Paper for session at WAC4, Cape Town, South Africa, January 1999

*Materiel Culture* international perspectives on recent military remains

**Evaluating and Managing Cold War Era Historic Properties:**

The Cultural Significance of U.S. Air Force Defensive Radar Systems

Mandy Whorton
Argonne National Laboratory
1075 S Yukon Street, Suite 209
Lakewood, Colorado 80226 USA
Tel. 303-986-1140, ext. 216, Fax 303-986-1311, Email mwhorton@anl.gov

The Cold War (1946-1989) was a global conflict that prompted the construction of increasingly complex military technological systems spanning large geographic areas. In the early 1950s, the United States constructed an aircraft early warning radar network across Alaska and extending east along the arctic perimeter of Canada and Iceland. By the end of the decade, the threat of aircraft carrying nuclear bombs was replaced by the threat of missiles armed with thermonuclear warheads, and in the late 1950s, the United States began constructing a ballistic missile early warning network to detect intercontinental ballistic missiles launched from the polar regions. In the 1970s, in response to the threat of sea-based ballistic missiles, the United States constructed another radar warning system with coverage for the Atlantic, Pacific, and Gulf/Caribbean coasts. The design, construction, and operation of all of these radar systems represented significant technical accomplishments for the United States.

In the mid-1990s, the U.S. Air Force began to evaluate the historic significance of these defensive aircraft and missile warning systems and to explore cost-effective ways to preserve their legacies. This describes these systems, the process and context used to evaluate their cultural significance, and the actions the U.S. Air Force has taken to document their historic contributions.

**Historical Background and Context**

In the late 1940s and early 1950s, the United States developed several aircraft warning radar systems to detect polar flights by Soviet Union bombers. These radars were some of the first technical systems developed and deployed during the Cold War. They represented an important strategic shift of the Cold War away from the initial confrontations between the Soviet Union and the United States in Europe between 1946 and 1948 and toward a more global nuclear standoff that characterized the remainder of the era.

In early 1947, the U.S. Air Force began planning for a radar warning network to provide strategic air defense of North America, but Congress was reluctant to fund an upgraded or expanded network because of costs and doubts about the effectiveness of World War II era radar equipment. However, when the Soviet Union exploded its first atomic bomb and developed an intercontinental bomber in late 1949, well ahead of American predictions for this capability, Congress quickly appropriated money for the Aircraft Control and Warning (AC&W) System.
DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.
DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.
Construction contracts were issued in early 1950 for 10 permanent Alaskan radar sites, including five coastal surveillance sites, three interior ground control and intercept sites, and two control centers. In June 1950, following the attack on South Korea, the U.S. Air Force put air defense systems on around-the-clock operation. Defense appropriations from Congress increased significantly in the wake of the Korean attack, and the U.S. Air Force was able to accelerate completion of the AC&W system and installation of new radar equipment. The 10 original sites became operational between 1952 and 1954. Two additional sites were selected in 1951 to expand radar coverage in the interior; these sites became operational in 1954.

Each AC&W site consisted of a complex of 10 to 15 wood frame buildings connected by enclosed passageways. The buildings included radome towers, operations, administration, dormitories, power plant, and other facilities. The permanent sites were equipped with the AN/TPS-3 and other new radar systems that provided better coverage than the types used in World War II (e.g., AN/CPS-5).

Even as the AC&W System was under construction, plans were being made to improve and expand air defense coverage with better radar and more stations located throughout the polar region, including Canada, Iceland, and Greenland. A joint United States-Canadian initiative, the Pine Tree Line, became operational in 1954. More than 30 installations were located along the United States-Canada border and were very similar in design to the AC&W installations. Canada developed its own warning system, known as the Mid Canada Line, to fill in gaps left by the Pine Tree Line in Canada’s interior along the 55th parallel. This system relied on simple Doppler radar and was prone to numerous false warnings (Schaffel 1991; Neufeld 1995). Soon, the Distant Early Warning (DEW) Line was constructed by the United States and operated by the North American Air Defense Command (NORAD), a joint United States-Canadian command formed in 1957. It was the most ambitious, expensive, and comprehensive system to be developed for aircraft control and warning.

The DEW Line consisted of a series of radar stations located near the Arctic Circle (at the 70th parallel) to provide several additional hours of warning and interception time. In 1954, largely in response to advances in Soviet air power, the DEW Line construction became the highest priority in the U.S. Air Force (Shaffel 1991). The U.S. Air Force contracted with General Electric to design and construct 57 DEW Line installations spaced about 100 mi apart — from the northwestern tip of Alaska to Cape Dyer in eastern Canada. In addition to the main receiver stations, unmanned transmitters were located between the posts (Buderi 1996). Construction began in the spring of 1955 and was completed by early 1957. In 1958, at a cost of over $1 billion and after remarkable engineering construction achievements, the DEW Line reached initial operating capacity.

The DEW Line stations employed new, longer-range radar with auto-warning capabilities (Buderi 1996). These radars not only provided better coverage, but also required significantly fewer men to operate them. Unlike the Pine Tree stations, which required over 200 radar personnel, DEW Line radar could be operated around-the-clock with as few as 10 men (Neufeld 1995).

The DEW Line buildings also incorporated improvements on the earlier aircraft warning networks. Rather than constructing separate buildings interconnected through utilidors, the DEW Line buildings were modular structures that fit together in a train-like fashion. Modular buildings were fabricated, shipped, and assembled on-site to meet the requirements of the particular installation. Intermediate stations consisted of 5 modular buildings, auxiliary stations had 25, and main stations required 50. Because of the extreme weather conditions and geographic isolation of
the sites, large supplies of heating oil and other supplies were needed so large tanks and warehouses were present at all of the DEW Line installations.

The North American air defense networks operated from the 1950s until the end of the Cold War. However, they declined in importance after the emergence of intercontinental and submarine-launched ballistic missiles (ICBMs and SLBMs). The Soviet Union first tested an ICBM and launched its first satellite, *Sputnik*, in 1957. From that time forward, resources in both countries were focused on missile delivery and warning systems (Levine 1994).

Although missile defense had been considered as early as 1952, it did not receive serious support until after the launch of *Sputnik*. Five days after the launch, Congress made missile defense a top national priority and approved $1 billion for the construction of the Ballistic Missile Early Warning System (BMEWS).

The BMEWS project called for three northern radar installations located in Alaska, Greenland, and the United Kingdom. By the summer of 1958 construction was underway at the first two sites, and they became operational in 1961. The site in England became operational in 1963.

The system consisted of two types of radars. The first type used massive detection radar screens, each measuring 400 feet by 165 feet (larger than a football field on end) and weighing more than 1,000 tons. The second radar type used a parabolic dish tracking antennae, modeled after an experimental radar developed at Millstone Hill, Massachusetts, by the Lincoln Laboratory and others. Scanning equipment located in buildings in front of each radar screen would feed radar signals to the screen through two rows of feed horns located on the exterior face of the building. The screen would project two radar beams and collect a continuous echo. An object piercing the lower fan would signal the alarm. Position and velocity of the object would be measured. Seconds later as the object passed through the upper fan, position and velocity would be measured again, and computers would determine if the object was following a ballistic trajectory. If an object was determined to be a missile, a second tracking radar would lock onto the missile and track it to impact. Each site had a different configuration of these radars.

Climatic conditions presented challenges for the BMEWS project. Although the U.S. Air Force and Army had experience with construction in arctic climates, the scale and weight of the BMEWS equipment required the development of new construction techniques, particularly at the Thule site in Greenland where permafrost was present at less than 7 feet and temperatures could drop to 60°F (50°C) below zero. For instance, the heat from a building constructed on the surface would melt the permafrost and cause the building to sink, which created a special problem for the scanner buildings, which had to be extremely stable. To accommodate these conditions, thousands of feet of pipe were incorporated into the building foundations. The pipes were left exposed on the sides of the buildings and were fitted with covers that could be opened and closed. In the winter months, these pipes were left open to circulate cold air beneath the buildings and freeze the ground above the permafrost. In the summer the pipes were closed. The theory was that the heat from the building foundations would melt the ground above the permafrost without compromising the permafrost. The foundations sagged slightly, but for the most part, this system was effective.

Although the BMEWS sites continued to function extremely reliably throughout the Cold War, the 1950s technology became increasingly expensive to support, and new technology outpaced some of the BMEWS capabilities. Consequently, in the 1980s, the U.S. Air Force began upgrading
the BMEWS network with phased-array radar, which is electronically steered and much faster (see PAVE PAWS discussion below). Construction began on the Thule upgrade in 1984. After the upgraded radar became operational in 1987, the original screens were dismantled, and the remaining buildings are awaiting demolition. The new radar was built atop an existing transmitter building, largely as an attempt to ward off Soviet complaints that the upgrade represented the deployment of a new radar and was a violation of the Anti-Ballistic Missile (ABM) Treaty. In 1991, the third site at Fylingdales Moor in the United Kingdom was also upgraded to phased-array radar. The new facility is the only three-faced phased-array radar in the United States network and provides 360 degrees of coverage. Site II in Alaska is scheduled to be upgraded at the turn of the century but currently operates with its original radar equipment. (The computers were upgraded in the 1980s.)

The development in the 1970s of sea-based missile delivery systems brought about the need for a new warning system and a new technology. The widespread deployment of advanced nuclear submarines equipped with multi-range SLBMs in the 1970s, coupled with an expansion of Soviet naval forces, prompted a major strategic shift from the polar concept on which BMEWS was based (Catudal 1988; Moore and Compton-Hall 1986; Watson 1982). Rather than being confined to attacking the United States from ground-based sites in the USSR, SLBMs provided the Soviet Union with a mobile missile force capable of attacking the United States coasts.

The United States responded to this new threat by constructing a ground-based missile early warning system, the Precision Acquisition Vehicle Reentry Phased-array Warning System (PAVE PAWS), to cover the Atlantic and Pacific coasts. The PAVE PAWS systems were complemented by satellite surveillance, which allowed detection of a SLBM launch from heat plumes (Burrows 1986). Construction of the first two PAVE PAWS sites, at Otis Air Force Base (AFB) in Massachusetts and Beale AFB in California, began in 1978. The sites became operational in 1979 and 1980, respectively.

PAVE PAWS utilizes phased-array radar technology, incorporating thousands of individual antennae incorporated into a radar face on the side of a radar building. The Army and Raytheon Corporation developed this technology in the 1960s for use with an ABM system. It was first deployed at Eglin AFB in Florida for use in space tracking (still operational), and then at the Safeguard ABM Complex in North Dakota. The Safeguard System was dismantled in 1975-1976, but the Perimeter Acquisition Radar (PAR) Facility was retained as a complement to the north-pointing BMEWS for use in early warning. Both of these facilities have single array faces. Raytheon designed the first twin-faced phased-array radar facilities for PAVE PAWS.

In the mid-1980s, the PAVE PAWS network was expanded to cover the South Atlantic and Caribbean with the addition of sites in Georgia and Texas. These facilities became operational in 1985 and 1987, near the end of the Cold War. They are very similar to the first two sites but incorporate some technical advances that expand their coverage and discrimination capabilities. Since 1993, these sites have been in "caretaker status," meaning the facilities are not operational but are being maintained should they be needed in the future.

Additional facilities complemented the primary early warning network consisting of BMEWS and PAVE PAWS. Included were the PAR facility in North Dakota; the Spacetrack facility at Eglin AFB; satellites; and the Cobra Dane radar facility, deployed on Shemya Island in the Aleutian chain to collect data on Soviet missile tests off the Kamchatka Peninsula and as a secondary mission to provide SLBM and ICBM tracking capabilities.
Management of Aircraft and Missile Warning Systems as Historic Properties

The Department of Defense began a broad evaluation of its Cold War era properties in 1991. Downsizing, realignment, and base closures create an urgency to complete evaluations before important properties are unintentionally altered or destroyed without documentation. The U.S. Air Force — which itself is a creation of the Cold War — owns numerous properties built during this era. Over the past 5 years, the U.S. Air Force has inventoried a variety of installations to determine which of its thousands of Cold War era properties are historically significant. Although sites and facilities less than 50 years old must possess “exceptional importance” to qualify for inclusion in the National Register of Historic Places (NRHP), some properties, including those associated with the aircraft and missile early warning systems, clearly meet this criterion. Federally owned properties eligible for the NRHP require some form of treatment as historic properties.

The U.S. Air Force determined that the AC&W network, the DEW Line stations located in Alaska, the BMEWS installation in Alaska, and the PAVE PAWS network are eligible for the NRHP and require management as historic properties. How the properties are to be managed varies depending on their condition and current use.

The original AC&W network was mostly abandoned in the 1970s. All of the original radar equipment was removed; many of the buildings were demolished or abandoned. Abandoned wood frame buildings exposed to arctic conditions quickly fell into disrepair and now represent safety hazards and eyesores. The U.S. Air Force plans to demolish the remaining buildings and withdraw personnel from the sites. (Most of the installations have minimally attended radar with a mission of ensuring air sovereignty over Alaska. These radars can be operated remotely and do not require on-site manning.) Before demolition occurs, the U.S. Air Force has committed to recordation of the network through the compilation of a systematic history and the photographic and architectural documentation of one representative site. In addition, the U.S. Air Force will prepare a popular brochure describing the historical significance of this system.

The DEW Line installations were closed in the late 1980s, but much of the infrastructure remains. Photographic documentation and collection of as-built drawings for two of the sites — Bullen Point in Alaska and BAR-1 in Canada — has been completed. The U.S. Air Force intends to document the history of the DEW Line in a popular brochure and identify materials from the system to be archived for future historical research.

The BMEWS network had been significantly modified at the end of the Cold War. Only one site, Clear Air Station in Alaska, retains its historical integrity. In the next 5 years, the Air Force will construct a new phased-array radar to replace the original BMEWS equipment. Treaty restrictions require that the original property be demolished after the upgrade. The U.S. Air Force has committed to preserving the history of this important system. It will fully document the site with photographs and drawings; will prepare a popular brochure interpreting the historical importance of BMEWS; and it will curate one of the computer consoles and set up an interpretive display in a U.S. Air Force museum.

The PAVE PAWS network will also be preserved through documentation. The two later sites, which became obsolete after the end of the Cold War, have been documented with photographs and drawings. The first two sites are still operational and are subject to continual modifications, some of which may alter features of the facilities that are unique to their Cold War missions. To preserve the Cold War history of these buildings, they will be documented in the next couple of years (closer to the end of their period of significance). In addition, a systematic history will be prepared.
Conclusion

Aircraft and later missile radar early warning stations played an important role in the Cold War. They are associated with important technological, social, political, and military themes of the Cold War and are worthy of preservation. The scope and scale of these systems make physical preservation impractical, but the U.S. Air Force program of historical evaluation and documentation of these systems will provide valuable information to future generations studying this historic period.

Acknowledgements
I am grateful to the U.S. Air Force, particularly Casey Buechler of the 611 Air Support Group, for funding Argonne’s work in this area. I am also indebted to my colleague, Dr. John Hoffecker, who has engaged me in many lively discussions and debates on this topic.

References