Natural Radio

News, Comments and Letters About Natural Radio

September 2009

I was in Ohio all of this past week shooting video for two children's DVDs that I have been working on. We spent Monday and Tuesday in Dayton shooting an enormous layout of G-scale trains at EnterTrainment Junction for a Toy Trains video. The layout covers 25,000 square feet and has over 2 miles of track with 95 trains running. I've photographed a lot of layouts in the past couple of years and have never seen one that comes close to the massiveness and design of this one. It's definitely worth a visit if you like model trains and get to the Cincinnati area..

EnterTrainment Junction is just a couple of minutes away from the Voice of America Museum at the former VOA Bethany relay facility. I had visited the site several years ago when I was in town for the Dayton Hamvention and had hoped to return on this trip, but the shooting schedule didn't allow me time to get over there. Later I discovered that it would have been a wasted trip as the museum is currently closed for renovation. The lat time I was there, their future was in question, but it looks like several sources of funding have come through and they have some great plans for the expanded museum. There is an excellent website about the facility and future plans for the museum at http://tedlandphairsamerica.blogspot.com/2009/07/our-temple-of-radio.html

From Cincinnati we headed 35 miles north to Dayton to the National Museum of the Air Force at Wright-Patterson Air Force Base to get some footage for our upcoming Jets & Planes video. The museum has about 17 acres under roof at the main facility and about another 4 or 5 acres in another hangar on the base where the Presidential Airplanes and Experimental aircraft are kept. The total area is over 1 million square feet indoors. There are over 400 aircraft in the collection – just about 1 of everything the Air Force ever used, from a replica of the Wright Brothers Flyer to the B-1B Lancer Bomber and the Northrop B-2 Spirit "flying wing".

Although I covered most of the ground in the museum two or three times, the schedule didn't allow time to really peruse the exhibits in detail or look at the many videos and detailed exhibits. I was totally exhausted by the end of the day since we were up at 5 and shooting by 7 and carrying camera and tripod from exhibit to exhibit.

Of course I did stop to look at any radio equipment on display. There wasn't a lot, but there is a replica of a WWII control tower of the type that were quickly constructed at the many air fields built in Great Britain during the war, and that was fully equipped with vintage WWII radio equipment.

Almost all of the aircraft can be viewed from the outside only, but the larger Presidential Aircraft allowed a walk-thru, although all of the equipment and furnishings were behind Plexiglas.

President Harry Truman's plane, "The Independence", was a Douglas VC-118 which was a military variation of the DC-6 commercial airliner. The radios were of the ARC-5 / BC-221 variety which I bought at the surplus store for $5.00 in my earlier years.

President Dwight Eisenhower's personal airplane between 1954 and 1961 was the "Columbine III". The plane is a Lockheed VC-121E, the only one ever built, which is similar to the C-121 is the military version of the famed Constellation commercial transport. The radios were Collins, and there were a couple of ancient looking teletype machines in the back of the plane.

The Boeing VC-137C used by president Kennedy stands in stark contrast to the one used by his predecessor. This is the military version for the Boeing 707 Commercial Airliner and features a very modern looking appearance. The technology in the plane features a large communications center, with lots of buttons and displays. I don't know when this was added, as the plane was used as "Air Force One" through the Nixon Administration. Nevertheless it was amazing to see the technology go from basic vacuum tube radios to modern digital technology.

The other impressive item was the Missile and 140 foot tall Space Gallery which has Jupiter, Titan Thor, Minuteman III and Peacekeeper Missiles on display in the vertical position. Various nuclear warheads as well as versions of the first atomic and hydrogen bombs are on display. They are labeled as non-functioning. Let's hope they double-checked.

Now of course nuclear weapons have a relationship to Natural Radio so read on.

Starfish Prime – It's fairly common knowledge that nuclear weapons have a VLF signature. Theses strong, impulsive VLF signals show a spectral peak in the range of 10 kHz to 15 kHz, not unlike lightning. The spectrum of an explosion produces whistler looks like a natural whistler. According to Helliwell, observations of whistlers induced by nuclear explosions were begun at Stanford (Palo Alto, CA, USA) in 1953.

Two atmospheric tests in Nevada, Nancy (altitude - .09 km.), on March 24, 1953 and Lea (altitude - .45 km.), on October 13, 1958 produced two-hop whistlers that were heard at Stanford, approximately 600 km away.

There were 21 high-altitude nuclear explosions conducted by the US and the USSR between 1958 and 1963. These produced very different effects from the earlier and concurrent atmospheric tests. There is no blast wave above the atmosphere as there is no air to transmit the shockwave. There is also no fireball or mushroom cloud without air.

For low-altitude bursts in the atmosphere, the "prompt" radiations, ionizing radiation caused by the fission or fusion reaction in the warhead and decay of fission products

left by the explosion are significantly attenuated by the atmosphere. Thus, for high-altitude explosions above the atmosphere, the immediate radiation effects are greater than for atmospheric blasts.

Here are some effects that are unique to high-altitude nuclear explosions:

- The Electromagnetic pulse (EMP) is significant only for high-altitude bursts. These detonations cause rapid ionization of the upper atmosphere which can produce an intense impulse of radio frequency radiation which can damage or disrupt electronic equipment in orbit and on earth. For these blasts, the EMP can affect relatively large areas.
- These explosions can cause strong ionospheric ionization which can cause radio and radar “blackouts” and other disruptions.
- These bursts produce charged particles that can be captured by the Earth's magnetic field. This creates artificial radiation belts that can damage satellites and present a serious hazard to astronauts and cosmonauts in orbit.

Helliwell reports one-hop whistlers at various locations from the Teak, Orange and Starfish Prime shots.

Starfish Prime is probably the most interesting of the tests because of its effects. Starfish Prime was a 1.4 megaton burst detonated at 400 km. above Johnston Island on July 9, 1962. This had an explosive force (yield) 70 times greater than the bombs dropped on Hiroshima and Nagasaki which were each equal to about 20,000 tons of TNT.

The Starfish Prime test was one of five high-altitude tests grouped together as "Operation Fishbowl" and a part of the larger Operation Dominic. This series of tests in 1962 began around the time of the Cuban Missile crisis in response to the Soviet announcement on August 30, 1961 that they were ending a three year moratorium on testing.

According to an official government report,

“The data sought concerns ICBM kill mechanisms and vulnerability, penetration aids, retaliatory force capabilities, AICBM effectiveness, early warning systems, intelligence satellites, and communications and control. The physics information to be obtained in seeking answers to the above lies in the areas of debris location, debris charge, production and loss of electrons in the fireball production and loss of electrons in the ionosphere, electromagnetic noise, and absorption and refraction of electromagnetic waves, nuclear, thermal and X-radiations output and damage mechanisms, electromagnetic pulse output and damage mechanisms, and ultra-violet through infra-red radiations output, damage and attenuation.”

After the bomb was detonated, the sky above the Pacific was aglow with a red artificial aurora that lasted for more than seven minutes. These effects were predicted by scientist Nicholas Christofilos, who had earlier worked on the Operation Argus high-altitude nuclear bursts.

The U.S. Department of Energy's (DOE) Office of Scientific and Technical Information (OSTI) reported that the aurora was also visible and recorded on film from the Samoan Islands, about 3200 kilometers (2000 statute miles) from Johnston Island.

More important than visual effects, the electromagnetic pulse (EMP) created by the explosion test damaged electronics in Honolulu and New Zealand (approximately 1,300 kilometers away), fused 300 street lights on Oahu (Hawaii), set off about 100 burglar alarms, and caused the failure of a microwave repeater on Kauai, which cut off telephone communications with the other Hawaiian islands

Results of the experiment indicated that the radius for an effective satellite kill from the prompt radiations produced by this type of nuclear weapon in space was roughly 80 km.

While some of the energetic beta particles followed the Earth's magnetic field lines and formed the artificial aurora that illuminated the sky, other high-energy electrons became trapped and formed radiation belts around the earth. It's not surprising that there was much uncertainty and debate about the composition, magnitude and potential adverse effects from this trapped radiation after the detonation, as this test occurred just a few years after the discover of the Van Allen belts.

Because of the large radius affected by the EMP and the artificial radiation belt, satellite kill is non-discriminatory, and thus a major downside of this type of weapon. Three satellites (Ariel, TRAAC, and Transit 4B) were all disabled after passing through the radiation belt. Four more satellites eventually failed, while Cosmos V, Injun I and Telstar suffered minor degradation, due to some radiation damage to solar cells, etc. These man-made radiation belts eventually crippled one-third of all satellites in low orbit. Detectors on Telstar, TRAAC, Injun, and Ariel 1 were used to measure distribution of the radiation produced by the tests, and I would surmise that lots of useful information was gathered on how to protect satellites from enemy weaponry and also from solar flares, CMEs and geomagnetic storm effects.

Other test results showed that for a well-shielded satellite or manned spacecraft in a circular polar earth orbit, four months after *Starfish*, the radiation dose rate was at least 60 rads/day. This caused no little concern at NASA with regard to its manned space programs, and I would guess the same concerns were felt in the USSR.

In 1963, Brown et al. reported in the *Journal of Geophysical Research* that Starfish Prime had created a belt of MeV electrons, and Bill Hess reported in 1968 that some Starfish electrons remained for five years.

Starfish prime produced the most intense whistler observed during this study, but the whistler was only heard in Wellington, New Zealand and not at Stanford or any of the other sites. It was determined that the VLF impulse was not produced at the detonation altitude, but rather by radiation that entered the earth-ionosphere waveguide. The impulse then travelled through the waveguide and entered and exited a whistler duct in the conventional manner.

Thus an explosion-produced whistler would have the same spectral characteristics as a whistler that originated from lightning.

In summary, Helliwell states, "From the results obtained so far on the properties of explosion-excited whistlers, there is little evidence to indicate that these events could be used to detect the occurrence of nuclear explosions."

Let's hope we never have another chance to find out.

Radio Testing – It's now been a couple of months since we've seen any sunspots and I am hoping for a little bit of activity so that I can evaluate the radio sent to me by Edgar Greene as promised a couple of months ago. With the approaching fall equinox, maybe we'll see at least a nice high speed stream from a coronal hole that will generate enough activity so that I can try the receiver out with something other than sferics.

Gigantic Jets Transfer Energy to Ionosphere – On September 14, 2001, scientists at the Arecibo Observatory photographed a gigantic jet—double the height of those previously observed—reaching around 70 km (43 miles) into the atmosphere, and only about ten have been observed since then.

Gigantic jets have been observed both terrestrially and from orbit. These jets suggest direct electrical coupling between tropospheric thunderstorms and the ionosphere. They originate near the top of thunderstorms and extend all the way to the lower edge of the ionosphere at an altitude of about 90 km. Phenomena such as sprites and blue jets terminate at much lower altitudes.

In an online letter to *Nature Geoscience*, Dr. Steven Cummer, a professor at Duke University in Durham, North Carolina, reports that he and his colleagues managed to measure the electrical discharge from a single gigantic jet, released from tropical storm Cristobal as it passed nearby Duke University in Durham, North Carolina, in July 2008.

Using low-light photography and low-frequency magnetic field measurements, they were able to show the presence and dynamics of significant transfer of electric charge between the troposphere and the ionosphere. Their observations indicate that the total charge transfer for the single jet was 144 Coulombs for an assumed channel length of 75 kilometers. This would be comparable to the charge transfer in strong cloud-to-ground lightning strikes. Cummer said, "No one had been very close to one with the right radio instrumentation before, so we didn't know whether they just petered out without doing anything much, or whether they actually took some charge and dumped it somewhere."

Like many discoveries, this one was almost by accident. Cummer and his team had set up to observe sprites and other unusual types of above-cloud lightning associated with Tropical Storm Cristobal on July 21, 2008. What they saw was the gigantic jet. You don't need any fancy instrumentation to see a gigantic jet; you just need to be far enough away from a storm so that your view isn't blocked by clouds. Gigantic jets may be seen shooting up from the top of the storm. "They're definitely bright enough and long-enough lasting to see," Cummer said.

There are implications that these gigantic jets can have an influence on what is happening with other lightning in the storm, and of course we don't know how this is tied to whistler generation. It's just one more piece in the puzzle that should increase our understanding of atmospheric phenomenon.