FAA William J. Hughes Technical Center
Ground Based Performance Monitor (GBPM)

Houston

Field Reference Data File

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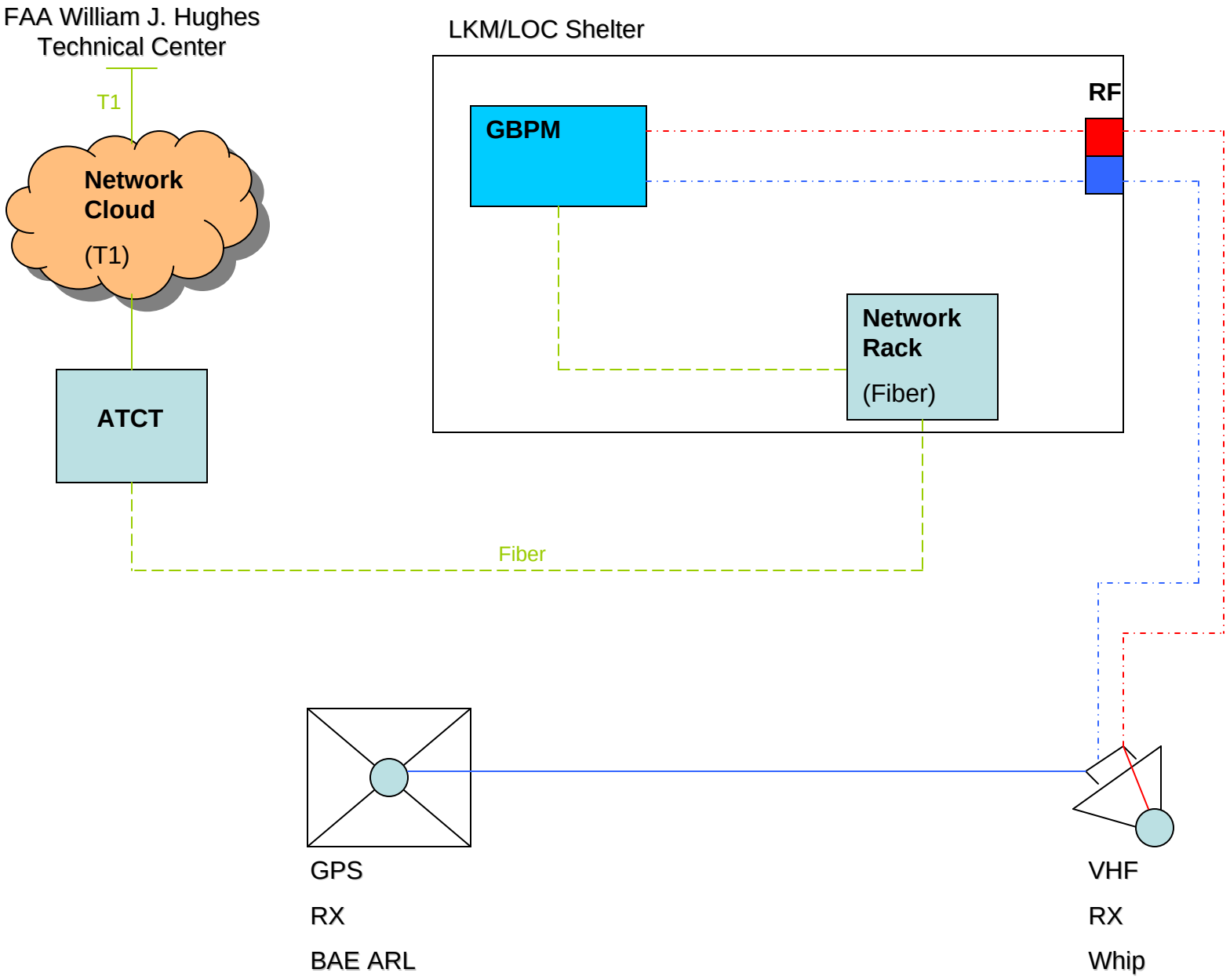
Location

LKM/LOC Shelter, IAH
[29 57' 37.50" N, 95 20' 45.95" W]


FAA William J. Hughes
Technical Center
T1
Network
Cloud
(T1)
ATCT
LKM/LOC Shelter
GBPM
RF
Network
Rack
(Fiber)
Fiber
GPS
RX
BAE ARL
VHF
RX
Whip

IAH Technical Instruction Manual

For LAAS/GBAS Ground Based Performance Monitor

(GBPM)

July 8, 2011

Department of Transportation
Federal Aviation Administration

Table of Contents

1.0 INTRODUCTION

This package was developed to document the physical installation and structural layout of the Houston Intercontinental Airport LAAS/GBAS Ground Based Performance Monitor (GBPM). The documentation includes a complete hardware component list as well as full wiring schematics that include rack dimensions, power distribution, GPS and network shelf configuration, installation layout, and the T1 network configuration installed for the Houston Intercontinental Airport remote site.

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 is used to identify miniscule positioning errors.

It should be noted here that the GBPM currently resides in the IAH LKM/LOC Shelter.

Appendix A includes images of the GBPM in its present field configuration. Please refer to Appendix A for visual stimulus as necessary.

Appendix B documents the Installation Control Drawing for the ARL1900 BAE GPS Ground Reference Antenna.

Appendix C includes hardware tolerances for the BRM4 Antenna Ballast Mount.

Appendix D includes mast specifications and ballast requirements for the BRM4 Antenna Ballast Mount.

2.0 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 LAAS 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.

3.0 Boot-up Procedure

Turn the UPS Power Supply to the **on** state by pressing the power button located the front of the unit, which is facing the rear side of the GBPM.

Turn the Un-UPSed Power Strip to the **on** state by pressing the power switch located on the front of the unit, which is facing the front side of the GBPM.

Flip the KVM into position and power on; utilize Console 6 (**ctrl** + **alt** + **6**) for this will allow the user to access the display.

In order to change the working directory to that of the LAAS code scheme, type **cd Cat3gbpm** into the command prompt.

In order to begin, type **./go** or **go** into the command prompt.

The user will be prompted to ascertain if the individual is ready to begin, type **Y** or **y** to approve.

The user will be prompted to select a site from a list, in this case; select **?** for IAH.

4.0 On-site Data Collection

It is important to note that these instructions are based upon the idea that the user is on-site at Houston Intercontinental Airport, the appropriate portable media device is utilized for local data collection, and that the GBPM is powered on and collecting data.

The IP address for the IAH portable media device is: 192.168.5.?
The working directory of the IAH portable media device is labeled as: Share1
Should this device be unavailable, any portable media will complete the task as needed.

Flip the KVM into position and power on; utilize Console 6 (**ctrl** + **alt** + **6**) for local data collection.

Using standard RJ-45, plug the IAH portable media device into the 8-port network switch located on the Network Shelf of the GBPM.

Using the KVM, create a local network and ftp to 192.168.5.? in order to access and create a share to the IAH portable media device.

(If a different portable media device is being used, ftp to the appropriate IP address.)

Log into the device by typing **Login** in the command prompt and then enter the username and password of the IAH portable media device as instructed. It is important to note that this information is located on the device for convenience only.

In order to change the working directory to that of the portable media device, type **cd Share1** into the command prompt.

In order to enable binary data transfer mode, type **binary** into the command prompt.

In order to turn interactive mode to the off state, type **prompt** into the command prompt.

In order to access the correct sub-directory and initialize data transfer, type **lcd /temp7** into the command prompt.

In order to start data transfer, type **mput ./1119*** into the command prompt and await completion.

Once all data has been collected and stored onto the portable media device, type **quit** into the command prompt in order to terminate the data collection process.

Disconnect the IAH portable media device, power down the KVM, and flip back into the GBPM if needed.

5.0 Remote Data Collection

It is important to note that these instructions are based upon the idea that the user is off-site and that the GBPM is powered on and collecting data.

The IP address for the IAH QNX Central Processing Unit is: 192.168.5.?

Flip the KVM into position and power on (or activate auxiliary computer console); utilize Console 6 (**ctrl** + **alt** + **6**) for remote data retrieval.

The user will be prompted to select a remote site from a list, in this case; select IAH.

At any time, type **cd temp7** into the command prompt in order to view the data attributed to the selected remote site, in this case; IAH.

In order to telnet and access data from the IAH remote site, type **telnet 192.168.5.?** into the command prompt.

Log into the IAH remote site by typing **Login** in the command prompt and then enter the username and password of the GBPM as instructed.

Use *ditto* to access the desktop of the IAH remote site by typing **ditto –k –q /dev/con6** into the command prompt.

Once all data has been collected and stored, hold **ctrl** and type **e** into the command prompt in order to terminate the remote data retrieval process.

In order to exit telnet and return to the local desktop, hold **ctrl** and type **d** into the command prompt.

6.0 Pulling Data from the IAH Hard Drive

It is important to note that these instructions are based upon the idea that the user is off-site and the appropriate hard drive is utilized for pulling the data.

The IP address for the IAH hard drive is: 192.168.1.?
The working directory of the IAH hard drive is labeled as: Share1
The IAH hard drive is located in the LAAS Laboratory in Building 301 of the William J. Hughes Technical Center.

Using standard RJ-45 or other media type (i.e. serial link), plug the IAH hard drive (containing data) into the individual computer console that the user wishes to transfer and store the data.

(The process of pulling data from the IAH hard drive is *not* OS specific; translate this instruction set as needed per OS.)

Using the computer console, create a local network and ftp to **192.168.1.?** (or other) in order to access and create a share to the IAH hard drive.

Log into the device by typing **Login** in the command prompt and then enter the username and password of the IAH hard drive as instructed. It is important to note that this information is located on the device for convenience only.

In order to change the working directory to that of the IAH hard drive, type **cd sls** into the command prompt.

In order to enable binary data transfer mode, type **binary** into the command prompt.

In order to turn interactive mode to the off state, type **prompt** into the command prompt.

In order to access the correct sub-directory and initialize data transfer, type **lcd /Desk*** into the command prompt.

In order to start data transfer, type **mget ./1031*.acr** into the command prompt and await completion.
Once all data has been collected and stored onto the computer console, type **quit** into the command prompt in order to terminate the data collection process.

Disconnect the IAH hard drive and utilize the now collected data as needed.

7.0 Loading Software to the GBPM

It is important to note that these instructions are based upon the idea that the user is on-site at Houston Intercontinental Airport and that the GBPM is powered on and collecting data.

There exists a two line script used to auto start the LAAS code scheme during CPU boot-up, the script is documented below:

```
cd /Cat3gbpm
/Cat3gbpm/go</dev/con6>/dev/con6&
```

This two line script will run the current software on the Ground Based Performance Monitor.

There are three sub-directories that software is to be maintained, they are listed below:

temp7	Includes running and archived data
Cat3gbpm	Includes currently running software
GBPMzip	A directory used to zip all versions of utilized software

There are three sub-directories that handle applicable file transfer, they are listed below:

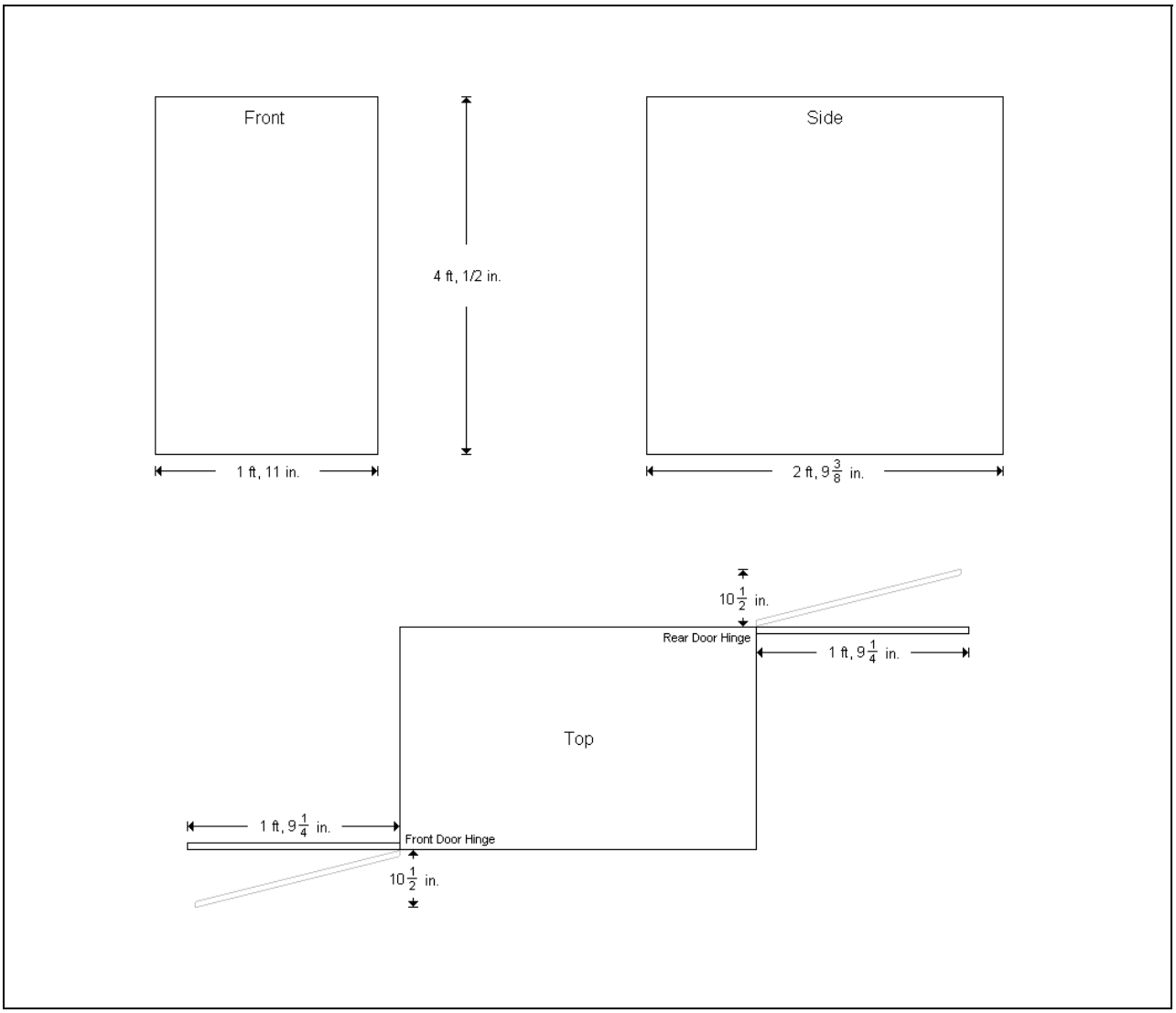
WebOutput	Includes files that will be input for the website display
datazip	Includes files that are zipped from the ftp data transfer
dataFTP	Includes files that are currently being transferred

Should additional software need to be installed, see the above sub-directories as needed.

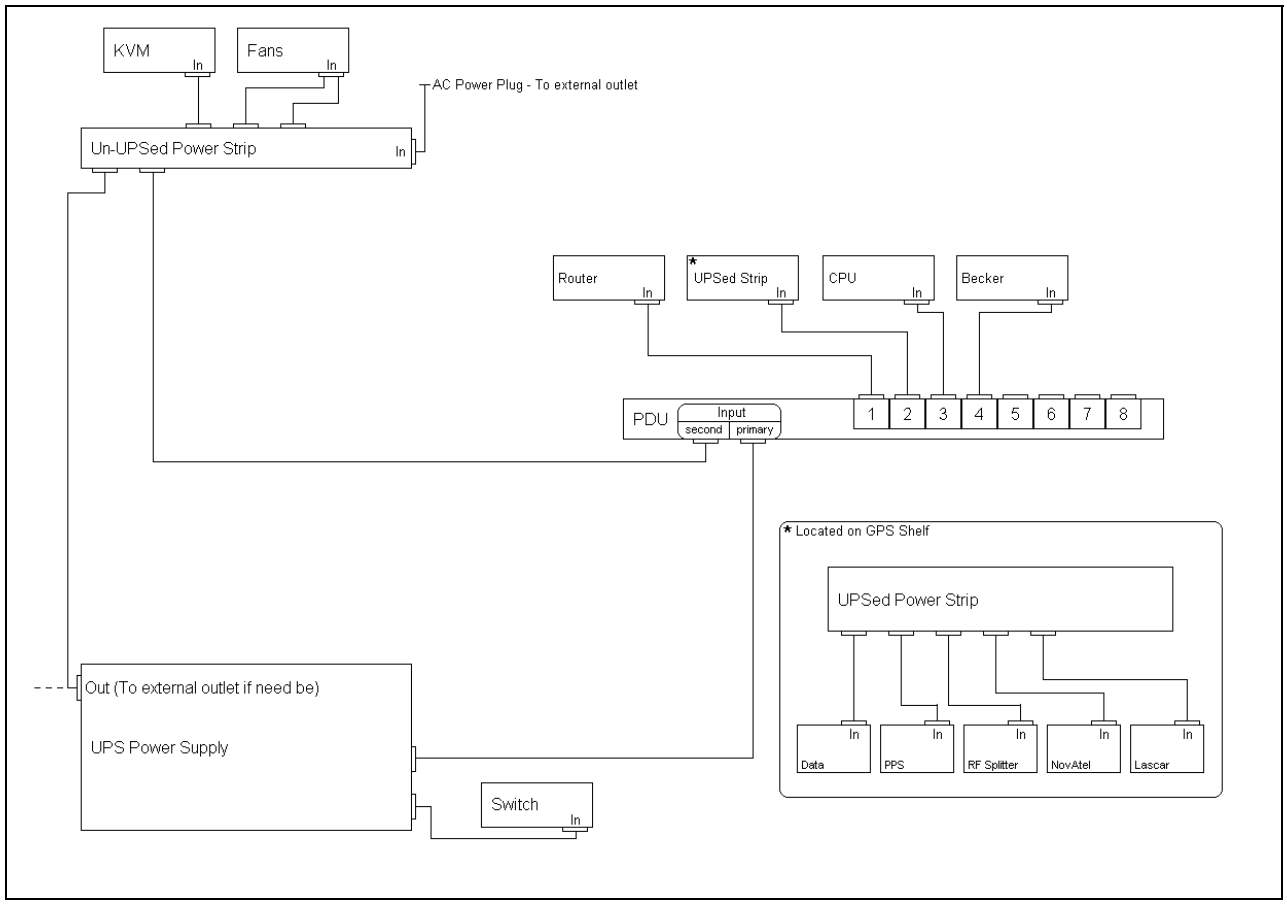
8.0 Materials/Component List

Description	Specifications	Model / Part Number
Sunon Impedance Protected Exterior Mounted Fans (x2)	115 V ~ 50-60 HZ 0.21 / 0.18 AMP	SP101A 1123HST.GN
KVM-P17-TP	100-240 V ~ 50-60 HZ 1.1 AMP	S919691008151- 0609N002
CISCO Systems 2811 Series Integrated Service Router		SNFTX1028A518
CISCO WIC Interface / Network Card (x4)		WIC-1DSU-T1-V2
Optimux-106 Fiber Multiplexer	4 E1/T1/Serial 10/100BaseTx	Optimux-106
Citel POE Surge Protector		MJ8-POE-A
Network Enabled Power Distribution Unit	120 V ~ 60 HZ 15 AMP	PDUMH15ATNET
TrippLite 12 Outlet un-UPS Power Strip	120 V 15 AMP	RS-1215-RA AGIP120V61PRM
Becker VDB Receiver RS 4909 A	114.525 MHz	(8004) 0602970000968711
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)	114.525 MHz Cut to 24 + 4/32”	B66
Super Logics QNX Central Processing Unit		5L-2U-AT-945GC2-BA
AccelePort 8r 920-PCI DB25 Card/Cable		(1P) 70001362
APC Smart UPS	120 V ~ 50-60 Hz 12 AMP	1500 1440VA 980W
Lascar Adjustable Power Supply	1.5-30 V 1.0 AMP	PSU 130
NovAtel GPS Receiver / WAAS	DL-4	41017296
GPS Networking Incorporated T-Splitter		LDCB51X2
Mini-Circuits Bias-Tee RF-Splitter	10-4200 MHz	ZFBT-4R2G RF091500429
QVS Surge Protected Power Strip		No requirement
Data RS232-RS485 Converter	2000 V Isolated	IC-485SI
PPS RS232-RS485 Converter	2000 V Isolated	IC-485SI
3COM Office Connect Dual Speed 16 Plus Network Switch		No requirement
1U 12“ Vented Component Shelf		1906-3-221-01
3U 12” Vented Component Shelf		1906-3-221-03
PCtel GPS Antenna, DC Block, Passive Splitter	As configured on: 06/30/2011	No requirement
BAE GPS Antenna, L1/L2 Filter, Pre-Amp	As configured on: 06/30/2011	No requirement
Ballast Roof Mount Installation Package	See Attachment 1	See Attachment 1

9.0 Rack Dimensions/Scope



10.0 Schematic for Power Distribution



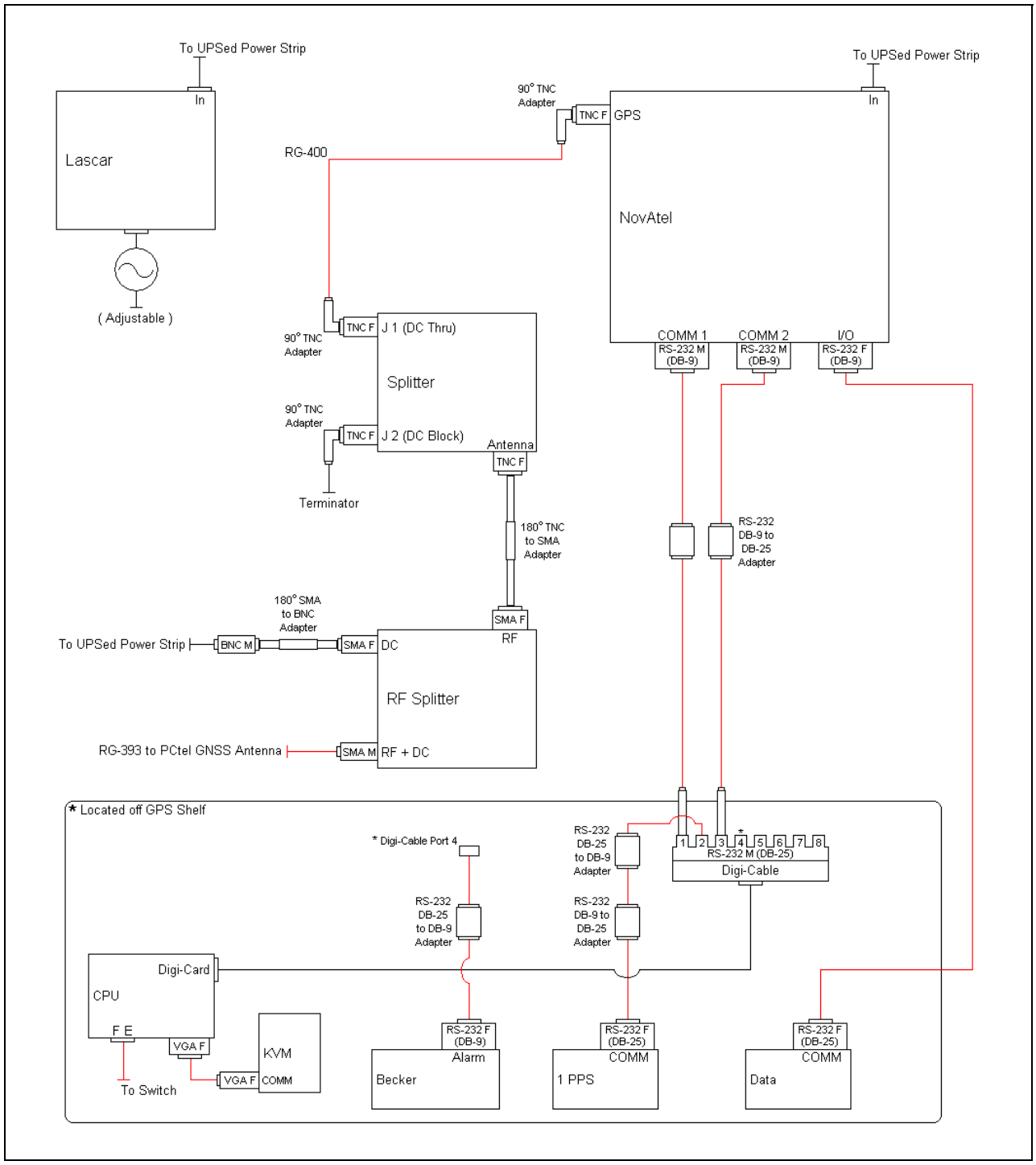
It is important to note that the term “PDU” refers to the network enabled power distribution unit located within the GBPM.

It is also important to note that Ports 5 through 8 on the PDU are currently deactivated and can not be utilized for the existing configuration.

All power distribution wiring consists of standard HP power cables provided with the shipment packages as described in the Materials/Component List.

On occasion, several power cables were modified in terms of length in order to reduce the clutter within the GBPM itself, however; this is not a requirement.

11.0 Schematic for GPS Shelf



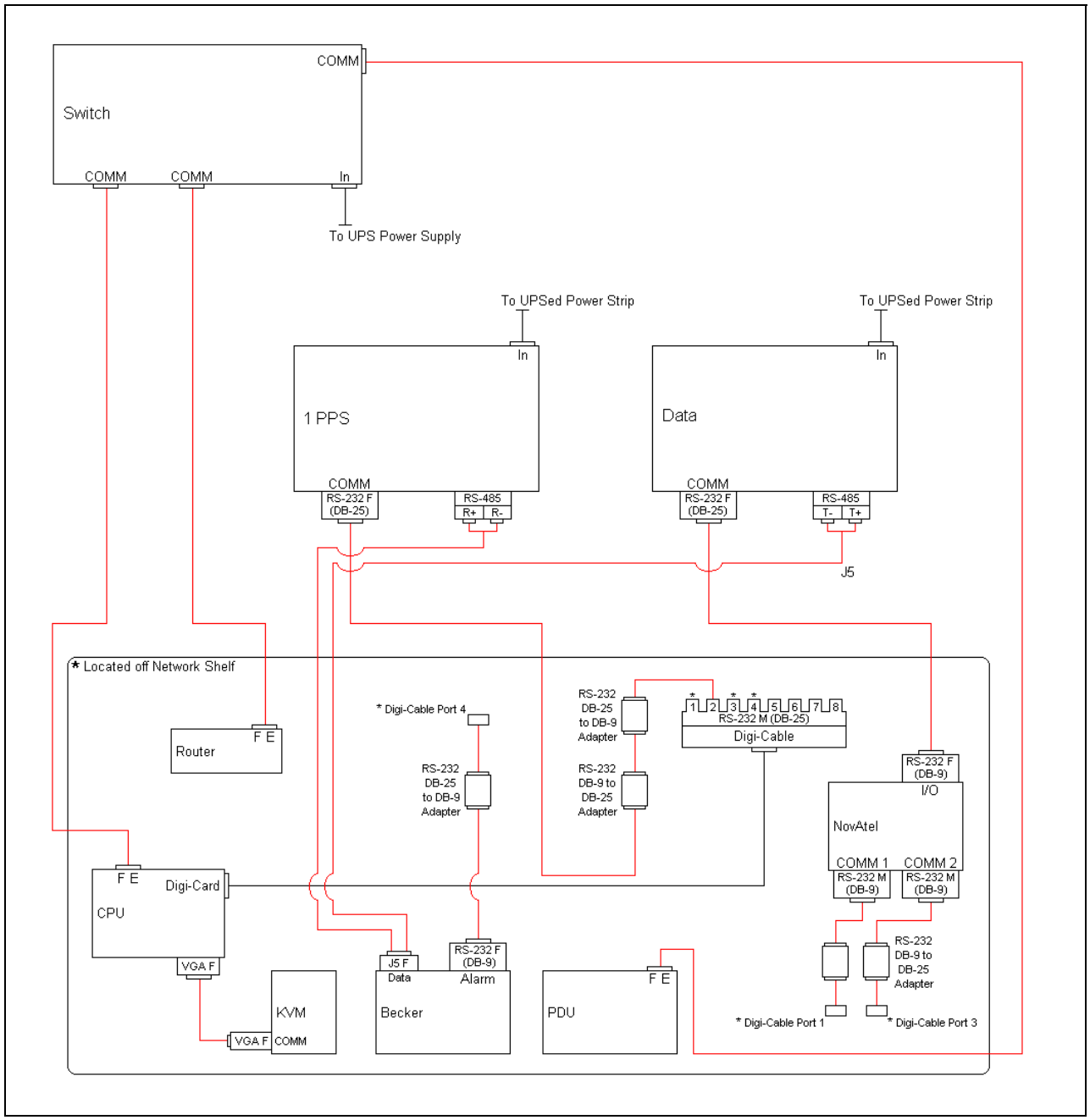
It is important to note that the Digi-Cable is an 8 port DB-25 concentrator serial cable.

It is also important to note that Ports 5 through 8 on the Digi-Cable are currently not in use and will not be utilized for the existing configuration.

For a comprehensive description of the Digi-Cable, please refer to the datasheet as provided here: http://ftp1.digi.com/support/documentation/90000253_E.pdf.

The Lascar Adjustable Power Supply is currently not in use, however; it may be utilized in the future should trouble shooting be necessary.

12.0 Schematic for Network Shelf

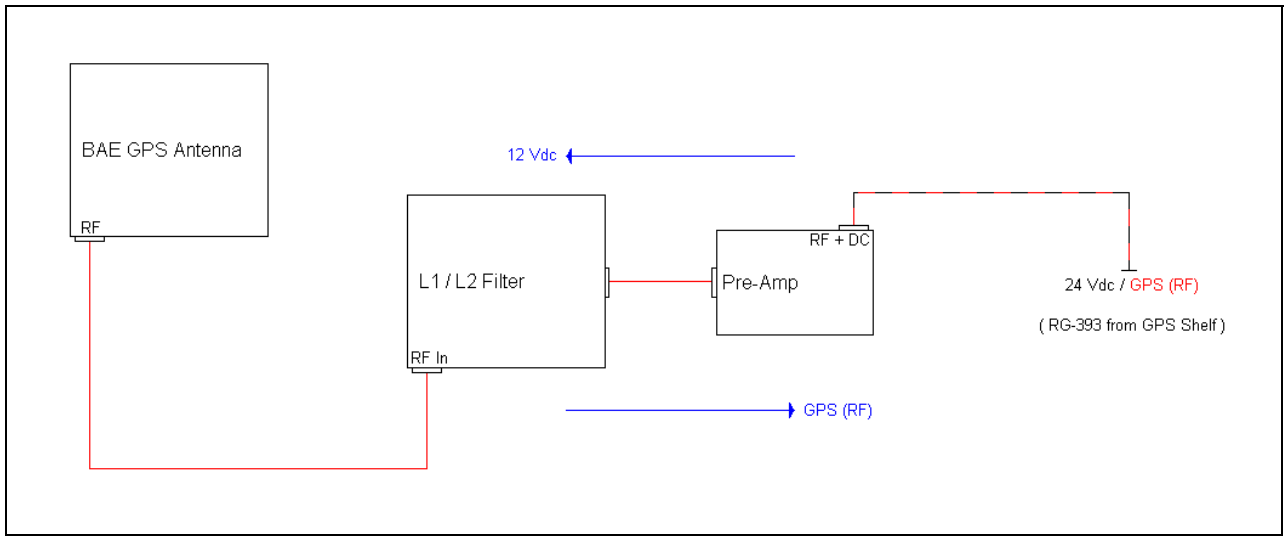


It is important to note that the Digi-Cable is an 8 port DB-25 concentrator serial cable.

It is also important to note that Ports 5 through 8 on the Digi-Cable are currently not in use and will not be utilized for the existing configuration.

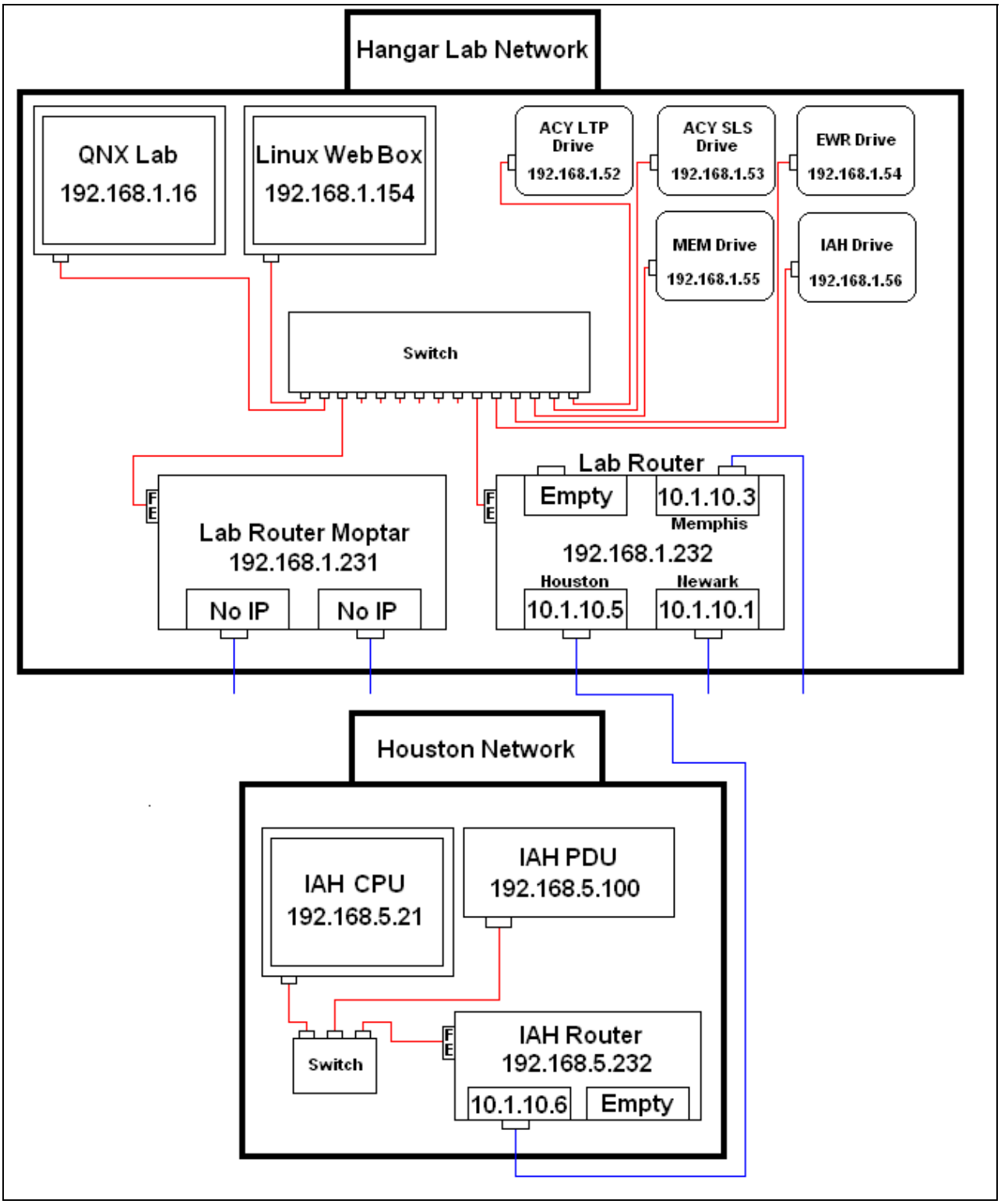
For a comprehensive description of the Digi-Cable, please refer to the datasheet as provided here: http://ftp1.digi.com/support/documentation/90000253_E.pdf

13.0 BAE GPS Antenna Specifics including Feed Configuration Roof-side



It is important to note that the BAE GPS Antenna is currently an option for future usage.

14.0 ACY (LAAS Lab, bldg. 301) to IAH GBPM Network Configuration

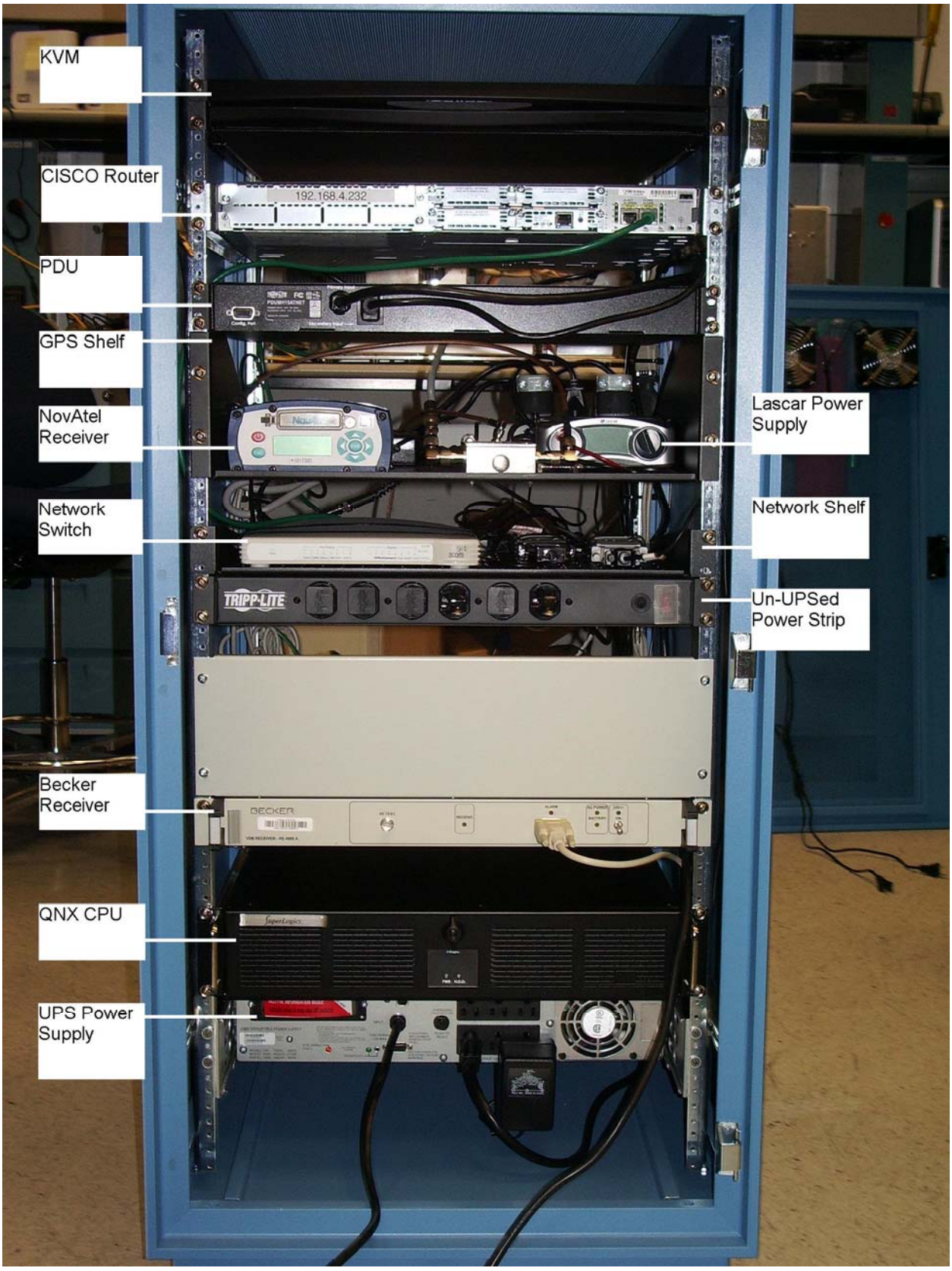


The network scheme as documented above illustrates the existing configuration for the LAAS Lab, Building 301 of the WJHTC, and may be subject to change.

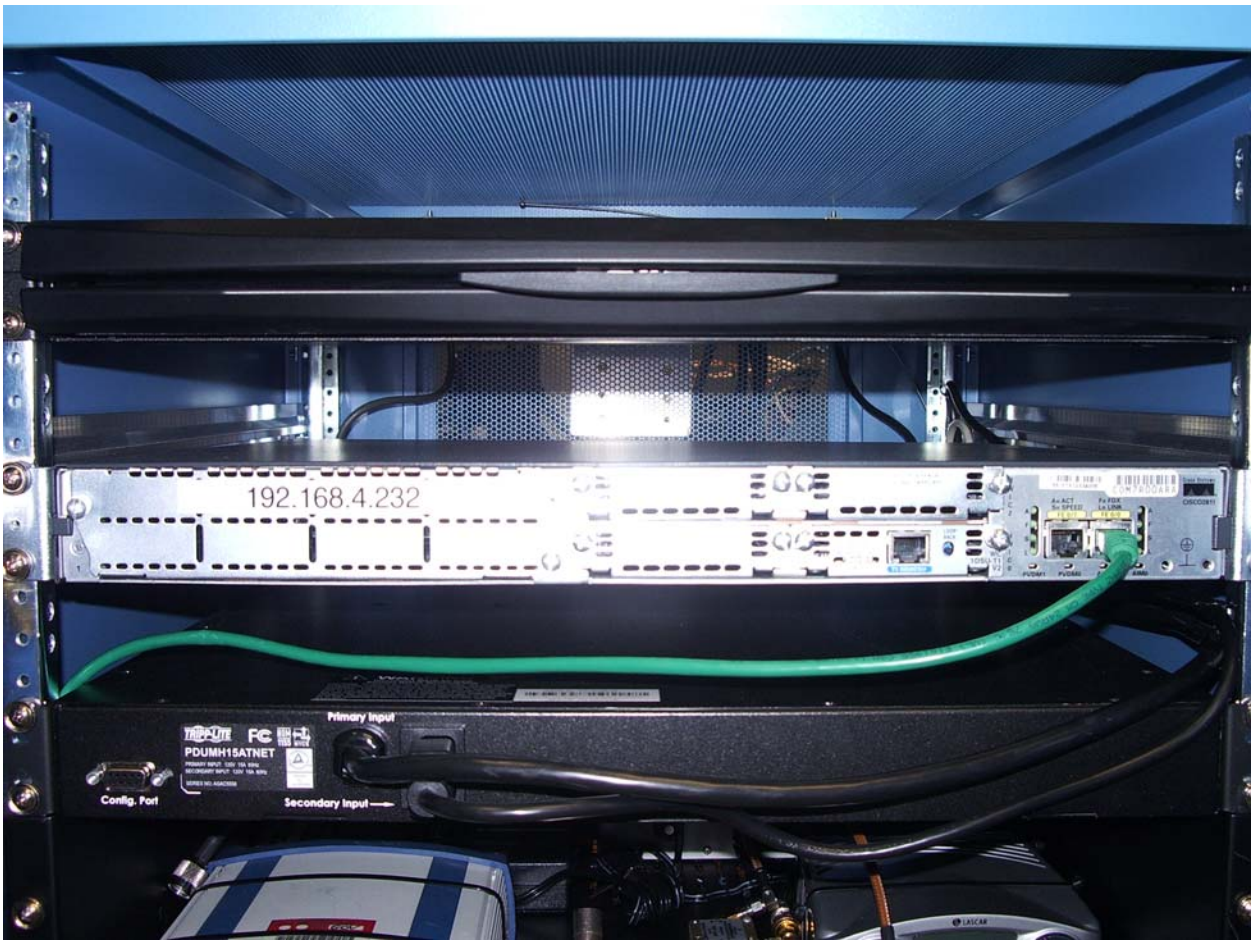
Appendix A:

Image Set: GBPM in Present Field Configuration

Rack Exterior (Front: Fire Extinguisher Door, Rear: Fire Sensor Door)

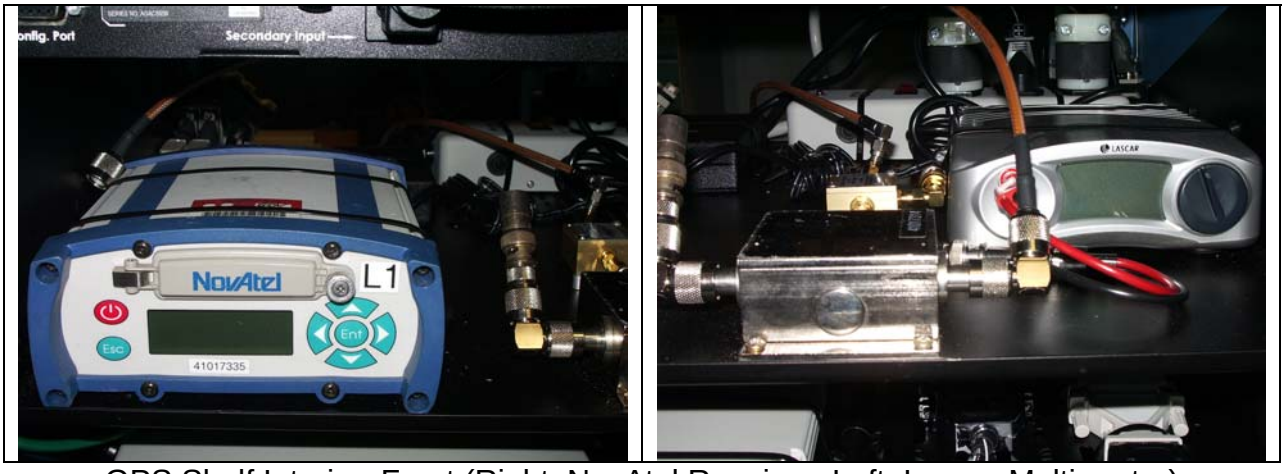


Rack Interior, Front (Full System View)



Rack Interior, Front (Top to Bottom: KVM, CISCO Router, PDU)

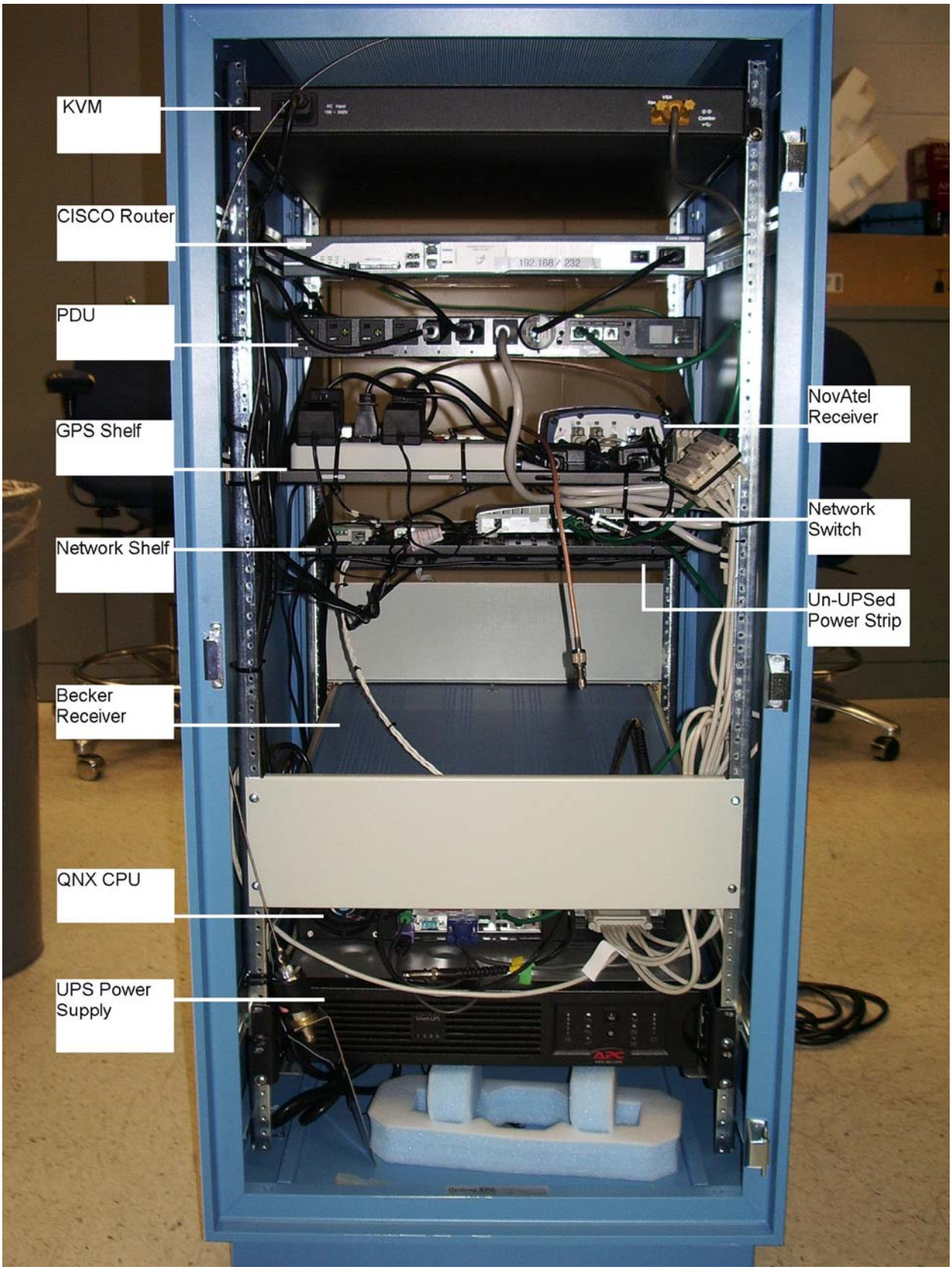
Rack Interior, Front (Top to Bottom: GPS Shelf, Network Shelf, Un-UPSed Power Strip)



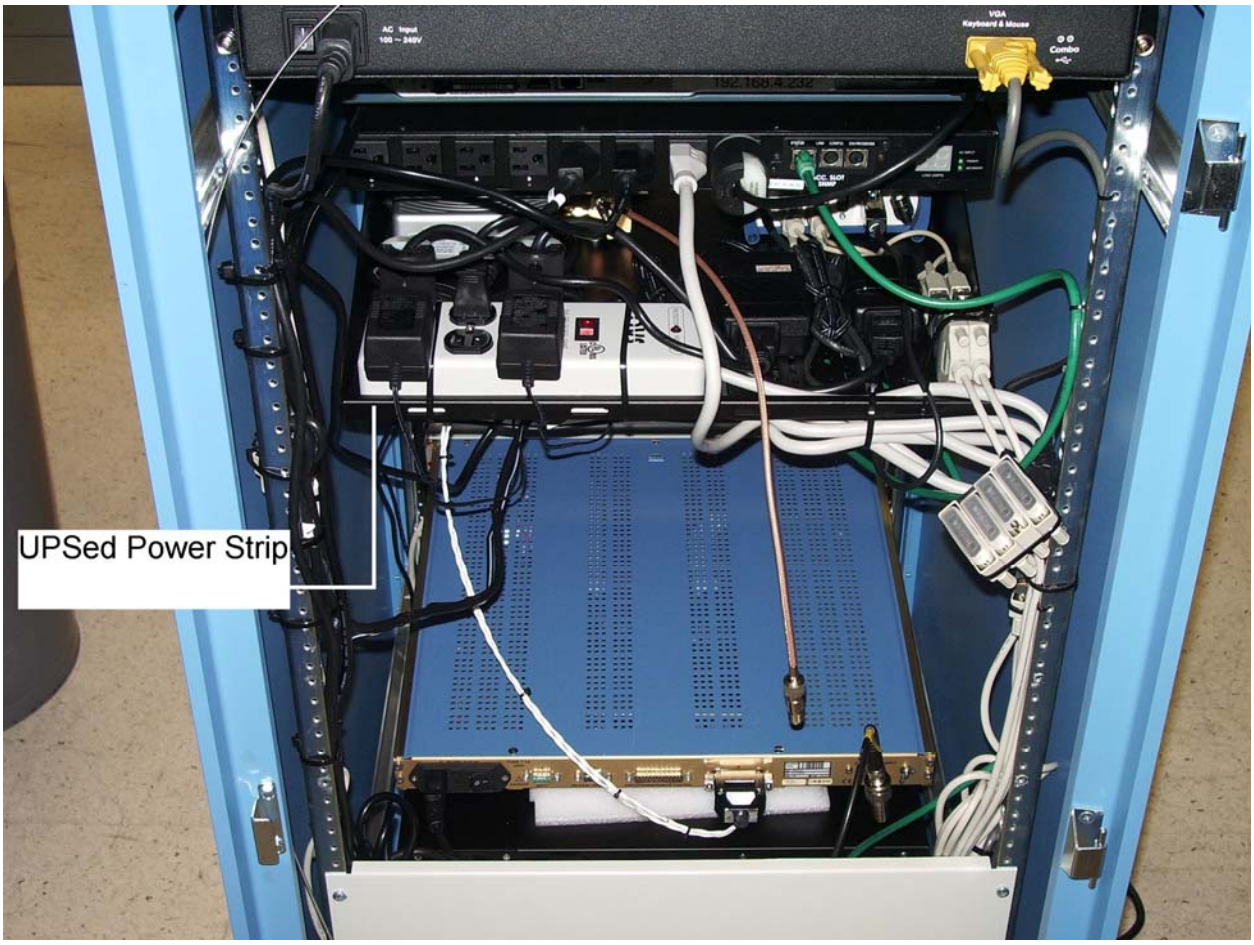
GPS Shelf Interior, Front (Right: NovAtel Receiver, Left: Lascar Multi-meter)

Rack Interior, Front (Top to Bottom: Face Plate, Becker Receiver)

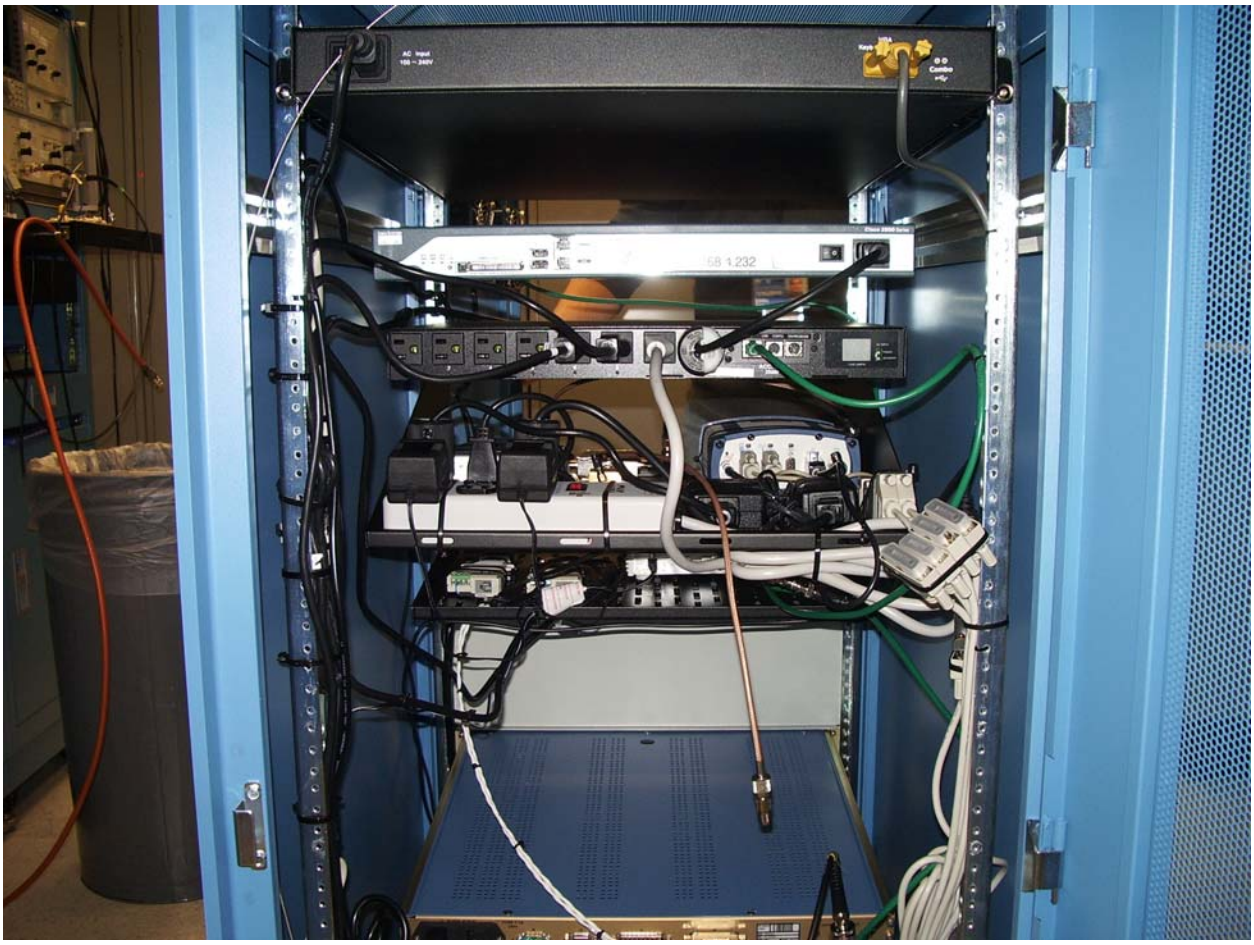
Rack Interior, Front (Top to Bottom: CPU, UPS Power Supply)



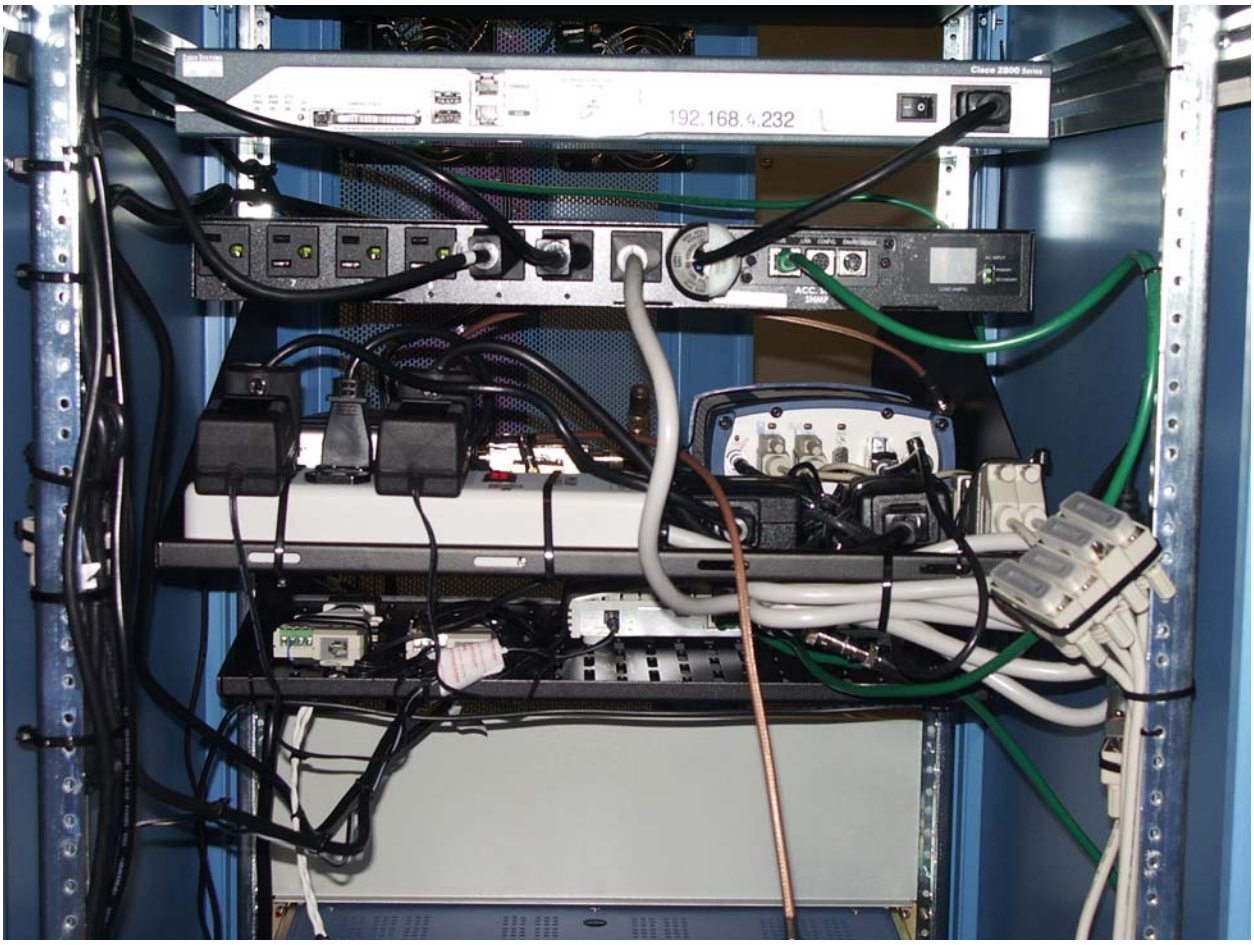
Rack Interior, Rear (Full System View)



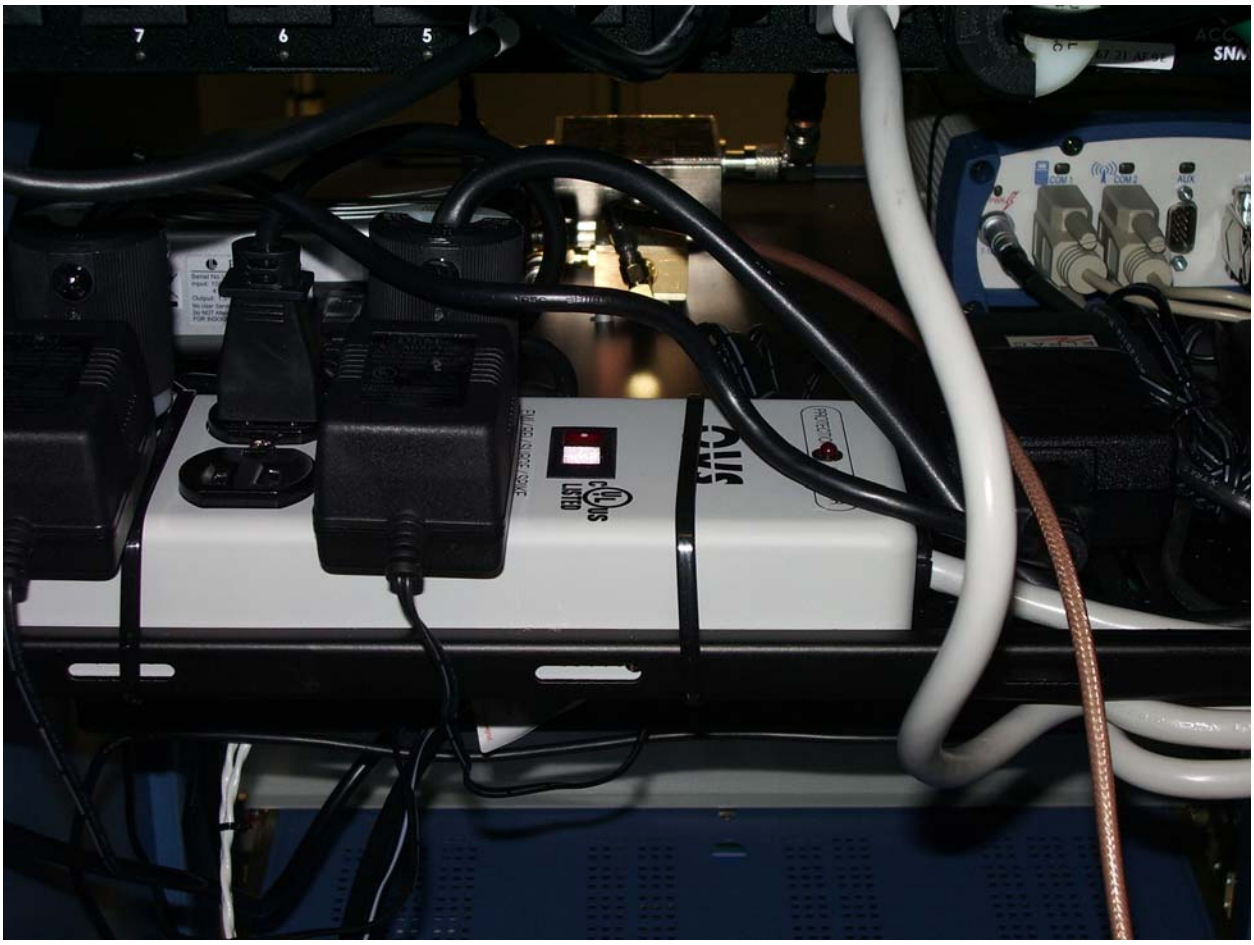
Rack Interior, Rear (Full System Pier-In View)



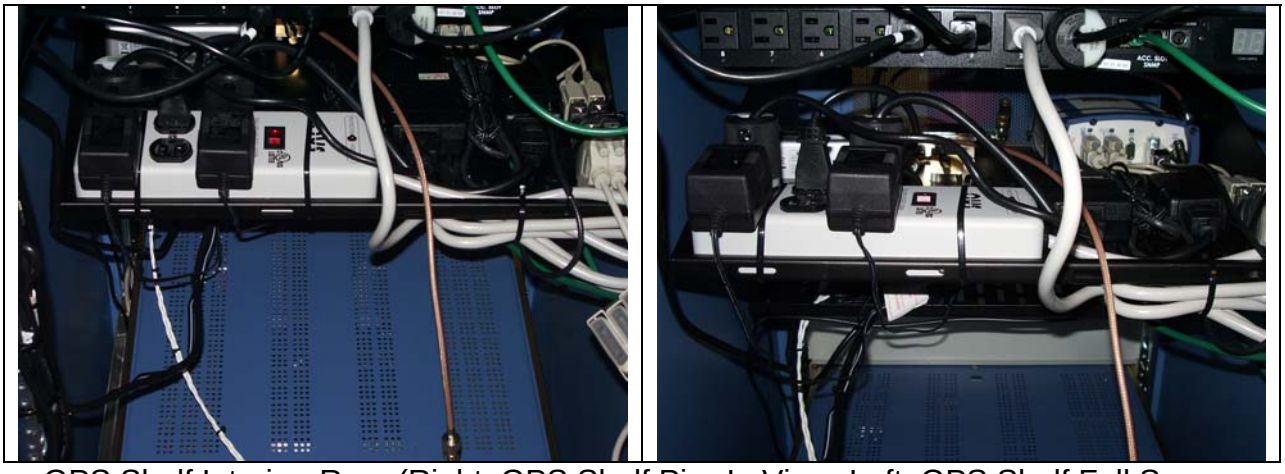
Rack Interior, Rear (Top to Bottom: KVM, CISCO Router, PDU, GPS Shelf, Network Shelf, Becker Receiver)



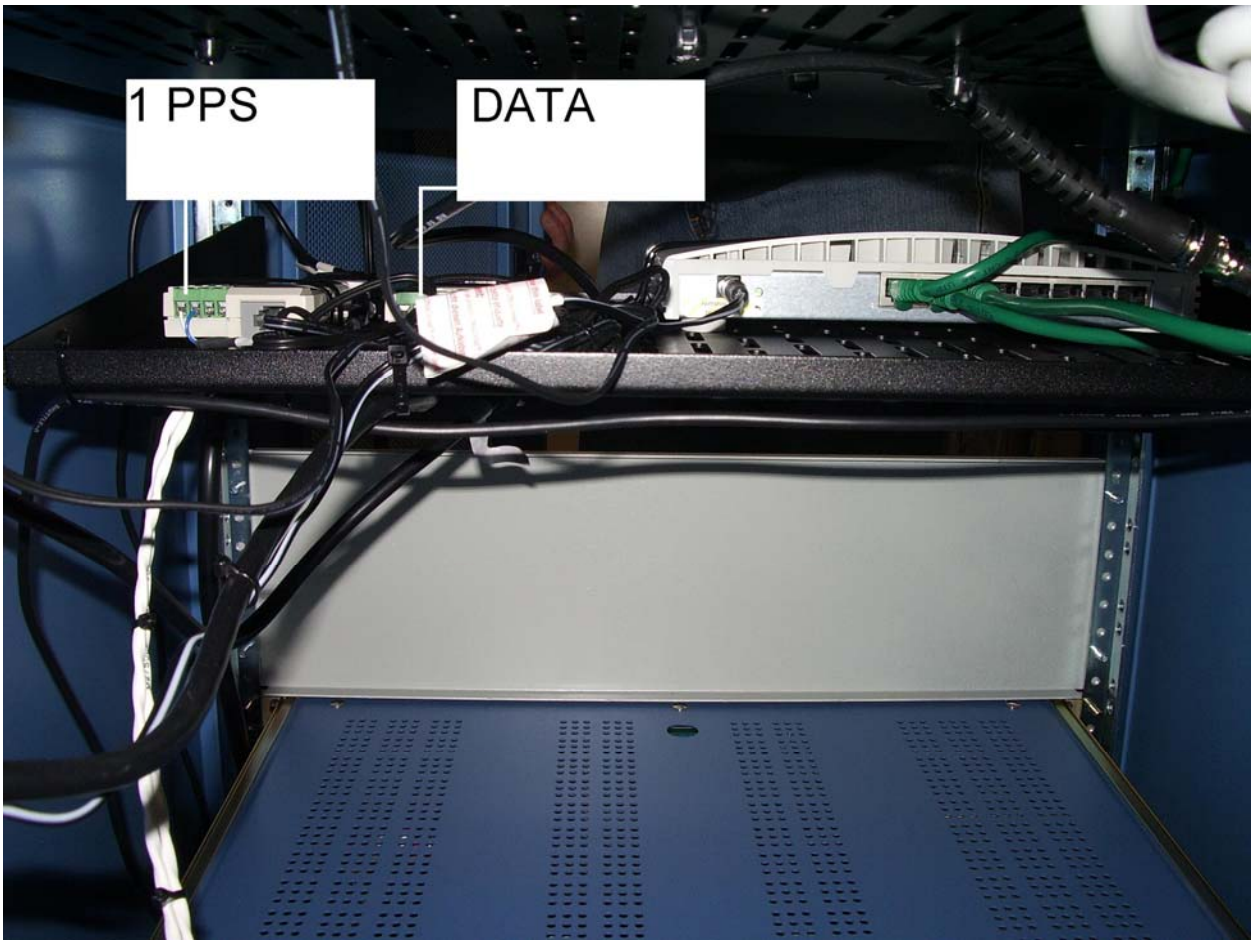
Rack Interior, Rear (Detail View, Top to Bottom: CISCO Router, PDU, GPS Shelf, Network Shelf, Becker Receiver)



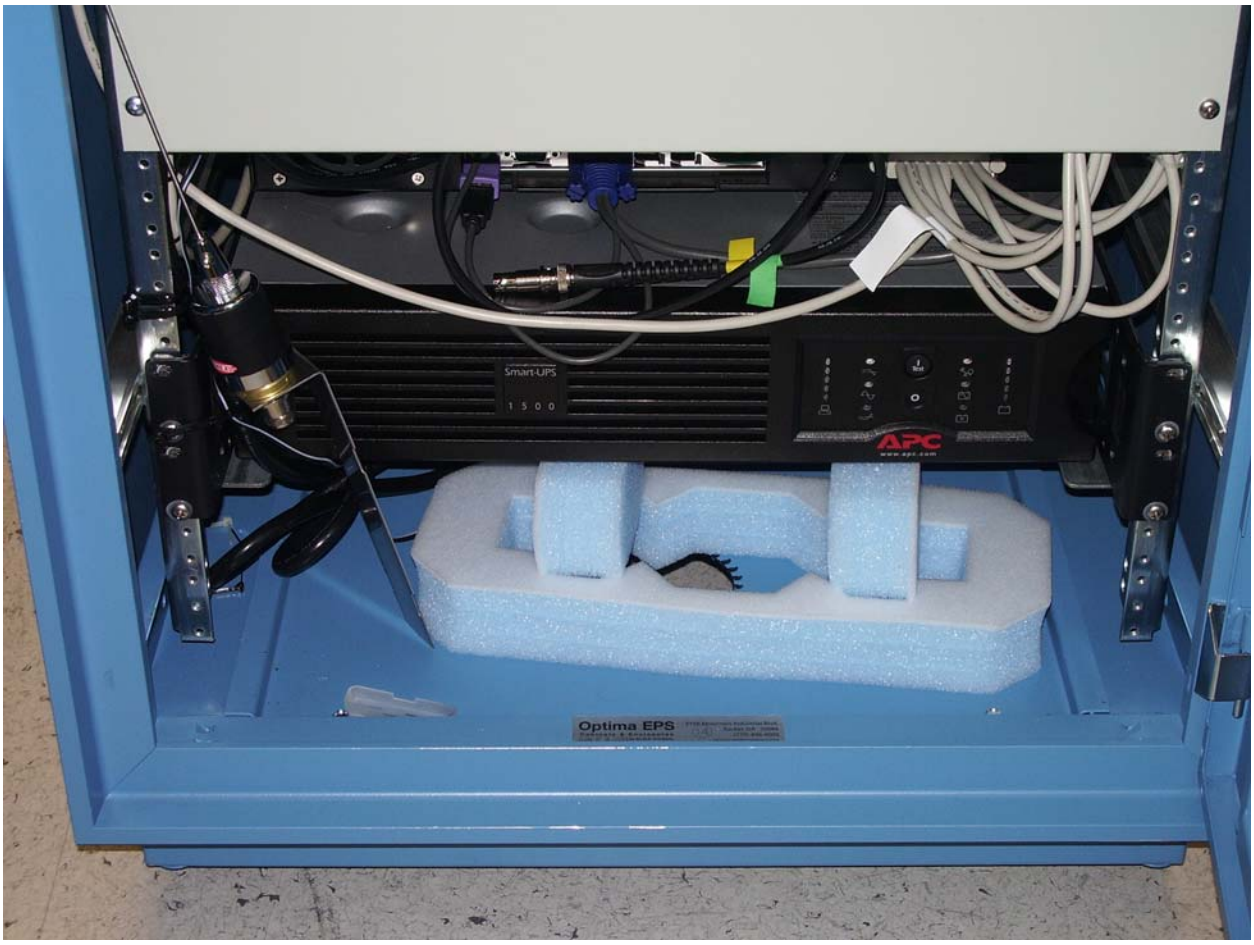
Rack Interior, Rear (Detail View: GPS Shelf)



GPS Shelf Interior, Rear (Right: GPS Shelf Pier-In View, Left: GPS Shelf Full Screen View)



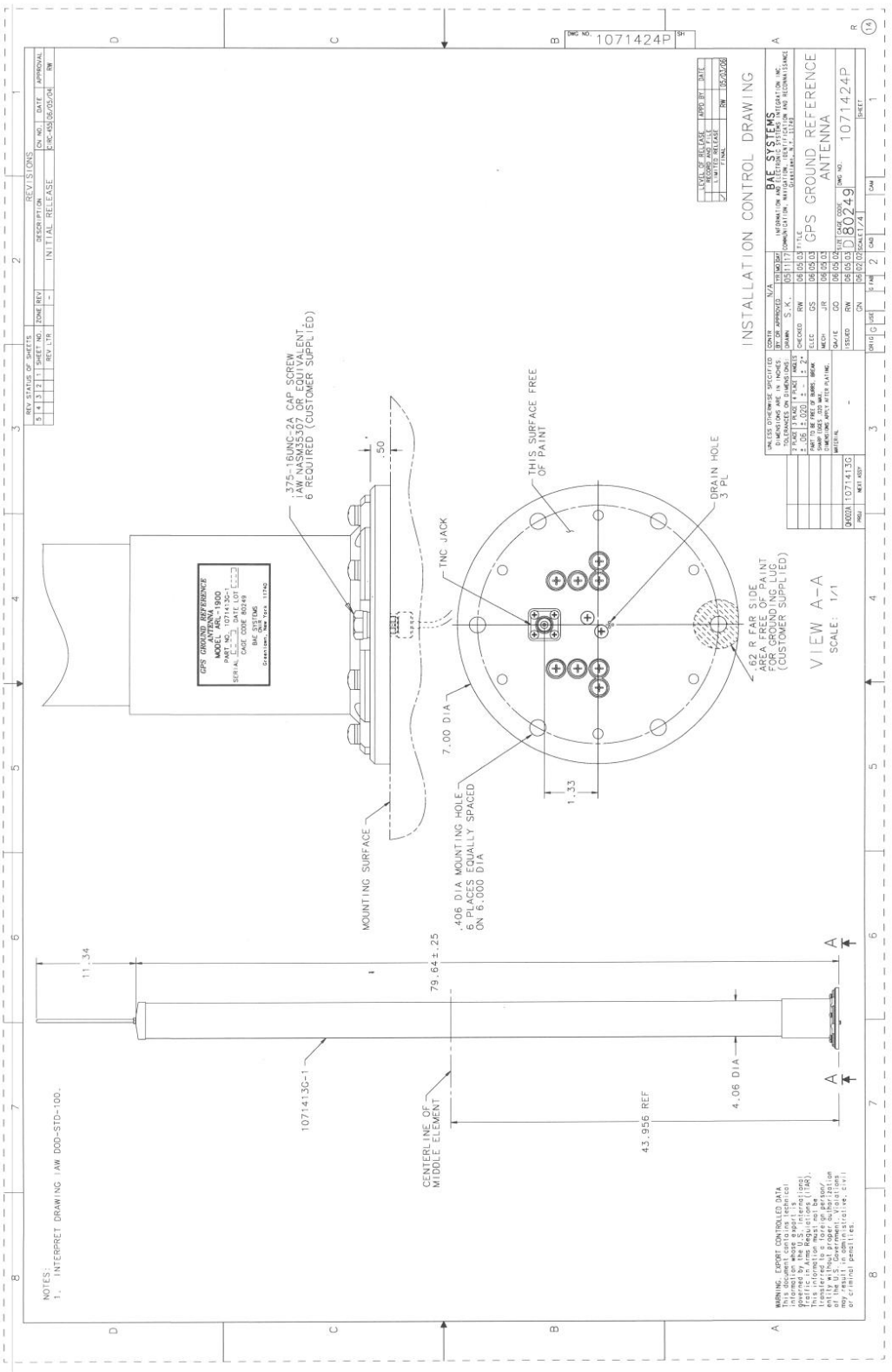
Rack Interior, Rear (Detail View: Network Shelf)



Rack Interior, Rear (Detail View: UPS Power Supply)

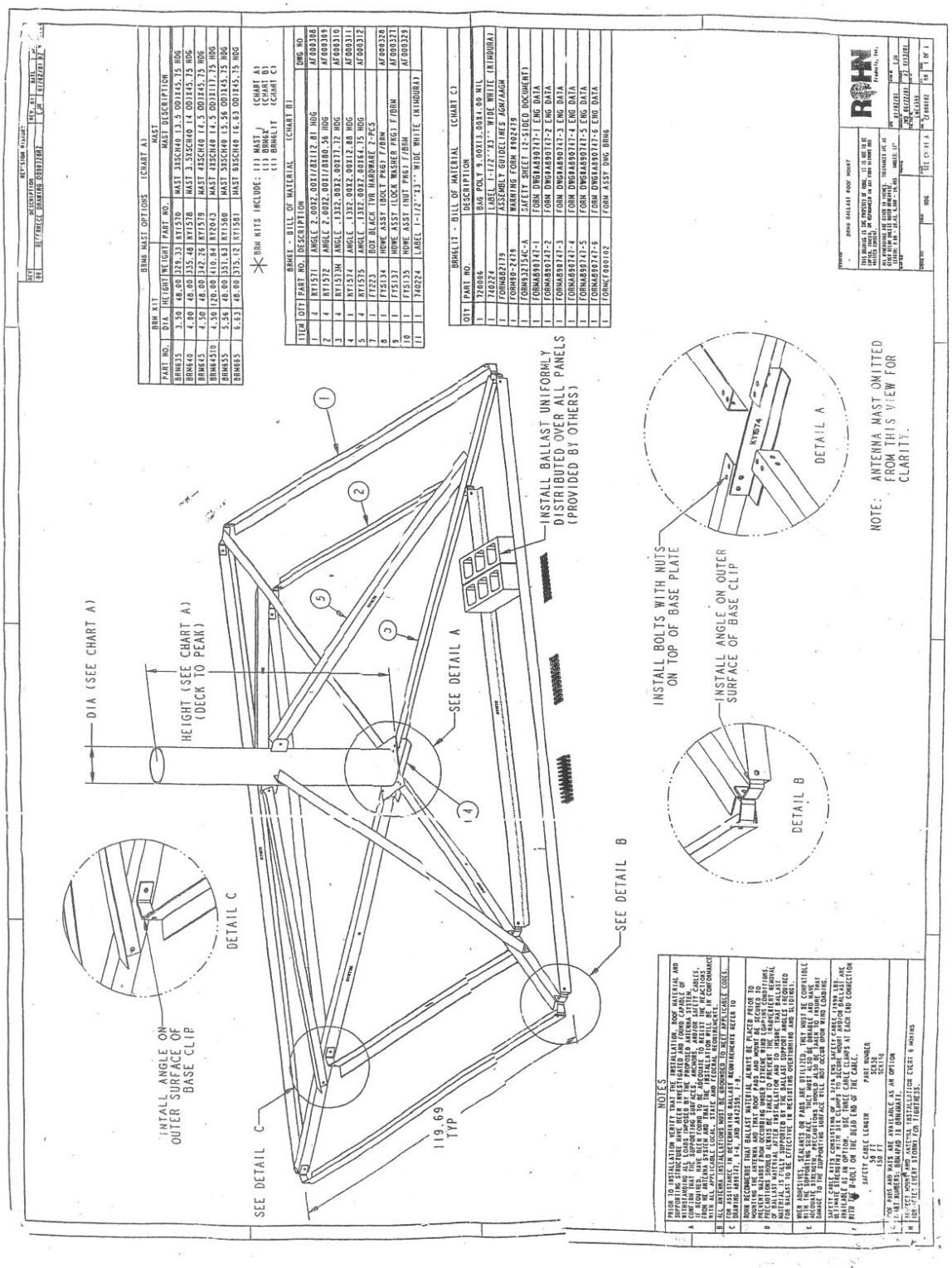
Appendix B:

ARL1900 BAE GPS Ground Reference Antenna Installation Control Drawing


INSTALLATION CONTROL DRAWING
GPS GROUND REFERENCE ANTENNA
BAE SYSTEMS
1071424P
.375-16UNC-2A CAP SCREW IAW NAS3503 OR EQUIVALENT 6 REQUIRED (CUSTOMER SUPPLIED)
.50
THIS SURFACE FREE OF PAINT
TNC JACK
DRAIN HOLE 3 PL
62 R FAR SIDE AREA FREE OF PAINT FOR GROUNDING LUG (CUSTOMER SUPPLIED)
VIEW A-A
SCALE: 1/1
7.00 DIA
1.33
MOUNTING SURFACE
.406 DIA MOUNTING HOLE 6 PLACES EQUALLY SPACED ON 6.000 DIA
11.34
79.64±.25
1071413G-1
CENTERLINE OF MIDDLE ELEMENT
43.956 REF
4.06 DIA
NOTES:
1. INTERPRET DRAWING IAW DOD-STD-100.
WARNING: EXPORT CONTROLLED DATA

Appendix C:

Data Sheet for BRM4 Antenna Ballast Mount w/ Hardware Specifications


DIA (SEE CHART A)
HEIGHT (SEE CHART A) (DECK TO PEAK)
INSTALL BALLAST UNIFORMLY DISTRIBUTED OVER ALL PANELS (PROVIDED BY OTHERS)
SEE DETAIL A
SEE DETAIL B
SEE DETAIL C
INSTALL ANGLE ON OUTER SURFACE OF BASE CLIP
INSTALL BOLTS WITH NUTS ON TOP OF BASE PLATE
INSTALL ANGLE ON OUTER SURFACE OF BASE CLIP
DETAIL A
DETAIL B
DETAIL C
119.69 TYP
NOTE: ANTENNA MAST OMITTED FROM THIS VIEW FOR CLARITY.
NOTES

ROHN

Installation Helpful Hints

For

AGMA, AAGM, AGM6, BRM4, and BRM6 Models

For ease of assembly, please follow these suggested guidelines

AGMA

1. Assemble base braces and support mast first. Do not tighten; leave all bolt connections loose.
2. Assemble knee braces.
3. Place base pans in place and assemble with base clips.
4. Tighten all nuts and bolts, starting with support mast connections first.
5. Install safety wires and grounding as required.

AAGM, AGM6, BRM4 and BRM6

1. Assemble base braces and support mast first. Do not tighten; leave all bolt connections loose.
2. Assemble knee braces.
3. Place outer angle supports in place and assemble with base clips.
4. Place inner angle supports in place and assemble with base clips.
5. Tighten all nuts and bolts starting with support mast connections first.
6. Install safety wires and grounding as required.

 Form No. 88-2179R2

WARNING

Assembling dish antennas on windy days can be dangerous. Because of the projected area of the antenna, even slight winds create strong forces.

Do not attempt to assemble, move or mount a dish antenna on windy days or serious, even ***fatal,*** accidents can occur.

Improperly installed antenna mounts or antenna mounts mounted on inadequate structures are very susceptible to wind damage. This damage can be very serious and can result in ***property damage, loss of service, personal injury and even death.*** ROHN assumes no responsibility to assure the installation is structurally sound to support all loads, and properly sealed against leaks.

ROHN
P.O. Box 2000
Peoria, Illinois 61656

Form No. 90-2479

BRM6 BALLAST REQUIREMENTS TABLE

ANTENNA DIAMETER	BALLAST (POUNDS)	ZERO VELOCITY LOAD (PSF)	DESIGN WIND VELOCITIES COEFFICIENT OF FRICTION = .50					
			EL = 0°		EL = 20°		EL = 40°	
			Vmax	Vs	Vmax	Vs	Vmax	Vs
4 FT (1.2m)	500	5.0	87	67	103	75	112	92
	750	7.5	107	82	131	92	142	113
	1000	10.0	125	95	154	107	167	131
	1250	12.5	139	106	169	119	189	146
	1500	15.0	148	117	180	131	203	160
	1750	17.5	157	126	190	141	211	173
	2000	20.0	165	135	196	151	211	185
6 FT (1.8m)	500	5.0	58	45	65	50	69	61
	750	7.5	71	55	83	61	89	75
	1000	10.0	83	63	99	71	106	87
	1250	12.5	93	71	112	79	120	97
	1500	15.0	99	78	120	87	129	107
	1750	17.5	105	84	127	94	137	115
	2000	20.0	110	90	130	101	141	123
	2250	22.5	115	95	130	107	141	131
	2500	25.0	120	100	130	113	141	138
	2750	27.5	125	105	130	118	141	141
	3000	30.0	127	110	130	123	141	141
8 FT (2.4m)	750	7.5	53	41	57	46	60	56
	1000	10.0	62	47	69	53	73	65
	1250	12.5	69	53	79	59	84	73
	1500	15.0	74	58	85	65	90	80
	1750	17.5	78	63	91	70	96	86
	2000	20.0	82	67	97	75	102	92
	2250	22.5	86	71	98	80	103	98
	2500	25.0	90	75	98	84	103	103
	2750	27.5	94	79	98	88	103	103
	3000	30.0	95	82	98	92	103	103

NO.:	▲ REVISION DESCRIPTION	▲ DATE	▲ REV.BY	▲ CHKD.BY	▲ APPD.BY

DRAWN BY: CSR	DATE: 2-8-89	UNR-ROHN
CHECKED BY: MJW	DATE: 3/7/89	
APP'D. ENG: DGB	DATE: 3/7/89	BRM6 BALLAST REQUIREMENTS
APP'D SALES: PL	DATE: 3/7/89	
FILE NUMBER: 2433ORK		
DRAWING NUMBER: A890747-1 of 6		

NOTES FOR BRM6 BALLAST REQUIREMENTS

1. Ballast requirements are provided to assist consumers in determining the applicability of the BRM6 for an antenna installation. Refer to sheets 4, 5, and 6 for the criteria used to develop the ballast requirements table. The ballast data and development criteria should not be relied upon without competent local professional examination and verification of its accuracy and suitability for a specific site or application.

2. Ballast requirements are based on typical ANSI/EIA-222-D paraboloid antennas supported 12 inches from the vertex of the antenna on a 48 inch long mounting pipe on a flat supporting surface. The vertex of the antenna is assumed to be at the top of the mounting pipe. Specific antenna types and/or other mounting configurations may require more stringent strength and ballast requirements and must be investigated for each installation. The load carrying requirements of the supporting surface, the mast, the antenna and the antenna's connection to the mast must also be investigated for each installation.

3. The ballast weights indicated are net ballast weights, and must be uniformly distributed over all panels. The weight of the mount and antenna may be considered as ballast. The following table summarizes the weight of the BRM6 mount:

BRM6 ANTENNA MOUNT WEIGHTS

Mount No.	BRM635	BRM640	BRM645	BRM655	BRM665
Mast Pipe Size	3" Std.	3 1/2" Std.	4" Std.	5" Std.	6" Std.
Weight (lbs)	244	251	257	273	290

4. The zero velocity loads shown are equal to the ballast weights indicated divided by the total area enclosed by the perimeter of the mount (100 sq. ft.). This area is greater than the ballast panel contact area. Loads which must also be investigated include reactions caused by wind forces and moments, live loads, and dead loads of ballast, mount, antenna, miscellaneous equipment and roof pads. Refer to sheet 4 for maximum ANSI/EIA-222-D wind load coefficients for paraboloid antennas supported as described in note 2.

5. The tabulated maximum wind velocities (Vmax) are based on a minimum 1.5 factor of safety against structural failure and overturning. The wind velocity and the appropriate factor of safety for an installation must be determined on an individual site basis. Potential increases in wind velocity due to channeling, roof projections, and other obstructions, must be considered when determining ballast requirements.

Drawing Number: A890747-2 of 6

NOTES FOR BRM6 BALLAST [illegible]

6. The tabulated wind velocities resulting in sliding (Vs) are based on a factor of safety equal to 1.0 and a coefficient of friction equal to .50. A 1.0 factor of safety was used assuming that at higher wind velocities, safety cables or other suitable attachments to the support structure would prevent sliding beyond a safe, designated area. Wind velocities are given for 0, 20 and 40 degree antenna elevation angles. The appropriate coefficient of friction and factor of safety to determine wind velocities resulting in sliding must be determined on an individual site basis. The coefficient of friction may vary under changing moisture and temperature conditions. The minimum coefficient of friction must be used to evaluate sliding resistance.

7. The values of Vs indicated do not apply for installations which are prevented from sliding by cables or other suitable attachments to the supporting structure. Attachments to the supporting structure, under such conditions, must resist the portion of wind load which exceeds the frictional sliding resistance of the mount.

8. Refer to sheets 4, 5, and 6 for assistance in determining Vmax and Vs for specific wind load coefficients and/or other factors of safety and coefficients of friction.

9. Roof pads are recommended to prevent damage to roof membranes. Pads should be placed under all ballast panels and under the mast pipe. The minimum coefficient of friction must be considered for calculating the wind velocities resulting in sliding. When roof pads are utilized, the surface between the ballast panels and the roof pads and the surface between the roof pads and the supporting surface must both be considered.

10. Rohn recommends that ballast material always be placed prior to mounting the antenna and that roof pads and mount be secured to prevent hazards from occurring under extreme wind loading conditions. Precautions should also be taken to prevent the inadvertent removal of ballast material after installation and to insure that ballast material is fully supported by the ballast support angles (required for ballast to be effective in resisting overturning and sliding).

11. When adhesives, sealants or pads are utilized, they must be compatible with the supporting surface. They must also be durable and have adequate strength. Precautions should also be taken to insure that damage to the supporting surface will not occur upon wind loading.

12. Adhesives and sealants must be capable of resisting shear, otherwise, they may act as a lubricant and decrease the effective coefficient of friction between the ballast panels and the supporting surface. Windward ballast panels may partially lift off at wind velocities below the maximum wind velocities indicated. Adhesives or sealants may be disturbed under such circumstances and may require repairing after major wind loading events.

13. The installation, roof material and supporting structure must be capable of withstanding all loads imposed by the antenna system. Supporting surfaces, anchors and/or safety cables must be sufficient to resist the reactions from the antenna system. The installation must meet all applicable local, state and federal requirements. Due to the many variables involved, Rohn does not accept responsibility for verifying the applicability of the BRM6 for a specific installation.

Drawing Number: A890747-3 of 6

B. STRUCTURAL CAPACITY OF MOUNT

The following ultimate structural capacities of the BRM6 mount were determined from full-scale load tests.

ULTIMATE STRUCTURAL CAPACITY OF BRM6		
LOADING CONDITION	MAXIMUM SHEAR AND OVERTURNING	MAXIMUM TWISTING MOMENT
POINT OF LOAD APPLICATION	X = 3.0" Z = 48.0"	X = 24.2" Z = 48.0"
ULTIMATE CAPACITY	3000 LBS	1525 LBS

The wind velocities corresponding to the above ultimate structural capacities, reduced by a factor of safety (F.S.) against structural failure, may be calculated as follows:

MAXIMUM SHEAR AND OVERTURNING CONDITION

$$Vr1 = \left[\frac{3000}{F.S.(CFr(A)+F)}\right]^{1/2} \text{mph}$$

$$Vmr1 = \left[\frac{3000(48.0/12)}{F.S.(CMr(A)+M)}\right]^{1/2} \text{mph}$$

$$Vmz1 = \left[\frac{3000(3.0/12)}{F.S.(CMz(A)+T)}\right]^{1/2} \text{mph}$$

MAXIMUM TWISTING MOMENT CONDITION

$$Vr2 = \left[\frac{1525}{F.S.(CFr(A)+F)}\right]^{1/2} \text{mph}$$

$$Vmr2 = \left[\frac{1525(48.0/12)}{F.S.(CMr(A)+M)}\right]^{1/2} \text{mph}$$

$$Vmz2 = \left[\frac{1525(24.2/12)}{F.S.(CMz(A)+T)}\right]^{1/2} \text{mph}$$

The minimum value of Vr1, Vmr1, Vmz1, Vr2, Vmr2 and Vmz2 represents the wind velocity (Vu) based on a factor of safety against structural failure.

C. OVERTURNING RESISTANCE

Based upon full-scale overturning tests of the BRM6 mount, the maximum wind velocity (Vot) based on a factor of safety against overturning may be calculated as follows:

$$V_1 = \left[\frac{5.28(B) - 136 - F.S.(M)}{F.S.\ (CMr)(A) + 5.28(CFz)(A)}\right]^{1/2} \text{mph}$$

$$V_2 = \left[\frac{3.46(B) + 2096 - F.S.(M)}{F.S.\ (CMr)(A) + 3.46(CFz)(A)}\right]^{1/2} \text{mph}$$

$$Vot = \text{Minimum of } V_1 \text{ or } V_2$$

Drawing Number: A890747-5 of 6

CRITERIA FOR DEVELOPING [illegible]

A. MAXIMUM WIND LOADING COEFFICIENTS

The following table summarizes the maximum ANSI/EIA-222-D wind load coefficients for paraboloid antennas supported 12 inches from the vertex of the antenna on a 48 inch long mounting pipe considering elevation rotation about the vertex and azimuth rotation about the support. The loading conditions indicated occur at different azimuth rotations with respect to wind direction. Specific antenna types and/or other mounting configurations may require consideration of more stringent wind load coefficients.

LOADING CONDITION		MAXIMUM VERTICAL LOADS		MAXIMUM SHEAR AND OVERTURNING			MAXIMUM TWISTING MOMENT		
ANT. DIA.	EL ANGLE	CFz[1] UPLIFT	CFz[1] DOWNLOAD	CFr	CMr	CMz	CFr	CMr	CMz
4 FT (1.2m)	0	0	0	.004357	.017426	.000180	.001697	.006788	.002680
	20	.000301	-.001522	.004129	.014956	.000187	.001674	.007242	.002453
	40	.000584	-.002591	.003542	.011256	.000069	.001524	.006607	.002038
6 FT (1.8m)	0	0	0	.004357	.017426	.000620	.001697	.006788	.003420
	20	.000301	-.001522	.004129	.014841	.000570	.001674	.007555	.003116
	40	.000584	-.002591	.003542	.011017	.000215	.001524	.007052	.002535
8 FT (2.4m)	0	0	0	.004357	.017426	.001060	.001697	.006788	.004160
	20	.000301	-.001522	.004129	.014727	.000953	.001674	.007869	.003779
	40	.000584	-.002591	.003542	.010781	.000500	.001524	.007498	.003032

[1] Positive direction for CFz is upward

Vertical Download = $B - CFz(A)(V)^2$ lbs

Lateral Load = $CFr(A)(V)^2 + F$ lbs

Overturning Moment = $CMr(A)(V)^2 + M$ ft-lbs

Twisting Moment = $CMz(A)(V)^2 + T$ ft-lbs

A = Frontal area of antenna, sq. ft.

V = Wind velocity at centerline of antenna, mph

B = Ballast weight including weight of mount, antenna and all other vertical loads supported by mount, lbs

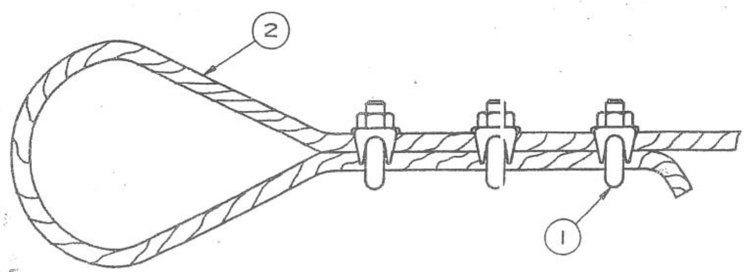
F, M, T = Lateral load, overturning and twisting moments due to additional wind and dead loads on mount, ballast, etc., lbs or ft-lbs

For development of the ballast requirement table, it was assumed that the additional moments due to eccentric antenna weights would be negligible (except as noted in paragraph F), and that F, M and T were also negligible for all wind directions and elevation angles. The actual values of these forces and moments may be significant, and must be investigated for each installation.

Drawing Number: A890747-4 of 6

BILL OF MATERIAL

SCK150	SCK100	SCK50	FYS131	ITEM	PART NO	DESCRIPTION	DWG NO
			6	1	3/16 CCM	3/16" CABLE CLAMP	
		1		2	FY140	3/16" CABLE X 50' (3/16 EHS 3990 LBS. ULT. STRG.)	B890012
	1			2	FY141	3/16" CABLE X 100' (3/16 EHS 3990 LBS. ULT. STRG.)	B890012
1				2	FY142	3/16" CABLE X 150' (3/16 EHS 3990 LBS. ULT. STRG.)	B890012
			1		720030	POLY BAG 4" WIDE X 10" LONG	
1	1	1			FYS131	CABLE CLAMP & BAG ASSEMBLY	B890012
					SCK50	50' SAFETY CABLE KIT	B890012
					SCK100	100' SAFETY CABLE KIT	B890012
					SCK150	150' SAFETY CABLE KIT	B890012



TYPICAL OF BOTH ENDS

R1 ROTATED CLIPS ON CABLE 3-26-91 BGA

ROHN

Title
SAFETY CABLE KITS

Scale NONE

Drawn by BGA Date 2-7-89

Checked by KA Date 2-7-89

Approved by Engineering Date

Approved by Production MAC/GDF Date 3-9-89

Approved by Sales Date

Drawing Type : FAB

Unless otherwise specified, dimensions are given in inches. Tolerances are as noted.

Material Finish Weight

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File Number EF2469DF

Drawing Number B890012R1

Appendix D:

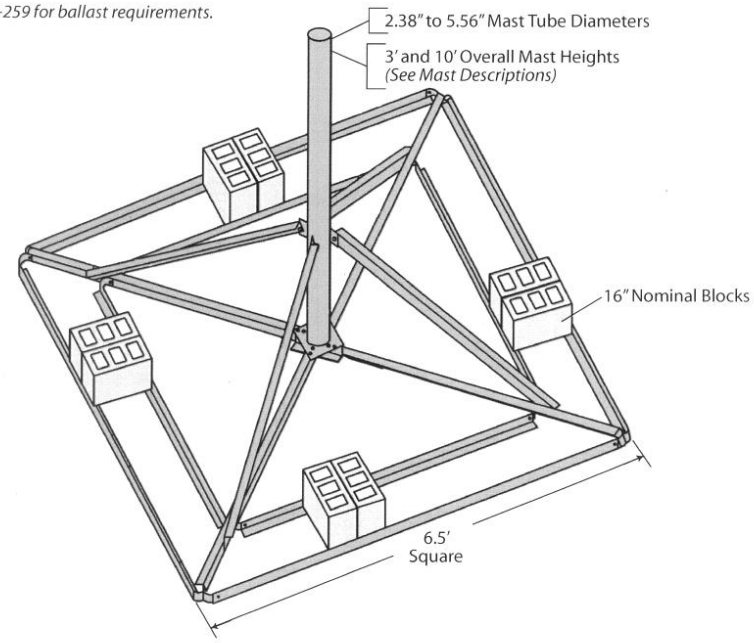
Data Sheet for BRM4 Antenna Ballast Mount w/ Mast Specifications

BRM4
NON-PENETRATING

The BRM4 mount is hot-dip galvanized after fabrication for corrosion protection.

Order (1) optional BRM4MAT (1/8" thick) or (1) optional BRM4PAD (3/8" thick) for a protective barrier between the mount and the roof. Order (1) optional SCK150 safety cable kit (3/8" x 150').

Refer to pages 258-259 for ballast requirements.



MAST SPECIFICATIONS

Mount Part No.	Mast Part No.	Mast Description & Height
BRM425	KY1590	2.38" O.D. x 0.154" wall x 3.0'
BRM430	KY1592	2.88" O.D. x 0.203" wall x 3.0'
BRM435	KY1594	3.50" O.D. x 0.216" wall x 3.0'
BRM440	KY1596	4.00" O.D. x 0.226" wall x 3.0'
BRM445	KY1598	4.50" O.D. x 0.237" wall x 3.0'
BRM455	KY1600	5.56" O.D. x 0.258" wall x 3.0'
BRM42510	KY2061	2.38" O.D. x 0.154" wall x 10.0'
BRM43510	KY2063	3.50" O.D. x 0.216" wall x 10.0'
BRM44510	KY2065	4.50" O.D. x 0.237" wall x 10.0'

BRM4
BALLAST REQUIREMENTS

Effective Projected Area (EPA) (FT^2)	Ballast (LBS)	Zero Velocity Load (PSF)	Vs (MPH)	Vmax at centroid of projected area, (MPH)							
				h=2 FT	h=3 FT	h=4 FT	h=5 FT	h=6 FT	h=7 FT	h=8 FT	h=9 FT
2	300	7.1	171	242	198	171	153	140	130	121	114
	500	11.8	221	313	256	221	198	181	167	157	148
	700	16.6	261	370	302	262	234	214	198	185	175
	900	21.3	296	416	340	294	263	240	223	208	196
	1100	26.0	328	448	366	317	284	259	240	224	211
	1300	30.8	356	478	391	338	302	276	256	239	225
	1500	35.5	383	506	414	358	320	292	271	253	239
	1700	40.2	407	533	435	377	337	308	285	267	251
	1900	45.0	431	558	456	395	353	322	299	279	263
	2100	49.7	453	583	476	412	369	336	312	291	275
	2300	54.4	474	604	493	427	382	349	323	302	285
4	300	7.1	121	171	140	121	108	99	92	86	81
	500	11.8	156	221	181	157	140	128	118	111	104
	700	16.6	185	262	214	185	166	151	140	131	123
	900	21.3	210	294	240	208	186	170	157	147	139
	1100	26.0	232	317	259	224	201	183	169	159	149
	1300	30.8	252	328	276	239	214	195	181	169	159
	1500	35.5	271	358	292	253	226	207	191	179	169
	1700	40.2	288	377	308	267	238	218	201	188	178
	1900	45.0	305	395	322	279	250	228	211	197	186
	2100	49.7	320	412	336	291	261	238	220	206	194
	2300	54.4	335	427	349	302	270	247	228	213	201
6	300	7.1	99	140	114	99	89	81	75	70	66
	500	11.8	128	181	148	128	114	104	97	90	85
	700	16.6	151	214	175	151	135	123	114	107	101
	900	21.3	171	240	196	170	152	139	128	120	113
	1100	26.0	189	259	211	183	164	149	138	129	122
	1300	30.8	206	276	225	195	175	159	148	138	130
	1500	35.5	221	292	239	207	185	169	156	146	138
	1700	40.2	235	308	251	218	195	178	165	154	145
	1900	45.0	249	322	263	228	204	186	172	161	152
	2100	49.7	261	336	275	238	213	194	180	168	159
	2300	54.4	274	349	285	247	220	201	186	174	164
8	300	7.1	86	121	99	86	77	70	65	61	57
	500	11.8	110	157	128	111	99	90	84	78	74
	700	16.6	131	185	151	131	117	107	99	93	87
	900	21.3	148	208	170	147	132	120	111	104	98
	1100	26.0	164	224	183	159	142	129	120	112	106
	1300	30.8	178	239	195	169	151	138	128	120	113
	1500	35.5	191	253	207	179	160	146	135	127	119
	1700	40.2	204	267	218	188	169	154	142	133	126
	1900	45.0	215	279	228	197	177	161	149	140	132
	2100	49.7	226	291	238	206	184	168	156	146	137
	2300	54.4	237	302	247	213	191	174	161	151	142
10	300	7.1	77	108	89	77	69	63	58	54	51
	500	11.8	99	140	114	99	89	81	75	70	66
	700	16.6	117	166	135	117	105	96	89	83	78
	900	21.3	133	186	152	132	118	107	100	93	88
	1100	26.0	147	201	164	142	127	116	107	100	95
	1300	30.8	159	214	175	151	135	123	114	107	101
	1500	35.5	171	226	185	160	143	131	121	113	107
	1700	40.2	182	238	195	169	151	138	127	119	112
	1900	45.0	193	250	204	177	158	144	134	125	118
	2100	49.7	203	261	213	184	165	150	139	130	123
	2300	54.4	212	270	220	191	171	156	144	135	127
12	300	7.1	70	99	81	70	63	57	53	49	47
	500	11.8	90	128	104	90	81	74	68	64	60
	700	16.6	107	151	123	107	96	87	81	76	71
	900	21.3	121	170	139	120	107	98	91	85	80
	1100	26.0	134	183	149	129	116	106	98	92	86
	1300	30.8	145	195	159	138	123	113	104	98	92
	1500	35.5	156	207	169	146	131	119	111	103	97
	1700	40.2	166	218	178	154	138	126	116	109	103
	1900	45.0	176	228	186	161	144	132	122	114	107
	2100	49.7	185	238	194	168	150	137	127	119	112
	2300	54.4	193	247	201	174	156	142	132	123	116

h = Distance from support surface to centroid of EPA.

Vmax = Effective wind velocity based on strength or overturning.

Vs = Effective wind velocity resulting in sliding on a flat surface with a .50 coefficient of friction.

NOTE: *Mast strength may govern antenna capacity.*

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BRM4
BALLAST REQUIREMENTS

Effective Projected Area (EPA) (FT^2)	Ballast (LBS)	Zero Velocity Load (PSF)	Vs (MPH)	Vmax at centroid of projected area, (MPH)							
				h=2 FT	h=3 FT	h=4 FT	h=5 FT	h=6 FT	h=7 FT	h=8 FT	h=9 FT
14	300	7.1	65	92	75	65	58	53	49	46	43
	500	11.8	84	118	97	84	75	68	63	59	56
	700	16.6	99	140	114	99	89	81	75	70	66
	900	21.3	112	157	128	111	100	91	84	79	74
	1100	26.0	124	169	138	120	107	98	91	85	80
	1300	30.8	135	181	148	128	114	104	97	90	85
	1500	35.5	145	191	156	135	121	111	102	96	90
	1700	40.2	154	201	165	142	127	116	108	101	95
	1900	45.0	163	211	172	149	134	122	113	106	100
	2100	49.7	171	220	180	156	139	127	118	110	104
	2300	54.4	179	228	186	161	144	132	122	114	108
16	300	7.1	61	86	70	61	54	49	46	43	40
	500	11.8	78	111	90	78	70	64	59	55	52
	700	16.6	92	131	107	93	83	76	70	65	62
	900	21.3	105	147	120	104	93	85	79	74	69
	1100	26.0	116	159	129	112	100	92	85	79	75
	1300	30.8	126	169	138	120	107	98	90	85	80
	1500	35.5	135	179	146	127	113	103	96	90	84
	1700	40.2	144	188	154	133	119	109	101	94	89
	1900	45.0	152	197	161	140	125	114	106	99	93
	2100	49.7	160	206	168	146	130	119	110	103	97
	2300	54.4	168	213	174	151	135	123	114	107	101
18	300	7.1	57	81	66	57	51	47	43	40	38
	500	11.8	74	104	85	74	66	60	56	52	49
	700	16.6	87	123	101	87	78	71	66	62	58
	900	21.3	99	139	113	98	88	80	74	69	65
	1100	26.0	109	149	122	106	95	86	80	75	70
	1300	30.8	119	159	130	113	101	92	85	80	75
	1500	35.5	128	169	138	119	107	97	90	84	80
	1700	40.2	136	178	145	126	112	103	95	89	84
	1900	45.0	144	186	152	132	118	107	100	93	88
	2100	49.7	151	194	159	137	123	112	104	97	92
	2300	54.4	158	201	164	142	127	116	108	101	95
20	300	7.1	54	77	63	54	48	44	41	38	36
	500	11.8	70	99	81	70	63	57	53	49	47
	700	16.6	83	117	96	83	74	68	63	59	55
	900	21.3	94	132	107	93	83	76	70	66	62
	1100	26.0	104	142	116	100	90	82	76	71	67
	1300	30.8	113	151	123	107	96	87	81	76	71
	1500	35.5	121	160	131	113	101	92	86	80	75
	1700	40.2	129	169	138	119	107	97	90	84	79
	1900	45.0	136	177	144	125	112	102	94	88	83
	2100	49.7	143	184	150	130	117	106	99	92	87
	2300	54.4	150	191	156	135	121	110	102	95	90
22	300	7.1	52	73	60	52	46	42	39	37	34
	500	11.8	67	94	77	67	60	54	50	47	44
	700	16.6	79	112	91	79	71	64	60	56	53
	900	21.3	89	126	102	89	79	72	67	63	59
	1100	26.0	99	135	110	96	86	78	72	68	64
	1300	30.8	107	144	118	102	91	83	77	72	68
	1500	35.5	115	153	125	108	97	88	82	76	72
	1700	40.2	123	161	131	114	102	93	86	80	76
	1900	45.0	130	168	137	119	106	97	90	84	79
	2100	49.7	137	176	143	124	111	101	94	88	83
	2300	54.4	143	182	149	129	115	105	97	91	86
24	300	7.1	49	70	57	49	44	40	37	35	33
	500	11.8	64	90	74	64	57	52	48	45	43
	700	16.6	75	107	87	76	68	62	57	53	50
	900	21.3	86	120	98	85	76	69	64	60	57
	1100	26.0	95	129	106	92	82	75	69	65	61
	1300	30.8	103	138	113	98	87	80	74	69	65
	1500	35.5	110	146	119	103	92	84	78	73	69
	1700	40.2	118	154	126	109	97	89	82	77	73
	1900	45.0	124	161	132	114	102	93	86	81	76
	2100	49.7	131	168	137	119	106	97	90	84	79
	2300	54.4	137	174	142	123	110	101	93	87	82

h = Distance from support surface to centroid of EPA.

Vmax = Effective wind velocity based on strength or overturning.

Vs = Effective wind velocity resulting in sliding on a flat surface with a .50 coefficient of friction.

NOTE: *Mast strength may govern antenna capacity.*

Central Service Area
Navaids/Infrastructure Engineering Center

Installation Package

LAAS Ground Based Performance Monitor (GBPM)

Transmittal Number: XXXX
Supplement Number: XXXX

From: *Project Engineer, Routing Symbol*

Signed:_____, **Date:**_____

Reviewed: *Systems Engineer, Routing Symbol*

Signed:_____, **Date:**_____

Through: Manager, Navaids Engineering Center, *Location, Routing Symbol*

Signed:_____, **Date:**_____

To: Manager, Navaids/Infrastructure Construction/Installation Center, *Location, Routing Symbol*

Signed:_____, **Date:**_____

TABLE OF CONTENTS

LAAS Ground Based Performance Monitor (GBPM)

SECTION 1 PROJECT DESCRIPTION

1.0 General Description

LAAS Ground Based Performance Monitor (GBPM), Installed at the IAH LKM/LOC Shelter.

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 LAAS 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.

1.1 Definition of Work

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 is used to identify miniscule positioning errors. It is important to note that the duration of GBPM service is generally 2 to 5 years.

1.2 Infrastructure, Service, and Needs Checklist

Note: Installation of GBPM will be performed by AJP-652, w/ limited on-site support required.

☐ 110 VAC/60 Hz – 1 Circuit/Duplex @ 15 Amps (2 if available)

☐ Precision Survey (AJP-652 FAA performed) – Access to PAC or SAC

☐ AJP-652 FAA provided T1 – Other required hardware in order to link-up the FAA ATCT (or other FAA local) Fiber-Ring to the T1 demarcation point

☐ Network/Fiber-Ring POC/assistance for extension from AJP-652 FAA provided T1 – Demarcation from FAA Fiber-Ring to LKM/LOC

☐ An open area (good sky view) on a rooftop or field, for GPS antenna ballast mount (6.5'w x 6.5'd x 10'h) and a VHF whip antenna <LKM/LOC adequate>

☐ Line of Site to VDB TX Antenna of GBAS/LGF <LOS expected>

☐ 2 RF cable runs (antenna to rack) – Extensions provided by AJP-652 <available @ location>

☐ A secure HVACed area for a ~ 2'w x 3'd x 4'h rack enclosure <available @ location>

1.3 On-site Support Requirements Checklist

☐ Primary POC for Houston installation of GBPM (not limited to installation dates)

☐ Temporary storage, transport, and lift of the GBPM hardware and support equipment

☐ Mechanical lift for placement of GBPM and cherry/bucket truck for GPS antenna positioning

☐ Dedicated AOA escort(s) – Shelter access (2 to 3 days) to accommodate AJP-652 personnel and vehicles for installation and survey of GBPM

☐ Access to PAC/SAC for precision survey of GBPM GPS antenna (GBAS corrected positioning, AJP-652 FAA performed)

☐ Primary Network/Fiber-Ring POC for on-site/remote assistance and access (not limited to installation dates)

SECTION 2 ENGINEERING AND SCHEDULE

2.0 Lead Project Engineer

Lead Project Engineer:	Carmen Tedeschi	AJP-652	Phone: (609) 485-7165

2.1 System Engineers

Software Engineers:	Chad Kemp	AJP-652	Phone: (609) 485-6308
	Shelly Beauchamp	AJP-652	Phone: (609) 485-8358
	Shawn Casler	AJP-652	Phone: (609) 485-6914
Hardware Engineers:	Chad Kemp	AJP-652	Phone: (609) 485-6308
	Joseph Gillespie	AJP-652	Phone: (609) 485-4579
	Andre Ramjattan	AJP-652	Phone: (609) 485-7232
	Julian Babel	AJP-652	Phone: (609) 485-4589

2.2 Coordination

Air Traffic:	John Croft	IAH TRACON (I90)	Phone: (281) 233-0530
System Support Center:	Sean Suski	HAS I.T.	Phone: (281) 233-1626
IAH Airport Authority:	William Zrioka	HAS	Phone: (281) 233-1364
	Carlos Ortiz	HAS	Phone: (281) 233-1842
	Robert Bielek	HAS	Phone: (281) 233-1941
	Adil Godiwalla	HAS	Phone: (281) 233-1934
TECH OPS District Office:	Randall Stinson	WCK2-IAH	Phone: (281) 230-8477
	Steven Ivy	WCK2-IAH	Phone: (281) 230-8484
	Robert Dunn	AJW-CK	Phone: (281) 233-0577

NOTE: All names should be recommended to attend the commencement of installation activities

2.3 Schedule

Installation Performance Time	61	Days
Drawings and Installation Instructions Available	*07/08/2011*	
Proposed Installation Start Date	*08/10/2011*	
Commissioning/Chart Publication/Service Available	*08/24/2011*	

2.4 Reference Material

GBPM: Houston Installation and Procedure Package [Houston Installation Package.doc]

BAE: BAE Systems ARL-1900 Antenna [BAE Systems ARL-1900 Antenna.pdf]
BAE Background/Calibration Memorandum [06060201.tm.doc]
747 Tailfin – Estimate of Multipath Error [08032101.tm.pdf]
Antenna Lengths Information [Antenna Height measurements chart BAE_latest.doc]

VDB: GNSS-Based Precision Approach LAAS Signal-in-Space Interface Control Document [DO-246D]
Minimum Operational Performance Standards for GPS LAAS Airborne Equipment [DO-253C]
Minimum Aviation System Performance Standards for the LAAS [DO-245A]

7460: 7460 for IAH GBPM [7460_IAH GBPM at LKM LOC w attachments.pdf]

Cisco: Cisco 2800 Series Integrated Services Routers Quick Start Guide [2800_qsg.pdf]

SECTION 3 FUNDING AND ACCOUNTING DATA

3.0 Installation Cost Estimate

Asset #1: System/Labor	$40,000.00
Asset #2: T1/Network	$10,000.00
Asset #3: Install Material	$5,000.00
Asset #4: Install Labor	$5,000.00
Total	$60,000.00

SECTION 4 ADDITIONAL INFORMATION

4.0 Facility Identifier

FAC: IAH LKM/LOC Shelter

4.1 Materials/Component List

See Attachment #3 for a list of project materials provided with the GBPM.

4.2 Frequency Transmitting Authorization (FTA)

Not applicable. The GBPM is a *receive* only device.

4.3 Flight Inspection

Not applicable. The GBPM is not considered to be a NAVAID.

4.4 Training

Operational and Maintenance On-site Training Session *06/30/2011*
- Additional training provided if necessary.

4.5 Schedule B Items

See Attachment #4 for a list of Schedule B items provided with the GBPM.

4.6 Integrated Risk Management Checklist

IRMC Checklist Signed: *Yes/No*
IRMC Serial Number: IRMC-IMPL-11-461

4.7 Special Instructions/ Maintenance Checklist

The FAA Technical Center GBAS staff will have a dedicated T1 line in-place for remote system ops verification and data farming. 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 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 has been provided in Section 2 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 seizes. If beeping does not seize then this could indicate a building wiring fault, in which case immediate attention should be given to resolving the issue. Contact information has been provided in Section 2 if further assistance is required.**

SECTION 5 PROJECT CHECKLIST

- ☐ **TI Manual for IAH GBPM** (***Attachment 1***)
- ☐ **7460 for IAH GBPM** (***Attachment 2***)
- ☐ **Materials/Component List** (***Attachment 3***)
- ☐ **Schedule B Items** (***Attachment 4***)
- ☐ **External Cables** (***Attachment 5***)
- ☐ **T1 Network Cloud** (***Attachment 6***)
- ☐ **Image Set: Site Survey and Positioning** (***Attachment 7***)
- ☐ **Image Set: LKM/LOC Shelter and Antenna Hardware** (***Attachment 8***)

Attachment 1

TI Manual for IAH GBPM

LAAS Ground Based Performance Monitor (GBPM)

See:
IAH Installation and Procedure Package for LAAS/GBAS Ground Based Performance Monitor (GBPM)
[Houston Installation Package.doc]

Attachment 2

7460 for IAH GBPM

LAAS Ground Based Performance Monitor (GBPM)

See:
7460 for IAH GBPM
[7460_IAH GBPM at LKM LOC w attachments.pdf]

Attachment 3

Materials/Component List

LAAS Ground Based Performance Monitor (GBPM)

Description	Specifications	Model / Part Number
Sunon Impedance Protected Exterior Mounted Fans (x2)	115 V ~ 50-60 HZ 0.21 / 0.18 AMP	SP101A 1123HST.GN
KVM-P17-TP	100-240 V ~ 50-60 HZ 1.1 AMP	S919691008151- 0609N002
CISCO Systems 2811 Series Integrated Service Router		SNFTX1028A518
CISCO WIC Interface / Network Card (x4)		WIC-1DSU-T1-V2
Optimux-106 Fiber Multiplexer	4 E1/T1/Serial 10/100BaseTx	Optimux-106
Citel POE Surge Protector		MJ8-POE-A
Network Enabled Power Distribution Unit	120 V ~ 60 HZ 15 AMP	PDUMH15ATNET
TrippLite 12 Outlet un-UPS Power Strip	120 V 15 AMP	RS-1215-RA AGIP120V61PRM
Becker VDB Receiver RS 4909 A	114.525 MHz	(8004) 0602970000968711
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)	114.525 MHz Cut to 24 + 4/32”	B66
Super Logics QNX Central Processing Unit		5L-2U-AT-945GC2-BA
AccelePort 8r 920-PCI DB25 Card/Cable		(1P) 70001362
APC Smart UPS	120 V ~ 50-60 Hz 12 AMP	1500 1440VA 980W
Lascar Adjustable Power Supply	1.5-30 V 1.0 AMP	PSU 130
NovAtel GPS Receiver / WAAS	DL-4	41017296
GPS Networking Incorporated T-Splitter		LDCB51X2
Mini-Circuits Bias-Tee RF-Splitter	10-4200 MHz	ZFBT-4R2G RF091500429
QVS Surge Protected Power Strip		No requirement
Data RS232-RS485 Converter	2000 V Isolated	IC-485SI
PPS RS232-RS485 Converter	2000 V Isolated	IC-485SI
3COM Office Connect Dual Speed 16 Plus Network Switch		No requirement
1U 12“ Vented Component Shelf		1906-3-221-01
3U 12” Vented Component Shelf		1906-3-221-03
PCtel GPS Antenna, DC Block, Passive Splitter	As configured on: 06/30/2011	No requirement
BAE GPS Antenna, L1/L2 Filter, Pre-Amp	As configured on: 06/30/2011	No requirement
Ballast Roof Mount Installation Package	See Attachment 1	See Attachment 1

Attachment 4

Schedule B Items

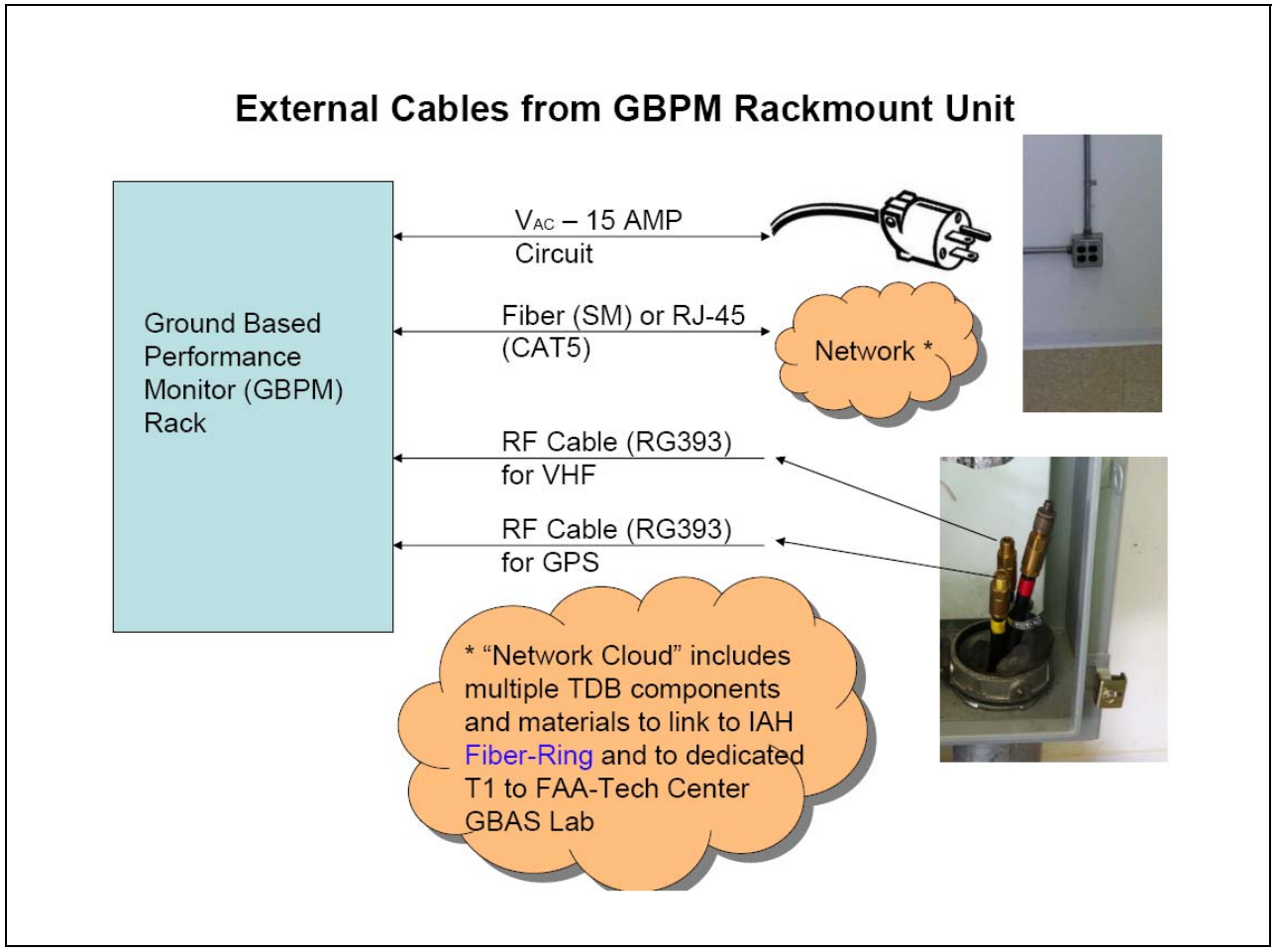
LAAS Ground Based Performance Monitor (GBPM)

Schedule B Code	Description	Unit of Measure
83.02	Base metal mountings, fittings and similar articles suitable for furniture, doors, staircases, windows, blinds, coachwork, saddlery, trunks, chests, caskets or the like; base metal hat- racks, hat-pegs, brackets and similar fixtures; castors with mountings of base metal; automatic door closers of base metal; and base metal parts thereof	Kg.
84.14	Air or vacuum pumps, air or other gas compressors and fans; ventilating or recycling hoods incorporating a fan, whether or not fitted with filters; parts thereof	No.
8471.41	Automatic data processing machines and units thereof; magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, not elsewhere specified or included Comprising in the same housing at least a central processing unit and an input and output unit, whether or not combined	No.
85.28	Monitors and projectors, not incorporating television reception apparatus; reception apparatus for television, whether or not incorporating radio-broadcast receivers or sound or video recording or reproducing apparatus	No.
8517.62	Machines for the reception, conversion and transmission or regeneration of voice, images or other data, including switching and routing apparatus	No.
8504.40.6018	Electrical transformers, static converters (for example, rectifiers) and inductors; power supplies for automatic data processing machines or units thereof of heading 8471; parts thereof Suitable for physical incorporation into automatic data processing machines or units thereof of heading 8471	No.
85.42	Electronic integrated circuits; parts thereof	No.
84.87	Machinery parts, not containing electrical connectors, insulators, coils, contacts or other electrical features, and not specified or included elsewhere	No.
8544.42.0000	Insulated (including enameled or anodized) wire, cable (including coaxial cable) and other insulated electrical conductors, whether or not fitted with connectors; optical fiber cables, made up of individually sheathed fibers, whether or not assembled with electric conductors or fitted with connectors	X
85.36	Electrical apparatus for switching or protecting electrical circuits, or for making connections to or in electrical circuits (for example, switches, relays, fuses, surge suppressors, plugs, sockets, lamp- holders and other connectors, junction boxes), for a voltage not exceeding 1,000 V; connectors for optical fibers, optical fiber bundles or cables	X
7616.99.5050	Other articles of aluminum, hangers and supports for pipes and tubes	Kg.
7326.90.8530	Other articles of iron or steel, hangers and similar supports for tubes and pipes	Kg.

Attachment 5

External Cables

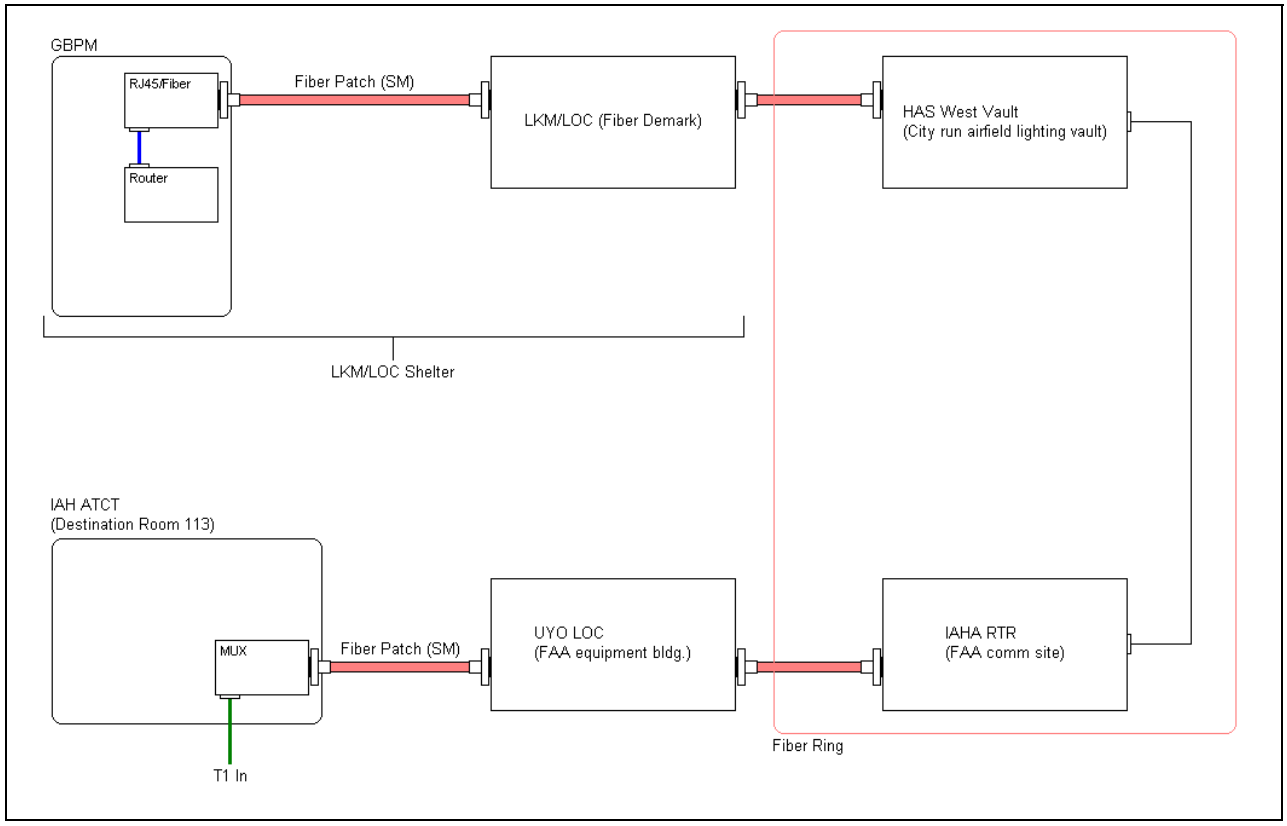
LAAS Ground Based Performance Monitor (GBPM)



Attachment 6

T1 Network Cloud

LAAS Ground Based Performance Monitor (GBPM)

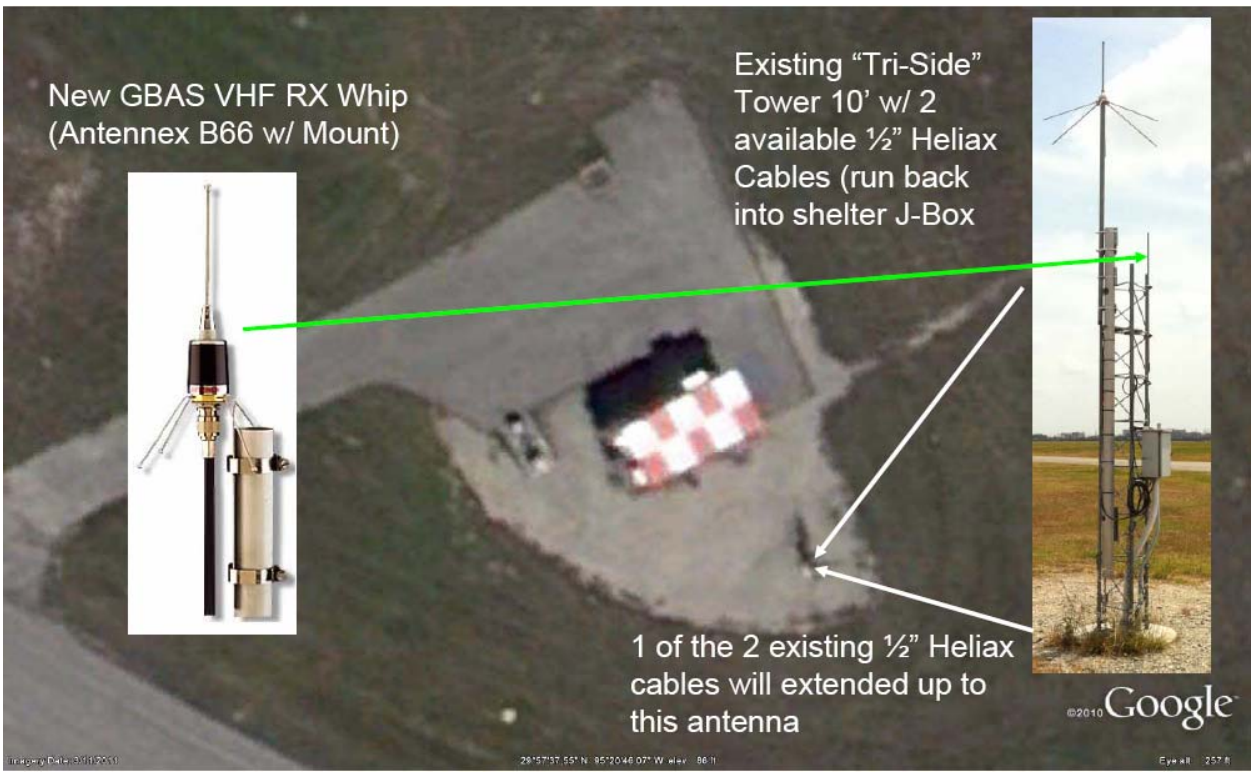


Attachment 7

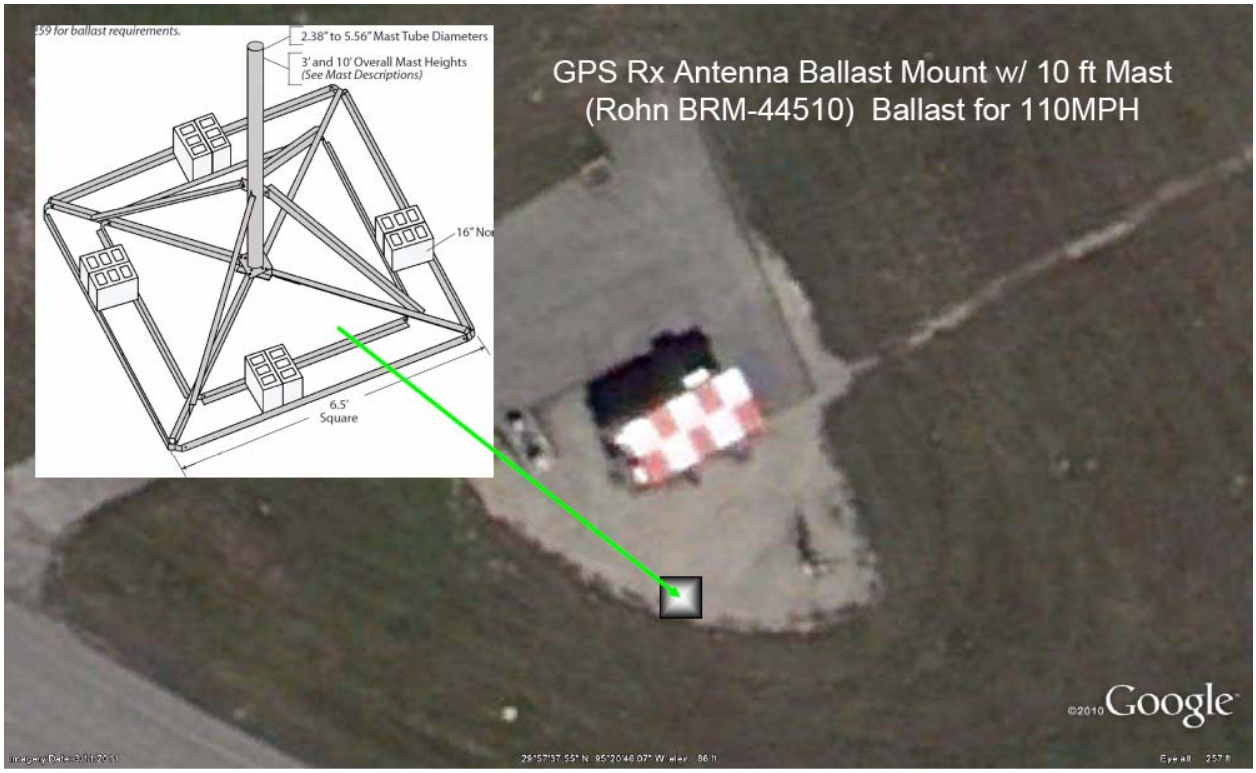
Image Set: Site Survey and Positioning

LAAS Ground Based Performance Monitor (GBPM)

Proposed GBPM Location, IAH LKM/LOC Shelter (Aerial View)



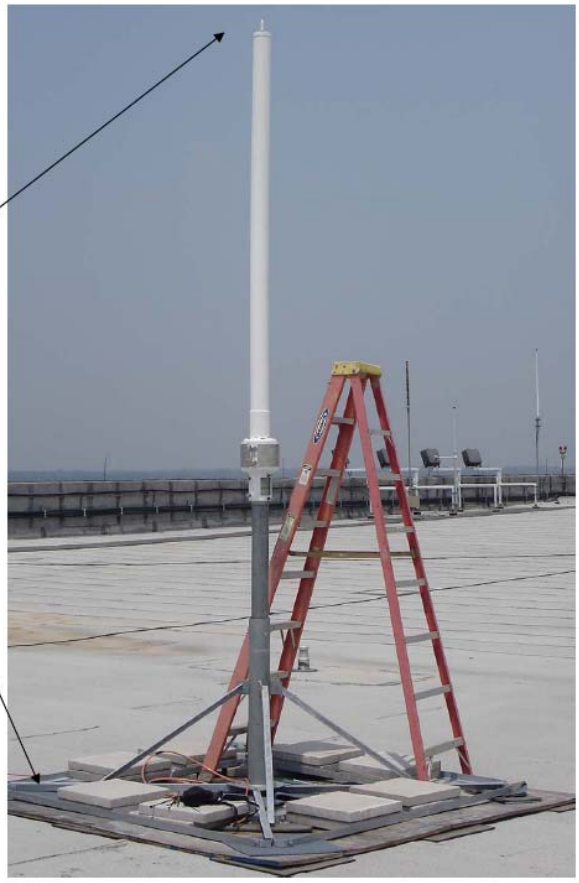
IAH FAA GBPM, VHF Data RX Antenna (Aerial View)



IAH FAA GBPM, GPS RX Antenna Ballast Mount/Platform (Aerial View)

Center of mount base to be at;
29 57’ 37.23”N 95 20’ 46.01” 85-ft MSL
(Antenna and Mount height is 18.51’ - AGL)
(Footprint is 6.5’ square)

2nd existing Heliax Cable from “Tri-Side” tower will be extended to this location (will be direct-burial and hand trenched by AJP ~25 feet)



IAH FAA GBPM, GPS Antenna/Ballast Mount Representation and Details

Attachment 8

Image Set: LKM/LOC Shelter and Antenna Hardware

LAAS Ground Based Performance Monitor (GBPM)

LKM/LOC Shelter, Left Back Corner (Forward View)

LKM/LOC Shelter, Open Corner for GBPM (Forward View)

LKM/LOC Shelter, Cable Ends (Forward View)

LKM/LOC Shelter, Front View (Outside View)

LKM/LOC Shelter, Rear View (Outside View)

Exsiting “Tri-Side” Tower and Antenna Pod (Outside View)

GBAS/GNSS Field Monitor (aka Ground Based Performance Monitor) or GBPM for IAH

Detail for Installation and Support of an FAA GBPM for Houston Intercont. Airport (IAH) – Desired Site Identified

Federal Aviation Administration

Presented to: IAH FAA and GBAS Stakeholders

By: Carmen Tedeschi

Date: May 17th 2011

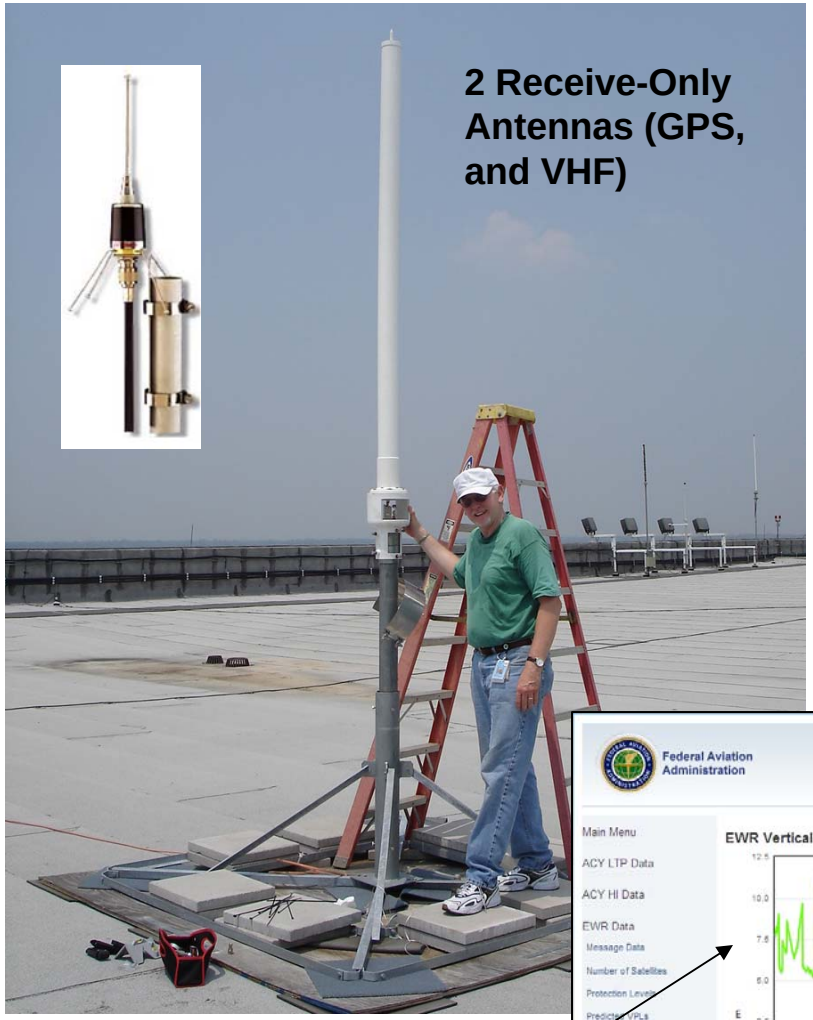
IAH FAA GBAS/GNSS Field Monitor (Ground Based Performance Monitor) - GBPM

•For Familiarization and Coordination Purposes, 7460, and accompanying docs to be provided by FAA GBAS Team (AJP-652) – Install dates TBD

AJP-652 Manager - John Warburton 609-485-6782

IAH GBPM Lead - Carmen Tedeschi 609-485-7165

GBAS GBPM System Snapshot



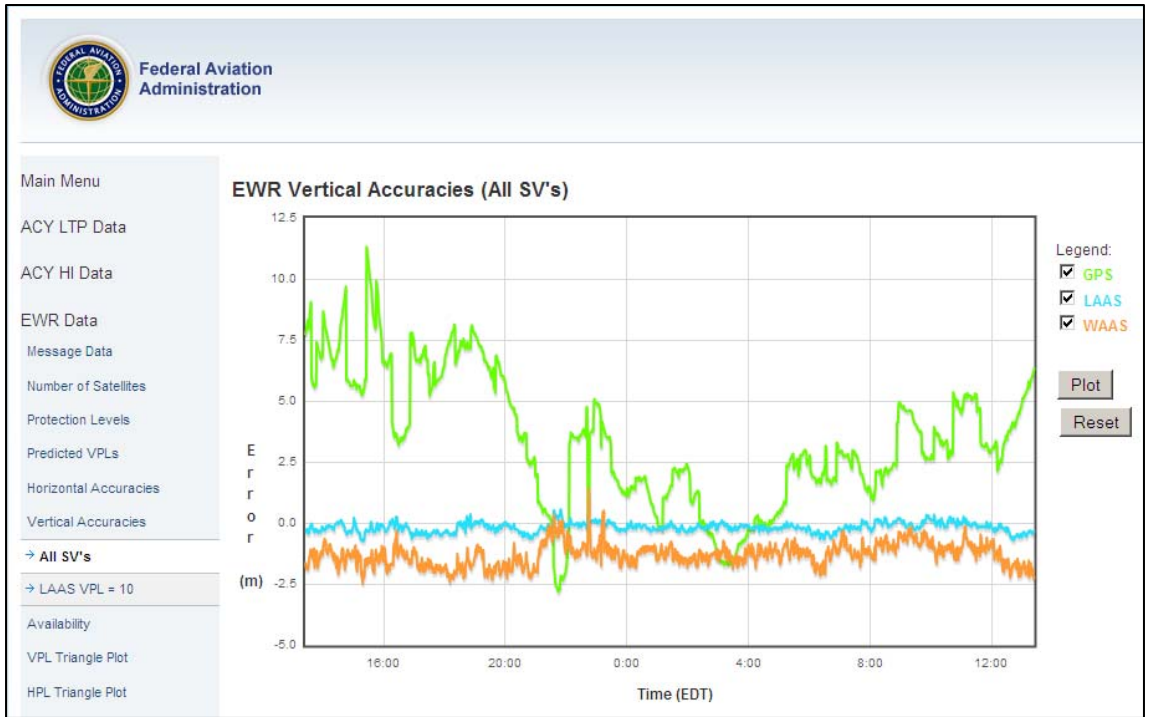
Network Link to FAA Tech-Center and Web style monitoring

GBPM Facts and Purpose:

- The GBPM Field Monitor will NOT be directly linked to the IAH 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/

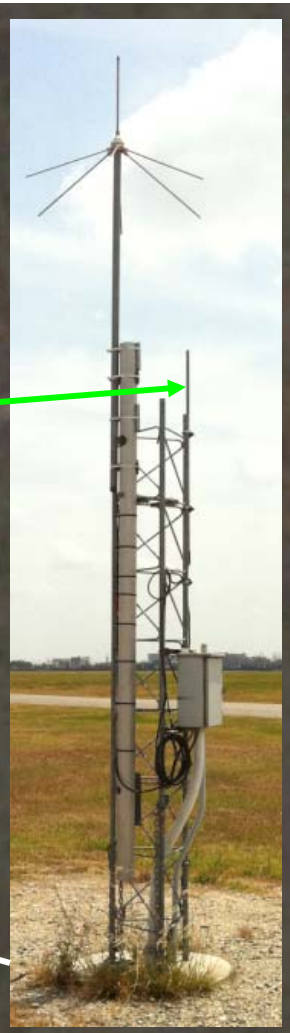
Example Web-Type Page for NAS Service Provider Monitoring



IAH FAA GBPM – VHF Data Receive Antenna

New GBAS VHF RX Whip
(Antennex B66 w/ Mount)

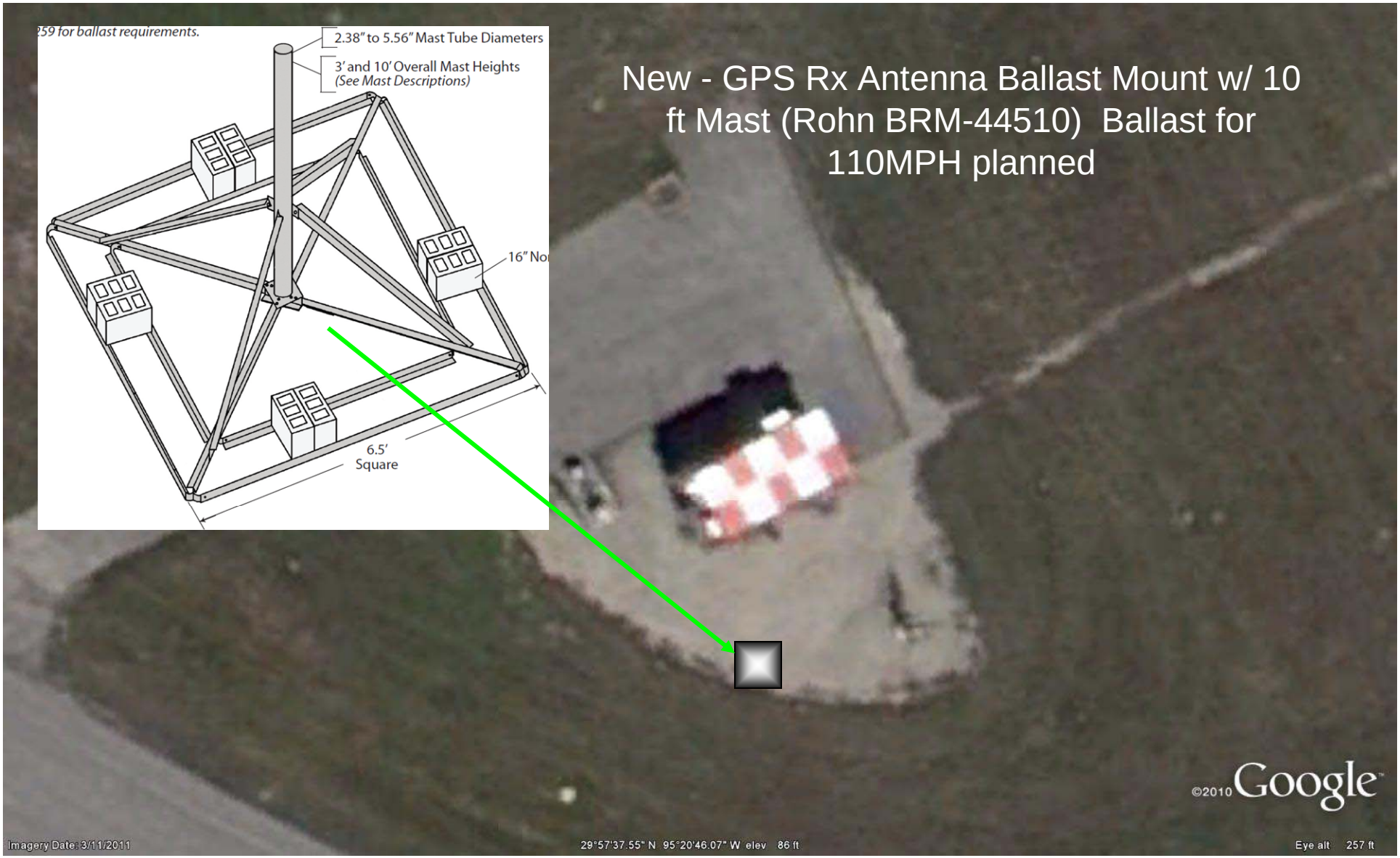
Existing “Tri-Side” Tower 10’ w/ 2 available ½” Heliax Cables (run back into shelter J-Box)



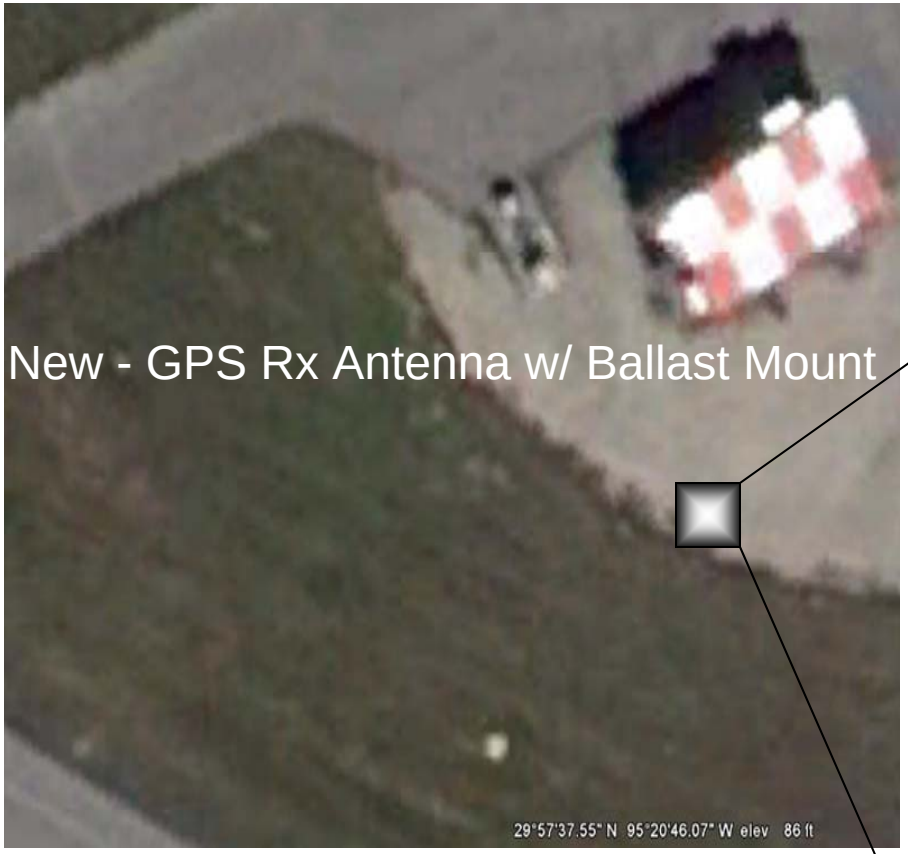
1 of the 2 existing ½” Heliax cables will be extended up to this antenna

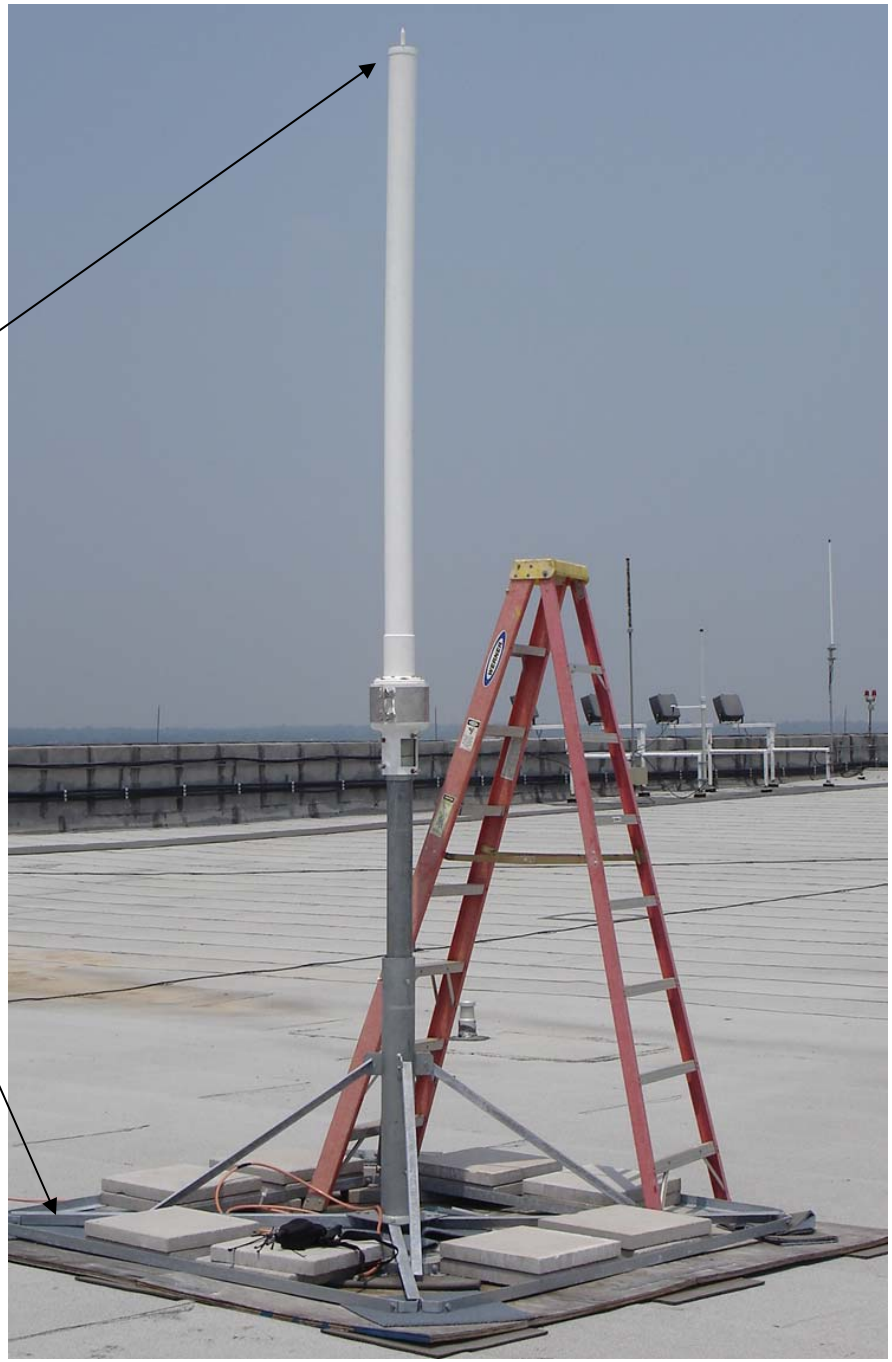
Imagery Date: 3/11/2011 29°57'37.55" N 95°20'46.07" W elev 86 ft Eye alt 257 ft

IAH FAA GBPM– GPS Receive Antenna Mount (Ballast type platform)



IAH FAA GBPM GPS Antenna / Ballast Mount Representation and Details





Center of mount base at:

29 57’ 37.23”N, 95 20’ 46.01” 85-ft MSL

(Antenna and Mount height is 18.51’ - AGL)

(Footprint is 6.5’ square)

2nd existing Heliax Cable from “Tri-Side” tower will be extended to this location (will be direct-burial and hand trenched by AJP ~25 feet)

IAH FAA GBPM Hardened Equipment Rack and Probable Location in LKM/LOC shelter

External Cables from GBPM Rackmount Unit

Ground Based Performance Monitor (GBPM) Rack

V_{AC} – 15 AMP Circuit

Fiber (SM) or RJ-45 (CAT5)

Network *

RF Cable (RG393) for VHF

RF Cable (RG393) for GPS

* “Network Cloud” includes multiple TDB components and materials to link to IAH Fiber-Ring and to dedicated T1 to FAA-Tech Center GBAS Lab

GBPM Infrastructure, Service, and Needs:

•Installation to be performed by AJP-652, w/ limited on-site support* required (next slide)

•110 VAC / 60Hz – 1 Circuit/Duplex @ 15amps (2 if available)

•Precision Survey (AJP-652 FAA Performed) – Access to PAC or SAC

•AJP-652 provided T1, and other required hardware to link-up to FAA ATCT (or other FAA local) Fiber-Ring to T1 demarcation point.

•Network/Fiber-Ring POC/assistance for extension from AJP provided T1 - demarcation to FAA Fiber Ring to LKM/LOC

•An open area (good sky view) on a rooftop, or on field, for GPS antenna ballast mount (6.5'w x 6.5'd X 10'h), and a VHF whip antenna. <LKM/LOC adequate>

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

•2 RF cable runs - (Antennas to Rack) <Available @ Location> , extensions provided by AJP-652

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

AJP-652 IAH On-Site Support* Requirements

- Primary POC for IAH (not limited to install dates)
- Temporary storage, transport, and lift of the GBPM hardware and support equipment.
- Mechanical lift for placement of equipment rack, cherry/bucket truck for GPS antenna placement.
- Dedicated AOA Escort(s), and shelter access for 2 to 3 days for AJP personnel (2 or 3) and vehicles for installation and survey.
- Access to PAC (or SAC) 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 IAH POC for on-site/remote assistance and access (not limited to install dates)

IAH GBPM Required Documents – AJP provided

- 7460 to be submitted by AJP-652, w/ HAS as the likely “sponsor” (GBAS service provider).
- Maintenance Letter or Memorandum of Agreement (MOA) between AJP-652, and IAH FAA (WCK2-IAH) with installation, duration, service, POCs, and other details.
  - Duration of GBPM service generally 2 to 5 years.
- A complete As-Planned/Installed engineering and operations package.

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

- Questions

Mr. Carmen Tedeschi
Engineering Development Services
Navigation Team (AJP-652)
FAA WJH Technical Center
Building 301, Room 305 B
ACY Intl Airport NJ 08405
609-485-7165

Please Type or Print on This Form

Form Approved OMB No.2120-0001
Expiration Date: 9/30/2010

U.S. Department of Transportation
Federal Aviation Administration

Failure To Provide All Requested Information May Delay Processing of Your Notice

Notice of Proposed Construction or Alteration

FOR FAA USE ONLY
Aeronautical Study Number

1. Sponsor *(person, company, etc. proposing this action):*
Attn. of: Houston Airport System
Name: William Zrioka
Address: 16930 JFK Blvd
<E-Mial> william.zrioka@houstontx.gov
City: Houston State: TX Zip: 77032
Telephone: 281-233-1364 Fax: 281-233-1895

2. Sponsor's Representative *(if other than #1):*
Attn. of: Same
Name:
Address:
City: State: Zip:
Telephone: Fax:

3. Notice of: ☒ New Construction ☐ Alteration ☐ Existing

4. Duration: ☐ Permanent ☒ Temporary (24 months, 0 days)

5. Work Schedule: Beginning July 2011 End Sept 2011

6. Type: ☐ Antenna Tower ☐ Crane ☐ Building ☐ Power Line ☐ Landfill ☐ Water Tank ☒ Other 2 Receive only antennas

7. Marking/Painting and/or Lighting Preferred:
☐ Red Lights and Paint ☐ Dual - Red and Medium Intensity White
☐ White - Medium Intensity ☐ Dual - Red and high Intensity White
☐ White - High Intensity ☐ Other

8. FCC Antenna Structure Registration Number *(if applicable):*

9. Latitude: Multi ° Point ' "
10. Longitude: See ° Descript ' "
11. Datum: ☒ NAD 83 ☐ NAD 27 ☐ Other
12. Nearest: City: Houston State TX
13. Nearest *Public-use* *(not private-use)* or Military Airport or Heliport:
IAH (George Bush Intercontinental)
14. Distance from #13. to Structure: IAH ATCT is 10,324 ft Distant
15. Direction from #13. to Structure: Heading From ATCT is 213* True
16. Site Elevation *(AMSL)*: See ft.
17. Total Structure Height *(AGL)*: Below ft.
18. Overall Height (#16 + #17) *(AMSL)*: Data ft.
19. Previous FAA Aeronautical Study Number *(if applicable)*:
N/A -OE

20. Description of Location: *(Attach a USGS 7.5 minute Quadrangle Map with the precise site marked and any certified survey)*

Airport - IAH (Bush Intercontinental - Houston Texas) The area is contained within the gravel parking area, and Shelter Identified as LKM/LOC which is the Localizer shelter for runway 15-R of IAH

Attachments;
HAS Surveyors report attached
BAE ARL_1900 (GPS Antenna) and Ballast mount depiction attached
VHF antenna depiction attached
7.5 Minute Quadrangle map attached
Location shelter and Triax tower pictures attached
Google Earth Mark-Up attached

21. Complete Description of Proposal:
The purpose of this project is for installation of a remote GBAS field monitor owned by the FAA - AJP-652
The location is contained to the shelter and gravel area surrounding IAH's LKM/LOC (Localizer shelter for RW 15-R)
Location use, FAA Installation Package, and Technical Instruction Manual (TIM) has been coordinated w/ Randall Stinson (FAA - SATSS 1-281-230-8477)
The installation includes 3 primary components:
1) Indoor Equipment Rack (to be installed in Localizer shelter) - TIM/Install Package available if required
2) GPS receive antenna (BAE ARL-1900) and ballast mount (ROHN BRM44510) w/ ballast for 110mph wind/load
3) VHF receive whip-type antenna (Liard/Antenex B-66, w/ base station mount), to go on an existing tri-ax tower.
Precision survey (1A), and marking for the 2 Antenna locations performed by HAS surveyor - Jeff Schmelter 6/8/2011
1) Equipment rack to be housed in the LKM/LOC shelter - cabling/power/safety detail available from TIM if required
2) GPS Receive-Only Antenna (BAE ARL-1900) and mount (ROHN BRM44510) to be located at position;
- NAD 83 Geographic Coordinates N 29 57 37.28261, W 95 20 45.96695, NAVD 88(2001) Elevation 81.26 feet (AMSL)
- Antenna and mount height 18.51 ft (AGL), Overall GPS antenna Structure Height 99.77 ft (AMSL)
3) VHF Receive-Only Antenna (Liard/Antenex B-66, w/ base station mount) to be located on existing tower at position;
- NAD 83 Geographic Coordinates N 29 57 37.33046, W 95 20 45.73424, NAVD 88(2001) Elevation 81.38 feet (AMSL)
- Existing tri-side tower height is 10.40 ft, antenna is 2 ft, so total structure is 12.40 ft (AGL), final (AMSL) 93.78 ft.

Complete FAA Installation Package (DRAFT) attached for full installation details and descriptions

Frequency/Power (kW)	
Receive	Only
Receive	Only

Notice is required by 14 Code of Federal Regulations, part 77 pursuant to 49 U.S.C., Section 44718. Persons who knowingly and willingly violate the notice requirements of part 77 are subject to a civil penalty of $1,000 per day until the notice is received, pursuant to 49 U.S.C., Section 46301(a)

I hereby certify that all of the above statements made by me are true, complete, and correct to the best of my knowledge. In addition, I agree to mark and/or light the structure in accordance with established marking & lighting standards as necessary.

Date	Typed or Printed Name and Title of Person Filing Notice	Signature
06/16/11	Carmen A Tedeschi AJP-652 609.485-7165 carmen.tedeschi@faa.gov	

Houston Airport System (HAS) Professional Surveyor Report

Prepared by Jeff Schmelter-HAS-Surveyor 6/8/2011.

Details for Installation and support of an FAA GBPM (GBAS Field Monitor) for George Bush Intercontinental Airport (IAH)

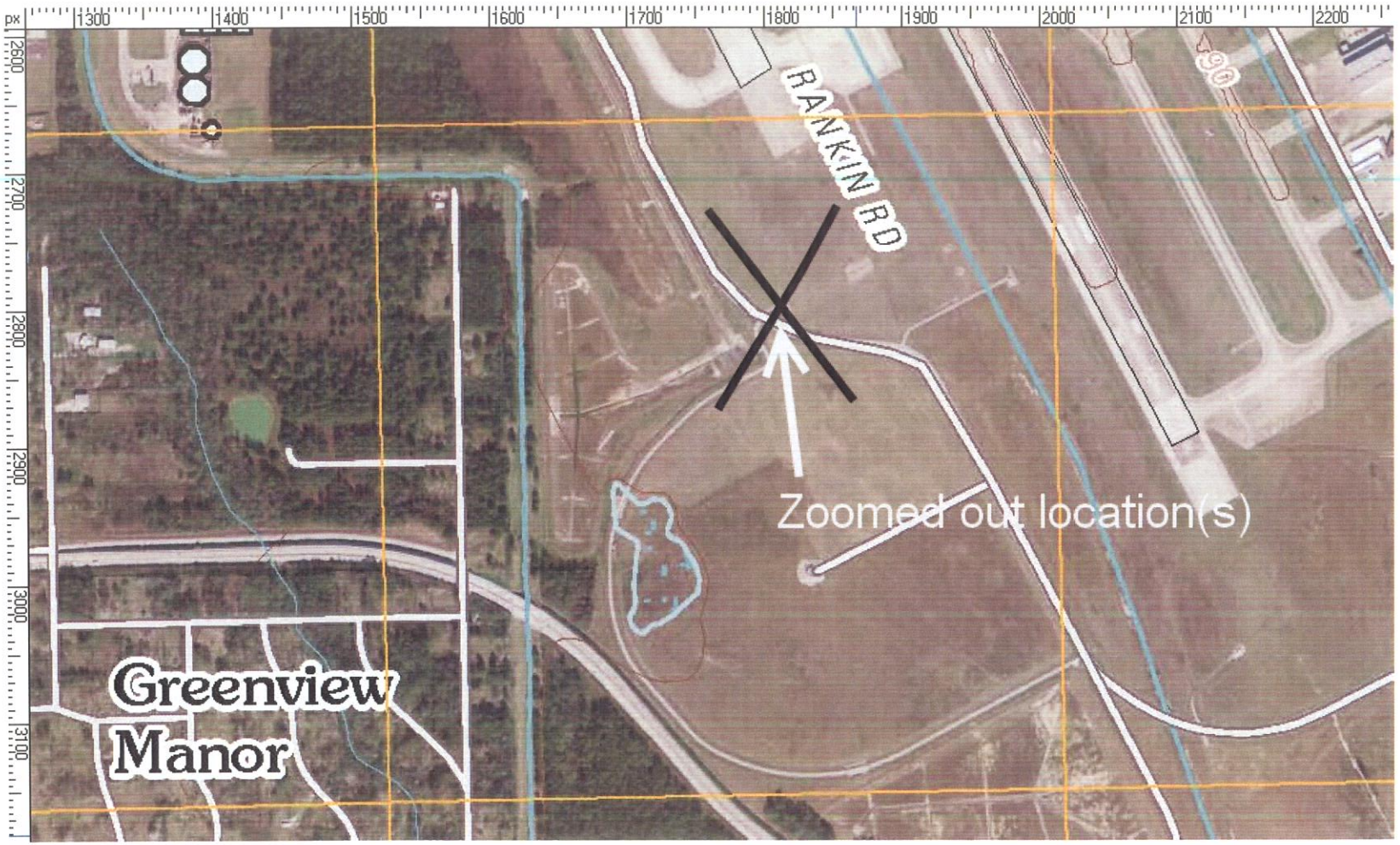
Monument and data points:

The HAS Surveyors used City of Houston monument 5465-3233 with Geographic Coordinates N 29 57 08.48655, W 95 19 59.41090, it being a Aluminum Rod inside a PVC Sleeve, with the elevation of 80.684. We used GPS RTK procedures for the survey needed.

On Wednesday June 8, HAS-Surveyor, Jeffrey Schmelter, observed and set a 60-D nail in gravel for a location of a IAH FAA GBAS/GNSS Field Monitor (Ground Based Performance Monitor)-GPBM, with NAD 83 Geographic Coordinates N 29 57 37.28261, W 95 20 45.96695, elevation of 81.26 feet for a proposed Field Monitor, with a vertical datum of NAVD 88, 2001 adjustment.

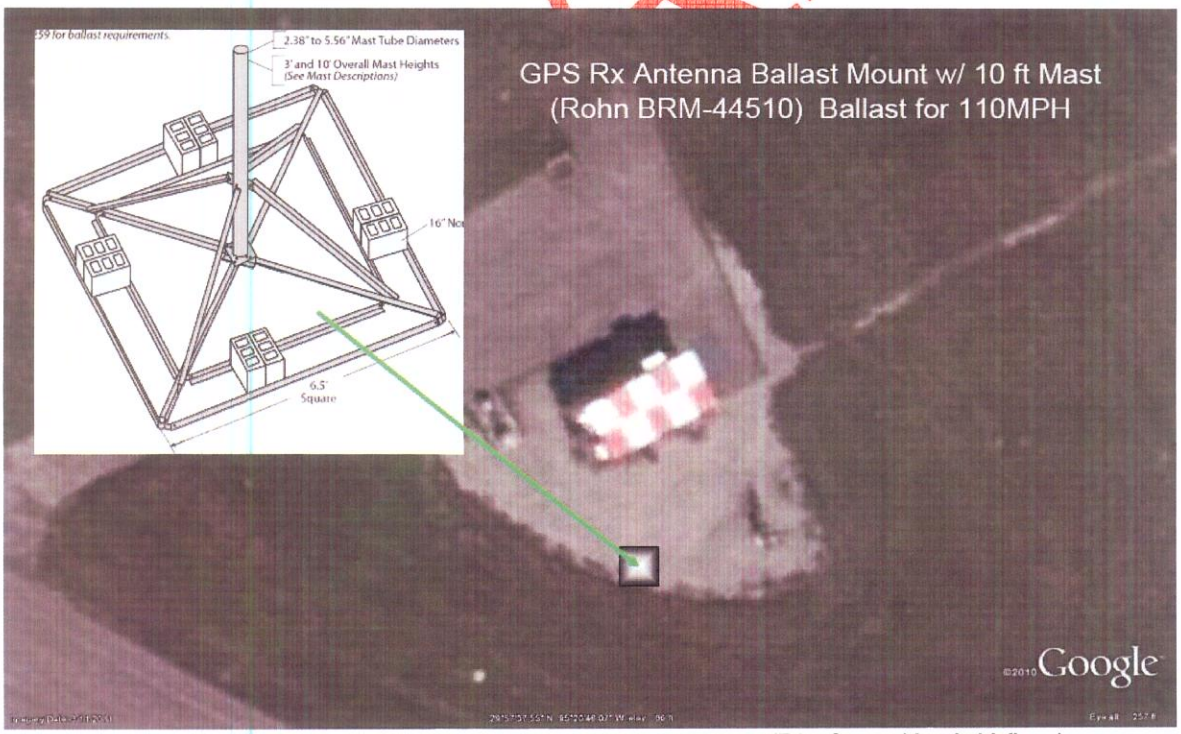
We also surveyed in one of the existing "Tri-Side" Heliax Antenna. It's Geographic Coordinates are: N 29 57 37.33046, W 95 20 45.73424, and an elevation of 81.38 at the concrete base and extending upwards 10.40 feet for the height elevation of 91.78 for the tri-sides of the Antenna mount

Accuracy 1A met or exceeded (using HAS operated Real-Time Kinematic – GPS survey station)


RANKIN RD
Zoomed out location(s)
Greenview
Manor


FAA GBAS Monitor Equipment Rack (Indoors)
GPS Antenna w/ Ballast Mount on ground
VHF Antenna On Existing Tri-Ax Tower
© 2011 Google
©2010 Google
Imagery Date: 3/10/2011 1944
29°57'37.40" N 95°20'45.97" W elev 86 ft
Eye alt 233 ft

IAH FAA GBPM, VHF Data RX Antenna (Aerial View)



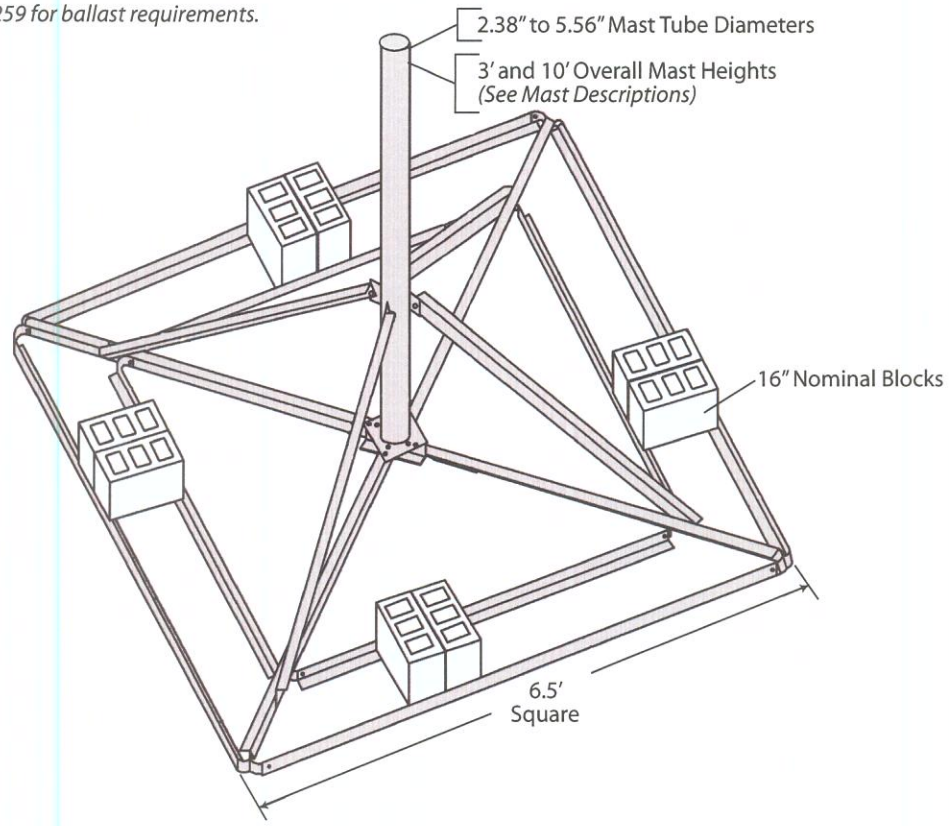
IAH FAA GBPM, GPS RX Antenna Ballast Mount/Platform (Aerial View)

BRM4
NON-PENETRATING

The BRM4 mount is hot-dip galvanized after fabrication for corrosion protection.

Order (1) optional BRM4MAT (1/8" thick) or (1) optional BRM4PAD (3/8" thick) for a protective barrier between the mount and the roof. Order (1) optional SCK150 safety cable kit (3/8" x 150').

Refer to pages 258-259 for ballast requirements.



MAST SPECIFICATIONS

Mount Part No.	Mast Part No.	Mast Description & Height
BRM425	KY1590	2.38" O.D. x 0.154" wall x 3.0'
BRM430	KY1592	2.88" O.D. x 0.203" wall x 3.0'
BRM435	KY1594	3.50" O.D. x 0.216" wall x 3.0'
BRM440	KY1596	4.00" O.D. x 0.226" wall x 3.0'
BRM445	KY1598	4.50" O.D. x 0.237" wall x 3.0'
BRM455	KY1600	5.56" O.D. x 0.258" wall x 3.0'
BRM42510	KY2061	2.38" O.D. x 0.154" wall x 10.0'
BRM43510	KY2063	3.50" O.D. x 0.216" wall x 10.0'
BRM44510	KY2065	4.50" O.D. x 0.237" wall x 10.0'

BRM4
BALLAST REQUIREMENTS

Effective Projected Area (EPA) (FT^2)	Ballast (LBS)	Zero Velocity Load (PSF)	Vs (MPH)	Vmax at centroid of projected area, (MPH)							
				h=2 FT	h=3 FT	h=4 FT	h=5 FT	h=6 FT	h=7 FT	h=8 FT	h=9 FT
2	300	7.1	171	242	198	171	153	140	130	121	114
	500	11.8	221	313	256	221	198	181	167	157	148
	700	16.6	261	370	302	262	234	214	198	185	175
	900	21.3	296	416	340	294	263	240	223	208	196
	1100	26.0	328	448	366	317	284	259	240	224	211
	1300	30.8	356	478	391	338	302	276	256	239	225
	1500	35.5	383	506	414	358	320	292	271	253	239
	1700	40.2	407	533	435	377	337	308	285	267	251
	1900	45.0	431	558	456	395	353	322	299	279	263
	2100	49.7	453	583	476	412	369	336	312	291	275
	2300	54.4	474	604	493	427	382	349	323	302	285
4	300	7.1	121	171	140	121	108	99	92	86	81
	500	11.8	156	221	181	157	140	128	118	111	104
	700	16.6	185	262	214	185	166	151	140	131	123
	900	21.3	210	294	240	208	186	170	157	147	139
	1100	26.0	232	317	259	224	201	183	169	159	149
	1300	30.8	252	328	276	239	214	195	181	169	159
	1500	35.5	271	358	292	253	226	207	191	179	169
	1700	40.2	288	377	308	267	238	218	201	188	178
	1900	45.0	305	395	322	279	250	228	211	197	186
	2100	49.7	320	412	336	291	261	238	220	206	194
	2300	54.4	335	427	349	302	270	247	228	213	201
6	300	7.1	99	140	114	99	89	81	75	70	66
	500	11.8	128	181	148	128	114	104	97	90	85
	700	16.6	151	214	175	151	135	123	114	107	101
	900	21.3	171	240	196	170	152	139	128	120	113
	1100	26.0	189	259	211	183	164	149	138	129	122
	1300	30.8	206	276	225	195	175	159	148	138	130
	1500	35.5	221	292	239	207	185	169	156	146	138
	1700	40.2	235	308	251	218	195	178	165	154	145
	1900	45.0	249	322	263	228	204	186	172	161	152
	2100	49.7	261	336	275	238	213	194	180	168	159
	2300	54.4	274	349	285	247	220	201	186	174	164
8	300	7.1	86	121	99	86	77	70	65	61	57
	500	11.8	110	157	128	111	99	90	84	78	74
	700	16.6	131	185	151	131	117	107	99	93	87
	900	21.3	148	208	170	147	132	120	111	104	98
	1100	26.0	164	224	183	159	142	129	120	112	106
	1300	30.8	178	239	195	169	151	138	128	120	113
	1500	35.5	191	253	207	179	160	146	135	127	119
	1700	40.2	204	267	218	188	169	154	142	133	126
	1900	45.0	215	279	228	197	177	161	149	140	132
	2100	49.7	226	291	238	206	184	168	156	146	137
	2300	54.4	237	302	247	213	191	174	161	151	142
10	300	7.1	77	108	89	77	69	63	58	54	51
	500	11.8	99	140	114	99	89	81	75	70	66
	700	16.6	117	166	135	117	105	96	89	83	78
	900	21.3	133	186	152	132	118	107	100	93	88
	1100	26.0	147	201	164	142	127	116	107	100	95
	1300	30.8	159	214	175	151	135	123	114	107	101
	1500	35.5	171	226	185	160	143	131	121	113	107
	1700	40.2	182	238	195	169	151	138	127	119	112
	1900	45.0	193	250	204	177	158	144	134	125	118
	2100	49.7	203	261	213	184	165	150	139	130	123
	2300	54.4	212	270	220	191	171	156	144	135	127
12	300	7.1	70	99	81	70	63	57	53	49	47
	500	11.8	90	128	104	90	81	74	68	64	60
	700	16.6	107	151	123	107	96	87	81	76	71
	900	21.3	121	170	139	120	107	98	91	85	80
	1100	26.0	134	183	149	129	116	106	98	92	86
	1300	30.8	145	195	159	138	123	113	104	98	92
	1500	35.5	156	207	169	146	131	119	111	103	97
	1700	40.2	166	218	178	154	138	126	116	109	103
	1900	45.0	176	228	186	161	144	132	122	114	107
	2100	49.7	185	238	194	168	150	137	127	119	112
	2300	54.4	193	247	201	174	156	142	132	123	116

h = Distance from support surface to centroid of EPA.

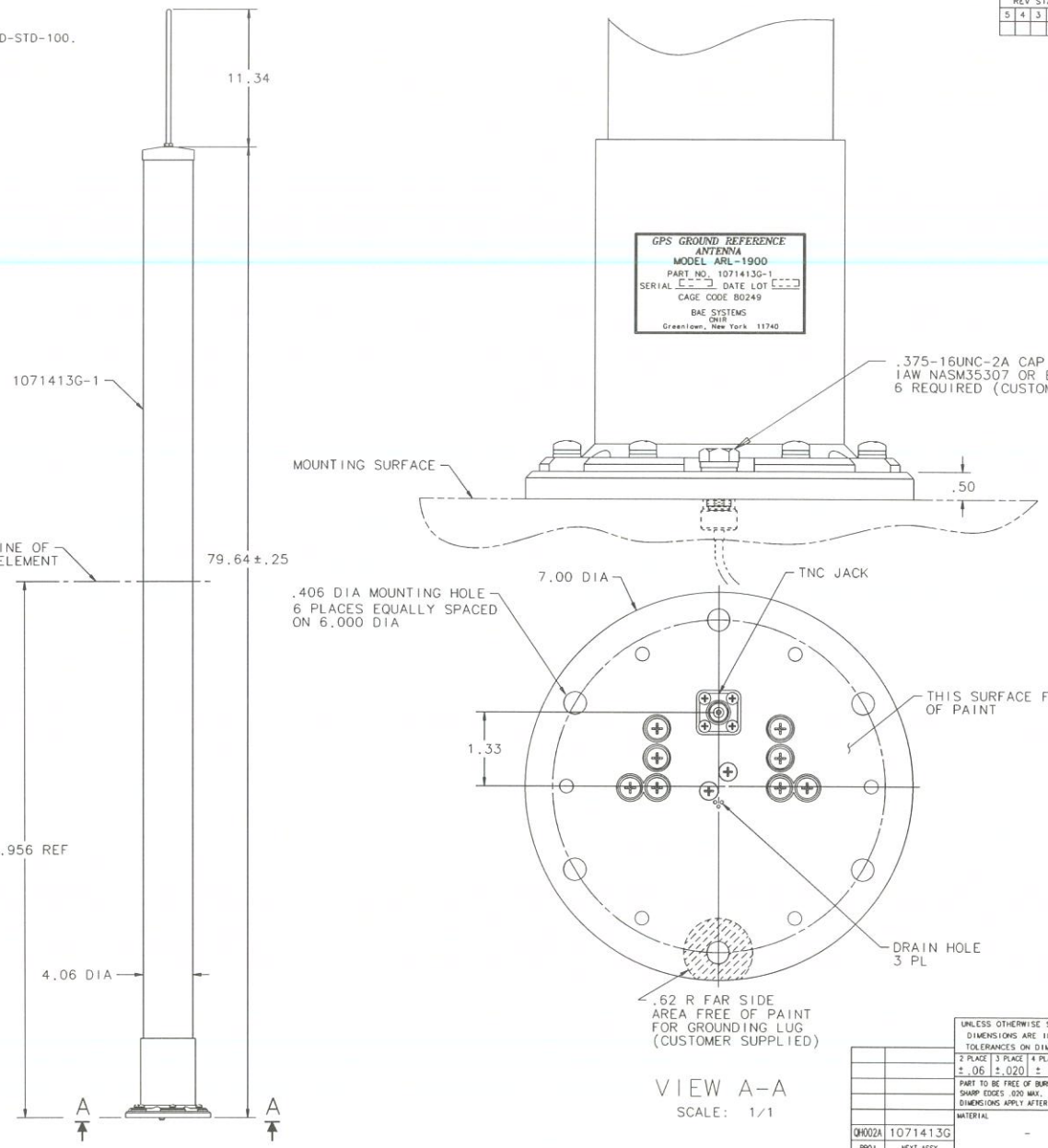
Vmax = Effective wind velocity based on strength or overturning.

Vs = Effective wind velocity resulting in sliding on a flat surface with a .50 coefficient of friction.

NOTE: *Mast strength may govern antenna capacity.*

NOTES:
1. INTERPRET DRAWING IAW DOD-STD-100.

REV STATUS OF SHEETS						REVISIONS					
5	4	3	2	1	SHEET NO.	ZONE	REV	DESCRIPTION	CN NO.	DATE	APPROVAL
					REV LTR		-	INITIAL RELEASE	CIRC-455	06/05/04	RW



VIEW A-A
SCALE: 1/1

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LEVEL OF RELEASE	APPD BY	DATE
RECORD AND FILE		
LIMITED RELEASE		
✓ FINAL	RW	05/03/06

INSTALLATION CONTROL DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON DIMENSIONS: 2 PLACE ±.06 3 PLACE ±.020 4 PLACE ± - ANGLES ± 2° PART TO BE FREE OF BURRS. BREAK SHARP EDGES .020 MAX. DIMENSIONS APPLY AFTER PLATING. MATERIAL -			CONTR	N/A			BAE SYSTEMS INFORMATION AND ELECTRONIC SYSTEMS INTEGRATION INC. COMMUNICATION, NAVIGATION, IDENTIFICATION AND RECONNAISSANCE Greenlawn, N.Y. 11740				
			BY OR APPROVED		YR	MO	DAY				
			DRAWN	S.K.	05	11	17	TITLE			
			CHECKED	RW	06	05	03	GPS GROUND REFERENCE ANTENNA			
			ELEC	GS	06	05	03				
			MECH	JR	06	05	03				
			QA/IE	GO	06	05	04	SIZE	CAGE CODE	DWG NO.	
QH002A	1071413G		ISSUED	RW	06	05	03	D	80249	1071424P	
PROJ	NEXT ASSY			GN	06	02	02	SCALE 1/4		SHEET	

ORIG G USE G FAB 2 CAD CAM 1

DWG NO. 1071424P SH

R 14