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March 26, 2025

To: EDGES group
From: Rigel C. Cappallo
Subject: EDGES-3 repair trip to Adak, AK, March 2025

1 Background

The EDGES 2024/25 winter observational campaign on Adak Island in Alaska has faced many challenges. Difficulties with the autonomous system were numerous, with a large chunk of them owing to the gas-powered generator. To that end, one additional maintenance trip was performed by John Barrett and Ken Wilson in late January.

In late February a new issue with the antenna arose, leading to a large dip around 60 MHz in the measured antenna S11. From the data it was inferred the most likely culprit was the brass nut at the SMA connector no longer making electrical contact with the aluminum antenna box. This issue ensured that no useful data could be collected, so it was decided to send Rigel Cappallo on one more maintenance trip in early March. The goal of this trip was to correct the issue with the antenna, and to try to make the generator finally perform as it was originally designed to. The following is a report on that maintenance visit.

2 Maintenance

2.1 March 12$^{\text{th}}$

The plane into Adak landed a bit ahead of schedule (around noon local time), which allowed me to drop off my things and get out to the site for a significant amount of time. The site itself was a little worse for the wear, with various things unplugged and unmounted and snow drifted about in the hut (and on the batteries, Fig. 1). The weather made it inadvisable to attempt the fix on the connection; very strong winds coupled with copious amounts of unrelenting sideways rain guaranteed there was no hope of keeping the surfaces hot and dry. With that task abandoned for the day, I turned my attention to the hut and generator.

After some general housekeeping and plugging things into their proper places, I opened up the generator and replaced the altered valve cover with the brand new one I had cannibalized from the back-up generator at Haystack (Fig. 2). Everything in the electronics box was still functioning nominally. I started up the generator and left it to run for $\sim$ five hours in order to fully recharge the batteries. After that it was set to shut off, with an antenna S11 and then sky data to be taken

overnight.

Figure 1: The electronics hut upon arrival to the site. Snow had drifted clear to the back of the hut, covering the batteries in the process.

Figure 2: *left:* The previous valve cover with the alteration to allow a second fuel line. *right:* The new valve cover, without the post-production alteration.

2.2 March 13th

Morning delivered driving snow with a few inches already on the ground. When I arrived at the site the generator was running, having started automatically about 30 minutes previously, but then it died a few minutes later. It was still snowing and blowing too hard to attempt the connection repair, so I decided to see if the external fuel pump we had sent was actually running. I tested the voltage after the 24 V to 12 V converter and found it was zero. I iterated with Chris Eckert via email and we decided to remove the converter from the circuit by wiring the pump directly to the 12 V generator battery.

There was one more generator issue worth mentioning. I had disconnected the serial connection at some point to perform some diagnostics, and when I plugged it back in (with the generator off but the electronics box on) there was a spark that jumped the gap. After this event, everything still seemed to be functioning properly.

Fortunately, around noon there was a break in the snow and I decided it was the best time to attempt the antenna repair. Once I removed the shielding and the grease, I saw that the brass nut was loose (i.e. I could easily turn it with the tip of my finger, left panel of Fig. 3). I also noticed that most of the dielectric grease had leaked out of the SMA connection covering and run down the side of the antenna, ultimately resting upon the top of the small aluminum box above the pipe.

I cleaned both surfaces with Q-tips and alcohol, applied polish to abrade the surfaces, covered the area with conductive epoxy, and tightened the brass bolt. Then with a heat gun I kept the area at 150 $^{\mathrm{O}}$F for two hours to cure the epoxy (Fig. 3, right panel). Once cured, I applied more dielectric grease to the connection and re-covered it, this time leaving the opening slit on the inner SMA connection cover facing the sky, in hopes of ameliorating the leaky grease issue (Fig. 4).

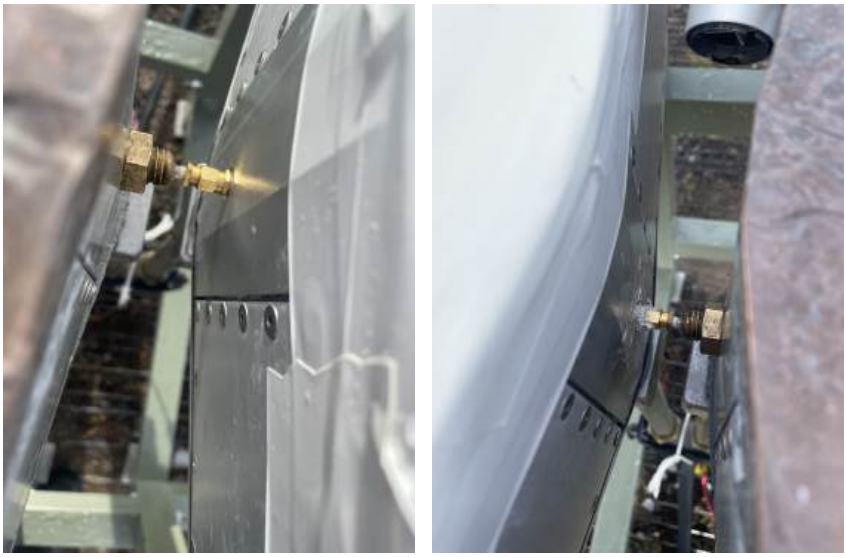

Figure 3: *left:* The connection after removing the covers and grease. *right:* The connection after the epoxy was applied, being cured by the heat gun just visible in the top of the photo.

Figure 4: *left:* The connection between antenna boxes before the repair was performed. *right:* The connection in its final state after the repair.

2.3 March 14th

After the previous day's antenna repair we looked at a quick antenna S11, and unfortunately it still looked terrible, essentially the same as it had before the repair. So John Barrett, myself, and Alan

Rogers met virtually to discuss other possibilities. We decided to check the continuity between the two antenna boxes via the brass pipes. I found there was a break between the top of the brass pipe and the little aluminum box under the electronics half of the antenna, with a DC resistance of $\sim 15{,}000\ \Omega$. The corrosion was extensive, as brass and aluminum are far apart on the galvanic scale, and the sea is on the order of hundreds of meters away (Fig. 5, left panel). To fix the connection, I loosened the brass bolts and cleared away the corrosion, first with the blade of a knife and then by cleaning and polishing (Fig. 5, right panel).

Figure 5: *left:* Corrosion visible at the interface between the top of the brass pipes and the small aluminum boxes. *right:* The same area after polishing and cleaning.

Turning my attention to the genertor, I rewired the external fuel pump to be powered directly from the 12 V generator battery (though still controlled by the Arduino), removing the potentially faulty converter (Fig. 6). For the task I used leftover 18 aug copper wire from the ground plane.

The antenna was left to perform a full antenna S11 and then take sky data overnight.

2.4 March 15$^{\text{th}}$

The scheduled departure flight was on this day, but due to 30 MPH sustained winds coupled with freezing rain, the flight was delayed a day. This turned out to be fortuitous, as the antenna S11 was still showing some signs of poor electrical connections, although it was somewhat improved from earlier.

The conduit for electricity from one box to the other, through the brass pipes, has six interfaces where corrosion can build, three per side: the point where the bottom panel of the box meets the small aluminum box, the point where the bottom of the aluminum box meets the top of the brass pipes, and then the point where the bottom of the brass pipes meets the aluminum of the black box (Fig. 7). Using a multi-meter, I found there was still resistance in that circuit of the order 10 Ω, specifically where top of the small aluminum box meets the bottom panel of the empty antenna

box. This was more difficult to fix, as the nut that tightens that connection cannot be accessed without removing the top panel of the antenna box, which I did not have time to do. I cleaned and polished the area, and then applied some of the conductive epoxy remaining from the earlier repair. It was not cured, as the weather was not amenable to that, but the thinking was that even uncured, it would still conduct. After all six connections were cleaned and polished thoroughly, the resistance between the two boxes returned to zero. This failure mode is bound to recur, given the environment, but the hope is that it will not happen before the end of the observing season, which is April 23$^{\text{rd}}$.

Another new issue arose on this day, where we lost contact with the VNA, thus rendering calibration impossible. From the power management system it was clear that it was powering up, but no connection could be established. It is a similar failure mode to the one we observed in the Western Australia machine in 2023. It is possible that the VNA itself is fried, or the media converter failed. The media converter just rests on the bottom of the box, so if water found its way in there it would

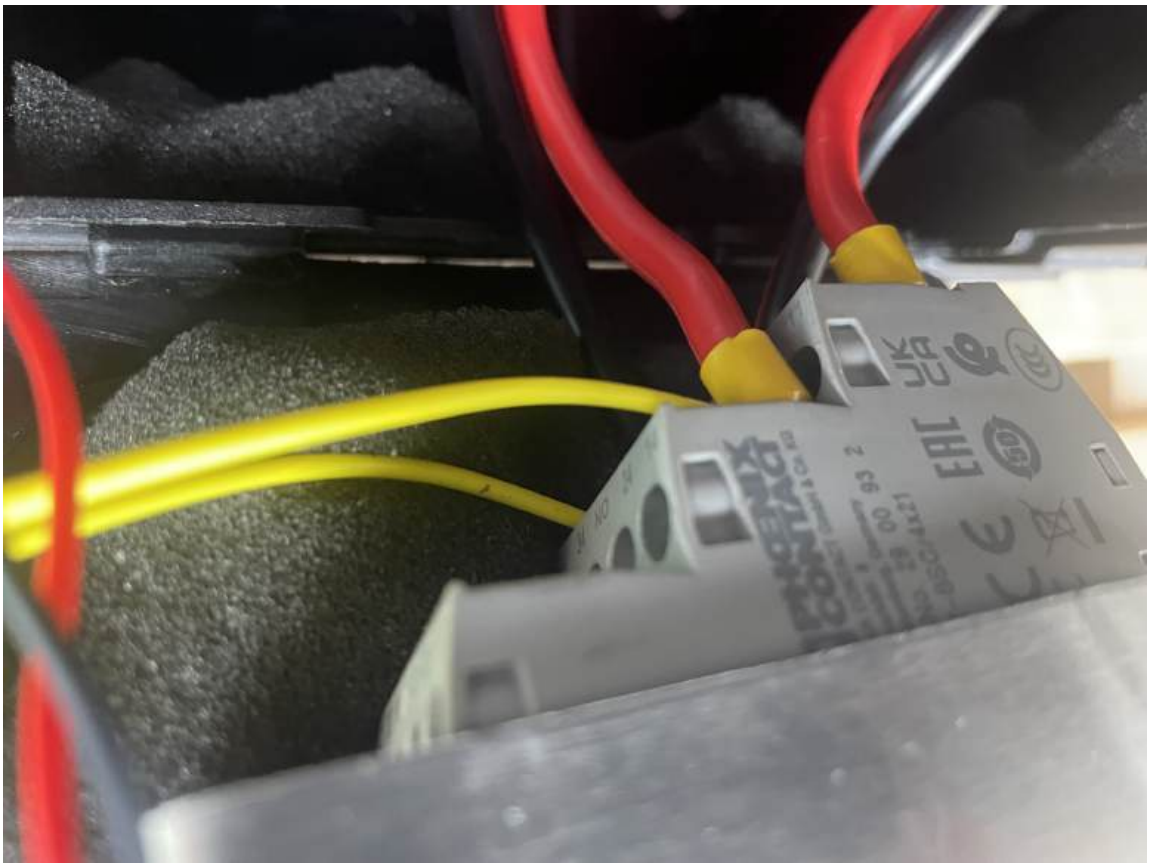

Figure 6: The rewiring for the external fuel pump. Now the power comes directly from the 12 V battery, via the relay (yellow wires).

likely damage it. I noticed that water tended to pool on top of the antenna boxes, even from the previous day (Fig. 8), thus it seems possible that it may have found its way into the box. There was no solution to this problem that didn't involve removing the antenna panels, and was thus not addressed. Any future data from this deployment will have to be calibrated using files obtained prior to this malfunction.

2.5 March 16th

The departing flight left at noon, which gave me just enough time to head up to the site, make sure the generator was running, and clean up (Fig. 9).

Figure 7: The corrosion in the screw threads of the interface between the bottom of the brass pipes and the black box.

Figure 8: Water pooled on the top of the antenna box. This water remained from the previous day's rain. The white weatherproofing tape may not be adequate in a windy, perpetually damp environment such as Adak.

Figure 9: The state of the electronics hut upon departure from Adak.

Figure 10: The EDGES antenna in the field on Adak.