EW History: Air Defense Radars And Linebacker II

Traci*ng an eventful EW career* and the lessons learned from the Linebacker II campaign.

by David Sjolund

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I enlisted in the Air Force in 1953 and attended electronic school at Keesler AFB. Upon graduation I was assigned to Automatic Tracking Radar School at Keesler AFB where I learned how the SCR 584 worked. In 1954 I was transferred to Eglin AFB to operate and maintain the SCR 584. From Eglin AFB I entered Aviation Cadets and became an Officer in the Air Force. I was reassigned to Keesler AFB to become an Electronic Warfare Officer (EWO.) After graduating I was assigned to a B-47 crew as an EWO. I remained in the EWO field for the duration of my Air Force career.

I believe the SCR 584 was the first automatic tracking radar designed to shoot down aircraft. Unfortunately, we gave many of these systems to the Russians after WWII. The Soviet designation was the "Whiff." I believe the Soviets reverse-engineered the SCR 584 to develop the SA 2 system which we faced in Viet Nam. I also believe the SA 2 system missile was designed by the German engineers working for Russia after WWII.

The SCR 584 was used on the Eglin AFB bomb test range to perform radar bomb scoring. (The test range became the ECM test range in the early 60's). The range consisted of six sites that are spaced a mile apart on Santa Rosa Island. The six sites transferred jamming data to a large computer complex on Eglin AFB that would follow the ECM test aircraft using the SADS 1 radar. The SADS 1 (a M 33 radar) could track the ECM aircraft very accurately. Initially dry data (no ECM radiation) was collected on the SADS 1 and SADS 2 (a simulated SA 2 system.) The miss distance between the SADS 1 and the SADS 2 had to be 50 feet or less in over 80% of the simulated missile tracks for the system errors to be eliminated. Then the jammer was turned on and the miss distance of the plane's position as measured by SADS 1 and SADS 2 was compared. An ECM technique was considered good if 80% of the test's simulated missiles missed the ECM test target by over 200 feet. It should be noted that the M 33 was the radar that controlled the Hawk Missile System. We gave several Hawk Missile Systems to the Israelis which they used in the Arab Israeli War in the late 60's. The Arab Air Force suffered an attrition rate of 95% due to the Hawk missiles (47 of 49.) The Arab aircraft had no ECM installed.

B-66

After completing seven years of night school I attended Auburn for three years and earned an Aeronautical Engineering Degree (BSAE) in August 1967. I was 'rewarded' by being passed over for promotion to Major. Officers who went to school had a 75% chance of being passed over for promotion while those in SEA had a 75% chance of promotion. Location is everything! This circumstance led me to plan for my retirement as soon as eligible, about 7 years away. I decided to use the next 7 years to learn what industry did not know in the field of ECM, tactics, SAM systems and the USSR. These areas were classified secret and very few people were cleared for the data due to difficulty and expense. I was in the right place at the right time with a Top Secret clearance and a BSAE. I was motivated to acquire ECM knowledge.

I was assigned to the B-66 operation in Thailand in '67/'68. The B-66 operation supported the B-52's with their flights over North Viet Nam (NVN) by flying a race track pattern perpendicular to the B-52 pattern, providing jamming. We had a Morse code frequency identifying NVN MIG aircraft departures from the NVN airports. On a flight I received the code and calculated the intersection of MIGs and our B-66. I told the pilot, Major Dave Otteson, that we should abort the jamming mission because of the looming intersection of the MIGs and our plane. If we delayed our turn the MIGs could follow our turning airplane and aim at our engine exhaust heat with an IR Atoll missile and we could not defend against it. Only by turning immediately could we stay out of range of the IR homing device on the missile. We aborted the mission and returned to base. At the debriefing I was criticized for aborting the mission. The next day another B-66 mission like ours took off and the crew did not react to the Morse code alert for MIG departures. The B-66 was shot down losing the crew. We did not fly more of these missions and I was credited with exposing the vulnerability of predictable patterns.

Linebacker II

After I flew my 100 missions I returned stateside to Wright Patterson AFB, joining the Blue Team. Three years later, in the fall of 1972, I joined Major Billy Nix at SAC Headquarters. Major Nix needed an ECM engineer to calculate the attrition rate of the B-52 should we bomb NVN in an attempt to end the war.

First, my team examined the ECM test data that SAC had recently collected at Eglin AFB ECM test range. The optimum technique showed that 80% of the simulated missiles passed more than 200 feet from the test B-52. They had also developed a new flight formation tactic of three-plane "cells", spaced 500 feet apart in Azimuth, Elevation and Range with the location known only to each cell leader. This produced multiple jamming strobes on the SA 2 scopes. If all three operators were not tracking the same B-52 an additional 500 feet of missile error was created. If this situation sounds confusing, imagine the problems the three NVN SA 2 operators had in assuring that each was tracking the same B-52. SAC

analysis of the three-plane "cell" formation testing at Eglin ECM test range showed a 10% increase over a single plane target in the number of simulated missiles passing more than 200 feet from the test B-52.

Finally, Soviet SA 2 missile engineers designed a fragmentation pattern of four ounce frags to maximize the probability of kill (PK) of the 400 pound warhead after the proximity fuse was turned on. The warhead produced a pattern of one frag per square foot at 50 feet. Note: A pilot in the cockpit is approximately two cubic feet in volume. Thus if the missile and the B-52 are flying head-on the frag pattern, shaped like an expanding dog collar perpendicular to the X axis of the missile, will kill the pilot as well as bring down the B-52. However, if the B-52 ECM caused the missile to fly an erratic pattern, the PK of the missile would be much lower. I came up with an attrition rate of 3% which was a combination of the three-plane cell formation, the optimum noise modulation ECM technique and the fragmentation pattern of the SA 2.

Now the plan was made. The 3% attrition rate was considered acceptable. We thought a three day campaign would break the back of NVN. We limited the bombing fleet to nine three-plane cells spaced four hours apart. This minimized the probability of a mid-air collision. The campaign was launched on December 18, 1972. On the first day, three aircraft were lost at ranges of ten, twenty and thirty miles from the SA 2 sites. NVN changed their strategy on day two by concentrating their missile intercepts at the thirty mile range. Only one airplane was lost because at that distance the frag pattern was less than one frag/100 feet. On day three, NVN realized that if they delayed the attacks until the aircraft were ten to twelve miles away, just after the B-52 released its bombs. It was better for the SA 2 as the bomb bay doors were still open, increasing the radar cross section of the B-52. This ensured greater missile success for NVN and they brought down seven aircraft.

On the morning of the fourth day Major Billy Nix asked me to go to the Eglin test site to observe the SADS 2 testing and try to determine why we lost seven aircraft the prior day. I observed weak jamming at the radar scopes. The next day at SAC Headquarters I reported the weak jamming and asked if the jamming patterns had been optimized for the low altitude of the Single Integrated Operational Plan (SIOP) and not for the high altitude mission that the B-52s were flying in NVN. After talking with Northrop DSD it was determined that the antennas had not been optimized for high altitude. They could be optimized for high altitude by changing the "pancake" shaped pattern to a "donut" shaped pattern below the airplane. This would create a 6 dB improvement at -45^{o} but it would take six days for the first antenna to be delivered. Because the loss rate was as indicated in our analysis, we continued the campaign.

Contributing to the seven aircraft loss on day three was the effort to bomb one of the SA 2 sites that had shot down four of the B-52s. I advised against this decision because it would require flying a radial heading directly over the site.

Also the site location was not accurately known as GPS did not exist at this time. My experience at Eglin in the early 50's indicated that the 500 pound bombs we were using could not destroy the site except with a direct hit and we would probably lose several aircraft. My prediction proved to be correct as we lost two of the nine aircraft in bombing this site and the site was back on the air the next day. On the fifth through the eleventh day we lost less than one aircraft per day for a total of fifteen aircraft. On December 29, 1972 NVN agreed to sign a truce ending the conflict.

Lessons Learned

Part of the last eighteen months of my Air Force career was spent determining the lessons learned from the Linebacker 11 campaign. The first of three lessons learned was the importance of destroying the EW/GCI radar that provided data to the SA 2 sites before commencing the attack. This EW/GCI site also controlled the enemy fighter aircraft. The second lesson was the importance of destroying the runways in the initial days of the attack, eliminating the ability of the fighters to land in the dark after a mission. The third lesson was to avoid flying directly over a SAM site. The AF applied these lessons during Desert Storm to great effect. The loss rate was fractions of 1% and I think no F-15s or B-52s were lost to SAMS.

Industry Experience

Upon my retirement from the Air Force in 1974, I joined Northrop DSD spending the next six years updating the ECM systems on the B-52 and F-15. It should be noted that Egypt became pro US in 1974 and gave us SA 2s, SA 3s and other systems from their inventory that allowed us to optimize our SADS and ECM. Northrop's noise modulated ALQ-135 used on the F-15 received threat data from the Loral ALR-56 Radar Warning Receiver (RWR.) If the threat was trying to engage the F-15, appropriate ECM would be applied by the ALQ-135 as needed. The pilot had only to turn the ALQ-135 onto automatic mode and avoid flying over the threat that was shown on the RWR. If the ALR-56 was not operating the ALQ-135 manual mode could be engaged but was minimally effective and highlighted the F-15 on the enemy radar.

We also developed an RF set-on receiver for the B-52's ALQ-28s. This receiver, along with the correct low or high altitude antenna, improved the jamming/signal (J/S) 10 dB before opening the bomb bay doors for bomb release. It did not provide adequate J/S with the bomb bay doors open but turning away from the threat after releasing the bombs would help reduce the vulnerability. The engines couldn't provide power for unlimited jamming capability.

In 1980 Stan Hall hired me to work in ECM advanced programs at Litton AMECOM. I tried to sell the EA6B to the Air Force and they did buy the EA6B years later. Within a year of my hiring, Stan left for California. I missed working in the environment he created and contacted him. In 1985 Stan Hall hired me again, this time to work in a new ECM division at Hughes Aircraft Company. Of

the 100s of engineers Stan hired I think I was the only one he hired twice. Again, I was enjoying my work and living in California where I had wanted to be for at least 20 years. I spent my final four years at Hughes, teamed with Boeing and Amherst developing a large anechoic chamber at Edwards AFB. I was responsible for the $10 million Hughes portion. I retired from civilian work in the fall of '98 and moved to St. Petersburg, FL.

My motivation to write this article was reading the book on Linebacker II authored by Larry Mitchell III. Since I had been at Headquarters SAC during the event and heavily involved I could document how the 3% attrition figure was determined, why the same profiles were flown on the first three days of Linebacker II and finally, why seven B-52s were lost on day three.