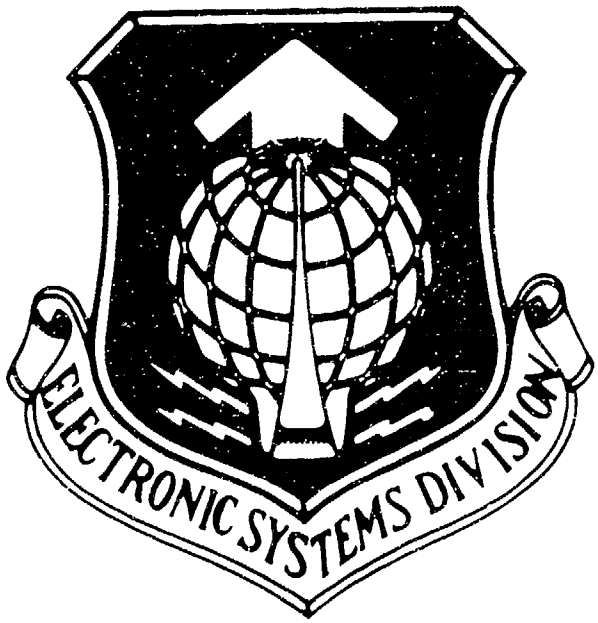
MEETING THE CHALLENGE: ESD AND THE COBRA DANE CONSTRUCTION EFFORT ON SHEMYA ISLAND

BY

DR. E. MICHAEL DEL PAPA



HISTORY OFFICE
3245th AIR BASE GROUP
HANSCOM AIR FORCE BASE
BEDFORD, MASSACHUSETTS

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COBRA DANE CHRONOLOGY

1 Feb 72	Hq USAF issued a program management directive (PMD No. I-Y-2-001-(1)-31015F) designating Air Force Systems Command (AFSC) as implementing command for the acquisition and deployment of the COBRA DANE radar to be operated at Shemya AFB by the Aerospace Defense Command (ADC).
May 72	ESD provided the Alaskan Air Command (AAC) with a military interdepartmental purchase request (MIPR) in the amount of $45,500 to cover the costs of dismantling a 200-man Atomic Energy Commission (AEC) work camp, transporting it from Amchitka Island, and reassembling it on Shemya.
28 Jun 72	ESD conducted a pre-solicitation briefing on the COBRA DANE program attended by 100 representatives from 29 different companies.
28 Oct 72	ESD issued the COBRA DANE request for proposal (RFP).
11 Jan 73	Contractor proposals for the COBRA DANE program were submitted to ESD.
6 Jun 73	ESD announced the award of a fixed price incentive firm (FPIF) contract for the COBRA DANE system to the Raytheon Company of Wayland, Massachusetts.
Aug 73	Construction began on the foundation for the six-story COBRA DANE radar structure and attached one-story Precision Measurement Equipment Laboratory (PMEL).
5 Sep 73	The first COOL BARGE shipment of 600 tons of construction materials arrived at Shemya.
11-14 Sep 73	Preliminary design review (PDR) of the COBRA DANE facility was completed.
17 Sep 73	The first Military Airlift Command (MAC) airlift of construction material, six tons of foundation reinforcement rods, arrived at Shemya.
9-12 Oct 73	PDR of the COBRA DANE system was completed.
Oct 73	Construction work was completed on the foundation for the six-story COBRA DANE radar structure and attached one-story PMEL building.

Oct 73	A special survey was conducted by AAC, ADC, and ESD to determine if the Shemya AFB power plant was adequate to support the COBRA DANE program. Results indicated that the power plant would be insufficient for program support during the COBRA DANE test and evaluation period scheduled to commence in July 1975.
11-14 Dec 73	Critical design review (CDR) of the COBRA DANE facility was satisfactorily completed.
12-19 Feb 74	CDR of the COBRA DANE system was successfully completed.
16 May 74	Unloading of a COOL BARGE containing four Cooper-Bessemer generators and ancillary equipment from the United States Army's SAFEGUARD Anti-Ballistic Missile (ABM) program was completed. This equipment would be employed in a $6.1 million program to update the Shemya AFB power plant.
22 May 74	Work began on the erection of the structural steel framework for both the COBRA DANE radar facility and attached PMEL building.
24 May 74	Approximately 30 truck loads of SAFEGUARD phased array radar (PAR) transmitter components had been shipped from General Electric Company (GE), Syracuse, New York, to Raytheon, where the equipment would be used by the COBRA DANE prime contractor as government-furnished equipment (GFE).
25-29 May 74	A soil sampling and site survey of Alaid Island was successfully completed.
17 Jun 74	ESD received word that the 10-foot diameter, plastic, dish reflector that would be mounted on the top of the 65-foot high calibration tower on Alaid Island had been completely destroyed by fire while being transported by truck to Seattle for COOL BARGE shipment to Shemya.
Aug 74	Work was completed on the outer steel shell of both the COBRA DANE radar facility and PMEL building.
16 Sep 74	A C-5A special assignment airlift mission (SAAM), carrying 65 tons of required construction items, landed at Shemya.
19 Sep 74	Work began on the erection of the calibration tower on Alaid Island.

25 Sep 74	Construction of the calibration tower on Alaid Island was completed, four days ahead of schedule.
5 Nov 74	Work was completed on the enclosure of the radar facility array face with fire retardant plywood.
19 Jan 75	A fire completely destroyed 45 of the 99 required 8:1 power dividers used in the COBRA DANE array subsystem.
1 Feb 75	Shemya Island was struck by an earthquake which registered 7.5 on the Richter scale and whose epicenter was located 50 miles north-northwest of the island at 53.053 North, 173.619 East.
5 Feb 75	ESD issued a change order to the COBRA DANE prime contract to accelerate delivery of replacements for the 45 8:1 power dividers destroyed by fire.
8 Feb 75	Shemya Island was hit by a second earthquake that registered 5.8 on the Richter scale.
15 Feb 75	A MAC survey team completed its evaluation of the ability of the earthquake-damaged Shemya runway to support C-141 and C-5A aircraft.
20 Feb 75	MAC reinstated the SAAM missions for transporting COBRA DANE prime mission equipment from Hanscom AFB to Shemya.
22 Feb 75	AAC notified both Headquarters USAF and ESD of its inability to supply sufficient power to COBRA DANE for equipment installation and checkout.
16 May 75	All power equipment for COBRA DANE interim power was installed and connected, and feeder lines had been installed and connected to both the transformers and the Raytheon switchgear.
May 75	Work began on the removal of the fire retardant plywood from the face of the COBRA DANE radar facility and the installation of array plates.
20 Jun 75	At the request of Lieutenant General Wilbur L. Creech, ESD Commander, the COBRA DANE system program office developed an assessment of the most pessimistic schedule for COBRA DANE initial operational capability (IOC).
18 Aug 75	A team comprised of software experts from ESD, Aerospace Defense Command (ADCOM), RADC, and Lincoln Laboratory, inaugurated a complete Air Force assessment of the problems affecting COBRA DANE software development and their impact, if any, on the program's scheduled milestones.

10 Sep 75	Work was completed on the Air Force assessment of the problems affecting COBRA DANE software development and their impact, if any, on the program's scheduled milestones.
10 Nov 75	A meeting was held at AAC to coordinate the start of COBRA DANE radio frequency (RF) radiation.
14 Nov 75	The COBRA DANE radar facility at Shemya radiated for the first time. Total radiation time was approximately one and one-half hours with power emanating from just one of the 96 high power transmitter tubes.
1 Dec 75	ESD issued to Raytheon the sole source RFP for operation, maintenance, and logistics support of the COBRA DANE radar for the first full year following IOC.
4 Dec 75	The last MAC SAAM of COBRA DANE prime mission equipment was completed when a C-141 aircraft delivered the COBRA DANE Cyber 74-18 computer to Shemya.
27 Jan 76	Preliminary qualification testing (PQT) began for the mission computer program and the simulation computer program. This PQT was hampered by the fact that the 131,000-word core memory of the Cyber 74-18 computer was inadequate to meet core memory requirements.
12 Apr 76	Prime power was made available to COBRA DANE by using two of the four Cooper-Bessemer generators.
25 Apr 76	The bearings within the two Cooper-Bessemer generators turbo-chargers burned out, resulting in a complete loss of power.
18 Jun 76	Headquarters USAF approved the AFSC recommendation that a surplus Cyber 74 computer be assigned to the COBRA DANE program to solve the computer core memory problem.
30 Jun 76	ESD awarded Raytheon a $10,375,000 operations and maintenance (O&M) contract for COBRA DANE.
Jun 76	ESD and Raytheon negotiated an engineering change proposal (ECP) to the prime contract which changed the projected IOC date of the COBRA DANE system from 6 March to 31 October 1976.
28 Jul 76	For the first time, the COBRA DANE radar detected and tracked a Soviet missile launch.
11 Sep 76	A second COBRA DANE computer, a Cyber 74-14, was shipped to Shemya.

Sep 76	ESD and Raytheon negotiated an ECP to the prime contract which changed the COBRA DANE IOC date from 31 October 1976 to 15 January 1977.
28 Oct 76	System testing of COBRA DANE commenced with power being supplied by the upgraded AAC power plant at Shemya.
15 Nov 76	The second COBRA DANE computer, a Cyber 74-14, was put into operation and successfully alleviated the core memory problem.
30 Nov 76	COBRA DANE system performance testing, which included subsystem performance logistical review, SPACETRACK and early warning capability, was completed.
1-15 Dec 76	COBRA DANE reliability/maintainability/availability (R/M/A) demonstration carried out.
17 Dec 76	Raytheon commenced full-time O&M of the COBRA DANE system.
17 Dec 76	COBRA DANE successfully commenced operations, collecting intelligence information and SPACETRACK data for ADCOM's SPACETRACK network.
Dec 76	ESD accepted the COBRA DANE system from Raytheon with noted deficiencies scheduled to be corrected by 28 February 1977.
25-27 Jan 77	Planning for turnover/transition of the COBRA DANE system commenced between ESD and ADCOM.
13 Jul 77	Actual turnover/transition of the COBRA DANE system took place when representatives from ADCOM, AFLC, and ESD signed the COBRA DANE System Turnover Certificate.
13 Jul 77	COBRA DANE achieved IOC with the signing of the COBRA DANE System Turnover Certificate.
1 Oct 77	Program Management Responsibility Transfer (PMRT) of the COBRA DANE radar system from ESD to the Sacramento Air Logistics Center (SM-ALC) of AFLC for logistics support was accomplished.

Introduction

The Electronic Systems Division (ESD) of Air Force Systems Command (AFSC), with headquarters at Hanscom AFB, Bedford, Massachusetts, is responsible for managing the acquisition of command, control, and communications (C^3) systems for the Air Force as well as selective electronic systems for other military services and Department of Defense (DOD) agencies.[1]

In addition to C^3 systems, ESD's acquisition management responsibilities also encompass navigation and surveillance systems, weather observing and forecasting systems, electronic physical sesurity surveillance and intrusion detection systems, air traffic control and landing systems, and computer-based information systems.[2] Recently, ESD successfully completed one of its most difficult and challenging acquisition efforts. This action involved the COBRA DANE program -- a single-faced, phased array radar system located on Shemya Island, Alaska.

Background and Objectives of COBRA DANE Program

On 1 February 1972, Headquarters USAF issued a program management directive (PMD No. I-Y-2-001-(1)-31015F) designating Air Force Systems Command as implementing command for the "acquisition and deployment of the COBRA DANE radar to be operated at Shemya AFB by ADC [Aerospace Defense Command]. . . ."[3] The primary purpose of the COBRA DANE radar would be:[4]

> to acquire precise radar metric and signature data on developing Soviet ballistic missile weapon systems for weapon system characteristics determination. The Soviet developmental test to Kamchatka and the Pacific Ocean provide the U.S. the primary source for collection of this data early in the Soviet developmental programs. The current Shemya radar system

> is not adequate to collect the required data on the current Soviet multiple R/V [reentry vehicle] systems and can be expected to be more inadequate when the tests of the new Soviet systems (currently under preparation) commence. Consequently, there is a compelling need now for the COBRA DANE capability and every effort should be made to expedite acquisition.

Mr. Thomas P. O'Mahony, Deputy System Program Director of the COBRA DANE System Program Office (SPO) at ESD, provided a more succinct and lucid explanation of the main objective of the COBRA DANE program when he stated that "It was necessary. . .to have some measure of what [the Soviets] were doing so our defense planners would know where we were from an intelligence viewpoint."[5]

While primarily oriented towards the collection of intelligence data on Soviet intercontinental and sea-launched ballistic missile (ICBM/SLBM) systems, COBRA DANE was also earmarked for such corollary missions as early warning and SPACETRACK.[6] The early warning mission would involve the detection and tracking of Soviet ICBMs/SLBMs and the reporting, in near-real time (NRT), on those missiles for which impact in the continental United States (CONUS) was predicted. The data derived from the early warning mission of COBRA DANE would include launch and impact point information that would be employed in attack assessment.[7] With regard to the SPACETRACK mission, the installation and operation of COBRA DANE on Shemya would greatly enhance the SPACETRACK data on Soviet satellite launches and space programs currently provided by the AN/FPS-17-79 and 80 detection and tracking radars situated on the island.[8]

System Description and Location

Under plans developed by ESD, the COBRA DANE system would consist of an AN/FPS-108 radar facility measuring 87 by 107 feet at

its base and approximately six stories or 100 feet in height, plus an attached one-story Precision Measurement Equipment Laboratory (PMEL) measuring 87 feet square.[9] Both structures would be built on a 230-foot-high bluff located on the northwestern section of Shemya Island overlooking the Bering Sea.[10] The selection of Shemya as the site for COBRA DANE was an obvious one. The island is situated 480 nautical miles from Kamchatka Peninsula and the surrounding ocean area, the primary impact area for practically all Soviet missile tests. From Shemya, COBRA DANE would be able to obtain data on missile trajectories, separation velocities, payload maneuvers, and signature data on reentry vehicles from missiles fired from both the Russian land mass and the Soviet's primary SLBM launch site.[11]

Challenges Posed by COBRA DANE Program

The nature of the COBRA DANE program acquisition concept, coupled with the selection of Shemya Island as the location for the radar system, posed enormous challenges to the hard work, dedication, and ingenuity of ESD personnel. To begin with, the program acquisition concept developed for COBRA DANE called for the "turnkey" installation (with the prime contractor totally responsible for the radar and the facility housing it) of a fully operational system 33 months after the award of the system acquisition contract, scheduled to be awarded during the third quarter of fiscal year (FY) 1973 (January-March 1973).[12] Of even greater importance, the selection of Shemya as the site for COBRA DANE represented an engineering and logistical nightmare, since climatic conditions on the island imposed severe restraints on such vital activities as supply,

support, logistics, maintenance, communications, transportation, and on-site construction.[13]

Shemya Island

Shemya Island, described by one individual as a two- by four-mile "speck of desolation," is situated near the western tip of the Aleutian Island chain, approximately 500 miles across the Bering Sea from the Russian eastern seaboard.[14] The island, sometimes referred to as the "Black Pearl of the Pacific," but more commonly known as the "Land of Horizontal Snow," is a meteorological disaster area.[15] Indeed, bad weather and Shemya Island are nearly synonymous. The island receives an abnormally large amount of precipitation, with three out of every five days marked by either rain or wet snow.[16]

The only surprising climatic condition associated with Shemya, if one can use that phrase, is its year-round temperature range, which fluctuates little from a low of 28 degrees in the dead of winter to a high of 53 degrees in the heart of summer. This situation is the result of the meeting of warm tropical water from the south with cold Siberian air from the north. While this phenomenon is responsible for both the unusual temperature range and ice-free water conditions surrounding Shemya, it also creates a year-round tumult of high winds and thick fog. Gale-force "williwaws," sometimes reaching speeds of 160 mph, combine with wet snow during the winter months to lend credence to Shemya's reputation as the "Land of Horizontal Snow."[17] As one observer described conditions on Shemya: "There are only eight to 10 clear days a year, but there is never a serene or dry season."[18] Because of the island's meteorological

makeup, outside construction activity is confined to a six-month period from May to October.[19]

Under the terms of the COBRA DANE PMD, and in accordance with plans developed by ESD, construction of the AN/FPS-108 radar system on Shemya would be accomplished under both the Military Construction Program (MCP) and the prime contract. Responsibility for the design and construction of the large six-story facility housing the radar system and the one-story PMEL building would rest with the prime contractor. All other on-site support improvement actions necessary to activate the system, such as grading, power, and utilities, would be an MCP responsibility.[20]

Site Survey

In the late winter and early spring of 1972, ESD undertook action to complete the PMD-directed COBRA DANE site survey by 1 April. ESD representatives, accompanied by individuals from the Rome Air Development Center (RADC), held a meeting with Alaskan Air Command (AAC) personnel at Elmendorf AFB, Alaska. Following this meeting, ESD, RADC, AAC, ADC, and Air Force Communications Service (AFCS) personnel proceeded to Shemya AFB where contact was made with all local units and discussions were completed on such topics as transportation, housing, messing, siting, radio frequency interference (RFI), and logistics support. While this team was visiting Shemya, another group of personnel remained at AAC Headquarters to work with AAC representatives in further identifying both required and available support. This latter group arrived at a tentative host-tenant agreement for support of COBRA DANE.[21]

At Shemya, a specific site for the COBRA DANE radar was chosen which was acceptable to AAC, as well as ESD, RADC, and ADC. Following selection of the site, a successful site survey was completed. No RFI or electromagnetic compatibility (EMC) problems were anticipated with the selected COBRA DANE site since this subject was covered in great detail during the site visit.[22]

Work Camp

While ESD personnel were at Shemya, they discovered that there were no quarters available on the island for the additional contractor personnel required during the construction and installation phase of the COBRA DANE program. As a potential solution to this problem, AAC personnel informed the COBRA DANE site survey team that the Atomic Energy Commission (AEC) possessed a complete 200-man work camp on Amchitka Island, including living, messing, and recreation facilities, that was available for use on the COBRA DANE program.[23] In May 1972, ESD provided AAC with a military interdepartmental purchase request (MIPR) in the amount of $45,500 to cover the costs of dismantling the work camp, transporting it from Amchitka, and reassembling it on Shemya.[24]

COBRA DANE Request for Proposal (RFP)

With the successful completion of these preliminary preparations, attention now focused on the issuance of the COBRA DANE request for proposal (RFP) and award of the prime contract. On 28 June 1972, a pre-solicitation briefing on the COBRA DANE program was conducted at ESD. At this briefing, attended by 100 representatives from 29 different companies, a summary of the then current program status and requirements was reviewed along with the caveat that the

RFP could contain changes from the material presented. Following completion of the briefing, the attendees were given the opportunity to submit written questions. Copies of these questions, along with ESD's responses, were provided to each of the attending companies.[25]

During July and August 1972, ESD provided potential prime contractors with the opportunity to visit the selected site of the proposed COBRA DANE radar on Shemya Island.[26] The primary objective of these site visits was to familiarize the contractors with some of the difficulties they could expect to encounter during the course of the COBRA DANE program with such things as weather, transportation, and logistics support.[27]

Issuance of the COBRA DANE RFP, originally scheduled to take place in August, was postponed until 28 October because of various changes incorporated into the document. Once the RFP was issued, a Proposal Evaluation Board (PEB) and a Source Selection Evaluation Board (SSEB) were established. Source Selection Authority (SSA) for the COBRA DANE prime contract was vested in the ESD Commander, Major General Albert R. Shiely, Jr.[28]

COBRA DANE Contract Award

Contractor proposals for the COBRA DANE system were submitted to ESD on 11 January 1973. Following the completion of both the evaluation and negotiation processes, ESD announced on 6 June the award of a fixed price incentive firm (FPIF) contract for the COBRA DANE system to the Raytheon Company of Wayland, Massachusetts.[29] As major subcontractors, Raytheon selected the System Development Corporation (SDC) of Santa Monica, California, for system software;

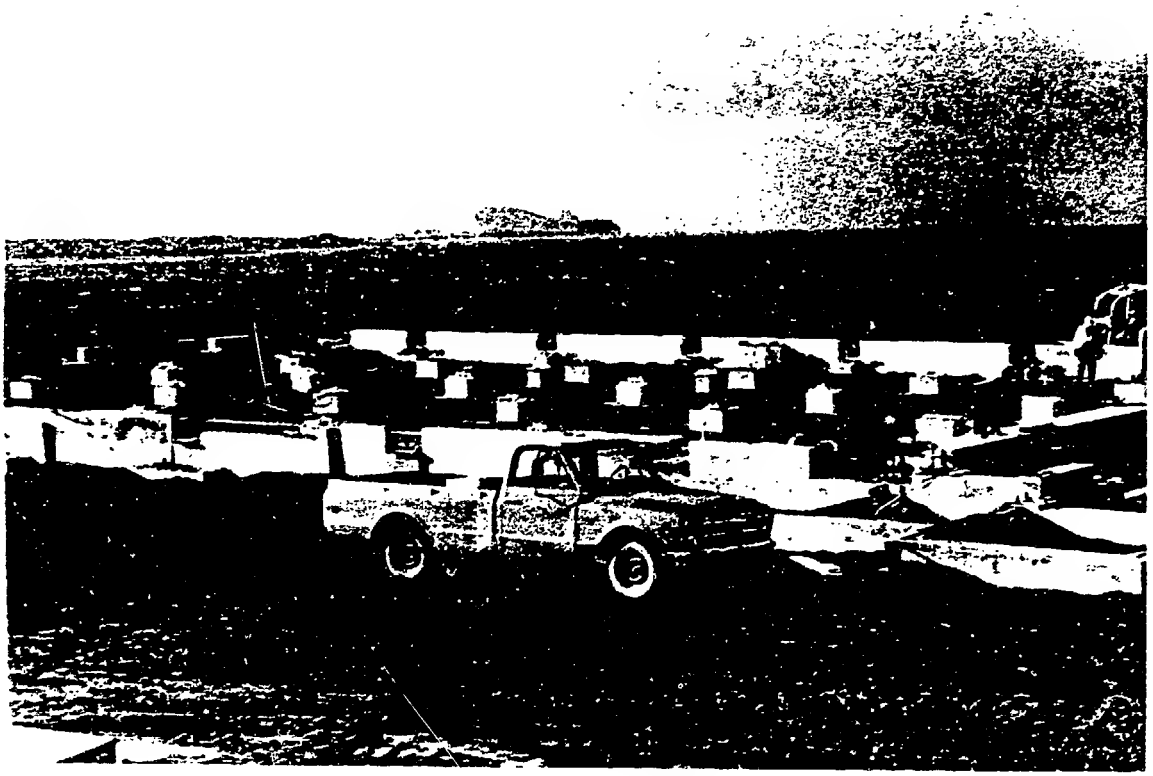
Metcalf and Eddy, Incorporated of Boston, Massachusetts, for architectural engineering; and B.E.C.K. Associates of Seattle, Washington, for facility construction.[30] Acquisition costs for the COBRA DANE program were estimated at $66.4 million.[31]

Construction of Radar Facility and PMEL Building Foundations

The first major task confronting Raytheon was the construction of the foundation for the COBRA DANE radar facility and PMEL building. This effort, like all others following it, was made more complex by the fact that all construction material, equipment, and personnel had to be transported to Shemya from Seattle by either sealift or airlift.[32] Airlift was the responsibility of the Military Airlift Command (MAC).[33] Responsibility for sealift rested with the Military Sealift Command (MSC) under COOL BARGE, the program which resupplies remote locations throughout Alaska, using seagoing barges during the summer months. For part of the year, these remote locations are accessible only by air.[34]

The first COOL BARGE shipment to Shemya, involving approximately 600 tons of construction materials, departed Seattle during the first week of August 1973. At approximately the same time, MAC prepared an airlift shipment of six tons of foundation materials.[35] The barge shipment reached Shemya on 5 September, followed twelve days later, on 17 September, by the arrival of the airlifted reinforcement rods.[36]

Construction of the foundation for the six-story radar structure and attached one-story PMEL building, begun in August, was completed in October 1973. This achievement marked the first major



Foundation for six-story COBRA DANE radar facility
and one-story PMEL building.

milestone on the COBRA DANE program.[37] Once the foundation was completed, the site and work camp were placed in caretaker status until the spring of 1974 when work would begin on construction of the radar facility and PMEL building.[38]

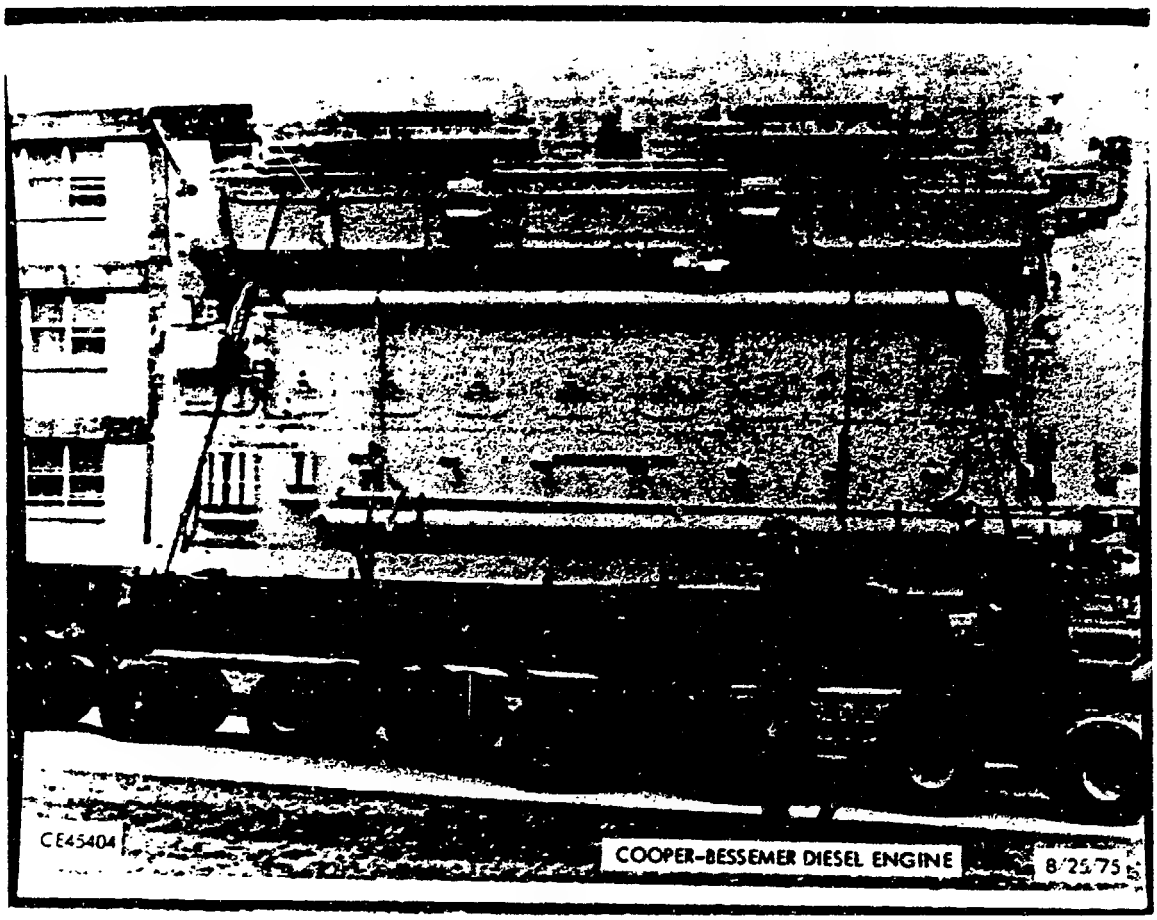
Design Reviews

During the period September 1973-February 1974, a series of design reviews were carried out on the COBRA DANE facility, radar hardware, and software systems.[39] Preliminary design review (PDR) of the facility, for example, was completed on 11-14 September, while PDR of the system itself was held on 9-12 October.[40] Critical design review (CDR) of the COBRA DANE facility was satisfactorily conducted on 11-14 December, and system CDR was successfully completed on 12-19 February 1974.[41]

Shemya AFB Power Plant

One of the first major problems to affect the COBRA DANE program occurred in the late fall and early winter of 1973 and involved the power plant at Shemya. In October, a special survey was conducted by AAC, ADC, and ESD personnel to determine if the Shemya AFB power plant was adequate to support the COBRA DANE program. Results of the survey indicated that the power plant would be insufficient for program support during the COBRA DANE test and evaluation period scheduled to commence in July 1975.[42]

With the assistance of both Headquarters AFSC and the Air Staff, ESD was able to secure $6.1 million in FY 1974 MCP emergency funds for updating the Shemya power plant. This update program, directed by AAC, would use four Cooper-Bessemer generators and ancillary



Cooper-Bessemer Diesel Generator.

equipment from the United States Army's SAFEGUARD Anti-Ballistic Missile (ABM) program.[43] Following release of the generators by the Army in early March 1974, they were shipped to Seattle, arriving on 5 April.[44] Eleven days later, on 16 April, the COOL BARGE departed Seattle for Shemya, arriving in early May.[45] Unloading of the COOL BARGE was completed on 16 May 1974.[46] While all of this was taking place, ESD received word that the Air Staff had given its approval to the design and construction of a new power plant for Shemya.[47]

The employment of surplus SAFEGUARD ABM equipment in the COBRA DANE program, such as the Cooper-Bessemer generators obtained for use in the Shemya power plant upgrade project, represented a policy actively encouraged and heartily endorsed at the highest levels of DOD. On 14 March 1974, Deputy Secretary of Defense William P. Clements, Jr., encouraged Secretary of the Air Force John L. McLucas "to consider utilizing the residual inventory of Malmstrom PAR [SAFEGUARD phased array radar] hardware, particularly major assemblies, for any appropriate Air Force requirement."[48]

In conformance with Deputy Secretary Clement's policy, the COBRA DANE SPO at ESD prepared an engineering change proposal (ECP) to the Raytheon contract covering the use of SAFEGUARD PAR transmitter equipment in the radar system.[49] By 24 May, approximately 30 truck loads of PAR transmitter components had been shipped from General Electric Company (GE), Syracuse, New York, to Raytheon, where the equipment would be used by the COBRA DANE prime contractor as government-furnished equipment (GFE).[50] ESD estimated the cost savings to the government resulting from this action at approximately $260,000.[51]

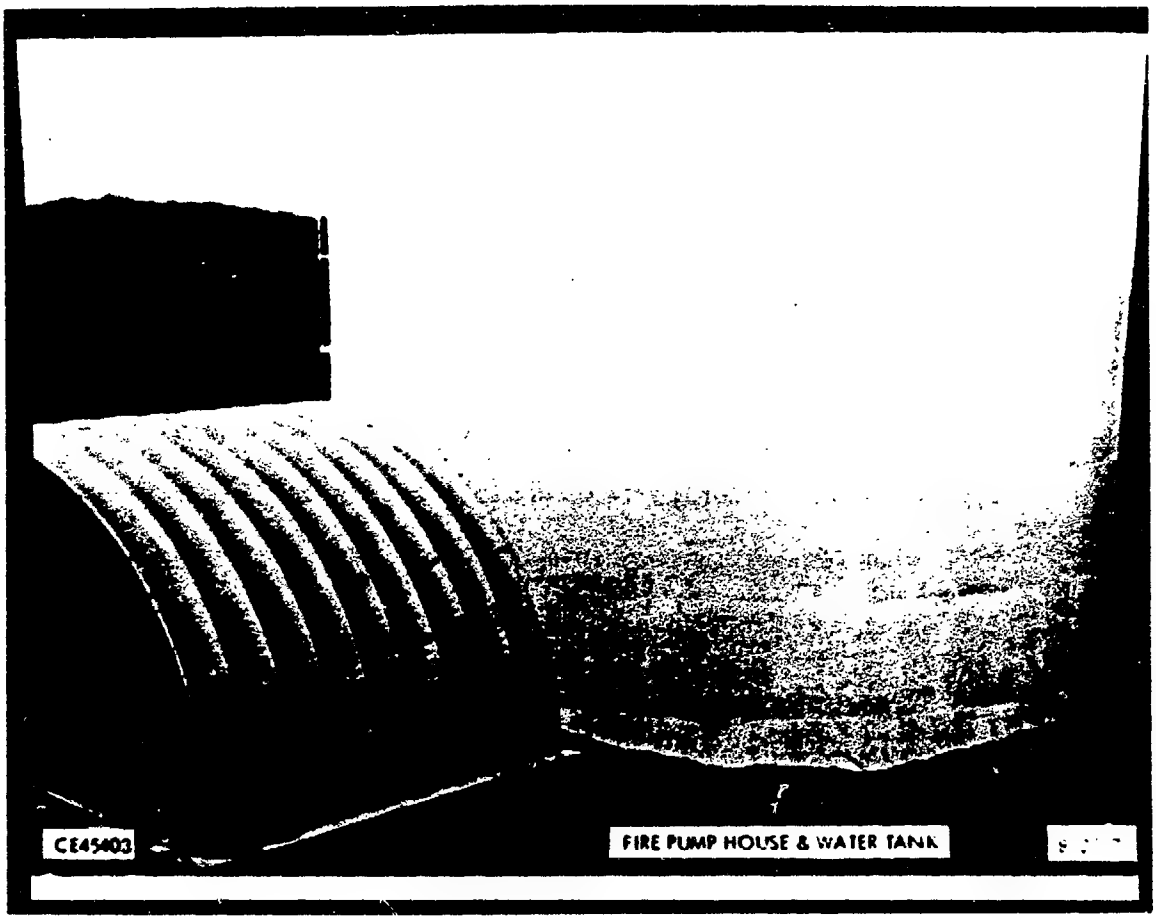
COBRA DANE Fire Protection System

While arrangements were being completed to upgrade the Shemya power plant, ESD planners turned their attention to a more minor, but nevertheless important, problem affecting the proposed COBRA DANE fire protection system. One of the requirements in the fire protection system specification called for a 250,000-gallon water tank. By April 1974, it had become obvious to ESD personnel that as a result of a national shortage of many structural steel items, a 250,000-gallon storage tank would not be available for fire protection when needed in the autumn of 1974.[52] At the instigation of ESD, a study of various alternatives was instituted. This study resulted in the location of a 500,000-gallon tank on Shemya which was cleaned and modified for fire protection use.[53]

Construction of Radar Facility and PMEL Building

The primary objective of the COBRA DANE construction effort for 1974 was the completion of the steel framework for both the radar facility and PMEL building and enclosure of the facility radar face with fire retardant plywood by October 1974, before the onset of winter. Once the radar structure and PMEL building were enclosed, inside construction activity and installation of the prime mission equipment could be carried out during the winter months.[54]

On 16 April 1974, a special COBRA DANE COOL BARGE, loaded with approximately 6,000 tons of construction material, as well as the four Cooper-Bessemer generators and ancillary equipment necessary for the Shemya power plant upgrade effort, departed Seattle for



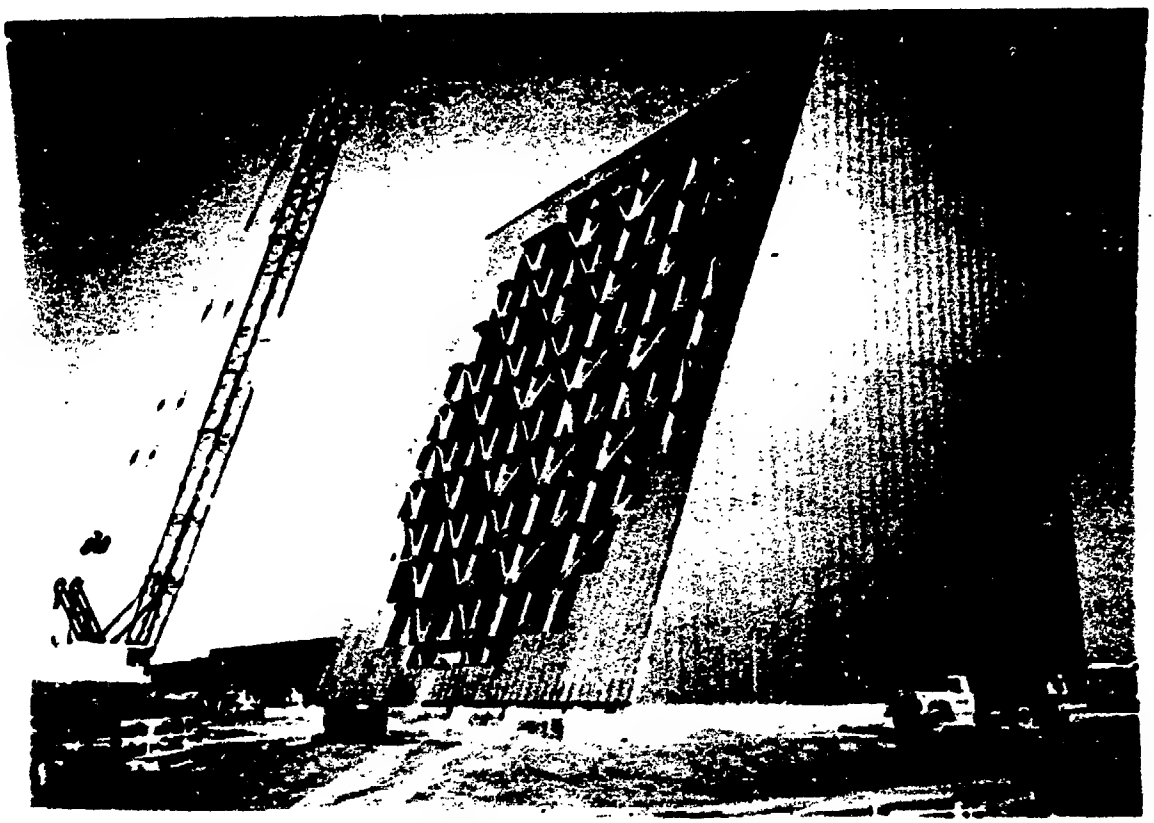
Fire pump house and water tank at Shemya AFB.

Shemya.[55] Following its arrival at the island dock, the COBRA DANE COOL BARGE shipment was completely unloaded by 16 May.[56]

This initial 1974 shipment of construction material was short approximately 100 tons of structural steel which remained to be fabricated when a strike halted production at the Isaacson Structural Steel plant in Seattle from 3 April to 21 May.[57] In an effort to avoid a slip in the construction schedule, Headquarters AFSC authorized ESD to acquire up to 50 tons of structural steel on a priority basis. The Air Staff approved this approach, and on 18 April, Raytheon and its construction contractor, B.E.C.K. Associates, instructed the Portland Wire Company to fabricate a priority order of 43.5 tons of structural steel which was eventually airlifted to Shemya from McChord AFB, Washington.[58]

Erection of the structural steel commenced on 22 May and by the first week of August, the contractor had completed work on the outer steel shell of both the radar facility and the PMEL building and was laying concrete floors in both structures.[59] While this was going on, the balance of the construction and building material necessary for the completion of the COBRA DANE facility, approximately 500 tons, was being collected at the Seattle staging area for delivery to Shemya via the 3 September COOL BARGE shipment.[60]

During the first week of September, ESD was notified that the COOL BARGE shipment scheduled to depart for Shemya on 3 September would be delayed from nine to twelve days. To prevent any possible schedule slip resulting from the delay in the arrival of the COOL BARGE shipment, a C-5A special assignment airlift mission (SAAM) was



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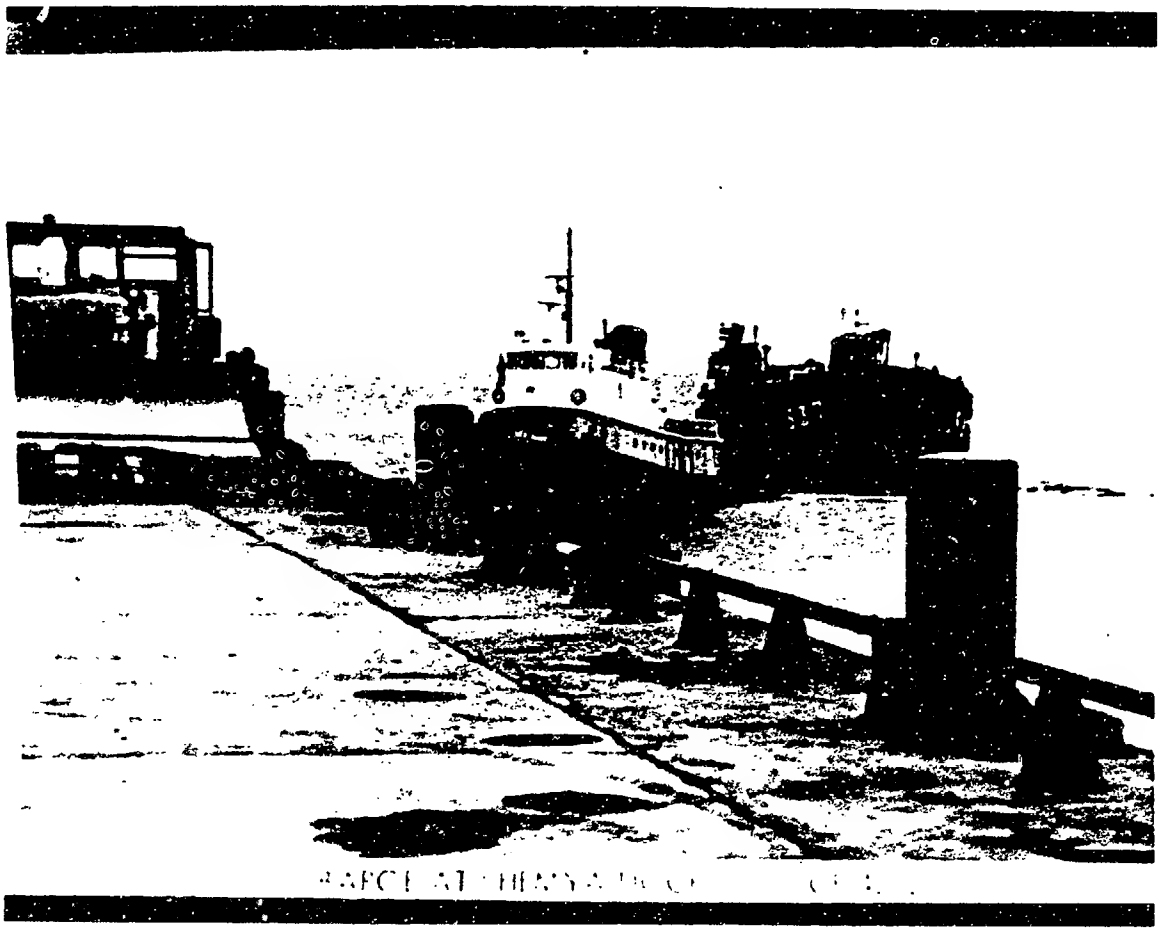
Work completed on outer steel shell of radar facility and PMEL building.

arranged.[61] This special airlift mission, carrying 65 tons of required construction items, landed at Shemya on 16 September.[62]

Two days after the arrival of the C-5A mission at Shemya, on 18 September, the COOL BARGE departed from Seattle laden with 2,170 tons of cargo.[63] Arriving at Shemya one month later on 18 October, the COOL BARGE ran into a situation of near crisis proportions when adverse weather conditions prevented it from successfully docking until 28 October.[64] The crisis situation arose from the fact that the COOL BARGE carried the fire retardant plywood needed to enclose the array face of the COBRA DANE radar facility. Once docking was finally effected on 28 October, the additional stevedore personnel flown in earlier by the COOL BARGE contractor facilitated the completion of cargo unloading by 31 October.[65] The delay in receiving the fire retardant plywood on board the barge, however, necessitated the special airlift of additional plywood. On 25 October, this additional plywood was airlifted from McChord AFB, arriving at Shemya on the following day, 26 October.[66] With enough plywood on hand, the enclosure of the radar facility array face area was completed on 5 November 1974, thus insuring that inside construction and installation of the prime system equipment could proceed during the winter months.[67]

Erection of Calibration Tower on Alaid Island

In concert with the construction activity on Shemya, work progressed on the erection of a 65-foot high calibration tower on Alaid Island.[68] A small, rocky, precipitous atoll in the Bering Sea, Alaid Island is situated approximately ten miles northwest of Shemya and accessible only by boat or helicopter.[69] The sole purpose for



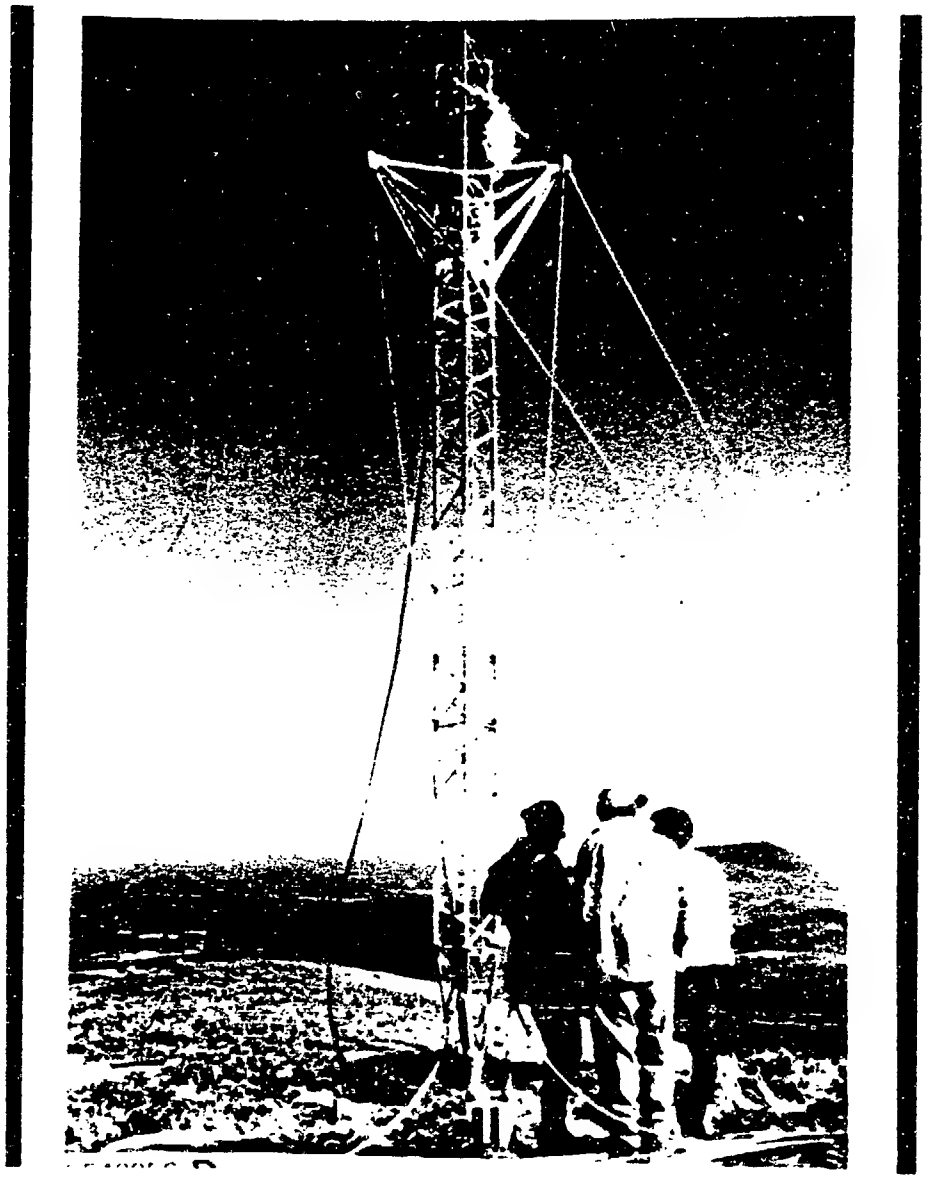
COOL BARGE arrival at Shemya dock.

erecting an inert boresight tower on unmanned Alaid Island was to insure the calibration accuracy of the COBRA DANE radar on Shemya.[70]

A soil sampling and site survey of Alaid Island was successfully conducted on 25-29 May 1974. As a result of this survey, plans were developed to airlift the required construction material by helicopter directly to the selected tower site. This was necessitated by the fact that the slope of the hill upon which the tower would be erected, combined with the tundra growth on the island, effectively precluded the movement of these materials to the construction site by means of heavy equipment.[71]

On 17 June 1974, ESD received word that the 10-foot diameter, plastic, dish reflector that would be mounted on the top of the calibration tower had been completely destroyed by fire while being transported by truck to Seattle for COOL BARGE shipment to Shemya.[72]

Following reorder of the reflector, it was airlifted to Shemya on 16 September on board a COBRA DANE C-5A SAAM aircraft.[73] Construction of the tower on Alaid Island commenced on 19 September and was completed on 25 September, four days ahead of schedule.[74] Triangular in shape, the tower consists of steel angle sections painted white and international orange and crowned by a ten-foot diameter, plastic, dish reflector. Stability is provided by three guy wires, 120 degrees apart, 50 feet from the tower base. Periodic maintenance visits to Alaid Island to tighten the tower guy wires, touch up rust spots on the steel, and insure that the reflector dish remains rigidly connected to the tower, are conducted every six to twelve months, for a period of two to three hours per visit.[75]



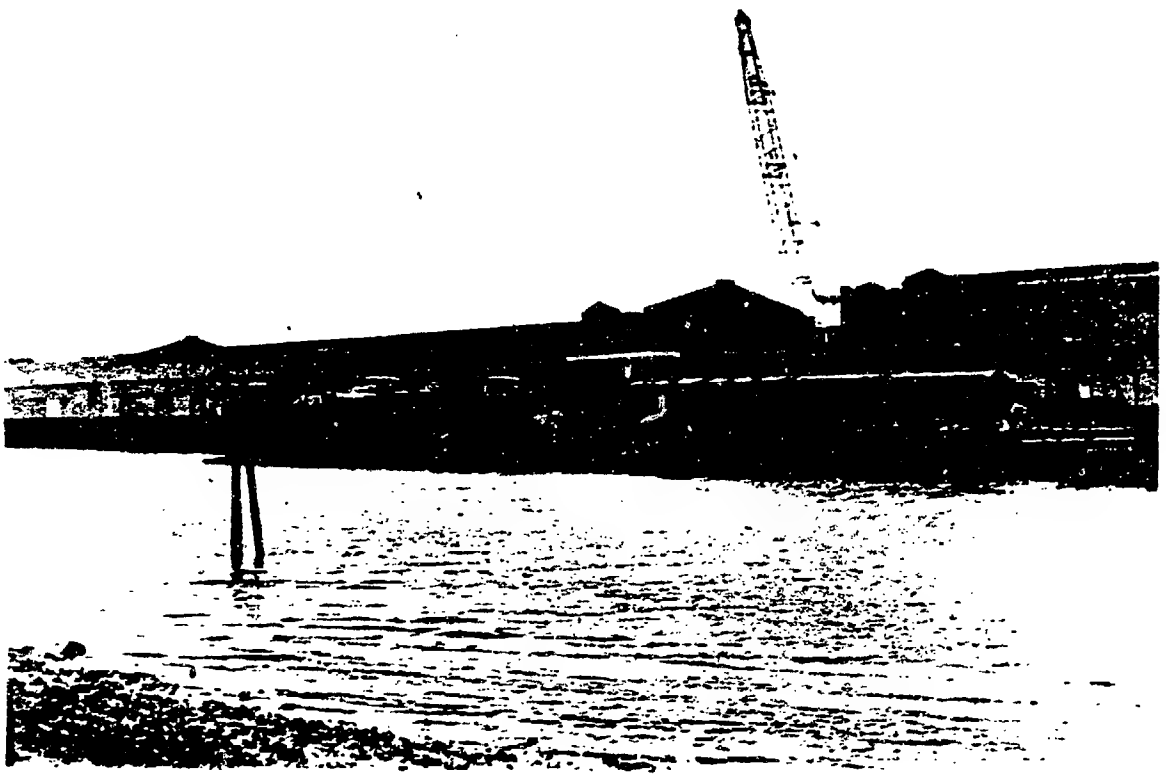
65-foot high calibration tower on Alaid Island.

Installation and Checkout of a Portion of the COBRA DANE Array and Transmitter Subsystems

Closely paralleling the construction activity on Shemya and Alaid Islands was the progress made on the installation and checkout of a portion of the COBRA DANE array and transmitter subsystems at Raytheon's plant in Wayland. In addition, the COBRA DANE computer facility, in operation at the Raytheon plant since December 1973, was being used to develop the system programs. The three main computer developments were mission software, simulation, and diagnostic programs -- all of which were progressing on schedule.[76] The first major COBRA DANE computer programming milestone, demonstration of the basic software which operated the global displays, was successfully completed on 7 October 1974.[77]

COBRA DANE Power Divider Fire

In January 1975, the COBRA DANE program experienced a minor setback that was a portent of the more serious difficulties that were to confront it throughout the year. On 19 January, a fire completely destroyed 45 of the 99 required 8:1 power dividers used in the COBRA DANE array subsystem. The fire occurred at Triple P Packaging and Paper Products, Incorporated, in West Bridgewater, Massachusetts, where the power dividers were being packaged in preparation for shipment to Shemya.[78] On 5 February, ESD issued a change order to the COBRA DANE prime contract to accelerate delivery of replacements for the 45 8:1 power dividers destroyed. This action was necessary to maintain the system's scheduled initial operational capability (IOC) date which would otherwise have slipped by 75 days and increased program costs by $1.5 million. Cost of the ESD-issued change order was not to exceed $95,000.[79]



COOL BARGE being unloaded at Shemya dock.

First Shemya Island Earthquake

Close on the heels of the power divider fire, an event took place which literally shook the COBRA DANE program to its very foundations. On 1 February 1975, Shemya Island was struck by an earthquake which registered 7.5 on the Richter scale and whose epicenter was located 50 miles north-northwest of the island at 53.053 North, 173.619 East. Fortunately, the COBRA DANE radar received only minor damage.[80] Following surveys conducted by Metcalf and Eddy and Weston Geophysical Research, Incorporated, Weston, Massachusetts, Colonel Richard W. Coraine, the COBRA DANE System Program Director, reported that "Present indications are that COBRA DANE withstood the earthquake well and that its foundation is still solid. No damage occurred which should impact the development or installation schedule."[81] Mr. O'Mahony provided the following explanation for the system's success in withstanding the earthquake:[82]

> The DANE was constructed to withstand earthquakes with Seismic 4 impact. That's a geological category for the extreme in earthquake damage. Well, when we started, no one really knew how to build something to withstand that kind of impact. It was new term even to industry. For the construction people, it was a calculated guess -- more concrete and wire. We were the first, to my knowledge, to delve into that problem and we may have established the norm.

While the COBRA DANE facility escaped virtually unscathed from the earthquake, the main runway on Shemya sustained major damage. Mr. O'Mahony, who traveled to Shemya with a special four-man contractor survey team to assess damage, reported the "The runway is broken about 4,000 feet from the East end and has a drop of 4 inches to 10 inches."[83] With only 6,000 feet of the main runway in usable condition, the C-141 SAAM of COBRA DANE prime mission equipment

scheduled for 3 February 1975 was cancelled and a MAC survey team was dispatched to evaluate the ability of the main runway at Shemya to support C-141 and C-5A aircraft.[84]

Second Shemya Island Earthquake

On 8 February, Shemya was hit by a second earthquake that registered 5.8 on the Richter scale.[85] "I was in bed dozing when the clothes hangers began moving," Mr. O'Mahony recalled.[86]

> The room started swaying and I heard a thundering noise, a slow rumble, like a train coming at me. Then there was a loud thud and it seemed like the train was moving away. It was enough to know we'd just been hit.

Fortunately, there was no additional damage to the COBRA DANE facility and very little additional damage to the runway or base proper resulting from the second earthquake.[87]

The MAC survey team completed its evaluation of the ability of the earthquake-damaged Shemya runway to support C-141 and C-5A aircraft on 15 February.[88] Five days later, on 20 February, MAC reinstated the SAAM missions for transporting COBRA DANE prime mission equipment from Hanscom AFB to Shemya.[89] The first of these missions, involving a C-141 aircraft carrying array plates and coaxial cable, departed Hanscom on 26 February.[90] Eventually, a total of 700 tons of materiel would be delivered from Hanscom to Shemya via 21 separate SAAM missions (seven C-5As and 14 C-141s) extending from February to December 1975.[91]

COBRA DANE Power Problem

While still occupied in assessing the amount of damage inflicted by the two massive earthquakes which struck Shemya, ESD was once again confronted with the nagging problem of obtaining sufficient

power for the COBRA DANE facility. On 22 February 1975, AAC notified both Headquarters USAF and ESD of its inability to supply sufficient power to COBRA DANE for equipment installation and checkout scheduled to begin in March. In addition, AAC stated that the Shemya power plant upgrade program was behind schedule.[92] ESD found this:[93]

> totally unacceptable for the COBRA DANE program. COBRA DANE is an urgently required, vital national defense radar. Delays announced/forecasted by AAC in furnishing timely power (in both quantity and quality) to COBRA DANE will adversely impact the program schedule and could delay IOC [scheduled for 6 March 1976] by as much as 150 days. Cost impact for each day of delay is estimated at $25K [thousand].

To avoid both the added delay and additional expense, ESD requested Air Staff approval (1) to deploy eight Bare Base 750KW turbine generators and ancillary equipment to Shemya to provide temporary power, and (2) to accelerate the Shemya power plant update program schedule. ESD estimated the cost of deploying and installing the eight Bare Base generators at $750,000.[94] This was later revised to $825,000.[95]

Once approval was received from Headquarters USAF to deploy, install, and operate eight war reserve materiel (WRM) generators for COBRA DANE interim power, dedicated airlift of the generators from Holloman AFB, New Mexico, to Shemya commenced on 2 April.[96] The final SAAM of materiel to Shemya, a C-5A loaded with generator and transformer interface equipment, departed Hanscom on 3 April with refueling and rest stops scheduled for Dover AFB, Delaware, and Elmendorf AFB, Alaska. As a result of both mechanical and weather difficulties, this C-5A SAAM was delayed at Dover for three days. Finally arriving at Elmendorf on 6 April, the aircraft experienced additional

weather and maintenance problems. A second C-5A was dispatched to Elmendorf to continue the generator SAAM flight, but both this aircraft and the original C-5A were "grounded" on 11 April pending the completion of a time compliance technical order (TCTO) compliance review conducted by a special Lockheed survey team.[97] To avoid any further delay, AAC chartered a C-133 which airlifted the generator and transformer interface equipment to Shemya on 29 April.[98] Seventeen days later, on 16 May, all power equipment was installed and operational, the transformers were installed and connected, and feeder lines had been installed and connected to both the transformers and the Raytheon switchgear.[99]

Installation of COBRA DANE Array Plates

Removal of the fire retardant plywood from the face of the COBRA DANE radar facility and installation of array plates commenced during the first week of May 1975. While original plans called for the installation of four plates per day, in point of fact 11 plates were installed on the first day, followed by 15 on the second day.[100] Similar progress was made on work involving the transmitter groups. According to the developed schedule, the first transmitter group would be installed by 15 May and a second by the end of the month.[101] By 5 June, however, nine out of the 12 transmitter groups had been installed, all transmitter group cables were on site, interconnections were completed on the first two transmitter groups and were in progress on a third, and low voltage checks had been accomplished on the first two transmitter groups. In addition, approximately 300 of the nearly 5,000 missing phase array elements were installed, 48

phase shifter racks were in place thus completing the upper three floors in the six-story structure, the 8:1 corporate feed dividers (which input to the phase shifter racks) were completed on the fourth and sixth floors, and one of four phase shifter distribution units had been moved into position on the third floor.[102]

Progress on construction of the PMEL building was equally impressive. As of 5 June, the placement of floor tile was completed, 50 percent of the ceilings were installed, all telephone and speaker wires were in place, installation of PA speakers was 60 percent finished, and outside lighting, computer room duct work, demineralized water mains, and installation of the ten-inch fire main were all complete. With the exception of painting, completion date for the PMEL building was scheduled for 15 June 1975.[103] Total acquisition costs for the COBRA DANE program, as of 1 July 1975, were estimated at $68.1 million.[104]

COBRA DANE Software Development Problems

Up until the spring of 1975, the problems and crises confronting the COBRA DANE program, while of impressive proportions, had nevertheless appeared one at a time. Towards the end of April 1975, however, it became apparent that several problems were arising simultaneously in the software development area.[105] These included a computer core memory problem in which core requirements exceeded availability, a timing problem which effectively precluded the processing of all required real time data, and a problem with the basic method of scheduling radar commands. Under the original concept for scheduling radar commands, a highly dynamic scheduler would be employed,

allowing wide flexibility in the use of pulse widths and pulse repetition rates. Unfortunately, this particular concept proved to be beyond the state-of-the-art and a fixed template approach had to be pursued. While less flexible than the dynamic scheduler, the fixed template approach did fulfill system requirements.[106]

On 16 May, Colonel Coraine notified the ESD Command Section that:[107]

> We are becoming increasingly concerned about whether or not software problems can be solved in time to allow adherence to the currently scheduled IOC [date of 6 March 1976]. In the past, Raytheon has been exceptionally good in providing workarounds for problems and we in no way mean to inhibit them in this effort. Our feeling is that the task is formidable and presents a tremendous challenge.

At the request of Lieutenant General Wilbur L. Creech, ESD Commander, on 20 June 1975 the COBRA DANE SPO developed an assessment of the most pessimistic schedule for IOC of the system.[108] Among the software development difficulties which posed a potentially adverse impact on the scheduled IOC date, the COBRA DANE SPO highlighted the fact that:[109]

> The major problem now is that we have exceeded the 131K word core capability of our Cyber 74-18 computer. The long range solution is probably to add core or purchase a larger and more efficient computer. However, in the short haul in order to make IOC, certain simultaneous functions (SPACETRACK, Early Warning, and possibly even Intelligence) may have to be changed from an automatic mode to a manual mode, or sacrificed.

In its pessimistic assessment, the COBRA DANE SPO projected an IOC slip of a little more than three and a half months, from 6 March to July 1976. At the same time, confidence was expressed "that we have a good chance of meeting the basic requirements of COBRA DANE by 6 Mar 76."[110] This would be accomplished by means of dedicated and

aggressive actions on the part of both Raytheon and the Air Force, "and lots of plain good old luck!"[111]

The optimism generated by the COBRA DANE SPO lasted less than two months. As a result of a delay in the conduct of software preliminary qualification testing (PQT)/formal qualification testing (FQT), scheduled to commence in August 1975, ESD initiated a complete Air Force assessment of the problems affecting COBRA DANE software development and their impact, if any, on the program's scheduled milestones.[112] This assessment, conducted by a team comprised of software experts from ESD, ADCOM,* RADC, and Lincoln Laboratory, commenced on 18 August and was completed on 10 September 1975.[113]

The results of the assessment indicated that COBRA DANE software development difficulties could not be resolved in time to prevent an impact on the 6 March 1976 IOC date. This determination was briefed to the ESD Commander and to Headquarters AFSC and the Air Staff and resulted in direction from Headquarters USAF to continue with the acquisition of a full COBRA DANE capability, that is, prime mission, intelligence gathering, with corollary missions of early warning and SPACETRACK, with a slip in IOC date.[114] Raytheon projected the IOC slip at three and a half months, from 6 March to July 1976. ESD on the other hand, anticipated at least a seven-month slip, to October 1976, based upon the results of the Air Force assessment of software development problems.[115]

*On 1 July 1975, the designation for the Aerospace Defense Command was changed from ADC to ADCOM.

On 10 November 1975, a meeting to coordinate the start of COBRA DANE radio frequency (RF) radiation with all concerned activities was held at AAC. As a result of this meeting, a list of agreed-to action items for ESD and AAC was developed. This list of action items fell into two categories: (a) actions necessary to insure compatibility between Shemya AFB flight/ground activities and initial COBRA DANE radiation; and (b) actions required for the long term, when COBRA DANE would be operating 24 hours a day.[116]

An important COBRA DANE program milestone was reached on 14 November when the radar facility at Shemya radiated for the first time. Total radiation time was approximately one and one-half hours with power emanating from just one of the 96 high power transmitter tubes.[117]

For two days late in November, the COBRA DANE radar facility and PMEL building were once again put to the test by the forces of Mother Nature. On 21-22 November, a severe winter storm with winds in excess of 100 knots slammed into Shemya Island. Fortunately, no serious damage was done to the COBRA DANE facility or equipment.[118]

Issuance of RFP for COBRA DANE Operations and Maintenance (O&M) Contract

December 1975 was witness to two important events involving the COBRA DANE program. The first of these occurred on 1 December when ESD issued to Raytheon the sole source RFP for operation, maintenance, and logistics support of the COBRA DANE radar for the first full year following system IOC.[119] This action was dictated by COBRA DANE PMD No. I-Y-2-001(3)/31015F issued by Headquarters USAF on 11 September 1974. Following the first full year of contractor-

supplied operation, maintenance, and logistics support of the COBRA DANE system, ADCOM would assume funding responsibility for operation and maintenance (O&M), with Air Force Logistics Command (AFLC) bearing responsibility for providing wholesale logistics support.[120] At the end of 1975, ESD anticipated receipt of Raytheon's response to the RFP sometime early in January 1976.[121]

Three days after the issuance of the RFP, MAC's special airlift mission of COBRA DANE prime mission equipment -- begun in February 1975 -- was completed.[122] On 4 December, the Cyber 74-18 computer was delivered to Shemya on board a C-141 aircraft.[123] In all, a total of 700 tons of COBRA DANE prime mission equipment was delivered to Shemya via 21 separate missions involving seven C-5A and 14 C-141 flights.[124]

COBRA DANE Power Supply Problem

At the beginning of CY 1976, two major problems confronting the COBRA DANE program still remained to be resolved. One of these was insufficient power. In April 1975, after it had become obvious that power from the new Shemya base power plant would not become available on schedule, ESD obtained eight WRM generators from Holloman AFB. These were established on Shemya to supplement the power received from the old AAC power plant. During the last six months of 1975, however, power failures occurred on five of the eight generators.[125] As a consequence, the government was unable to fulfill the contractor's power requirements on 15 December 1975 for the first time.[126]

In January 1976, problems experienced with the interim power supplied by the eight WRM generators continued to have an adverse

impact on the COBRA DANE testing schedule. At the same time, work continued on the installation of four Cooper-Bessemer generators in the Shemya base power plant. Three of these generators were accepted by AAC on 6 April and less than one week later, on 12 April, prime power was made available to COBRA DANE by using two of the four Cooper-Bassemer generators.[127]

This arrangement operated satisfactorily until 25 April when the bearings within the two Cooper-Bessemer generators turbo-chargers burned out, resulting in a complete loss of power. Before prime power was resumed again on 30 April, COBRA DANE operated on power supplied by the WRM generators. These continued to be employed as emergency or back-up equipment until July 1976 when they were disconnected and readied for return shipment to Holloman AFB.[128]

COBRA DANE Computer Core Memory Problem

The second major unresolved problem confronting the COBRA DANE program at the beginning of CY 1976 involved system software, specifically, the computer core memory problem. The COBRA DANE computer, a Cyber 74-18, possessed a 131,000-word core memory which was considered adequate when the program first began. As the program evolved, however, the requirements for core memory exceeded capability by 33 percent.[129]

On 27 January 1976, PQT began for the mission computer program and the simulation computer program. In this, as in earlier software tests, the computer core memory problem had an adverse impact.[130] In an effort to solve this problem, Headquarters AFSC recommended to the Air Staff that a surplus Cyber 74 computer be assigned to the

COBRA DANE program.[131] Headquarters USAF approved this recommendation on 18 June 1976.[132] Less than three months later, on 11 September, the second computer, a Cyber 74-14, was shipped to Shemya. The Vappi Corporation of Cambridge, Massachusetts, commenced modification work on the sixth floor of the radar facility, to accommodate the second computer, on 24 September.[133] The second computer was put into operation on 15 November and successfully alleviated the core memory problem.[134]

Change to COBRA DANE Initial Operational Capability (IOC) Date

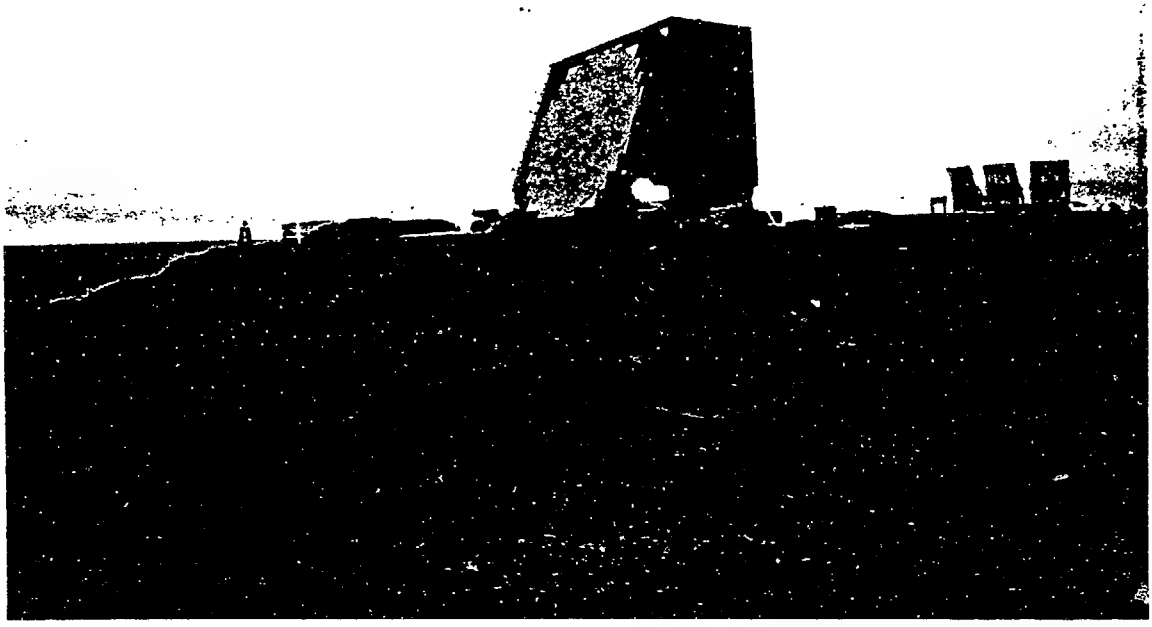
As a result of the problems experienced with the COBRA DANE power supply and the computer core memory, ESD and Raytheon negotiated an ECP to the prime contract in June 1976 which changed the projected IOC date from 6 March 1976 to 31 October 1976.[135] In September, a further program schedule slip was negotiated and the COBRA DANE IOC was pushed back to 15 January 1977.[136]

Award of COBRA DANE O&M Contract

In addition to the IOC schedule slip, in June ESD was also involved in negotiations with Raytheon on the O&M contract for the COBRA DANE system. These negotiations were completed on 30 June when ESD awarded Raytheon a $10,375,000 O&M contract for COBRA DANE.[137]

First Detection and Track of a Soviet Missile Launch by COBRA DANE

One of the most significant and important milestones in the COBRA DANE program was attained on 28 July when the radar at Shemya detected and tracked a Soviet missile launch. Whereas COBRA DANE



Completed COBRA DANE system on Shemya Island.

had previously tracked several satellites, this represented the first time that the system had ever detected and tracked a Soviet missile launch. Less than a month later, on 25 August, COBRA DANE successfully detected and tracked a second Soviet missile launch.[138]

COBRA DANE System Testing

System testing of COBRA DANE commenced on 28 October 1976 with power being supplied by the upgraded AAC power plant at Shemya.[139] System performance testing, which included subsystem performance, logistical review, SPACETRACK and early warning capability, was completed on 30 November, followed, from 1-15 December, by a reliability/maintainability/availability (R/M/A) demonstration. All testing was satisfactorily completed on 16 December.[140] The next day, Raytheon commenced full-time O&M of the system.[141] On the same date, COBRA DANE successfully commenced operations, collecting intelligence information and SPACETRACK data for ADCOM's SPACETRACK network.[142]

ESD Acceptance of COBRA DANE from Raytheon

At the end of December, ESD accepted the COBRA DANE system from Raytheon with noted deficiencies scheduled to be corrected by 28 February 1977.[143] During this interim period between system acceptance and turnover to the operating command, ESD was responsible for the COBRA DANE system while ADCOM actually operated the equipment and Raytheon provided O&M support.[144] On 25-27 January 1977, planning for turnover/transition of the COBRA DANE system began between ESD and ADCOM.[145]

Turnover/Transition of COBRA DANE from ESD to ADCOM and AFLC

The actual turnover/transition of the COBRA DANE system occurred on 13 July 1977 when representatives from ADCOM, AFLC, and ESD signed the COBRA DANE System Turnover Certificate.[146] This document provided for the formal turnover of system responsibility for COBRA DANE from ESD to ADCOM.[147] In addition, this event marked the IOC date for COBRA DANE.[148] Program Management Responsibility Transfer (PMRT) of the radar system from ESD to the Sacramento Air Logistics Center (SM-ALC) of AFLC for logistics support occurred on 1 October.[149] According to Mr. O'Mahony:[150]

> This transfer marks the end of an extremely important and successful acquisition program for the Air Force. The Program Management Responsibility Transfer date of 1 Oct was jointly established by ESD and the Sacramento Air Logistics Center nearly three years ago. Even more remarkable is the fact that the system is being transferred without any residual Program Management Responsibility Transfer tasks.

System Description

The completed COBRA DANE radar facility measured 110 feet in height, 108 feet in width, and 85 feet in length.[151] The radar's clocklike face, 96 feet in diameter and slanted 20 degrees, contained 34,768 sensors attached to 96 antenna plates.[152] Of these sensors, 15,360 were active elements radiating electronic impulses in constantly changing directions. The remaining elements were nonradiating or "passive" elements which received the return signals from the radar's active elements.[153]

The term phased array, when applied to COBRA DANE, signifies radar scanning without antenna motion. By feeding electrical energy to a number of active radiating elements in precise, computer-

Air Force specialist traces missile flight on
control data grid display within the COBRA DANE radar complex.

controlled patterns, COBRA DANE could detect and track orbiting objects at very high speeds involving fractions of a second.[154]

Conclusion

COBRA DANE represents a huge technological advance over the 17-year-old AN/FPS-17-79 and 80 detection and tracking radars that it replaced on Shemya. In contrast to these rotating, dish radars, which could only track one object at a time, COBRA DANE is capable of simultaneously detecting and tracking the paths of 300 missiles within the earth's atmosphere and up to 200 objects orbiting in outer space.[155] Equally impressive, COBRA DANE is capable of spotting an object the size of a basketball at a range of 2,000 miles.[156] The estimated final acquisition cost of the COBRA DANE system, as of 19 July 1978, was placed at $71.3 million.[157]

The fact that COBRA DANE IOC and turnover to ADCOM occurred several months behind schedule has distracted little from the overall consensus that the program was an extremely successful effort.[158] "Believe me," Mr. O'Mahony explained:[159]

> we didn't go into the program like blue-eyed optimists. We knew we had a very ambitious schedule. We had just 33 months after the contract was awarded in 1973 to complete the facility and have the system fully operational.
>
> And we had to wonder just how we were going to build something like that on a place like Shemya with all the logistics and weather problems. The gloom-and-doom people said it would take six or seven years.

Mr. Ed Thomas, Chief, Engineering and Testing for COBRA DANE, expressed a feeling of accomplishment that was shared by everyone who worked on the program:[160]

> There's satisfaction that goes with it all. We took a radar system we knew would work, made it bigger and more powerful

Close-up view of COBRA DANE's clocklike face containing 34,768 sensors attached to 96 antenna plates.

than anyone had ever done, and put it on an island 13,000 miles away in the most severe weather conditions.

The ultimate accolade on the success of the COBRA DANE program came from Colonel Coraine when he revealed that "The data gathered by the radar has exceeded all expectations, and is extremely useful to the intelligence community."[161]