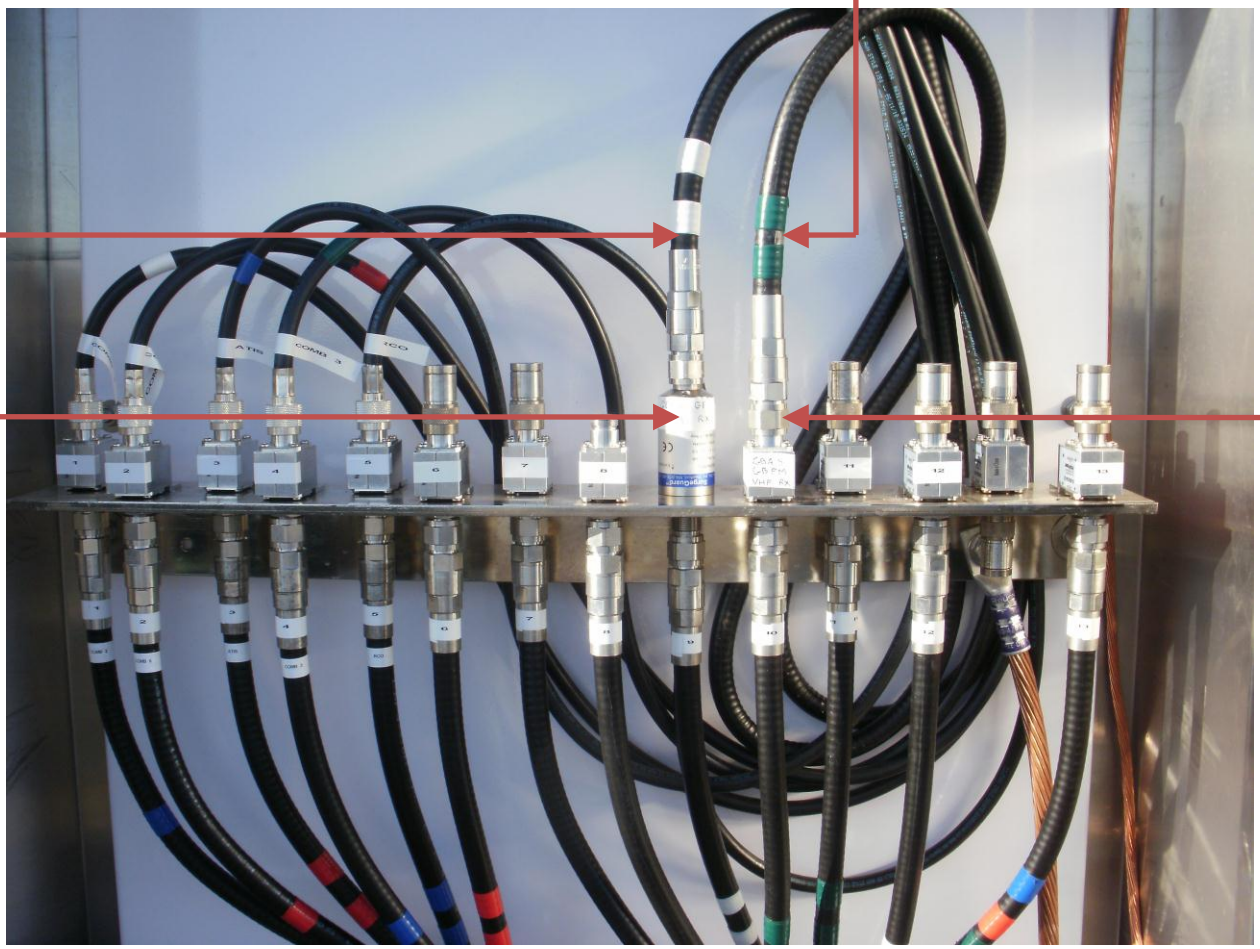
To RTR Tower J-Box

Double White – GPS, Port 9

LDF4-50 ½" Semi Rigid Heliax

To RTR Tower J-Box

Double Green – VHF, Port 10



GPS Antenna Lightning Suppressor

Model #: FPLNFNFBP12

Polyphasor VHF Lightning Arrestor

Broadband DC Blocked Protector

Model #: IS-B50LN-C0

RTR Shelter

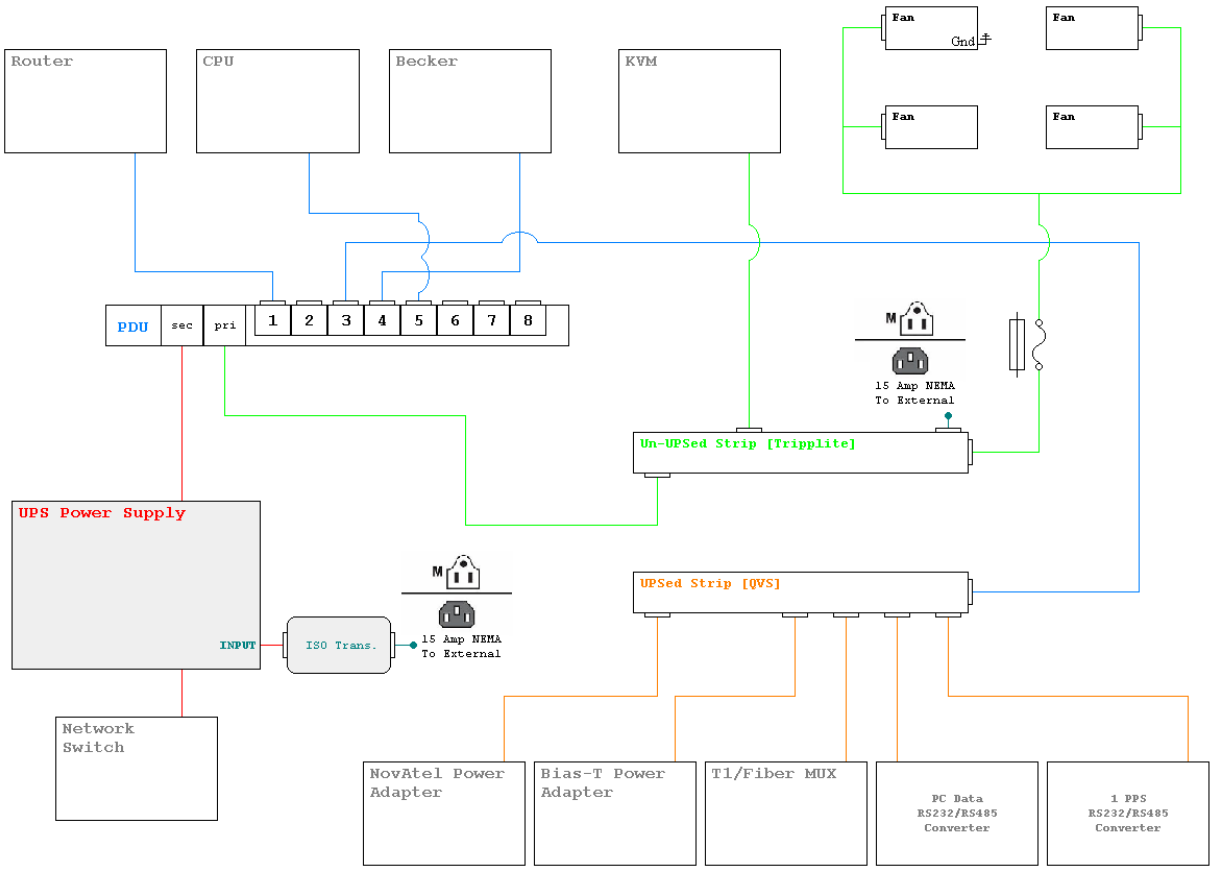
North Side, Exterior

RTR Shelter J-Box

Existing RF Cable Runs to RTR Tower

1.9 REFERENCE - Power Distribution and Wiring Schematics

Power Distribution:

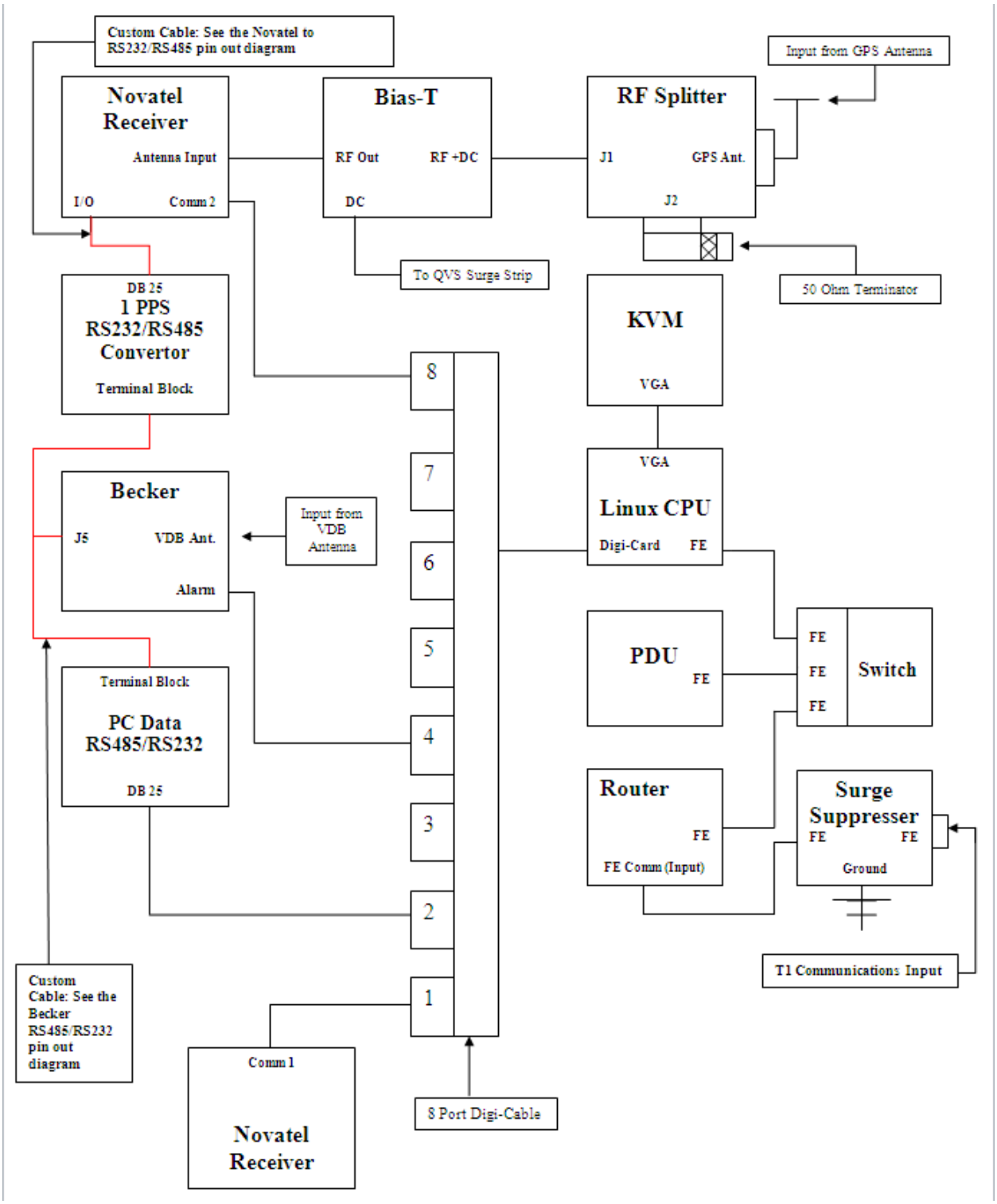


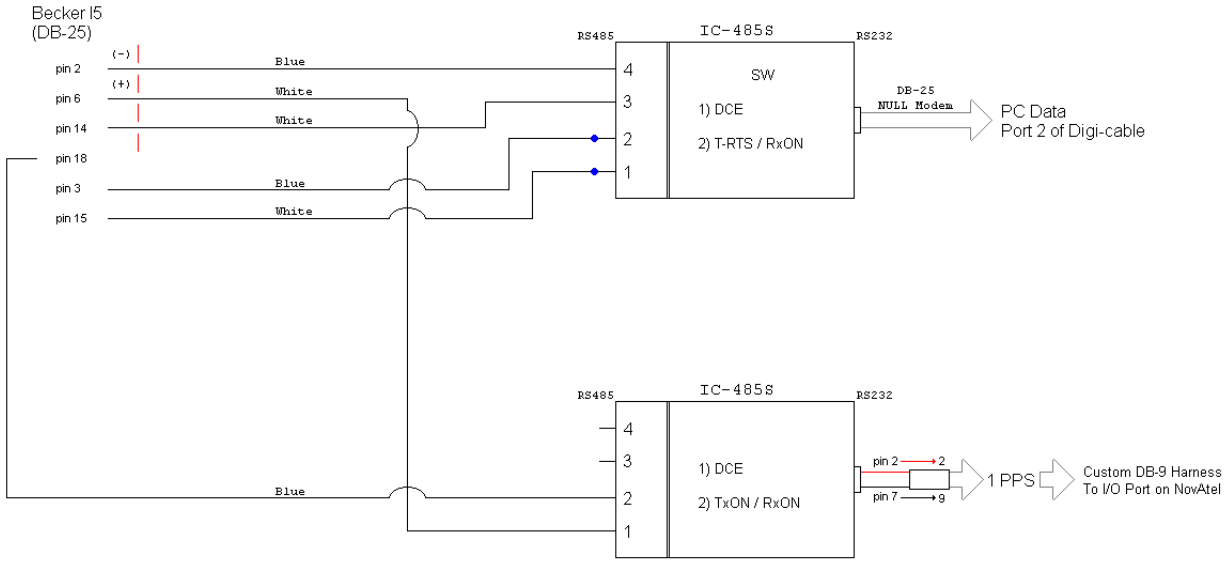
The following schematic shows the serial data distribution/wiring chart for the rack-mount system.

The final two schematics show the Becker VDB Receiver RS232/RS485 technical drawing and GBPM Fan Casing/Wiring Harness wiring respectively.

Cable pin outs for the Novatel Receiver I/O port (DB9) to RS232/RS485 Converter (DB 25)

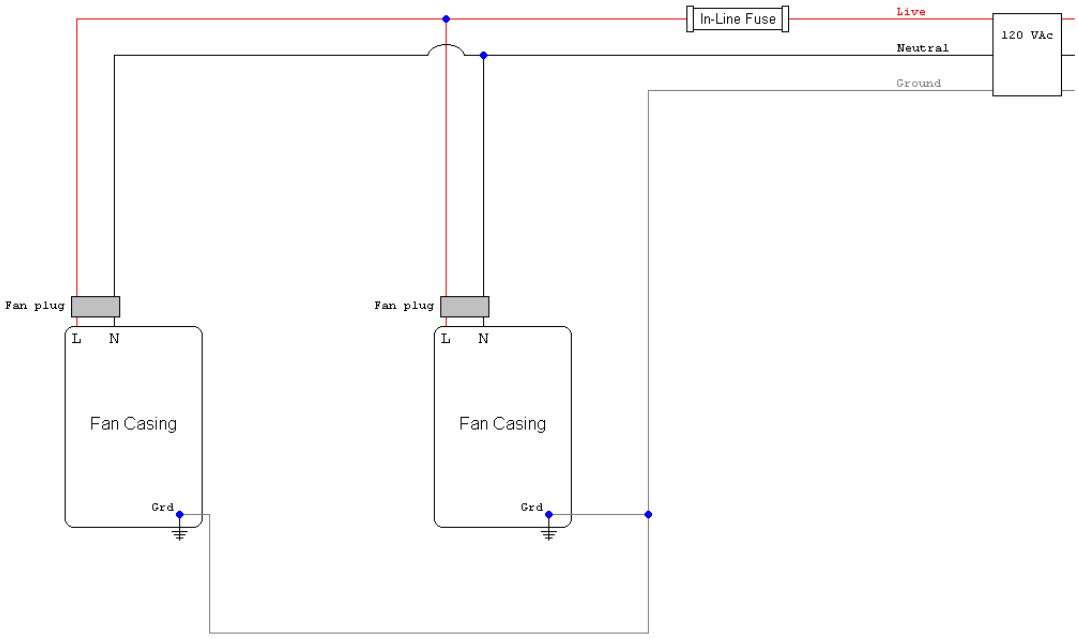
	RS232/RS485 Convertor (DB25)	Novatel Receiver (DB9)
PPS 1 Signal	2	2
Ground	7	9


Custom Cable: See the Novatel to RS232/RS485 pin out diagram
Input from GPS Antenna
Novatel Receiver
Antenna Input
I/O
Comm 2
Bias-T
RF Out
RF +DC
DC
RF Splitter
J1
GPS Ant.
J2
To QVS Surge Strip
50 Ohm Terminator
DB 25
1 PPS RS232/RS485 Convertor
Terminal Block
KVM
VGA
8
7
6
5
4
3
2
1
Becker
J5
VDB Ant.
Alarm
Input from VDB Antenna
VGA
Linux CPU
Digi-Card
FE
PDU
FE
FE
FE
FE
Switch
Terminal Block
PC Data RS485/RS232
DB 25
Router
FE
FE Comm (Input)
Surge Suppresser
FE
FE
Ground
T1 Communications Input
Custom Cable: See the Becker RS485/RS232 pin out diagram
Comm 1
Novatel Receiver
8 Port Digi-Cable



* When referencing custom harness pinouts, see drawing on previous page.

	RS232/RS485	NovAtel I/O Port
Ground	7	9
1 PPS	2	2
	DB-25	DB-9

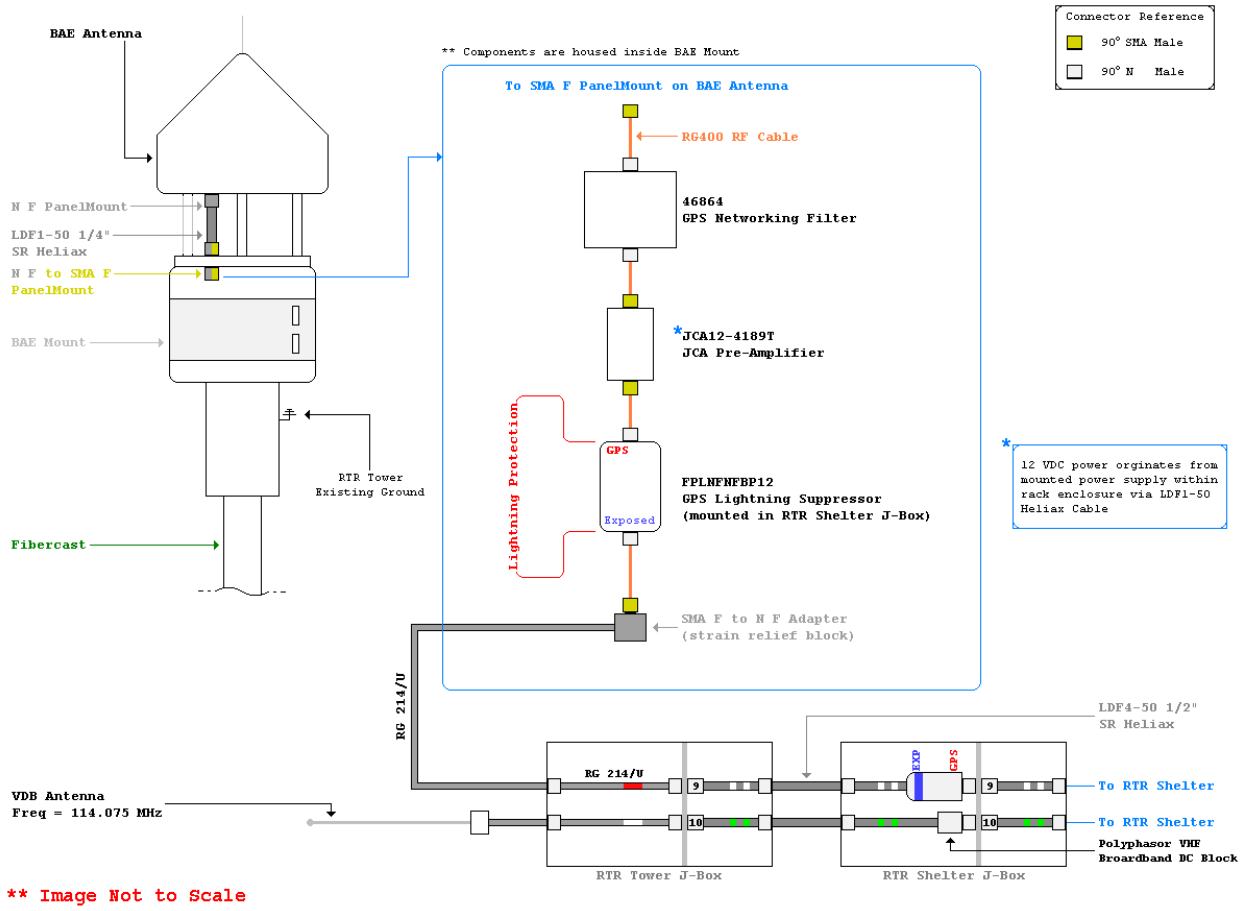


SECTION 2.0 GPS/VHF Antenna Cable Runs and Mounting

Included in this section is a complete layout of the GPS BAE Antenna and Mount. Details include a technical drawing, an image set, as well as maintenance instructions for disassembly and/or repair of internal components. Two RF cable runs (LDF4-50 ½" Heliax) from the RTR Shelter (GBPM) run up to the RTR Tower J-Box to provide data linkage and power to the GPS and VHF antennas. From the RTR Tower J-Box, the existing RF lines (now RG 214/U) were re-routed to provide the necessary linkage with the antennas. Please refer to Section 1.8 RF and Rack Power Cable Runs for information regarding these RF cable runs from the GBPM (RTR Shelter) to the RTR Shelter J-box (ports 9, 10 for GPS and VHF).

Please refer to Appendix B – BAE Single Element DGPS Array/Reference Antenna Line Art and Performance Plots for GPS antenna specifications and technical details.

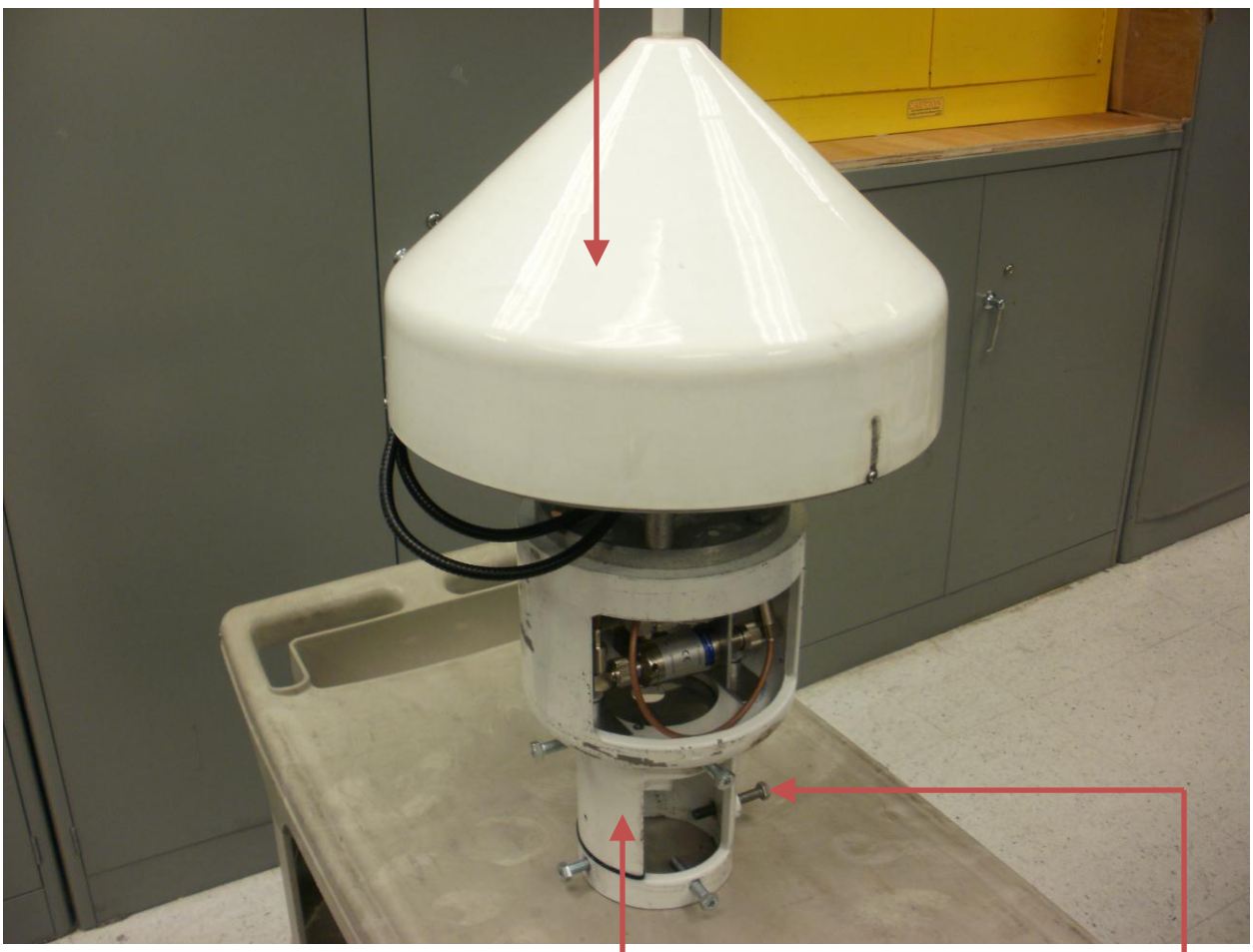
2.1 Technical Drawings



2.2 GPS Antenna Image Set

BAE Single Element DGPS Array/Reference Antenna

- Technical Details available in Appendix B -



BAE Antenna Mount

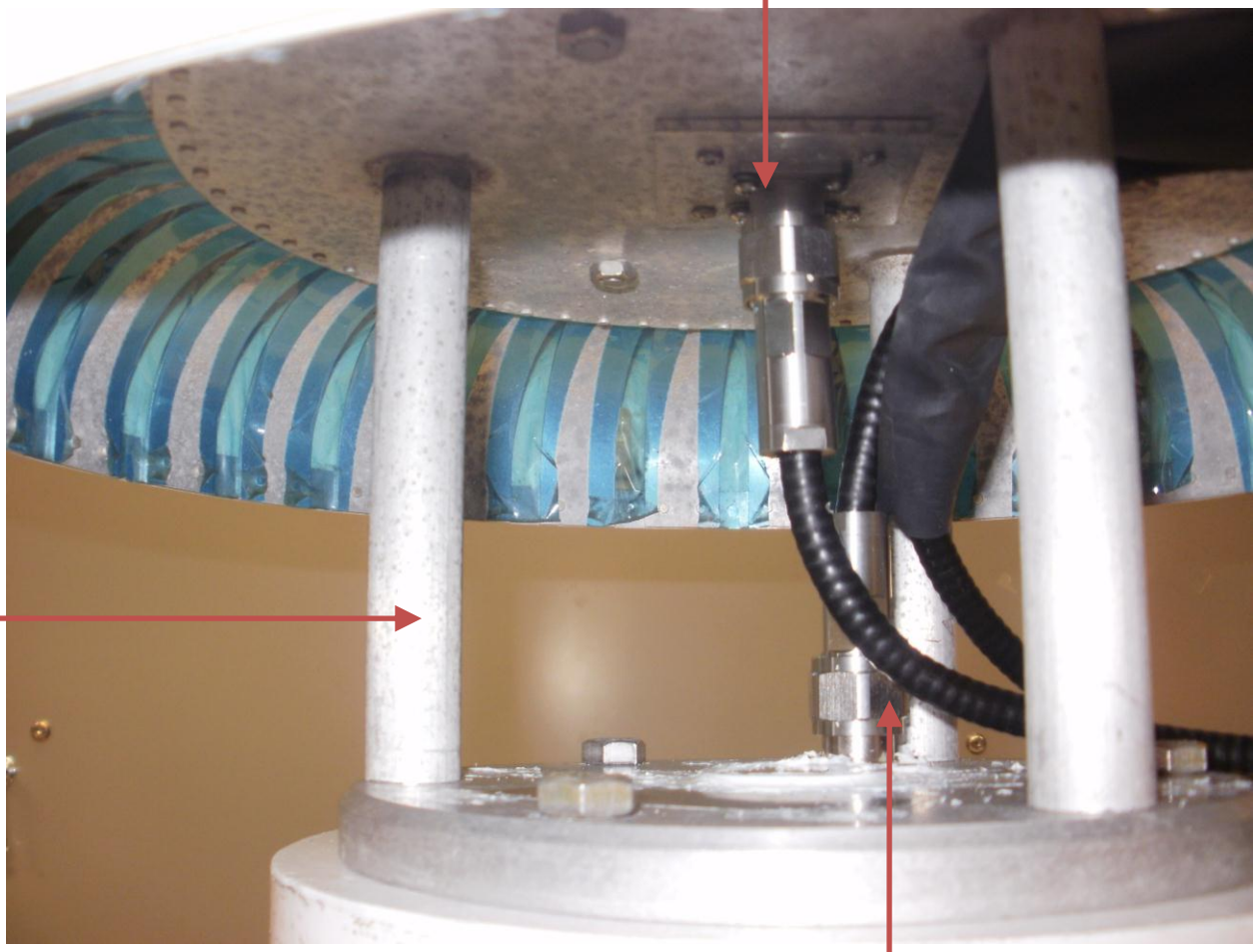
(Pictured with internal components visible)

Mounting Bolts

(To be fitted onto RTR Tower Fiber-cast)

GPS Signal Output

N Male Andrews Connector to LDF1-50 ¼" Heliax Cable



BAE ARL-1900 Antenna Struts/Mount

GPS Signal Input

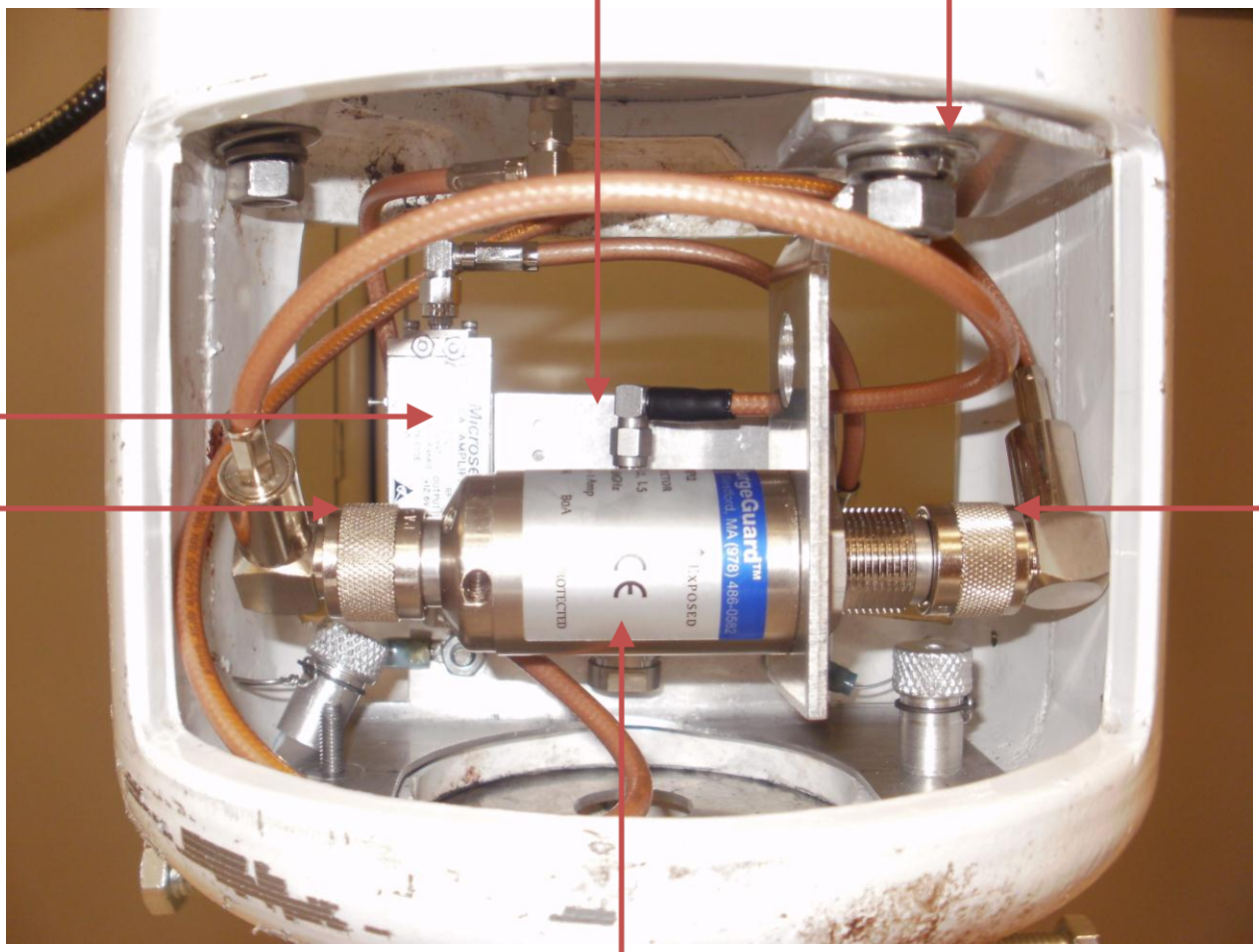
N Male Andrews Connector to LDF1-50 ¼" Heliax Cable

JCA Pre-Amplifier

(Mounted to Block)

GPS Filter

Swing Arm/Pivot



N Male Connector

(**Protected** side)

GPS Suppressor

N Male Connector

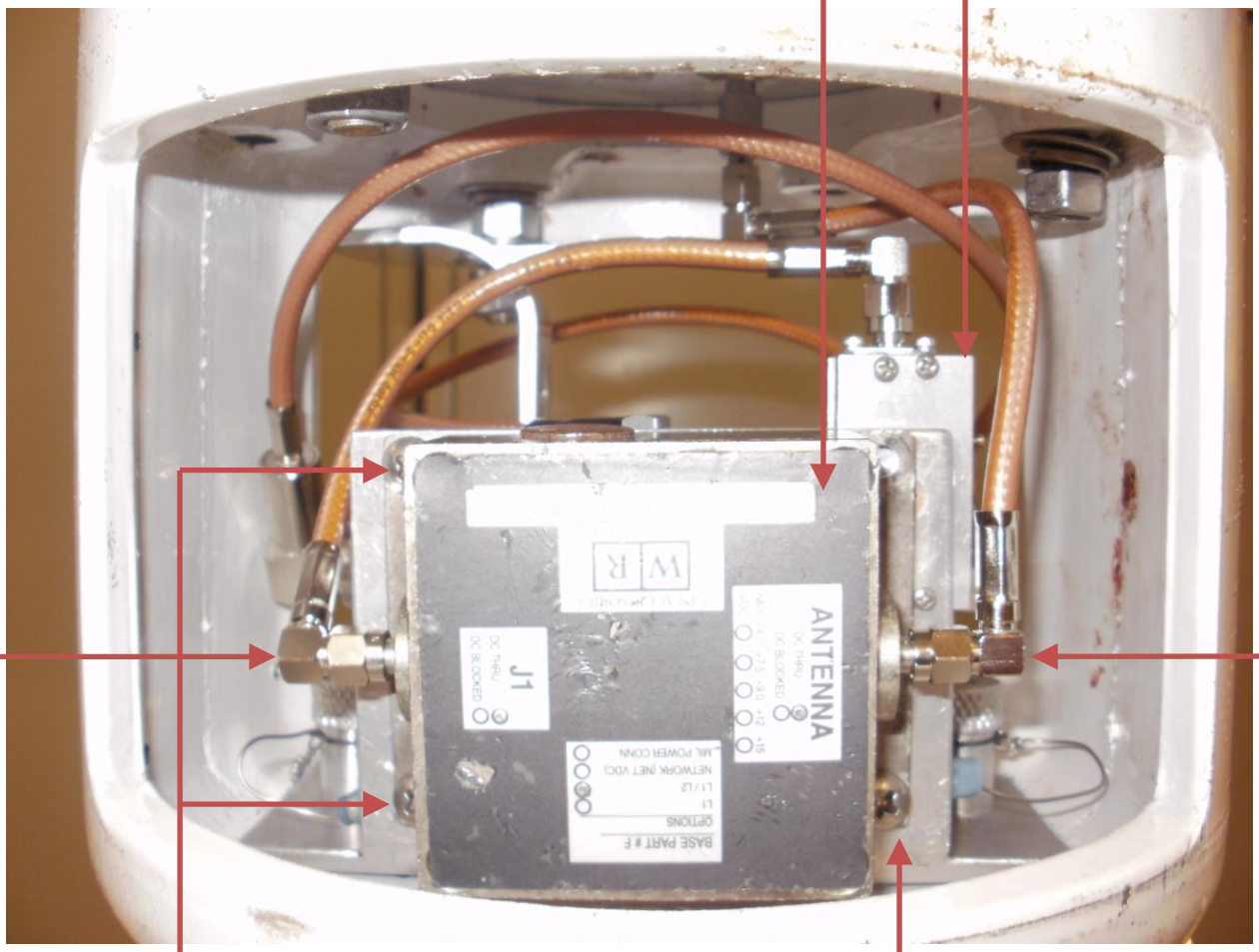
(**Exposed** side)

SMA Male Connector

(**J1** side)

GPS Filter

JCA Pre-Amplifier



#2 Phillips Head Bolts
(x3)

(Hex nuts on reverse)

SMA Male Connector

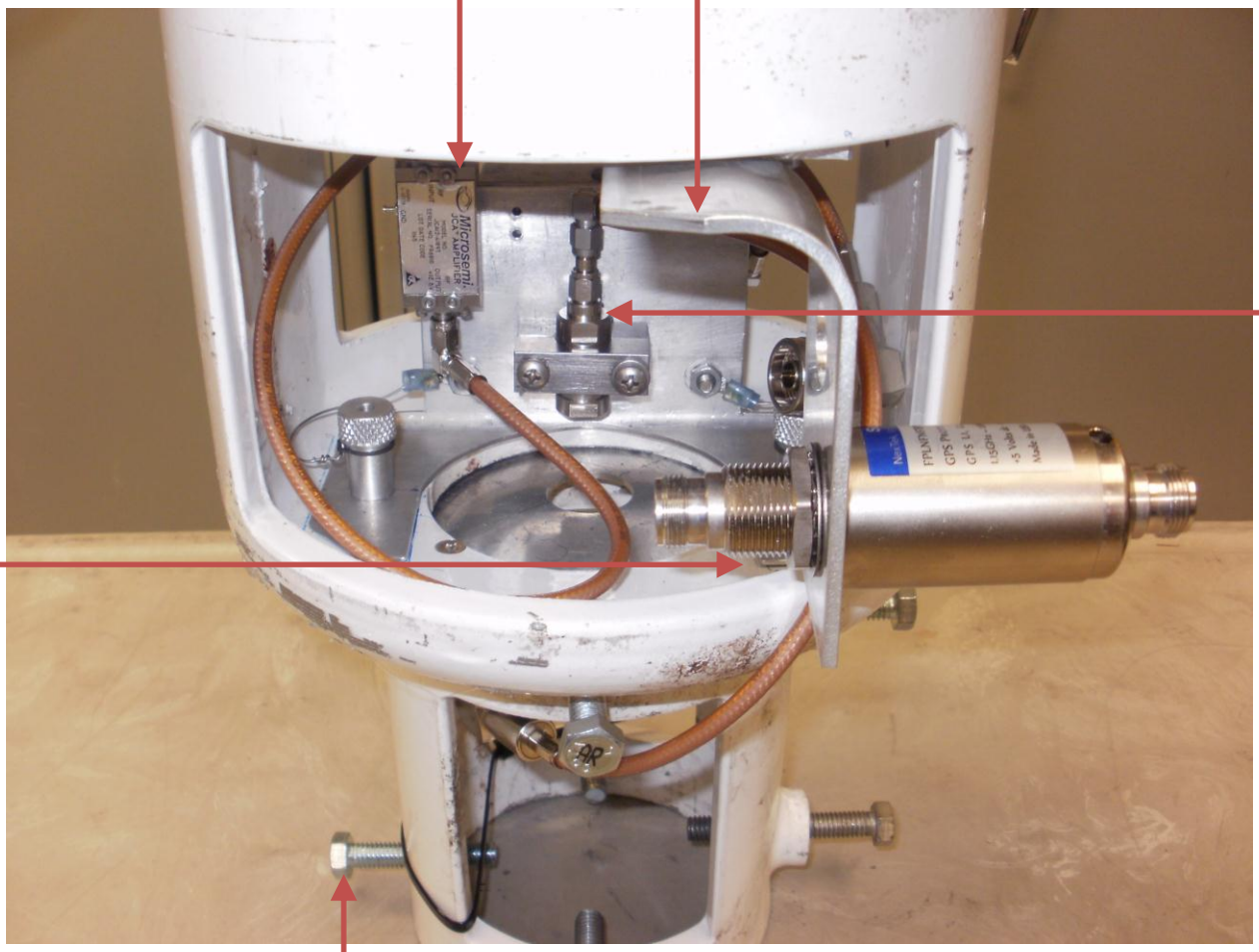
(**Antenna** side)

GPS Suppressor

JCA Pre-Amplifier

Swing Arm/Pivot

(Shown fully "extended")



Mounting Bolts

(To be fitted onto RTR Tower Fiber-cast)

SMA F to N F Adapter

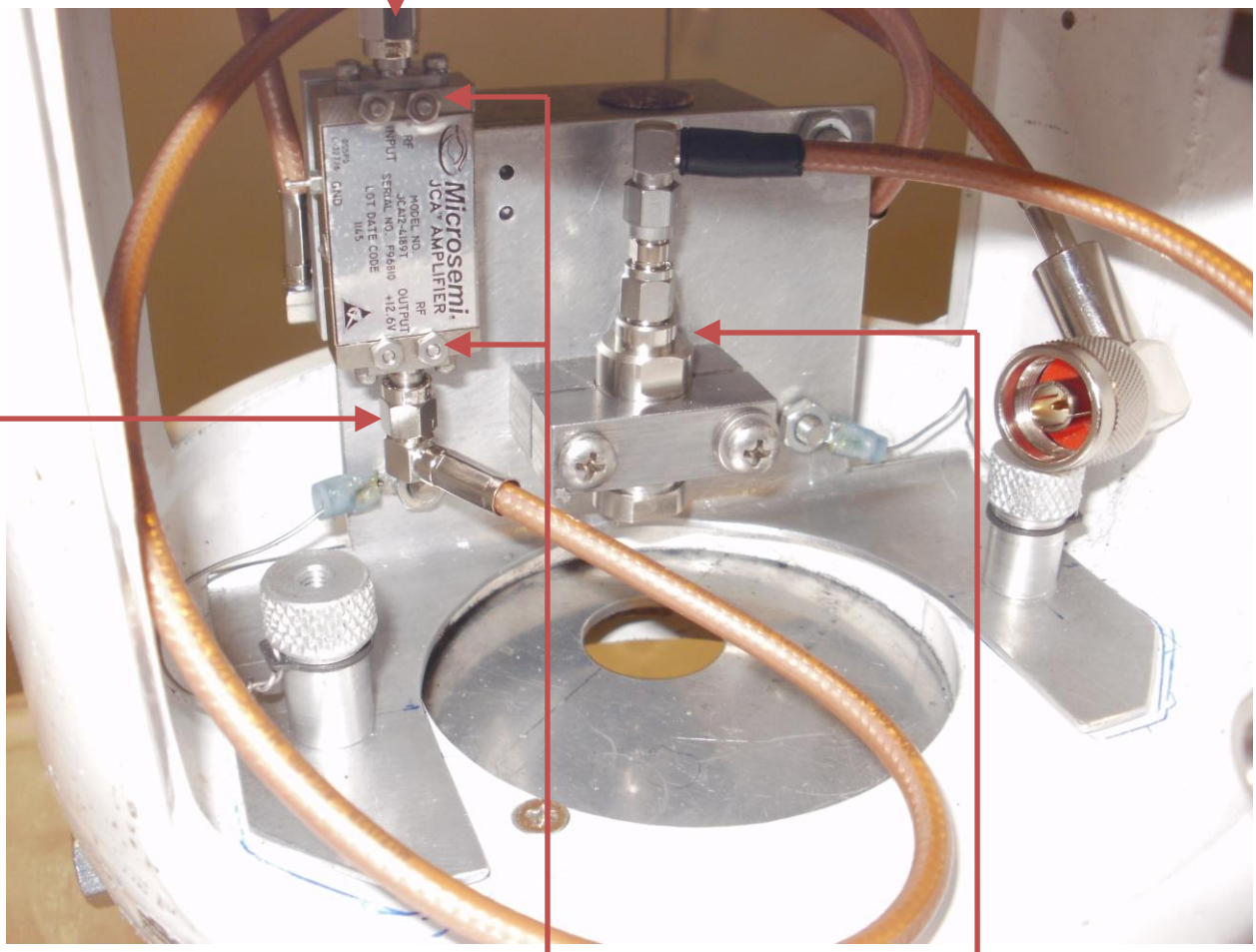
(Mounted in Strain Relief Block)

SMA Male Connector

(**RF Output** side)

SMA Male Connector

(**RF Input** side)



3/16 in. Hex Nuts (x4)

(Use Nut Driver to Remove)

SMA F to N F Adapter

(Mounted in Strain Relief Block)

BAE Single Element DGPS Array/Reference Antenna

- Technical Details available in Appendix B -

South West Outrigger/Fiber-cast Arrangement

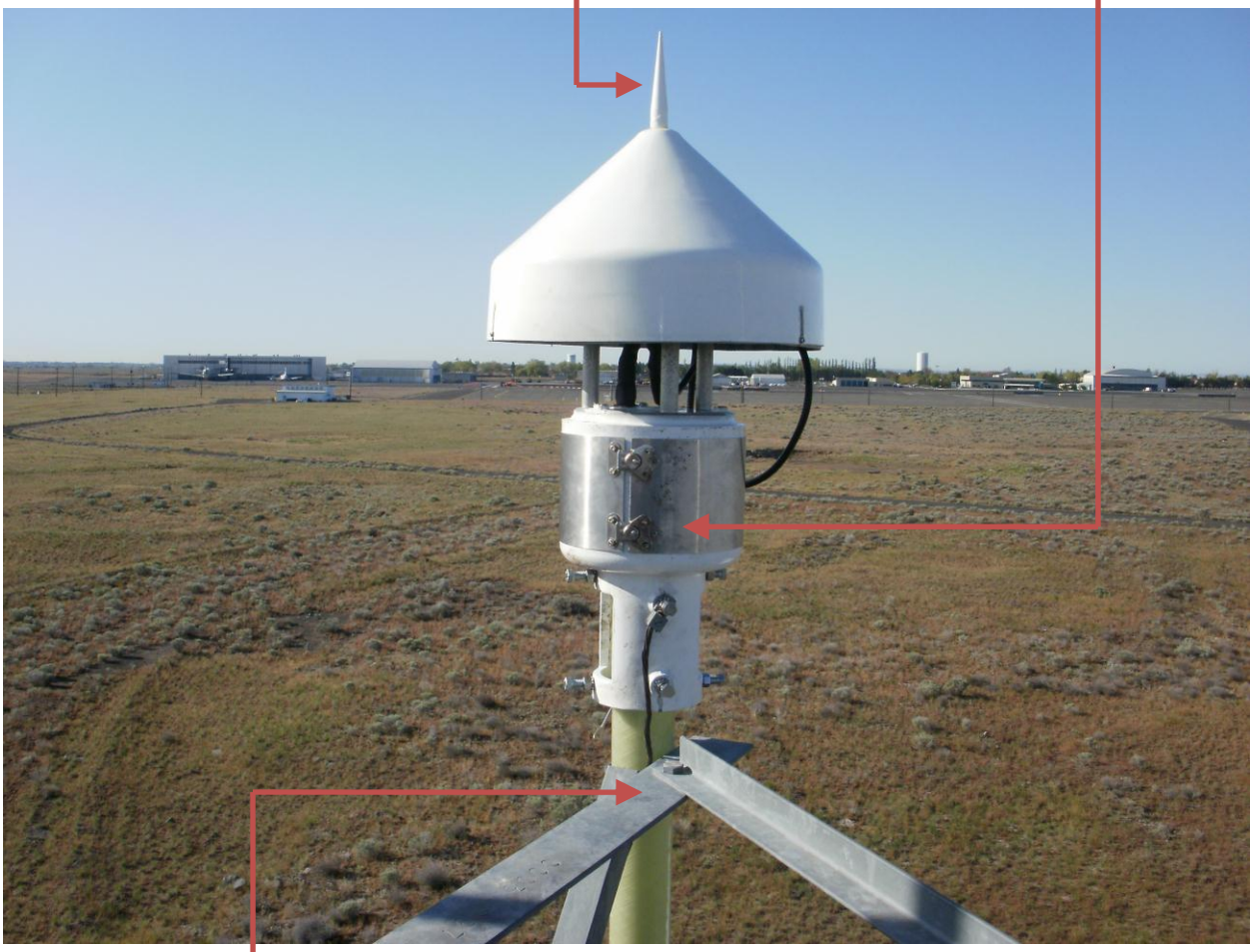
(Used existing RG 214/U Cable Run from RTR Tower J-Box)

RTR Tower and

RTR Tower J-Box

Bird Spike

Mount Cover



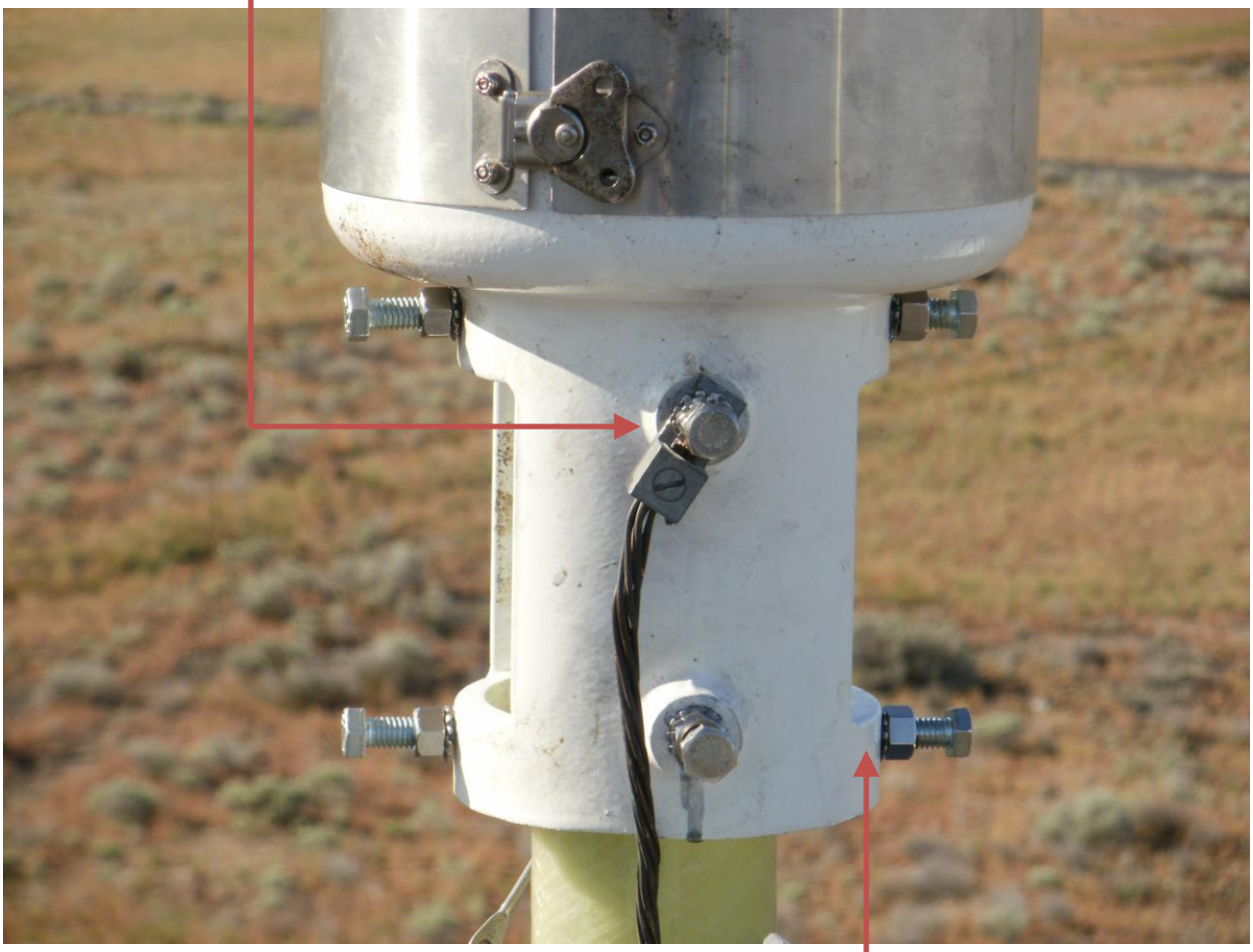
South West Outrigger/Fiber-cast Arrangement

(Used existing RG 214/U Cable Run from RTR Tower J-Box)

Lightning Protection

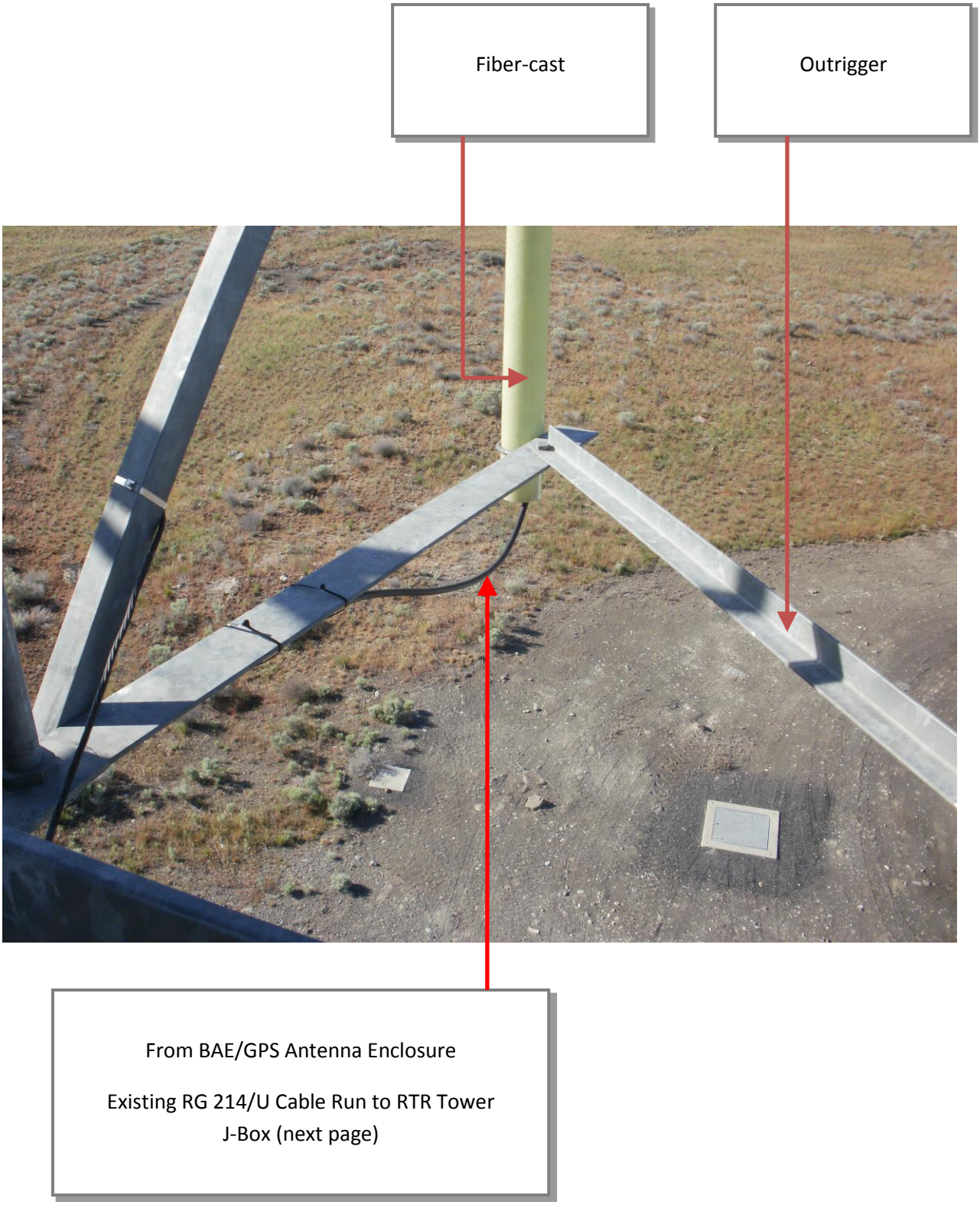
Existing Copper Braid and Grounding Lug

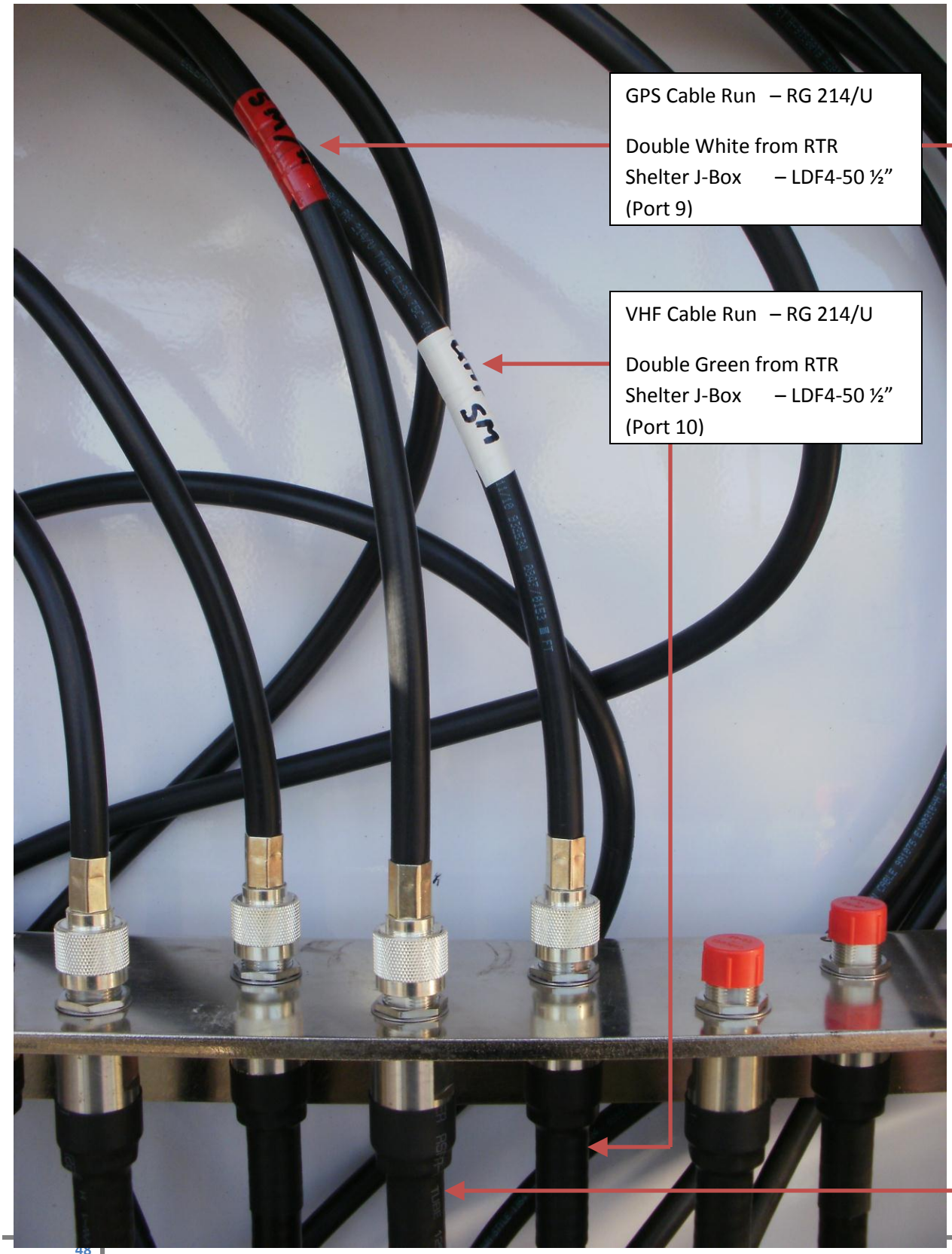
(Lubricated with IDEAL Anti-Rust)



Mounting Bolts

(Fitted onto RTR Tower Fiber-cast)


Fiber-cast
Outrigger
From BAE/GPS Antenna Enclosure
Existing RG 214/U Cable Run to RTR Tower J-Box (next page)


GPS Cable Run – RG 214/U
Double White from RTR Shelter J-Box – LDF4-50 ½" (Port 9)
VHF Cable Run – RG 214/U
Double Green from RTR Shelter J-Box – LDF4-50 ½" (Port 10)

2.3 GPS Antenna Maintenance

Operating Swing Arm

1. Disconnect 90° N Male (RG-400) connector on **protected** side of GPS Suppressor.
2. Disconnect 90° N Male (RG-400) connector from **exposed** side of GPS Suppressor.
3. Pivot Swing Arm outward in a counter-clockwise motion to gain access to GPS Suppressor.

Removing/Replacing GPS Suppressor

1. Repeat steps 1-3 from the Operating Swing Arm instruction set.
2. Use a 15/16" open ended/closed end wrench to loosen retention nut. Remove retention nut and star washer from assembly.
3. Remove device from Swing Arm. Replace if necessary.

Removing/Replacing GPS Filter

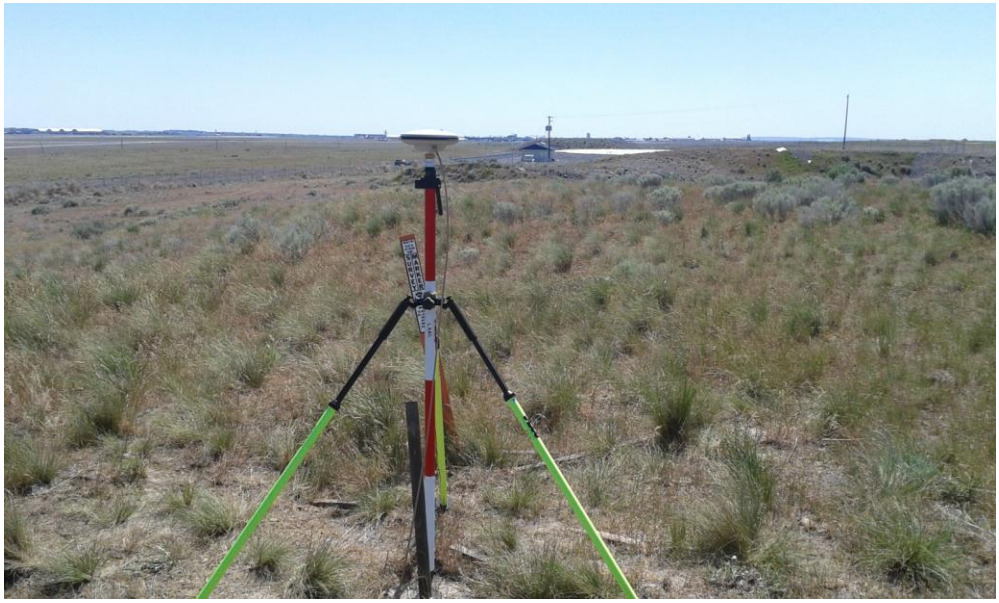
1. Repeat steps 1-3 from the Operating Swing Arm instruction set.
2. Disconnect SMA (RG-400) connector on the **Antenna (DC Thru)** side of the GPS Filter using a 5/16" wrench.
3. Disconnect 90° SMA (RG-400) connector on the **J1 (DC Thru)** side of the GPS Filter using a 5/16" wrench.
4. Loosen #2 Phillips head bolts (x3). Remove hex nuts and #2 Phillips head bolts.
5. Remove device from mounting plate. Replace if necessary.

Removing/Replacing JCA Pre-Amplifier

1. Repeat steps 1-3 from the Operating Swing Arm instruction set.
2. Disconnect SMA (RG-400) connector on the **RF Input** side of the JCA Pre-Amplifier using a 5/16" wrench.
3. Disconnect 90° SMA (RG-400) connector on the **RF Output** side of the JCA Pre-Amplifier using a 5/16" wrench.
4. Loosen and remove hex nuts (x4) with a 3/16" nut driver.
5. Slide device from mounting block. Replace if necessary.

2.4 GPS Antenna Survey

To obtain accurate position data for the GPS Antenna, a survey was conducted at the Grant County International Airport PAC survey marker using the local datum for the site (NAD83, NAVD88). Prior to this survey, the location of the GPS Antenna used for the GBPM was unknown. Obtaining an accurate position is critical to GBPM operation because this ensures that the calculated GBAS performance error is as precise as possible. Equipment used to complete this survey included a NovAtel pinwheel antenna, surveying tripod, NovAtel DL-V3 GPS Receiver, and data collection and processing software developed by NovAtel.



To obtain this position data, the NovAtel pinwheel antenna is mounted to the surveying tripod, which has been centered and leveled on the airport PAC survey marker (Primary Airport Control Point). The slant range is calculated by measuring the distance from the phase center of the pinwheel antenna to the survey point of the PAC. The survey height is then calculated by adding the slant range to the known height of the PAC. With this height now calculated, we can accurately determine the Latitude, Longitude, and Ellipsoid Height of the pinwheel antenna. This data allows for precise recording of GPS error. With data recorded at both the PAC and GBPM simultaneously, this same error, and its associated corrections, can then be induced into the GPS data at the GBPM, in order to calculate an accurate position for the GPS antenna, which was previously an unknown point.

Survey Data (NAD-83 Horizontal, NAVD-88 Vertical Datum):

NAD83

Station		Latitude (D M S Hem)	Longitude (D M S Hem)	Easting (m)	Norhting (m)	H-Ell (m)	H-MSL (m)	SDHori (m)	SDHeig (m)
GBPM		47 11 56.89988N	119 19 09.71968W	324328.675	5229903.607	349.753	370.381	N/A!	N/A!
MWH_A		47 13 35.36016N	119 20 08.59698W	323180.973	5232979.784	348.885	369.471	N/A!	N/A!

2.5 VHF Antenna Image Set

The VHF (Very-high Frequency) Data Broadcast (VDB) Antenna is a stationary VHF antenna (single or multi-bay) that is designed to reduce the gain pattern in the direction of the ground plane in order to minimize the intensity of multipath. A Laird VHF Unity Gain Antenna was used at the RTR remote site to receive the VDB signal and provide the VDB data to the GBPM.

The Laird VHF ¼ Wave 66-174 MHz Unity Gain Antenna was cut to a frequency of 114.075 MHz in order to comply with the VDB Ground Subsystem. The VHF antenna was mounted on the north-easterly crossbar of the RTR Tower, which is roughly chest level above the standing platform and welded to the north and east side railings of the RTR Tower bay. The existing RG 214/U cable run from the RTR Tower J-Box (single white band, port 10) was re-routed along the eastern railing and crossbar to the VHF Antenna. The cable run was secured tightly to the eastern railing and crossbar using outdoor-grade wire ties and steel hose clamps.

East Railing

North Railing

VHF Antenna (114.075 MHz)

Mounted to north-easterly crossbar of RTR Tower bay (chest level), LOS to VDB

VHF Antenna (114.075 MHz)

Mounted to north-easterly crossbar of RTR Tower bay (chest level), LOS to VDB

Crossbar

VHF Antenna Mount

(Secured to crossbar with 2 steel hose clamps)

Existing RG 214/U RF Cable Run to RTR Tower J-Box

(Single white band)

Crossbar

East Railing

Existing RG 214/U RF Cable
Run to RTR Tower J-Box

(Single white band)

Existing RG 214/U RF Cable Run to RTR Tower J-Box

(Single white band)

RTR Tower J-Box

Existing RTR Tower Ground

3/0 Copper Braid

VHF Antenna Ground

3/0 Copper Braid

Split Bolt Connector – Copper Alloy

Type IK, Conductor Range: 250 MCM

SECTION 3.0 VHF RF Cavity Filter

Included in this section is a complete layout of the Cavity Filter, which is mounted in the rear of the GBPM. Details include a technical drawing and accompanying image set.

The GBPM enclosure is located in the RTR Shelter, directly south-west of the RTR (Remote Transmitter Receiver) Tower. The RTR Site (shelter and tower) houses an array of high power transmit/receive devices therefore; a Cavity Filter (tuned to 114.075 MHz) had to be installed within the enclosure to prevent these undesired frequencies from over-saturating the Becker VDB receiver. Cavity filters are designed to operate in the megahertz to gigahertz bands, used for most broadcast radio, television, wireless communication (cellphones, Wi-Fi, etc.), and thus most RF and microwave devices. As a sharply tuned resonant circuit, the cavity filter will only allow the desired frequency to pass through the circuit, while rejecting as much of the undesired frequencies as possible.

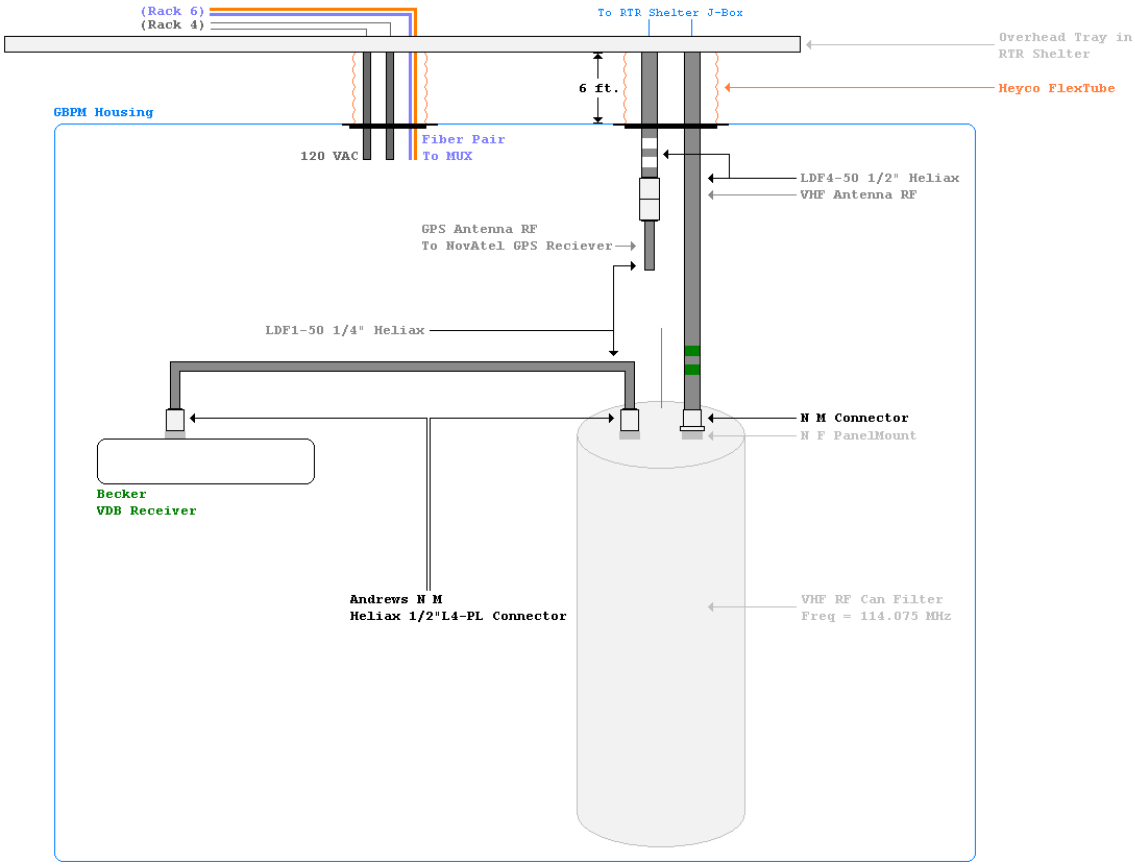
Two LDF4-50 ½" Semi-Rigid Heliax cable runs were installed on-site at the RTR Shelter. These cable runs provide RF for the VHF and GPS Antennas and were ran from the GBPM enclosure, up roughly 6 ft. to the cable tray (via Heyco Flextube) and through the north wall penetration to the RTR Shelter J-Box (Port 9 for GPS, Port 10 for VHF). An RF pigtail was used to convert the GPS cable run (double white) into LDF1-50 ¼" Semi-Rigid Heliax in order to connect to the port labeled "Antenna" on the GPS Splitter.

The VHF Antenna cable run (double green) is connected to the input side of the VHF RF Filter, which has been tuned to 114.075 MHz. A second LDF1-50 ¼" Semi-Rigid Heliax cable run bridges the VHF RF Filter output side to the Becker VDB Receiver input.

A second Heyco Flextube was used to house the Power and Fiber-optic cable runs. For detailed information regarding these separate cable runs, please refer to *Section 1.8 RF and Rack Power Cable Runs* and *Section 4.1 T1 Network Cloud and ATCT Layout* for power and fiber-optics respectively.

NOTE: When performing maintenance, please refer to image set for visual aid if necessary. All components will be labeled and identified clearly.

3.1 Technical Drawings

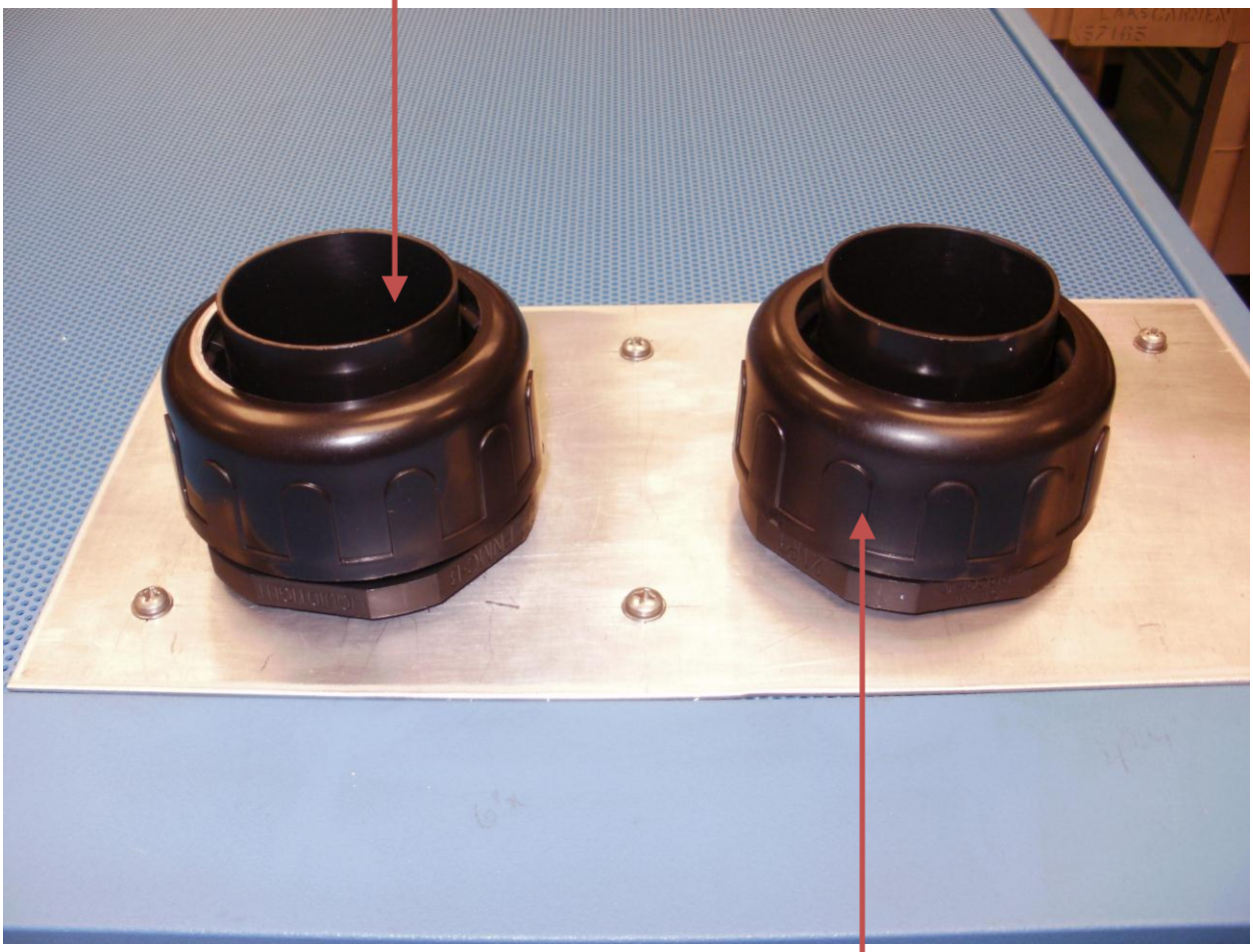


** Image Not to Scale

3.2 VHF RF Cavity Filter Image Set

Heyco FlexTube Bulkhead

(**AC Power and Fiber**)



Heyco FlexTube Bulkhead

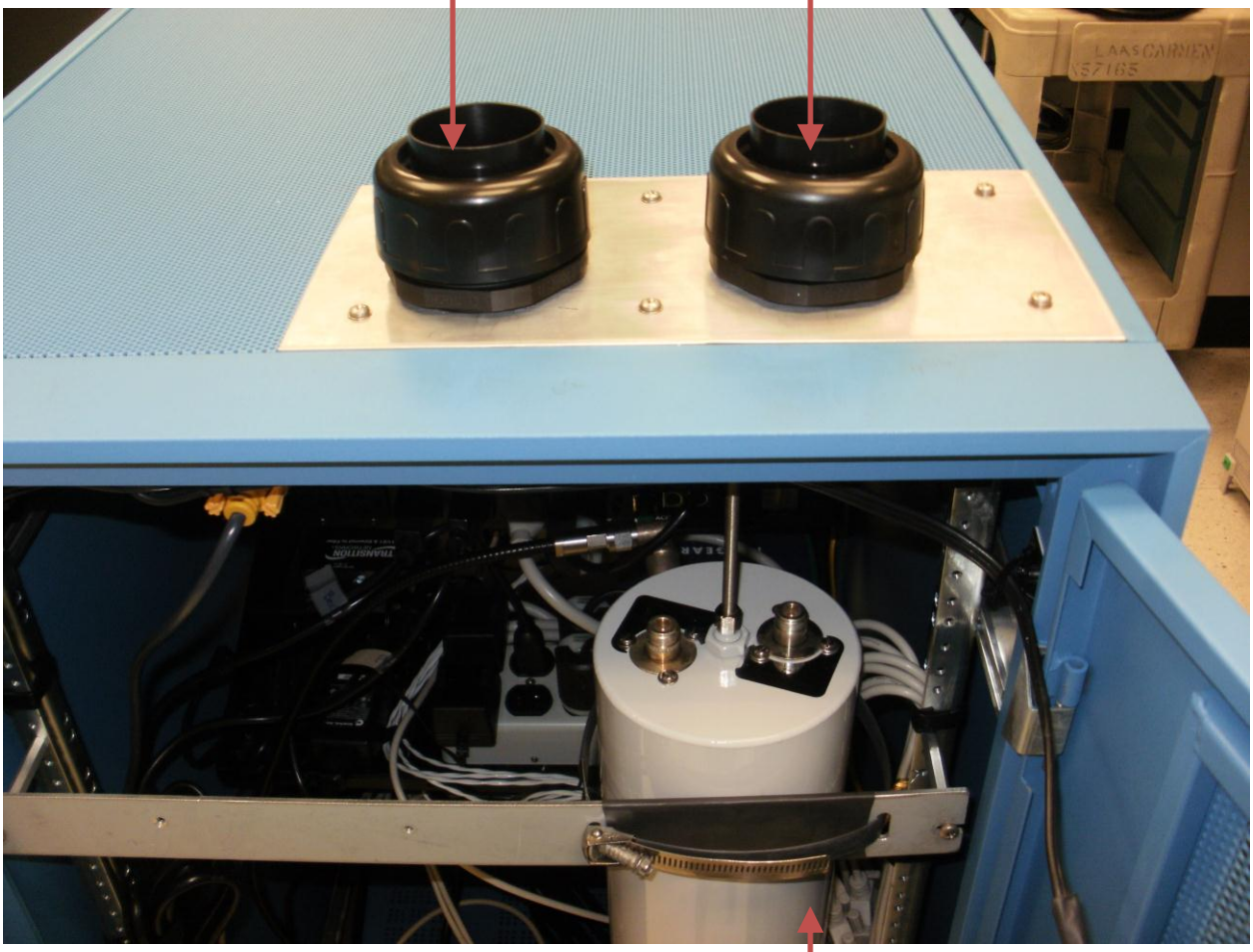
(**GPS & VHF Whip Antenna**)

Heyco FlexTube Bulkhead

(**AC Power and Fiber**)

Heyco FlexTube Bulkhead

(**GPS & VHF Whip Antenna**)

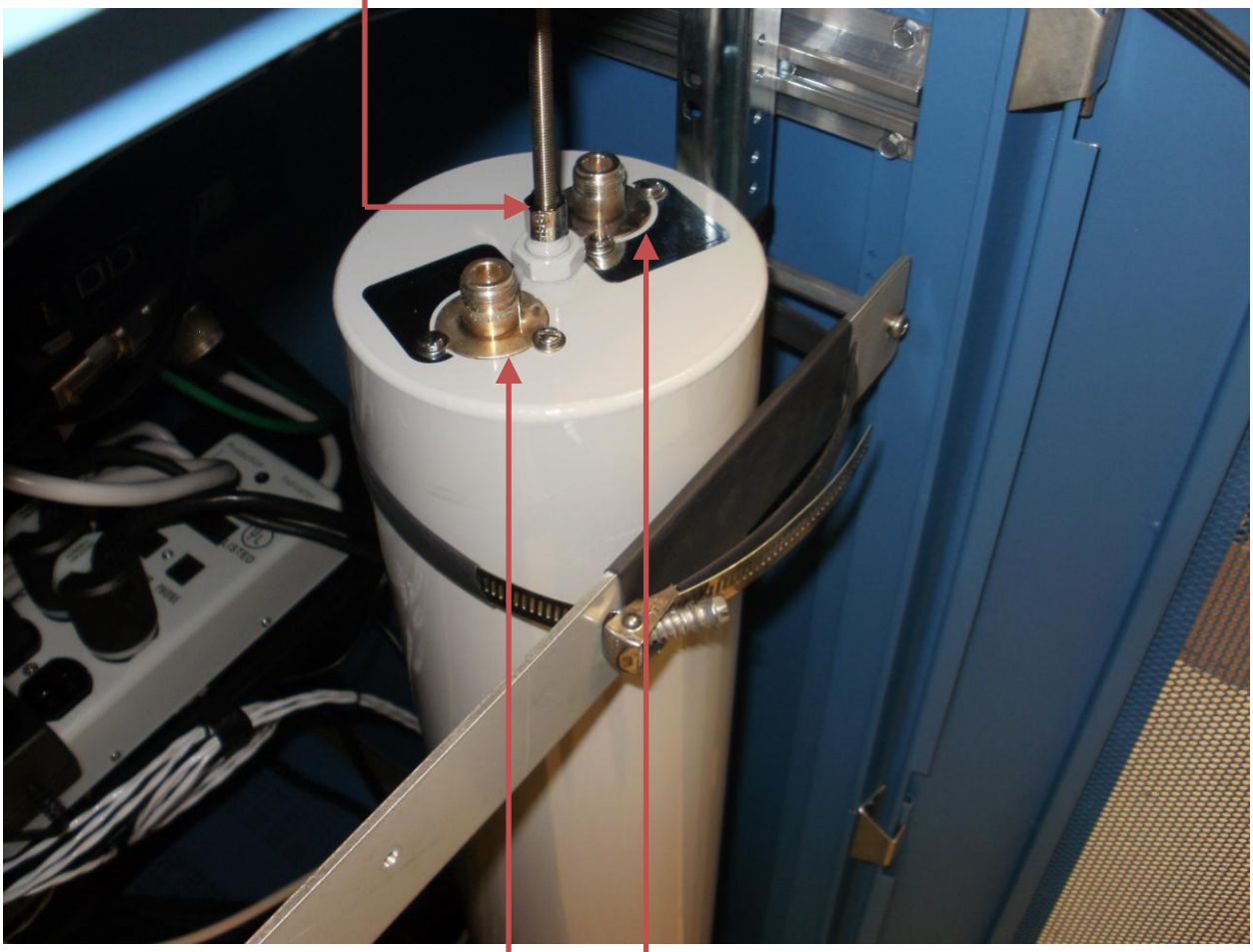


VHF RF Cavity Filter

(Tuned to 114.075 MHz)

Tuning Rod

(Tuned to 114.075 MHz)



Filter Output

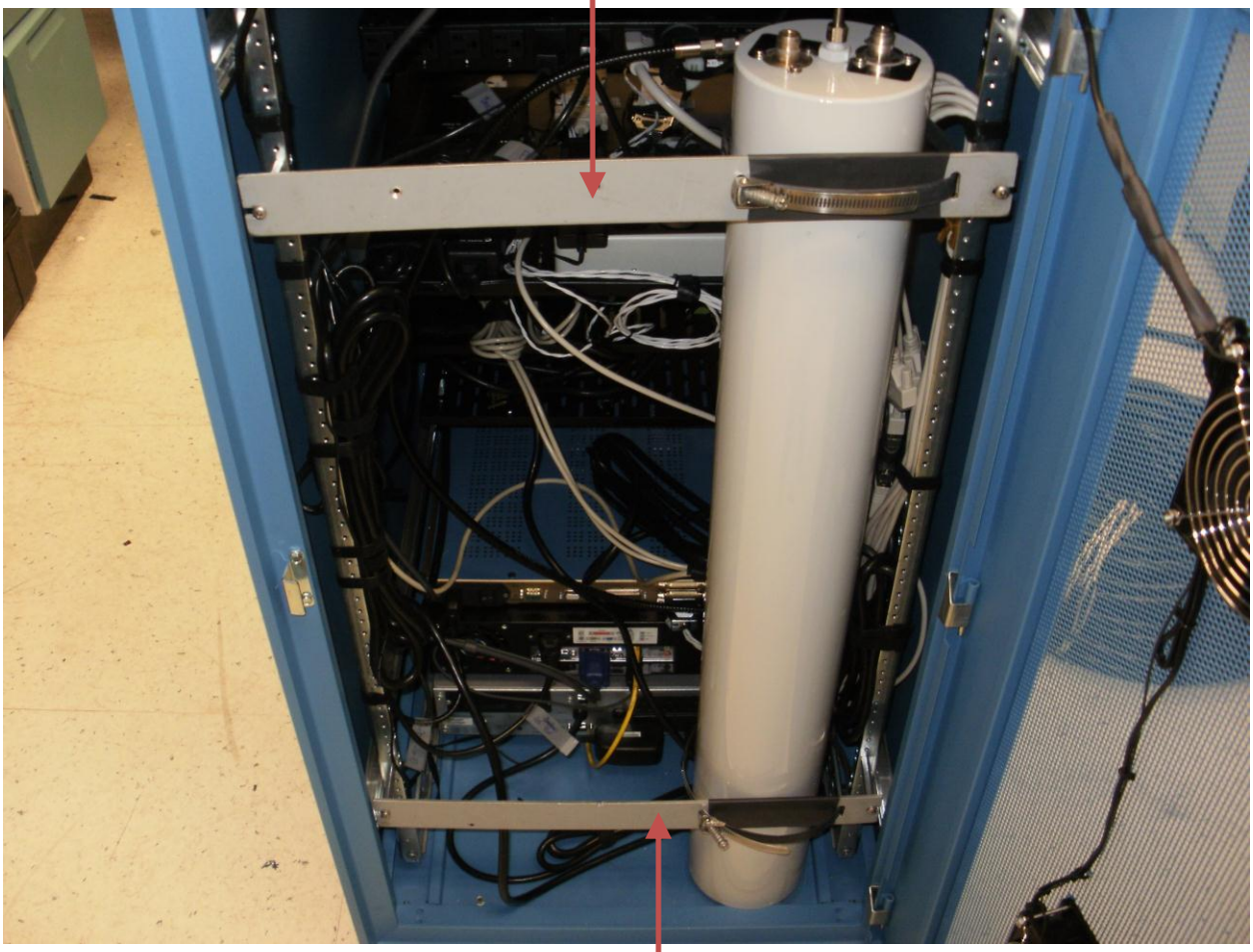
N Male LDF1-50 ¼ in. Heliax Cable to Becker VDB Receiver

Filter Input

From Laird VHF ¼ Wave 66-174 MHz Unity Gain Antenna

Mounting Bracket

(Secured to Filter w/ stainless steel hose-clamps (x2)



Mounting Bracket

(Secured to Filter w/ stainless steel hose-clamps (x2)

GPS Antenna RF Input

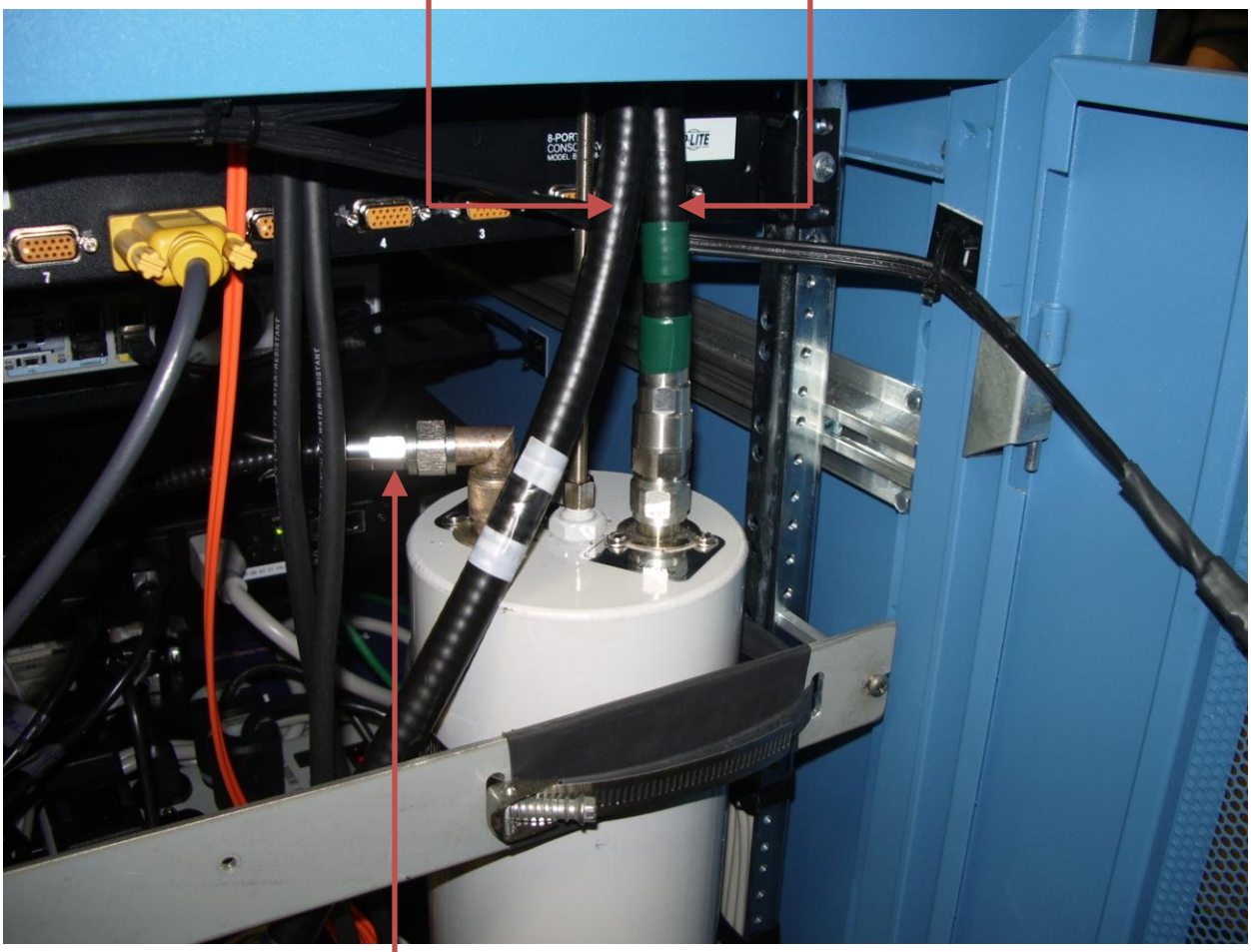
LDF4-50 ½“ Heliax Cable Run from RTR Shelter J-Box

(Double White, Port 9)

VHF Antenna RF Input

LDF4-50 ½“ Heliax Cable Run from RTR Shelter J-Box

(Double Green, Port 10)

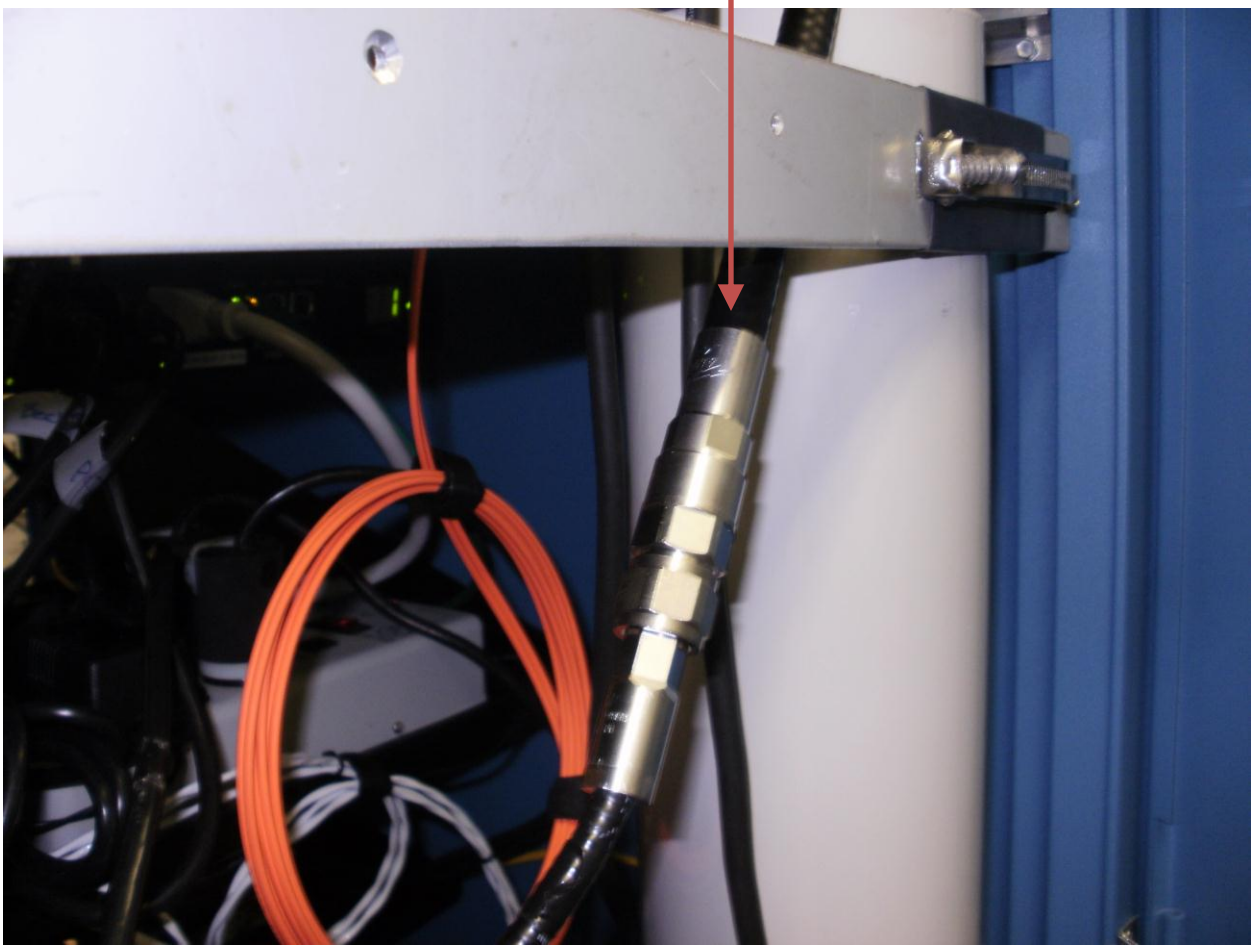


Filter Output

N Male LDF1-50 ¼ in. Heliax Cable to Becker VDB Receiver

GPS Antenna RF Pig-Tail

LDF4-50 ½“ Heliax Cable Run from RTR Shelter J-Box to LDF1-50 ¼” Heliax (GPS Splitter)



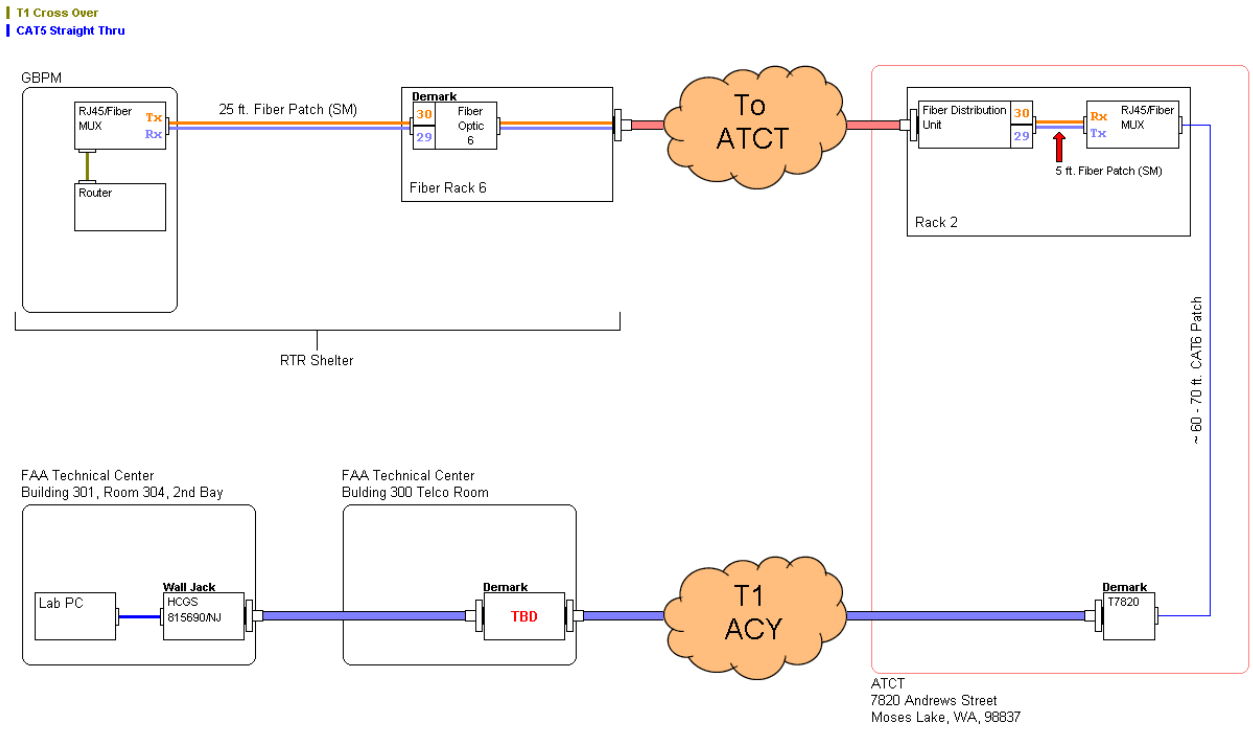
SECTION 4.0 Networking and Fiber Runs

4.1 T1 Network Cloud and ATCT Layout Plan

A T1 network line will be installed from the William J. Hughes Technical Center to the Grant County International ATCT – 7820 Andrews St, Moses Lake, WA, 98837. This line will allow remote access from the FAA Laboratory to the GBPM in the RTR Shelter. Having access to this data will allow FAA personnel to use it for analysis and to display on the LAAS website (laas.tc.faa.gov).

A T1 to Fiber Multiplexer is installed in Rack 2, which is located in the ATCT Telco Room. This device is used to convert the Ethernet media (from demark point T7820) into SM ST fiber. The SM ST pair enters the Fiber Ring on ports 29 and 30 of Rack 2's Fiber Distribution Unit, which are *Receive* and *Transmit* respectively (Rx and Tx are reversed on Network Shelf MUX in Rack 2 only). A sister device is installed in the GBPM enclosure to convert the media back to Ethernet (input to router, from Fiber Rack 6 in RTR Shelter). A 25 ft. SM ST fiber patch cable is run from the MUX in the GBPM to Fiber Rack 6 in the RTR Shelter to complete this connection. The SM ST fiber patch is run approximately 6 feet above the GBPM and across the Overhead Tray into Fiber Rack 6 through the installed HeycoFlex Tubing

This network will allow the GBAS team to access the data collected by the GBPM. Please see the diagram below for complete network details.



RTR Shelter

Fiber Rack 6

25 ft. 50/125 SM ST Fiber Patch from MUX in GBPM to Fiber Rack 6 via Overhead Tray/HeycoFlex Tube

HeycoFlex Tube Run

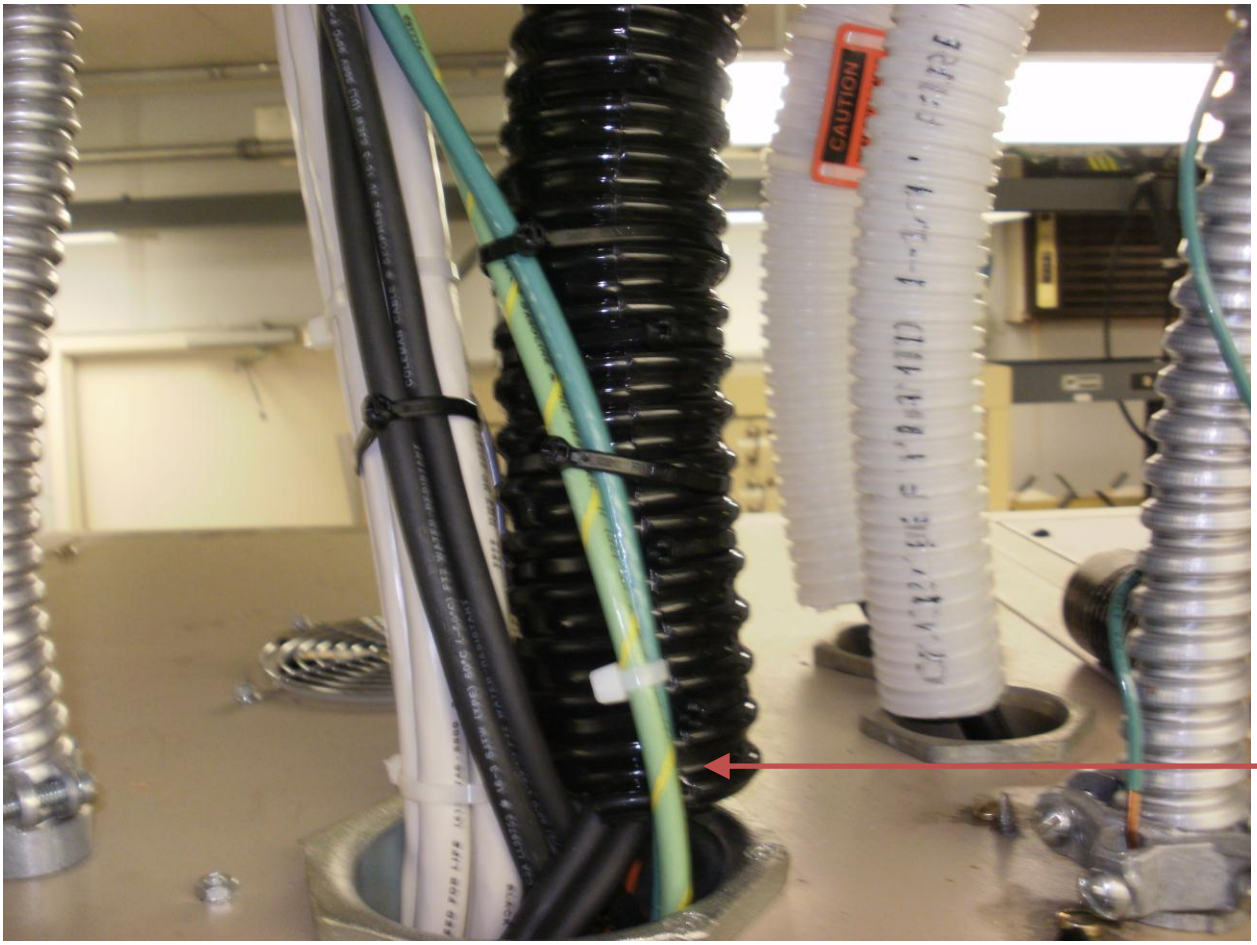
To Fiber Rack 6

25 ft. 50/125 SM ST Fiber Patch from MUX in GBPM
to Fiber Rack 6 via Overhead Tray

HeycoFlex Tube Termination

Fiber Rack 6 Cable Access

25 ft. 50/125 SM ST Fiber Patch from MUX in GBPM
to Fiber Rack 6 via Overhead Tray



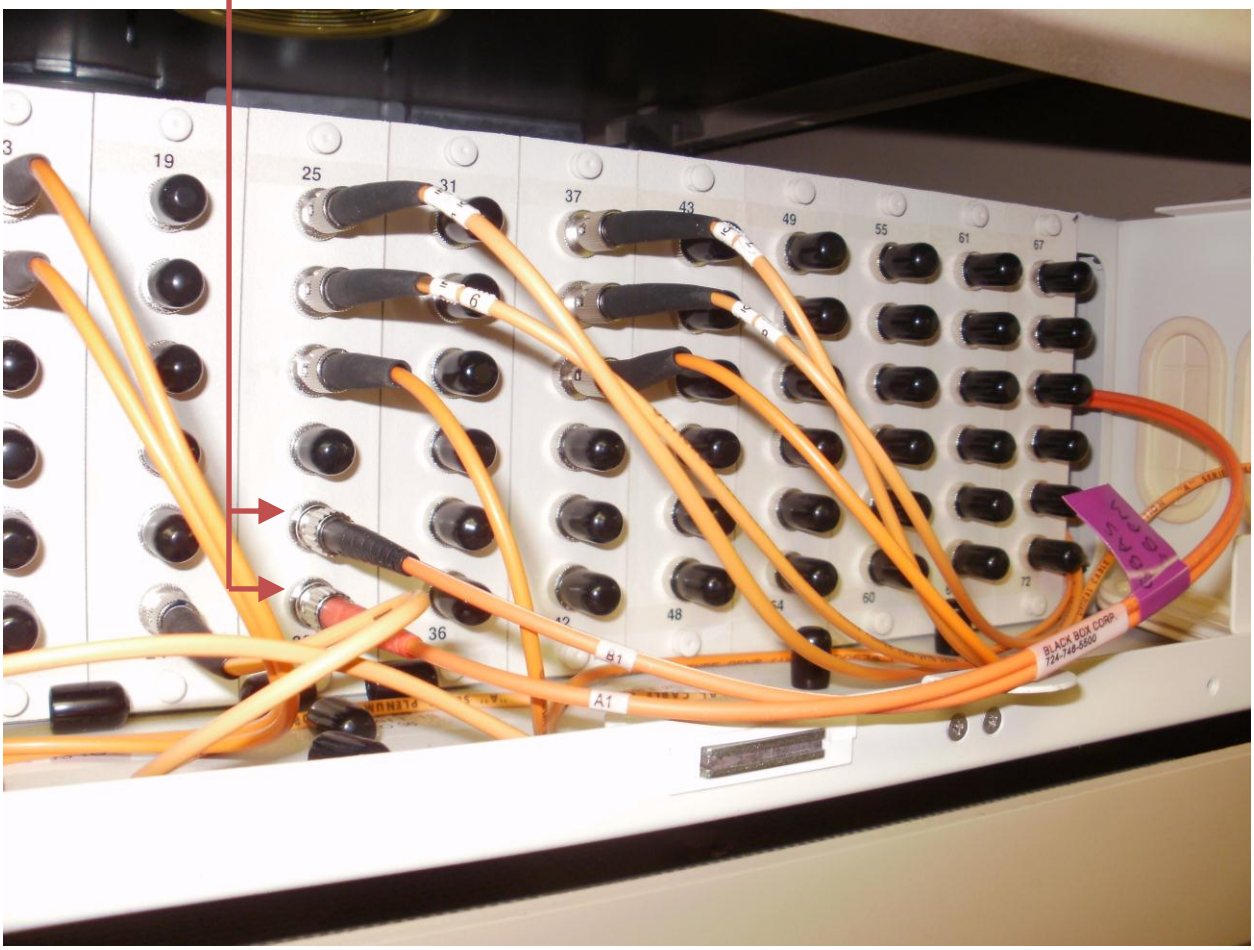
50/125 SM ST Fiber Pair

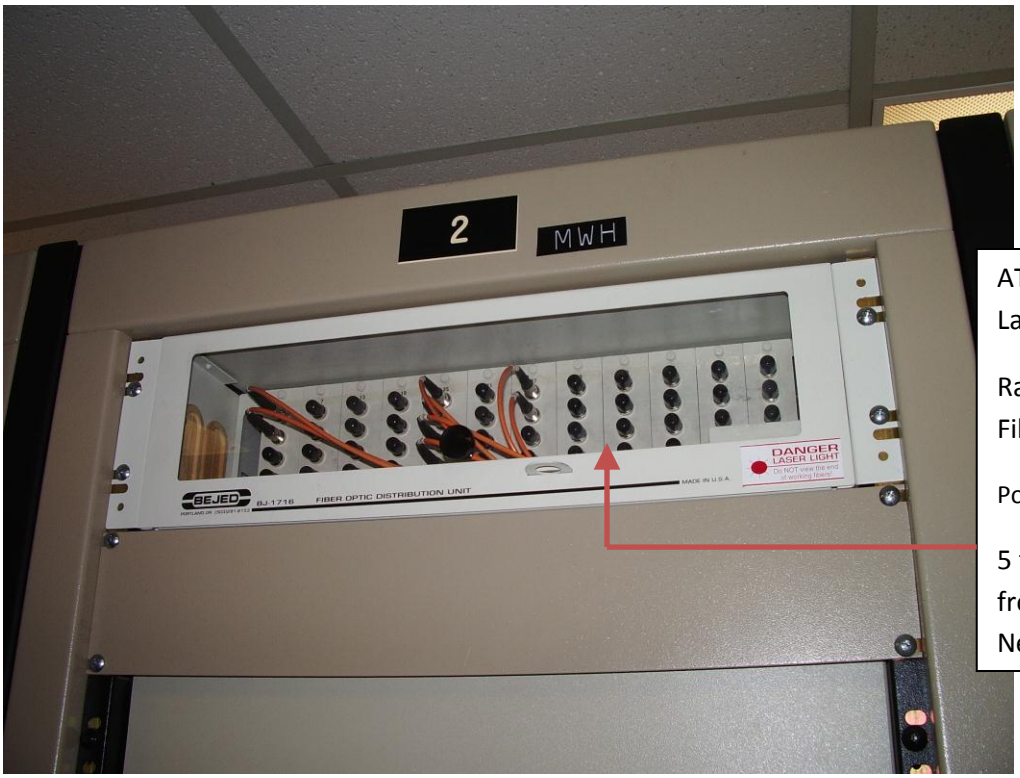
From Fiber Rack 6 Cable Access (page 62)

50/125 SM ST Fiber Pair

Port 29 Rx (black), Port 30 Tx (red)

25 ft. 50/125 SM ST Fiber Patch from MUX in GBPM to Fiber Rack 6 via Overhead Tray/HeycoFlex Tube



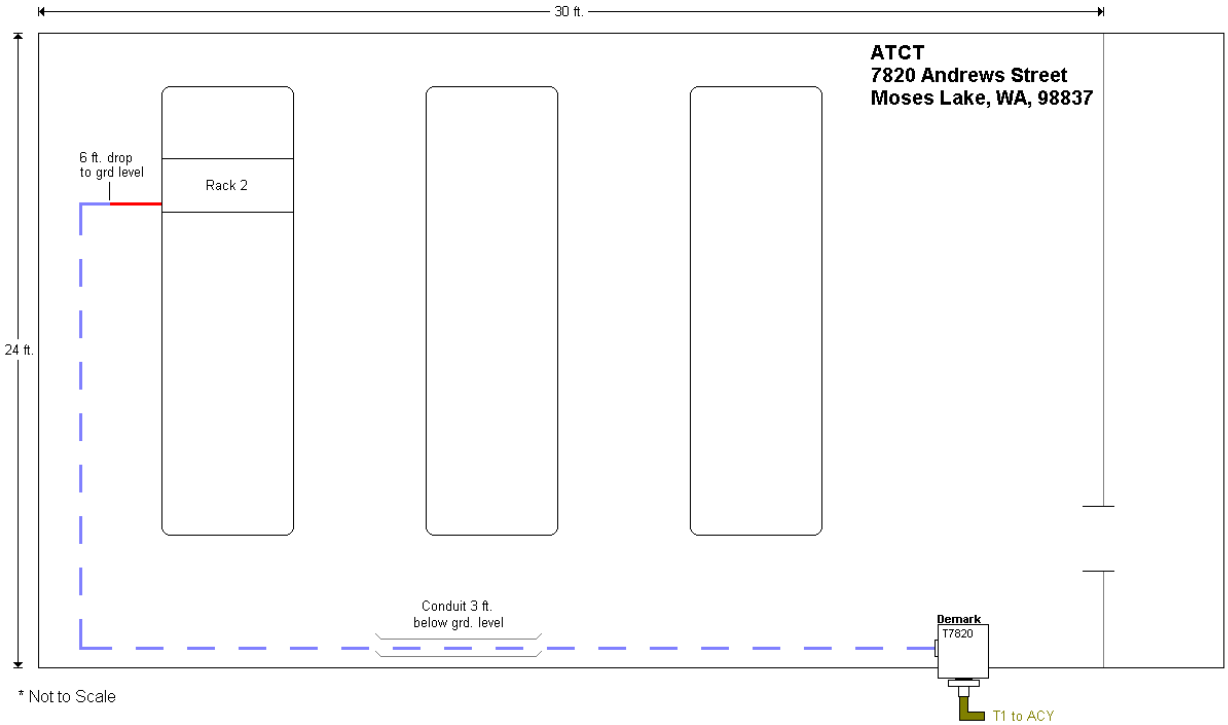


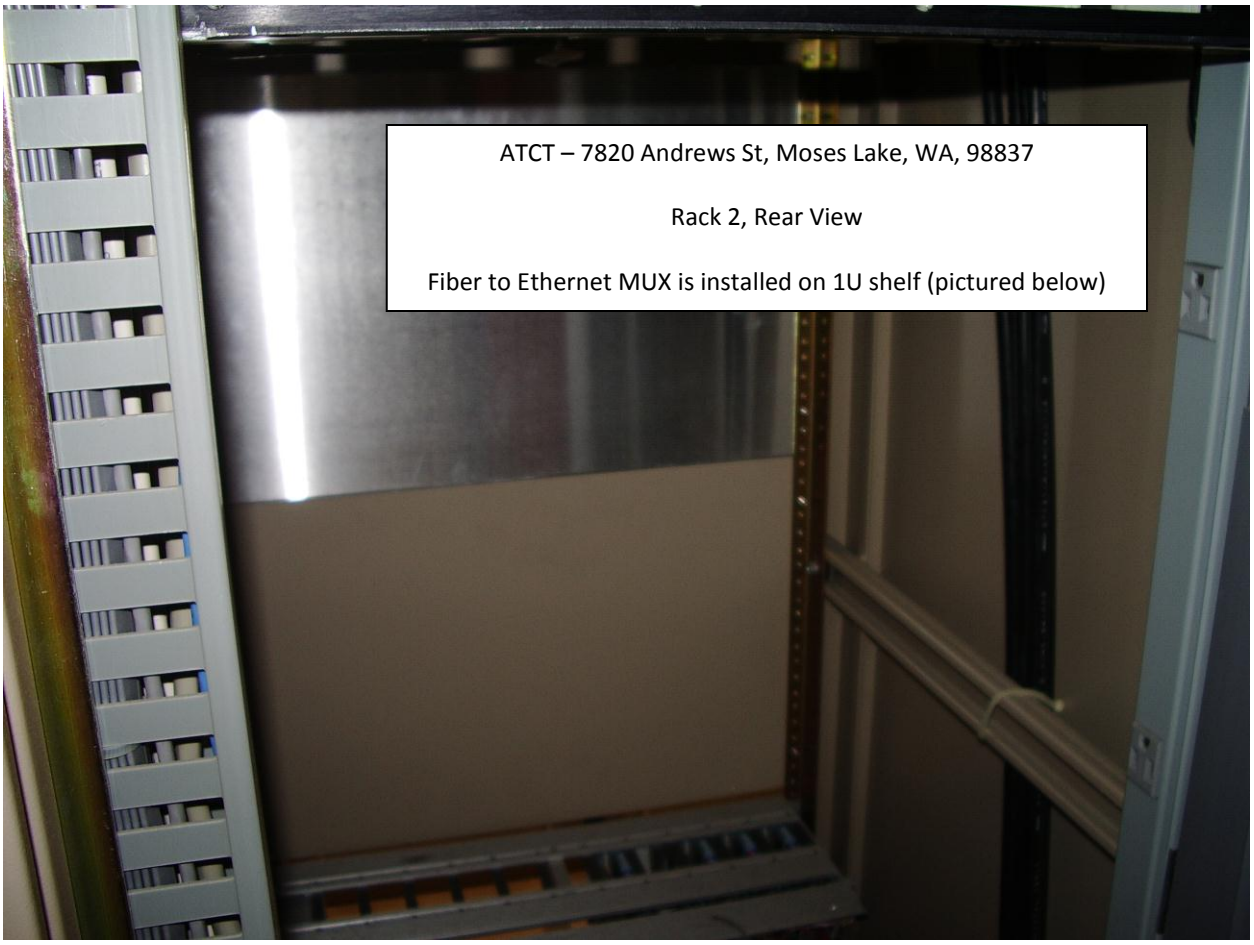
ATCT – 7820 Andrews St, Moses Lake, WA, 98837

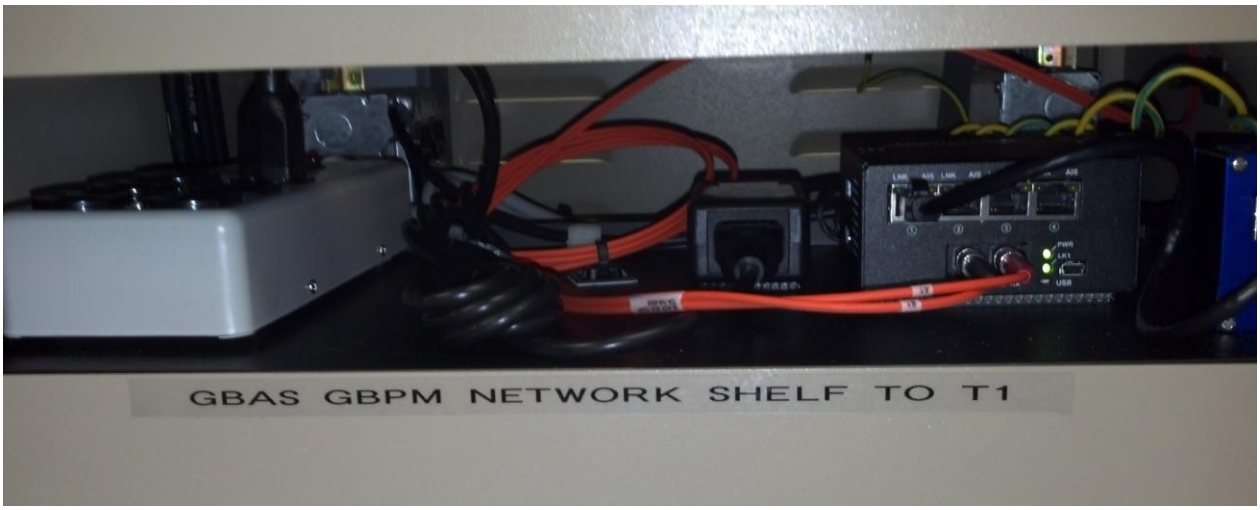
Rack 2, fiber demarcation from Fiber Rack 6 in RTR Shelter

Port 29 Rx (black), Port 30 Tx (red)

5 ft. 50/125 SM ST Fiber Patch from Rack 2 Panel to MUX on 1U Network Shelf



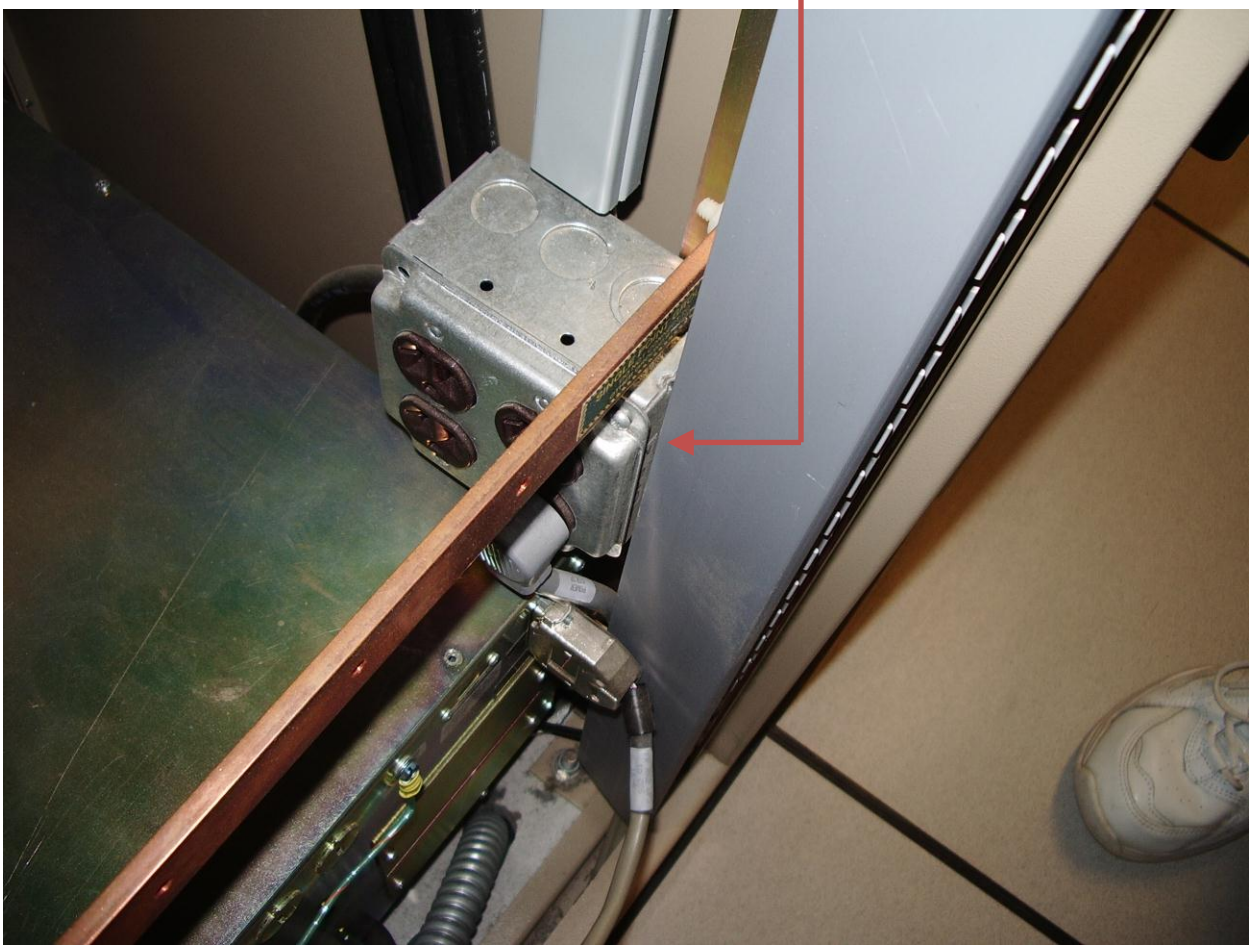

ATCT – 7820 Andrews St, Moses Lake, WA, 98837
Rack 2, Rear View
Fiber to Ethernet MUX is installed on 1U shelf (pictured below)


GBAS GBPM NETWORK SHELF TO T1

ATCT – 7820 Andrews St, Moses Lake, WA, 98837

Rack 2, Rear View

120 V Power Outlet for Installed Network Shelf (page 66)



Access Panel to secure CAT6 cable (installed) from MUX to existing conduit

Existing conduit 3 ft. beneath tile floor (ground level)

Runs ~65 ft. to demark breakout T7820

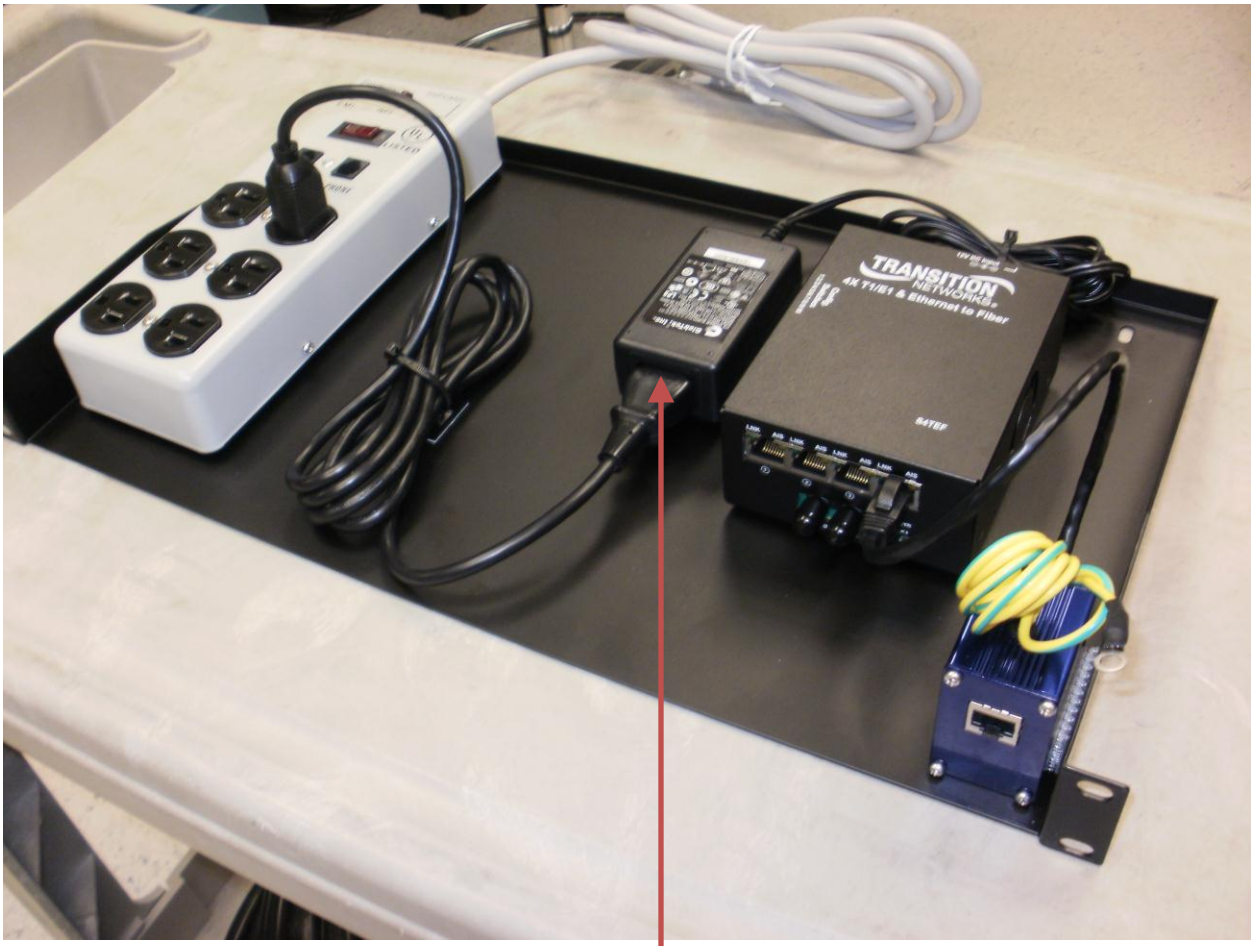
ATCT – 7820 Andrews St, Moses Lake, WA, 98837

Demarcation Breakout T7820, T1 to ACY

CAT6 cable from MUX to demark T7820

4.2 T1 Fiber to Ethernet Multiplexer/Bus Rack-mount Shelf

This custom rack-mount shelf will be installed in Rack 2, located in the ATCT – 7820 Andrews St, Moses Lake, WA, 98837. See description in Section 4.1 T1 Network Cloud and ATCT Layout Plan.



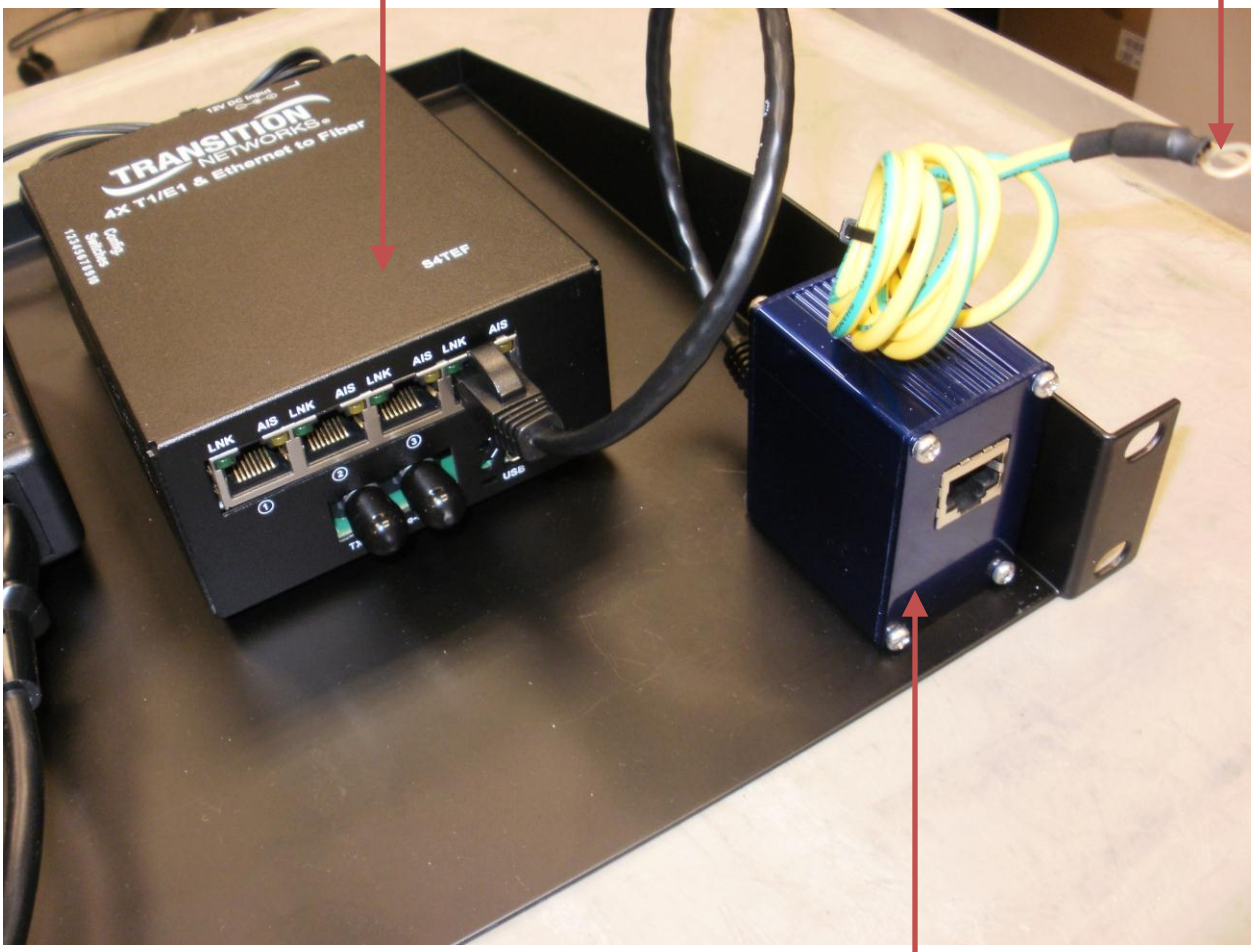
GlobTek 240 VAC Power Adapter for

Transition Networks T1 Fiber to Ethernet Multiplexer

Transition Networks T1 Fiber to Ethernet Multiplexer

4-port, ST Fiber Connections

Grounding Lug

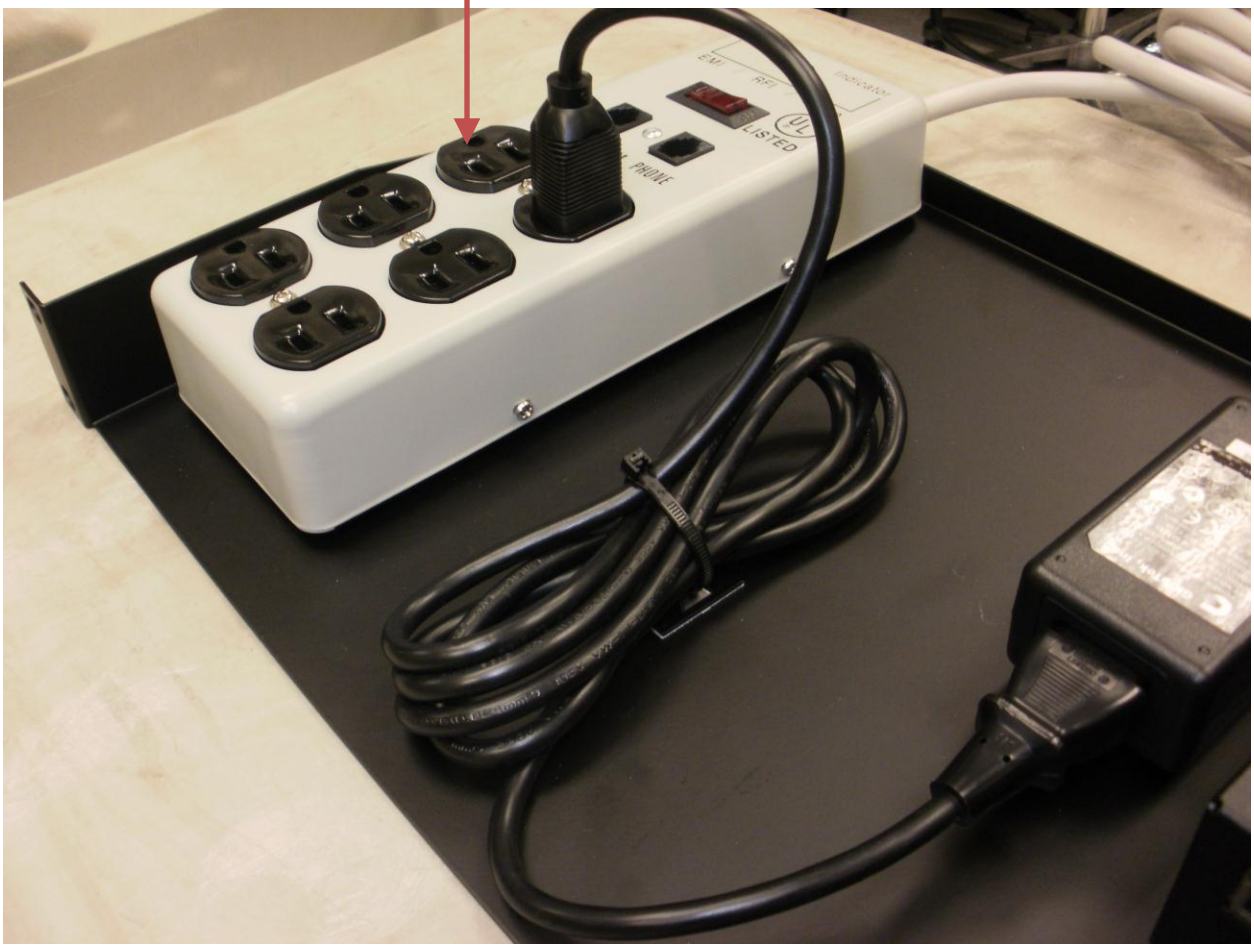


Citel POE Surge Protector

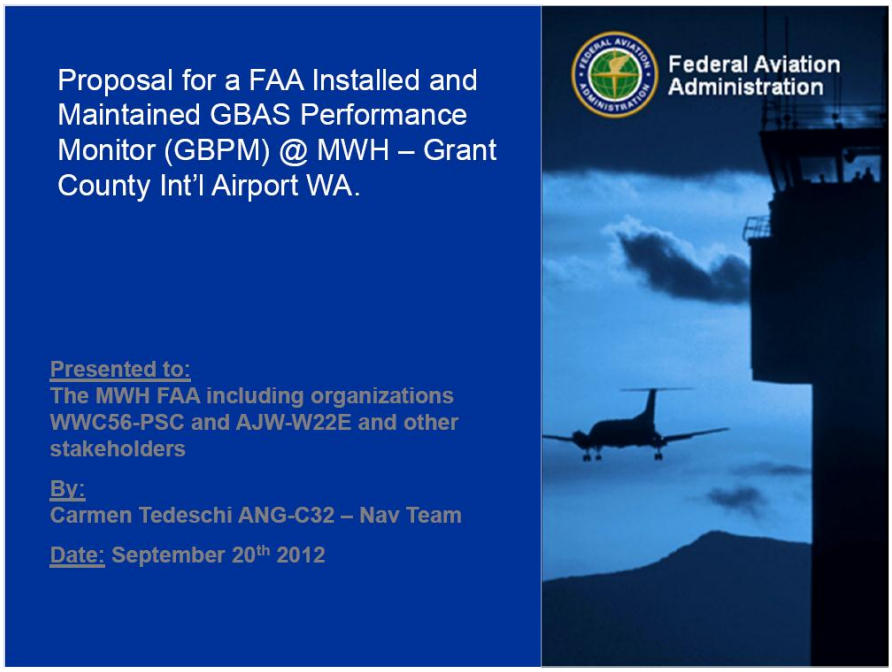
120 VAC @ 60 Hz

QVS Surge Protected Power Strip

120 VAC @ 60 Hz



Appendix A – MWH GBAS Field Monitor GBPM Proposal (Familiarization and Coordination)



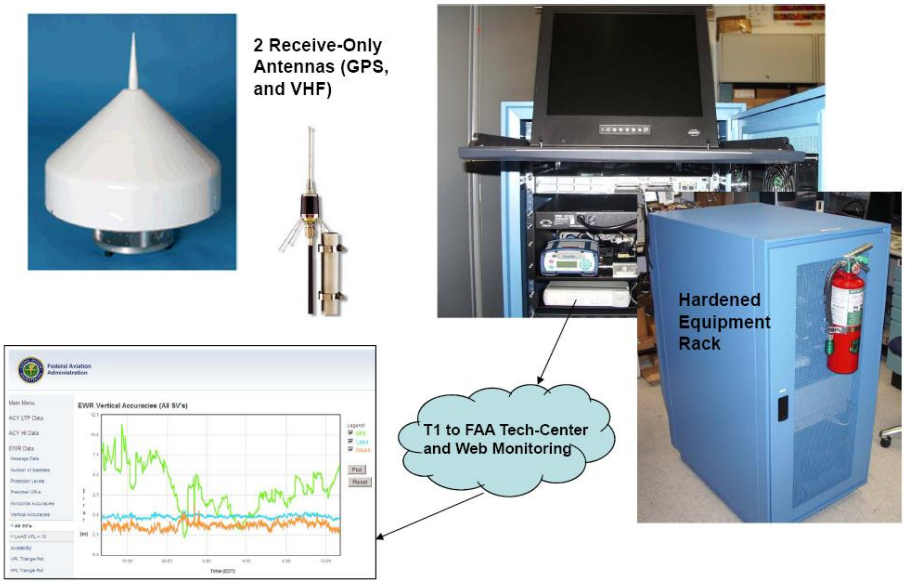
MWH FAA – GBPM System Desired Site Identified w/ John Wolfe and Eric Stoudt

•For Familiarization and Coordination Purposes, 7460, and accompanying docs to be provided by FAA GBAS Team (ANG-C32) – Install dates TBD

ANG-C32 Manager - John Warburton 609-485-6782

MWH GBPM Lead - Carmen Tedeschi 609-485-7165

MWH GBPM System Snapshot

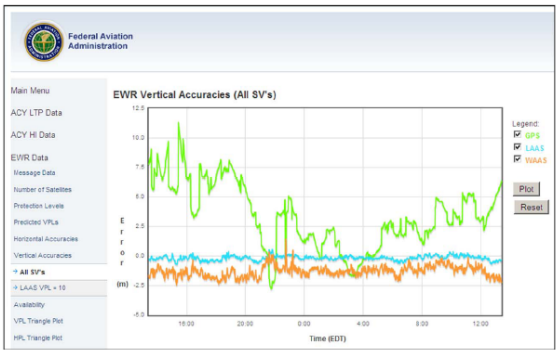


GBPM Facts and Purpose:

- The GBPM Field Monitor is NOT directly linked to the MWH GBAS
- Uses VHF Data Broadcast (VDB) corrections from DGPS positioning of GBAS, along with raw GPS/WAAS observables to compute accurate position of monitor system (Precision Surveyed GPS Antenna)
- The position calculated from this data is compared to the position of the precision-surveyed GBAS Grade GPS antenna which is used to identify even minuscule position errors (GPS vs WAAS vs GBAS).
- System is best described as a static 24/7, isolated, user platform, with network capability.

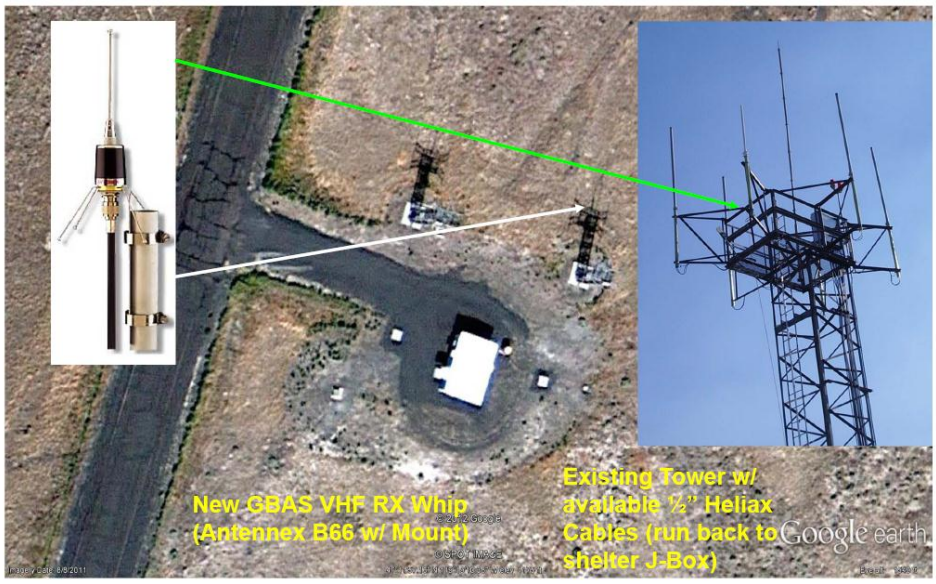
http://laas.tc.faa.gov/

Example Web-Type Page for Performance Monitoring



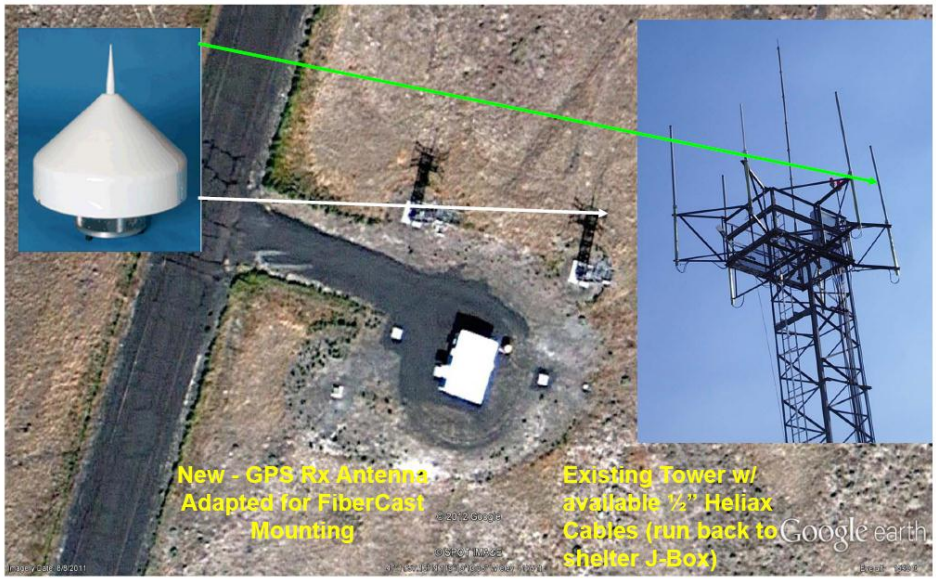
MWH FAA GBPM – VHF Data Receive Antenna

Not to scale (approximate weight 0.5 lbs)



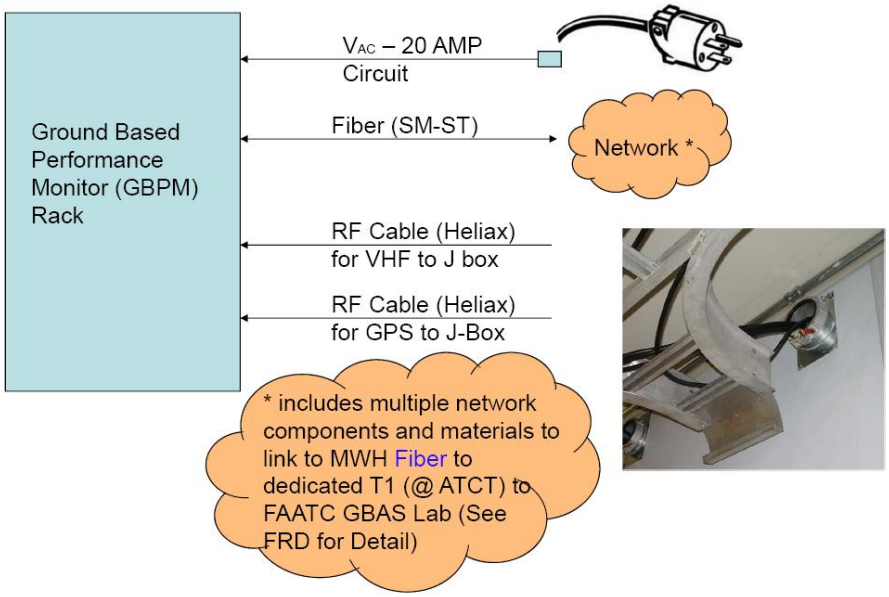
MWH FAA GBPM– GPS Receive Antenna (Adapted to FiberCast)

Not to scale (approximate weight 3 lbs)



MWH FAA GBPM Hardened Equipment Rack, Fiber Link, and Proposed Location in RTR shelter

External Cables from GBPM Rackmount Unit



GBPM Infrastructure, Service, and Needs:

•Installation and Hardware to be provided by ANG-C32, w/ limited on-site support* required (next slide)

•110 VAC / 60Hz – 1 Duplex @ 20amps *(*may need new circuit – SSC*)

•Precision Survey (ANG-C32 FAA Performed) – Access to PAC

•ANG-C32 provided T1, and other required hardware to link-up to FAA ATCT demarcation area.

•Network/Fiber-Ring and POC/assistance for extension from ANG provided T1 - demarcation to FAA Fiber Ring to RTR Shelter

•Limited rack space at fiber feed in ATCT for MuxBus (~ 2U)

•Line Of Site to VDB TX Antenna of GBAS / LGF **<LOS Confirmed>**

•2 RF cable runs - (Antennas to J-Box) **<Available @ Location>** , extensions to rack provided by ANG-C32

•A secure HVACed area for a ~ 2'w x 3'd x 4'h Rack enclosure. **<Available @ Location>**

ANG-C32 MWH On-Site Support* Requirements

- Primary POC for MWH (not limited to install dates)
- Temporary storage, transport, and lift of the GBPM hardware and support equipment.
- If required - bucket truck for GPS antenna placement.
  - ANG-C32 able to traverse tower as appropriate w/ safety gear
- Dedicated AOA Escort(s), and Shelter/ATCT access for 2 to 3 days for ANG personnel (3 or 4).
- Access to PAC for precision survey (for as-installed, and GBAS corrected positioning) of GBPM GPS antenna (AJP-652 performs and provides gear for this) ~ 2 to 4 hours
- Primary Network/Fiber-Ring MWH POC for on-site/remote assistance and access (not limited to install dates)

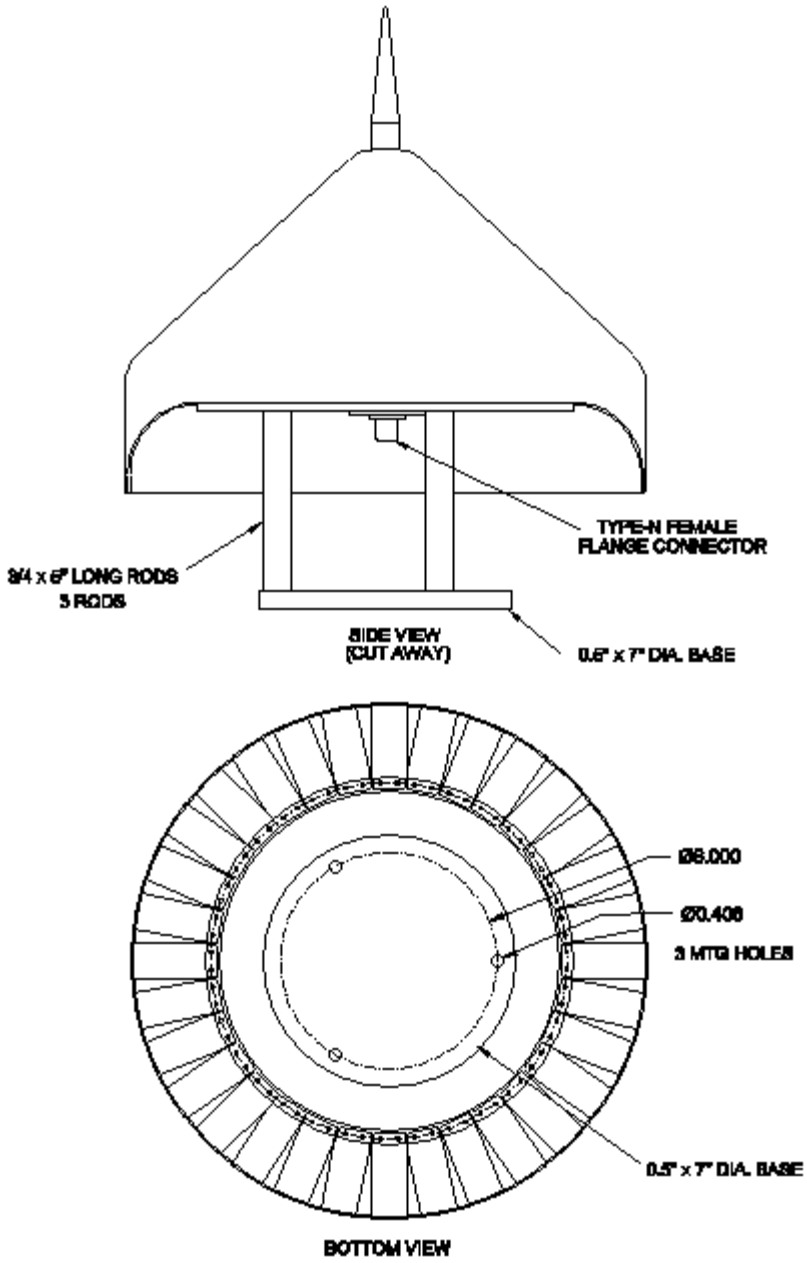
MWH GBPM Required Docs – ANG provided

- 7460 to be submitted by ANG-C32
- If Required - MOA or Other Document Formality between ANG-C32 and MWH FAA with installation, duration, service, POCs, etc.
  - Duration of GBPM deployment generally 3 to 5 years.
- A complete As-Planned/Installed engineering and operations package (Field Reference Data File).

GBAS GBPM Team Members

- Carmen Tedeschi – GBPM Team Lead
  - 609-485-7165
- Chad Kemp – Hardware and Networking
  - 609-485-6308
- Shawn Casler – Networking and Software
  - 609-485-6914
- Joseph Gillespie – Engineering Documentation
  - 609-485-4579
- Campbell Motley – Coordination Support/Docs
  - 703-841-2664

Appendix B – BAE Single Element DGPS Array/Reference Antenna Line Art & Performance Plots



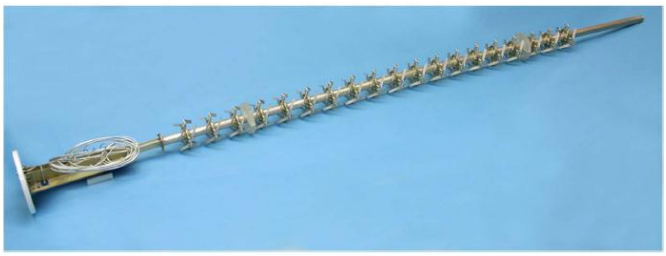
BAE SYSTEMS

BAE Systems Model ARL-1900 Array Antenna – Element Validation Antenna Assembly

Slide # 3

BAE SYSTEMS

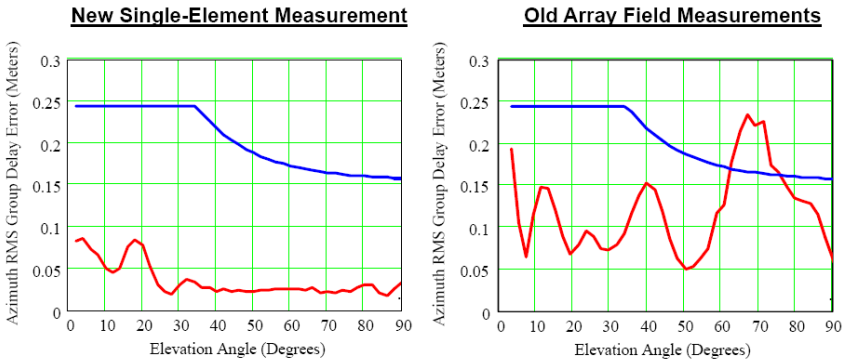
BAE Systems Model ARL-1900 Array Antenna – Photos of Power Divider and Array Antenna



Slide # 5

BAE SYSTEMS

RMS Group Delay Error – Main Limitation in Old Design



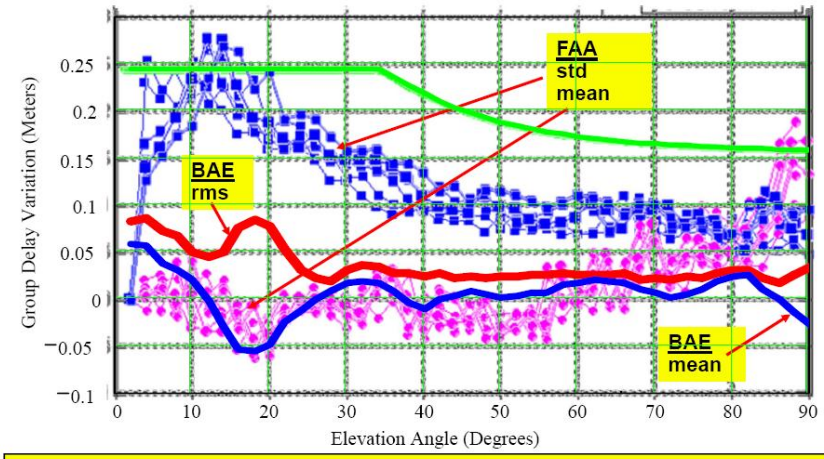
Single-element validation antenna measurements indicate greatly improved performance for the new design

This slide was taken from the Final Report – Phase 1 for DGPS Ground Reference Antenna Element.

Slide # 7

BAE SYSTEMS

FAA Tech Center Measurements of Single Element Antenna

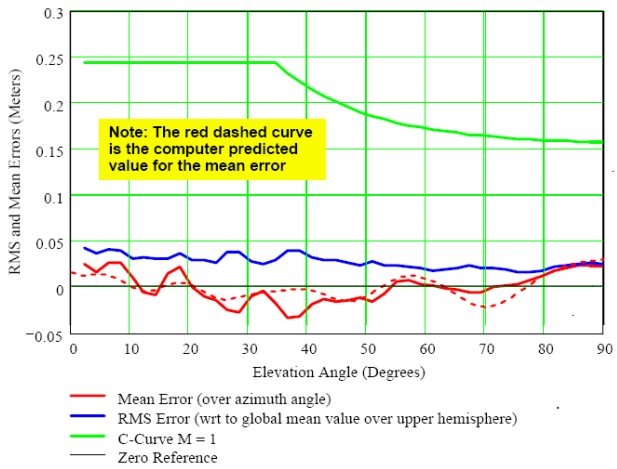


6 sets of FAA Tech Center data are superimposed. The data was taken on 2 days at one test point with 2 receivers, and at another test site on another day, again with 2 receivers. The single antenna has minimal variation of the mean. The error is dominated by multipath. Note: the BAE rms and mean values were measured at their Greenlawn, NY anechoic chamber.

Slide # 8

BAE SYSTEMS

RMS and Mean Group (Code) Delay Error

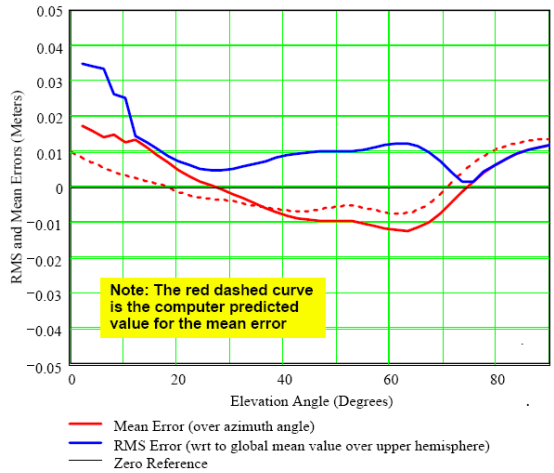


19-element array antenna measurements indicate significantly improved performance for the new design

Slide # 9

BAE SYSTEMS

RMS and Mean Carrier Delay Error

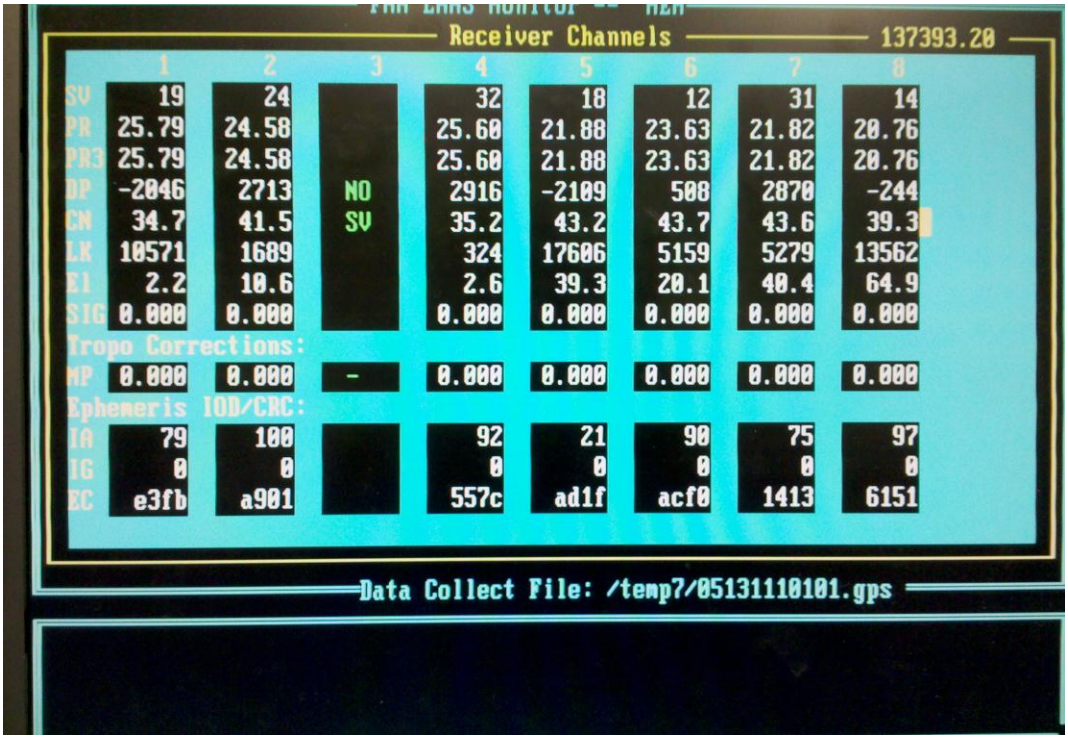


This slide is included for comparison of the carrier delay characteristics to those of the group delay characteristic presented in the previous slide.

Slide # 10

Appendix C – Keyboard, Video, and Mouse Interface (KVM) Code Screens for CAT I

Screen 1:

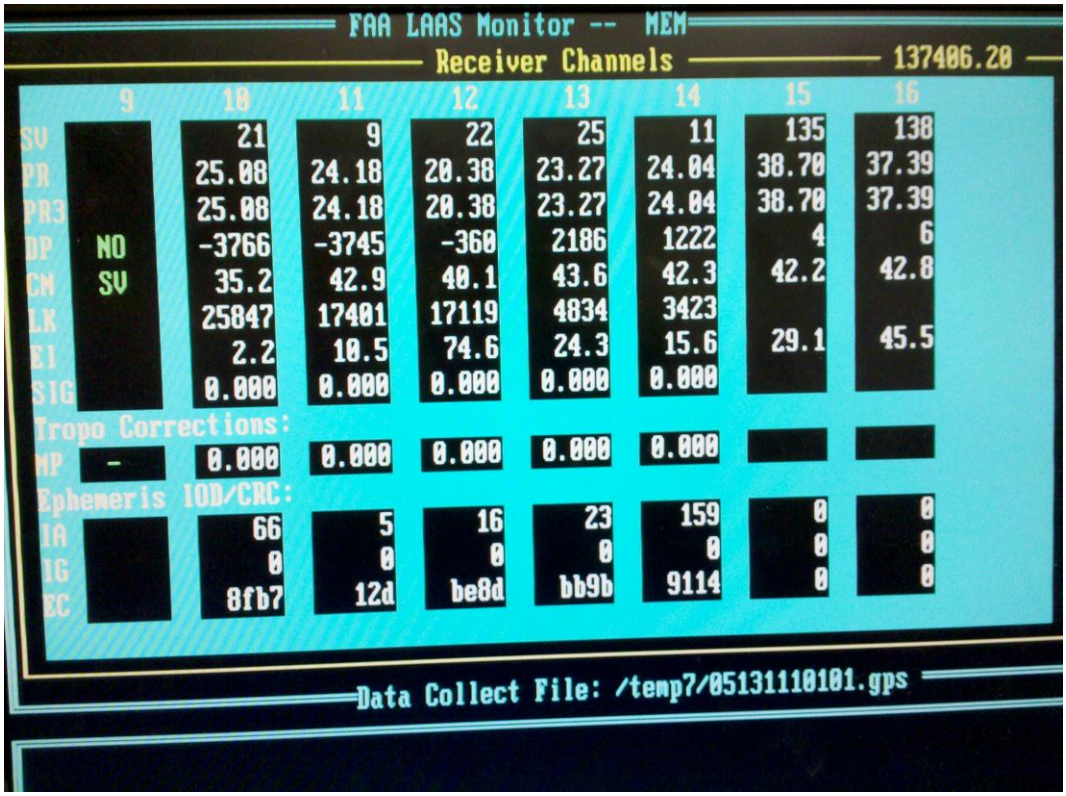


Columns 1 through 8: GPS Channel Numbers

GPS Receiver has the capability to track 16 SVs simultaneously. The first 8 channels are displayed on Screen 1.

- SV: GPS Satellite Number being tracked on specified channel
- PR: Pseudorange of SV using 100 seconds corrections
- PR30: Pseudorange of SV using 30 seconds corrections
- DP: Doppler measurements – Speed of SV
- CN: Carrier to Noise Density – Power Level/Noise ratio of SV
- LK : Lock-time – Period of time SV has been tracked by GPS receiver
- El: Elevation – Degrees of elevation of given SV
- IA: IOD of Ephemeris as decoded by GPS receiver to determine valid data
- EC: Ephemeris CRC – CRC from SV message to determine message is decoded correctly
- GPS Time (In upper right-hand corner): Data logged every 0.2 seconds. Shows current time in GPS seconds. This field will continually update as long as receiver is tracking a sufficient number of SVs, and is outputting data to the computer for processing.

Screen q:

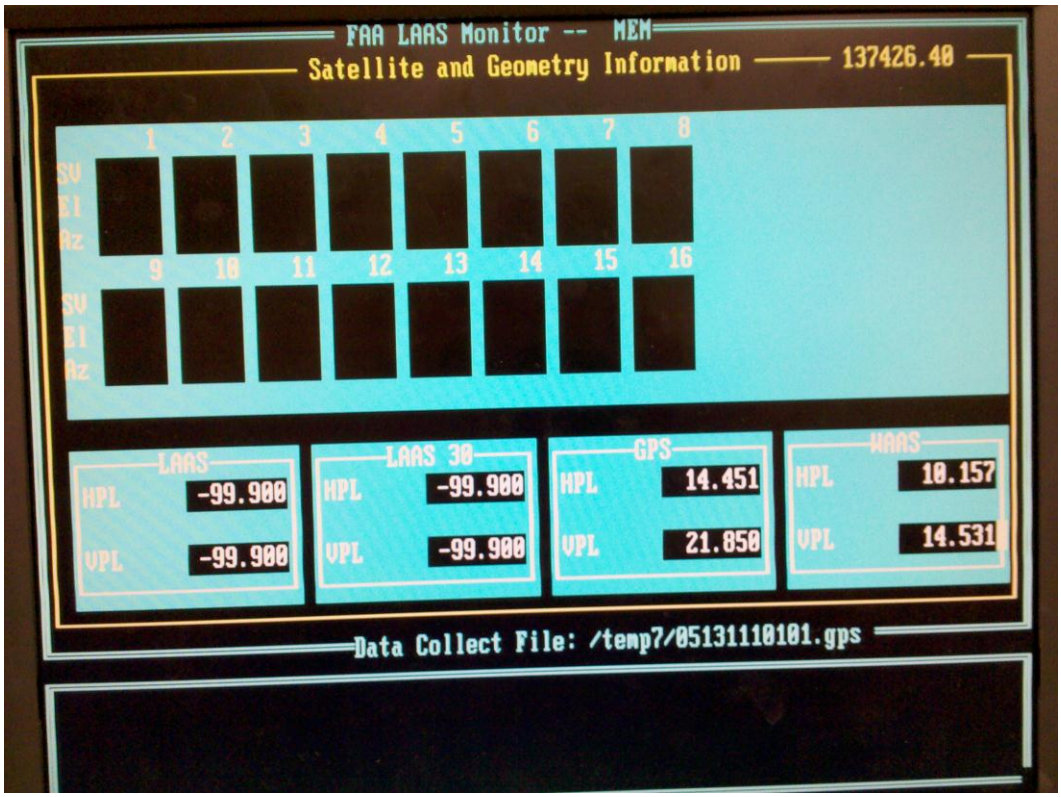


Columns 9 through 16: GPS Channel Numbers

GPS Receiver has the capability to track 16 SVs simultaneously. The last 8 channels are displayed on Screen **q**.

- WAAS Geo SVs that are tracked by the GPS receiver are displayed on the last two channels, 15 and 16.
    - Due to the stationary state, C/No values have minimal change, and are useful in helping to detect and observe RFI, along with other abnormal activity

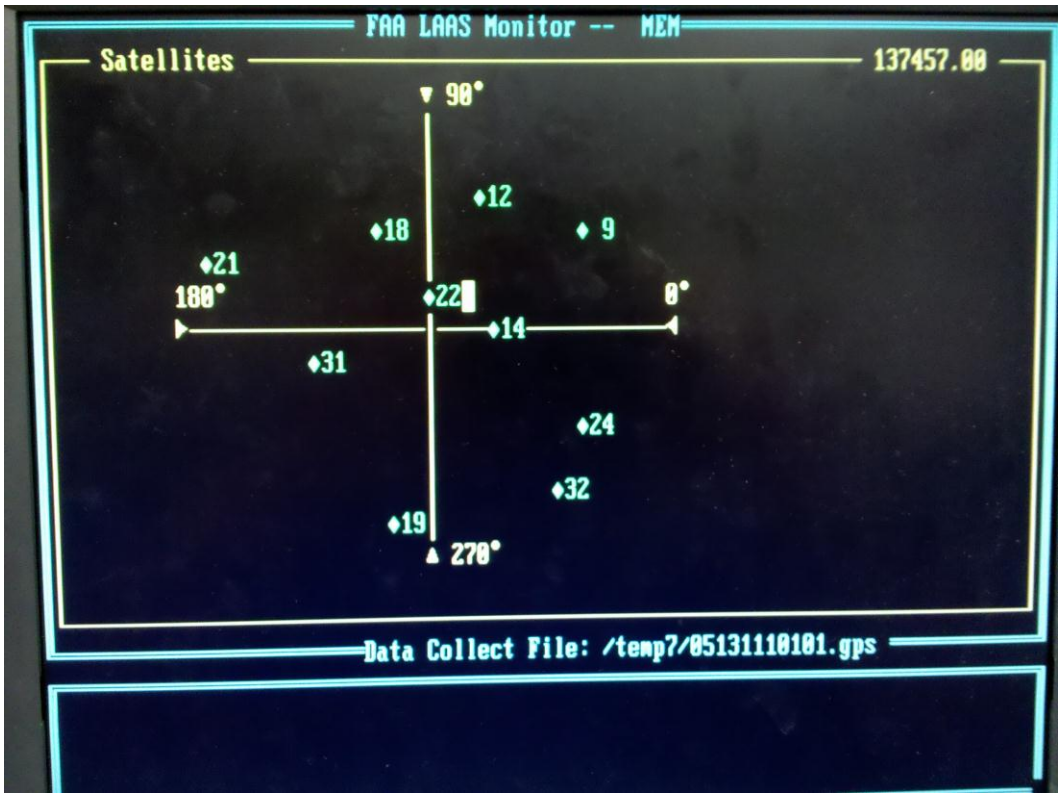
Screen 2:



This screen displays Azimuth and Elevation of all SVs tracked by the GPS Receiver.

- Displays Horizontal and Vertical Protection Limits (HPL, VPL) calculated for LAAS, GPS, and WAAS (these are absolute maximums (m)).

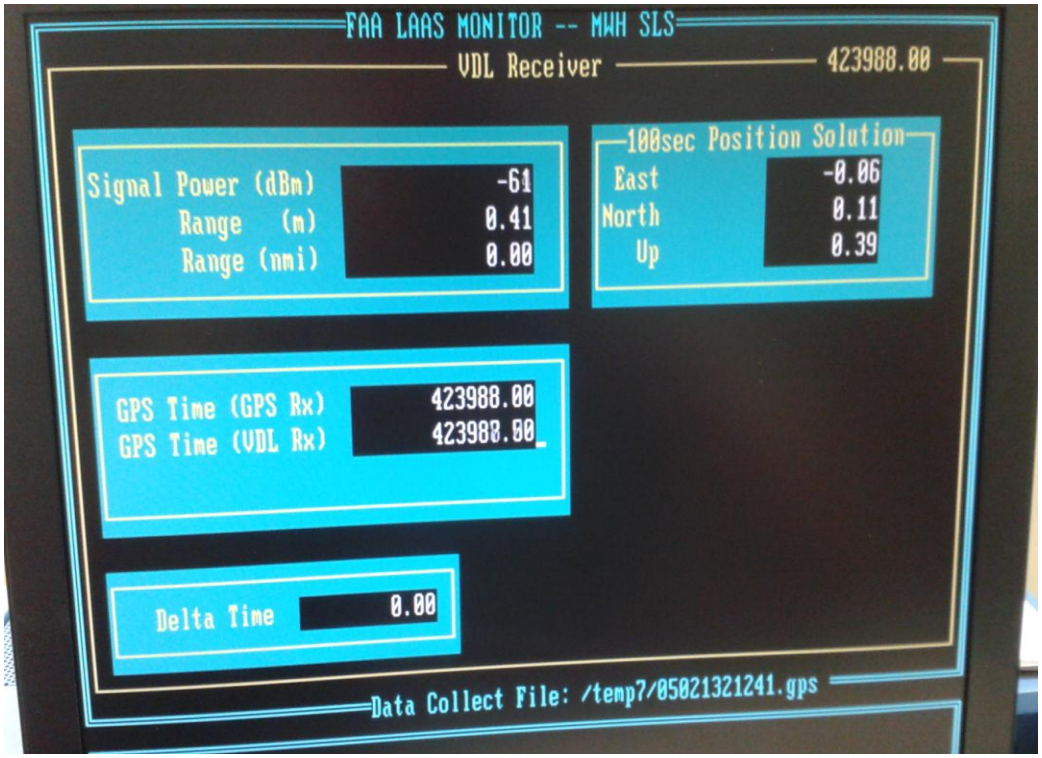
Screen 3:



This screen displays a 3D-like view of the constellation as seen by the GPS receiver.

- Azimuth counter-clockwise from 0 to 360 degrees
- Elevation from outside (0 degrees) to middle of the zenith (90 degrees)

Screen 4:

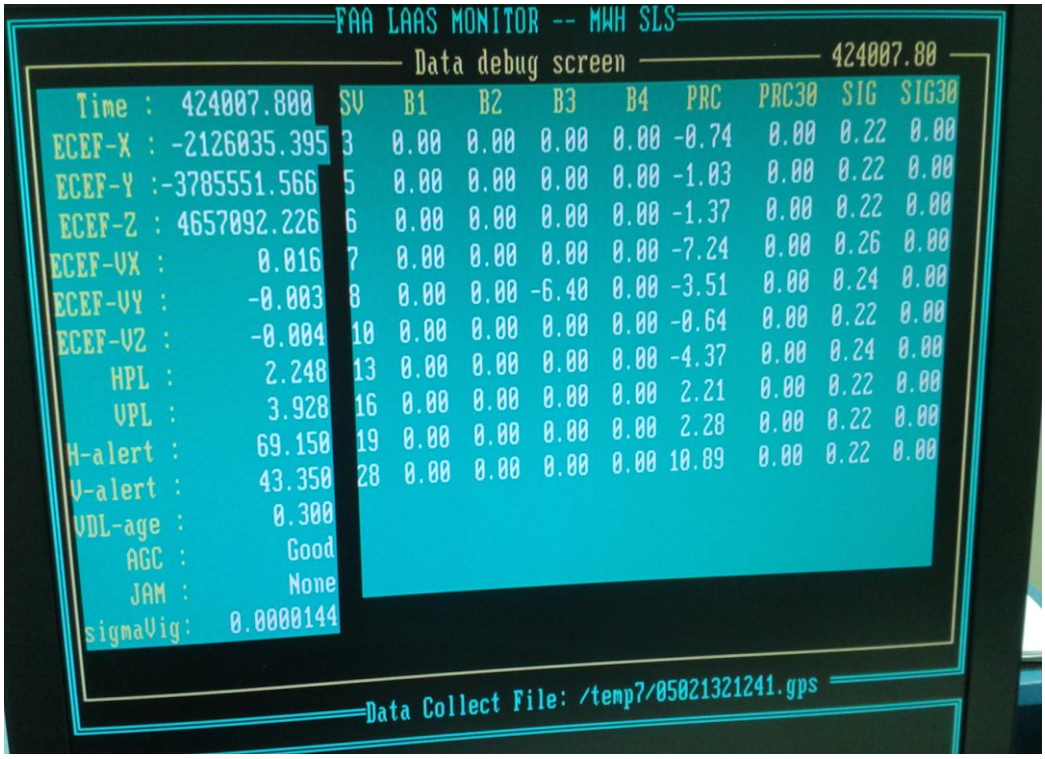


This screen displays general information on the VDB signal broadcast from GBAS system.

- Signal Power (dBm): Signal Power of VDB Broadcast
- GPS Time (GPS RX): Time in GPS seconds as computed from GPS receiver in GBPM
- GPS Time (VDL RX): Time on VDB messages from the tuned GBAS station, calculated against GPS time
- 100sec Position Solution: Shows error in the vectors ENU

This screen is useful to display when the last VDB message was received in order to determine if the VHF broadcast from GBAS has stopped.

Screen 5:



- Time: GPS Time (in seconds) from the GPS receiver
- ECEF – X, Y, Z: Corrected position based on GPS receiver data and corrections from the GBAS station, in the ECEF vector format
- ECEF – VX, VY, VZ: Velocities based on corrected positions from GPS receiver data and corrections from the GBAS station, in the ECEF vector format
- HPL, VPL: Horizontal (HPL) and Vertical (VPL) Protection Limits calculated based on data from both the monitor receiver and messages broadcast from the GBAS site. These are calculated maximums in both vectors based on the currently used/observed constellation.
- H-alert, V-alert: Alert limits in Horizontal and Vertical directions that, if reached by error or Protection Limit, would be cause for unusual service for the user as a safety case
- VDL-age: Time since last VDB message was received. One of many indicators of missed messages, or VHF broadcast stoppage.
- AGC: Internal flag on GPS receiver to show if signal levels for receiver are adequate
- JAM: Internal flag on GPS receiver to show if suspected jamming is occurring
- SV, B1, B2, B3, B4, PRC, PRC30, SIG, SIG30 : In the columns, this displays the data transmitted in the Type-1 Message from the GBAS in the VDB data
- SV: SV Number of satellite for the data in that row
- B1: B-value (error) for that satellite (SV) on reference 1

- B2: B-value (error) for that satellite (SV) on reference 2
- B3: B-value (error) for that satellite (SV) on reference 3
- B4: B-value (error) for that satellite (SV) on reference 4
- PRC: Pseudo-range correction based on the error of satellite distance
- SIG: Sigma-PR ground

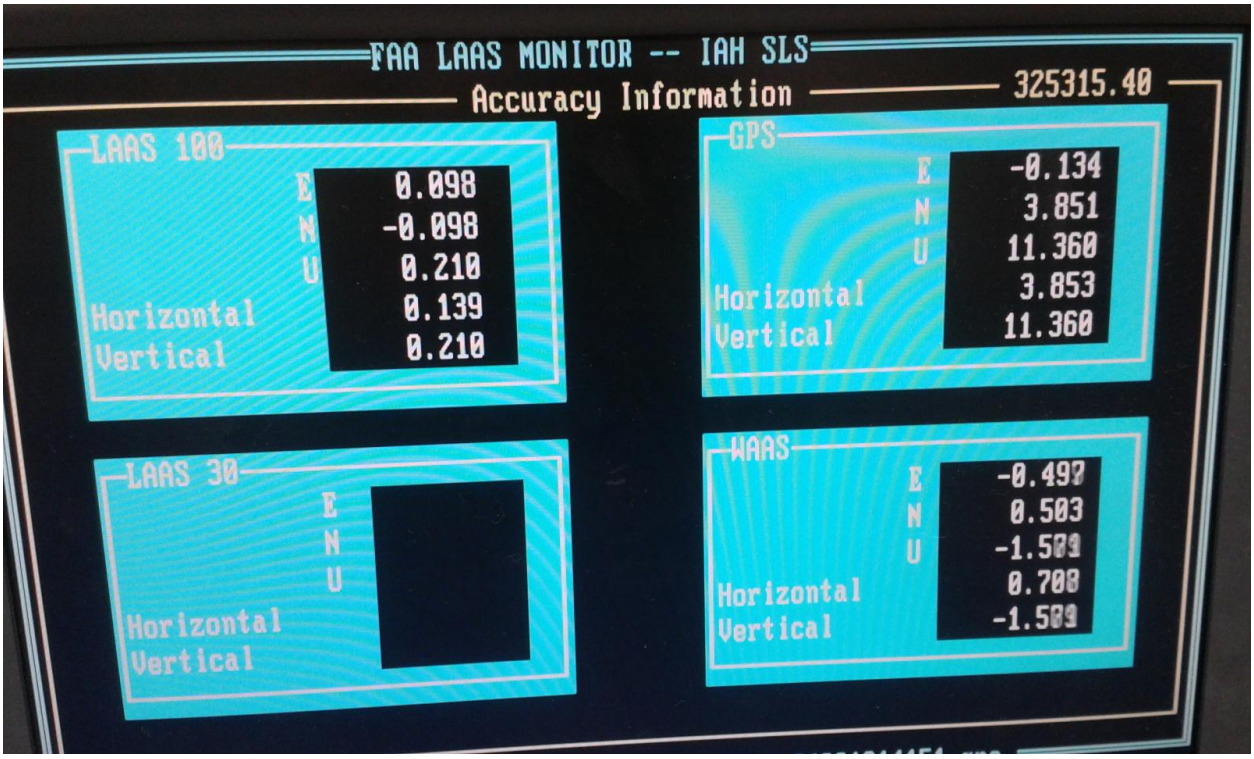
Screen 6:

This screen shows the Frequency of VDB message types received by the GBPM (average messages per second). The averages are taken in 5, 30, and 300 second blocks.

- Type 1: All SV corrections information – Two correction messages per second are required
- Type 2: Local airport and area information – frequency should average approximately 1 every 2 seconds, or 0.50 for the SLS-4000.
- Type 4: Airport approach information (Final Approach Segments – FAS) – Should average at a minimum of 1 every 2 seconds, but as high as 3 every 2 seconds, or 1.50.
- Type 11: Only used for CAT III systems (GAST-D).

Adding up the frequency of messages received, per interval, should equal 4.00, or four (4) messages received per second.

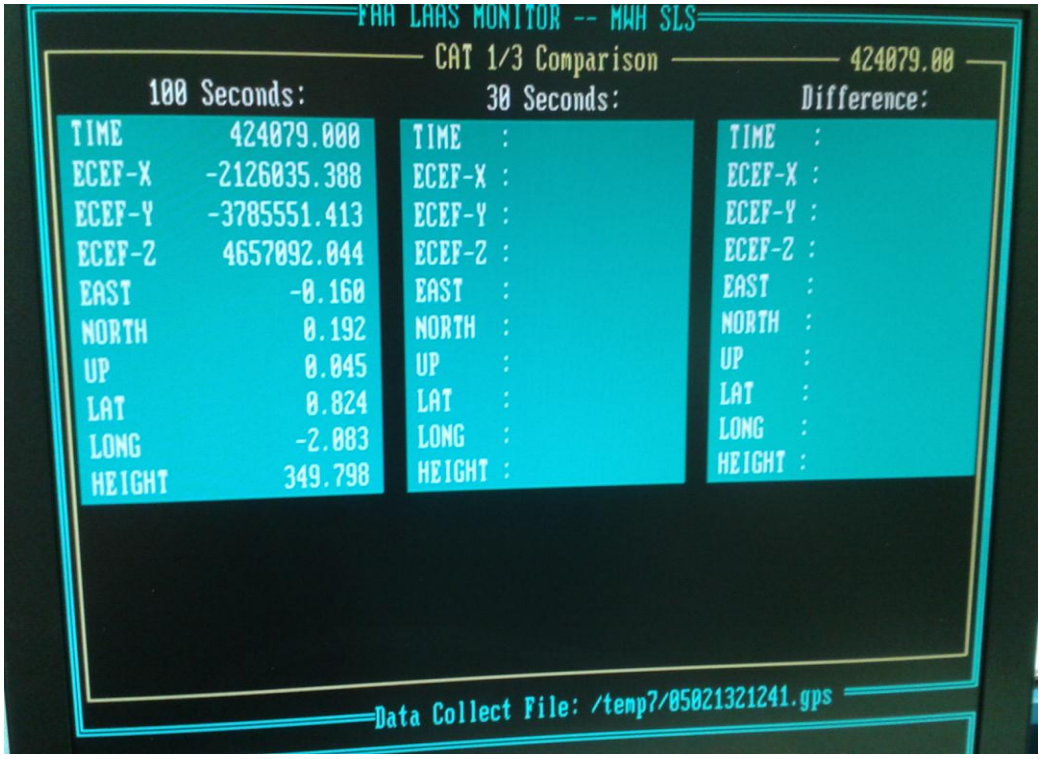
Screen 7:



This screen displays Accuracy information (in meters) for the vectors of ENU and Horizontal/Vertical, based on correction information from the GBAS, LAAS, GPS, and WAAS.

- NOTE: LAAS 30 (Fast Corrections) is only used for CAT III systems (GAST-D)

Screen 8:



This screen displays Corrected Position Information for CAT I (uses 100 seconds only).

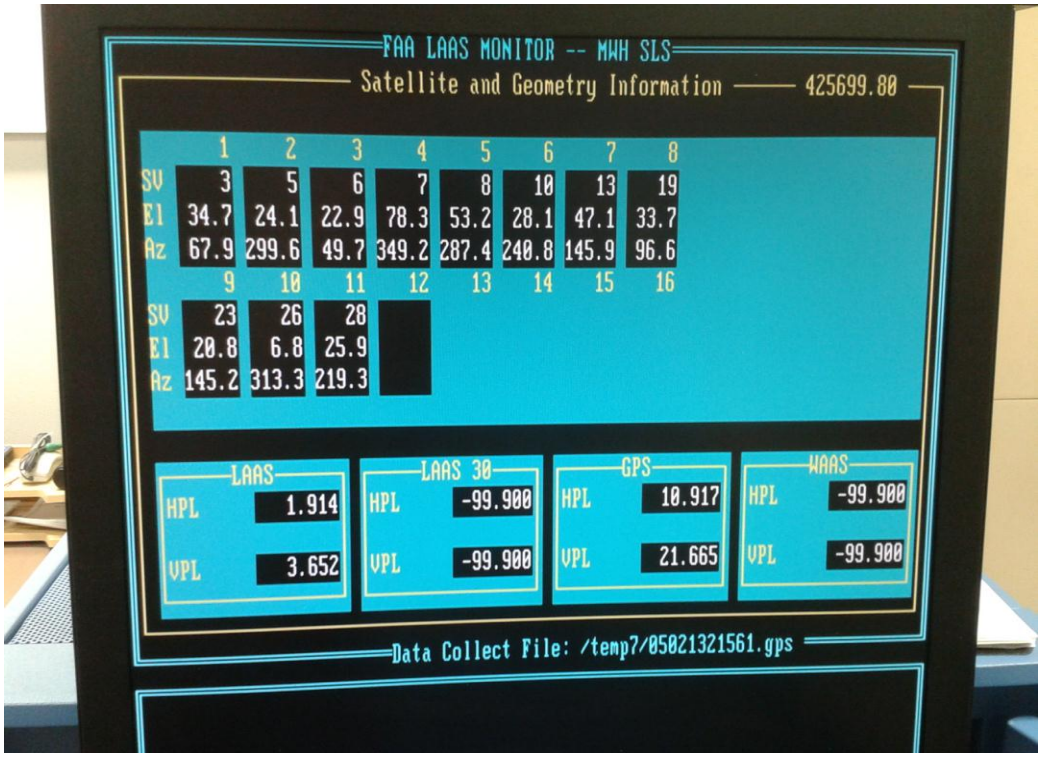
Screen 9:

The screen displays the Worst Case Solution Information: If SV/SVs in the constellation were lost, for a variety of different reasons; this screen demonstrates a worst case scenario for Accuracy and Protection Limits (PLs) based on that situation.

- SV: Satellites left in constellation to make this solution
- HPL/VPL: Horizontal and Vertical Protection Limits for LAAS, WAAS, and GPS with this “worst case” satellite constellation set
- H-Err/V-Err: Horizontal and Vertical Error for LAAS, WAAS, and GPS, with this “worst case” satellite constellation set

Appendix D – KVM Code Screens CAT III (only shows screens that differ from CAT I)

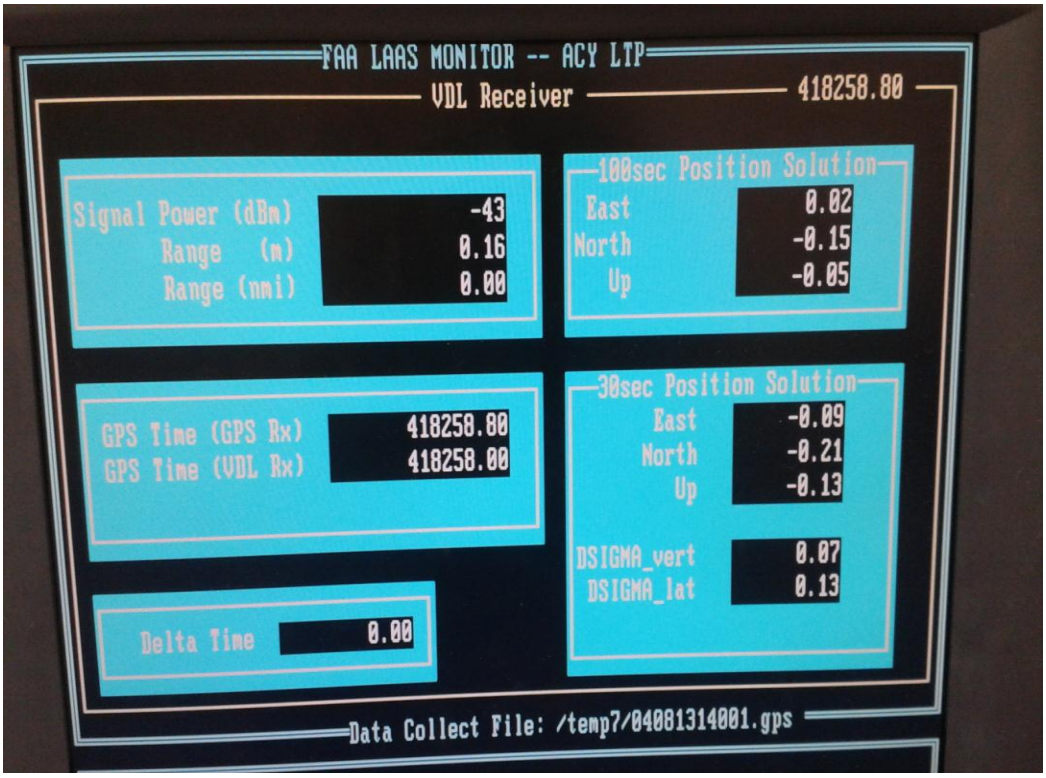
Screen 2:



This screen displays Azimuth and Elevation of all SVs tracked by the GPS Receiver (in degrees).

- Displays Horizontal and Vertical Protection Limits (HPL, VPL) calculated for LAAS, LAAS30 (Fast Corrections), GPS, and WAAS.

Screen 4:

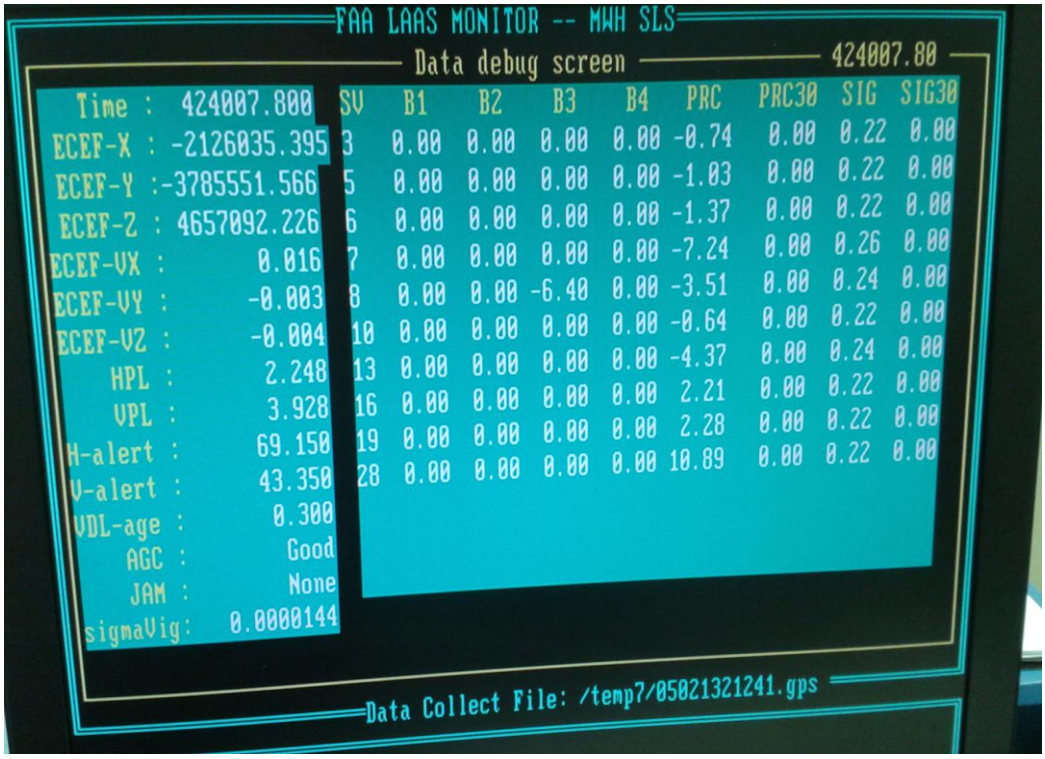


This screen displays General information on the VDB signal broadcast from GBAS system.

- Signal Power (dBm): Signal Power of VDB Broadcast
- GPS Time (GPS RX): Time in GPS seconds as computed from GPS receiver in GBPM
- GPS Time (VDL RX): Time on VDB messages from the tuned GBAS station, calculated against GPS time
- 100sec Position Solution: Display that shows the error in the vectors ENU
- 30sec Position Solution: Display that shows the error in the vectors of ENU
    - DSIGMA-vert/DSIGMA-lat: Differences in horizontal and vertical vectors between the 100 and 30 second data sets

This screen is useful to display when the last VDB message was received in order to determine if the VHF broadcast from GBAS has stopped.

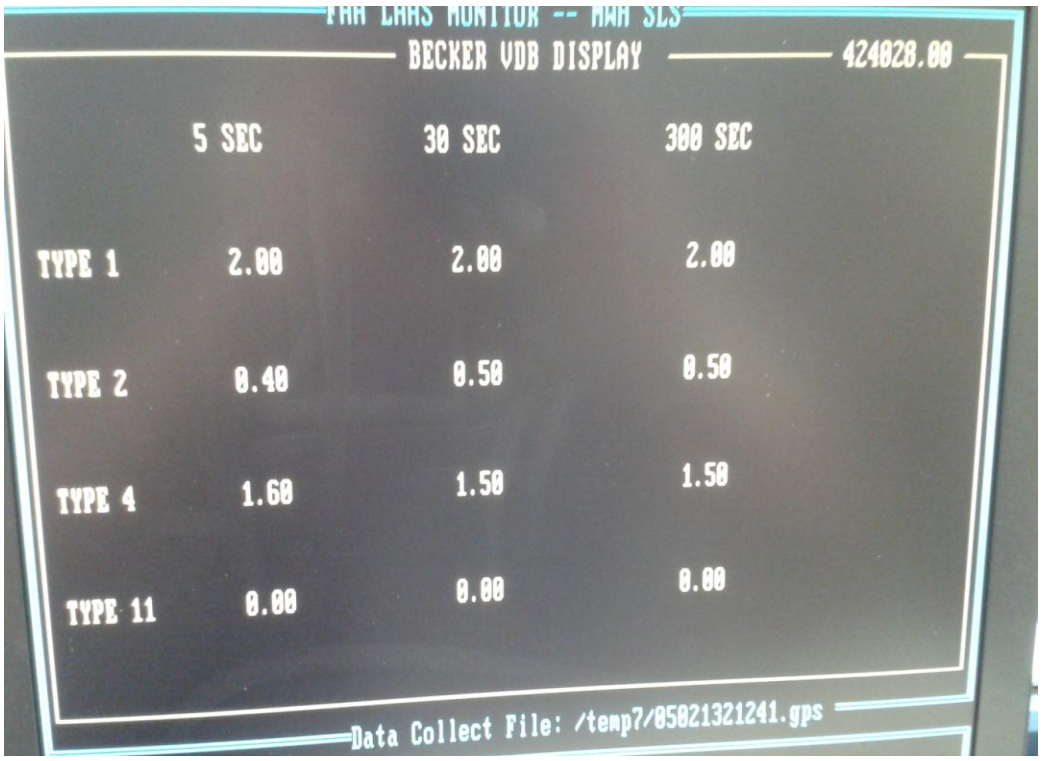
Screen 5:



- Time: GPS Time (in seconds) from the GPS receiver
- ECEF – X, Y, Z: Corrected position based on GPS receiver data and corrections from the GBAS station, in the ECEF vector format
- ECEF – VX, VY, VZ: Velocities based on corrected positions from GPS receiver data and corrections from the GBAS station, in the ECEF vector format
- HPL, VPL: Horizontal (HPL) and Vertical (VPL) Protection Limits calculated based on data from both the monitor receiver and messages broadcast from the GBAS site. These are calculated maximums in both vectors based on the currently used/observed constellation.
- H-alert, V-alert: Alert limits in Horizontal and Vertical directions that, if reached by error or Protection Limit, would be cause for unusual service for the user as a safety case
- VDL-age: Time since last VDB message was received. One of many indicators of missed messages, or VHF broadcast stoppage.
- AGC: Internal flag on GPS receiver to show if signal levels for receiver are adequate
- JAM: Internal flag on GPS receiver to show if suspected jamming is occurring
- SV, B1, B2, B3, B4, PRC, PRC30, SIG, SIG30 : In the columns, this displays the data transmitted in the Type-1 Message from the GBAS in the VDB data
- SV: SV Number of satellite for the data in that row
- B1: B-value (error) for that satellite (SV) on reference 1

- B2: B-value (error) for that satellite (SV) on reference 2
- B3: B-value (error) for that satellite (SV) on reference 3
- B4: B-value (error) for that satellite (SV) on reference 4
- PRC: Pseudo-range correction based on error of satellite distance in 100 second smoothing (basic CAT I analysis)
- PRC30: Pseudo-range correction based on error of satellite distance in 30 second smoothing (Fast corrections – for CAT III analysis)
- SIG: Sigma-PR ground
- SIG30: Sigma-PR ground for 30 second data (CAT III)

Screen 6:

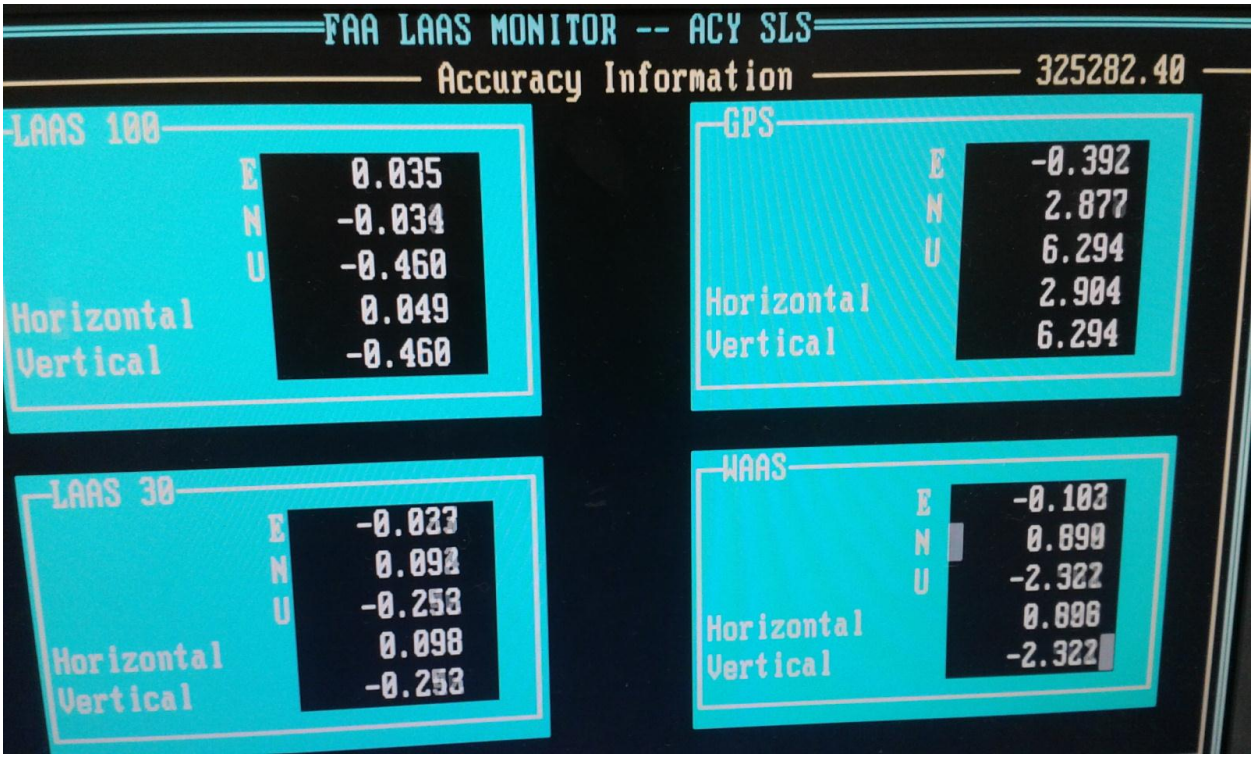


This screen shows the Frequency of VDB message types received by the GBPM (average messages per second). The averages are taken in 5, 30, and 300 second blocks.

- Type 1: All SV corrections information – frequency should average at two (2) per second
- Type 2: Local airport and area information – frequency should average around one (1) every two (2) seconds, or 0.50.
- Type 4: Airport approach information (Final Approach Segments – FAS) – Should average at a minimum of one (1) every two (2) seconds, but as high as three (3) every two (2) seconds, or 1.50.

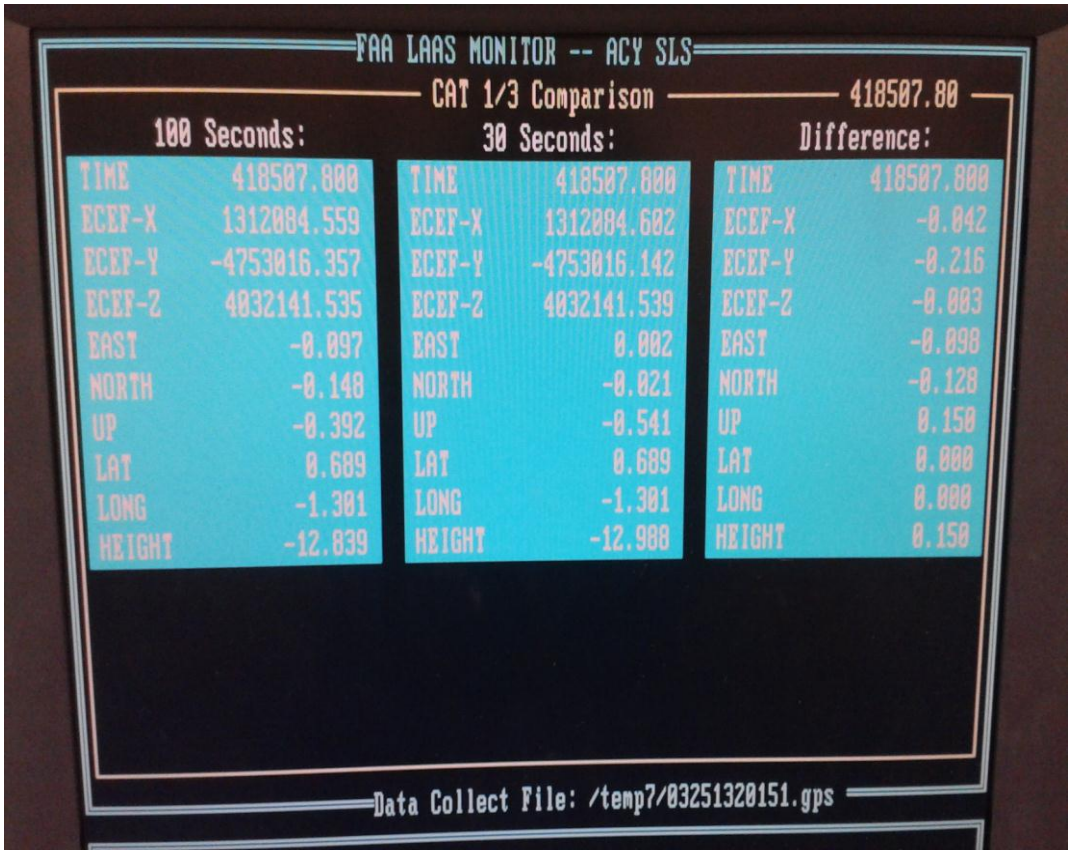
- Type 11: All SV Corrections information (30 seconds)– frequency should average at two (2) per second
- Adding up the frequency of messages received, per interval, should equal 6.00, or six (6) messages received per second.

Screen 7:



This screen displays Accuracy information (in meters) for the vectors of ENU and Horizontal/Vertical, based on correction information from the GBAS, LAAS, LAAS30 (Fast Corrections – CAT III), GPS, and WAAS.

Screen 8:



This screen displays Corrected Position Information for CAT I and CAT III (shows the differences).

- Position Information based on 100 and 30 second smoothing. The differences between the results are displayed in the “Differences” column
- This information is used to analyze the quality of the environment, and determine if CAT III can be supported