Rural Training Center-Thailand: EmComm Paper

Sam: New Year Upgrade

www.neighborhoodlink.com/org/rtcth E-mail: rtc2k5@gmail.com

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For 2012 the American Radio Relay League (ARRL) launched the DIY (Do It Yourself) with Ham Radio campaign. We like to think of Sparky and Sam as RTC-TH DIY ham radio projects. In support of the ARRL program, we will endeavor to attach the ARRL DIY button to appropriate RTC-TH EmComm projects throughout 2012.

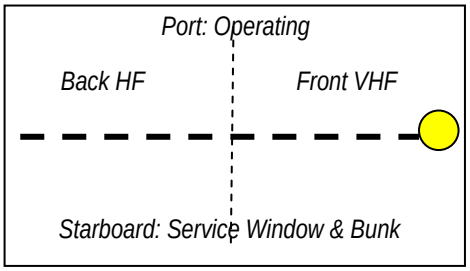
The ARRL DIY ("Do It Yourself) campaign theme

After a number of delays and starts and re-starts, we began work on antenna and mast mounts for Samantha ("Sam", the Volts-wagon) the RTC-TH EmComm portable field station. Sam could be parked at an emergency shelter, relief helicopter land zone, or anywhere needing an off-the-grid emergency radio communications station.

Sam is still under construction.

RTC-TH EmComm radios could be moved from a fixed base station for use in Sam. We plan to equip Sam with an array of portable VHF and HF omni-directional and directional antennas. The key issue was if the antennas would be mounted on Sam or set up separately nearby Sam.

Important considerations were rapid deployment, easy of set up / take down with 1 person (minimum), compact size (thinking this goes hand in hand with easy set up), and low-cost (the RTC-TH operates on a shoe-string or sometimes less).



General layout: HF (back half), VHF (front half); operating (port side--- top in this diagram); service window / bunk area on the starboard side).

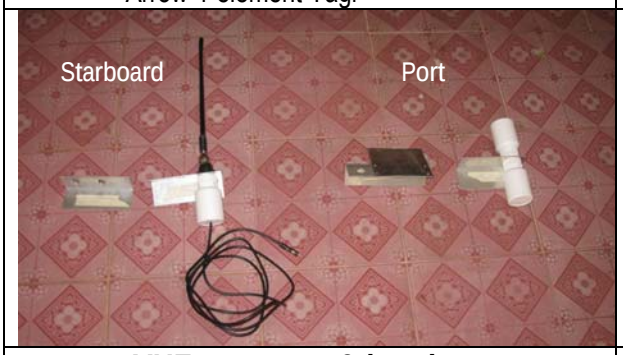
Early on Option 1 was to mount antennas on Sam. The idea was to use the weight of the trailer to help stabilize the portable push-up masts. This also meant not having to put stakes in the ground. If operating in rainy monsoon conditions, mud or saturated soils might not provide a firm anchor to masts and guy lines.

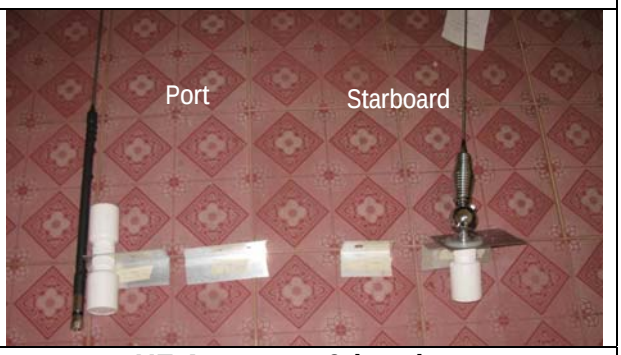
Using Sam and its steel frame as part of the antenna mount also tied it to the copper plate station ground bus panel. (ICE #602 anti-oxidant mixture will be used between the aluminum brackets and steel frame. ICE#603 will be used on galvanized hardware to steel contacts.)

The table on the next page summarizes the possible antennas and brackets on Sam.

Notes: 1. Over time, various antenna projects may change the list of available antennas. 2. Some antennas may be shifted back and forth between Sparky and Sam as needed. 3. At this time, there is no HF radio assigned to Sam. The HF antenna options are in case the HF radio is used in Sam depending on the EmComm deployment needs.

VHF Antennas Onboard Sam	HF Antennas Onboard Sam
• Tram 1150 5/8λ vertical whip on NMO magnetic mount • 2m Sling shot beam (large diameter alum tubing) • 2m Hentenna (beam antenna) • Thai Slim Jim (aluminum tubing) Optional: Kenji DP-CL2E 144-150 vertical whip Arrow 4-element Yagi	• Super Antenna MP-1 multi-band vertical whip • 1 wire (40m / 80m) NVIS antenna • Ball/spring mount whip + wire NVIS antenna Optional: OPEK HVT-400 multi-band vertical whip





VHF antennas & brackets				HF Antennas & brackets			
Starboard		Port		Port		Starboard	
Inboard	Outboard	Inboard	Outboard	Outboard	Inboard	Inboard	Outboard
2 open slots for future expansion	1 open slot; AM/FM antenna	1 open slot; plate for NMO magnetic mounted 5/8 λ whip	1 open slot; Kenji DP CL 2E 144-150 MHz vertical whip	1 open slot; OPEK HVT 400 multi-band vertical whip	1 open slot; 1 wire dual band NVIS 40m / 80m	1 open slot; space to clamp Super MP-1 multi-band vertical whip	Ball / spring whip + wire NVIS
Lightning Arrester				Lightning Arrester			
ICE #302		ICE #302	ICE #302	ICE #300	ICE #308	ICE #300	ICE #308
Possible VHF Antenna Switch Position				Possible HF Antenna Switch Position			
		1	2	1	2	3	(2)
Starboard Mast		Port Mast		Starboard Mast		Port Mast	
Weather mast for Davis Weather Wizard III; masthead open for vertical VHF whip		VHF vertical, beam, or combination of both		Open for future expansion		Multi-band Inverted Vee Dipole wire antenna	
Alternate VHF Antenna Switch Position				Alternate HF Antenna Switch Position			
(3)		(3)	4			4	
Lightning Arrester				Lightning Arrester			
ICE #302		ICE #302	ICE #302			ICE #309	

Push-up Mast Options				
Height options →	Lowest	Middle		Highest
Silver	1.4m	2.63m	3.74m	4.91m
Blue	1.42m	2.4m		3.39m

Notes:
1. Antenna switch positions can be reassigned based on antennas being used on any particular day.
2. Any particular antenna switch may or may not be fully used on any particular day.
3. Lightning arresters, like antenna switch positions, are limited in number. Not all antennas may be set up and used on any particular day.
4. Antenna hieghts vary depending on the wind conditions and the PVC extensions used with a particular antenna above the mast heights given in the table above. (See details packed with each antenna.)

The heavy monsoon rains in northern Thailand made us reluctant to drill holes in Sam's shell, especially the roof. Sam's exterior skin is light weight sheet aluminum incapable of supporting various types of surface antenna mounts. After careful thought and planning, we opted to use brackets mounted by drilling horizontally into Sam's structure steel framework. At this point in time, Sam's internal wiring is minimal, so it was relatively easy to avoid drilling into the wiring harness.

Just like working on an old house, once you start a task, Mr. Murphy shows up and a seemingly "simple" task soon cascades into a string other work that further delays completion of the original task.

Gordon "Gordo" West (WB6NOA) believes EmComm hams should be able to set up their radio equipment and get on the air in 60 minutes or less. So the RTC-TH EmComm goals for Sam are:

- **Speedy Solo Set-Up:** The KISS approach of RTC-TH EmComm is based on worst-case scenario thinking. With this in mind, Sam is planned for single-handed set up and operating following West's 60 minute rule of thumb. A big factor meet this goal is having just about everything onboard Sam ready to roll. Sam is intended to be a portable field station ready to go.
- **Independent / Off-grid Operating:** To be consistent with the basic RTC-TH philosophy, we also need to operate in a self-sufficient and sustainable manner. In the future Sam will have solar battery recharging capability.

Background:

Sparky and Sam (Samantha) are the manifestation of an integrated concept of an alternative energy demonstration vehicle and field EmComm (emergency communications). All electric vehicles and battery power for emergency radio operations seems to be a "no brainer."

Plans to set up a traditional "ham shack" got shelved when we had to devote time at 2 different locations about 10 km apart. There wasn't enough budget or radio equipment to set up 2 stations. Building one station at one location when operating out of 2 places seemed too limiting. The compromise was to operate portable and move the limited equipment between the two locations.

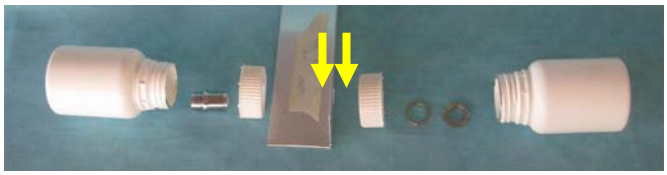
Sam was a fairly clean slate. The interior only had a 12 VDC ceiling light and the 12 VDC circuit box with a toggle switch for the emergency beacon. Sam's interior is 1.45 m wide, 2.2 m long, and 1.14 m high. Power comes from two 6 VDC wet cell batteries wired in series for a total of 225 amp hours. They are stowed externally in front of the rear axle. The port (left) side of the container box is the door. When open, it provides shade and ventilation for the operators.

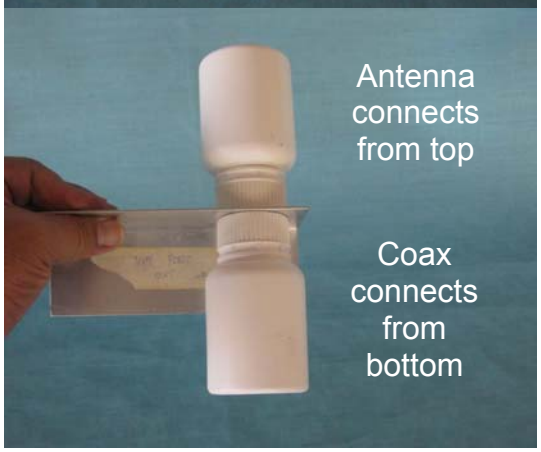
With careful planning and efficient space utilization, we seek to have an effective portable "Go shack" rather than typical "Go Bag".

Sam's antennas cannot be mounted permanently due to the low ceilings of the various parking structures available on our properties. Outdoors, Sam must be stopped, parked, and chocked before any antennas can be set up. This means the bracket mounted antenna connectors are exposed to the air and environment until any antennas are connected. In addition to the normal dust and grime when parked (even indoors), field conditions in Thailand can also mean lots of rain.

We developed an antenna connector shelter for use on Sam. We collected empty vitamin pill bottles and the packet of silica gel that came with them. We removed the label and put the silica gel packet aside. After removing the cardboard cap insert, we drilled a 5/8 inch diameter hole for an SO239 bulkhead connector in the center of the cap.

Placing the bottle on the right-angled aluminum stock for the antenna bracket told us where to drill the hole for the connector.

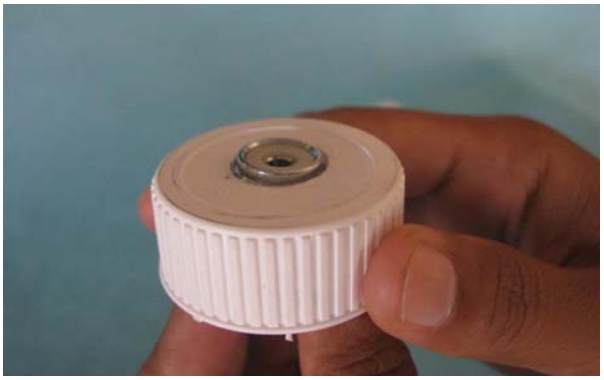




Applying silicon sealer to each cap and the bracket (yellow arrows in the photo) assures a water tight seal to protect the connector. The bottle caps are mechanically attached to the bracket by the SO239 and the silicon sealer.

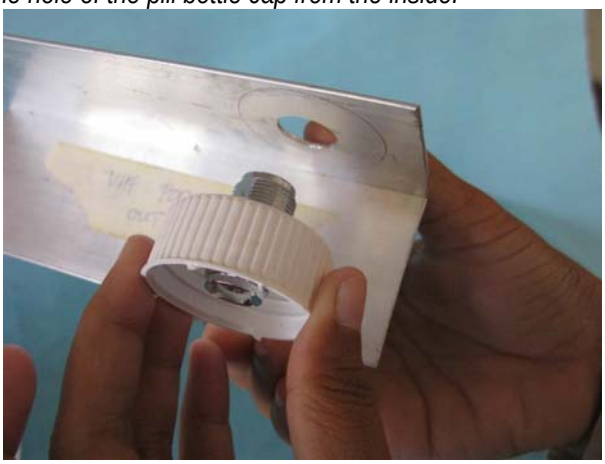
The antennas and coax are stored in Sam until there is a need to connect them. The connectors needed protection from the top and the bottom. When the bracket is mounted on Sam, whether Sam is parked indoors or outdoors, the connector is protected from dust, grime, rain, dew, or sunshine. Over time, the plastic of the pill bottle may deteriorate, so we keep collecting these since we continue to consume vitamins. And this is another example we can use at Na Fa Elementary School to reinforce the "Reduce, Re-Use, Recycle" lessons.

The following photos show the step-by-step assembly sequence of the SO239, aluminum bracket and the bottle caps. Carefully disassemble the SO239 bulkhead connector. The threaded section with the lock washer and nut is the end where the antenna will attach to the SO239.

Hold the short end of the SO239; insert it in the hole of the pill bottle cap from the inside.

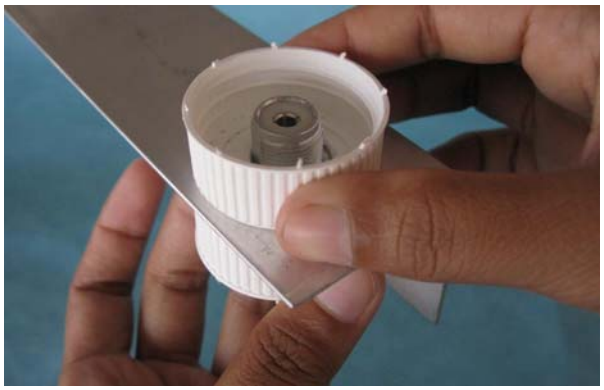
Push the SO239 flush against the inside of the cap.



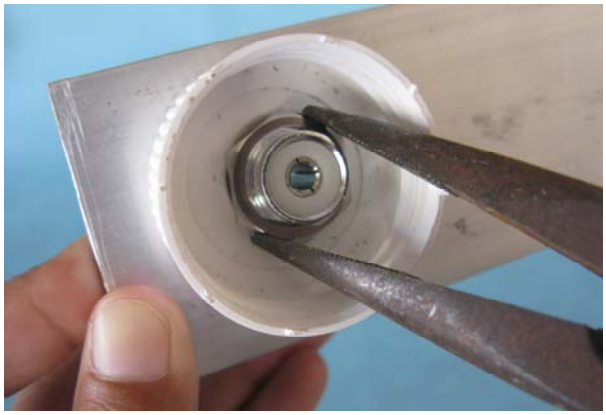
Put a bead of silicon sealer on the cap.

Insert the connector into the hole in the bracket.

Put a bead of silicon sealer on the cap.




Apply the silicon sealer sparingly. As you tighten the fitting, the compression will force the sealer through the hole around the SO239. Be careful not to clog the fitting.



Be care not to cross thread the nut. Use needle nose pliers to tighten the connector to the bracket.

Basic parts for the bottom mast mount support are a metal sleeve (to hold the mast) and a metal tab to attach the mount to Sam's frame. The tab also forms a "slotted" bottom for the sleeve to allow rainwater to drain out. It also supports the smooth surface to rotate the mast.

Welding the bottom mast bracket to Sam was a 2 step process. First, the sleeve and tab had to be welded together. The thin metal of the sleeve called for careful welding as it could easily melt

Mark (N7YLA) successfully used a golf ball as a means to easily rotate a Yagi (beam) antenna on his mast in a similar sleeve. We didn't have access to golf balls. The roller ball from the empty deodorant bottle proved to be too small. But the cap from the bottle seemed to work well.

Pi Korn welding the "tab" to the "sleeve".

The tops of empty discarded deodorant bottles provide a smooth surface allowing easy mast rotation.

A good part of the DIY effort is making do with what you have on hand. That is especially true for our projects in rural Thailand and our shoe string budget. Many discarded items would end up in a landfill. We also want to get "full value" for our money. So what may appear to be a pack rat mentality actually saves us cash on our projects.

Rear mast mounts must clear lights and wiring.

The base tab is welded to Sam's steel frame

The mast would slip into the base sleeve.

The 2 rear mast mounts are designated for HF use.

This simple mast support system has the advantage of rapid mast set up without the need for stakes or mast stands on the ground. Also, if necessary, everything attached to Sam can be moved a short distance simply by lowering the masts and moving Sam. The key disadvantage of the simple mast supports is minimal adjustment for leveling. There is some flex in the system to handle only a few degrees adjustment. A 2 axis base sleeve adapter has been designed and is on file if needed.

Front mast mounts are symmetrical to the rear mounts.

Welding the base tab to the frame.

The 2 front mast mounts are designated for VHF use.

A touch of paint finishes off this part of the installation.

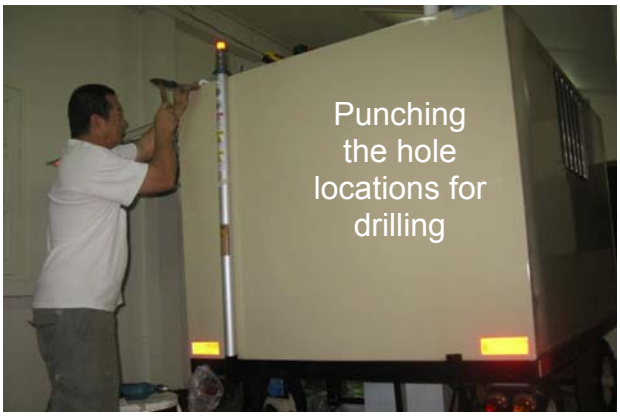
Front mast mounts are symmetrically to the rear mounts.

Welding the base tab to the frame.

The 2 front mast mounts are designated for VHF use.

A touch of paint finishes off the basic installation.

The upper end of the push-up masts are supported by 2 antenna brackets on either side of the mast. To properly position the brackets, a mast was held in place and "plumbed" for verticality. The outboard bracket was positioned, bolt holes marked, punched, and drilled. Once mounted, the mast was checked for plumbness again. Then the second bracket positioned, holes marked, punched, and drilled. An additional challenge was to position bolt holes to match the structural beams inside Sam



The upper mast support consists of a pair of roof level antenna brackets. The ring-eye bolts are for tie-downs to secure the mast to Sam. The yellow arrows point to rubber chaffing guards and more SO239 fittings.

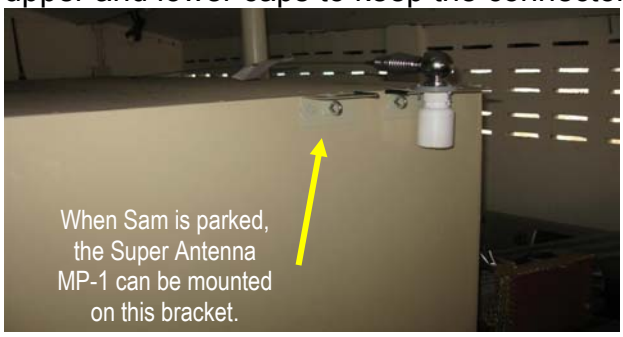
You can readily see how easy it is for one person to slip the bottom of the mast into the base sleeve. This automatically aligns the mast between the two upper antenna brackets. Lashing the mast in place with cord attached to the 2 eye bolts. A quick check with a spirit level and adjusting the mast if needed and we are ready to mount an antenna. Then the antenna is attached along with the proper coax, ICE jumper to the relevant antenna switch positions. Just push up the mast, and you should be able to get on the air in a matter of minutes---far below Gordon West's 60 minute rule of thumb.

When the SO239 connector is not in use, the pill bottle shelters protect it from dust, grit, grim and the weather. The antenna connects at the top. The coax jumper to the ICE lightning arrestor connects at the bottom.

We applied silicon sealer around the bolt holes and along the upper edge of the antenna brackets before the bolts were finally tightened to complete installing the antenna brackets. This added precaution goes a long way toward protecting Sam from leaks and interior rust. Any water infiltrating might go unnoticed in the hollow interior structural frame members through which we drilled through to complete attaching the brackets.

When the SO239 connectors are not being used, they can also fall prey to insects such as mud dauber wasps building nests in all sorts of nooks and crannies. The silica gel pack that came with the vitamins in the bottle were also put to use protecting the SO239 connectors from moisture.

If rain falls during operations, a plastic bag is used to keep rainwater from the antenna filling the upper cap. Silicon sealer used during installation weatherizes the upper and lower caps to keep the connector dry.



Right rear corner bracket for a spring/ball whip antenna. This will be modified to mimic the whip + wire HF NVIS antenna system mounted on Sparky's front bumper.

The Super Antenna MP-1 the primary HF antenna on Sam. An attachment point still needs to be finalized for a 1-wire dual band NVIS antenna. Space is available on Sam for the OPEK HVT-400 mobile multiband antenna (primarily used on Sparky).

In the future, other wire antennas can be deployed on the push-up masts. These have yet to be determined and will be the subject of future DIY projects.

From these antenna brackets and masts, feed lines go to the station bus bar where ICE lightning arrestors are available before connecting to the HF antenna switch and the radio.

Sam's grounding begins with the steel frame. A separate #6 AWG copper grounding cable can be used to attach Sam to the ground ring at a station site.

The front mast mounts were more challenging due to the electrical wiring. The main panel is located on the front interior wall near the ceiling where the exterior antenna bracket bolts emerge. So we had to disconnect the batteries for safety and relocate the panel.

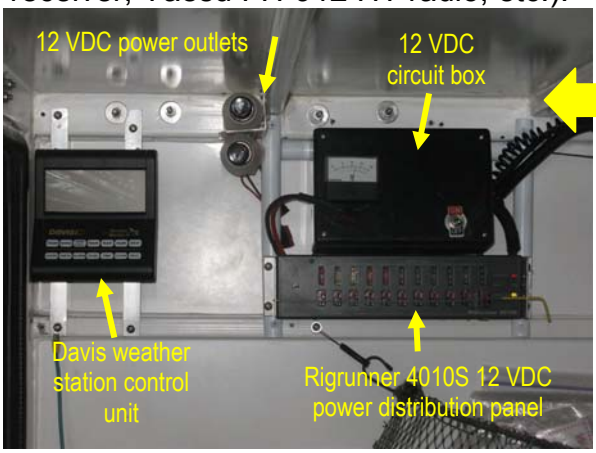
The front antenna brackets share the roof edge with the emergency beacon. To the left of the beacon is a bracket with an AM/FM antenna. This will connect to a radio inside Sam. The brackets to the right of the beacon has a steel platform

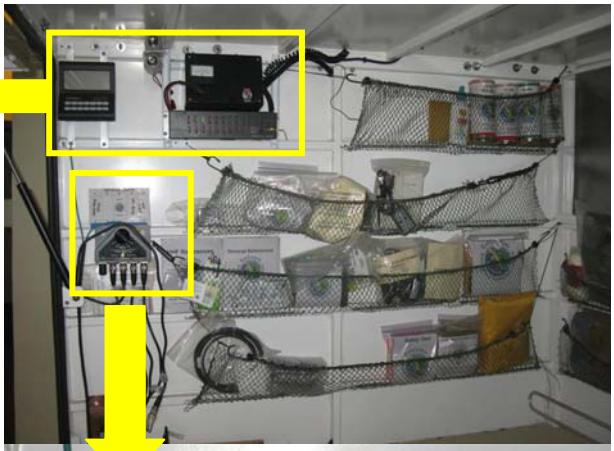
for the Tram 1150 5/8λ 2m VHF whip antenna on an NMO magnetic mount and an SO239 weatherized fitting for optional use of the Kenji DP-CL2E VHF antenna (usually carried on Sparky as a backup mobile whip). The Tram 1150 on a magnet mount is the primary VHF antenna to get on the air rapidly.

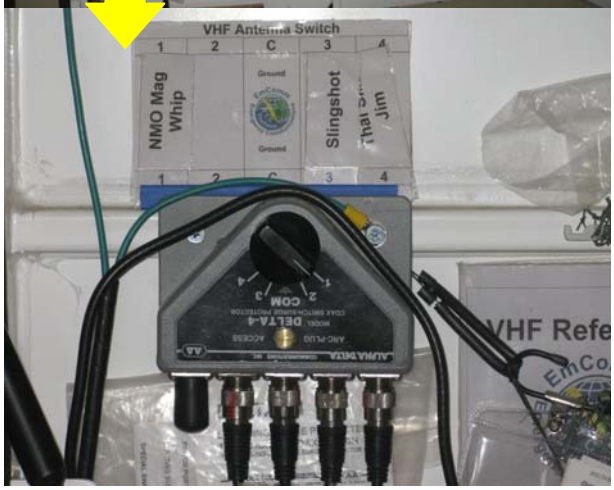
The placement of the bolts for the VHF exterior antenna brackets forced moving Sam's circuit box. This box controls and powers the emergency beacon (see toggle switch on the box in the photo) and provides power to the interior ceiling light and the Rigrunner 4010S 12 VDC power distribution panel for the radios and related equipment. Moving the main circuit box also forced moving the Rigrunner. We had to make an integrated mounting bracket to hold both units (see photos below).

The Rigrunner 4010S was centered below Sam's circuit box. This made room for the Davis Weather station control unit. This also puts it at the VHF Control Radio Operator's position. [**Note:** The VHF operating position is considered to primary operator position in Sam as VHF is more commonly available in Thailand.]

Two 12 VDC power outlets are located near the ceiling between the weather station display and Sam's circuit box. Various units can be powered from the 12 VDC outlets or by their own internal batteries (e.g. the Davis weather station, GPS receiver, Yaesu FH-912 HT radio, etc.).







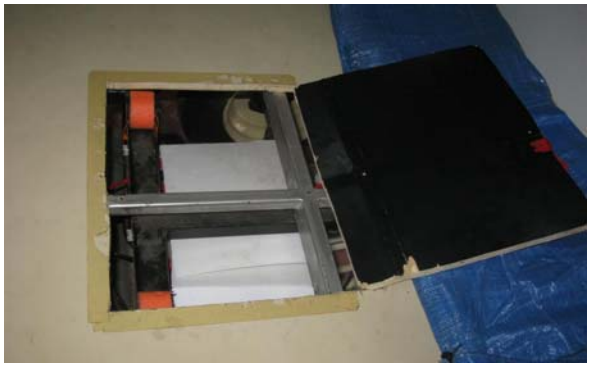
The photo above shows the Davis weather control unit, 12 VDC sockets, Sam's circuit box, and the Rigrunner 4010S. The upper right photo shows Sam's entire interior front wall. The photo on the right shows a close up of the VHF antenna switch and the placard showing which antenna is connected to which switch position. The placard is adjustable allowing different antenna name tags to be posted to the appropriate VHF switch position. Jumpers connect the switch to the ICE lightning protection units under Sam.

The VHF (left photo) and HF (right photo ICE lightning arresters stowed with jumpers to their respective antenna switches. The ICE bus bars are installed on the main ground bus under Sam during operations. In the works is a heavy duty ground cable. This would be used to connect Sam to the station ground ring at either of our licensed operating stations.

Overhead stowage of 2m VHF antennas (Tram 1150 magnet mount and the Thai Slim Jim). The Tram can be set up very quickly to enable almost instant "get on the air". The Thai Slim Jim is intended for use with a push-up mast for greater range. Both antennas are in easy reach once the side door is opened. Unhooking the bungee cord from the S-hook releases the antennas.

Sam's batteries are normally charged via a custom charger on 220 VAC line power. The connector is externally mounted on the left rear frame. We are exploring alternative charging methods to have more flexibility in recharging the batteries.

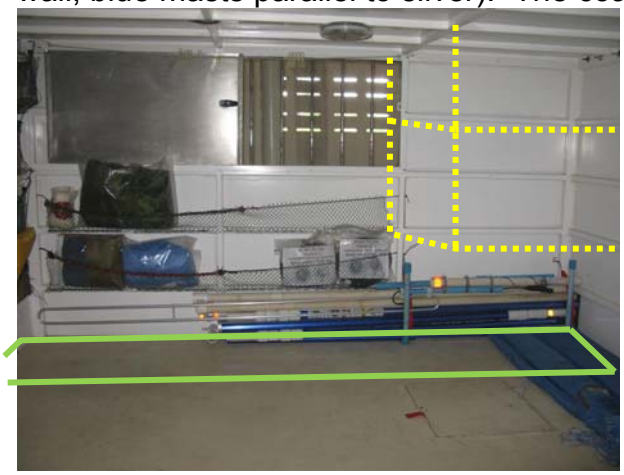
We had to cut through the plywood floor to make a battery access service panel. Unfortunately Sam's framework only allows us to check and service the batteries. If they need to be removed, it must be done from underneath Sam.



I used left over pieces of corrugated plastic “future board) to make battery covers for all of Sam’s batteries. The red pull tab lifts the cover panel. The white covers on the batteries are corrugated “future board”. These provide protection against accidental shorting of the battery tables should conductive material accidentally fall on top of the batteries.

Safety is always on our minds. We added foam corner guards for Sam’s side door. The bright orange color and the hot pink flagging give folks warning to avoid walking into the door. The door corners are about 1.6 m AGL (above ground level) when opened. The doors are supported by pneumatic struts. But we also have safety bars to lock the door in the open position to keep them from accidentally closing. The door is also a good sunshade for the operators.

A storage rack for the 4 silver and 4 blue push-up masts was made starting at the rear right corner. The masts are stacked on top of each other (silver against the wall; blue masts parallel to silver). The coax feed lines for the masts are stowed in Net bins immediately above the masts.



Interior view of the service window wall and push-up mast storage.

Plans call for a storage rack system to hold plastic storage bins (see yellow dashed lines in the photos). These would hold support supplies for a deployment.

A closed cell foam sleeping mattress wide enough for 1 person is planned for the space outlined in green lines in the photos above. When folded in 3 sections, it forms a seat for the person at the service window.

Small hanging work desks are being designed for the service window and each radio operating position. Also in the are regular and night (red) LED lights over the work desks. The LEDs draw less power and would help conserve battery power.

The next phase of work depends on getting the necessary supplies, hardware, fittings, and materials. There are numerous challenges in the DIY effort for Sam. Not only is it difficult to find quality ham radio parts and equipment, even finding common hardware can be a daunting task. Limited secure work space is another

hurdle. We often joke and call our “workshop” the “wonder works”.

The typical work day on Sam begins with emptying the boxes of tools, supplies, etc. securely stored overnight in Sam. Working out of boxes is like living out of suit cases. We don’t have a work bench or table. We end up sitting or kneeling on the floor to do the work. To find a tool, part, fitting, or hardware item, you need to search through the appropriate box. Efficiency is a pipe dream. If you can imagine your work space is a closet and you must move everything out of the closet so you can get into the closet to begin work modifying the closet, you have an idea of how we have to work on Sam. So yes, sometimes it seems a wonder we actually can get the work done.



The general appearance of Sam’s interior after the New Year upgrade.