HAARP Antenna Array ~ Photographic Tour

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1. Introduction

The High Frequency Active Auroral Research Program (HAARP) site in Alaska originally was to be used by the US Air Force for an Over-The-Horizon Radar (OTHR), and a large power plant building was constructed in the late 1980s for that purpose. However, with the temporary end of the Cold War in the early 1990s the facility was repurposed for scientific research. HAARP's roots are entirely political but, nevertheless, it has served a valid scientific purpose. Its primary application has been aeronomy, the science of the upper atmosphere where ionization occurs (figure 1). HAARP is not an OTHR but it does have some radar capability.

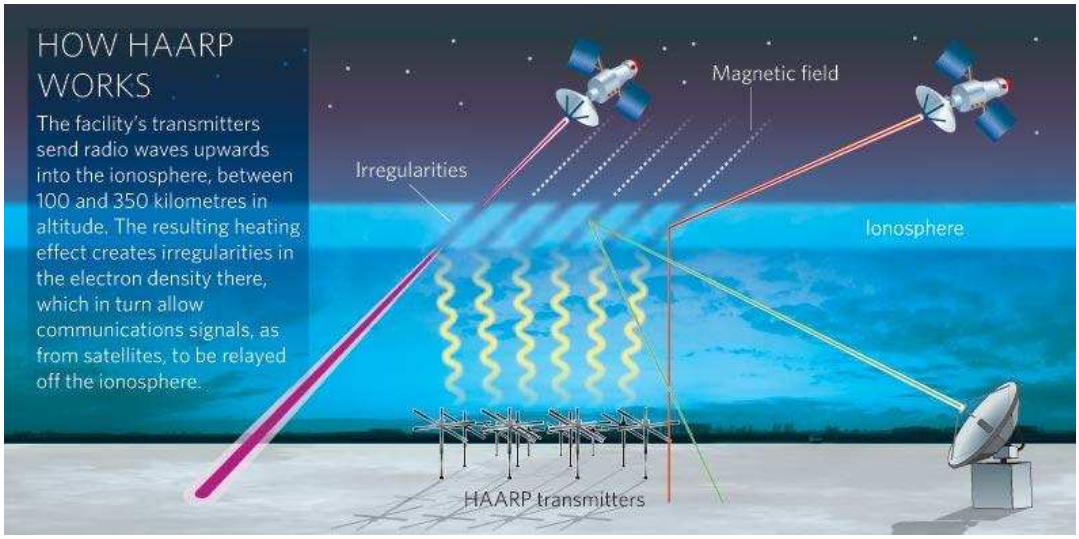

Figure 1 ~ HAARP is used to study the upper atmosphere between 100 and 350 km, which is too high for balloon sensors and too low for satellite sensors. Very little is known about the high-latitude ionosphere, so HAARP at 63° north magnetic latitude is in a good position to study it. Image source: {Nature}

HAARP always has been controversial. It is well-known in this and every other country that as soon as the government sponsors research, there must be a conspiracy. Indeed, several books have been published that describe vast government conspiracies to use HAARP to control everything from the weather to earthquakes to human behavior. I briefly discuss this in the next section.

The construction of HAARP itself started in 1993 with first operation in late 1994. It had been in operation for almost 20 years when shuttered in 2013 after the US Air Force completed its mission. The Air Force left all the antennas, transmitters and power plant mostly intact. In mid-2015 the facility was transferred to University of Alaska Fairbanks for operation by the UAF Geophysical Institute. The Geophysical Institute plans to return HAARP to full research service by spring 2017.

I drove from Anchorage to Glennallen on the afternoon of 26 August 2016, a distance of about 190 mi (306 km) to attend a HAARP open house. Glennallen is a small community about 25 mi (40 km) southwest of the HAARP facility and the site of a presentation that evening by UAF-GI about HAARP. The next morning I drove to the HAARP facility. Since the facility was not yet back in full operation, people attending the open house could self-tour the entire site. Guided tours also were available by UAF-GI staff. My main interest during the open house

was the antenna array (figure 2). The array will be the focus of this photographic tour but I also briefly discuss the facility power plant.

Figure 2 ~ The HAARP antenna array covers 1.33 million ft^2 (123.7 thousand m^2) of real estate. Image © 2016 W. Reeve

2. Public Involvement

While in operation HAARP had some public involvement, but not much. In particular, in early 2008 HAARP conducted a *Lunar Echo Experiment* that encouraged public participation {ReeveLEE}. HAARP also maintained a website that included data from its many sensors. Many scientific papers associated with HAARP experiments are publicly available (for example, search in the abstracts field in {NASA-ADS} for keyword *HAARP*). UAF-GI, as new owner, intends to be more open about HAARP's operation. The *get-started* presentation at Glennallen on 26 August was to inform the local population of their plans. Geophysical Institute Director Dr. Robert McCoy made introductory remarks, and Assistant Research Professor Dr. Chris Fallen discussed the science involved. At the outset Dr. Fallen made it clear he was not going to prove the facility could not be used for mind control as asserted on 25 August 2016 by Alaska Dispatch News (figure 3). His main point, *How do you disprove absurdity?*

The presentation was held at the National Park Service's Wrangell-St. Elias National Park Visitor Center (a federal park facility a few miles south of Glennallen) and attended by upwards of 100 people or maybe more. According to the desk attendant at the Caribou Hotel, one of the few hotels available in the area, people came "from all over but mostly Fairbanks and Anchorage". During the audience question and answer session at the end of Dr. Fallen's presentation, almost all questions had to do with HAARP's alleged nefarious purposes, harmful effects and surrounding conspiracies. We also listened to attendees who had done "a lot of internet research" that conclusively proved the Air Force used HAARP to locate caves in Afghanistan and to cause earthquakes in other

parts of the world. It appeared that many people were convinced the facility was (and will be) used for mind control and to cause global calamities and other harmful effects. I asked the only question of an ordinary nature, "*Will the transmitting schedule be publicly available?*" Answer: "*Yes*".


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HAARP's new owner holds open house to prove facility 'is not capable of mind control'

Author: Yereth Rosen Updated: 2 days ago Published 3 days ago

The antennas of the upper-atmosphere research station near Gakona keep exploring at the facility, which is now owned by the University of Alaska Fairbanks. (Bill Bristow / UAF)

Figure 3 ~ Alaska Dispatch News headline from 25 August 2016. This is how I found out about the HAARP presentation and open house on 26 and 27 August. The quotes in the headline imply that HAARP's new owner made the statement but that was not the case. Of course, this type of reporting is normal for the hysterical news media. Image source: Alaska Dispatch News {ADN}

3. Antenna System

The original research facility was comparatively small, consisting of only 18 high frequency crossed-dipole antennas and associated transmitters with total power of 360 kW. Later developments expanded the array to 48 antennas and 960 kW and finally to 180 antennas with 3.6 MW total power. When the Air Force shut down the site in 2013, it removed some equipment, including the vacuum tubes from the transmitters, but apparently did no irreparable damage that would prevent reactivation of ionospheric research by UAF-GI.

The center of the antenna array is at geographic coordinates 62° 23' 32.66" N, 145° 09' 01.95" W and about 570 m above mean sea level on a broad plain overlooking the Copper River to the south and east (figure 4). The 180 crossed-dipole antennas are arranged in a 12 x 15 matrix covering an area of 1.33 million ft^2 (123.7 thousand m^2). The dipole elements are oriented north-south and east-west.

The array is directional. Its main pattern points vertically with steering up to 30° from vertical (all technical data from {HAARP}). The pointing direction can be steered at a rate up to 15° in 15 µs. The main lobe beamwidth varies with frequency from about 15° at 3 MHz to 5° at 10 MHz, and directivity varies from 20 dB at 3 MHz to 30 dB at 10 MHz.

The transmitter frequency and antenna array tuning are based on the characteristics of the ionosphere at the time of the experiment, so it is often impossible to know the exact frequencies in advance. The effects of HAARP transmissions on the ionosphere are similar to those caused by strong solar flare events except that the HAARP

transmissions cover only a relatively small local area and occur at prearranged times for comparatively easy study and not randomly as are solar events.

HAARP is powerful enough to heat and alter the ionosphere above the facility. For illustration, assume a 10° beamwidth and 200 km ionosphere height. The projected area above the facility that is affected has a radius of about 17 km or an area of about 900 km^2, a small spatial extent that barely reaches above Glennallen.

Figure 4 ~ Satellite image of the area surrounding the HAARP facility (north is up). The map is about 50 km across. The river system from upper-right to lower-left is the Copper River, which is intersected by the Sandford River that flows from lower-right. The Gaknona River flows southward from top of image. The nearest community is Gakona about 8 mi (13 km) southwest of HAARP where the Gakona River flows into the Copper River. Image source: Google Earth

The transmitters are located in enclosures near the antennas. Each of thirty such enclosures (figure 5) contains six pairs of 10 kW transmitters (figure 6 and 7). Each transmitter pair feeds a crossed-dipole antenna through semi-flexible coaxial cable (figure 8). The coaxial cables exit through the sides of the enclosures (figure 9) and are direct buried to the antenna supports (figure 10). The coaxial cables have to be relatively large to handle the 10 kW transmitter power and the higher voltages associated with a maximum antenna VSWR of 3.2:1 (the peak mismatch voltage in this case is about 1.5 times the matched voltage).

Figure 5 ~ The white transmitter enclosures appear to be modified shipping containers, 40 ft (12 m) long. The green enclosures near the center of this image are step-down power transformers and medium voltage (12.5 kV) sectionalizing terminals that serve two enclosures. Image © 2016 W. Reeve

Figure 6 ~ Interior view of a typical transmitter enclosure. A central aisle provides front access to equipment cabinets on either side. On the near-right, one of the transmitter cabinets has been opened for examination. I believe the exposed components in the two upper compartments are motorized tuning inductors or capacitors (or both). Image © 2016 W. Reeve

Figure 7 ~ Interior view of a transmitter cabinet. The HAARP transmitters use vacuum tube HPAs (high power amplifiers), and I believe this image shows two of the tubes with what appear to be cooling stacks. Image © 2016 W. Reeve

Figure 8 ~ Typical coaxial cable coupling at a transmitter. There are two connectors but only one is used. The coax appears to be 1-1/4 or 1-5/8 in air dielectric corrugated semi-flexible cable; however, I did not see any cable pressurization system manifolds or gauges so the cables may have a foamed polyethylene (PE) dielectric. The jack-screw tuning rods for the matching inductors (or capacitors) are visible in the open cabinet to the left of the cable. Image © 2016 W. Reeve

Figure 9 ~ Cable exits at a transmitter enclosure. The stacked timbers underneath the enclosures indicate the enclosures are free-floating and do not have thermal piles for foundation support. Image © 2016 W. Reeve

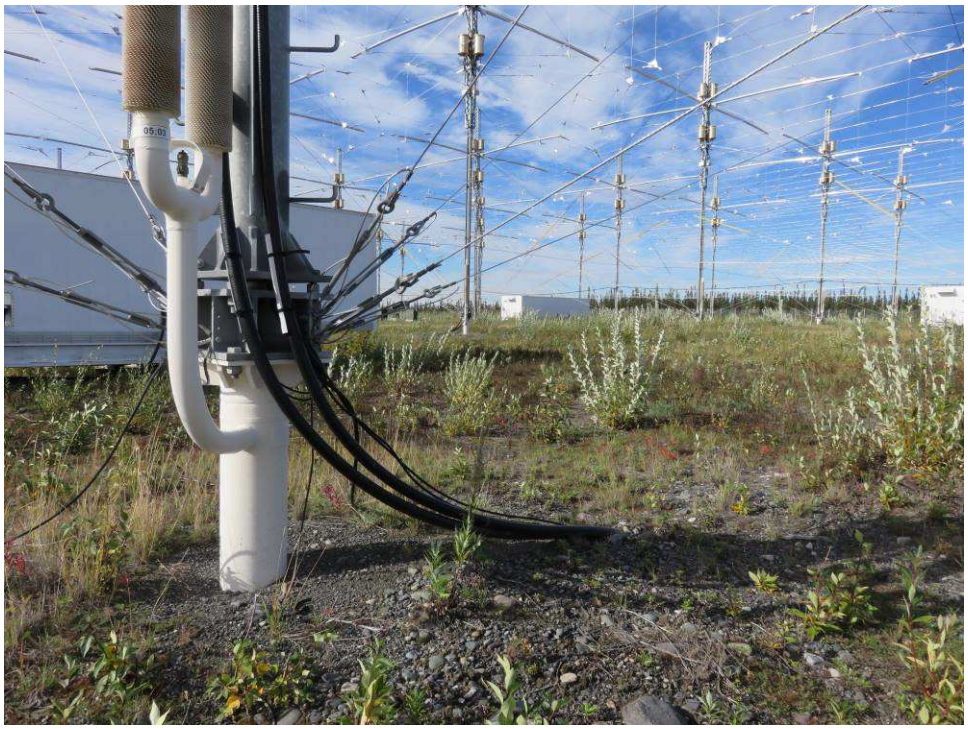

Figure 10 ~ Coaxial cables from the transmitter enclosures to the antennas are direct buried and emerge from the ground near a thermal pile, where they are attached to the tower and rise for connection to the baluns and antenna matching units associated with the crossed-dipoles. Note the numerous guy attachments from adjacent towers. The piles not only support a tower base but also are anchors for adjacent tower guy wires. Image © 2016 W. Reeve

To cover the full frequency range, each crossed-dipole actually has high and low frequency elements supported together on 22 m (72 ft) towers (figure 11). The HAARP dipole antennas can be configured for circular (left and right) and linear (horizontal) polarizations. The upper low frequency dipoles use horizontal metal pipes (figure 12), which I believe are heavy-duty aluminum, supported by non-conductive Kevlar guys. Each dipole, including the lower high frequency dipole, has aluminum wires that fan out from the central support structure. These electrically thicken the dipoles to broaden their bandwidth and to control antenna pattern sidelobes (figure 13).

The aluminum wires are supported by each other and insulated strands that stretch between the wire terminations and their anchors in a mechanically complicated self-supporting arrangement (figure 14). Mounted on each tower are four antenna matching units and baluns for antenna tuning and for converting from the unbalanced coaxial feeds to the balanced antennas (figure 15 and 16).

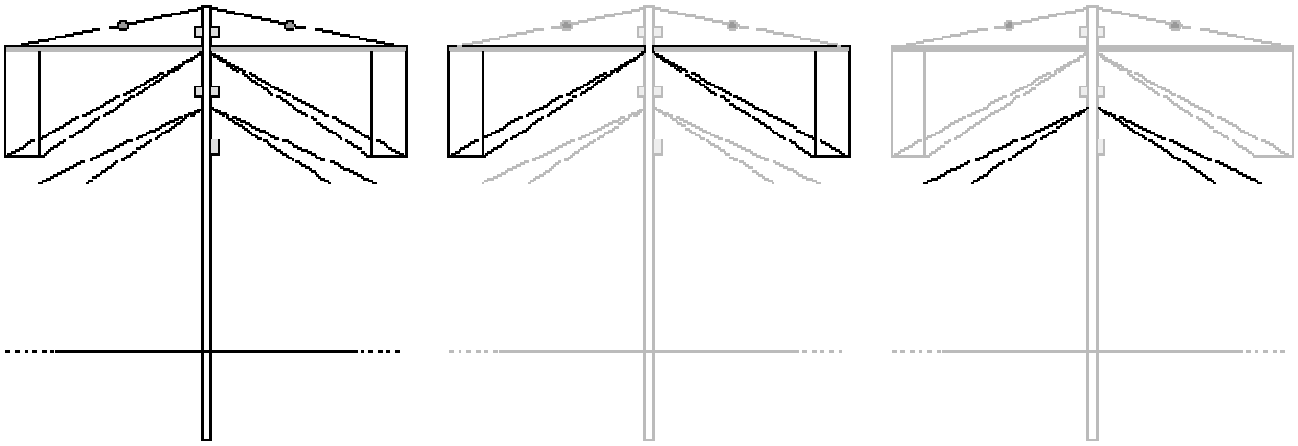

Figure 11 ~ Elevation drawing of the crossed-dipoles used in the HAARP antenna system. The antennas consist of two sets of elements (shown together in the left image). One set is optimized for lower frequencies (highlighted in middle image) and the other for higher frequencies (highlighted in right image). These images show one of the two crossed-dipoles; the other dipole is at a right angle out of and into the page. The ground plane is shown as a line below the antennas. Images source: {HAARP}.

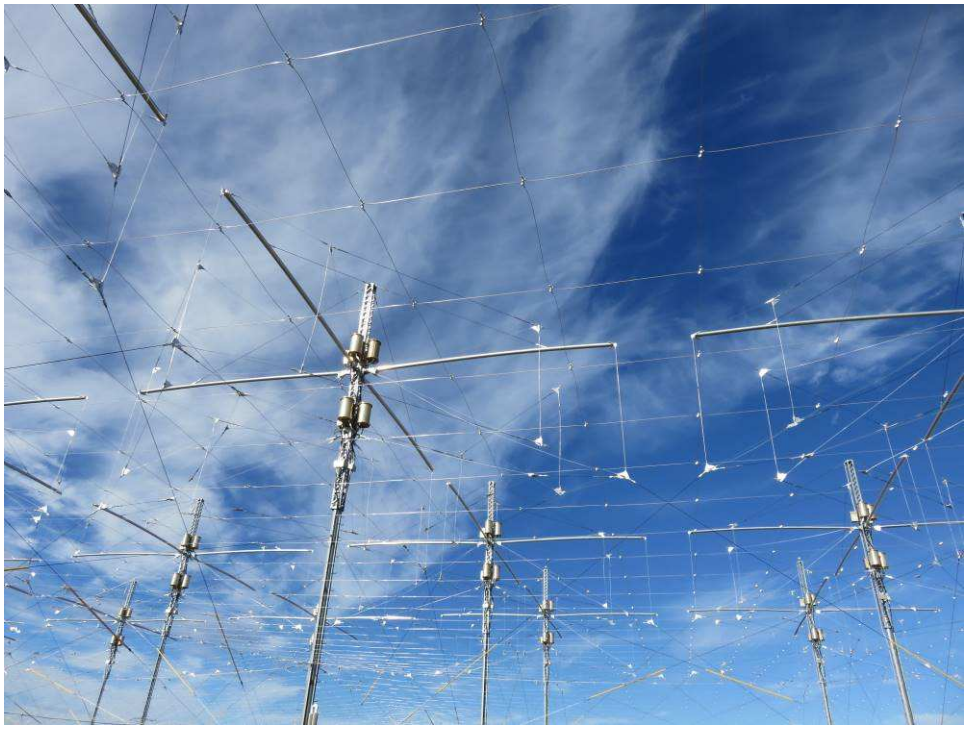

Figure 12 ~ The cobwebs of conductive antenna wires and non-conductive guy wires and messenger strands associated with the antennas and supporting structures are apparent in this image. Seen here are the main crossed-dipole pipe elements near the structure top and bandwidth broadening wire elements, supporting guys, antenna matching units and baluns and the elevated ground plane. It is quite difficult to visually separate them even when standing below. Image © 2016 W. Reeve

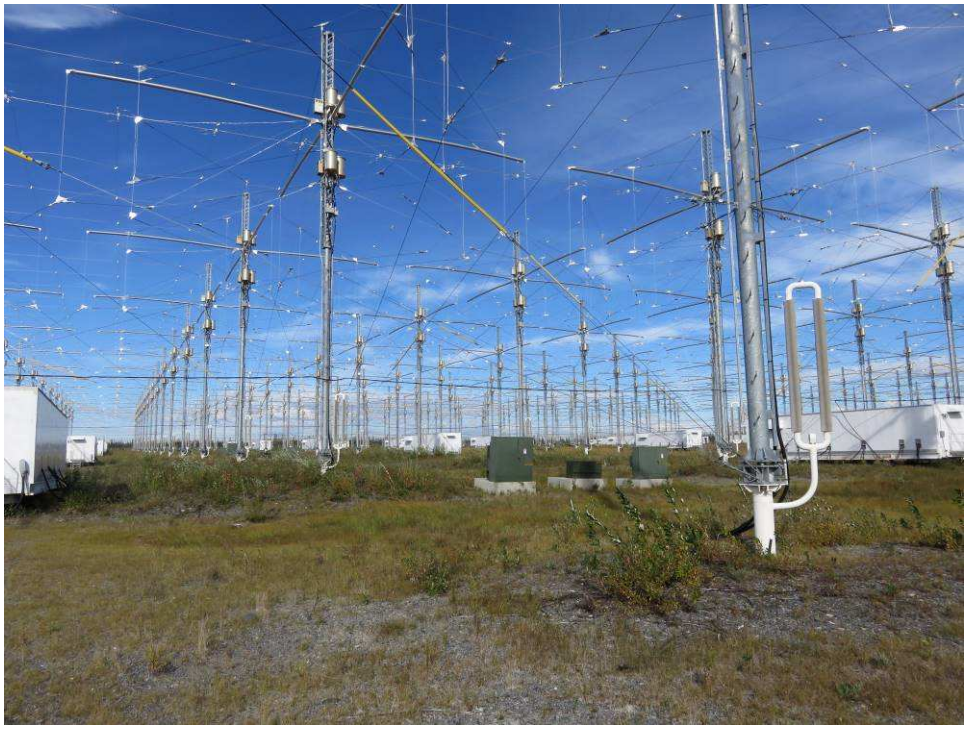

Figure 13 ~ Another view of the antenna array shows the intricate antenna components. The green enclosures near the center of this image are step-down transformers and a medium voltage sectionalizing terminal that feeds the transformers. The heat dissipating loop of a thermal pile can be seen on the near-right. Image © 2016 W. Reeve

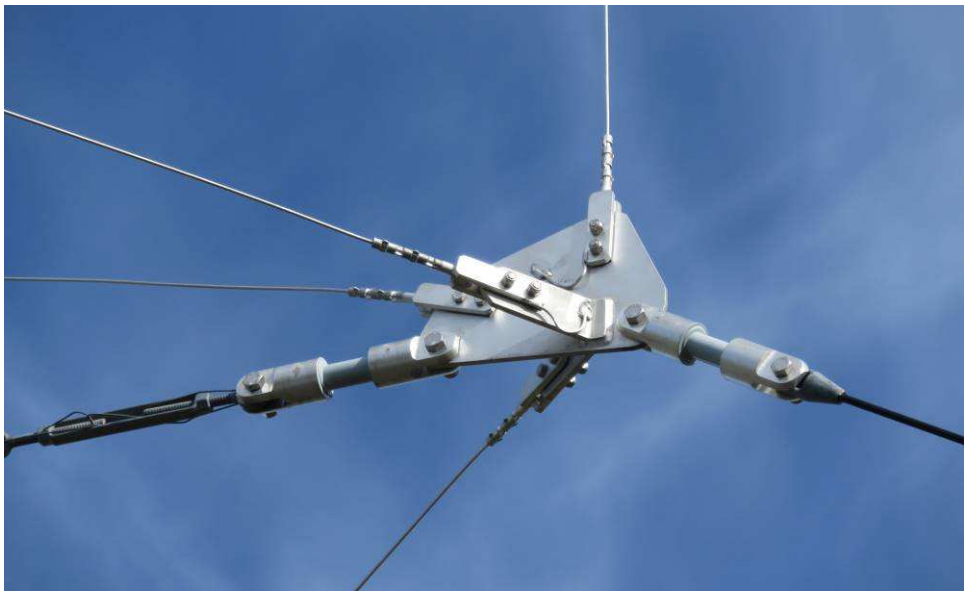

Figure 14 ~ The HAARP antennas are mechanically interlinked for mutual support. This image shows a typical support for four conductive bandwidth broadening elements (silver parts) and two insulated guy wires. It is no surprise the facility cost US taxpayers almost 300 million USD. Image © 2016 W. Reeve

Figure 15 ~ Cylindrical antenna matching units, one for each upper and lower frequency crossed-dipole elements. Note the straps from the matching units to the dipole elements. The ground plane wires are closest to the camera and form a square pattern or mesh. Image © 2016 W. Reeve

Figure 16 ~ UAF-GI information indicates the balun transformer is the small gray rectangular enclosure in the lower-center directly below the cylindrical antenna matching unit; however, I believe they actually are power splitters and the baluns are inside the Antenna Matching Units. The straps from the antenna matching units to the dipole elements on each side are more easily seen than the previous image. Note also the complex assemblies for joining the bandwidth broadening elements on each of the four sides of the support structure. Image © 2016 W. Reeve

The terrain in an around the HAARP site has permafrost to about 44 m depth. Permafrost is ground that remains frozen year-around. Permafrost is covered by an active layer that melts during summer; the active layer depth depends on the insulating values of the foliage and soils. Once the insulating surface foliage is disturbed or removed, for example during construction, the permafrost near the surface melts during summer and the water-saturated soils underneath the surface provide no structural support. Therefore, the antenna supporting

structures and associated anchors are set on thermal piles that remove heat from the soil and keep the ground frozen year-around (figure 17).

Figure 17 ~ Thermal piles are the white pipes shown here. The larger pipe provides mechanical support for each antenna support structure and keeps the ground frozen year-around. The galvanized steel tower base is mounted directly to the top of the pile and guy wires from adjacent towers connect to it for anchoring; the mechanical loads are symmetrical. The heat absorbing portion of the piles probably is buried a few tens of meters, and the heat is dissipated by the loop to the right. The black tubing behind the pile is the coaxial cable feeding the dipoles. Image © 2016 W. Reeve

4. Antenna Ground Plane

The HAARP antenna system has an elevated ground plane at a height of 4.6 m (15 ft) above ground level (figure 18 and 19). The plane actually is a mesh of fairly small wires that appear to be the same size as the antenna element wires.

Figure 18 ~ Ground plane (or ground screen) against a background of high thin clouds. The mesh is about 1 m (3 ft), and the wire intersections are held together with special ferrule-type connectors (inset below). Images © 2016 W. Reeve

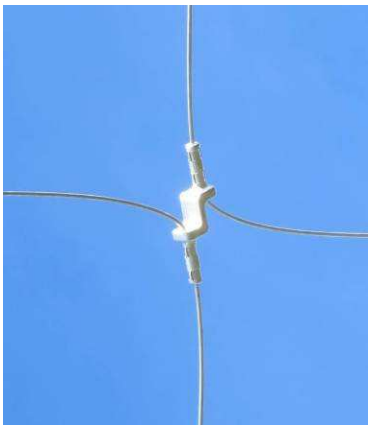

Figure 19 ~ View of one edge of the ground plane against a blue sky. The ground plane extends from the center to left side of the image. It covers a larger area than the antennas. The thermal piles shown here provide support for the ground plane and also are anchors for the antenna support structures. Image © 2016 W. Reeve

5. RF Radiation Safety

Access to the antenna array is restricted for obvious reasons. According to UAF's Dr. Fallen, the RF radiation levels outside the perimeter fence meet federal RF safety guidelines when the transmitters are operating at full 3.6 MW power levels (figure 20). He also said that technical workers can safely work under the ground plane

while the transmitters are operating. I would prefer to verify the calculations before wandering around the site during operation.

Figure 20 ~ I am standing next to the eastern perimeter fence about 0.8 km (0.5 mi) from the main building; this portion of the fence runs north-south parallel to the antenna array access road. Image © 2016 W. Reeve

6. Operations Building and Power Plant

The Air Force left a 13.5 MW power plant with five diesel engine-generator sets completely intact. The sets are located in the main building (figure 21), which originally was designed to house a much larger power plant for an OTHR.

Figure 21 ~ The Operations Building shown here was designed originally for an Over-The-Horizon-Radar facility but was repurposed for the HAARP scientific mission. Five exhaust stacks for the diesel engine-generator sets can be seen on the right side of the picture. Image © 2016 W. Reeve

The HAARP facility is connected to the local rural electric cooperative (Copper Valley Electric Association, CVEA), which supplies power to the site at all times (at a cost of 50 000 USD/mo) except when the transmitters are operating during experiments. At that time, the facility switches to standalone operation. The electric utility intertie presently does not have reciprocal capability but UAF intends to change the interconnection so HAARP can provide emergency backup to CVEA's local grid, which consists of hydro and diesel electric plants and transmission and distribution lines that extend a few miles north and 145 miles south of the HAARP site.

Each engine-generator set has a 4000 hp (3000 kW) engine driving a 2600 kW generator (figure 22). The engines are relatively low time with 3700 to 4200 h per unit and are named "Angel 1", "Angle 2", and so on. As told to me by HAARP staff "The Angels DO play this HAARP!", a humorous retort to the ridiculous book by conspiracy gadfly Nick Begich titled ***Angels Don't Play This HAARP: Advances in Tesla Technology***.

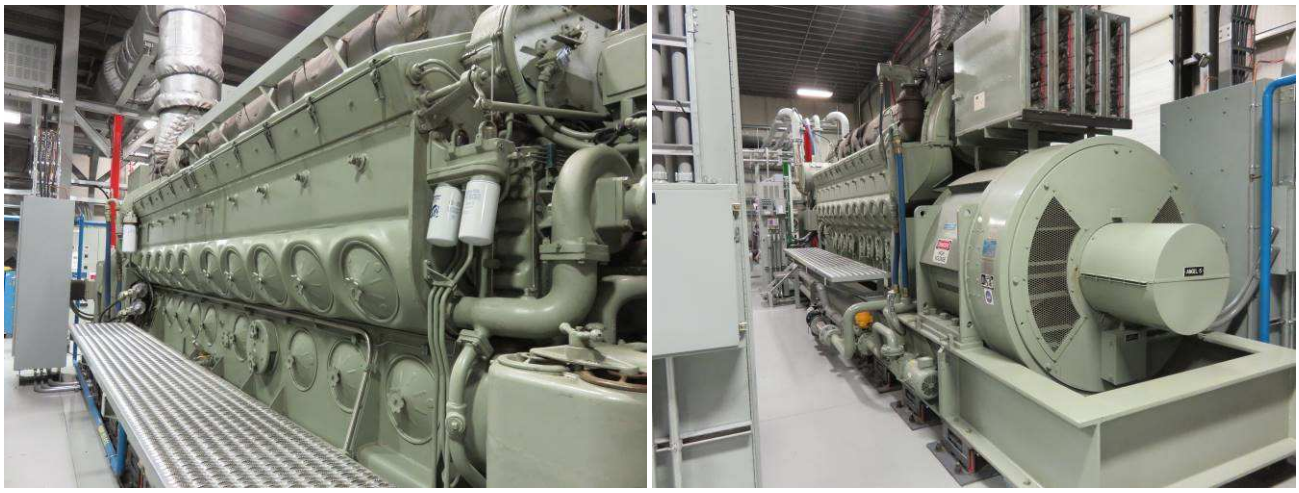

Figure 22 ~ Left: One of the five 4000 hp (3 MW) diesel engines. Right: A 2.6 MW electrical generator. The generators were originally designed for pulsed loading from an OTHR. Images © 2016 W. Reeve

7. References

{ADN} http://www.adn.com/alaska-news/science/2016/08/24/haarps-new-owner-holds-open-house-to-prove-facility-is-not-capable-of-mind-control/

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