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ADC HISTORICAL STUDY NO. 32

HISTORY OF BMEWS 1957-1964

by THOMAS W. RAY

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Early Plans. While it was not until 1958 that a Ballistic Missile Early Warning System (BMEWS) was actually authorized, such a system was envisioned and formally proposed three years before. General Operational Requirement No. 96, "A Ballistic Missile Detection Support System," dated 10 Jun 1955, called for three northern radar sites capable of detecting and tracking ICBM's launched in the Soviet Union against North American targets. By 1955, air defense planners realized that Soviet scientists and technicians sometime in the near future, perhaps in the early 1960's, would fabricate ICBM weapons pocketing nuclear warheads that could fly 5,000 miles or more from launching sites in northern Russia and Siberia. Logically, enemy missiles destined for U.S. targets would be aimed to exploit the shortest feasible air route -- that which arced over the North Pole. And since an ICBM trajectory described a geometric arc from which it would not deviate, the task of detecting an ICBM attack and ascertaining its targets, was reduced to determining exact position "fixes" on ICBM's soon after being launched from Soviet soil. Total time on ICBM flight from the USSR to the U.S. was estimated to take somewhere between 33 and 46 minutes. Given these "fixes," computers could instantly calculate the flight path of each ICBM, then forecast within a 300-mile radius its point of impact.[1]

Once this data was extracted -- at least 15 minutes before an ICBM reached its target -- it was important that the information be flashed to military units responsible for North America's defense. In effect, this would furnish a minimum of 15 minutes of advance warning of an impending ICBM attack, pointing up the necessity of communications so swift they could convey advance warning data to tactical units thousands of miles away in only a few seconds time.

Fifteen minutes sounded like a mere flick of the hour hand, but in reality, much that was worthwhile could be accomplished during this brief time. Air Defense Command fighter interceptors and Strategic Air Command bombers could become airborne and scatter to pre-selected dispersal bases. Manned interceptors,

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1. USAF Insp Gen, "Survey of the Ballistic Missile Early Warning System," 6 Apr-20 May 1959 [Doc 116 in Hist of ADC, Jan-Jun 1959]; Msg ADLSI-E 0392, ADC to SAC, 25 Jun 1958 [Doc 118 in Hist of ADC, 1958]; Msg DPLBC 4213, SAC to ADC, 8 Apr 1958 [Doc 120 in Hist of ADC, 1958]; Hist of ADC, Jan-Jun 1959, pp. 79-80.

consequently, would be on hand to destroy follow-up waves of Soviet bombers. U.S. citizens could avail themselves of the 15-minute warning period to take cover. Still worse for the enemy, SAC bombers would commence retaliatory bombing attacks that, in combination with SAC ICBM's launched against Soviet targets, would leave the Soviet Union in shambles. These 15 minutes, therefore, would be precious moments that would be well spent preparing for, and initiating reprisals against, nuclear attack.

It was for this reason that a BMEWS network would serve a two-fold puspose. Soviet strategists, realizing that their country, too, stood to become the scene of a nuclear bombardment of even greater severity than that which they had caused, would be less inclined to trigger a nuclear exchange. Hence, BMEWS would act as much to help stave off a future ICBM attack, as it would to detect and report any such attack.[2]

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2. USAF, Insp Gen, "Survey of the Ballistic Missile Early Warning System," 6 Apr-20 May 1959 [Doc 116 in Hist of ADC, Jan-Jun 1959]; Msg ADLSI-E 0392, ADC to SAC, 25 Jun 1958 [Doc 118 in Hist of ADC, 1958]; Msg DPLBC 4213, SAC to ADC, 8 Apr 1958 [Doc 120 in Hist of ADC, 1958]; Rpt, Radio Corp of America, Ballistic Missile Early Warning System, Final Report, 12 Jun 1964

Since several years would be consumed in designing, fabricating, transporting and installing the radar and communications equipment involved, air defense planners were anxious to get things started soon after their June 1955 proposal. But the very cost doomed the whole project to a still-birth. Cost estimates to build and equip three BMEWS sites placed the project in the $1.3 billion bracket -- enough to cause USAF to back down. The June 1955 proposal, was speedily shelved.[3]

Then, in October 1957, the Soviet Union orbited its first satellite, Sputnik I, whereupon, considerable soul-searching ensued at USAF. The Soviets had developed a ballistic missile obviously able to put a payload in orbit or on American shores. Once the threat had clearly transcended the speculation stage to pass into the realm of reality, things happened fast. Within weeks, USAF whipped up General Operational Requirement No. 156, "Ballistic Missile Defense

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[Cont'd] [Cited hereinafter as BMEWS Final Program Report], pp. 2-1 to 2-10.

3. USAF, Insp Gen, "Survey of Ballistic Missile Early Warning System," 6 Apr-20 May 1959 [Doc 116 in Hist of ADC, Jan-Jun 1959].

System" (7 November 1957), which resurrected certain concepts embodied in the original June 1955 plan. A BMEWS was called for that would offer effective radar coverage over probable paths of ICBM's aimed at North America. The network was to aspire to 100 per cent reliability, operate full time under all conditions of weather, incorporate ECCM devices, reject false alarms precipitated by meteors and atmospheric phenomena, and contain either substitute apparatus or overlap coverage to allow radar maintenance without a corresponding loss of coverage during requisite maintenance down time. Three radar complexes, in essence, would be so situated as to energize overlapping coverage above Canadian and Soviet portions of the Arctic perimeter for a distance of 2,600 miles. By erecting this triple complex of radars at Thule, Greenland (Site I), Clear, Alaska (Site II) and at some then undetermined site in the United Kingdom (Site III), radar coverage would be spread in overlapping layers above practically all of the Russian land mass. Consequently, any barrage of ICBM's fired from Soviet sites at North American targets would soon penetrate the BMEWS screen alerting the ADC/NORAD COC and SAC Command Post at least 15 minutes before impact.

According to intelligence estimates, the USSR would attain a capability of launching a fleet of 100 ICBM's by 1960. The Thule site was earmarked as first to undergo construction, with a view to its completion by 1959. Next came the Clear, Alaska site, tentatively scheduled for completion in early 1960. The last site, in Great Britain, was to be readied for operational duty by 1961, according to early plans. About $750 million was estimated for total costs.[4]

Scarcely had the ink dried on USAF's GOR 156, when it received DOD and congressional endorsement. Not long after, Radio Corporation of America was named the prime contractor responsible for planning, designing, fabricating, testing, installing and for at least two years, operating and maintaining, the BMEWS network, employing whatever subcontractors were considered necessary. In January 1958, Congress appropriated funds for construction of the Thule site. The

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4. ADC Historical Study No. 26, "Air Defense in National Policy, 1958-1964," pp. 1-2; USAF, "General Operational Requirement for Ballistic Missile Early Warning System (GOR 156)," 7 Nov 1957 [Doc 104 in Hist of ADC, 1958]; Msg AFOAC-EQ 56124, USAF to ADC, 4 Feb 1958 [Doc 107 in Hist of ADC, 1958]; C&E Digest, Vol 8, No. 4 (Apr 1958), pp. 22-23 [HRF]; Hist of RADC, ARDC, Jul-Dec 1957, p. 105; Hist of ADC, Jan-Jun 1959, pp. 79-80.

same month, Western Electric Company was designated prime contractor for the BMEWS external communications for interconnecting BMEWS sites with NORAD/ADC COC. ADC drafted a BMEWS Preliminary Operations Plan, dated 10 March 1958, that SAC warmly supported, contingent on the SAC Command Post being made one of the primary recipients of ICBM attack data. BMEWS was accorded a high priority on the Department of Defense Master Urgency List. AMC was designated USAF's executive agency for BMEWS systems development and funding, with the understanding that ADC would assume control of BMEWS upon achievement of an operational readiness status. BMEWS was to be operated by a civilian contractor for at least two years. On 9 May 1958, the Secretary of Defense authorized USAF to proceed with construction of BMEWS Sites I (Thule) and II (Clear), together with the BMEWS Display Facility in the NORAD/ADC COC. Costs for all three projects were to be kept within bounds of $822.7 million funding ceiling. Radars contemplated for Sites I and II were to be reduced in number to conserve funds.[5]

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5. ADC Historical Study No. 26, pp. 2-3; USAF, Insp Gen, "Survey of Ballistic Missile Early Warning System," 6 Apr-20 May 1959 [Doc 116 in Hist of ADC,

Given these funding guidelines, the various BMEWS requirements, and the plateau of technology then obtaining, the following equipments were selected for the three sites under the categories of search radars, tracking radars, data processing computers, and display systems. Two types of radars were picked for BMEWS sites. The L-band, high-powered FPS-50 scanner search set designed by General Electric was structured to look not unlike a concave billboard of gigantic proportions. It was an improved version of the FPS-17 model developed earlier by General Electric. The parabolic reflecter of the FPS-50 stood 165 feet high and extended 400 feet in width -- greater in dimensions than a football field tilted on edge. Weighing all of 1,300 to 5,000 tons (depending on location), the FPS-50 operated on a frequency band of 404 and 446 mcs. The radar functioned to project two

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[Cont'd] Jan-Jun 1959]; Msg AFDDC-SP 52531, USAF to AMC, 7 Nov 1957 [Doc 103 in Hist of ADC, 1958]; Msg AFOAC-E/Q 56124, USAF to ADC, 4 Feb 1958 [Doc 107 in Hist of ADC, 1958]; Msg AFMPP/EQ/1 55646, USAF to AMC, 24 Jan 1958 [Doc 113 in Hist of ADC, 1958]; Msg DLBC 4213, SAC to ADC, 8 Apr 1958 [Doc 120 in Hist of ADC, 1958]; Msg MCPY-1-66-E, Ch EDSD to AMC, 2 Apr 1958 [Doc 123 in Hist of ADC, 1958]; Msg AFOAC 50700, USAF to ADC, 10 May 1958 [Doc 125 in Hist of ADC, 1958]; Hist of ADC, 1958, pp. 92-101; Hist of RADC, ARDC, Jul-Dec 1957, pp. 105-12.

separate radar fans, the bottom-most at 3.5 degrees elevation and the upper-most at 7 degrees elevation. The FPS-50 range was estimated to be 2,500 nautical miles. A pipe organ antenna feed system energized a series of split beams that swept horizontally back and forth within a few seconds' time. With ICBM azimuth, range, elevation, course and speed data furnished by the FPS-50, the computerized data processing system could quickly approximate an ICBM trajectory.

Estimated ICBM trajectories could thereupon be fed into the second radar--an RCA FPS-49 L-band tracking set, which worked in the 404 to 446 frequency band on an average power of 540 kilowatts and a peak power of 10 megawatts. Endowed with a range of 2,600 nautical miles, the FPS-49 functioned to reduce the rate of false alarms and to feed data on actual ICBM raids into the computer for ascertaining general impact areas. Socketed atop a pedastal rising high above the ground, the FPS-49 parabolic reflector, measuring between 70 and 80 feet in diameter, contained a monopulse feed horn. The reflector could swing a full 360 degree circle and swivel vertically from a horizontal position to one directly overhead. The enormous FPS-49 was enclosed inside a pressurized spherical shell, or radome, measuring 140 feet in diameter, that kept the apparatus immune to wind damage, and corrosion. Between the FPS-49 and the FPS-50 radars, BMEWS sites would enjoy a 99 per cent detection capability against an ICBM raid, with advance warning time ranging from 15 minutes minimum, to 37 minutes maximum. According to early plans, this warning data would be displayed at the NORAD/ADC COC, communicated simultaneously via two separate routes per site, to insure its reception in Colorado Springs.[6]

With the $822.7 million funding ceiling imposed by the Defense Department, a number of conspicuous re-adjustments were in order. Instead of the FPS-50 scanner search set containing three radar fan elevations each, as originally contemplated, they would contain only two, as described above. Radar transmitters in certain technological buildings would be

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6. C&E Digest, Vol 8, No. 4 (Apr 1958), pp. 22-23 [HRF]; ADC, Air Defense Command's Ground Radars, n.d., ca. 1962, pp. 30-33; Hist of ADC, 1958, pp. 97-99; BMEWS Final Program Rpt, pp. 2-1 to 2-10; C&E Digest, Vol 13, No. 10 (Dec 1963), pp. 10-11 [HRF]; C&E Digest, Vol 10, No. 10 (Oct 1960), pp. 1-8 [HRF].

reduced in number. Most drastic of all, an interim site configuration, approved by USAF on 6 November 1958, divided into two phases, would be implemented which would be considerably less than originally envisioned. The Thule and Clear sites, during Phase I, would have four and three FPS-50's erected, respectively, as first programmed, but no FPS-49's. The United Kingdom site would operate three FPS-49 trackers alone. At a later date, during Phase II of the interim configuration, both the Thule and Clear sites were to gain two FPS-49's apiece -- one less per site, however, than the three FPS-49's initially planned for Sites I and II. But the U.K. site No. III, during this interim period, would not even get one of the three FPS-50 radars it was supposed to receive according to early plans. Original target dates, meanwhile, were shoved months behind schedule, owing to funding limitations and consequent rearrangement in plans that slowed down the programming process.[7]

<u>Site I, Thule</u>. Once the interim program was studied and Phase I was authorized by USAF, however,

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7. <u>BMEWS Final Program Rpt</u>, 12 Jun 1954, pp. 2-4 to 2-10 [HRF]; <u>Hist of ADC</u>, Jan-Jun 1959, pp. 81-86.

the BMEWS project picked up considerably more speed. The BMEWS Site I at Thule received immediate attention from construction teams, numbers of whom swarmed there during 1958. First to undergo construction and first completed, the Thule site enjoyed the singular distinction of being not only the initial BMEWS installation, but also largest. Site survey teams had picked the location best suited for Site I months before USAF approved Phase I of interim configuration. Situated about 600 miles north of the Arctic Circle, and 927 miles south of the geographic north pole, BMEWS Site I was 12 miles from Thule Air Base, near North Star Bay on the west coast of Greenland. This location facilitated logistical support and personnel supply, rendering Site I accessible to air transport and, during the summer, sea transport. Aiming to meet an IOC (Initial Operational Capability) target date near the end of 1960, construction work on certain facets of the project commenced in May 1958. By April 1959, enough of the requisite preparations had been accomplished to enable crews to begin emplacing the heavy radar equipment. For the next 16 months, construction proceeded at a rapid pace. Giant antennas were raised; heavy transformers and rectifiers were set; power amplifiers and capacitors were assembled; electronic cabinets were secured; and miles of thick, heavy cables were strung. Heeding the urgency to finish on schedule, systems construction in some cases proceeded concurrently with systems development. Spread over a stretch of land more than one mile long, Site I grew to contain four king-sized FPS-50 antennas good for 40 degrees azimuth radar coverage apiece -- so positioned as to offer collectively an arc of radar coverage embracing 160 degrees. This coverage spread above northern Europe and north central Asia. All sorts of engineering problems presented themselves, not least of which was fathoming a method to plant the 1,500 ton FPS-50 antennas firmly in the permafrost, without later jeopardizing them from the four weather to which they would regularly be exposed. Each FPS-50 was fastened in the ground snugly enough to withstand winds up to 185 miles per hour, temperatures down to minus 65 degrees Fahrenheit, and a six-inch coating of ice. The FPS-50's were placed at least 600 feet apart to preclude mutual electronic interference. Other precautions taken

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included the shielding of otherwise vulnerable facilities nearby, to protect personnel and electronic equipment from RF energy fields. Something on the order of 21 miles of ducting-like waveguides were layed for funneling the radio frequency (RF) energy generated inside three separate transmitter buildings to four multi-story FPS-50 scanning switch and antenna feedhorn buildings, whence the RF energy was bounced off four 165-foot by 400-foot FPS-50 antenna reflectors. The resulting two-fans of radar pulses reflected all objects encountered and after due reception and amplification by data processing equipment, the echoes converted into signals on operations consoles. The 120,000 volts of direct current power required to energize all this was created by banks of Klystron tubes, each measuring nine feet tall, in combination with high voltage regulators, transformers, rectifiers and capacitors. All told, 290 cabinets of electronic equipment, 10 monitoring consoles, eight high-speed scanning switches, 704 feedhorns and 440 miles of interconnecting cables and waveguides (apart from the transmitter buildings, scanning buildings and giant reflectors) were installed at the Thule site.

By August 1960, the BMEWS Site I at Thule assumed its final form in the Phase I interim configuration.[8]

All this while, communications were installed by various subcontractors under the aegis of Western Electric Company to insure that enemy ICBM data received by Thule would be instantly transmitted simultaneously. If one broke down, a second would be on hand to carry on. Briefly, one primary route exploited a submarine cable, in use by September 1960, 1,950 miles from Thule to Dear Lake, Newfoundland. From there, a commercial microwave radio-relay route continued transmissions across Nova Scotia and New Brunswick into the United States via New York, Georgia and Texas to Colorado Springs.

The second Thule-Colorado Springs communications route, instead of going by sea and land, first took to the air. The high-powered AN/FRC-47 tropospheric-scatter radio communications system, named Dew Drop, was installed at Thule to bounce radio signals off

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8. BMEWS Final Program Rpt, 12 Jun 1964, pp. 2-12, 4-13 to 4-25 [HRF]; C&E Digest, Vol 10, No. 10, (Oct 1960) pp. 1-8 [HRF]; C&E Digest, Vol 10, No. 4 (Apr 1960), pp. 10-11 [HRF]; C&E Digest, Vol 13, No. 10 (Dec 1963), pp. 7-10 [HRF]; Hist of ADC, Jan-Jun 1960, p. 59.

the troposphere. These, in turn, were received by a similar facility at Cape Dyer, Baffin Island, employed in the rearward communications network of the DEW Line. From Cape Dyer, BMEWS messages were retransmitted, again via tropospheric-scatter radio, to Goose Bay, Labrador, thence travelling overland via commercial circuits to Colorado Springs. This route became fully operational on 15 September 1961.

While both primary communications routes, for the most part, handled data-link transmissions for sake of expediency, they were capable of handling telephonic voice and teletype messages as well. Besides the two primary routes, certain back-up facilities were provided for emergency communications if both of the two regular routes failed.[9]

With radars emplaced by August 1960 and the submarine cable route implemented by December 1960, Site I was enabled to attain an IOC effective 1 October 1960. A 700-strong personnel contingent was employed by RCA to operate, maintain and support the unit around-the-clock, every day of the week, until January 1962, when

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9. BMEWS Final Program Rpt, 12 Jun 1964, pp. 2-16 to 2-17 and 4-59 to 4-63 [HRF]; Hist of ADC, Jan-Jun 1959, pp. 91-94; C&E Digest, Vol 10, No. 4 (Apr 1960),

ADC was scheduled to assume control. Between times, the equipment had to be finally calibrated, then undergo a battery of checks and tests.

No sooner was the Phase I interim configuration achieved, than work commenced on a modified configuration called Phase IA. This change resulted from an urgent need for FPS-49 radar tracking equipment to complement the four FPS-50 scanning search sets. The Phase II interim configuration desired next to be implemented - calling for a pair of FPS-49's at both sites I and II - had yet to be authorized. Since funds to finance four FPS-49's were not available, USAF, as a compromise measure, approved a Phase IA configuration on 4 August 1960 that applied to the Thule site alone, allowing it to possess a single FPS-49A tracking set. Construction on the FPS-49A began in October 1960 and was completed in July 1961. Meanwhile, systems and subsystems tests and checks were performed on the Phase I equipment to the satisfaction of inspection teams and on 31 December 1960,

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[Cont'd] p. 12 [HRF]; C&E Digest, Vol 13, No. 10 pp. 13-14 [HRF].

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Site I was declared manually operable. Effective 30 January 1961, the Thule site was pronounced automatically operable. Tests of the Phase IA FPS-49A tracking radar took place from June to December 1961. Total costs for the Thule site approximated $425 million.[10]

Site II, Clear, Alaska. Construction of the second BMEWS site at Clear, Alaska, was started in mid-1958. Clear was situated 60 miles southwest of Fairbanks and 1,602 miles south of the geographic north pole. The site was picked in early 1958 from a list of 11 locations in the Anchorage-Fairbanks area. Three FPS-50 scanner search sets and associated equipment were authorized for Site II in the Phase I interim configuration. Ground clearing preparations and foundation construction commenced in July 1958 and continued for 31 months until December 1960.

In addition to labor union difficulties and a serious fire in a transmitter building (4 May 1960) which prolonged construction progress, BMEWS Site II

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10. BMEWS Final Program Rpt, 12 Jun 1964, pp. 2-10, 4-18, 4-25 to 4-26 [HRF]; C&E Digest, Vol 10, No. 10 (Oct 1960) p. 11 [HRF]; Hist of ADC, Jul-Dec 1960, pp. 76-77 and Jan-Jun 1961, p. 87.

was not given the preferential treatment that Site I at Thule received. Notwithstanding, enough ground work was accomplished by early 1960 so that equipment emplacement began in June of that year. All equipments, including radar and transmitter buildings, were up and functioning by March 1961, whereupon contractor tests and checks were conducted until completed in September 1961. The three FPS-50's facing northward offered complementary coverage equal to a 120-degree arc that spread above most of northeastern Asia. One FPS-50 was singularly modified to beam a 10-degree wide radar elevation "droop" in coverage (five degrees in the upper fan; two degrees in the lower fan) to detect ICBM's launched in a certain area at low angles, that otherwise would escape detection by either the Clear or the Thule radars.

Just as the Thule site enjoyed dual communication routes, two separate communication routes were implemented for the Clear site. One route depended wholly on a series of microwave radio-relay systems situated between Clear and Colorado Springs. This route, which became operational on 31 August 1961, generally followed the ALCAN Highway through Alaska and Canada to Edmonton, Alberta, thence to Lethbridge, Alberta, through Montana, finally reaching Colorado Springs. The other route exploited a combination of facilities, some new, some already in existence. A microwave radio-relay system was employed from Clear to Boswell Bay, where a newly erected tropospheric-scatter radio system (added to the White Alice Alaskan communications network) transmitted Site II messages to Annette Island. Here, another microwave radio-relay facility carried Site II messages to Ketchikan, whence they were continued by an existing commercial submarine cable to Port Angeles, Washington. From Port Angeles, Site II messages were routed over commercial telephone circuits through California eastward to Colorado Springs. This route was operational on 30 June 1961. With both radars and rearward communications functioning by the summer of 1961, the Clear site was enabled to achieve an IOC effective 30 September 1961. It became fully operational on 31 December 1961. Costs for Site II approximated $350 million.[11]

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11. BMEWS Final Program Rpt, 12 Jun 1964, pp. 2-13, 2-18, 4-26 to 4-37, 4-60 to 4-65, 5-2 to 5-3 [HRF]; C&E Digest, Vol 13, No. 10 (Dec 1963), pp. 10-12

<u>Site III, Fylingdales, England.</u> BMEWS Forward Site III, like the first two, was programmed in late 1957. Being assigned the lowest priority of the three, Site III got a relatively late start. Not until March 1959 were all U.K. sites eliminated. Fylingdales, was located in North Yorkshire, England, about six miles from the North Sea coast near the town of Pickering. After a drawn-out period of negotiations, a joint U.K./U.S. agreement was signed in February 1960. The U.S. agreed to furnish the radars, data processing and other specialized electronic equipments, plus spare parts enough for five years of operation and the Transatlantic communication systems. The U.K. promised to supply the land, buildings, utilities (including power plant), certain support facilities and equipment, internal communications and the communication links to U.K. authorities. April 1963 was established as the target date for an IOC status. When completed, Site III was to be operated and commanded by the RAF according to ground rules jointly arrived at by both the U.S. and the U.K. As mentioned above, Site III was authorized

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[Cont'd] [HRF]; Hist of ADC, Jan-Jun 1959, pp. 94-95; Jan-Jun 1960, p. 59; Jul-Dec 1960, pp. 76-77; Jan-Jun 1961, pp. 88-89.

three FPS-50 scanning search sets. Construction did not get underway until late 1960. In the spring of 1961, a series of labor strikes erupted, causing serious delays in the timetable for construction progress. In all, some 53 labor strikes occurred at the BMEWS Site III. Foul weather, also, took a hand in protracting scheduled construction. What originally had been programmed to last 25 months, was dragged out a total of 37 months -- one year longer than planned. Nevertheless, in doubling up on certain activities by availing themselves of the principle of concurrent implementation, construction and technical crews managed to prevent the 12-months construction lag from delaying the IOC target date more than 5 months. Accordingly, the Fylingdales site achieved its IOC in September 1963. In January 1964 it became fully operational in an automatic mode. Costs were estimated at about $120 million.

Three FPS-49 tracking sets were situated to provide an azimuth sector coverage up to 135 degrees, over north and central Europe, including much of the European USSR and nearby communist satellite nations. Two of the three FPS-49's scanned the assigned surveillance sector while the third remained poised to lock onto whatever targets were deemed threatening. Not only were Site III FPS-49's designed to detect ICBM's aimed at North America, but also to trigger a four-minute advance warning of intermediate range ballistic missiles (IRBM's) destined for the U.K. Communications for this latter purpose were installed in the RAF Air Defense Operations Centre and the Air Ministry Operations Room. To alert North America of an impending ICBM attack, no less than four trans-atlantic communications arteries were available, three of which utilized submarine cables and all of which eventually ended at Colorado Springs. Transatlantic Telephone Cable-One (TAT-1) connected with a U.S. land network carrying Site III messages to Wright-Patterson AFB, Dayton, Ohio, from whence they were relayed to Ent AFB via commercial facilities. Trans-atlantic Telephone Cable-3 (TAT-3) was linked to U.S. land communications systems at Tuckerton, New Jersey, which in turn transmitted Site III messages to Colorado Springs through Newbern, Illinois, via a combination of hardened cable and microwave radio-relay systems. Canadian Transatlantic Telephone Cable (CANTAT) connected with facilities at Wildcove, Newfoundland, which also were linked to those at Tuckerton, New

Jersey. The fourth artery was comprised of the North Atlantic Radio System which interconnected Site III with a DEW Line station at Cape Dyer, Baffin Island, from which Site III communications reached Colorado Springs via the DEW Line rearward route. Tropospheric-scatter radio systems were erected at Fylingdales and at Keflavik, Iceland, to transmit Site III messages to Cape Dyer.[12]

Facilities in the Zone of the Interior. While the BMEWS three-site forward facilities were under construction, certain BMEWS facilities were readied in the CONUS. These were the BMEWS display systems for NORAD, SAC and USAF, the most elaborate of which was the NORAD Central Computer and Display Facility (CC&DF) inside the three-story, windowless NORAD Combat Operation Center at Ent AFB, Colorado. Here, Fenske, Fedrick and Miller (FF&M) iconorama display

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12. BMEWS Final Program Rpt, 12 Jun 1964, pp. 2-14 to 2-19; 4-37 to 4-42; 4-61 to 4-63 and 5-3 to 5-5 [HRF]; C&E Digest, Vol 10, No. 10 (Oct 1960), pp. 11-12 [HRF]; C&E Digest, Vol 13, No. 10 (Dec 1963), pp. 11-12 [HRF]; Hist of ADC, Jan-Jun 1959, pp. 86-87; Jul-Dec 1959, pp. 57-60; Jan-Jun 1960, pp. 59-60, 66-70; Jan-Jun 1961, pp. 88-91; Jul-Dec 1961, pp. 104-05.

apparatus, together with modified RCA data processing equipment, were installed in 1960. While the projectors and certain other components of the FF&M system proved troublesome at first, most of the problems were ironed out by December 1960, when data communications links with Site I at Thule were completed. Thereafter, ICBM information was received, processed and displayed for tactical action by CINCNORAD. While all this was ordinarily accomplished automatically, there was also built into the system a manual capability to display ICBM data for backup purposes.

Among other things, this information included: (1) calculated ICBM launch and impact areas; (2) the five-minute threat summary index; (3) time, in minutes until the next missile impact; (4) status data regarding functionability of BMEWS forward sites; (5) indications of ECM activity; (2) the NORAD and the U.K. alarm level decisions. Practically all these data were simultaneously transmitted by the NORAD CC&DF to a similar display facility at SAC headquarters at Offutt AFB, Omaha, and to three display facilities in the Pentagon: the Joint War Room of the JCS; the Defense Intelligence Agency; and the USAF Command Post. The display systems were modified to receive ICBM data from Site II at Clear in 1961, and from Site III at Fylingdales in 1963.[13]

On 5 January 1962, ADC formally assumed possession of Sites I and II at Thule and Clear from the Air Force Systems Command. Operations and maintenance were thereupon supervised by units of the 71st Surveillance Wing (BMEWS) belonging to the 9th Aerospace Defense Division (ADC). The 71st Surveillance Wing was activated on 1 January 1962. The 9th Aerospace Defense Division's 1st Aerospace Surveillance and Control Squadron (activated 14 February 1961; redesignated the 1st Aerospace Control Squadron on 1 July 1962), operated the display facilities in the NORAD COC.

By this time, the BMEWS network had encountered and resolved its first major obstacle - the false alarm problem. The moon -- nearly a quarter of a million miles away -- was the first offender in this category. On 5 October 1960, just days after Site I

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13. BMEWS Final Program Rpt, 12 Jun 1964, pp. 2-14 to 2-15, 4-47 to 4-54 and 5-6 [HRF]; C&E Digest, Vol 13, No. 10 (Dec 1963) pp. 12-13 [HRF]; Hist of ADC, Jan-Jun 1960, pp. 88-91; Jul-Dec 1959, pp. 60-65; Jan-Jun 1960, p. 60.

at Thule had reached its IOC status, the moon rising from the horizon triggered an alarm level five - highest at the time - at the NORAD COC. Since no impact predictions ensued, however, NORAD personnel treated this as a false alarm. A penetration was first reported of the lower fan, then after a lapse of 20 minutes, of the upper fan, as the moon climbed heavenward on its journey. To preclude further moon-engendered false alarms, a permanent "fix" was devised and applied, which effectively eliminated moon returns from being routed into the computer.

Next in line for false-alarm producers came spurious reports caused by on-sight electrical interference. Comprising single-fan threats, these spurious reports also failed to precipitate undue action on the part of NORAD personnel. An investigation revealed two blameworthy causes for the spurious reports: vehicular traffic in the vicinity of the radar reflectors; and RF signal generators when used for receiver maintenance. Suppression kits soon were added to vehicles authorized in reflector areas; and operation of signal generators was confined to inside closed screen rooms. The spurious noise problem, consequently, came to an end.

Scarcely was this problem solved when another false-alarm situation cropped up. This time, the multiplicity of orbiting satellites and their fragments triggered unnecessary alarms involving both fans of the Thule and Clear sites. A modification was quickly fabricated and, in July 1961, installed at Sites I and II, which thereafter kept satellite data from generating false alarms. Two other BMEWS problems at this time involved arcing in FPS-50 scanner switches, and severences of submarine cables by fishing trawlers, both of which were shortly corrected.[14]

<u>ECCM "Fixes</u>." The need for ECCM devices was recognized in 1961, following tests conducted in the summer of that year. ADC immediately levied a requirement for 10 ECCM "fixes," estimated to cost over $40 million, for implementation over a three-year period. Included were three modifications termed "Hasty" fixes that cost $160,000, which USAF agreed should be installed within a year's time to render

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14. <u>BMEWS Final Program Rpt</u>, 12 Jun 1964, pp. 5-7 to 5-12 [HRF]; Hist of ADC, Jul-Dec 1960, pp. 85-91; Jan-Jun 1961, pp. 91-93; Jul-Dec 1961, pp. 98-103.

BMEWS as much immune to jamming as possible. These comprised a noise monitor, a target test generator, and an ECM simulator for each site, which were installed and tested between 27 December 1961 and May 1962. In the spring of 1962, USAF sought $43 million in funds from the Defense Department to amortize costs of BMEWS permanent ECCM fixes. But, $28 million was the most the Secretary of Defense authorized in 1963. Sometime in 1966 was established for the completion of the ECCM fixes at the three forward BMEWS sites. By mid-1964 RCA was awarded a contract of $10.5 million for ECCM fixes; while General Electric was awarded a contract for $200,000 for a feasibility study on the use of side-lobe cancellation for BMEWS radars.

Other things, besides ECCM fixes, were programmed to improve the BMEWS network. The Clear site, in late 1963, was authorized one FPS-92 (an improved FPS-49) tracking radar, to be operational around mid-1966. Furthermore, modifications were programmed for detecting and tracking sea-launched ballistic missiles (SLBM's) by BMEWS, with an operational capability date in September 1966. On the other hand, an ADC request for a gap-filler radar to fill a low-altitude gap between Greenland and England was turned down by the OSD.[15]

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15. Hist of ADC, Jul-Dec 1961, pp. 103-04; Jan-Jun 1963, pp. 708; Jan-Jun 1964, pp. 27-38; ADC Management Analysis Program Information Center, (PIC) Summaries of Status, 4 Oct 1963, 11 Oct 1963, 17 Jan 1964; RESTRICTED DATA, ADC to ADC Staff Agencies, "USAF Current Status Reports," for Dec 1961 (18 Jan 1962) and Jan 1962 (19 Feb 1962 [HRF]; NORAD Historical Summary, Jan-Jun 1964, pp. 57-58.

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