ADC HISTORICAL STUDY NO. 34

SECRET

RADAR PROGRAMS FOR AIR DEFENSE 1946-1966

by RICHARD F. McMULLEN

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FOREWORD

Radar was put into use by the British shortly before World War II. It proved of inestimable value in guarding the British Isles from German air attack during the "Battle of Britain." The pattern of future air defense was established by this experience. It involved, basically, the use of radar to detect the approach of hostile bombers and control the operations of friendly fighters sent aloft to intercept the hostiles.

An air defense system similar to that used so successfully by the British was established in the United States in World War II. It was never used, because no attempt was made to attack the Continental United States. When the war initiative was seized by the Allies it became more and more apparent that air attack on the United States was highly unlikely. The radar network was progressively dismantled until, by the end of the war, it had ceased to exist.

No really serious attempt was made to re-create it until an increase in international tensions, beginning in 1948, brought about the Cold War. The Korean War of 1950 convinced nearly everybody in authority that a strong air defense, ready to function at any moment, was necessary. From this point the growth of the radar network was steady for several years. Development of improved types of radars was pursued energetically.

Some of the emphasis placed on conventional land-based radar drained away when the Russians began testing long-range ground-to-ground missiles in August 1957 and put a satellite in orbit in October 1957. These actions proved that an intercontinental ballistic missile was both feasible and probable. The radars of the air defense network were directed against manned bombers. Something else would have to be devised to detect the ICBM and considerable attention was turned in that direction.

Nevertheless, the manned bomber was still a part of the total threat, so the radar network in the United States, though somewhat reduced, was still in regular operation in 1966. Few could foresee a day when it would be completely dismantled.

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PART ONE

THE CAMPAIGN FOR A BASIC RADAR NETWORK

1946 - 1950

CHAPTER ONE

PLAN SUPREMACY: THE INITIAL EFFORT

1946 - 1948

The Air Defense Command was activated on 27 March 1946. It was instructed to "organize and administer the integrated air defense system of the Continental United States."[1] Air defense implied the existence of a radar network to detect the approach of hostile bombers and control the operations of friendly interceptors. In that sense, ADC had nothing to administer. Not a single search radar was in operation.

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1. AAF to ADC, "Interim Mission," 12 Mar 1946 [Doc 7 in Hist of ADC, Jan-Jun 1951].

General Carl A. Spaatz, Commanding General, Army Air Forces, expanded on this basic charter in testimony before the House Appropriations Committee on 20 May 1946. He hoped that Congress would provide enough money to permit ADC to operate radar sites 24 hours a day. But, in the same testimony, General Spaatz revealed that he had no intention of assigning an appreciable portion of regular Air Force strength to air defense duty. He told the Committee that the air defenses of the nation would be manned "principally" by the National Guard and Air Reserve units.[2]

The first ADC commander, Lt. Gen. George E. Stratemeyer, was well aware that he could not defend against a surprise air attack if he had to depend on the week-end warriors of the Air National Guard and the Air Reserve. At best, these organizations would not be available immediately and they were far from being at their best. The Air National Guard was not organized until 25 April 1946 and it would be years before it was manned, equipped and adequately trained in air

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2. House Hearings on the Military Establishment Appropriation Bill for FY 1947, pp. 407, 408 and 414.

defense techniques. The Air Reserve was still discussing which airfields it was going to use for training.[3]

In this situation, General Stratemeyer proposed, in August 1946, that he be allowed to do the best he could, with available resources, to maintain an in-being air defense along the most critical approaches to the United States. This proposal got a mixed reaction at AAF. The Assistant Chief of Air Staff for Operations, Lt. Gen. Earle E. Partridge, felt that the ADC request was reasonable but, under the existing circumstances, unrealistic. General Partridge reasoned that the AAF should avoid giving the public, so soon after World War II, the impression that air attack was anticipated. But this viewpoint was not expressed in the AAF reply to ADC. The reply merely stated that the ADC proposal had been favorably considered and that ADC should submit a plan showing how it intended to deploy an air defense in being.[4]

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3. ADC to AAF, "Problems Confronting ADC in Dealing with Civilian Air Components," 16 Apr 1946 [App. IX in Hist of ADC, Mar 1946-Jun 1947].

4. ADC to AAF, "Mission of the Air Defense Command," 5 Aug 1946 [App. IV in Hist of ADC, Mar 1946-Jun 1947]; Memo, AC/AS-3, AAF for DC/AS, AAF, "Mission of the ADC," 24 Aug 1946 [in DRB C/S Files 1946 2500-28394]; 1st Ind (ADC to AAF, "Mission of the Air Defense Command," 5 Aug 1946), AAF to ADC, 19 Sep 1946 [App. IV in Hist of ADC, Mar 1946-Jun 1947].

The AAF request of September 1946 actually resulted in two ADC plans, one submitted in October and one in November. The Air Defense Plan (Short Term) of 19 October 1946 was modest to an extreme. General Stratemeyer thought he knew where he could lay his hands on nine prime radars and the manpower to operate them. With this early warning capability he thought he could provide a moderately effective defense for one strategic area.[5] He did not specify which area.

Somewhat more ambitious was the November plan. It said five strategic areas (Boston-New York-Philadelphia-Washington, San Francisco, Chicago-Detroit, Los Angeles and Seattle-Pasco) could be defended if 24 heavy radars, along with the necessary aircraft and ancillary equipment, were provided. If AAF approved the November plan by the end of 1946, ADC predicted that it would be ready to defend New York-Philadelphia-Washington by April 1948, San Francisco by July 1948, Chicago by October 1948, Los Angeles by January 1949, Detroit by March 1949, Seattle-Pasco by May 1949 and Boston by July 1949.[6]

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5. ADC to AAF, "Establishment of an Active Air Defense of the United States," 19 Oct 1946 [Doc 23 in AMC Case Hist of the AC&W System].

6. ADC to AAF, "Establishment of an Air Defense in Being," 22 Nov 1946 [USAF HD 419.101-31].

No immediate reply was made to either of ADC's 1946 plans. That there was a wide difference of opinion as to the nature of air defense was obvious in testimony before the House Appropriations Committee in connection with the military budget for Fiscal 1948. Lt. Gen. Charles P. Hall, a Ground Forces officer who was Director of Operations and Training in the War Department General Staff, made the basic War Department presentation on the appropriation bill on 17 February 1947. General Hall told the Committee that ADC comprised six numbered air forces that were in support of the six armies located in the United States. This was the traditional Army view of the purpose of air defense -- support of ground troops. General Hall made no mention of strategic areas.[7]

When General Spaatz came forward to testify on 6 March 1947 he explained that the best way of defending the country was to "get them (enemy bombers) at the place they start from, and that is primarily our mission."[8] This testimony was certainly no vote of confidence in the type of air defense

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7. Hearings before the Subcommittee of the House Committee on Appropriations on the Military Establishment Appropriation Bill for 1948, p. 17.

8. Ibid., p. 629.

ADC thought it was obligated to provide for the country. It was, instead, a throwback to the mid-thirties when the "big-bomber" school of thought in the Air Corps felt that a good offense would obviate the need for any kind of defense.

A third point of view was offered by Lt. Gen. Ira C. Eaker, General Spaatz' deputy. Also testifying on 6 March 1947, General Eaker described ADC in this manner:[9]

> This organization (ADC) is charged with provision of the air defense organization for the continental United States. It mans the communication system, the electronic detection devices and the fighter defenses. Since the Air Reserve and Air National Guard are the primary elements of this system, the Air Defense Command has the peacetime function of supervising the Air Force phase of Reserve, National Guard and ROTC training and organization. It also controls and mans the complete air warning system. We learned from experience in the last war that it is necessary to have such a command in peacetime which stays home and in emergency undertakes at once the air defense of the country. We did not have such a command when the last war started and as a result it had to be organized in a period of great emergency and national strain. By having this organization prevalent in peacetime, much of the confusion will be eliminated in a future emergency and the defensive task will be accomplished with much greater economy and efficiency.

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9. Ibid., pp. 633-35.

General Eaker's picture of ADC was somewhat closer to the picture ADC had of itself although the statement that the ANG and Air Reserve were the "primary elements" of the system did not coincide with ADC visions of an in-being air defense.

A fourth view of ADC's mission was presented by Maj. Gen. O.P. Weyland, AAF Director of Plans, also on 6 March 1947. "It is obvious," General Weyland testified, "that at the start of a war we will be the recipient of an all-out surprise attack. From the air, such an attack will be against the industry and economy of the continental United States. Forces for defense against such a blow must be maintained in a state of immediate readiness."[10] This was what ADC had in mind.

Initial reply to the ADC plans of October and November 1946 came in March 1947. Shortly after his testimony before the House Appropriations Committee, General Spaatz apparently came to the conclusion that the matter of a permanent mission for ADC, which would justify the actual procurement of equipment, was stuck on dead center. In a personal letter of 14 March 1947 to General Stratemeyer, he advised ADC not to

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10. Ibid., pp. 642-43.

rock the boat until budget and unification problems had been settled.[11]

Nevertheless, ADC proceeded with the development of a long-range air defense plan. This plan, issued in April 1947, gave 1955 as a target date for realization and was predicated on AAF acceptance of the "in-being" plan of November 1946. The long-range plan of April 1947 carried on from that point. Only the defense of the five critical areas mentioned in the November plan was considered in the April plan, but the area around each was widened considerably. A network of 114 heavy radars was proposed in the April plan.[12]

An indication of the dearth of ADC resources at this time, the 505th Airborne Control and Warning (AC&W) Group was established at McChord AFB, Washington, in May 1947, with the principal mission of dismantling and storing of World War II radars. At the same time, however, the 505th put in working order AN/CPS-5 radars at Arlington, Washington (near Bellingham), and at Half Moon Bay, California (near San Francisco). Both radars operated only

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11. Ltr, Spaatz to Stratemeyer, 14 Mar 1947 [DRB C/S Files 1947, 43701-43800].

12. ADC to AAF, "Air Defense Plan (Long Term)," 4 Apr 1947 [USAF HD 419.01].

part-time and mainly for the purpose of providing ground-controlled interception (GCI) training for interceptor squadrons based nearby. This was the extent of the ADC radar netowrk at the end of 1947, nearly two years after establishment of the command.[13]

No action was taken on any of ADC's plans during the summer of 1947, because Washington was engrossed in the reorganization of the military establishment. But after the creation of an independent Air Force within a new Department of Defense in September 1947, the log jam began to break. On 12 November 1947 Secretary of Defense James Forrestal made a public announcement that planning for a nation-wide radar early warning system was underway.[14]

Planning for a substantial radar early warning network had been underway in USAF for several weeks prior to Mr. Forrestal's announcement of 12 November 1947, so it was possible to complete the finished plan, which drew heavily on early ADC planning, on 18 November. It was approved by General Spaatz on 21 November. This blueprint called for the placement of 374 radars within the United States, feeding information into 14 control centers. Completion of this

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13. ADC Historical Study, A Decade of Continental Air Defense, 1946-1956, Jul 1956, p. 9.

14. New York Times, 13 Nov 1947.

network was anticipated by 30 June 1953, at a cost (excluding 37 radars for Alaska) of $136 millions. It was planned that the radars around the periphery of the United States would operate 24 hours a day, those in the interior being limited to part-time operation. It was expected that the Air National Guard would assist in manning the system.[15]

The Air Force plan for a radar screen across the air approaches to the United States was given the code name SUPREMACY in late 1947 and the Bureau of the Budget was consulted as to the best method of gaining Congressional approval for it. The budget examiners recommended that enabling legislation be presented to Congress before any money was requested. Consequently, the Air Force prepared draft legislation in January 1948 and asked for Army and Navy concurrence. Army concurrence was received promptly, but the Navy felt the matter needed thorough study, a process which required several months.[16]

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15. Memo, Brig. Gen. F.L. Ankenbrandt, Chief, Air Communications Group, USAF for C/S, USAF, "Air Control and Warning Plan for Alaska and the Continental United States," 18 Nov 1947 [DOC 1]; Presentation on AC&W System for Alaska and the United States, Ankenbrandt, 19 Nov 1947 [DOC 2]; Conference minutes, Meeting on AC&W Plan for Alaska and the United States, USAF, 21 Nov 1947 [HRF].

16. Memo, Gen. Hoyt S. Vandenberg, C/S, USAF for Stuart Symington, Sec/AF, "Comments on Mr. Forrestal's Memo

While the Navy studied the SUPREMACY proposal, events in other parts of the world indicated that the era of good feeling which came with victory in World War II was about to end. On 24 February 1948 a Communist coup in Czechoslovakia added that country to the group of Russian satellites in eastern Europe. On 5 March, General Lucius Clay, American commander in Berlin, noted a new tenseness in his dealings with his Russian counterparts and expressed the opinion that some hostile move on the part of the Russians might come with dramatic suddenness. On 8 March, observers on the scene predicted that Chang Kai-shek would lose China to the Communists. On 12 March the British government, sensing the change in the international political climate, expressed the need to discuss Atlantic security with the United States.[17]

This tension led to anxiety over the safety of the Atomic Energy Commission's plant at Hanford (or Pasco) Washington. Therefore, General Spaatz, on 27 March 1948,

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[Cont'd] to the JCS, dated 1 July 1948," 30 Jul 1948 [Doc 12 in AMC Case Hist of the AC&W System].

17. Warner R. Schilling, Paul Y. Hammond and Glenn H. Snyder, Strategy, Politics and Defense Budgets (New York, 1962), pp. 40-41.

ordered ADC to put the AN/CPS-5 at Arlington, Washington, on a 24-hours-a-day basis, along with newly activated AN/TPS-1B sites at Spokane, Neah Bay and Hanford in Washington and Portland in Oregon. The AN/CPS-5 at Half Moon Bay was permitted to continue part-time operations.

The results, when assessed in mid-April, were disheartening, if enlightening. Disregarding the difficulties of the interceptor force, very little defense was provided for Hanford, because the technicians who manned the radars were generally inexperienced trainees who had not mastered the intricate art of directing an interceptor to a precise point in the air. Furthermore, ADC told USAF that both the personnel and equipment available were inadequate to maintain 24-hour operation of the five sites indefinitely. The men were overworked, the radars frequently needed repairs, and the portable power equipment in use could not stand continuous operation. Authority had been granted to shut down one radar at a time, in rotation.[18]

In spite of the patent failure in the Northwest, ADC was directed,on 23 April 1948, to extend this makeshift

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18. Msg ADC to 4AF, 27 Mar 1948 [Doc 24 in Hist of ADC, Jan-Jun 1951]; ADC to USAF, "Status of Continental Air Defense," 15 Apr 1948 [Doc 28 in Hist of ADC, Jan-Jun 1951].

system to the northeastern United States and the Albuquer-
que area.[19]

Five days later, on 28 April 1948, the Navy completed its study of the draft legislation concerning SUPREMACY, requesting only minor changes. The approved draft was then submitted to the Bureau of the Budget. There it lay until 24 May 1948, when the Budget Bureau submitted a series of questions and comments concerning the radar screen. These were answered by the end of the month, but meanwhile, on 27 May 1948, Senator Chan Gurney of South Dakota introduced a bill to authorize SUPREMACY. Bureau of the Budget approval had not been obtained. Unfortunately, 1948 was an election year and Congress adjourned in June, before any hearings could be held on Senator Gurney's bill.[20]

The USAF directive of 23 April 1948 was supplemented by a clarifying letter of 4 May which listed the critical areas to be defended and their order of priority:[21]

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19. USAF to ADC, "Air Defense of the Continental United States," 23 Apr 1948 [Doc 31 in Hist of ADC, Jan-Jun 1951].

20. Memo, Vandenberg for Symington, "Comments on Mr. Forrestal's Memo to the JCS, dated 1 July 1948," 30 Jul 1948 [Doc 121 in AMC Case Hist of the AC&W System].

21. USAF to ADC, "Air Defense of the Continental United States," 4 May 1948 [Doc 32 in Hist of ADC, Jan-Jun 1951].

Northwest:

a. Hanford Engineering Works, Pasco, Washington
b. Seattle
c. Bonneville Hydro Electric Station, Bonneville, Oregon
d. Renton, Washington
e. Tacoma

Northeast:

a. Washington D.C.
b. New York-Newark-Jersey City
c. Philadelphia
d. Westover AFB, Massachusetts
e. McGuire AFB, New Jersey
f. Hartford, Connecticut
g. Boston
h. Niagara Falls

New Mexico:

a. Air Force Special Weapons Project (AFSWP) at Sandia, including Kirtland AFB
b. AEC facility at Los Alamos
c. Walker AFB, Roswell

All that ADC found it possible to do immediately in the Northeast was to activate an AN/CPS-6 at Twin Lights, New Jersey, and AN/TPS-1B's at Palermo, New Jersey, and Montauk, New York. A primitive control center was established at Roslyn, New York. This radar "net" was exercised against a visiting squadron of British Vampire bombers in August 1948. First Air Force characterized the resulting radar coverage as "totally inadequate."[22]

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22. 1AF to ADC, "Report on Air Defense Maneuvers in the Metropolitan New York Area," 14 Oct 1948 [Doc 39 in Hist of ADC, Jan-Jun 1951].

CHAPTER TWO

PLAN SUPREMACY REVISED: A BEGINNING IS MADE
1949 - 1950

SUPREMACY died with the 80th Congress, but planning for a radar early warning network continued. While waiting for the 81st Congress to convene in January 1949, Secretary of Defense Forrestal believed there was time for the JCS to examine the Air Force proposal and decide whether it was really feasible, especially since it recommended use of modified World War II radar and the spending of a serious amount of money in a time of limited defense budgets. Mr.

Forrestal made his request on 1 July 1948 and requested an answer by 1 October.[1]

The Air Force, of course, was aware of Mr. Forrestal's request of the JCS and, in view of his concern over costs, surmised that the Secretary of Defense might be more willing to support a somewhat more austere "interim" radar network than the full SUPREMACY, even though he had approved the earlier Gurney bill as introduced in the Senate. Preparation of a new plan was undertaken by Maj. Gen. Gordon P. Saville, head of the Air Defense Group in USAF, and presented to Mr. Forrestal on 9 September 1948. General Saville outlined a radar network deploying 61 radars -- five currently in operation, 19 World War II radars then in storage but usable, plus 12 AN/CPS-6B and 25 AN/FPS-3 radars to be produced in 1949 and 1950. General Saville warned Mr. Forrestal that this proposal would provide an early warning network that was far from ideal and merely represented what could be done by 1952 with minimum funds. He estimated that this "interim" plan would require $70 million in construction

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1. Memo, Sec/Def for JCS, 1 Jul 1948 [Doc 110 in AMC Case Hist of the AC&W System].

funds, $45 million of which would be needed in Fiscal Year 1949.[2]

Both Mr. Forrestal and the JCS felt that the "interim" plan was worthy of support and in October 1948 the Secretary of Defense released $706,000 from his contingency fund to permit advance planning and site surveys pending Congressional action in 1949.[3]

Meanwhile, pending Department of Defense and Congressional approval of the Interim AC&W program, USAF decided on maximum use of whatever World War II radar was available. In September 1948, USAF authorized ADC to put into operation 13 additional radar stations in the northeastern United States. To cut the cost, ADC was instructed to use only government-owned property, a restriction which forced use of some sites which were not ideally located. The total temporary system was given the name LASHUP to distinguish it

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2. Presentation to Sec/Def by Maj. Gen. Gordon P. Saville, Air Def Div, USAF, "Interim Program for AC&W System in the Continental United States and Alaska," 9 Sep 1948 [Doc 18 in Hist of ADC, Jan-Jun 1951].

3. Memo, Dir/Plans & Org, DCS/O, USAF for Dir/Installations, DCS/M, USAF, "Interim Program for Employment of AC&W Radar," 7 Oct 1948 [Doc 129 in AMC Case Hist of the AC&W System]: Memo. Sec/AF for Sec/Def, "Interim Program for AC&W Systems in the Continental United States and Alaska," 20 Oct 1948 [DOC 3].

from the interim system, for which money was to be sought from Congress. The name was appropriate, suggesting, as it did, the picture of an obsolescent radar set lashed to the top of a pole with a length of frayed rope. But it did provide some measure of air defense capability.

By the end of September 1948, ADC was able to provide USAF with a list of sites for 12 of the 13 additional radars in the Northeast. These were to be placed at Presque Isle and Dow Air Force Bases and Fort William in Maine; Grenier AFB in New Hampshire; Fort Ethan Allen in Vermont; Camp Edwards in Massachusetts; Jamestown, Seneca and Pine Camp in New York; Fort Custis in Virginia; Ravenna in Ohio and Selfridge AFB in Michigan. The Presque Isle site was to be equipped with an AN/TPS-1B, the others with the AN/CPS-5.[4]

A reorganization of 1 December 1948, which created Continental Air Command (ConAC) as a superior headquarters over both ADC and Tactical Air Command, had no appreciable effect on the growth of the radar system, although it generated certain administrative anomalies. The Commanding

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4. Msg 648, ADC to USAF, 30 Sep 1948 [Doc 49 in Hist of ADC, Jan-Jun 1951].

General of ADC was also Deputy for Air Defense on the ConAC staff and it was often uncertain in which capacity he spoke.

A House resolution authorizing the construction of the interim radar network was introduced 9 February 1949. The next day General Saville explained the need for such a system to a subcommittee of the House Armed Services Committee. None of the questioning of General Saville could be regarded as hostile, indicating that at least the subcommittee considered the project desirable. There was some surprise that the proposed radar network (which had increased from 61 to 75 sets between the time the concept was presented to Secretary Forrestal on 9 September 1948 and the time the legislation was drawn) would not guarantee absolute protection, but when General Saville explained that absolute protection could never be guaranteed, the questioners appeared to be satisfied. It was brought out in testimony that the new equipment was likely to cost $26 million and that World War II equipment to be used in the interim system was valued at $46 million. In answer to a question which suggested that the existing air defense system was "not in very good shape," General Saville responded that "words would be [inadequate] to describe how poor it is. It is almost negligible."[5]

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5. Hearings of the Subcommittee of the House Armed Services Committee on H.R. 2546, 10 Feb 1949, p. 338.

The subcommittee agreed with General Saville that creation of the proposed radar warning and control system was necessary and reported favorably on H.R. 2546. The full House and Senate had no objections and the authorization bill became law on 30 March 1949.[6]

But an authorization bill is only that and no funds are available until Congress provides an appropriation. This was not done immediately. Of significance in this connection was the appointment, on 28 March 1949, of Louis Johnson as Secretary of Defense It soon became clear that the reduction of expenditures was a major preoccupation with Mr. Johnson. It became difficult enough to obtain funds for existing military programs. Money for new programs, such as air defense radar, was even harder to come by. The Air Force had planned to obtain the initial portion of the $85 million required for radar site construction from the Supplemental Appropriation for Fiscal Year 1949, the remainder from the regular appropriation for Fiscal Year 1950. This was not to be done, as the Air Force discovered in April 1949 conferences with the Bureau of the Budget. Acting in accordance with fiscal policies laid

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6. Pulic Law 30, 81st Congress.

down by Mr. Johnson and approved by President Truman, the Bureau of the Budget not only refused to authorize inclusion of radar funds in the 1950 budget, let alone the 1949 supplemental, but also recommended that part of the authorized $85 million be deferred to the 1952 budget. USAF contested this recommendation and obtained from the Joint Chiefs of Staff a statement that the radar program had a high priority and should not be deferred. This reclama had no effect on the budget makers, however, and the 1950 budget submitted to Congress earmarked no funds at all for the 75-radar program.[7]

The northeastern LASHUP system was exercised (Exercise BLACKJACK) in June 1949, but the results were inconclusive because the exercise lacked realism. SAC bombers, principally B-29's, were recalled after only six days and B-26's of considerably poorer performance substituted. Performance

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7. Memo, Dir/Installations, DCS/M, USAF for Compt USAF, "AC&W System," 15 Apr 1949 [Doc 154 in AMC Case Hist of the AC&W System]; Memo, DCS/P&O, USAF for DCS/O, USAF "Re-examination of the Approved AC&W Program," 29 Apr 1949 [as cited in Footnote 15, Chap. IV, p.30, to Dr. C. L. Grant, The Development of Continental Air Defense to 1 September 1954, USAF Hist Study 126. Hereafter cited as Grant.]; Memo for Record, L/Col. W.C. O'Dell, Ofc of DCS/P&O, USAF, no subj, 2 May 1949 [Doc 157 in AMC Case Hist of the AC&W System]; Memo, DCS/P&O, USAF for DCS/O, USAF, "Proposed AC&W System," 17 May 1949 [Doc 158 in AMC Case Hist of the AC&W System]; Memo, Comptroller, USAF for DCS/M, USAF, "Additional Authorization for the Radar Screen," 1 Jun 1949 [Doc 164 in AMC Case Hist of the AC&W System].

of the radars varied considerably, some being barely operational, while others tracked "faker" aircraft at surprising ranges. For example, the capability of the AN/CPS-6 at Twin Lights, New Jersey, was virtually zero. At the same time, the AN/CPS-5 at Selfridge AFB, Michigan, after some experimentation during the exercise, was able to track a simulated hostile at a range of 210 miles.[8]

Three months later, in September, another test, Exercise LOOKOUT, was run in the same area. Radar capability was relatively poor, since detection averaged 84 miles on targets over 10,000 feet and 71 miles on targets below that level. One encouraging sign, however, was the increased cooperation between pilots and weapons controllers. Radar maintenance was sharply critized, reflecting the acute shortage of radar technicians.[9]

There was also a small augmentation and recasting of the radar defenses of the Northwest in 1949. Where five

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8. Report of Air Def Exercise BLACKJACK, 1-30 Jun 1949 [Doc 52 in Hist of ADC, Jan-Jun 1951].

9. Report of Air Def Exercise LOOKOUT, 10-16 Sep 1949 [Doc 53 in Hist of ADC, Jan-Jun 1951]; 26AD to EADF, "Final Report and Final Evaluation for LOOKOUT," 19 Sep 1949 [Doc 54 in Hist of ADC, Jan-Jun 1951].

stations were operational during the emergency of April 1948, seven were operating under LASHUP by October 1949. Locations, too, were somewhat different. The 1949 network comprised stations at Whidbey Island, Olympia, Pacific Beach, Neah Bay, Moses Lake and Sequim, all in Washington. For protection of the Los Alamos atomic facility, a single radar was made operational at Kirtland AFB, New Mexico. All these sites were equipped with the AN/CPS-5 radar.[10]

Although the initial USAF plan for a permanent radar network had been drawn in late 1947, Congress had still not provided financial support for it by the autumn of 1949. On 29 September 1949, however, President Truman announced that the Soviet Union had produced an atomic explosion the previous August. Interest in air defense almost immediately quickened. For example, while Representatives Jackson and Mitchell and Senator Magnuson of Washington had been expressing mild concern over the defenses of the Northwest in August, the commander of ADC's 25th Air Division (at Silver Lake, Washington) reported in October that strong civilian pressure for improved air defenses was being felt all along

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10. Hist of ADC, Jan-Jun 1951, pp. 79-81.

the West Coast. General Omar Bradley, Chairman of the Joint Chiefs of Staff, also felt these pressures. On 12 October 1949 he told the New York Times that completion of the radar fence was an essential military requirement. Without it, he added, an atomic attack on the industrial heart of the nation was entirely possible.[11]

Congress also felt this pressure and on 29 October 1949 passed the FY 1950 appropriation bill which permitted the Air Force to proceed with the radar program. The original bill had included nothing for the Permanent radar system, but the bill as passed contained five million dollars for that purpose. In addition, the Air Force was authorized to transfer $50 million from other projects to the radar program. The Air Force did not relish the idea of raiding other projects to finance the Permanent radar system, but felt that the radar network was so important that it was finally decided to take $33 million from the fund for operations and maintenance and $17 million from funds for construction of aircraft in order to finance the

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11. Memo, Maj. Gen. Thomas D. White, Dir/Legislation and Liaison, USAF, for Sec/AF, 22 Aug 1949 [Grant, footnote, p. 30]; New York Times, 13 Oct 1949; Pers ltr, Lt. Gen. Ennis Whitehead, CG, ConAC to Maj. Gen. W. F. McKee, Asst Vice C/S, USAF, 28 Oct 1949 [Grant, footnote, p. 30].

radar system. On 2 December 1948, USAF directed the Army Corps of Engineers to proceed with construction of the first 24 sites of the Permanent network.[12] These were, by priority, as shown in Table 1.

It was planned, in the spring of 1950, to equip the 75 stations of the Permanent network with three types of long-range radar: AN/CPS-5, AN/CPS-6B and AN/FPS-3. The CPS-5 was an existing radar and was being used in the LASHUP system. The other two types were new and improved sets that had only recently reached the production stage. It was expected that the first CPS-6B would be ready for installation in July 1950. As for the FPS-3, a modified version of the CPS-5, the first set was to become available in October 1950.[13]

The remainder of the LASHUP network was nearly complete by June 1950. At this time, 10 stations were operating

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12. Public Law 434, 81 Congress, 29 Oct 1949; Memo, Symington for Vandenberg, 31 Oct 1949 [DRB C/S Files 1949 25101-25200, cited in notes taken by Dr. Grant for USAF Hist Study 126]; Memo, McKee for Symington, 9 Nov 1949 [Grant, footnote 17, Chap. IV, p. 30]; 1st Ind (EADF to ConAC, "Initiation of Active Air Defense for Vital Eastern Coastal Zone, 16 Nov 1949), ConAC to EADF, 2 Dec 1949 [as cited in Hist of ConAC, Jan-Jun 1950, Vol. III].

13. Memo, Capt. W. F. Burch, AMC for Lt. Col G. G. Getz, AMC "Progress Report Permanent AC&W Installation Program," 17 Mar 1950 [Doc 222 in AMC Case Hist of AC&W System].

in the northwest -- Spokane, Moses Lake, Pasco, Paine Field, McChord AFB, Vancouver, Neah Bay, Pacific Beach and Whidbey Island in Washington and Seaside in Oregon. Protection for California was afforded by radars at Half Moon Bay, Mt. Tamalpais, Taft, Muroc, Point Concepcion, Van Nuys and Fort McArthur. In New Mexico, the solitary radar at Kirtland AFB was supplemented by installations at Los Alamos and Roswell. For protection of the Atomic Energy Commission plant at Oak Ridge, Tennessee, a LASHUP radar was installed at nearby McGhee-Tyson Airport. The other 23 LASHUP installations, of a total of 44, were located in the northeastern United States.[14]

Not everybody was satisfied, however, that the radar network was being organized quickly enough. Representative Thor C. Tollefson of Washington rose in the House on 12 January 1950 to point out that Boeing was being forced to shift aircraft production from Seattle to Wichita because of inadequate air defense in the northwestern United States. Tollefson added that the people of the Pacific Northwest were thoroughly aroused over the situation and demanded

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14. Hist of ADC, Jan-Jun 1951, pp. 80-81.

action. To answer this demand, the radars of the 25th Air Division (responsible for the defense of this area) were placed on an around-the-clock operational basis in February 1950. It was also noted that No. 1 priority in the Permanent radar system was held by McChord AFB, a site intended for defense of the Seattle area.[15]

The full-time radar system in the Northwest was exercised between 18-24 June 1950 (Operation WHIPSTOCK). Although the limitations of obsolete equipment were apparent, WHIPSTOCK was considerably more encouraging than earlier exercises, because the increased experience of the operating personnel was evident. Simulated hostile bombers were detected more readily and tracked for longer periods. LASHUP was admittedly an inferior system, but better than it had been earlier.[16]

On 25 June 1950, North Korea invaded South Korea and a major military confrontation between the United States and the Soviet Union became a possibility. Barely two weeks later, on 11 July 1950, the Secretary of the Air Force asked the Secretary of Defense to approve a plan to expedite the construction of the Permanent radar network. The Secretary

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15. Ibid., p.410; Congressional Record, House, 12 Jan 1950, p.357.

16. Annex III of the Report of the 25 Air Division

of Defense gave prompt approval, because on 17 July the Under Secretary of the Air Force issued verbal orders that expeditious action under the terms of the plan submitted to the Secretary of Defense be undertaken.[17]

Thereupon, on 21 July 1950, USAF directed the Corps of Engineers to proceed with construction of a second segment of the Permanent radar network, comprising sites 25 through 52, with priorities as shown in Table 2.

But even this degree of expedition was insufficient. In 27 July 1950 testimony before a closed session of the House Armed Services Committee, Maj. Gen. Charles T. Myers, Vice Commander of ConAC, promised that the first 24 radar stations of the Permanent network would be completed by the end of December 1950. Nineteen, he said, were under construction. Furthermore, General Myers added, the remainder of the system through Priority 85 (including 75 radar sites and 9 control centers -- Priority No. 81 was not used)

[Cont'd] on Operation WHIPSTOCK, 18-24 Jun 1950 [Doc 56 in Hist of ADC, Jan-Jun 1951].

17. Memo, Lt. Gen. E.W. Rawlings, Comptroller, USAF for DCS/M, USAF, "Expediting Completion of the Radar Fence," 27 Jul 1950 [Doc 274 in AMC Case Hist of the AC&W System].

would be finished by 1 July 1951. This statement went far beyond the directive issued to the Corps of Engineers on 21 July 1950.[18]

The priorities of the radar installations beyond No. 52 were as shown in Table 3.

The promises of July 1950 proved impossible to meet. Lack of coordination between the various agencies involved (USAF, Corps of Engineers, AMC, ConAC and General Electric) caused some of the delay. The very immensity of the project made it unrealistic to expect to have the first 24 sites operationally ready within five months, the complete system within 11 months. For example, a single AN/CPS-6B radar, including ancillary electronic equipment, filled 85 freight cars.

The optimism of 27 July was somewhat tempered by Corps of Engineers testimony at the first meeting, on 8 August 1950, of the special radar subcommittee of the House Armed Services Committee. Representative Carl Vinson of Georgia, chairman of the full committee, also appointed himself chairman of the special subcommittee. At this meeting, representatives of the Corps of Engineers

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[18] Transcript of Executive Session Hearings, House Armed Services Committee, 27 July 1950 [Doc 275 in AMC Case Hist of theAC&W System].

testified that with an additional $2.5 million it might be possible to complete the construction of 24 sites by 1 November 1950, although seven would be only at the point of beneficial occupancy at that time. The subcommittee was also informed that ConAC would not have sufficient manpower at that time to man 24 new stations in addition to the LASHUP network. Twenty-four LASHUP sites would have to be abandoned in order to man the 24 Permanent stations. The subcommittee was not satisfied with the progress reported. It was insufficient, Mr. Vinson concluded, in light of the world situation. In effect, the program outlined on 27 July was still controlling. Maj. Gen. F. L. Ankenbrandt, Director of Communications, USAF, recommended to the Chief of Staff that multiple shifts and unlimited overtime on the part of construction contractors be utilized as one method of improving completion dates.[19]

Then other things began to happen. In early September, employees at the Syracuse plant of General Electric, where the CPS-6B was being fabricated, went on strike. The strike was quickly settled, but the damage to CPS-6B production

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19. Memo, DCS/M, USAF for C/S, USAF, "Meeting with Mr. Vinson's Subcommittee on the AC&W Program," 9 Aug 1950 [DOC]; New York Times, 9 Aug 1950; Memo, Dir/Comm, USAF for C/S, USAF, "Acceleration of Construction Program for First Twenty-four AC&W Sites of ConAC," 16 Aug 1950 [Doc 303 in AMC Case Hist of the AC&W System].

had been done. At about the same time, ConAC discovered that some construction was being delayed because of shortages of building materials. The importance of the program was underlined in early September when Under Secretary of the Air Force John A. McCone and Assistant Secretary Eugene Zuckert visited AMC to remind everybody concerned of the Air Force promises to Congress and urge them to greater effort. AMC chose this occasion to announce that it had contracted with five firms (Gustav Hirsch Organization, Philco, National Scientific Laboratories, General Electric and Bendix) to provide a considerable number of electronic engineers to assist AMC teams with radar installation.[20]

A construction report as of 1 October 1950 was not optimistic over the chances of completion by the end of the year. Only the sites at McChord (96 per cent) and Saddle Mountain, Washington (85 per cent) were as much as three-quarters finished. It should be noted that installation and testing of the radar ancillary gear remained to be done after construction was complete. The two worst examples

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20. Memo, MCPPXE, AMC for MCPPXE-44, AMC, "Request for Removal of Completed Equipment from Strike-bound Plant," 5 Sep 1950 [Doc 318 in AMC Hist of AC&W System]; ConAC to USAF, "Factors Delaying the AC&W Construction Program -- Lack of Construction Materials," 9 Sep 1950 [Doc 320 in AMC Case Hist of AC&W System]; AMC to OCAMA, "Permanent Aircraft Control and Warning Program (Project Speed)," 13 Sep 1950 [Doc 325 in AMC Case Hist of AC&W System].

were El Vado, New Mexico (18 per cent complete) and Keweenaw, Michigan (26 per cent).[21]

Mr. Zuckert got the bad news from the USAF Comptroller the following day, 2 October. It appeared, the Comptroller reported, that only four of the promised 24 sites would be operationally ready by the end of 1950. Seven more were likely to reach readiness in January 1951, four in February and the final nine in March. The goal for the remainder of the Permanent system, for the time being, was 1 July 1951. Of the first priority group, 12 were to be equipped with the CPS-6B. Seven were to get the wartime TPS-1B initially, the FPS-3 eventually. Five would have the CPS-5.[22]

The next day, 3 October 1950, Under Secretary McCone passed this word along, in somewhat modified form, to the Vinson Subcommittee. Mr. McCone adjusted his earlier testimony by promising that the first of the 24 radar sites would be operational by 1 March 1951, the remainder of the

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21. USAF to ConAC, "Report, Aircraft Control and Warning Program, ZI Area," 12 Oct 1950 [Doc 349 in AMC Case Hist of AC&W System].

22. Memo, Comptroller, USAF for Asst/Sec/AF, "Progress of the Permanent Radar Net," 2 Oct 1950 [Doc 341 in AMC Case Hist of the AC&W System].

Permanent system by 1 July 1951. The adjusted operational date for the first 24 sites was accepted by the subcommittee.[23]

Two months later, on 6 December 1950, Mr. McCone had still worse news to pass along to Chairman Vinson. In late November, the Air Force Under Secretary had visited McChord, scheduled to be the first operational site in the Permanent system, and discovered that no firm operational date could be forecast for this station because of a shortage of spare parts. This situation was likely to affect all sites in the Permanent network. Therefore, Mr. McCone found it necessary to inform Mr. Vinson in early December that it would be impossible to either complete the first 24 sites by 1 March 1951 or the entire system by 1 July 1951. He explained that the earlier promise had been based on the transfer of old radars to the new sites, but that in view of the world situation the Air Force had decided to use only new equipment at the Permanent sites. Completion of the system would therefore be delayed from one to four months. The full subcommittee was briefed on the changed situation on 15 December 1950. At that time it was predicted that the full system would be operationally ready by 1 November 1951. Still later in December that target date was dropped

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23. Extract from testimony before the Vinson subcommittee of the House Armed Services Committee, 3 Oct 1950 [Doc 363 in AMC Case Hist of the AC&W System].

back to 31 December 1951. The first 24 sites were promised by 31 July 1951. None, of course, were operational at the end of 1950.[24]

Whatever aircraft control and warning capability there was in the United States at the time was provided by 44 LASHUP sites of varying capacity. These were located as shown in Table 4.

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24. Memo, McCone for Vandenberg, 30 Nov 1950 [Grant, footnote 18, Chap. V, p. 40]; Ltr, McCone to Vinson, no subj, 6 Dec 1950 [DOC 385 in AMC Hist of the AC&W System]; Report, Programs Analysis Div, USAF, "Status of the Radar Screen," 19 Dec 1950 [DOC 392 in AMC Case Hist of the AC&W System]; USAF to AMC, "Progress of the Permanent Radar Net," 26 Dec 1950 [DOC 393 in AMC Case Hist of the AC&W System].

PART TWO

A MODERN RADAR NETWORK TAKES SHAPE

1951 - 1957

CHAPTER THREE

COMPLETION OF THE PERMANENT RADAR SYSTEM
1951 - 1952

Responsibility for the operation of the radar network figuratively changed hands in January 1951 with the re-establishment of Air Defense Command. While the mission was passed from ConAC to ADC, the same people continued to handle the problems involved.

The problems faced by the new ADC were many. Construction of radar sites, spurred by a plenitude of money, was proceeding at a good clip and had become, by early 1951, a minor problem. The installation and calibration of the radar became the major problem, illustrated by the site at McChord AFB, No. 1 on the priority list established for the initial 24 sites of the Permanent system. Beneficial occupancy of the buildings on the site occurred in the fall of 1950. Installation of the CPS-6B radar was completed on 28 February 1951. The next step was operational readiness, defined by ADC as involving final calibration, establishment of an on-the-job training program, completion

of all communications circuits and full integration of the site into the air defense system. Passing these latter requirements proved unusually difficult. The CPS-6B, the first of its kind in ADC, was disappointing in performance. In April tests it achieved a range of only 165 miles, being outranged by both TPS-1B and CPS-5 radars (World War II types which were considered nearly obsolete) at nearby LASHUP sites. The new Moving Target Indicator (MTI) also failed to perform according to specifications. As a result, the site at McChord was not fully operational by the forecast date (established in December 1950) of 31 July 1951, nor were any of the other 23 priority sites.[1]

Nevertheless, the Air Force kept an optimistic face turned toward Congress. On 6 July 1951, during testimony on the Air Force appropriation bill for Fiscal 1952, Congressman John J. Riley of South Carolina asked if the 1 November 1951 completion date (mentioned in testimony before the Vinson subcommittee on 15 December 1950) for the total Permanent system was firm. Maj. Gen. F. L. Ankenbrandt, USAF Director of Communications, answered with an unqualified yes.[2]

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1. Hist of WADF, Jan-Jun 1951, pp. 107-09; ADC Command Data Book, 31 Jul 1951 [HRF].

2. House Appropriations Committee Hearings on Air Force Appropriation for Fiscal 1952, pp. 235, 240 and 594.

Because of the delay in the operational readiness of the Permanent radar stations and because LASHUP sites would have to be closed when Permanent sites did become operational, LASHUP equipment was moved to some Permanent sites in the spring of 1951, creating hybrid "LP" (for LASHUP-Permanent) stations at 23 locations as shown in Table 5.

Despite the fact that none of the Permanent radar sites had achieved operational readiness by the middle of 1951, considerable work had been accomplished. Of the 75 installations which were to make up the Permanent network, 65 had reached the point of "beneficial occupancy" by 30 June 1951. This meant that ADC personnel were present on the site and assisting with the installation of the radar and communications equipment. Seventeen of these stations were considered "technically equipped," meaning that the radar had been installed.[3]

Although the Permanent system was far from complete, ADC, in July 1951, received USAF approval to proceed with the installation of 44 mobile radars to increase the amount of protection afforded the most important SAC bases and supplement the Permanent system. Also, ADC was directed to equip, man and operate eight radar stations in Canada.

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3. ADC Command Data Book, 30 Jun 1951 [HRF].

The target date for the operational readiness of both groups of radars was 1 July 1952.[4]

Both programs had been under discussion for some time. The principle of joint Canadian-American defense of territory north of the Mexican border was laid down in 1940 with establishment of the Permanent Joint Defense Board. This principle was reiterated after World War II and joint planning continued. One major decision was that to extend American early warning radar coverage into Canada. By July 1951 it had been decided that 35 radar sites would be established in Canada, with 22 to be financed by the United States. Eight of these were to be controlled by ADC, the remainder by Northeast Air Command. The eight ADC stations were to be located as follows:

C-10 Raymore, Ontario
C-14 Pagwa, Ontario
C-15 Armstrong, Ontario
C-16 Sioux Lookout, Ontario
C-17 Beausejour, Manitoba
C-19 Puntzi Mountain, British Columbia
C-20 Baldy Hughes Mountain, British Columbia
C-21 Saskatoon Mountain, British Columbia

The Raymore site was to be administered by Eastern Air Defense Force (EADF), C-14 through C-17 by Central Air Force (CADF) and C-19 through C-21 by Western Air Defense Force (WADF).[5]

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4. USAF to ADC, "Air Defense Command Responsibilities with Respect to the USAF World-Wide Radar Program," 10 Jul 1951 [Doc 188 in Hist of CADF, Jul-Dec 1951].

5. Hist of ADC, Jan - Jun 1951.

At the end of 1951, only five Canadian radar sites were operating, all manned by Royal Canadian Air Force (RCAF) personnel. These sites offered limited capability, because they were sited at interim locations and equipped with LASHUP radar borrowed from the United States. Furthermore, because of manpower limitations imposed by the Canadian defense budget, it was possible to operate these stations only eight hours a day. In this situation, ADC offered, at the end of the year, to supply ADC personnel to bring these five stations to 24-hour operation until the Canadian manpower deficiency was overcome. This did not prove necessary, however, because the RCAF later announced that it had discovered a source of manpower that would permit it to operate the five LASHUP stations 24 hours a day between March and September 1952.[6]

As to the new program for mobile radars within the United States, it will be recalled that the 75-station Permanent network was regarded as an interim system substituted for the 374-station Plan SUPREMACY of late 1947 when it appeared unlikely that the Truman administration and Congress would support the larger program. Air defense

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6. ADC to USAF, "Increase in Capability of Canadian LASHUP Radar Sites from 8 Hour to 24 Hour Operation," 4 Jan 1952 [Doc 11 in Hist of ADC, Jul-Dec 1951]; Msg ADOPR 437, ADC to USAF, 26 Feb 1952 [Doc 12 in Hist of ADC, Jul-Dec 1951].

planners, however, had never been satisfied that a 75-station network would completely fulfill requirements for an aircraft warning and control system. Therefore, plans for a 44-station addition to the Permanent system were drawn in 1950. These 44 "Mobile" stations were designed to fill two purposes. One was protection of six virtually undefended SAC bases -- Rapid City AFB, South Dakota; Walker AFB, New Mexico; Biggs AFB, Texas; Davis-Monthan AFB, Arizona; MacDill AFB, Florida and Barksdale AFB, Louisiana. Each "cluster" of Mobile radars in this category would involve an AN/MPS-7 heavy radar (a mobile version of the FPS-3) supported by three TPS-1D radars. The TPS-1D was an improved model of the TPS-1B/C type used in the LASHUP system. SAC defense would thereby require 24 radars. The other 20 were to be deployed on the perimeter of the United States and in the interstices of the Permanent system. To differentiate between the stations of the Permanent system ("P" sites) and the supplementary program, the new stations were designated "M" sites.[7] The 44 Mobile radars were tentatively deployed as shown in Table 6. The only activity with regard to the M-sites during the remainder of 1951 was the tentative selection of sites. No construction was undertaken and no equipment was placed.

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7. USAF to ADC, "Air Defense Command Responsibilities with Respect to the USAF World-Wide Radar Program," 10 Jul 1951 [Doc 188 in Hist of CADF, Jul-Dec 1951].

Because there was a continuing shortage of spare parts for the new CPS-6B and FPS-3 radars, it began to appear, by the summer of 1951, that none of the Permanent stations would ever qualify for "fully operational" status. ADC, therefore, found it necessary to modify the ground rules as to what qualified a radar station for full membership in the air defense family. It was decided to establish the category of "24-hour operational," meaning that the station could operate around the clock, no matter what the situation as regards spare parts.[8]

Under these relaxed criteria, 20 stations of the Permanent network were declared operational during the last half of 1951. These were, chronologically:[9]

August 1951:

P-1 McChord AFB, Washington (CPS-6B)

September 1951:

P-14 Bellevue Hill, Vermont (CPS-6B)
P-21 Shawnee, New York (CPS-6B)

October 1951:

P-31 Elkhorn, Wisconsin (CPS-6B)
P-30 Benton, Pennsylvania (CPS-6B)
P-58 Mather AFB, California (CPS-6B)
P-38 Mt. Tamalpais, California (CPS-6B)
P-9 Highlands, New Jersey (CPS-6B)
P-10 North Truro, Massachusetts (CPS-6B)
P-13 Brunswick, Maine (CPS-6B)
P-20 Selfridge AFB, Michigan (CPS-6B)

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8. Hist of WADF, Jul-Dec 1951, pp. 7-9.

9. ADC Command Data Book, 31 Jan 1952 [HRF].

November 1951:

P-7 Gonzales, New Mexico (FPS-3)
P-16 Keweenaw, Michigan (FPS-3)
P-34 Empire, Michigan (CPS-6B)
P-51 Osceola, Wisconsin (CPS-6B)

December 1951:

P-2 Cambria, California (FPS-3)
P-37 Point Arena, California (FPS-3)
P-74 Madera, California (FPS-3)
P-57 Naselle, Washington (FPS-3)
P-35 Osceola, Wisconsin (CPS-6B)

Sixteen of these operational sites were contained in ConAC's original list of 24 priority sites. Those not included were:

Priority	Location	
2	P-44	Bohokus Peak, Washington
4	P-40	Saddle Mountain, Washington
5	P-6	Mt. Bonaparte, Washington
6	P-8	El Vado, New Mexico
20	P-49	Watertown, New York
21	P-66	Sault Ste. Marie, Michigan
23	P-69	Finland, Minnesota
24	P-60	Colville, Washington

It was noteworthy that these missing priority sites were all scheduled for FPS-3 radars. Deliveries of the FPS-3 were considerably slower than deliveries of the CPS-6B. Also, several of these sites were in extremely isolated locations, rendering construction and equipment installation more difficult.

A new element entered planning for the supplementary Mobile radar program in early 1952. While USAF, in July 1951, had approved the addition of 44 mobile stations to the Permanent system on the basis of protection for six

especially vulnerable SAC bases (24 sites) and the filling of gaps in the Permanent system (20 sites), later intelligence estimates had underlined the necessity of providing a double perimeter of radar coverage for essential areas in the Northeast, Northwest and California. It was therefore proposed, in January 1952, to use about half the Mobile radars in partial completion of the double perimeter. The double perimeter concept involved placing an inner ring of radars about 70 miles from the outside edge of the target area. The outer ring was to be situated about 120 miles outside the target area, with radars about 120 miles apart. The new program would still provide reasonable high altitude coverage for SAC bases and AEC installations outside the double perimeters. ADC suggested that the 44 radars of the Mobile system, including six in Canada, be resited as shown in Table 7.

This reorientation of the Mobile program was approved by USAF on 21 March 1952, along with the admonition that the $22.3 million Congress had authorized for construction of the M-sites would not be exceeded. This brought up an interesting point. If the M-sites were to be used in a double perimeter radar deployment they would have to be established at fixed locations. Therefore, ADC felt that housing should be a comfortable as possible. In this situation ADC was of the opinion that the $22.3 million

appropriated would cover the construction costs of perhaps 30 stations, but concluded that discretion dictated leaving this problem to the future.[10]

In approving the original M-site program in July 1951, USAF had mentioned a completion date of July 1952. In the spring of 1952, this proposed completion date was patently impossible, especially since it was anticipated that deliveries of the MPS-7 would not begin until the spring of 1953. ADC believed that 1954 was a more logical completion date.[11]

By the end of 1952, siting for most of the 44 radars of the initial Mobile program had been completed, but ADC did not believe there was any particular hurry, because it was unlikely that either the MPS-7 or MPS-11 (substituted for the TPS-1D in the summer of 1952) would begin to arrive before late 1953 or early 1954. This was nearly a year behind earlier schedules. Three of the M-sites were being operated on a LASHUP basis at the end of the year. Site M-90 at Walker AFB, New Mexico, was equipped with a TPS-1B, while M-94 at Kirtland AFB, New Mexico, and M-97 at Rapid City AFB, South Dakota, had CPS-5 sets.[12]

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10. 1st Ind (ADC to USAF, "Mobile Radar Program" 18 Jan 1952), USAF to ADC, 21 Mar 1952 [Doc 19 in Hist of ADC, Jan-Jun 1952]; 2nd Ind (ADC to USAF, "Mobile Radar Program," 18 Jan 1952), ADC to USAF, 29 Apr 1952 [Doc 19 in Hist of ADC, Jan-Jun 1952].

11. Hist of ADC, Jul-Dec 1952, pp. 129-30.

12. Ibid., pp. 138-39.

The second phase of the Mobile radar program was approved by USAF on 18 October 1952 for implementation in Fiscal 1954. The statement of approval, however, contained the proviso that the second phase stations would have to be manned and equipped from resources already programmed for ADC. In other words, USAF would provide funds for construction, but nothing else.[13]

In July 1951, ADC was given responsibility for manning and operating eight Permanent-type radar stations in Canada. In addition, the first phase of the Mobile radar program included six stations in Canada, while the second phase program added three more. While Canadian approval for the first eight ADC-operated stations had long since been obtained, approval for the nine Mobile stations was not immediately forthcoming. It was the ADC view that this apparent reluctance stemmed from lack of Canadian appreciation of the double perimeter concept of radar coverage. After an inconclusive exchange of correspondence in late 1952, the three principals -- USAF, ADC and RCAF-ADC -- met in conference in January 1953. Here the fog of misunderstanding was cleared away and the RCAF-ADC representatives conceded the value of the nine Mobile stations. Government-to-government agreement was still required, but the Canadians

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13. USAF to ADC, "Mobile Radar Program (Second Phase), 18 Oct 1952 [Doc 134 in Hist of ADC, Jul-Dec 1952].

were of the opinion that such an agreement would be reached shortly.[14]

At the end of 1952, pending completion of the eight stations of what had come to be known as the Pinetree Line in Southern Canada, the RCAF was operating a seven-station network of LASHUP radar, using AMES-11 equipment salvaged from World War II.[15]

The Permanent network of 75 radars was operational by the end of 1952, approximately a year behind schedule. In addition to the 20 stations declared operational at the end of 1951, 39 reached that status during the first six months of 1952, while 16 were added in the last half of the year (Table 8). The distribution of radars among these 75 stations was roughly the same as originally programmed. Forty-eight sites had the FPS-3, while 14 had the CPS-6B and 13 had the FPS-10, a stripped-down version of the CPS-6B.[16]

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14. Msg AFOOP-OP-D 53520, USAF to ADC, 12 Jul 1952 [Doc 132 in Hist of ADC, Jul-Dec 1952]; Msg ADOPR 1540, ADC to USAF, 18 Jul 1952 [Doc 133 in Hist of ADC, Jul-Dec 1952]; USAF to ADC, "Canadian Approval for Three Mobile radar Sites," 5 Nov 1952 [Doc 129 in Hist of ADC, Jul-Dec 1952]; ADC to RCAF-ADC, "Mobile Radar Program (Second Phase)," 5 Dec 1952 [Doc 124 in Hist of ADC, Jul-Dec 1952]; Memo, Maj. M. F. Crispen, ADC P&R for Col. E. A. Herbes, ADC P&R, "Conference Hq USAF, 13 and 14 Jan 1953, Regarding Mobile Sites in Canada and Lash-Up Operation for 8 REP Sites," 17 Jan 1953 [Doc 128 in Hist of ADC, Jul-Dec 1952].

15. Hist of ADC, Jul-Dec 1952, p. 23.

16. Map 2 in Hist of ADC, Jan-Jun 1952; Map following p. 2, Hist of ADC, Jul-Dec 1952.

CHAPTER FOUR

THE MOBILE RADAR PROGRAM IN TROUBLE

1953

None of the radars of the first phase (44 stations) of the Mobile Program were operational at the end of 1952, despite the fact that the original planning called for completion of all 44 by 1 July 1952. Neither were any Phase I stations operational at the end of 1953. The reason for the delay was not hard to find. Unlike the P-system, where speed in achieving operational capability was considered essential and money was a minor problem, the Mobile system was meant to be created at minimum cost. Government land was to be used wherever possible and cost was a major factor in every discussion of competing sites. When one site could be developed for $200,000 less than another in the same neighborhood, the less expensive site was normally chosen. This emphasis on cost naturally led to delays in siting and construction. Also, when the first phase was originally planned, prospective sites were specified in a most general manner. When siting teams arrived in the area, it was often discovered that the site originally named was unsuitable for any one of a number of reasons.

This uncertainty as to exact site often led to delays that stretched into months and even years.

A few examples of the problems faced may serve to illustrate why no Phase I stations were operational at the end of 1953. Station M-127 was originally sited at Susanville, California. The siting team found this location particularly unsuitable in relation to other radars in the area and after considerable study recommended that M-127 be transferred to Winnemucca, Nevada. If this was done, it was believed that radar coverage would be sufficient to permit deletion of M-123 at Fort Bidwell, California. This shift was eventually approved, but problems remained. A radar station, it should be pointed out, is normally divided into two distinct sections -- an operational area where the radar is located and a cantonment area containing housing, food service and recreational facilities and other support activities. The ideal situation occurred where the two sections were adjacent, but this was not always possible, as at Winnemucca. Probably the best location for the cantonment area was on land which the Southern Pacific Land Company, a subsidiary of the railroad, offered to lease, but not sell, to the Air Force. Several miles away was a plot of land owned by the Department of the Interior, which could be transferred to the Air Force at no cost. After months of indecision, cost proved the overriding factor and

the Department of the Interior plot was chosen. As a result, the Army Corps of Engineers could not begin designing the construction until December 1953. The date proposed for beneficial occupancy of M-127 was set back to February 1955. The location of M-123 was consequently transferred to Berlin, Maryland, where EADF could not begin siting activity until 1954.[1]

Consider the problem of M-111. In the initial planning this station was to be located at Camp Williams, Wisconsin. Further study of the deployment of Phase I radars, however, suggested that additional protection was needed along the Canadian border in the area where North Dakota and Minnesota meet. The proposed location was shifted to Pembina, North Dakota. A siting team discovered, however, that construction at Pembina would involve considerable expense in the handling of sewage. It was recommended by CADF that a site at Hallock, Minnesota, be utilized instead. This recommendation was under consideration by ADC at the end of 1953.[2]

At site M-94, in the vicinity of Kirtland AFB, New Mexico, the first siting team recommended an operational location on Mt. Vulcan. Unfortunately, the owner of the proposed Mt. Vulcan site would not sell at the price offered by the Air Force and ADC would not permit CADF to resort to

1. Hist of WADF, Jul-Dec 1953, p. 58.
2. Hist of CADF, Jul-Dec 1953, p. 150.

condemnation proceedings. In December 1953 a siting team returned to the area and recommended a site at West Mesa, 22 miles west of Albuquerque. Higher authority had not approved this site at the end of the year.[3]

A slightly different problem was encountered at M-110, originally planned for Corea, Maine. About $30,000 had been spent in getting ready for construction and construction was about to begin when the Navy, which operated a radio interception and direction finding installation nearby, objected that a radar station in the area might cause some interference with radio reception. ADC directed EADF to find a new location for M-110. By the end of 1953, M-110 had been re-sited to Bucks Harbor, Maine.[4]

As a result of the various shifts in location, the deployment of Phase I radars of the Mobile system was considerably different than it had been when the program was originally proposed. End-1953 deployment at U. S. sites is given in Table 9.

Since none of the Phase I Mobile radar stations had reached the point of beneficial occupancy by the end of 1953, it followed that the Phase II sites, later starters in the race for funds, equipment and personnel, were in an earlier stage of development. The primary purpose of Phase

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3. Ibid., p. 163.

4. Hist of EADF, Jul-Dec 1953, p. 34.

II was to thicken early warning and control capability in the northern portion of the Midwest, along the West Coast and in the neighborhood of the Atomic Energy Commission's facilities in the Southeast.

The purpose was admirable and the justification was irrefutable. Nevertheless Phase II began to experience even more difficulties than were being faced by Phase I. In approving the Phase II program of 35 sites in October 1952, USAF explained that Phase II was seen as a Fiscal 1954 project, with construction funds to be provided by USAF, but with equipment and personnel to come from resources available to ADC. This promised to make Phase II austere enough, but in June 1953 ADC discovered that the Air Force military construction program for Fiscal 1954 contained no provision for construction of Phase II Mobile radar stations. Thereupon, General Benjamin W. Chidlaw, ADC Commander, wrote a strong reclama.[5]

No promise of construction funds was immediately forthcoming, so the remainder of 1953 was spent in surveying sites for the 32 U. S. Phase II stations on the premise that the necessary funds would eventually be made available. This was again a period of indecision. As had been true

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5. USAF to ADC, "Mobile Radar Program (Second Phase),' 18 Oct 1952 [Doc 134 in Hist of ADC, Jul-Dec 1952]; Msg ADHCG 1362, ADC to USAF, 10 Jun 1953 [Doc 83 in Hist of ADC, Jan-Jun 1953].

with respect to Phase I, the sites suggested in the original proposal had been chosen on the basis of map study. When siting teams reached the ground, the proposed sites often proved to be impossible, unsuitable or undesirable for a variety of reasons. Also, planners frequently changed their minds as to the exact areas to be provided radar coverage. The experience of CADF was perhaps atypical, but does underline the sort of indecision prevalent at this time. Early in 1953 it was agreed that the 35th Air Division would have six SM (Second Phase) stations, mainly for the protection of AEC plants at Oak Ridge, Tennessee, and Savannah River, South Carolina. These were to be SM-144 (Martin, Tennessee), SM-145 (Nashville, Tennessee), SM-148 (Valdosta, Georgia), SM-159 (Augusta, Georgia), SM-165 (Atlanta, Georgia) and SM-166 (Oglethorpe, Georgia). Later in the year it was decided that SM-148 should be shifted to Dublin, Georgia; SM-159 to Newton, South Carolina; SM-165 to Rising Fawn, Georgia and SM-166 to Atlanta. Still later, it was further decided that Trenton, South Carolina, would make a better location for SM-159.[6]

And so it went. In the course of all this mind changing, decisions deleting three of the Phase II 32 stations planned for the United States were reached.

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6. Hist of CADF, Jan-Jun 1953, pp. 235-38 and Jul-Dec 1953, pp. 149-50.

SM-134, originally planned for Berlin, Maryland, was deleted when it was determined to put a Phase I station at this location (M-123). SM-135 had a somewhat longer life. In early 1953 it was scheduled for Hettinger, North Dakota. At mid-year it was thought it could be put to better use at Lemmon, South Dakota. Finally, in December 1953, SM-135 was deleted altogether. The third of these sites, SM-146, was tentatively located at Corkscrew Mountain, Washington, but the site was not completely surveyed until decisions could be reached as to the exact location of the three Canadian sites directly north in British Columbia. When that was done, WADF concluded that SM-146 would not be necessary.[7]

At the end of 1953, therefore, it was proposed to deploy the 29 U. S. stations of the Phase II Mobile radar program in accordance with Table 10, although the permanency of these locations could not be guaranteed.

Although Canada had not yet joined the United States in a formal organization dedicated to the defense of North America by 1953, the Canadians had agreed to permit the United States to erect and operate 17 radar stations on Canadian territory. Eight of these were included in the Radar Extension Plan (REP), intended to supplement the

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7. Hist of EADF, Jul-Dec 1953, p. 39; Hist of CADF, Jul-Dec 1953, p. 149; Hist of WADF, Jul-Dec 1953, p. 67.

Permanent system in the United States. By the end of 1953 all eight of these stations were at least considered "limited operational" with FPS-3 radars, although several were hampered by inadequate communications. Four REP stations (C-10, Raymore; C-14, Pagwa; C-15, Armstrong and C-16, Sioux Lookout) were in Ontario in Eastern Canada. Beausejour (C-17) was in the prairie province of Manitoba. The other three (C-19, Puntzi Mountain; C-20, Baldy Houghes Mountain and C-21, Saskatoon Mountain) were in British Columbia.[8]

Progress was much slower with respect to the six Phase I Mobile stations planned for Ontario and three Phase II stations proposed for British Columbia. The Phase I stations were tentatively placed at Trenton (M-102), Wiarton (M-104), Sultan (M-107), Mattawa (M-108), Fire River (M-119) and Peninsula (M-120). Proposed Phase II radars were scheduled for Nakusp (SM-152), Kamloops (SM-153) and Birken (SM-154).[9]

No progress was made on the Canadian Mobile radar sites until the summer of 1953, because the Canadian government did not approve site surveys until 2 April 1953.

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8. Hist of WADF, Jul-Dec 1953, p. 45; Hist of CADF, Jul-Dec 1953, pp. 168-77; Hist of EADF, Jul-Dec 1953, pp. 19-20.

9. Hist of EADF, Jul-Dec 1953, p. 38; Hist of WADF, Jul-Dec 1953, p. 65.

Because of this delay, ADC could not predict beneficial occupancy of construction at any of the nine Canadian Mobile sites before the summer of 1955. Also, ADC anticipated further delays because the approval letter covered only site surveys. Construction, installation of radars, and placement of personnel would require further approvals.[10]

Meanwhile, the projected site of M-102 was moved from Trenton, Ontario, to Cape Sable, Nova Scotia, where it was believed this station could be used both as a surveillance radar and as the northern anchor for the Airborne Early Warning and Control system being planned for the East Coast. At the end of 1953 site surveys had been prepared for Cape Sable and Peninsula, Ontario (M-120) and forwarded to ADC for approval. This was the extent of progress on Phase I in Canada.[11]

As to Phase II, WADF proceeded to survey possible sites for SM-152, SM-153 and SM-154 and forwarded the required reports to ADC. In November 1953, however, WADF

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10. USAF to ADC, "Approval by the Canadian Government of Site Surveys for Nine Additional Radar Stations," 5 May 1953 [Doc 71 in Hist of ADC, Jan-Jun 1953]; Memo. Col Haskell Neal, Dir/C&E, ADC for Maj. Gen. R. M. Webster, U.S. Member, U. S.-Canadian Permanent Joint Defense Board, no subj, 13 Aug 1953 [Doc 72 in Hist of ADC, Jan-Jun 1953].

11. Hist of EADF, Jul-Dec 1953, p. 38.

thought it had found a new and better answer to the problem of defense of the Seattle-Vancouver area against attack from the north and northeast. In scouting out a possible alternate site for SM-154, the survey team discovered that a radar placed on Mt. Apex, 25 miles southwest of Penticton, British Columbia, would offer virtually the same radar coverage at 10,000 feet as that offered by SM-152, SM-153 and SM-146 (Okanagan, Washington) combined. WADF made this proposal to ADC, but no decision had been reached by the end of the year. Nevertheless, in the event the WADF recommendation was approved, a survey of Calgary, Alberta, as a possible substitute site for SM-152 was requested by ADC.[12]

Although difficulty was being experienced with the first two phases of the Mobile program, ADC requested, on 20 October 1953, that it be permitted to add a third phase, involving 25 additional radar stations. This new group was needed, ADC said, to make it difficult for a future enemy to "end-run" the radar defenses along the northern border and both coasts and approach the United States from the south. A few were to be used to plug gaps in coverage along the northern border. USAF approved

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12. Hist of WADF, Jul-Dec 1953, pp. 66-67.

this proposal (which had meanwhile grown to a total of 29 stations) on 11 January 1954.[13] In early 1954, it was proposed to site Phase III radars as shown in Table 11.

At the end of 1953, as had been true at the end of 1952, the radar defenses of the United States consisted of the 75 stations of the Permanent system. Some early warning and control capability had been added with the coming to operational status of the eight REP stations in Canada. The construction of 108 additional austerely built and austerely manned "Mobile" radar stations (44 Phase I, 35 Phase II and 29 Phase III) had been authorized (including nine in Canada), but none were close to operational capability at the end of the year.

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13. ADC to USAF, "3rd Phase Radar Program," 20 Oct 1953 [Doc 67 in Hist of ADC, Jul-Dec 1953]; USAF to ADC, "3rd Phase Radar Program," 11 Jan 1954 [Doc 70 in Hist of ADC, Jul-Dec 1953].

CHAPTER FIVE

DEVELOPMENT OF A SECOND GENERATION OF RADARS 1954 - 1955

While the 75-station Permanent radar system was operational in 1954 with FPS-3, CPS-6B and FPS-10 (a stripped-down variant of the CPS-6B) radars, doubts began to be heard about the capacity of these radars to do the job required of them, especially when Intelligence began to mention the existence of a new Soviet high altitude jet bomber. Improvements to operational search radars came under discussion.

One of the most promising appeared to be the GPA-27 device which included a klystron tube that offered the possibility of increasing the range of the FPS-3 by 5 to 10 per cent. It was hoped that addition of the GPA-27 would give the FPS-3 a search capability to 65,000 feet. As of June 1954 it appeared that the first GPA-27 would become

available in March 1956. The improved radar would be designated FPS-3A.[1]

A component, OA-347, that promised to increase the range of the CPS-6B by as much as 65 per cent, had been installed on 25 of 26 CPS-6B radars in 1954. Unfortunately, this improvement was considerably less than advertised. The principal problem was the QK-254 magnetron tube within the OA-347. Soon after initial installation it was discovered that the magnetron was incapable of producing the designed output of two megawatts of power. At anything above 1.5 megawatts the tubes failed. The failure rate was so great and replacement tubes were so scarce that at one point in early 1954 only four CPS-6B radars were permitted to operate with the magnetron. By the end of the year, though, Raytheon was able to furnish ADC 75 tubes a month, sufficient to permit operation of all OA-347 components. The net result of ADC experience with the OA-347 during 1954 was a noticeable improvement in the definition of objects on the radar scope, although the improvement in range was nothing like 65 per cent.[2]

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1. USAF to ADC, "Procurement of Radar Set AN/FPS-3A," 7 Jun 1954 [Doc 3 in Hist of ADC, Jul-Dec 1954].

2. Hist of ADC, Jul-Dec 1954, pp. 4-5.

Despite the advantages offered by the OA-347, both USAF and ADC agreed that it was uneconomical to spend more money in improvements on the CPS-6B, because the altitude capability of this set, at best, was in the neighborhood of 45,000 feet. In looking ahead to the probable nature of the threat in 1960, it was concluded that CPS-6B's and FPS-10's should be phased out of the system entirely by 1958, with replacement beginning in March 1957.

It was anticipated that the obsolete radar would be replaced by the FPS-3A and the FPS-7. The FPS-7, being developed for the Navy by General Electric, was expected to provide search capability to 100,000 feet. If this promise was realized, ADC could foresee the day when high altitude coverage for the Permanent system would be furnished by the FPS-7, medium altitude coverage by the FPS-3A, low altitude coverage by the FPS-14, an unattended gap filler radar.[3]

There was also some doubt as to the future of the TPS-1D, scheduled for use as primary radar at some Phase II Mobile sites. WADF brought up the point, in December 1954, that development of the FPS-14 unattended gap-fillers would make unnecessary the deployment of the TPS-1D at sites where they were to fulfill a gapfiller mission. Where the TPS-1D

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3. Ibid., pp. 5-6.

was scheduled for a direction center role, a heavy radar would be required. The ADC reply revealed that serious consideration was being given to replacement of all TPS-1D radars in the air defense program, but that no final plan had yet been drafted. This was a matter for solution in 1955.[4]

A sense of reality settled over the Mobile radar program during 1954. By the end of the year the target dates for the three phases of the program had been receded to the more achievable future. The date for completion of the first and second phases was set at June 1957. The deadline for the third phase was established at June 1958. The year 1954, as had been 1953, was one of building and site-shifting.[5]

One significant milestone was reached in Phase I of the Mobile program on 6 December 1954 when M-129 (MacDill AFB, Florida) became operational with an MPS-7 radar. It was the first of the Phase I sites to reach this status and the only Mobile radar to become operational during 1954.

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4. 1st Ind (WADF to ADC, "Change of Radar Equipment at SM Sites" 16 Dec 1954) ADC to WADF, 13 Jan 1955 [Doc 14 in Hist of ADC, Jul-Dec 1955].

5. Bi-Weekly AC&W Status Report, ADC, 17 Dec 1954 [Doc 74 in Hist of ADC, Jul-Dec 1954].

Beneficial occupancy was achieved at M-88 (Amarillo AFB, Texas), M-97 (Ellsworth AFB, S. D.), M-98 (Miles City, Montana), M-105 (Alpena, Michigan), M-109 (Grand Marais, Michigan), M-121 (Bedford, Virginia) and M-131 (Owingsville, Kentucky).[6]

In spite of earlier USAF insistence that the number of Phase I stations be maintained at 44, the number, with USAF concurrence, dropped to 42 during 1954. One of the deleted sites was at Elizabethtown, Pennsylvania. This site was listed as SM-133 (Phase II) at the end of 1953, but was redesignated M-107 in early 1954 when the site at Sultan, Ontario, was deleted from the program. Elizabethtown was in turn deleted later in the year when it was determined that other radars in the area would offer adequate coverage. M-123 (Berlin, Maryland) was deleted for the same reason.[7]

Some of the site-changing in the Phase I sites during 1954 resulted from moving locations from Phase II to Phase I. In this category were the change of M-104 from Wiarton, Ontario, to Fort Dearborn, New Hampshire (old SM-132); M-108 from Mattawa, Ontario, to Bowling Green,

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6. Ibid., Hist of CADF, Jul-Dec 1954, p. 37.

7. Hist of EADF, Jul-Dec 1954, p. 42.

Missouri (old SM-136) and M-111 from Hallock, Minnesota, to Dobbins AFB, Georgia (old SM-166). Others involved cost-cutting shifts from private land, which would have to be bought or leased, to military installations. These involved the shifts of M-114 from Fernandina Beach, Florida, to Jacksonville NAS, Florida; M-116 from Englehard, North Carolina, to Cherry Point MCAS, North Carolina; and M-124 from Aberdeen, North Carolina, to Pope AFB, North Carolina.[8]

Therefore, as of the end of 1954, Phase I radars of the Mobile system were scheduled for deployment within the United States as shown in Table 12.

Delay seemed to be endemic in the construction and equipping of the Phase I Mobile stations. For example, in WADF all but two Phase I stations experienced construction delays of from three to 17 months. Reasons for the delays were various. Indecision as to siting was the most obvious. Take M-96 at Almaden, California. The initial site on Mt. Umunhum was so small that there was doubt that a radar could be placed there. The possibility of moving M-96 to Mather AFB was still under consideration at the end of 1954. The problem at M-100, Mt. Hebo, Oregon, was different. A WADF inspector reported that Mt. Hebo construction was so sloppy

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8. Bi-Weekly Status Report, ADC, 17 Dec 1954 [Doc 74 in Hist of ADC, Jul-Dec 1954].

that he feared it would be unable to withstand the high winds prevalent in the area. In this situation, WADF could not take direct action as regards the construction contractor, being limited to reporting the difficulty to the Army Corps of Engineers, which held responsibility for construction, and hoping something would be done about it.[9] Something seemed to be delaying completion of nearly every Phase I site.

Still greater uncertainty was experienced with the Phase II program. One of the most unsettling actions was the removal of sites from Phase II to Phase I in order to maintain the number of Phase I sites at 44, a policy which was abandoned before the end of 1954 as being unworkable. At any rate, Fort Dearborn, New Hampshire (SM-132) was moved up to M-104 while the SM-132 designation was given to a site at Baudette, Minnesota. Similarly, Elizabethtown, Pennsylvania went from SM-133 to M-107 and was utlimately deleted from Phase I. SM-133 was resited at Hastings NAD, Nebraska. In other such actions, Bowling Green, Missouri (SM-136) became M-108; Almaden, California (SM-155) became M-96; and Dobbins AFB, Georgia (SM-166) became M-111. In these three instances, the SM numbers were not assigned to other locations, but were merely deleted from the program.[10]

9. Hist of WADF, Jul-Dec 1954, pp. 84-87.

10. Bi-Weekly Status Report, ADC, 17 Dec 1954 [Doc 74 in Hist of ADC, Jul-Dec 1954].

Delaying factors in connection with Phase II of the Mobile program were caused by indecision as to siting, since only two construction contracts (concerning SM-137 at Carmi, Illinois and SM-159 at Aiken, South Carolina) had been written at the end of 1954. Examples may serve to highlight the types of problems encountered. At SM-149 (Baker, Oregon) engineers discovered it would cost $100,000 to pipe water to the proposed mountaintop site. It was, therefore, deemed necessary to utilize a split site, with the radar on the mountain and the cantonment area in Baker. This required a re-drawing of plans and consequent delay. At SM-150 (Cottonwood, Idaho) construction at the ideal site for the radar promised to be so expensive that much time was lost in searching for a less desirable, but also less costly, site. At SM-152 (Geiger Field, Washington) initial plans did not call for use of an arctic tower with the radar to be erected on nearby Mica Peak. When it was pointed out that winds often reached 90 miles per hour and snow depth had been known to reach 20 feet at this location, it was obvious that plans would have to be changed.[11]

Some change occurred in connection with perhaps half the Phase II sites during 1954. The size of the program

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11. Ibid.; Hist of WADF, Jul-Dec 1954, pp. 88-92.

had dwindled somewhat. In the beginning 35 radars, 32 in the United States, were to be put into operation. By the end of 1954 the number scheduled for the United States had dropped to 27, sited as given in Table 13.

Phase III of the Mobile program, approved by USAF in January 1954, was in a still greater state of flux during the year. Since the original list of Phase III sites was not based on actual site surveys, a considerable number of location changes were necessary. Also, revelation that Phase III sites sometimes duplicated coverage offered by Phase I and Phase II sites, resulted in deletion of some proposed sites. For example, a CADF survey team discovered that placement of a radar on the top of Emory Peak, highest point in Big Bend National Park in southwest Texas along the Mexican border (TM-185), would require leveling the top of the peak and building it up with concrete. This would be a fabulously expensive construction job, so CADF recommended that the site be deleted. ADC agreed. In another instance, CADF moved the location of TM-183 from Cloverdale, New Mexico, to Douglas, Arizona, then discovered that radar coverage at this location would duplicate that provided by TM-182 (Nogales, Arizona) and M-92 (Tucson).[12]

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12. Hist of CADF, Jul-Dec 1954, pp. 35-37.

Three sites in the Phase III program were deleted when the locations at Baudette, Minnesota; Hastings NAD, Nebraska; and Lake Andes, South Dakota; were moved into Phase II. All in all, five sites were deleted from Phase III during 1954, leaving 24 active sites. USAF had approved 15 site surveys, but no construction contracts had been written by the end of the year. Phase III, at the end of 1954, is shown in Table 14.

The Canadian elements of the Phase I and Phase II Mobile radar programs (no Phase III sites were located in Canada) were drastically reduced during 1954. Of six Phase I Canadian sites mentioned in the original plan, only three remained at the end of 1954. Sites at M-104, Wiarton, Ontario; M-107, Sultan, Ontario; and M-108, Mattawa, Ontario; were deleted on the grounds that adequate radar coverage was offered by adjacent sites. In addition, the three Canadian sites remaining in Phase I were resited. The proposed location of M-102 was changed from Cape Sable to Barrington, Nova Scotia. In Ontario, M-119 was resited from Fire River to Oba and M-120 from Peninsula to Marathon. As to the proposal to locate three Phase II sites in British Columbia, similar action was taken. When a survey team established an actual site for SM-153 near Kamloops,

it became apparent that SM-152 (Nakusp) and SM-154 (Birken) would not be necessary.[13]

The reduction in the number of Mobile radars in Canada from nine to four, however, did not mean ADC was fully satisifed with radar coverage of the northern approaches to the United States. In the autumn of 1954, ADC requested USAF approval of a Phase IV of the Mobile radar program, involving 21 sites in Canada. The RCAF expressed interest in this proposal and suggested use of British Type 80 or 81 radars for this purpose. The RCAF was of the opinion that the British sets were the equivalent of the USAF FPS-7. ADC was not adamant in requiring the use of U.S. equipment and at the end of the year was asking USAF for more details on the British sets. While USAF had not officially approved Phase IV by the end of 1954, ADC had received informal information that it would be approved with operational dates set at the end of FY 1958.[14]

At the end of 1954, as had been true at the end of 1952 and the end of 1953, radar coverage of the United States was furnished by the 75-stations Permanent radar

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13. Memo, DC&E, ADC for ADMIS, ADC, "Revision of First and Second Phase Supplemental Radar Program's" 11 Feb 1954 [Doc 1 in Appendix I in Hist of ADC, Jan-Jun 1954].

14. Msg ADOCE-EG 58, ADC to USAF, 10 Jan 1955 [Doc 81 in Hist of ADC, Jul-Dec 1954]; Hist of ADC, Jul-Dec 1954, pp. 44-45.

network -- with one exception. The first Phase I Mobile station, M-129 at MacDill AFB, Florida, had reached operational status before the end of the year. Hopefully, increasing numbers of Mobile stations would achieve equivalent status in 1955. Meanwhile, the number of stations programmed in the Mobile system continued to decrease. From 99 at the end of 1953, the number to be deployed in the United States dropped to 93 (42 Phase I, 27 Phase II and 24 Phase III) during 1954. The number scheduled for Canada dropped from nine to four.

The year of 1955 was essentially another year of building for the Mobile radar system, a year in which ADC attempted to digest and integrate programs previously authorized and funded. Construction was generally aimed at completion in 1957, the year of maximum danger according to intelligence estimates. No new programs were authorized, although the costs of those previously approved continued to raise as the brick and mortar, equipment and manning stages were reached.

At the same time, planning for the improvement of the basic long range search radars continued. Probably the most far-reaching of the proposed improvements was the modification of the FPS-3 with the GPA-27, designed to give the FPS-3 (or FPS-3A as the modified version would be called) the ability to search to altitudes of 65,000. In

February 1955 USAF announced that 46 GPA-27 modification kits would be made available to ADC beginning in September 1956, with an additional 51 likely to be ready by 1 April 1958. Later in 1955 it was discovered that an FPS-3 with the GPA-27 as integral equipment (and known as the FPS-20) might become available in 1957. ADC recommended that the FPS-20 be procured in quantity in preference to the modified FPS-3, but USAF agreed only to the initial procurement of four FPS-20 models on the grounds that concentration on the FPS-20 might further delay the delivery of GPA-27 kits. As it was, a delay was already being experienced. In June 1954 it was anticipated that the first GPA-27 would be ready in March 1956. By February 1955 the estimated delivery date for the first modification kit had slipped to September 1956.[15]

As for the FPS-7, a radar being developed by General Electric and expected to provide search capability to 100,000 feet, development continued during 1955. Meanwhile, ADC was authorized 33 of these advanced sets. USAF estimated

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15. Msg AFMPP-EQ-4 58074, USAF to AMC, 23 Feb 1955 [Doc 45 in Hist of ADC, Jul-Dec 1955]; ADC to RAFD, "AN/GPA-27 Installation Priority List," 2 Sep 1955 [Doc 46 in Hist of ADC, Jul-Dec 1955]; Msg ADOCE-A 4254, ADC to USAF, 27 Oct 1955 [Doc 47 in Hist of ADC, Jul-Dec 1955]; Msg ADOCE-AL 4714, ADC to RAFD, 15 Dec 1955 [Doc 48 in Hist of ADC, Jul-Dec 1955].

that the first FPS-7 would be delivered to ADC in April 1957, with the 33rd set installed by June 1958.[16]

A search radar new to ADC experience also attracted some attention in 1955. This was the FPS-8, proposed for use at three Phase II mobile sites. An Air Proving Ground Command (APGC) Operational Suitability Test (OST) of the FPS-8, completed in August 1955, reached the conclusion that the FPS-8 offered superior performance to the FPS-3. ADC was somewhat surprised at this evaluation and, on the theory that the APGC findings might lead to a recommendation that greater numbers of the FPS-8 be allocated to ADC, conducted its own brief test of the new radar. This led ADC to the tentative conclusion that while the FPS-8 might be superior to the basic FPS-3, it was inferior to the FPS-3 modified by the GPA-27 (FPS-3A). No attempt was made, by the end of 1955, to pressure ADC into using the FPS-8 in great numbers.[17]

While 1954 planning called for complete disposition of the CPS-6B radar between March 1957 and the end of 1958,

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16. Hist of ADC, Jul-Dec 1955, pp. 19-20.

17. Msg ADOCE-EG 4317, ADC to WADF, 3 Nov 1955 [Doc 62 in Hist of ADC, Jul-Dec 1955]; Msg ADOCE-EG 226, ADC to USAF, 27 Jan 1956 [Doc 63 in Hist of ADC, Jul-Dec 1955]; Memo, ADOCE, ADC for DCS/O, ADC, "Installation of AN/FPS-8/MPS-11 Radar," 11 Jan 1956 [Doc 64 in Hist of ADC, Jul-Dec 1955].

subsequent plans changed the disposition period to the two years between mid-1957 and mid-1959. Since such a disposition schedule would leave the CPS-6B operational during the early days of the SAGE era, the question arose as to whether or not this set was, or could be made, compatible with SAGE. A series of tests conducted in early 1955 revealed that, with some effort, the CPS-6B could be made to operate successfully with SAGE. The validity of the disposition period was apparently confirmed.[18]

As might have been expected, further changes were made in the deployment of Mobile radars during 1955, but the changes were much fewer than occurred in earlier years. In Phase I, sites M-108 and M-124, at Bowling Green, Missouri, and Pope AFB, North Carolina, respectively, were deleted on the grounds of redundancy. This action reduced the number of Phase I stations within the United States from 39 to 37. The only change among Phase III sites was the shift of TM-183 from Douglas, Arizona, to Hachita, New Mexico. The total number of Phase III stations remained at 24.

The major change occurred in Phase II, where seven stations were deleted. Six of these were in two well-defined areas. Three sites along the eastern border of southern California (SM-158, Ferndale, California; SM-160, Poston,

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18. Hist of ADC, Jan-Jun 1955, pp. 6-7; Hist of ADC, Jul-Dec 1955, pp. 18 and 21-23.

Arizona and SM-161, Bakersfield, California, were replaced by unmanned gapfillers. Design action had been completed for all three sites and construction was underway at Poston when the deletion action came in February 1955. Contracts were terminated at some expense to the government, but in the long run the deletion saved money.[19]

Another group of three Phase II stations (SM-140, Sioux City, Iowa; SM-141, Falls City, Nebraska and SM-142, Nevada, Missouri) were deleted in a move to thin out defenses along the lower Missouri river, an area of relatively low priority when considering the total defenses of the nation. The seventh deletion of a Phase II site involved SM-148 at Robins AFB, Georgia. In a related action, the site of SM-165 was moved from Chattanooga, Tennessee, to Flintstone, Georgia.[20] The seven deletions reduced the Phase II program within the United States from 27 to 20 stations deployed, as given in Table 15.

Twelve additional Phase I stations (in addition to M-129, MacDill AFB, Florida, operational before the end of 1954) and the first Phase II station had reached some degree of operational capability before the end of 1955. ADC

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19. Hist of WADF, Jul-Dec 1954, p. 93.

20. Hist of CADF, Jan-Jun 1955, p. 20.

recognized three degrees of operational capability at that time. "Limited" Operational meant that because of shortages of personnel or equipment the station could not operate continually. "Sustained" Operational indicated the station had the minimum of personnel and equipment for continuous operation. "Fully" Operational was self-explanatory. Of the 15 Mobile stations operating at the end of 1955, only one (M-113, North Charleston, South Carolina) was considered fully operational. Eight fell into the "sustained" category:

M-95	Las Cruces, New Mexico
M-97	Ellsworth AFB, South Dakota
M-98	Miles City, Montana
M-112	Hunter AFB, Georgia
M-118	Burns, Oregon
M-126	Houma NAS, Louisiana
M-128	Kingman, Arizona
M-129	MacDill AFB, Florida

The six "limited" operational locations included the first Phase II station to reach operational status:

M-88	Amarillo AFB, Texas
M-90	Walker AFB, New Mexico
M-91	Texarkana, Arkansas
M-115	Fort Fisher, North Carolina
M-125	England AFB, Louisiana
SM-159	Aiken, South Carolina

It was significant that seven of the first 15 Mobile sites to become operational were located on Air Force or Navy bases where land did not have to be purchased and where utilities, and often buildings, were easily available. This

was not the situation at, for example, M-96 at Almaden, California, where there were delays in the acquisition of land and where unusual difficulties were encountered in building an access road.[21]

At the end of 1955, beneficial occupancy of construction had occurred at 28 of 37 U. S. Phase I sites and two of 20 Phase II sites. No construction contracts had yet been written at any of the 24 Phase III sites where proposed beneficial occupancy dates ranged from July 1956 to July 1957 and proposed operational dates varied from September 1956 to September 1957.[22]

The number of Canadian stations in the Mobile program shrank from four (as against an originally programmed total of nine) to three during 1955. The Phase I site at M-120, Marathon, Ontario, was deleted as being redundant. This left only M-102 at Barrington, Nova Scotia; M-119 at Lowther, Ontario (switched from Fire River, Ontario) and SM-153 at Kamloops, British Columbia. Construction contracts had not been written for any of these three stations by the end of 1955 and proposed operational dates were well into 1957.[23]

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21. Hist of WADF, Jul-Dec 1955, p. 21; ADC AC&W Status Report, 28 Dec 1955 [HRF].

22. ADC AC&W Status Report, 28 Dec 1955 [HRF].

23. Ibid.; Hist of WADF, Jul-Dec 1955, p. 23.

The proposed Phase IV of the Mobile program, designed to increase radar coverage in Canada, was revised on 18 March 1955 and increased the number of Phase IV stations from 21 to 26. It was intended that these radars (FPS-3A and FPS-7 types were specified) fill a gap between the line of radars operated by the Northeast Air Command in Labrador, Newfoundland and Greenland and the eastern end of the Pinetree Line in southern Canada; supplement the Mid-Canada Line of Doppler radars along the 55th parallel; and fill gaps between the Mid-Canada and Pinetree Lines. It was proposed to complete Phase IV in four increments, the first two to be operational in 1957, the last two in 1958. It was suggested that Phase IV radars be deployed as given in Table 16.

Both RCAF and USAF agreed that Phase IV was required, but at an RCAF-USAF-ADC conference of 17-18 November 1955, the question arose as to the compatibility of Phase IV with SAGE operations in Canada. It was, therefore, decided to re-work the Phase IV plan to include SAGE implications before the plan was presented to the Permanent Joint Defense Board. This planning was still being accomplished at the end of 1955.[24]

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24. Memo for Record, C&E, ADC, "USAF-RCAF Staff Officer Conference on Joint Radar Programs - Headquarters, USAF,: 22 Nov 1955 [Doc 108 in Hist of ADC, Jul-Dec 1955].

For the first time since 1952, radar coverage of the United States was appreciably increased during 1955. By the end of that year, the number of operational search radars had increased from 76 to 90.

CHAPTER SIX

THE FIRST MONEY CRISIS
1956 - 1957

While the guiding principle behind the now-fixed-location Mobile radar program was utmost austerity in construction, equipment and manning, even this concept of radar deployment encountered financial difficulty in 1956. The impending lack of funds was known to ADC earlier in the year, but it was not until July that the command became reconciled to a curtailment of the Mobile radar program. On 2 July 1956, General Earle E. Partridge, ADC Commander, asked his staff to take note of the crucial financial situation and suggest means by which ADC might "get the most air defense for the investment which may be available.[1]

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1. Memo, Partridge for Chief of Staff, ADC, "Revised ADC Plan," 2 Jul 1956 [Doc 17 in Hist of ADC, Jul-Dec 1956].

This re-examination of ADC operations impinged directly on the Mobile radar program, where considerable sums of money were being spent on construction and operations. In this situation, a drastic revision in the radar operational plan was recommended by the Directorate of Communications and Electronics within ADC. These recommendations included reduction to caretaker status of all radars scheduled to become operational in "open areas" (those outside the double perimeter) during the next fiscal year, reduction of operational radars in the Albuquerque and Florida areas to 40-hours-a-week training status, along with various stations on the outer rim of the double perimeter. Personnel saved in this manner were to be used to man stations on the inner rim of the double perimeter.[2]

ADC staff action in this matter continued through the summer and early autumn of 1956 and on 2 October a general meeting of the ADC staff and representatives of the three defense forces was held to discuss the realignment of ADC resources. Although no specific realignment resulted from this meeting, it was agreed that emphasis should be placed on quality, rather than quantity, of radar coverage so long as the financial crisis continued. After this

2. Memo, ADOCE-EG, ADC for ADOCE-AL, ADC, "Revised ADC Plan," 10 Jul 1956 [Doc 18 in Hist of ADC, Jul-Dec 1956].

meeting, Lt. Gen. Joseph H. Atkinson, who had assumed command of ADC on 17 September 1956, wrote to USAF outlining the steps he proposed to take to reduce the difference of $67 million which apparently existed between the amount needed by ADC and the amount available. It would be necessary, he said, to defer the activation of 18 AC&W stations, delay the operations of six activated, but non-operational, radar stations and reduce the operational capability of 56 existing radar stations.[3]

USAF did not believe the situation required such drastic action, however, and directed ADC to make further studies of re-programming. A series of USAF-ADC budget conferences in October and November 1956 produced some measure of relief when USAF agreed to make an additional $10 million available to ADC. These additional funds were welcome, but fell far short, as General Atkinson put it in a letter of 20 November 1956, of enabling ADC to "develop the air defense capability envisioned in the current Air Force program and improve our working and living conditions to a prudent minimum."[4]

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3. ADC to USAF, "Impact of Fiscal Year 57 Operational and Maintenance Funds Deficit," 5 Oct 1956 [Doc 19 in Hist of ADC, Jul-Dec 1956].

4. ADC to USAF, "Impact of Fiscal Year 1957 O&M Funds Deficit," 20 Nov 1956 [Doc 10 in Hist of ADC, Jul-Dec 1956].

Near the end of 1956, USAF concluded that the "irreducible" ADC deficit stood at $8 million and authorized ADC to do whatever was necessary to live within its income for Fiscal 1957. The decision was taken to hold up 15 under-construction radar stations within the United States until Fiscal 1958 operations money was available. These were:[5]

M-96	Almaden, California
M-130	Winston-Salem, North Carolina
SM-139	Willmar, Minnesota
SM-145	Joelton, Tennessee
SM-147	Malmstrom AFB, Montana
SM-150	Cottonwood, Idaho
SM-151	Geiger Field, Washington
TM-186	Pyote, Texas
TM-187	Ozona, Texas
TM-188	Eagle Pass, Texas
TM-189	Zapata, Texas
TM-191	Rockport, Texas
TM-192	Killeen, Texas
TM-193	Lufkin, Texas
TM-194	Lake Charles AFB, Louisiana

Looking back at the recent crisis concerning funds for Fiscal 1957 and ahead to Fiscal 1958, General Atkinson felt impelled, before the end of 1956, to "emphasize the inadvisability of continuing to increase physical plant in the face of current and projected severe shortages of operations and maintenance funds."[6]

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5. ADC to USAF, "Air Defense Reductions Caused by Insufficient O&M Funds," 7 Dec 1956 [Doc 11 in Hist of ADC, Jul-Dec 1956]; Memo, DCS/Comp, ADC for Dir/Command History, ADC, "Summary Material from Sec/AF Briefing," 9 Jan 1957 [Doc 12 in Hist of ADC, Jul-Dec 1956].

6. ADC to USAF, "Air Defense Reductions Caused by Insufficient O&M Funds," 7 Dec 1956 [Doc 11 in Hist of ADC, Jul-Dec 1956].

Despite the crippling money problems which developed late in the year, significant additions were made to the ADC radar network during 1956. Twenty-six Mobile stations became operational (19 Phase I and 7 Phase II), increasing the size of the aircraft control and warning organization from 90 to 116 stations within the United States. The Phase I stations which reached operational status during 1956 were the following:[7]

M-89	Sweetwater, Texas
M-92	Mt. Lemmon, Arizona
M-93	Winslow, Arizona
M-94	West Mesa, New Mexico
M-99	Gettysburg, South Dakota
M-100	Mt. Hebo, Oregon
M-101	Rochester, Minnesota
M-103	North Concord, Vermont
M-104	Rye, New Hampshire
M-105	Alpena, Michigan
M-106	Two Creeks, Wisconsin
M-109	Grand Marais, Michigan
M-110	Bucks Harbor, Maine
M-111	Marietta, Georgia
M-117	Roanoke Rapids, N. C.
M-121	Bedford, Virginia
M-122	Dallas Center, Iowa
M-127	Winnemucca, Nevada
M-131	Owingsville, Kentucky

This rash of completions in Phase I left only four of the 37 programmed Phase I United States stations short of operational status -- M-96, Almaden, California; M-114, Jacksonville NAS, Florida; M-116, Cherry Point MCAS, North Carolina; and M-130, Winston-Salem, North Carolina. Only

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7. ADC ACW Summary and Status Report, 31 Dec 1956 [HRF].

two of these (M-96 and M-130) were caught in the fund squeeze of late 1956. The other two were exempted.

The first Phase II station to become operational (SM-159, Aiken, South Carolina) reached that status before the end of 1955. The seven more which became operational during 1956 were the following.[8]

SM-137 Carmi, Illinois
SM-143 Walnut Ridge, Arkansas
SM-156 Fallon, Nevada
SM-157 Red Bluff, California
SM-162 Vincent AFB, Arizona
SM-163 Las Vegas, Nevada
SM-165 Flintstone, Georgia

Twelve of the 20 United States stations programmed for Phase II remained non-operational. Five of these -- SM-139, Willmar, Minnesota; SM-145, Joelton, Tennessee; SM-147, Malmstrom AFB, Montana; SM-150, Cottonwood, Idaho; and SM-151, Geiger Field, Washington -- were in the group of stations planned for operations in Fiscal 1957, but differed to Fiscal 1958 because of the fund shortage. A sixth -- SM-164 at Tonopah, Nevada -- was so close to operational readiness that it was to be allowed to proceed in Fiscal 1957. Construction of three Phase II stations -- SM-132, Baudette, Minnesota; SM-133, Hastings NAD, Nebraska; and SM-134, Pickstown (formerly Lake Andes), South Dakota -- was to be deferred to Fiscal 1958, also for money reasons.[9]

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8. Ibid.

9. Ibid.; Hist of CADF, Jul-Dec 1956, p. 24.

The Phase III program of 24 stations evinced continuing instability during 1956. None became operational and eight of the 10 stations scheduled for operations by the end of Fiscal 1957 were on the deferred list approved by USAF near the end of 1956. The exceptions were two Florida locations -- TM-198 at Tyndall AFB and TM-200 at Cross City. These were needed to support test operations of the Air Proving Ground Command at Eglin AFB, Florida.[10]

Central Air Defense Force continued to question some of the proposed sites for Phase III stations. In the autumn of 1956, CADF proposed to relocate TM-188 from Eagle Pass, Texas, to Laughlin AFB, Texas, and TM-189 from Zapata, Texas, to Laredo AFB, Texas, on the grounds that location on Air Force bases would materially reduce costs. This request was denied for the reason that the Air Force bases were not properly located. Later in 1956, CADF recommended changing three other sites in the Phase III program. The locations in question were TM-182 (Nogales, Arizona), TM-183 (Hachita, New Mexico) and TM-184 (Valentine, Texas). CADF had no specific recommendations as to TM-183 and TM-184, but as to TM-182 recommended that the Nogales location be deleted from the program and TM-202 at Grand Junction,

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10. Hist of ADC, Jul-Dec 1956, pp. 12-13.

Colorado, be substituted. Neither ADC nor USAF had reached a decision on these suggestions by the end of 1956.[11]

Meanwhile, although there was difficulty about operations and maintenance funds, money for radar development came from a different pocket and development of improved search radars continued unabated during 1956. The most important of these from the ADC standpoint was the FPS-20, to be created in any one of three ways -- by factory combination of the FPS-3 and GPA-27; by addition of GPA-57 to the FPS-3A (itself created by on-site retrofit of the FPS-3 with the GPA-27); and by retrofit of the MPS-7 (a mobile version of FPS-3) with GPA-58. It was anticipated that about 110 stations of the ADC radar network would eventually be equipped with the FPS-20. In June 1954 it had been expected that the first GPA-27 modification kit would be ready in March 1956. By February 1955 this date had slipped to September 1956. In June 1956 it was hoped the first GPA-27 modification kit would be available by March 1957. At the end of 1956, the availability date for the first FPS-20 was given as July 1957. The date for completion of the FPS-20 improvement project slipped accordingly. At the end of 1956, the expected completion date was January 1960.[12]

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11. Hist of CADF, Jul-Dec 1956, pp. 25-26.

12. ADC to Defense Forces, "Revised ADC AN/GPA-27 Program," 21 Jun 1956 [Doc 54 in Hist of ADC, Jan-Jun 1956]; Hist of ADC, Jul-Dec 1956, p. 21.

The other advanced radar expected by ADC was the FPS-7, a General Electric development counted upon to provide search capability to 100,000 feet. About 30 FPS-7 radars were scheduled for ADC use. During 1955, however, an inter-service study group (Project LAMPLIGHT) had pointed out the vulnerability of existing and programmed search radars to electronic countermeasures (ECM) and recommended the development of frequency diversity radars (diversified frequencies and rapid tuneability) as a means of defeating enemy ECM. The Air Research and Development Command (ARDC) accepted the LAMPLIGHT recommendations and began a study of frequency diversity radar. ADC was also impressed with the LAMPLIGHT arguments and recommended cessation of work on the FPS-7 if it could be assumed that frequency diversity (FD) radar would be available in the 1959-62 period. USAF was not convinced that FD could be developed that rapidly and directed that the FPS-7 program be continued. At the middle of 1956 it was estimated that the first FPS-7 would be ready in January 1958, with the installation program complete in August 1959. At the end of the year the programming estimates called for the FPS-7 to be installed between June 1958 and November 1959.[13]

13. Msg AFOAC-EA 59229, USAF to ADC, 13 Apr 1956 [Doc 56 in Hist of ADC, Jan-Jun 1956]; Memo, Dir/C&E, ADC for Commander, ADC, "AN/FPS-7 Program," 18 May 1956 [Doc 57 in Hist of ADC, Jan-Jun 1956]; ADC to USAF, "AN/FPS-7 Radar Program," 29 May 1956 [Doc 58 in Hist of ADC, Jan-Jun 1956]; Msg ADOCE-EG 956, ADC to USAF, 4 May 1956 [Doc 59 in Hist of

While ADC harbored continuing doubt about the efficiency of the FPS-8, despite the enthusiasm of the Air Proving Ground Command (one ADC test indicated this set had a range of 110 miles against a target flying at 20,000 feet), the delays experienced in connection with the FPS-20 and FPS-7 made it prudent to use variants of the FPS-8 (GPS-3 and MPS-11) as interim search radars pending receipt of advanced models. At the end of 1956 ADC planned to use 34 GPS-3 sets as interim search radars. Twenty-one were operational at that time.[14]

The Canadian portion of the Mobile radar program remained at three stations throughout 1956. Construction for SM-153 at Kamloops, British Columbia, was placed under contract in June 1956, with beneficial occupancy expected in June 1957. The other two stations -- M-102 at Barrington, Nova Scotia, and M-119 at Lowther, Ontario -- were caught in the Fiscal 1957 funding crisis and deferred until Fiscal 1958.

[Cont'd] ADC, Jan-Jun 1956]; Memo, Asst Dir/C&E, ADC for Dir/C&E, no subj, 16 May 1956 [Doc 60 in Hist of ADC, Jan-Jun 1956]; ADC to Defense Forces, "Revised ADC AN/FPS-7 Program," 19 Jun 1956 [Doc 61 in Hist of ADC, Jan-Jun 1956]; Hist of ADC, Jul-Dec 1956, p. 22.

14. Msg ADOCE-EG 226, ADC to USAF, 27 Jan 1956 [Doc 62 in Hist of ADC, Jan-Jun 1956]; Msg ADOCE-EG 15637, ADC to EADF and WADF, 5 Apr 1956 [Doc 63 in Hist of ADC, Jan-Jun 1956]; Msg ADOCE-EG 17210, ADC to EADF and WADF, 16 Apr 1956 [Doc 64 in Hist of ADC, Jan-Jun 1956]; Msg ADOCE-EG, no number, ADC to RAFD, 8 May 1956 [Doc 65 in Hist of ADC, Jan-Jun 1956]; Hist of ADC, Jul-Dec 1956, p. 22.

Phase IV of the Mobile program, which called for creation of 26 stations between the Mid-Canada Line (roughly along the 55th parallel) and the Pinetree Line along the U. S. - Canadian border, was still under consideration. On 26 March 1956, ADC submitted to USAF a revised Phase IV plan which still called for 26 stations, but delayed the operational date from 1958 to 1960.[15]

USAF replied, in June 1956, that the Phase IV additions to the radar network were desirable, but because of funding problems could probably not be completed before Fiscal 1962. Canada, meanwhile, authorized a commencement of site surveys, using Canadian manpower and at Canadian expense, but with ADC assistance. Canada, however, approved the immediate siting of only 18 stations, temporarily withholding approval of the eight stations planned for the neighborhood of the Mid-Canada Line. It was anticipated that siting could begin about 1 August 1956. Before much could be done, the serious financial crisis of Fiscal 1957 developed and Phase IV of the Mobile program was being held in abeyance at the end of 1956.[16]

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15. ADC to USAF, "Ground Environment Extension and Improvement in Canada," 26 Mar 1956 [Doc 141 in Hist of ADC, Jan-Jun 1956].

16. USAF to ADC, "Ground Environment Extension and Improvement in Canada," 8 Jun 1956 [Doc 144 in Hist of ADC, Jan-Jun 1956]; Msg AFOAC-EA 53521, USAF to ADC, 13 Jun 1956 [Doc 145 in Hist of ADC, Jan-Jun 1956]; Msg ADOCE-E 1518, ADC to USAF, 17 Jul 1956 [Doc 146 in Hist of ADC, Jan-Jun 1956]; Msg ADOCE-EG 1616, ADC to Defense Forces, 27 Jul 1956 [Doc 147 in Hist of ADC, Jan-Jun 1956].

The situation as regards operating and maintenance funds for the aircraft control and warning network was just as bad in Fiscal 1958 as it had been in Fiscal 1957. In March 1957, ADC submitted to USAF a financial plan for Fiscal 1958 which detailed the need for $420 million of operations and maintenance money. This sum included the cost of operating and maintaining the entire air defense system, not merely the radar network. Since the $420 million was $170 million more than was allocated for Fiscal 1957 and the financial climate did not appear to have improved, ADC cautioned the defense forces to make plans for getting along with 20 per cent less.[17]

As a planning exercise, ADC calculated, in April 1957, that $76 million could be saved by putting 29 operational radar stations on a standby basis. These, primarily in the interior of the United States and along the eastern approaches to the West Coast, are shown in Table 17.

Some measure of relief came later in the spring of 1957 when AMC agreed to support the DEW Line financially for the first half of Fiscal 1958, thereby reducing the ADC requirement for operation and maintenance funds from $420 million to $406 million. But when the blow came it was

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17. Msg ADHCP 727, ADC to Defense Forces, 15 Mar 1957 [Doc 38 in Hist of ADC, Jan-Jun 1957].

every bit as heavy as had been anticipated. As of the end of 1957 it appeared that ADC would be allocated approximately $400 million.[18]

This shortage, of course, dictated a fairly drastic reduction in the size of the ADC radar network and forced delays of the bringing to operational status of stations still under construction. The actual solution, as opposed to the standby proposal of April 1957, was to delete stations from the network. Only M-128 (Kingman, Arizona) was reduced to standby status. It was to resume operations when the SAGE system was ready. Thirteen stations were totally eliminated. While P-6 (Curlew, Washington) and P-11 (Yaak, Montana) were still operational with prime radars at the end of 1957, they were to become unattended gapfillers in early 1958. The other deletions were:[19]

M-101	Rochester, Minnesota
M-104	Rye, New Hampshire
M-105	Alpena, Michigan
M-106	Two Creeks, Wisconsin
M-109	Grand Marais, Michigan
M-122	Dallas Center, Iowa
M-131	Owingsville, Kentucky
SM-137	Carmi, Illinois
TM-183	Douglas, Arizona
TM-184	Valentine, Texas
TM-202	Grand Junction, Colorado

18. Minutes, ADC Command Council Meeting, 20 Jun 1957 [Doc 45 in Hist of ADC, Jan-Jun 1957]; Hist of ADC, Jan-Jun 1957, p. 30; Hist of ADC, Jul-Dec 1957, p. 10.

19. ADC ACW Status Report, 31 Jan 1958 [Doc 25 in Hist of ADC, Jul-Dec 1957].

Despite the severe shortage of operations and maintenance money, the Radar Improvement Program (replacement of less capable radars with the FPS-20 and FPS-7) continued during 1957. At this point in time it was anticipated that 119 FPS-20 sets would ultimately be deployed by ADC. The first three FPS-20 radars (P-45, Montauk, New York; P-50, Saratoga Springs, New York; and P-54, Palermo, New Jersey) became operational in the spring of 1957. By the end of the year, 17 were contributing to the defense of the United States. Meanwhile, the planned date for completion of the FPS-20 program slipped from December 1959 to June 1960.[20]

Continued frustration was experienced in development of the FPS-7. In the spring of 1957 there was hope that the first of the approximately 30 FPS-7 sets earmarked for ADC use would be operational by August 1958. But by September of 1957 USAF was passing the word that it was more likely that the date of initial operation would be November 1958. Nothing had happened to change this prediction by the end of 1957.[21]

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20. Hist of ADC, Jan-Jun 1957, pp. 45-46; Hist of ADC, Jul-Dec 1957, p. 22.

21. Msg ADOCE-AN 3154, ADC to USAF, 16 Sep 1957 [Doc 59 in Hist of ADC, Jan-Jun 1957]; Hist of ADC, Jul-Dec 1957, p. 31.

There was no doubt that the replacement of earlier radars with the FPS-20 and FPS-7 was a major ADC preoccupation during 1957. At the same time, however, there was increasing concentration on frequency diversity (FD) radar. because of increasing evidence that existing and programmed radars were highly vulnerable to the sophisticated electronics countermeasures (ECM) likely to be available to the Soviet bomber fleet. It was agreed by everybody concerned that ECM could be defeated by employment of a family of six radars each operating at a different frequency. The FPS-24 would operate at 200 mcs, the FPS-35 at 400 mcs, and the FPS-28 at 600 mcs, the previously programmed FPS-20 and FPS-7 at 1250 mcs and the FPS-27 at 2000 mcs. As of the spring of 1957, USAF proposed to buy eight FPS-35, nine FPS-24 and eight FPS-28 sets during Fiscal 1959.[22]

With this concrete evidence of USAF approval at hand, it fell to ADC to prepare a complete program for deployment of FD radars. This had been accomplished by the end of September 1957. And a prodigious program it was. In the first place, it was assumed that while the FPS-24

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22. Msg ADHVC 1033, ADC to USAF, 15 Apr 1957 [Doc 65 in Hist of ADC, Jan-Jun 1957]; Msg AFDRD-SC-4 56842, USAF to ARDC, 5 Jun 1957 [Doc 66 in Hist of ADC, Jan-Jun 1957]; Msg ADRRQ-S-5, ADC to USAF, 14 Jun 1957 [Doc 67 in Hist of ADC, Jan-Jun 1957].

and FPS-35 would be produced separately, they would be "married" as the FPS-24/35 at operating locations. It was further assumed that the FPS-24/35 would be introduced first, with installation beginning in mid-1959. Thirty-seven sets within the United States were expected to be operational by September 1961. Then would come the FPS-28, with installation beginning in September 1960. A total of 34 U. S. installations was to be operational by June 1963. Finally, installation of the FPS-27 would begin in June 1961, with 34 U. S. sets operational by March 1964. Thirty FPS-7 and nine FPS-20, for a total of 144 radars, were to complete the FD system within the United States. In addition, 24 FD radars were planned for Canada. It was perhaps ominous, in a time of austere funding, that ADC estimated the total cost of the RD system at one billion dollars, with $700 million going for equipment. Deployment of FPS-24/35, FPS-28, and FPS-27 radars within the United States was scheduled as given in Table 18. Approval of the ADC Frequency Diversity Plan, as it referred to sites in the United States, was granted by USAF on 21 October 1957.[23]

The number of Canadian radar stations owned and operated by ADC increased from 8 to 18 on 1 April 1957

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23. 1st Ind (ADC to USAF, "ADC Frequency Diversity Plan, Revised." 27 Sep 1957), USAF to ADC, 21 Oct 1957 [Doc 27 in Hist of ADC, Jul-Dec 1957].

when the U. S. Northeast Air Command (NEAC) was disbanded and its 11 radar stations were transferred to ADC cognizance. Ten were in Canada and one (G-32 at Thule, Greenland) recognized Danish sovereignty. The first eight ADC radar stations in Canada constituted the Radar Expansion Plan designed to supplement the Permanent system within the United States. The 10 stations inherited from NEAC stretched along the eastern approaches to Canada and were located as and equipped as follows:[24]

C-22 St. Johns, Newfoundland (CPS-6B)
C-23 Stephenville, Newfoundland (CPS-6B)
C-24 Melville, Labrador (CPS-6B)
C-25 Gander, Newfoundland (FPS-3A)
C-26 St. Anthony, Newfoundland (FPS-3A)
C-27 Cartwright, Labrador (FPS-3A)
C-28 Hopedale, Labrador (FPS-3A)
C-29 Saglek, Labrador (FPS-502)
C-30 Resolution Island, NWT (FPS-502)
C-31 Baffin Island, NWT (FPS-502)

The three Canadian stations of the Mobile system were caught in the same fund squeeze that had delayed operations of many Mobile stations within the United States. But beneficial occupancy of construction was achieved at all three locations during 1957 and at the end of the year it was expected that M-119 (Lowther, Ontario) would be operational in February 1958, M-102 (Barrington, Nova Scotia) in March 1958 and SM-153 (Kamloops, British Columbia) in November 1958.[25]

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24. ADC ACW Status Report, 31 Jan 1958 [Doc 25 in Hist of ADC, Jul-Dec 1957].

25. Ibid.

Phase IV of the Mobile radar program, originally intended to provide 26 prime radars in Canada between the Mid-Canada Line and the Pinetree Line, was in a state of suspended animation throughout 1957. Canada began site surveys of 18 sites (the Canadians had not approved the eight stations planned along the Mid-Canada Line) in the late summer of 1956, but otherwise no action had been taken, presumably because of the money crisis. Siting activity brought about numerous changes of site and at the end of 1957, the 18 Phase IV sites were tentatively located as given in Table 19.

The size of the search radar network within the United States actually declined during 1957 -- from 116 to 114 stations. This situation occurred when seven operating Phase I Mobile Stations were deleted for economy and marginal coverage reasons and an eighth (M-128, Kingman. Arizona) was placed in standby status pending the implementation of SAGE. One Phase II station (SM-137, Carmi, Illinois) was also removed from the operational network. These losses were only partially offset by the achievement of operational status by one Phase I, five Phase II and one Phase III stations.

These deletions from Phase I reduced the planned total from 37 to 30 stations, of which 26 were operational at the end of 1957 (See Table 20). The four non-operational

Phase I radars were the previously mentioned M-128, as well as M-96 (Almaden, California), M-114 (Jacksonville NAS, Florida) and M-116 (Cherry Point MCAS, North Carolina). Expected operational dates for these stations ranged from March to September 1958.

The program for Phase II dropped from 20 to 19 stations with the deletion of SM-137. Twelve of these were operational at the end of 1957.[26]

SM-138 Grand Rapids, Minnesota
SM-139 Willmar, Minnesota
SM-143 Walnut Ridge, Arkansas
SM-145 Joelton, Tennessee
SM-147 Malmstrom AFB, Montana
SM-156 Fallon NAS, Nevada
SM-157 Red Bluff, California
SM-159 Aiken, South Carolina
SM-162 Vincent AFB, Arizona
SM-163 Las Vegas, Nevada
SM-164 Tonopah, Nevada
SM-165 Flintstone, Georgia

It was anticipated that the seven Phase II stations still non-operational at the end of 1957 would become operational between February 1958 and January 1961.

Phase III was also reduced in scope during 1957 -- from 24 to 21 stations. One, TM-198 at Tyndall AFB, Florida, was operational by the end of the year with the modern FPS-20 radar. It was especially important that TM-198 become operational as soon as possible in order to provide support for the BOMARC test program. Plans called for the

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26. Ibid.

remaining 20 stations of Phase III to become operational by July 1960, which meant that Phase III, if all went according to plan, would be completed before Phase II.

It was customary for USAF/ADC plans to go awry, however, as they applied to the Mobile radar program. When USAF approved Phase I in July 1951, it covered 38 stations within the United States and carried a completion date of 1 July 1952. Five-and-one-half years after the original completion date, Phase I had shrunk to 30 stations, 26 of which were operational. Similar delays were encountered with Phase II. When USAF approved a 32-station Phase II on 18 October 1952, a completion date of 1 July 1954 was stated. At the end of 1957, Phase II had declined until it included only 19 stations, 12 of which were operational. Perhaps wisely, no completion date was mentioned when USAF approved a 29-station Phase III on 11 January 1954. One Phase III station was operational at the end of 1957, of a reduced program of 21 stations. The reductions cut the Mobile program from an original total of 99 U. S. stations to 70. At the end of 1957, therefore, ADC anticipated that a radar network of 140 stations (including 75 "P" sites) would eventually be available for aircraft warning and control purposes. Despite serious delays, caused mostly by shortages of funds and technical problems in the development of advanced radars, ADC was in

much better position to monitor aircraft movement at the end of 1957, with 114 relatively modern search radars operating, than it had been when the command was re-established in January 1951. At that earlier time only small numbers of World War II radars had been available. Although it had been far from easy, progress had been made.

Meanwhile, a new factor had been introduced into the air Defense equation. On 4 October 1957 the Russians successfully launched Sputnik I, an orbiting satellite, which proved that development of an intercontinental ballistic missile was not only possible, but likely. With attack from space ultimately possible, defense against the air-breathing threat by means of ground radars and manned interceptors suddenly did not seem nearly so imperative as it had in the early fifties. Justification of expansion and improvement of the long-range radar network accordingly became much more difficult.

PART THREE

SOPHISTICATION OF THE RADAR NETWORK
1958 - 1961

CHAPTER SEVEN

EMPHASIS ON DEFENSE AGAINST ELECTRONIC COUNTERMEASURES

1958

Although the programmed radar network was 30 stations short of completion at the end of 1957, emphasis within ADC was turning from network expansion to reduction of radar susceptibility to electronic counterneasures (ECM). Development of equipment for the electronic jamming of radar had proceeded to the point where the serious degradation of tracking capability was possible. One means of countering ECM, as suggested by Project LAMPLIGHT in 1955, was frequency diversity (FD) radar. ADC embraced this solution in 1956, assuming FD radar could be made available in 1959-1962, but USAF was dubious that the promised production dates could be met and directed that primary dependence, in the near future, be placed on the programmed FPS-7 and FPS-20.

In the spring of 1957, however, USAF got the FD program underway by announcing that it proposed to buy 25 FD radars (FPS-24/35 and FPS-28) during Fiscal 1959. ADC responded in September 1957 by preparing a five-year FD program that proposed the installation of 105 FD radars within the United States between July 1959 and March 1964. The program was approved by USAF the following month.

Despite continuing enthusiasm for FD radar, a series of frustrating delays occurred in 1958. First, development did not proceed as rapidly as had been hoped. In April it was disclosed that the first test model of the FPS-27 would not be available until January 1960, rather than March 1959 as previously planned. Also, the development agencies were slow to react to the ADC request that the FPS-24 and FPS-35 be combined into a single set. It was not until April 1958 that ARDC directed the Rome Air Development Center to proceed in the direction desired by ADC. As a result it was possible to predict when the FPS-24/35 would be available for testing. There was both good and bad news as regards the FPS-28. While development seemed to be following the earlier schedule, ADC learned in the late summer and early fall that

provisions for the procurement of the FPS-28 had been deleted from the budget for FY 1959.[1]

Of still greater importance was the realization that the extremely high power output of the FD radars would probably interfere with radio and other electronic equipment in the vicinity. This problem was first posed in July 1958 by Rome Air Force Depot, with the recommendation that all siting of FD radars be halted until full extent of this interference could be determined. ADC did not concur with this recommendation, taking the position that any adjustments required would be minor. Besides, significant delays in siting might cause ADC to lose construction funds from the Fiscal 1959 budget. Nevertheless, ADC participated in an October meeting of all interested agencies that failed to agree on the degree of interference that might be created by FD radar, but did agree that a considerable revision of the FD program might be necessary. The conference concluded that nothing further should be done about the purchase of land or construction of buildings for FD radar until the necessary studies had been made. ADC reluctantly agreed in late October.[2]

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1. Memo, DCS/O, ADC for V/C, ADC "Status of Frequency Diversity Radars," 14 Apr 1958 [Doc 22 in Hist of ADC, 1958]; Weekly Activity Report, ADLSI-E, 13 Aug 1958 and ADOCE, 7 Oct 1958 [HRF].

2. Msg MRMN 264, RAFD to ADC, 25 Jul 1958 [Doc 24 in Hist of ADC, 1958]; Msg ADOCE-EG 4222, ADC to RAFD, 1 Aug 1958, [Doc 25 in Hist of ADC, 1958]; Msg SILE-10-105-E,

The immense power of the FD radars also raised the possibility of radiation hazards in the immediate area. This was first suggested in an ADC siting guide for FD, issued in March 1958. Siting teams sent out by the defense forces were asked to keep such hazards in mind when placing FD radars. It was believed that locations where people were assembled or petroleum products or explosive devices were stored were especially vulnerable. The principle was excellent, but it soon developed that neither USAF, RAFD nor AMC possessed any firm information as to how far the danger area might extend. This matter was still under study at the end of 1958.[3]

Meanwhile, more exact frequency ranges for the various FD radars had been determined. It had been decided, by the end of 1958, that the FPS-24 would operate at 216-225 mcs, the FPS-35 at 420-450 mcs, the FPS-27 at 410-690 mcs and the FPS-28 at 2320-2680 mcs.[4]

[Con't] ADSID to ADC, 3 Oct 1958 [Doc 158 in Hist of ADC, Jan-Jun 1959]; Msg ADOCE-CE 4486, ADC to Defense Forces, 24 Oct 1958 [Doc 160 in Hist of ADC, Jan-Jun 1959]; Msg ADOCE-EG 4509, ADC to OCAMA, 31 Oct 1958 [Doc 161 in Hist of ADC, Jan-Jun 1959]; Msg SIL-10-178-E, ADSID to ADC, 27 Oct 1958 [Doc 162 in Hist of ADC, Jan-Jun 1959]; Msg ADOCE-CE 4498, ADC to USAF, 29 Oct 1958 [Doc 165 in Hist of ADC, Jan-Jun 1959].

3. ADC, "Siting Directive for Frequency Diversity Radar Program," n.d. but circa Mar 1958 [Doc 166 in Hist of ADC, Jan-Jun 1959]; Hist of ADC, Jan-Jun 1959, pp. 103-04.

4. Hist of ADC, Jan-Jun 1959, p. 99.

Concurrently, the ECM problem was also being approached from a different direction. The possibility of equipping existing search radars with what were collectively known as anti-jam modifications or "fixes" came in for examination. Although both the FD and anti-jam efforts were carried on simultaneously, they were intended to be complementary. It was hoped that anti-jam fixes could be applied promptly to provide interim defense against ECM while FD radars were being developed as the long-range solution. The need for anti-jam modifications to the FPS-20 radar in particular became evident after SAC bombers, equipped with the latest ECM equipment, virtually blinded ADC radars during exercises held on 24 October 1956 and 10 January 1957. The implications of this situation led both General Partridge of CONAD and General Atkinson of ADC to request action from USAF. General Atkinson write that he was "greatly concerned at our inability, either today or in the near future, to cope with the ECM threat."[5] He added that technical experts within ADC knew of several promising ideas for control of ECM, but that emphasis on development in this area was insufficient.[6]

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5. Lt. Gen. J. H. Atkinson, Cmdr/ADC to C/S, USAF, "Vulnerability of Our Ground Environment System to ECM," 22 Jan 1957 [Doc 30 in Hist of ADC, 1958].

6. Ibid.

The USAF reply was not highly encouraging, but did ask that ADC provide more details as to the nature of the modifications required. Also, significantly, USAF requested that ADC specify programs that could be curtailed or eliminated to provide the funds required for the anti-jam fixes. The money problem seemed to intrude everywhere. ADC responded on 15 July 1957 with a list of proposed modifications to the FPS-20 and the yet-to-be-received FPS-7. As to programs which could be curtailed in order to provide funds, ADC was not prepared to make recommendations.[7]

This proposal got nowhere, however, drawing USAF disapproval in November 1957. It was, USAF said, willing to take a calculated risk that the United States would not be attacked before 1962 when, hopefully, a considerable number of FD radars would be operational. This disapproval, it added, would save $70 millions. All USAF was willing to approve were minor modifications requested under the terms of AFR 57-5 and then only when there was evidence that the value gained would greatly outweigh the cost.[8]

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7. ADC to USAF, "Proposed Electronic Countermeasure Fixes for ADC Radars," 15 Jul 1957 [Doc 31 in Hist of ADC, 1958].

8. USAF to ADC, "Proposed Electronic Counter-Countermeasure Fixes for ADC Radars," 1 Nov 1957 [Doc 32 in Hist of ADC, 1958].

But ADC was not as willing as USAF to accept the calculated risk that there would be no attack before 1962 and informed USAF that it was preparing a new request on a site-by-site basis. The new proposal was forwarded by ADC on 13 December 1957, but differed little from the July request. ADC insisted that all FPS-7 and most FPS-20 radars receive anti-jam modifications, but estimated the cost at $32 million rather than the $70 million figure used by USAF.[9]

Meanwhile, ADC also approached the anti-jam problem from another tack. In late November 1957, ADC asked USAF to provide anti-jam equipment under the Quick Reaction Capability (QRC) program that had been so effective in providing electronic jamming equipment for SAC. Under QRC procedures the normal development-procurement-production cycle was greatly shortened by providing an electronics contractor with an open-end contract (Hallicrafters in the case of SAC) to furnish required equipment on a crash basis.[10]

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9. ADC to USAF, "Proposed Electronic Counter-Countermeasure Fixes for ADC Radars," 22 Nov 1957 [Doc 33 in Hist of ADC, 1958]; ADC to USAF, "ADC Proposed Electronic Counter-Countermeasures Retrofit Program for Ground Environment Radars," 13 Dec 1957 [Doc 37 in Hist of ADC, 1958].

10. Memo, DCS/P, ADC for V/C, ADC, "Quick Reaction Capability for Electronic Countermeasures," 22 Nov 1957 [Doc 34 in Hist of ADC, 1958].

USAF was doubtful that the QRC procedure would be of much value in the provision of large numbers of anti-jam devices, since QRC was geared to provide only small quantities of essentially off-the-shelf items, but added that a test of various anti-jam modifications was scheduled to take place at P-63 (Claysburg, Pennsylvania), beginning in March 1958. ARDC also entered the discussion with an opinion that money was the only problem in providing an effective anti-jam capability for ADC radars, because many of the needed fixes were known and available.[11]

It appeared that USAF was receding from its earlier disapproval of anti-jam modifications for ADC radars when, in January 1958, it asked ARDC to determine what should be done to protect FPS-7 and FPS-20 from ECM and estimate what the required modifications would cost. But within six weeks, USAF was cautioning ADC that the January request to ARDC did not necessarily mean that USAF was ready to finance anti-jam modifications, now estimated to cost $37

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11. USAF to ADC, "Adequate ECCM QRC Facilities for Air Defense Electronic Equipment" 20 Dec 1957 [Doc 35 in Hist of ADC, 1958]; Memo, DCS/O, ADC for V/C, ADC, "Adequate ECCM, QRC Facilities for Air Defense Electronic Equipment" 10 Jan 1958 [Doc 40 in Hist of ADC, 1958]; Pers Ltr, Maj. Gen. J. W. Sessums, V/C, ARDC to Lt. Gen. J. H. Atkinson, Cmdr, ADC, no subj, 23 Dec 1957 [Doc 38 in Hist of ADC, 1958].

millions, in the budget for FY 1959. USAF would wait for the ARDC evaluation before deciding.[12]

The Claysburg tests of March-April 1958 (Project WEX-VAL of the Weapons Systems Evaluation Group -- a JCS organization) were so successful in demonstrating the value of various anti-jam devices and techniques that neither NORAD nor ADC could understand continued USAF reluctance to finance the modifications in FY 1959. It was the USAF position, however, that it was not sure exactly what ADC wanted in this regard. Therefore, USAF asked that ADC prepare a detailed justification, in a form that would satisfy the requirements of AFR 57-5, for each modification desired.[13]

Electronics technology being in such a state of flux, preparation of the sort of detailed specifications and justifications required by AFR 57-5 was extremely difficult, but was eventually completed in June 1958.

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12. Msg AFOAC-E/W 54780, USAF to ARDC, 7 Jan 1958 [Doc 39 in Hist of ADC, 1958]; Pers Ltr, Maj. Gen. A. L. Pachynski, Dir/C&E, USAF to Maj. Gen. H. W. Grant, DCS/O ADC, no subj, 18 Feb 1958 [Doc 41 in Hist of ADC, 1958].

13. Pers Ltr, Maj. Gen. R. H. Lynn, V/C, ADC to Lt. Gen. D. L. Putt, DCS/D, USAF, no subj, 29 Apr 1958 [Doc 45 in Hist of ADC, 1958]; NORAD to USAF, "ECCM Modifications to Current ADC Radars," 9 May 1958 [Doc 44 in Hist of ADC, 1958]; Pers Ltr, Putt to Lynn, no subj, 19 May 1958 [Doc 46 in Hist of ADC, 1958]; Msg AFOAC-E/W 51493, USAF to ARDC, 29 May 1958 [Doc 47 in Hist of ADC, 1958].

This exercise brought forth an estimated cost of $37 million if only the FPS-20 were considered for modification. Inclusion of the FPS-7 would raise the cost to $70 million.[14]

All this effort, however, failed to convince USAF that it was necessary to fund anti-jam modifications with FY 1959 money. One reason given for disapproval of the ADC AFR 57-5 proposals was that the modifications to the FPS-20 were not economically justifiable because the FPS-20 would ultimately be phased out of the radar network. This attitude gradually softened during the later months of 1958 and by the end of the year USAF was agreeing in principle that the FPS-20 needed protection from ECM. No contracts had been written by the end of the year, however, and it appeared that the best ADC could hope for was that the necessary funds would be made available from the budget for FY 1960.[15]

Whatever the difficulties experienced by the proposed FD and anti-jam programs, the FPS-20 became operational in

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14. Pers Ltr, Lynn to Maj. Gen. J. S. Mills, DCS/D, USAF, no subj, 6 Jun 1958 [Doc 48 in Hist of ADC, 1958]; Memo, DCS/Plans, ADC for Cmdr, ADC, "Air Defense Command ECCM Modification Requirement," 7 Jul 1958 [Doc 41 in Hist of ADC, 1958]; Hist of ADC, 1958, p. 18.

15. Weekly Activity Reports, ADC, ADLSI-E, 16 Jul, 30 Jul and 31 Dec 1958 [HRF]; Hist of ADC, Jan-Jun 1959, p. 121.

such numbers in 1958 that it came to dominate the ADC network of long-range radars. Thirty-eight FPS-20 radars became operational within the United States in 1958, bringing the total to 55, or nearly half the number operated by ADC. That part of the aircraft control and warning network equipped with FPS-20 radars at the end of 1958 is shown in Table 21.

The size of the FPS-20 program was drastically reduced in 1958 in order to provide funds for FD radars. While it was intended, at the end of 1957, to use 119 FPS-20 sets within the United States, this number had been reduced to 76 (not counting three intended for the off-shore Texas Towers) by the end of 1958. Despite this drastic reduction in the FPS-20 program and the significant numbers brought to operational status during 1958, the completion date for the total program was slipped from June 1960 (as estimated at the end of 1957) to October 1961 when the last of the FPS-20 stations at SM-157 (Red Bluff, California) was expected to become operational.

Meanwhile, the FPS-7 experienced continuing difficulty by reason of manufacturing problems at the General Electric plant. While it had been hoped, at the end of 1957, that the first FPS-7 could become operational

in November 1958, that date came and went uneventfully. At the end of 1958 the expected date for initial operations of the FPS-7 had dropped back to May 1959. As a result, the date for completion of the FPS-7 program slipped to June 1962.[16]

The three Canadian sites in Phase I and II of the Mobile radar program became operational during 1958. Nine Canadian locations had been included in the Mobile program as originally proposed, but only three actually reached operational status. M-119 (Lowther, Ontario) became operational in July 1958, using the MPS-7 as primary search radar. The FPS-3 set was used by M-102 at Barrington, Nova Scotia (operational in November 1958) and SM-153 at Kamloops, British Columbia (operational in December 1958).[17]

The proposal to place 26 heavy radars between the Pinetree and Mid-Canada Lines, originally known as Phase IV of the Mobile program, continued to hang fire during 1958, gaining neither approval nor disapproval. Action was taken, however, to include seven of the Phase IV

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16. ADC ACW Status Report and ADC Program Resume, 31 Oct 1958 [Doc 21 in Hist of ADC, 1958].

17. Ibid.

sites as support for the SAGE system. Five were intended to thicken radar coverage in the 25th Air Division area in the Pacific Northwest. These were C-50 (Carberry, Manitoba), C-51 (Yorkton, Saskatchewan), C-52 (Dana, Saskatchewan), C-53 (Alsask, Saskatchewan) and C-54 (Olds, Alberta). It was planned that C-52 and C-54 be equipped with FPS-7 radars, C-50 and C-53 with the FPS-27 FD radar, and C-51 with the FPS-28 FD radar. It was anticipated that C-52 and C-54 would be operational in July 1962, C-51 in October 1962 and C-50 and C-53 in January 1963.[18]

When it was decided that a SAGE sector would be located in Canada, with headquarters in the Ottawa area, it was also decided that two additional radars would be needed in Canada to provide adequate coverage in the Ottawa sector. These were to be sited at two other Phase IV locations -- C-42 at Mistissini, Quebec, and C-44 at Moosonee, Ontario. The type of equipment and prospective operational dates had not been settled at the end of 1958.[19]

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18. Ibid.; Msg ADOCE-EG 4119, ADC to Det 1, ADC (Ottawa), 27 Jun 1958 [Doc 54a in Hist of ADC 1958]; Msg AFOOP-OC-F/3 50931, USAF to ADC, 16 May 1958 [Doc 54b in Hist of ADC, 1958].

19. Hist of ADC, 1958, p. 21.

The possibility that the air defense radars of ADC and the air traffic control radars of the Civil Aeronautics Administration (later absorbed by the Federal Aviation Agency -- FAA) might be mutually supporting was suggested as early as 1952 and was discussed intermittently by the two organizations until 1955. In that year, a series of mid-air collisions involving civilian aircraft dictated cooperation between the two radar networks. In March 1956, ADC was designated the Air Force organization authorized to deal with the CAA in this matter.[20]

A tentative CAA/ADC survey of May/June 1956 revealed that CAA planned 16 long-range radars near various major air terminals in the United States and that ADC had radars at seven of these points and planned others. The two agencies then formed a Joint Radar Planning Group (JRPG) to study the integration problem in depth. At its first meeting of 6 November 1956 the JRPG established a set of joint ground rules designed to control the selection of sites, the division of maintenance duties, and responsibility for funding, among other things.[21]

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20. ADC to USAF, "USAF Policy on Integration of Air Defense and CAA Air Traffic Control," no date [Doc 55 in Hist of ADC, 1958].

21. ADC/CAA, "Ground Rules for ADC and Civil Aeronautics Administration Joint Use of Radar Facilities," 6 Nov 1956 [Doc 56 in Hist of ADC, 1958].

After this initial agreement, however, JRPG ran into trouble. In surveying Department of Defense radar capabilities, the JRPG concluded that the Missile Master (FSG-1) radars to be used for antiaircraft purposes by the Army Air Defense Command (ARADCOM) could also be used for air traffic control. But ARADCOM, like ADC a component of Continental Air Defense Command (CONAD), would not agree to the operational ground rules established by CAA and ADC, holding that the Army must retain undiluted control of tactical radar.[22]

Several months of indecisive discussion of this point finally led ADC, in May 1957, to request that CONAD direct ARADCOM to participate in the joint effort in the interests of interdepartmental harmony. This was not done immediately, however, so the CAA and ADC entered into further two-way discussions. The CAA agreed to accept the FPS-20 currently being installed by ADC if a time-control feature was added to make it possible for the FPS-20 to control aircraft close to the control tower. ADC was satisfied that it could use the CAA ARSR-1 radar for defense operations if an amplitron were added. But ARADCOM insisted that the ARSR-1 would be imcompatible

22. ADC to CONAD, "Joint Use of USAF and CAA Radar," 21 Jan 1957 [Doc 57 in Hist of ADC, 1958].

with Missile Master and suggested that the FPS-8, a radar not highly regarded by ADC, be substituted for the ARSR-1. As a compromise, NORAD (created in September 1957 by addition of Canadian forces to CONAD) recommended that all three agencies use the FPS-33, another radar favored by ARADCOM. ADC protested that the range of the FPS-33 was too short, while CAA objected to it for a number of reasons.[23]

General Partridge, NORAD commander, stepped into the controversy in the fall of 1957 and directed ARADCOM to prepare to make use of the ARSR-1 in the antiaircraft defenses of Los Angeles, Seattle and Boston. The JRPG did not feel that this was the ideal approach in the face of continuing Army objection and recommended, instead, that a formal agreement between the Department of Commerce (parent of the CAA) and the Department of Defense be sought as a means of assuring Army cooperation. This document was ratified 9 January 1958 and the Army became a member of the JRPG whenever matters concerning the Army were under discussion.[24]

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23. Minutes of the Joint Radar Planning Group, 27 May 1957 [HRF]; Weekly Activity Report, ADOCE, 24 Sep 1957 [HRF]; Msg, CAA to ADC, 15 Oct 1957 [Doc 59 in Hist of ADC, 1958].

24. Hist of ADC, 1958, p. 27; "Agreement Relating to Joint Use of Certain Facilities by the Department of Commerce and the Department of Defense," 9 Jan 1958 [Doc 60 in Hist of ADC, 1958].

Meanwhile, before ratification of the Commerce/ Defense agreement, the JRPG agreed that FPS-20 radars would be used for air traffic control as well as air defense in the New York, Kansas City, Houston, Spokane, and San Antonio areas, and possibly the Jacksonville, Sacramento, Charleston, Wichita, Great Falls, and Omaha areas. CAA would install ARSR-1 radars for similar purposes in the vicinity of Denver, Salt Lake City, and Atlanta, and possibly Miami and Oakland. Joint sites (assuming Army cooperation) were to be located at Los Angeles, Seattle, Boston, and Pittsburgh.[25]

With the matter of who would do what apparently settled, at least tentatively, it was possible to give attention to the prickly problems of the integration of radars that were originally designed for somewhat different purposes. One such problem involved the use of air traffic beacons at CAA sites. Another concerned the handling of the military Selective Identification Feature (SIF) of the Mark X IFF (Identification, Friend or Foe) system in a joint operation. Investigation of these, and similar, matters consumed the remainder of 1958. Integration was apparently possible, but not easy.[26]

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25. Minutes of the Joint Radar Planning Group, 6 Nov 1957 [HRF].

26. Hist of ADC, 1958, p. 29.

The addition of 38 FPS-20 radars during 1958 significantly increased the quality of the ADC radar network. A small increase in quantity also occurred; the number of operational radars increasing from 114 to 121. The Phase I Mobile program was virtually completed with the coming to operational status of M-96 at Almaden, California, and M-116 at Cherry Point MCAS, North Carolina. The only Phase I station not operating at the end of 1958 was M-114 at Jacksonville NAS, Florida. The total scope of the Phase I program dropped during the year from 30 to 29 when M-128 at Kingman, Arizona, was taken from standby status and deactivated.

In Phase II, only one station -- SM-151 at Mica Peak, Washington -- became operational in 1958. This brought the number of operational stations in Phase II to 13, with six still non-operational. Anticipated operational dates for these stations stretched to June 1962. The most activity occurred in Phase III where five stations -- TM-186 at Pyote, Texas; TM-192 at Killeen, Texas; TM-193 at Lufkin, Texas; TM-194 at Lake Charles AFB, Louisiana; and TM-196 at Dauphin Island, Alabama -- became operational in 1958. This meant a total of six Phase III stations were operating, with 15 yet to come.

As in Phase II, the completion date for Phase III was expected to be June 1962.[27]

A negative milestone was reached 8 December 1958 when the first of the permanent stations to be lost to the ADC network was inactivated at P-8, Tierra Amarillo, New Mexico. This step was taken because the site was poorly located and because the installation of an FPS-20 radar at a nearby site (P-51, Moriarity, New Mexico) made the contribution of P-8 negligible.[28]

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27. ADC ACW Status Report and ADC Programming Resume, 31 Oct 1958 [Doc 21 in Hist of ADC, 1958]; Hist of CADF, Jul-Dec 1958, pp. 16-20; Hist of EADF, Jul-Dec 1958, pp. 36-38; Hist of WADF, Jul-Dec 1958, pp. 22-25.

28. Msg ADOOP-E 334, ADC to USAF 22 Jul 1958 [Doc 4 in Hist of ADC, Jan-Jun 1959]; Hist of CADF, Jul-Dec 1958, p. 16.

CHAPTER EIGHT

TESTING OF FREQUENCY DIVERSITY RADAR BEGINS

1959

Even though there was general agreement that frequency diversity radar was the best means of countering the electronic jamming (ECM) likely to be employed by enemy bombers, the FD radar program drawn by ADC and approved by USAF in late 1957 (proposing deployment of 105 FD radars -- not including the FPS-7 and FPS-20 -- by 1962) suffered a series of financial disasters during 1959. The first hint of things to come occurred in December 1958 when USAF let it be known that FD funds for FY 1960 had been reduced by $29 million and that it was therefore likely that completion of the FD program would have to be delayed from 1962 to 1965.[1]

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1. Msg ADLSI-E 590, ADC to USAF, 24 Dec 1958 [Doc 151 in Hist of ADC, Jan-Jun 1959]; Msg ADAMA 2182, ADC to USAF, 12 Jan 1959 [Doc 175 in Hist of ADC, Jan-Jun 1959]; Msg AFOAC-E/A 54750, USAF to ADC, 6 Jan 1959 [Doc 152 in Hist of ADC, Jan-Jun 1959].

Mere stretch-out of operational dates did not solve the financial problem, and, in fact, appeared to compound it. By the middle of 1959, USAF was finding it necessary to reveal to ADC that the FD radar program was having hard going in both DOD and Congressional circles because of late completion and high cost (FD sets were estimated to cost between three and four million dollars per unit). It was becoming reasonably obvious that the initial FD program would not be financed completely, although ADC took the position that any reduction was unacceptable if the nation was to be adequately defended against ECM-equipped bombers.[2]

The shape of the required reductions became clearer in June and July 1959 when it became known, for one thing, that DOD was planning an "austere" SAGE area for the central and south-central United States that would require seven less FD radars than previously planned. Further, it was announced that spending for FD would be limited to $73 million in FY 1960, $120 million in FY 1961 and $46 million in FY 1962. It was determined that this financial restriction would cost ADC

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2. Weekly Activity Report, ADLSI-E, 13 May 1959 [HRF]; Msg ADLSI-E 311, ADC to USAF, 16 Jun 1959 [Doc 178 in Hist of ADC, Jan-Jun 1959]; Msg AFODC 52574, USAF to ADC, 22 Jun 1959 [Doc 179 in Hist of ADC, Jan-Jun 1959].

26 FD radars in addition to the seven presumed lost in connection with "austere" SAGE. In asking that ADC perform the necessary re-programming, USAF expressed some doubt about the feasibility of the FPS-53 (the "married" FPS-24/35), requesting that ADC prepare both a program that involved all types of FD radars and one which deleted the hybrid FPS-53. Also, thinking ahead, USAF recommended that FD radar be so distributed that cancellation of the program at the end of any particular fiscal year would leave the best possible, from an air defense standpoint, geographical deployment of these advanced radars.[3]

Still more money trouble erupted in December 1959 when USAF told ADC there was an excellent chance that funds for the purchase of FPS-27/28 radars in Fiscal Years 1960-62 would be reduced from $202 million to $170 million, thereby cutting the probable procurement of these sets from the programmed 49 to 43. The first question was the manner in which ADC wished to spend the money -- all for the FPS-27, all for the FPS-28, or part

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3. Msg AFOOP-DE 53554, USAF to ADC, 22 Jul 1959 [Doc 13 in Hist of ADC, Jan-Jun 1959]; Weekly Activity Report, ADLMO-A, 8 Jul 1959 [HRF]; ADC AC&W Operational Status Report, 31 Jul 1959 [HRF].

for each. The initial ADC reaction was to ask that 12 FPS-27 models be bought in FY 1960, with 12 FPS-28 types to be added in FY 1961 and a combination of 12 FPS-27 and 10 FPS-28 in FY 1962 for a revised total of 46.[4]

There was another complication with respect to the FPS-28. From the inception of the FD program it had been impossible to obtain from the Federal Communications Commission a permanent allocation of the frequencies (510-690 mcs) needed to permit the FPS-28 to operate. By the end of 1959 ADC had come to the conclusion that such allocation was never going to be obtained. The obvious solution was to forget about the FPS-28, except for the test unit at M-126 (Houma NAS, Louisiana). Under the circumstances, ADC believed the $170 million expected to be available during the three ensuing fiscal years should be spent for 31 FPS-27 sets, plus seven additional FPS-24 types and a similar number of FPS-35 radars.[5]

The worst fears of USAF concerning the FPS-53 were also borne out. In July 1959, GEEIA (Ground Electronics Engineering-Installation Agency) reported that marriage

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4. Msg AFOAC-E/A 96383, USAF to ADC, 11 Dec 1959 [Doc 59 in Hist of ADC, Jul-Dec 1959]; Msg ADOAC-E 299, ADC to USAF, 17 Dec 1959 [Doc 58 in Hist ofADC, Jul-Dec 1959].

5. Msg ADOAC-E 299, ADC to USAF, 17 Dec 1959 [Doc 58 in Hist of ADC, Jul-Dec 1959]; Weekly Activity Reports, ADOAC-D, 18 Dec 1959 and ADLPG-E, 26 Dec 1959 [HRF].

of the FPS-24/35 was not feasible from an engineering standpoint and, even if feasible, would cost an additional $167 million. Consideration of the FPS-53 was therefore dropped.[6]

As a result of the predicted shortages of funds and technological problems, the size of the planned ADC FD network further declined to 84 stations during the last half of 1959. One of these was one of two surveillance stations added to the total ADC radar network during 1959 -- Z-111 at Patrick AFB, Florida, in the Cape Canaveral area. The other, Z-210 at Richmond NAS, Florida, near Miami, was equipped with CAA ARSR-1 radar. At the end of 1959, it was proposed that FD radar (including 27 FPS-7 sets but no FPS-20's) be deployed as given in Table 22.

Although the FPS-7 was developed and put into production before the FD program was established, this advanced radar was incorporated into the FD plan and was regarded at least temporarily as an FD set. Therefore, when the first two FPS-7 stations went into operation in 1959, it could be said that FD radar had gone into initial operation. The first to reach this status was P-9 at

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6. Msg ADOCE-EG 4816, ADC to GEEIA, 10 Mar 1959 [Doc 66 in Hist of ADC, Jul-Dec 1959]; Msg ROZMAD-7-433-E, GEEIA to ADC, 10 Jul 1959 [Doc 67 in Hist of ADC, Jul-Dec 1959]; Weekly Activity Report, ADLSI-E, 8 Jul 1959 [HRF].

Highlands, New Jersey, in September. The following month the FPS-7 at P-35, Osceola, Wisconsin, also went operational. While this was an important milestone, it actually represented about a two-year slippage in the operational readiness of the FPS-7. Plans made in 1955 foresaw this radar first reaching operational status before the end of 1957.[7]

Two technical problems surrounding the use of FD radar were directly related to the large concentrations of electrical power involved in FD search operations. One problem concerned the effect of FD on other electronic equipment in the area. How the radiation produced by FD would affect human beings, petroleum products and other volatile material in the vicinity was the heart of the second problem.[8]

As for interference, USAF concluded that the only way to find the necessary answers was to conduct a site-by-site study of the situation, using highly qualified electronics experts. To this end, GEEIA organized four teams of specially selected contractor representatives

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7. ADC ACW Status Report and ADC ACW Program Resume, 31 Dec 1959 [Doc 6 in Hist of ADC, Jul-Dec 1959].

8. Msg ADOCE-CE 4795, ADC to GEEIA, 27 Feb 1959 [Doc 156 in Hist of ADC, Jan-Jun 1959].

who were in the field by the end of 1959. It was hoped this study would be completed early in 1960.[9]

There was continued acknowledgement that the radiation hazard was likely to be serious, but knowledge was so sparse that the matter was still under study at the end of 1959. Whether men could safely work within 100 yards, 200 yards, or even 1,000 yards of operating FD radars could not be answered with authority. It began to appear highly likely, however, that the operations of existing radars would have to be curtailed in some degree while an FD set was being installed nearby.[10]

Preparations were also made for the testing of FD. In January 1959 it was decided that four stations in the southeast area of the United States would be used for test purposes. The FPS-24 would be tested at TM-199 (Eufaula, Alabama); the FPS-27 at TM-195 (Crystal Springs, Mississippi); the FPS-28 at M-126 (Houma NAS, Louisiana) and the FPS-35 at TM-197 (Thomasville, Alabama). Category I testing of the FPS-24 was expected to begin in April 1959, with FPS-27 and FPS-28 efforts starting in August

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9. Msg AFMME-CE 88648, USAF to ADC, 5 Nov 1959 [Doc 63 in Hist of ADC, Jul-Dec 1959]; Msg ROZMAD-59-33, GEEIA to ADC, 2 Nov 1959 [Doc 64 in Hist of ADC, Jul-Dec 1959]; Msg ADOAC-EG 8, ADC to Air Divs, 17 Nov 1959 [Doc 65 in Hist of ADC, Jul-Dec 1959].

10. Weekly Activity Report, ADOCE, 28 Apr 1959 [HRF]; Hist of ADC, Jul-Dec 1959, pp. 73-74.

1959 and FPS-35 tests in October 1959. Category II testing was also planned for an October 1959 beginning. Category III was expected to begin about a year later.[11]

Testing of the FPS-24 at Eufaula, Alabama, actually began in April of 1959, and testing of the other three specially designed FD sets (FPS-27/28/35) commenced later in the year. Category I testing (carried out by the contractor) was still underway at the end of 1959.[12]

The attempt of ADC to obtain anti-jam modifications for the non-FD FPS-20 radar continued to experience a series of frustrating delays during 1959, although some progress was made. While the detailed modification request submitted by ADC in June 1958 was not specifically approved, USAF apparently agreed, at least in principle, that ECM protection was needed for the FPS-20. Seemingly positive action came in March 1959 when USAF announced that most of the ECCM modifications desired by ADC would be financed in Fiscal Years 1959 and 1960. Only the ADC proposals for variable nod angle and antenna improvement

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11. Msg EAOPP 147, EADF to ADC, 20 Jan 1959 [Doc 153 in Hist of ADC, Jan-Jun 1959].

12. Msg ADCMA 2261, ADC to USAF; 19 May 1959 [Doc 111 in Hist of ADC, Jan-Jun 1959]; ADC AC&W Operational Status Report, 31 Jul 1959 [HRF]; ADC ACW Status Report and ADC ACW Program Resume, 31 Dec 1959 [Doc 6 in Hist of ADC, Jul-Dec 1959].

were denied. Contract negotiations were begun with Bendix and a contract was formalized on 25 June 1959.[13]

Even so, USAF was not entirely sure it knew exactly what was wanted in the way of anti-jam gear for the FPS-20 and asked ARDC to make another survey of the situation. It was, therefore, not until December 1959 that ARDC and ADC reached a meeting of the minds on detailed anti-jam fixes. It was decided that all approved anti-jam devices would be contained in two modification kits, designated MK-448 and MK-477, to be assembled by Bendix. Meanwhile, because of the major reduction in the FD radar program, it became apparent that more FPS-20 radars would be retained in the radar network than previously planned, increasing the numbers of FPS-20 sets to receive the anti-jam modifications. At the end of 1959, ADC had set this number at 84, with 76 scheduled for the United States and eight for Canada.[14]

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13. Msg ADLSI-E 60, ADC to USAF, 19 Feb 1959 [Doc 198 in Hist of ADC, Jan-Jun 1959]; Msg AFOAC EXA 57572, USAF to RCAF, 11 Mar 1959 [Doc 199 in Hist of ADC, Jan-Jun 1959]; Msg ADOCE-EW 5085, ADC to SAGE PO, 21 May 1959 [Doc 200 in Hist of ADC, Jan-Jun 1959]; Weekly Activity Report, Electronic Systems Div, 2 Jul 1959 [HRF].

14. ADC to ROAMA, "Class V Modification (ECCM) for AN/FPS-20 Radars," 15 Oct 1959 [Doc 68 in Hist of ADC, Jul-Dec 1959] ARDC to RADC, "Specifications for ECCM Modifications to Radar Sets AN/FPS-20, ARSR-1 and AN/FPS-6," 24 Dec 1959 [Doc 69 in Hist of ADC, Jul-Dec 1959].

From the time it was introduced as Phase IV of the Mobile radar program several years before, the plan for deepening radar coverage north of the United States - Canada border had undergone transformation by 1959. The original Phase IV plan had called for the addition of 26 long-range radars between the along-the-border Pinetree Line and the Mid-Canada Line of doppler radars roughly along the 55th parallel. The extent of Phase IV was subsequently reduced to 18 radars when the Canadians failed to agree that Phase IV radars were necessary in the immediate vicinity of the Mid-Canada Line. Sporadic siting action was taken during 1957 and 1958, but Phase IV never really began because of the continuing shortage of USAF funds and the lack of specific Canadian acceptance of the plan. In 1959 Phase IV was absorbed into a larger joint air defense plan which came to be known as the Continental Air Defense Integration North (CADIN) program. This involved complete integration of Canadian air defenses into the SAGE system, including a SAGE combat center at Ottawa and BOMARC missiles as well as seven additional long-range radars north of the existing Pinetree Line and stretching from Alberta in the west to Quebec in the east In the original CADIN plan of July

1959, the seven sites and proposed operational dates were given as follows:

C-42	Chibougamau, Quebec	November 1962
C-44	Moosonee, Quebec	September 1962
C-49	Gypsumville, Manitoba	March 1963
C-51	Yorkton, Saskatchewan	March 1963
C-52	Dana, Saskatchewan	March 1963
C-53	Alsask, Saskatchewan	March 1963
C-54	Olds, Alberta	March 1963

Types of radar to be utilized were not specified in the original plan.[15]

By the end of the year it had been decided that the two CADIN sites in Quebec would be equipped with the FPS-20 radar, while the five stations further west would get FD radar (three FPS-27 and two FPS-7). Also, the site of C-54 was shifted from Olds to Penhold, Alberta, because of possible electronic interference in the Olds area. There was increasing confidence as to the time required to equip and bring to operational readiness these isolated northerly stations. Proposed operational dates were improved from six months to a year. The CADIN program for new long-range radars was as follows at the end of 1959:

C-42	Chibougamau, Quebec	FPS-20	November 1961
C-44	Moosonee, Quebec	FPS-20	November 1961
C-49	Gypsumville, Manitoba	FPS-27	July 1962

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15. RCAF/USAF, Joint Plan for Continental Air Defense Integration North, 13 Jul 1959 [HRF].

C-51	Yorkton, Saskatchewan	FPS-7	May 1962
C-52	Dana, Saskatchewan	FPS-27	August 1962
C-53	Alsask, Saskatchewan	FPS-27	September 1962
C-54	Penhold, Alberta	FPS-7	May 1962

The date for completion of this portion of CADIN was improved from March 1963 to September 1962.[16]

The premise that cooperative use of air defense and air traffic control radar was both desirable and necessary having been established in 1958, further efforts at correlation between ADC and Federal Aviation Agency (which had succeeded CAA) equipment and missions continued through 1959. Coordination was rendered somewhat more complicated by the growth of the SAGE system, and especially by the proposal to put the SAGE control underground in a hardened, transistorized configuration. It was eventually agreed that it was imperative to include FAA requirements in hardened SAGE, since control of civilian air traffic would become especially important in the event of an airborne attack on the North American continent. This agreement was contained in a DOD/FAA accord (FAA was an independent agency, whereas CAA had been subordinate to the Department of Commerce) of 22 May 1959.[17]

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16. ADC ACW Status Report and ADC ACW Program Resume, 31 Dec 1959 [Doc 6 in Hist of ADC, Jul-Dec 1959].

17. Operational Employment Plan for the Super Combat Center, 19 Jun 1959 [HRF].

Pending the completion of a fully integrated air defense/air traffic control system, FAA asked, in the late spring of 1959, for ADC assistance in the interim control of civilian jet airliners which the commercial carriers were beginning to receive in considerable numbers. The result was a jet advisory agreement of July 1959 by which ADC permitted FAA to station controllers at various ADC radar stations along the flight paths of jet airliners in order that FAA might have continuous radar coverage of jet flights at high altitudes.[18]

Meanwhile joint ADC/FAA operations were getting underway. At the end of 1959, there were 10 stations of the ADC radar network that performed air traffic control duties as well as their normal air defense function:

P-47	Hutchinson, Kansas
P-54	Palermo, New Jersey
P-71	Omaha, Nebraska
P-72	Olathe NAS, Kansas
P-75	Lackland AFB, Texas
M-111	Marietta, Georgia
M-113	North Charleston, S. C.
SM-147	Malmstrom AFB, Montana
SM-151	Mica Peak, Washington
TM-191	Rockport, Texas

18. FAA/USAF, "Agreement for Use of USAF Radar Facilities to Provide Radar Advisory Service for Jet Aircraft Operations," 15 Jul 1959 [Doc 87 in Hist of ADC, Jul-Dec 1959].

Also, the FAA ARSR-1 at Richmond NAS, Florida, (Z-210) was feeding data into the air defense system. It was planned that the cooperative network would ultimately include 33 ADC radar stations, plus Air National Guard radar stations at Salt Lake City and Denver that produced information for the air defense system when operating. Also, six ARSR-1 sets were scheduled for installation at ADC radar stations.[19]

Despite the loss of three "permanent" stations from the operational radar network during 1959, there was a net gain of 10 stations to the total network as the number of operational stations rose from 121 to 131 during the year.

Loss of two of the three "P" stations which halted operations in late 1959 was to be only temporary. P-31 at Williams Bay, Wisconsin, was to become a gap-filler satellite of RP-31, the new P-31 site at Arlington Heights, Illinois. RP-31 was scheduled to become operational with an FPS-3 radar in January 1961. A similar situation prevailed in connection with the degradation of P-62 at Brookfield, Ohio, to the status of a gapfiller for

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19. ADC to Air Divs, "ADC/FAA Joint Use Radar Program," 19 Jan 1960 [Doc 86 in Hist of ADC, Jul-Dec 1959].

P-30 at Benton, Pennsylvania. The relocated P-62 at Oakdale (RP-62) was operational with an ARSR-1 radar at the end of 1959, but was providing data only to the FAA. It was expected to join the air defense network in October 1961 when construction and testing of an FPS-24 FD radar was complete. No replacement was intended for P-6 at Curlew, Washington, however. It simply became a gap-filler for P-60 at Colville, Washington. The size of the permanent network, after these actions, was thereby reduced from 74 to 71.[20]

The last of 29 programmed stations of Phase I of the Mobile radar program became operational in March 1959 when M-114 at Jacksonville NAS, Florida, reached that status. Two additional stations of the Phase II program -- SM-132 at Baudette, Minnesota, and SM-150 at Cottonwood, Idaho -- became operational in 1959, leaving four stations of this phase of the Mobile program still non-operational. Completion of Phase II remained a considerable time in the future, since the final four stations were not expected to be ready until 1961 and 1962. Phase III of the mobile radar program made the most progress during 1959, with nine stations becoming operational:

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20. ADC ACW Status Report and ADC ACW Program Resume, 31 Dec 1959 [Doc 6 in Hist of ADC, Jul-Dec 1959].

TM-177 Dickson, North Dakota
TM-180 Keno, Oregon
TM-181 Luke-Williams Range, Arizona
TM-187 Ozona, Texas
TM-188 Eagle Pass, Texas
TM-189 Zapata, Texas
TM-190 Port Isabel, Texas
TM-191 Rockport, Texas
TM-200 Cross City, Florida

This flurry of activity reduced the number of non-operational Phase III stations to six -- of a Phase III program of 21 stations. The last Phase III station was expected to become operational in May 1961. In addition, a new surveillance station in Florida at Richmond NAS (Z-210) began providing data from an ARSR-1 radar. Another "Z" site ("Z" representing stations not included in either the Permanent or Mobile radar programs) at Patrick AFB, Florida, was scheduled to become operational with an FPS-20 radar in January 1960. In sum, then, the aircraft control and warning system reporting to ADC control centers gained 13 stations and lost three in 1959, for a net gain of 10. The active air defense radar network contained 131 prime radars at the end of 1959.[21]

The 131-station radar network of end-1959 turned out to be the temporary high-water mark of the expansion of radar surveillance and interceptor control capability within the United States after World War II. Original

21. Ibid.

proposals for the various segments of the radar system had called for a total of 180 stations. The basic "permanent" system, approved prior to the re-establishment of ADC in January 1951, involved 75 stations. Seventy-three of these were still programmed at the end of 1959. Phase I of the Mobile radar program, approved by USAF in July 1951, originally covered 44 sites in the United States. At the end of 1959, Phase I had dwindled to 29 stations. Phase II of the Mobile program, approved in October 1952, started as a 32-station effort. It covered 19 stations at the end of 1959. When approved in January 1954, Phase III encompassed 29 stations. Twenty-one radars remained in this program at the end of 1959.

CHAPTER NINE

THE SECOND MONEY CRISIS DEVELOPS
1960

But further reductions were in the offing. In March 1960, USAF advised NORAD that a predicted severe shortage of funds for air defense in FY 1961 was sure to force a revision of plans. Among other things, USAF suggested that 32 radar stations in the interior of the United States and in Southeast Canada be deleted from the operational system. NORAD protested the proposed decrease in aircraft control and warning capacity, but argued that if reduction was imperative it should not be limited to the interior of the United States. Instead

NORAD believed that reductions in radar coverage should be in accordance with a plan, drawn up with ADC cooperation, which would retain double or triple radar coverage of the northeastern United States, double coverage along a line from Duluth to Seattle and south to San Diego, a single line of radar coverage across the southern border and single coverage of the interior of the country. Using this criterion, NORAD identified 26 radars that could be released from the defense network, 22 of which were within the United States. It was recommended that 15 stations be deactivated, with seven to be transferred to FAA, although they would continue to feed data into the air defense system. The 15 stations proposed for deletion were:[1]

P-7 Continental Divide, New Mexico
P-17 Wadena, Minnesota
P-42 Lake City, Tennessee
P-51 Moriarity, New Mexico
P-58 Mather AFB, California
P-60 Colville, Washington
P-68 Fordland, Missouri
P-77 Bartlesville, Oklahoma
M-89 Sweetwater, Texas

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1. USAF to NORAD, "Revised Air Defense Program" 30 Mar 1960 [Doc 1 in Hist of ADC, Jan-Jun 1960]; NORAD to USAF, "Reduced Air Defense Program," 20 Apr 1960 [Doc 2 in Hist of ADC, Jan-Jun 1960].

SM-144 Union City, Tennessee
SM-145 Joelton, Tennessee
SM-165 Flintstone, Georgia
TM-189 Zapata, Texas
TM-190 Port Isabel, Texas
TM-193 Lufkin, Texas

Transfer to FAA was recommended for:

P-52 Oaklahoma City, Oklahoma
P-75 Lackland AFB, Texas
P-78 Duncanville, Texas
M-91 Texarkana, Arkansas
M-94 West Mesa, New Mexico
M-95 Las Cruces, New Mexico
TM-192 Killeen, Texas

USAF approved the proposed deletions in May 1960 and in June directed ADC to make the necessary reductions. Some minor changes had been made between May and June. The to-be-deactivated group of stations was increased to 16 by the addition of P-75. The group of stations proposed for transfer to FAA remained at seven with the addition of P-79 (Ellington AFB, Texas).[2]

Fifteen of the prescribed 23 stations had left the air defense system by the end of 1960, although not precisely in the manner planned earlier. Deactivated were P-1, P-42, P-60, P-68, P-77, SM-139, SM-144, SM-145, SM-165, TM-189, TM-190 and TM-193. P-7 and P-51 had been transferred to FAA pending deactivation and no longer

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2. USAF to NORAD, "Revised Air Defense Program," 20 May 1960 [Doc 4 in Hist of ADC, Jan-Jun 1960]; USAF to ADC, "Implementation of Revised Air Defense C&W Program (416L)," 9 Jun 1960 [Doc 5 in Hist of ADC, Jan-Jun 1960].

relayed air defense data. TM-192 had been transferred to Air Training Command. Still operational in air defense at the end of 1960 were P-17, P-52, P-58, P-75, P-78, P-79, M-89, M-91, M-94 and M-95.[3]

Some of the earlier enthusiasm for FD radar wore thin in 1960 after testing programs for the FPS-24, FPS-27 and FPS-35 got well underway. The FPS-7 was regarded as an FD radar, although it was developed and tested before the FD program, as a separate entity, was devised. All three specifically FD radars revealed serious design deficiencies during testing and none were operating satisfactorily at test sites (the FPS-24 at TM-199, Eufaula, Alabama; the FPS-27 at TM-195, Crystal Springs, Mississippi; the FPS-35 at TM-197, Thomasville, Alabama) at the end of 1960. Testing of both the FPS-24 and FPS-27 had halted pending completion of required modifications by the contractor. The problems were many. Even if the FD radars could be made to work according to specifications, there was serious doubt as to their compatibility with SAGE. And no solution had been reached as regards interference with other electronic

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3. ADC AC&W Operational Status Report, 31 Dec 1960 [Doc 1 in Hist of ADC, Jul-Dec 1960].

systems. The FD radars emitted from three to five times as much power as existing radars and vastly multiplied the interference problem. The only answer, to this time, was for ADC to accept operating restrictions on the radar, thus lessening the efficiency of the radar.[4]

The FD situation looked so unpromising by December 1960 that the SAGE project office asked that the entire FD program be re-evaluated for feasibility. This task was undertaken as a joint effort by the Electronic Systems Center (ESC) of AMC and the Command and Control Development Division (CCDD) of ARDC. These agencies concluded that things were not really as bad as they looked and that FD was salvageable and could be made compatible with SAGE if sufficient effort and money was expended. It was recommended, however, that quantity procurement of the FPS-27 be delayed until May 1961 to permit further testing. USAF agreed to this postponement.[5]

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4. Command, Control and Surveillance Systems Summary ADC, Jan-1961, pp. 35-36 [Doc 4 in Hist of ADC, Jul-Dec 1960]; Msg ADLPG-E 2287, ADC to ARDC, 12 Aug 1960 [Doc 5 in Hist of ADC, Jul-Dec 1960]; Weekly Activity Report, ADOAC, 2 & 9 Dec 1960 [HRF]; Msg PGTY/MOY 16-9-39, APGC to ADC, 17 Sep 1960 [Doc 6 in Hist of ADC, Jul-Dec 1960]; Msg ADOOP-EI 2978, ADC to SAGE PO, 31 Oct 1960 [Doc 7 in Hist of ADC, Jul-Dec 1960]; Msg LEWSQ 238-E, ESC to ROAMA, 9 Nov 1960 [Doc 8 in Hist of ADC, Jul-Dec 1960]; ROAMA, "Advance 'PCSP' Data for C&E," 3 Feb 1961 [Doc 3 in Hist of ADC, Jul-Dec 1960].

5. Msg CCS-20-12-3-E, SAGE PO to ARDC, 21 Dec 1960 [Doc 9 in Hist of ADC, Jul-Dec 1960]; Msg 4D4CS-C 12-380-E, ADC Command and Control Defense Systems Office to ADC, 24 Dec 1960 [Doc 10 in Hist of ADC, Jul-Dec 1960]; Msg FMLEG 15E, ESC to USAF, 13 Jan 1961 [Doc 11 in Hist of ADC, Jul-Dec 1960]; Msg AFODC 81110, USAF to ESC, 30 Jan 1961 [Doc 12 in Hist of ADC, Jul-Dec 1960].

Because of continuing difficulty in obtaining definitive action on anti-jam modifications for the FPS-20 radar, another attempt was being made in late 1960 to make an FD set of the FPS-20. This proposal involved "marrying" the FPS-20 and FPS-30 to create a radar that would operate on four frequencies, two in the 600 mcs band and two in the 1200 mcs band. At the end of 1960 ADC was preparing to recommend that this marriage be consummated by about 30 FPS-20 radars at a cost of approximately $12 million.[6]

Despite testing problems, the first of the specifically FD radars was declared operational at Montauk, New York (P-45) in December 1960 when the FPS-35 radar entered the air defense network. What FD radar would do to adjacent electronic equipment became apparent soon after pre-operational testing began. All unshielded radio receivers experienced interference whenever the radar beam passed over. Television reception was scrambled within a six-mile radius. As to radiation, ADC decided, in September 1960, that ground-to-air transmitters, which always involved human operators, must be at least 100 meters from FD radars. This ruling followed criteria established earlier by ADSID.[7]

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6. Weekly Activity Report, ADLPG-E, 14 Dec 1960 [HRF].

7. Hist of 26 AD, Apr-Dec 1960, p. 100.

During 1960 the number of operational FPS-7 stations increased from two to 11. Stations at P-9 (Highlands, New Jersey) and P-35 (Osceola, Wisconsin) became operational in 1959. Joining this pair in 1960 were:[8]

P-10	North Truro, Massachusetts
P-12	North Bend, Oregon
P-21	Lockport, New York
P-34	Empire, Michigan
P-38	Mill Valley, California
P-44	Makah, Washington
P-53	Rockville, Indiana
M-118	Burns, Oregon
TM-196	Dauphin Island, Alabama

In late March 1960, USAF confirmed that 84 ADC radar stations would be equipped with FD radar (including the FPS-7.)[9] By the end of the year, however, that number had dwindled to 78, to be deployed as shown in Table 23.

None of the reprogramming action of early 1960 had any effect on the CADIN proposal to add seven radars in Canada between the Pinetree and Mid-Canada Lines. In fact, the Northern NORAD Region (NNR) asked, in May 1960, that the eastern end of this supplementary radar line be strengthened by the addition of FPS-24 FD radars at Winisk and Knob Lake in Quebec. If this was impossible, NNR suggested that the two FPS-7 radars scheduled for

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8. ADC AC&W Operational Status Report, 31 Dec 1960 [Doc 1 in Hist of ADC, Jul-Dec 1960].

9. USAF to NORAD, "Revised Air Defense Program," 30 Mar 1960 [Doc 1 in Hist of ADC, Jan-Jun 1960].

CADIN stations in western Canada (at Yorkton and Alsask, Saskatchewan) be transferred to Quebec. As a third option, NNR recommended three FPS-20 radars be made available at Great Whale Lake, Quebec, as well as Winisk and Knob Lake. At the end of 1960, NORAD had accepted the third option and was preparing to write a requirement for three additional FPS-20 search radars into its Objectives Plan.[10]

Meanwhile, no change was made in plans for the seven original CADIN supplementary radars, except that expected operational dates became more pessimistic. At the end of 1960 the deployment of new CADIN radars was programmed as follows:[11]

Site	Equipment	Operational Date Estimate End 1959	Operational Date Estimate End 1960
C-42 Chibougamau, Quebec	FPS-20	Nov 1961	Nov 1961
C-44 Moosonee, Quebec	FPS-20	Nov 1961	Feb 1962
C-49 Gypsumville, Manitoba	FPS-27	Jul 1962	Dec 1962
C-51 Yorkton, Saskatchewan	FPS-7	May 1962	Oct 1962
C-52 Dana, Saskatchewan	FPS-27	Aug 1962	Jan 1963
C-53 Alsask, Saskatchewan	FPS-7	Sep 1962	Nov 1962
C-54 Red Deer, Alberta	FPS-27	May 1962	Feb 1963

Progress was steady toward the goal of widest possible joint use of ADC and FAA radar, but there were continual

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10. Hist of NORAD, Jul-Dec 1960, pp. 14-15.

11. ADC AC&W Operational Status Report, 31 Dec 1960 [Doc 1 in Hist of ADC, Jul-Dec 1960].

problems as to who would do what, and when, in connection with such matters as maintenance, logistic support, financing, manpower and the handling of equipment which ADC no longer needed, but FAA wanted to continue using. The JRPG, formed at a time when joint use was in the study stage, continued to meet once a month to grapple with the problems that arose periodically despite increasing familiarity of each agency with the administrative methods and policies of the other.[12]

The number of operational joint use radar stations increased from 11 to 16 during 1960. These were located as shown in Table 24 at the end of 1960. In addition, two ADC stations in New Mexico -- P-7 at Continental Divide and P-51 at Moriarity were being used by FAA, although they no longer provided air defense information. The joint use plan in effect at the end of 1960 called for ultimate joint use of 50 radar stations, 35 belonging to ADC, 15 to FAA.

Because administration of a joint radar station was so complicated, ADC and FAA agreed that wherever possible meetings of minds be supported by a formal written compact. Under this concept, a Memorandum of Understanding covering the detailed arrangements for seven joint use stations

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12. Hist of ADC, Jul-Dec 1960, pp. 137-50.

was formalized 19 January 1961. This memorandum involved P-7, P-52 (Oklahoma City -- not currently in joint use, but scheduled to become so in 1961), P-58, P-75, P-79, M-91 and M-94. This document also spelled out arrangements for air defense use of 15 FAA radars in the Denver and Salt Lake areas.[13]

Economy measures essential in Fiscal Year 1961 were responsible for a net loss of 12 operational prime radar stations from the United States aircraft control and warning network in 1960. Fifteen stations were lost and three were gained to reduce the number of operational locations from 131 at the end of 1959 to 119 at the end of 1960.

Six of the seven "Permanent" stations deleted were in the interior of the United States or along the southern border, areas where radar coverage was being thinned-out by direction of the Department of Defense -- P-7 (Continental Divide, New Mexico), P-42 (Lake City, Tennessee), P-51 (Moriarity, New Mexico), P-60 (Colville, Washington), P-68 (Fordland, Missouri) and P-77 (Bartlesville, Oklahoma). The seventh deleted station was P-1 at McChord AFB, Washington, in the heart of the vital

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13. ADC/FAA Memorandum of Understanding, 19 Jan 1961 [Doc 166 in Hist of ADC, Jul-Dec 1960].

northwest area. It was replaced, however, by RP-1 at nearby Fort Lawton, Washington.[14]

Reductions in the permanent system were not as drastic as they might seem, since five of six resited Permanent stations were expected to become operational in early 1961. These were RP-31 (Arlington Heights, Illinois), RP-39 (San Pedro Hill, California), RP-54 (Ft. Meade, Maryland), RP-62 (Oakdale, Pennsylvania) and RP-63 (Gibbsboro, New Jersey). The sixth, RP-15 (Lompoc, California), was scheduled for operational readiness in May 1962.

The 29 operational stations of Phase I of the Mobile radar program were untouched by reductions, but eight stations of Phases II and III were closed. The four stations deleted from Phase II were SM-139 (Willmar, Minnesota), SM-144 (Union City, Tennessee), SM-145 (Joelton, Tennessee) and SM-165 (Flintstone, Georgia). These deletions reduced the total Phase II program to 15 stations, of which 12 were operational. The three stations not yet operational at the end of 1960 were SM-133 (Hastings, Nebraska), SM-134 (Pickstown, South Dakota) and SM-149 (Baker, Oregon). Four stations in

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14. ADC AC&W Operational Status Report, 31 Dec 1960 [Doc 1 in Hist of ADC, Jul-Dec 1960].

Texas -- TM-189 at Zapata, TM-190 at Port Isabel, TM-192 at Killeen and TM-193 at Lufkin -- were removed from Phase III, reducing the total program to 17 stations. These losses were partially offset by the coming to operational readiness of TM-178 at Lewiston, Montana. This brought the number of operational Phase III stations to 12. The five Phase III stations still short of operational readiness were TM-179 (Kalispell, Montana), TM-195 (Crystal Springs, Mississippi), TM-197 (Thomasville, Alabama), TM-199 (Eufaula, Alabama) and TM-201 (Sundance, Wyoming).

A measure of surveillance capability was added to the ADC network in 1960 when the Air National Guard radar station (CW-59) at Buckley Field (Denver), Colorado, began around-the-clock operations with an FPS-8 radar. A third supplementary radar (outside the "P" system and Phases I, II and III of the Mobile program), was expected to become operational at Z-211 (Patrick AFB, Florida) in July 1964.

While the size of the radar network decreased in 1960, quality was considerably improved. More than half the operating stations had either FD or FPS-20 sets. The FD group consisted of 11 FPS-7 and one FPS-35. Sixty

stations had the FPS-20. The remainder of the network (47 stations) had a mixture of CPS-6B, FPS-3, GPS-3, FPS-10, MPS-7, MPS-11, FPS-8 and ARSR-1 radars.[15]

15. Ibid.

CHAPTER TEN

FREQUENCY DIVERSITY RADAR DELAYED

1961

There was general agreement in 1961, as there had been in 1956, that FD radar was the best means of countering the ever-improving ECM capability of bomber forces. The theory was indisputable, but when the practical matter of getting FD radar into routine use in the operational air defense system was approached, substantial difficulties arose. Disregarding the FPS-7, which was developed before the FD era, but was included in the FD program because it operated at frequencies not covered by the FPS-24/27/35 sets, FD was in serious

trouble. Although the first production-model FPS-35 was installed at P-45 (Montauk, New York) in 1960 and hopefully declared operational in December of that year, it was removed from that status early in 1961 because it did not truly deserve such designation. Other FPS-35 sets were installed at P-20 (Selfridge AFB, Michigan), P-30 (Benton, Pennsylvania) and P-55 (Manassas, Virginia) in 1961, as was an FPS-24 at P-37 (Point Arena, California), but none was considered operational at the end of the year. The problems were well understood, and fell mainly into two areas. First, the FD radar had a tendency to interfere with anything else electronic in the area. Also, it was very difficult to keep the radar operating because of various mechanical weaknesses and an acute shortage of spare parts.

Interference was the more serious of the two problems. One theoretical answer was to provide high-power filters, but the initial ADC reaction was that nobody seemed to know how to go about building one. Proposed filters, however, were being tested by the end of 1961, but there was no assurance that they would be effective. As a result, it was necessary at Selfridge, for example, to close down the FPS-35 during periods of

IFR weather because the radar interfered with control tower operations. At M-96 (Almaden, California) testing of the FPS-24 could be conducted only at times when the local television stations were not operating.

It also appeared possible to restrain FD interference by narrowly restricting the frequencies used, but ADC opposed this solution as negating the very premise on which the frequency diversity concept was founded.[1]

A related problem was that the difference between the "breadboard" test models being analyzed on the Gulf Coast (FPS-27 at TM-195, Crystal Springs, Mississippi; FPS-35 at TM-197, Thomasville, Alabama; and FPS-24 at TM-199, Eufaula, Alabama) and the production-model radars being installed elsewhere in the United States was so great that the test results were hardly pertinent. Therefore, it would be impossible to obtain usable test results until the contractors (General Electric -- FPS-24, Westinghouse -- FPS-27, and Sperry -- FPS-35) could update the test models. This situation promised

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1. Msg ROXMWT 553-E, GEEIA to ADC, 16 Feb 1961 [Doc 6 in Hist of ADC, Jan-Jun 1961]; Msg ADOAC-AF 402, ADC to GEEIA, 21 Feb 1961 [Doc 5 in Hist of ADC, Jan-Jun 1961]; Msg ADOAC-AF 478, ADC to CCDD, 3 Mar 1961 [Doc 7 in Hist of ADC, Jan-Jun 1961]; Weekly Activity Reports, ADOAC-A, 10 and 23 Jun 1961 [HRF]; Msg ADOAC-AF 2898, ADC to AFSC, 22 Dec 1961 [Doc 12 in Hist of ADC, Jul-Dec 1961].

not only to delay Category II and III testing beyond the previously established completion date of May 1962, but also to seriously delay planned dates for operational readiness and compatibility with SAGE.

The FPS-27, in particular, was in such difficulty that USAF, in March 1961, considered terminating the entire FPS-27 program. Asked to comment on the matter, both APGC and ESD agreed, the following month, that a weather clutter problem which especially dogged the FPS-27 could be solved. Both agencies recommended continuance, especially since there was no alternative radar. USAF accepted this conclusion and released procurement funds, but shortly thereafter revealed that DOD was having doubts about the place of the FPS-27 in a period likely to be dominated by the ICBM and asked that ADC prepare an alternative FD plan which would eliminate the FPS-27. ADC objected to the loss of a major element of the FD program, but forwarded such an alternative plan to USAF in May 1961. The upshot of this exercise was not cancellation of the FPS-27, but rather the loss of six programmed sets. This decision, announced by USAF on 1 November 1961, resulted in deletion of programmed FPS-27 radars from RP-1 (Fort Lawton, Washington), P-67 (Custer, Michigan), P-74 (Madera, California), M-111 (Marietta, Georgia), M-127 (Winnemucca,

Nevada) and Z-211 (Patrick AFB, Florida).[2]

The deletion of six FPS-27 radars reduced the size of the FD radar program (including the FPS-7) from 78 stations to 72 at the end of 1961.[3]

A proposal to make an FD radar of the FPS-20 by "marrying" it to the FPS-30 died a quick death. USAF disapproved the proposal on 14 February 1961 on the grounds that projects of higher priority were absorbing all available funds.[4]

Anyway, the confusion of 1958 and 1959 over the type of anti-jam circuitry to be provided the FPS-20

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2. Msg PGTY/MOY 5-12-46, APGC to CCDD, 6 Dec 1960 [Doc 9 in Hist of ADC, Jan-Jun 1961]; Msg RCLCE 6-1-1-1-1-E, RADC to APGC, 7 Jan 1961 [Doc 10 in Hist of ADC, Jan-Jun 1961]; Msg PGTY/MOY 16-5-25, APGC to ESD, 17 May 1961 [Doc 11 in Hist of ADC, Jan-Jun 1961]; Msg PGTY 9-12-48, APGC to SAGE PO, 10 Dec 1960 [Doc 12 in Hist of ADC, Jan-Jun 1961]; Msg RONBLA 6, ROAMA to CCDD, 7 Jan 1961 [Doc 13 in Hist of ADC, Jan-Jun 1961]; Msg PGTYS 7-4-119, APGC to ADC, 7 Apr 1961 [Doc 14 in Hist of ADC, Jan-Jun 1961]; Msg ESG 11-4-1, ESD to USAF, 12 Apr 1961 [Doc 15 in Hist of ADC, Jan-Jun 1961]; Msg AFOOP-DE 64338, USAF to ADC, 21 Apr 1961 [Doc 16 in Hist of ADC, Jan-Jun 1961]; Msg LEMS 241-E, ESC to USAF, 11 Nov 1960 [Doc 17 in Hist of ADC, Jan-Jun 1961]; Msg ESSWS 15-6-68-E, ESD to ADC, 15 Jun 1961 [Doc 21 in Hist of ADC, Jan-Jun 1961]; Msg AFODC-OP 75011, USAF to ADC, 1 Nov 1961 [Doc 5 in Hist of ADC, Jul-Dec 1961].

3. ADC Control and Warning Equipment Report, 31 Dec 1961 [Doc 1 in Hist of ADC, Jul-Dec 1961].

4. Msg AFORQ-AD/C 97636, USAF to ADC, 28 Mar 1961 [Doc 4 in Hist of ADC, Jan-Jun 1961].

was gradually cleared away in 1960 and 1961 and actual modification began, thereby improving the performance of the FPS-20 in the face of electronic countermeasures. On 25 June 1959, Bendix was awarded a contract for production of 11 MK-447 modification kits and 33 kits of the MK-448 type. These kits were subsequently named AN/GPA-103 (MK-447) and AN/GPA-102 (MK-448). Both kits contained modifications functionally named -- to the technical mind -- Dicke Fix, improved logarithmic receiver, side lobe cancellor, duplexer, azimuth versus amplitude, moving target indicator, constant false alarm rate and improved sensitivity time control. Only the GPA-103 included a velocity filter. It also became obvious that installation of the modification kits would so greatly change the FPS-20 and FPS-20A that new model designations were required. The only differences between FPS-20 and FPS-20A were some minor internal modifications, but it was decided, nevertheless, that addition of GPA-102/103 would result in four new radars. Therefore, the FPS-20 with GPA-102 became FPS-64, FPS-20 with GPA-103 became FPS-65, FPS-20A with GPA-102 became FPS-66 and FPS-20A with GPA-103 became FPS-67.[5]

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5. Msg ADOAC-EW 2594, ADC to ROAMA, 20 Sep 1960 [Doc 67 in Hist of ADC, Jul-Dec 1961]; ADC, Communications and Electronics Digest, July 1961, pp. 7-13.

Testing of the GPA-102/103 began in August 1960 and by November 1960 so many deficiencies had been revealed and the likelihood of incompatibility with SAGE had become so apparent that ESC and the SAGE Project Office felt impelled to recommend that a second Bendix contract for 14 modification kits be cancelled and installation of the 44 kits under the earlier contract be limited to non-SAGE areas. ARDC and ADC, however, thought this proposal premature, especially since Bendix had acknowledged the shortcomings of the GPA-102/103 and had promised to rectify the deficiencies at Bendix expense. USAF, for the moment, sided with ARDC and ADC.[6]

But the USAF position was held only a short time and within two weeks USAF, noting the continuing lack of unanimity with regard to the GPA-103 in particular, decided to withhold further procurement of the GPA-103 until a proposed substitute (a Cascaded Dicke Fix/ Automatic Mapper combination suggested by ESC and the SAGE Project Office) could be tested. This test was concluded in the summer of 1961 and in September 1961 USAF concluded that the GPA-103 offered the greater anti-jam potentiality.[7]

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6. Msg RDRC 6-12-20, ARDC to CCDD, 6 Dec 1960 [Doc 41 in Hist of ADC. Jul-Dec 1961]; Weekly Activity Reports, ADLPG-E, 26 Oct, 23 Nov and 6 Dec 1960 [HRF].

7. Msg AFMMP-EP-2 70217, USAF to AMC, 16 Dec 1960 [Doc 71 in Hist of ADC, Jul-Dec 1961]; Weekly Activity Report, ADOAC-A, 22 Sep 1961 [HRF].

Meanwhile, in February 1961, GEEIA announced that it proposed to complete 40 GPA-102/103 installations before the end of 1961. It was planned that the first GPA-102 modification would be operational in July 1961, with 30 in place by the end of the year. It was also expected that the first GPA-103 would be operational in July, with 10 such modifications completed by the end of 1961.[8]

Performance fell short of plans, however, and at the end of 1961 only 20, instead of 40, FPS-20 radars were operational with the anti-jam modifications. Because of the protracted discussion of the GPA-103, only three such modification kits were in place at the end of 1961. Radar in the FPS-64/67 series were operational at the locations shown in Table 25 at the end of the year.

A proposal to reduce considerably ADC commitments to the Pinetree Line in Canada reached the point of government-to-government agreement in June 1961. In return for the transfer of 66 F-101B interceptors to Canada, that NORAD partner agreed to assume complete operational and financial responsibility for 11 Canadian

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8. Msg ROZICG 534-E, GEEIA to Eastern GEEIA Region, 2 Feb 1961 [Doc 72 in Hist of ADC, Jul-Dec 1961].

radar stations built and currently operated by ADC. Eight of these stations had been provided as a Radar Expansion Program in connection with the "Permanent" radar system within the United States. The other three were part of the subsequent Mobile radar program. The first of these stations, C-17 at Bausejour, Manitoba, was formally transferred to Canada on 1 October 1961. The schedule for the transfer of the other 10 stations was as follows:[9]

C-10	Ramore, Ontario	1 Jan 1962
SM-153	Kamloops, British Columbia	1 Apr 1962
M-102	Barrington, Nova Scotia	1 Jun 1962
C-16	Sioux Lookout, Ontario	1 Oct 1962
C-15	Armstrong, Ontario	1 Nov 1962
C-19	Puntzi Mountain, British Columbia	1 Feb 1963
C-20	Baldy Hughes, British Columbia	1 Mar 1963
C-21	Saskatoon Mountain, Alberta	1 Apr 1963
C-14	Pagwa, Ontario	1 Jun 1963
M-119	Lowther, Ontario	1 Jun 1963

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9. Note 604, U. S. Ambassador to Canada to Canadian Secretary of State for External Affairs, 12 Jun 1961 [Doc 403 in Hist of ADC, Jan-Jun 1961]; Agreement between RCAF and USAF, 12 Jul 1961 [Doc 405 in Hist of ADC, Jan-Jun 1961]; ADC Programmed Action Directive 61-15, 2 Aug 1961 [Doc 2 in Hist of ADC, Jul-Dec 1961]; Msg, Canadian Air Defence Hq to Station Beausejour, 13 Sep 1961 [Doc 3 in Hist of ADC, Jul-Dec 1961].

Meanwhile, the plan to strengthen Canadian radar defenses in the area between the Pinetree Line and the Mid-Canada Line with seven FPS-20, FPS-7 and FPS-27 radars went forward. Proposed operational dates of four of these sites, however, suffered further slippage. At the end of 1961, locations and proposed operational dates were:[10]

Site		Equipment	Operational Date Estimate End 1960	Operational Date Estimate End 1961
C-42	Chibougamau, Quebec	FPS-20	Nov 1961	May 1962
C-44	Moosonee, Quebec	FPS-20	Feb 1962	Jun 1962
C-49	Gypsumville, Manitoba	FPS-27	Dec 1962	Dec 1962
C-51	Yorkton, Saskatchewan	FPS-7	Oct 1962	Feb 1963
C-52	Dana, Saskatchewan	FPS-27	Jan 1963	Jan 1963
C-53	Alsask, Saskatchewan	FPS-7	Nov 1962	Jan 1963
C-54	Penhold, Alberta	FPS-27	Feb 1963	Feb 1963

While the number of joint use ADC/FAA radars gradually increased during 1961, most of the year was given over to a discussion of whether or not FAA could, or should, become a partner in the SAGE control system. Project TRAILSMOKE of April-June 1960 produced a conclusion that SAGE could be used in air traffic control. FAA, therefore, made tentative plans for the use of SAGE. But DOD cancellation of plans for hardening SAGE sites against nuclear attack and reductions in the scope of SAGE caused some doubt in FAA and led Elwood R. Quesada,

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10. ADC Control and Warning Equipment Report, 31 Dec 1961 [Doc 1 in Hist of ADC, Jul-Dec 1961].

FAA Administrator in the outgoing Eisenhower administration, to question USAF, in January 1961, about the permanence of SAGE. General Curtis E. LeMay, Chief of Staff, USAF, in an answer directed to Najeeb E. Halaby, FAA Administrator in the incoming Kennedy administration, was unable to guarantee the permanence of SAGE, but pointed out that as a lesser degree of SAGE computer capability was required for air defense purposes a greater degree would be available for control of civilian air traffic. General LeMay reaffirmed the desire of USAF to cooperate with FAA in the closest possible integration of air defense and air traffic control.[11]

This discussion took a new twist in March 1961 when President John F. Kennedy directed Mr. Halaby to make a thorough study that would lead to a long range plan for air traffic control. This study came to be known as Project BEACON and when submitted to the President on November 1, 1961, recommended against the use of SAGE in air traffic control. Rumors reaching ADC were to the effect that one school of thought in FAA

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11. Elwood R. Quesada, FAA Administrator to Gen. Curtis E. LeMay, C/S, USAF, no subj, 16 Jan 1961 [Doc 377 in Hist of ADC, Jul-Dec 1961]; LeMay to Najeeb E. Halaby, FAA Administrator, no subj, 20 Feb 1961 [Doc 378 in Hist of ADC, Jul-Dec 1961].

had qualms about FAA sharing responsibility for what might prove to be an Air Force white elephant that could cost as much as $700 million a year to operate. At any rate, Project BEACON recommended that FAA make maximum use of ADC radars, but with data being fed into an FAA-designed control system that appeared, in many ways, to duplicate SAGE.[12]

The conclusions of Project BEACON did not seem realistic to ADC. It was the ADC view that, in light of the considerable ADC capability in the tracking and control of aircraft, the futures of ADC and FAA were inextricably bound together. For FAA to recommend that a part of the air defense system not be used for air traffic control was, to ADC, completely illogical.[13]

Whatever the future of SAGE in air traffic control, the number of radar stations being jointly used by ADC and FAA increased from 16 to 22 during 1961. One of the new stations was MM-1 at Fort Heath, Massachusetts, a part of the anti-aircraft defenses of Boston, that supplied information not only to the Army, but to ADC and FAA as well. The other 21 joint-use stations were

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12. Wall Street Journal, 3 Apr 1961; New York Times, 13 Nov 1961; FAA, Report of the Task Force on Air Traffic Control, Oct 1961 [Doc 381 in Hist of ADC, Jul-Dec 1961].

13. Weekly Activity Report, ADLPD-D, 27 Dec 1961 [HRF].

located and equipped as shown in Table 26. The total joint-use program was reduced from 50 stations (35 ADC, 15 FAA) to 45 (31 ADC, 14 FAA) during 1961. The 14 FAA radars in the Denver and Salt Lake areas were expected to become operational in 1962 and 1963.[14]

There was very little change in the size of the air defense radar network during 1961. Three relocated Permanent stations (RP-39 at San Pedro Hill, California; RP-62 at Oakdale, Pennsylvania; and RP-63 at Gibbsboro, New Jersey) became operational, but two replaced stations (P-39 at San Clemente Island, California; and P-63 at Claysburg, Pennsylvania) ceased operations for a net gain of one station. The three remaining relocated stations (RP-15 at Lompoc, California; RP-31 at Arlington Heights, Illinois; and RP-54 at Fort Meade, Maryland) were expected to reach operational capability in 1962.

One Phase II and one Phase III station (SM-134 at Pickstown, South Dakota; and TM-179 at Kalispell, Montana) of the Mobile radar program reached operational readiness in 1961, while the Phase III station at TM-194 (Lake Charles, Louisiana) was reduced to gap filler

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14. ADC Control and Warning Equipment Report, 31 Dec 1961 [Doc 1 in Hist of ADC, Jul-Dec 1961].

status. These actions left two Phase III stations (SM-133 at Hastings, Nebraska; and SM-149 at Baker, Oregon) and four Phase III stations (TM-195 at Crystal Springs, Mississippi; TM-197 at Thomasville, Alabama; TM-199 at Eufaula, Alabama; and TM-201 at Sundance, Wyoming) for completion in 1962. The delays were caused at TM-195, TM-197 and TM-199 by the fact that these locations were being used as test sites for FD radars and had received early "breadboard" models of FD sets. They could not become operational in active air defense until the test sets had been modified to production-model specifications. TM-201 was delayed because it was to be used in an experiment to determine if atomic energy could be used to produce sufficient electrical power to operate a radar station.

Also added to the aircraft warning and control system in 1961 were MM-1, an Army Missile Master site equipped with the ARSR-1, and Z-211, a surveillance station at Patrick AFB, Florida. In sum, seven operational stations were gained and three lost, raising the total of long-range air defense radars from 119 at the end of 1960 to 123 at the end of 1961, a figure still somewhat short of the previous high-water mark of 131 stations at the end of 1959.[15]

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15. Ibid.

PART FOUR

RETRENCHMENT

1962 - 1966

CHAPTER ELEVEN

FREQUENCY DIVERSITY TESTING CONTINUES

1962

A change in the nature of air defense was heralded in October 1957 when the Russians placed Sputnik I in orbit and made a certainty of the possibility that intercontinental ballistic missiles would become a factor in offensive warfare.

Despite the emergence of the ICBM, it was evident that the manned bomber would continue to constitute a significant portion of the threat for an uncounted number of years into the future, so a continuing effort had to be made to increase the efficiency of the ground

environment of the air defense system. Part of this effort involved replacement of early post-war radar with more advanced equipment of the FPS-7 and FPS-20 types.

Also came the realization that the offense was getting ahead of the defense by development of airborne electronic countermeasures (ECM) that threatened to blind defense radar on the ground. The answer to the feint was the counter-feint, a suggestion put forward by Project LAMPLIGHT in 1955. The idea of frequency diversity (FD) radar was embraced by ADC and endorsed by USAF. In October of 1957, USAF approved an ADC plan which proposed the installation of 105 FD radars within the United States between July 1959 and March 1964.

Implementation, unfortunately, did not follow the original plan. Over the years the size of the FD program was pared down and two of the five proposed types of FD radars (FPS-28 and FPS-53) were dropped from consideration. None of the three surviving types (FPS-24/27/35) were fully operational at the end of 1961 -- two-and-one-half years after the date originally set for initial operations.

The problems haunting FD radar lay in three areas. The most important, from a public relations standpoint,

was the unfortunate tendency of the high-powered FD radar to interfere with the operation of other electronic devices for miles around. A second problem was also traceable to the immense power output of the FD sets. This one involved radiation, which seemed not only to be hazardous to nearby personnel but also to the electro-explosive devices (EED) used to trigger air-to-air and ground-to-air missiles. Finally, the FD radars were extremely difficult to maintain and spare parts seemed perpetually in short supply.

The interference problem grew in intensity in early 1962 as more and more FD radars reached the testing stage. The numbers of irritated radio and television station owners, not to mention listeners and watchers, increased rapidly and Congressional pressure in this matter grew steadily heavier. Finally, in July 1962, ADC reported to USAF that interference was being caused by every FD radar on the air and that the time for hand-wringing had passed. Something had to be done.[1]

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1. Msg ADOAC-ER 596, ADC to ESD, 1 Mar 1962 [DOC 4]; Msg ADOAC-ER 1304, ADC to 28 AD, 10 May 1962 [DOC 5]; Msg ADOAC-AF 1441, ADC to Air Divs, 25 May 1962 [DOC 6]; Msg ADOAC 1791, ADC to USAF, 6 Jul 1962 [DOC 7].

The USAF response was to call a conference of all interested Air Force agencies at Hanscom Field on 1-2 August 1962. The solution produced at this conference was almost deceptively simple. The burden of it was that the interference produced by FD radars was not really an Air Force problem. Experts in the field, including those of the Federal Communications Commission, insisted that interference could be avoided by owners of private electronic equipment if they would follow a few simple procedures. The answer seemed to lie in an intensive campaign of public education, a campaign which began in the fall of 1962. Air Force units were cautioned not to spend any Air Force money or use any Air Force equipment in helping civilians avoid interference from FD radars. Only advice was to be offered. The way was apparently open for unrestricted radar testing.[2]

While interference proved irritating, the possibility that the radiation from FD radars might touch off electronic-explosive triggering devices in missiles revealed a danger to life and property. Although radiation hazards to people had been discussed almost

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2. Msg AFSME-EE/GE 76388, USAF to RADC, 21 Aug 1962 [DOC 8]; Msg ADOAC-AF 2241, ADC to Air Divs, 24 Aug 1962 [DOC 9].

from the beginning of the FD program, the danger to EED was not recognized until September 1962 when the question was raised during the testing of an FPS-35 at P-20 (Selfridge AFB, Michigan). A similar situation arose shortly thereafter in connection with an FPS-24 at SM-147 (Malmstrom AFB, Montana). It was significant that ADC interceptor units, both storing EED, were located at these bases. ADC immediately asked that USAF appoint some agency to determine the true extent of the danger. Testing at Selfridge was severely limited and that at Malmstrom was halted completely. Pending an answer from USAF, the ADC air divisions were polled to discover how widespread this potential hazard might be. The replies indicated that 35 FD radars were located in areas where EED were either stored or handled.[3]

In October 1962, USAF directed AFSC to seek a solution to the EED problem which would not unduly restrict ADC operationa. To underline this proviso, ADC informed AFSC that it would not consider blanking or reducing the power of FD radar to protect EED until all other approaches to the problem had been rejected. No possible solutions had been suggested by AFSC by the end of 1962.[4]

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3. Msg ADOAC-ER 2539, ADC to USAF, 20 Sep 1962 [DOC 10]; Msg ADOAC-ER 2718, ADC to USAF, 11 Oct 1962 [DOC 11].

4. Weekly Activity Reports, ADOAC, 12-18 Oct and 9-15 Nov 1962 [HRF].

Various spare parts shortages had hampered FD radars from the start of testing, but one that promised to develop into a serious handicap in the future was the repeated failure of the antenna bearing in the test model of the FPS-24 at TM-199 (Eufaula, Alabama) and the imminent failure of a bearing in the set at P-37 (Point Arena, California). It appeared that the material used was not sufficiently strong to support the weight of the constantly turning antenna. No relief was in sight at the end of 1962.[5]

Category II testing of FD radars, supervised by AFSC, was completed 15 June 1962. Category III testing, which was supervised by ADC, began 1 July 1962. All testing was expected to be complete in early 1963.[6]

Seven FD radars (FPS-24/27/35) were considered fully operational at the end of 1962. Four stations were equipped with the FPS-35 (P-29 at Finley, North Dakota; P-30 at Benton, Pennsylvania; P-55 at Manassas, Virginia; and SM-149 at Baker, Oregon). Three had the FPS-24 (M-96 at Almaden, California; M-130 at Winston-Salem, North Carolina; and SM-150 at Cottonwood, Idaho). No

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5. Msg ADOAC-ER 1984, ADC to ESD, 26 Jul 1962 [DOC 12]; Weekly Activity Report, ADOAC, 20-26 Jul 1962 [HRF].

6. Weekly Activity Report, ADLSP-C, 10 Jul 1962 [HRF].

FPS-27 sets had yet reached operational status.[7] The remainder of the FD program is shown in Table 27. At the end of 1962, the FD program included 46 stations, as compared to the 105 listed in the original plan of September 1957 and the 84 shown in the 1959 program.

Although the FD radars were designed to detect manned bombers, the possibility that they might be of use in the detection of sea-launched ballistic missiles (SLBM) was raised in late 1961 and early 1962. Sea-launched missiles were defined as those fired by either surface vessels or submarines. It was believed the Soviet Union was entirely capable of developing a missile equivalent to the Polaris possessed by the U. S. Navy.

The matter was brought up by USAF in December 1961, when it asked for ADC comment on the SLBM detection capability of FD radar. It was conceded by ADC that FD radar might be able to detect an SLBM in flight, but that FD ability to predict launch and impact points of such missiles was likely to be nominal at best. ADC was also concerned that use of FD radars in SLBM detection might lessen their effectiveness in their primary mission of bomber detection and might decrease their degree of

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7. ADC Control and Warning and Equipment Report, 31 Jan 1963 [HRF].

compatibility with SAGE. Nevertheless, ADC felt a test of FD capability with respect to SLBM would be worthwhile.[8]

USAF assured ADC that any modification to FD radar for the purpose of SLBM warning would not limit performance of their primary mission or lessen SAGE compatibility. On the other hand, USAF insisted that the ability to predict launch and impact points was essential, since USAF was actively seeking development of a weapon capable of destroying a seaborne launcher. USAF added that it was seriously considering a Sperry proposal for modification of the FPS-35 for SLBM detection on the grounds that it appeared to be the cheapest and least complex method of providing an interim anti-SLBM warning capability during the development of a future system of far greater usefulness.[9]

This matter was discussed in a USAF/ESD/ADC conference of 30 January 1962, following which ESD recommended that Sperry be permitted to modify FPS-35 radars at P-45 (Montauk, New York) and P-55 (Manassas,

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8. USAF to ADC, "SLBM," 18 Dec 1961 [HRF]; S/NOFORN, Msg ADLPD-203, ADC to CCDSO, 25 Jan 1962 [DOC 15].

9. S/NOFORN, Msg AFORQ 95508, USAF to ADC, 24 Jan 1962 [DOC 13]; Msg ADLPD 206, ADC to CCDSO, 25 Jan 1962 [DOC 14].

Virginia) to see if the modified radars could detect missiles launched from Cape Canaveral in Florida. This recommendation was presented to the USAF Air Defense Panel on 2 March 1962 and generally approved, although the Panel concluded that the FPS-35 should not be expected to predict missile launch and impact points in view of an AFSC opinion that it was not feasible to attempt to destroy a submarine on the basis of data obtained from an FPS-36. A schedule was adopted which allowed three months for the test of the basic radar, 14 months for full-scale system tests and six months for the gathering of data and analysis of that data. At the end of this effort a decision would be made as to whether or not approximately a half-dozen more FPS-35 radars should receive the SLBM modification.[10]

Following final USAF approval of the FPS-35 feasibility test on 6 April 1962, the first meeting of the ADC FPS-35 Special Test Working Group, held on 2 May 1962, decided the test would begin on 21 May 1962 and end by 1 August 1962. Meanwhile, P-30 at Benton, Pennsylvania, had been substituted for P-45 as one of the two test locations.[11]

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10. Weekly Activity Reports, ADOAC, 2-8 Feb 1962, S/NOFORN, and ADLSP-C, 6 Mar 1962 [HRF].

11. Weekly Activity Reports, ADLPD-D, 6 Apr and 2 May 1962 [HRF]; Msg ADLPD 1041, ADC to USAF, 18 Apr 1962 [DOC 16]; Msg ADMME-AB 1108, ADC to ESD, 23 May 1962 [DOC 17].

The initial demonstration of FPS-35 ability to detect a ballistic missile came on 28 June 1962 when the radar at Manassas observed the launching of both Polaris and Minuteman missiles from Cape Canaveral. The test set at Benton did not detect the launchings because of an improper antenna angle, greater range and the existence of a severe temperature inversion along the East Coast (although the temperature inversion did not seem to bother the radar at Manassas). On 27 August 1962, the two FPS-35 test radars made seven observations on a Polaris missile at ranges between 900 nautical miles and 1145 nautical miles. In all, the Manassas radar made 15 detections during the test period, the Benton radar five. The missiles observed (Polaris, Minuteman, Titan and Thor-Delta) presented targets ranging in size from 25 square meters to 342 square meters. The USAF requirement was that the radar must be able to observe a 10-square-meter target at a range of 1000 miles. The FPS-35 test performance revealed that its ability to meet the requirement was marginal, at best.[12]

The question now arose as to the direction to follow in anti-SLBM development. There was general agreement among SAC, NORAD and ADC that the modified

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12. Weekly Activity Reports, ADLPD-D, 28 Jul and 28 Sep 1962 [HRF].

FPS-35 as tested at Manassas and Benton did not offer a credible deterrent against the SLBM threat, especially from a cost-effectiveness point of view. Sperry had estimated that modification of 10 FPS-35 sets to the Manassas/Benton configuration, plus automatic readout and refinement to a point where a one-square-meter target could be detected at a range of 840 miles, would cost $25 million and take 14-22 months. At the end of 1962, ADC was recommending that USAF closely examine a Hughes Aircraft Company proposal for an SLBM warning system, known as SPS-33, before coming to a decision on the FPS-35.[13]

Meanwhile, installation of the GPA-102/103 ECCM modifications to FPS-20 radars continued. Twenty such installations were in place and operating at the end of 1961. Seventeen more were added in 1962 as given in Table 28. Sixteen more FPS-64/67 modifications were planned for 1963 and 1964, giving a total program of 53 ECCM-modified FPS-20 radars. Twenty-two of these modifications were expected to produce an FPS-66 model, 19 an FPS-67, nine an FPS-64 and three an FPS-65.[14]

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13. Weekly Activity Report, ADOAC, 23-29 Nov 1962 [HRF]; Msg CS 9539, SAC to USAF, 1 Dec 1962 [DOC 18]; Msg ADLDC 3457, ADC to USAF, 13 Dec 1962 [DOC 19].

14. ADC Control and Warning Equipment Report, 31 Jan 1963 [HRF].

Similar ECCM modification was also being accomplished on FPS-7 radars by means of Engineering Change Proposal (ECP) 91. Since the FPS-7 was a somewhat more modern radar than the FPS-20 and had built into it a greater capability to combat electronic countermeasures than had the FPS-20, the changes introduced by ECP-91 were not as far-reaching as the GPA-102/103 modification of the FPS-20. Hence the nomenclature of the FPS-7 was not changed when ECP-91 was installed. Twenty ECP-91 installations were completed during 1962 as given in Table 29. Seven additional ECP-91 installations were planned for early 1963, for a total of 27. In all, it was planned to provide ECCM capability for 80 FPS-7 and FPS-20 radars. The FPS-64/67 and FPS-7 (ECP-91) configurations were not expected to be final at all locations however. In a number of instances the ECCM-modified FPS-7 and FPS-20 radars were to be eventually replaced by specially designed FD radars of the FPS-24/27/35 types.[15]

Two of the seven modern radars to be provided Canada under the CADIN project reached operational status in 1962. Both were in Quebec (C-42, Chibougamau

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15. Ibid.

and C-44, Moosonee), both were equipped with the FPS-20 and both became operational in October 1962. Four of the other five Canadian radar stations in CADIN, however, suffered further slippages:

Site		Equipment	Operational Dates: Estimate End-1961	Operational Dates: Estimate End-1962
C-49	Gypsumville, Manitoba	FPS-27	Dec 1962	Jun 1963
C-51	Yorkton, Saskatchewan	FPS-7	Feb 1963	Feb 1963
C-52	Dana, Saskatchewan	FPS-27	Jan 1963	Mar 1963
C-53	Alsask, Saskatchewan	FPS-7	Jan 1963	Mar 1963
C-54	Penhold, Alberta	FPS-27	Feb 1963	Apr 1963

In the autumn of 1962 the operational date for C-54 slipped from February 1963 to June 1963, an action which prompted the 25th Air Division to protest that this radar was desperately needed for SAGE use long before June 1963. It was the ADC position that it was unlikely that anything could be done about the situation, but that the problem would be placed before the Electronic Systems Division (ESD) of AFSC, the organization responsible for the installation and testing of the FPS-27 at C-54. After analyzing the particular difficulties at Penhold, ESD decided that it was possible to bring C-54 to operational capability in April 1963, a 60-day improvement.[16]

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16. Ibid; Weekly Activity Report, ADOAC, 14-20 Sep 1962 [HRF].

Despite the generally unfavorable comment about SAGE in the BEACON Report, FAA decided to investigate an Air Force suggestion that a joint test of three "Northern Tier" SAGE sectors -- Great Falls, Minot and Grand Forks -- be conducted before FAA made a final decision. Representatives of FAA visited the sectors in question in January 1962 and recommended to FAA Administrator Halaby that such a test be approved. For a short while, ADC considered modifying radar sites in the Northern Tier area to conform more closely to FAA requirements, but later came to the conclusion, with NORAD concurrence, that FAA should test Northern Tier in its strictly military configuration.[17]

The initial meeting of the ADC/FAA Northern Tier Implementation Group was held 18-20 July 1962. At that time it was tentatively agreed that the relocation of consoles should begin in October 1962 and necessary construction in November 1962. It was estimated that delivery of all FAA-required equipment would be completed in April 1963 and that FAA could be operational in the Northern Tier by 1 July 1963. In November 1962 it was necessary to revise these hopeful estimates

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17. Weekly Activity Reports, ADLSP-C, 16 Jan, 20 Feb and 26 Mar 1962 [HRF].

somewhat. Another Northern Tier meeting of 7-9 November estimated that construction would be complete by 15 February 1963, with all FAA equipment likely to be on hand by 1 July 1963. The new FAA Northern Tier operational date was given as 1 September 1963.[18]

The joint use radar network increased by another six stations during 1962, bringing the total to 28. Four of these were ADC sites (P-45, Montauk, New York; M-111, Marietta, Georgia; M-113, North Charleston, South Carolina; and M-114, Jacksonville NAS, Florida). The net addition was reduced by one, however, when TM-196, Dauphin Island, Alabama, was taken out of the joint-use category. Also, the first three of the 14 FAA radars planned for joint use in the Denver-Salt Lake City area reached operational readiness. These were Z-213 in Salt Lake City; Z-216 in Cedar City, Utah; and Z-218 in Rock Springs, Wyoming.[19]

The numerical size of the ADC radar network climbed back to the point where 131 long-range search radars were operational in the United States at the end of 1962, exactly the number operating at the previous

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18. Ibid., 24 Jul 1962 and ADOAC, 9-15 Nov 1962 [HRF].

19. ADC Control and Warning Equipment Report, 31 Jan 1963 [HRF].

high point at the end of 1959. Ten radars joined the operational network in 1962, while two were lost. Added were three relocated Permanent stations (RP-31 at Arlington Heights, Illinois; RP-54 at Ft. Meade, Maryland; and RP-78 at Perrin AFB, Texas). The Phase II Mobile radar program was completed with the addition of SM-133 at Hastings, Nebraska, and SM-149 at Baker, Oregon. Phase III came nearer completion when TM-201 at Sundance, Wyoming (which obtained power by use of a nuclear reactor) became operational. At the time of the Cuban crisis, a surveillance station, using a Navy FPS-37 radar, was added at Key West NAS, Florida (Z-209). The first three of 14 FAA radars on the Denver-Salt Lake City area (as mentioned above) became operational with ARSR-1/2 radars. Lost were M-97 at Ellsworth AFB, South Dakota, and the Army Missile Master site (MM-1) at Ft. Heath, Massachusetts.

Although the end-1962 radar network was similar in numerical size to the network operating at the end of 1959, the capability of the 1962 network was vastly greater. At the end of 1962, more than one-third (47) of the 131 operating radars were of the FD (FPS-24/35) or ECCM-modified FPS-20 (FPS-64/66/67) types. Another

50 were FPS-7 (20 of them modified with ECP-91) or FPS-20 sets. Only 25 had the older FPS-3, FPS-8, FPS-10, MPS-7, MPS-11 and GPS-3 models. Eight ARSR-1/2 FAA radars were in use.[20]

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20. Ibid.

CHAPTER TWELVE

CLOSER TIES WITH FAA
1963

The fact that 131 long-range search radars were actively producing air defense data at the end of 1962 was somewhat misleading, because higher authority had already decided that the number of strictly military radars would have to be reduced. In September 1962, NORAD recommended to the Secretary of Defense that SAGE be replaced with a transportable control system it called TRACE (Transportable Automated Control Environment). The TRACE system called for deployment of 38 TRACE units (each covering three

locations). When this system was implemented, NORAD believed that SAGE and 28 long-range radars could be inactivated.[1]

Secretary of Defense McNamara did not approve the TRACE concept, but he did believe reductions in the SAGE system were necessary. In November 1962, therefore, he recommended to the Joint Chiefs of Staff that 22 long-range radars be deleted (along with 10 SAGE direction centers) in order to save $100 million a year in operating expenses. The JCS argued that the proposed reductions were too sharp and premature, but Mr. McNamara was not totally dissuaded. On 3 December 1962 he recommended to President Kennedy that 17 radars (and six SAGE direction centers) be closed by the middle of 1964. The President approved.[2]

The ADC commander, Lt. Gen. Robert M. Lee, vigorously opposed this reduction in air defense capability, but to no avail. The JCS approved the reductions on 15 February 1963 and on 22 March 1963 detailed orders for inactivation of 17 long-range search radars

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1. Hist of NORAD, Jul-Dec 1962, pp. 59-63.

2. Memo, Sec/Def for JCS, "Continental Air Defense," 13 Nov 1962 [HRF]; Msg AFSDC 65734, USAF to ADC, 4 Jan 1963 [HRF].

(including two Texas Towers) were issued by USAF.

The 15 radars within the United States ordered closed were the following:[3]

RP-1	Fort Lawton, Washington (ARSR-1)
M-90	Walker AFB, New Mexico (MPS-7)
P-78	Duncanville, Texas (FPS-10)
M-93	Winslow, Arizona (GPS-3)
M-95	Las Cruces, New Mexico (FPS-20)
M-103	Lyndonville, Vermont (MPS-11)
M-116	Cherry Point MCAS, N.C. (FPS-8)
M-125	England AFB, Louisiana (FPS-20)
SM-138	Grand Rapids, Minnesota (FPS-67)
SM-143	Walnut Ridge, Arkansas (MPS-11)
SM-162	Yuma, Arizona (MPS-7)
TM-186	Pyote, Texas (FPS-3)
TM-187	Ozona, Texas (FPS-3)
TM-188	Eagle Pass, Texas (FPS-20)
TM-191	Rockport, Texas (FPS-3)

All but three of these stations (RP-1, M-103 and SM-138) were along the southern approaches to the United States and all but four (M-95, M-125, SM-138 and TM-188) were equipped with older, or FAA, radar. All but P-78 had been activated by the end of 1963. In total, however, the number of stations reporting into the air defense system actually increased from 131 to 133, because the loss of active military radars was more than offset by the addition of FAA and Air National Guard stations.[4]

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3. Msg ADCCR 469, ADC to USAF, 12 Feb 1963 [DOC 20]; Msg AFOAPD 32/63, USAF to ALZICOM, 22 Mar 1963 [DOC 21].

4. ADC Control and Warning Equipment Report, 31 Dec 1963 [HRF].

While ADC was going about the chore of reducing the air defense ground environment within the United States by 14 stations, an in-depth study of the total air defense system was underway. Directed by the Secretary of Defense in a memorandum of 7 January 1963, what came to be known as the Continental Air Defense Study (CADS) was undertaken under the chairmanship of Maj. Gen. Arthur C. Agan, Jr., ADC Deputy Chief of Staff for Plans. The final CADS report, published 10 May 1963, acknowledged that the weight of the strategic threat against North America had steadily shifted from bombers to ballistic missiles. It therefore had to be assumed, the CADS report added, that the initial Soviet attack would be made with missiles, to be followed by a force of more flexible bombers which would destroy what the missiles had missed.

It followed, then, that the air defense problem had changed from one of defending against surprise bomber attack to one of surviving a missile attack to fight effectively against a smaller, but higher quality, bomber force. CADS further acknowledged that the current ground environment was highly susceptible to a roll-back attack by ballistic missiles. The obvious solution, CADS tentatively concluded, was to shift as

much of the ground environment as possible to an airborne configuration. The development of an airborne warning and control system (AWACS) was recommended.

This did not mean the complete abolition of the ground-based long range radar network, however. In the first place, the cost of an entirely airborne system was prohibitively high. Besides, the Department of Defense was obligated to cooperate with FAA in the creation of an effective air traffic control system within the United States. CADS therefore recommended a United States-Canada surveillance system composed of 134 long-range radars, 60 less than currently operated, to provide a maximum combined air defense and traffic control capability. In this regard, CADS recommended that the air defense system cooperate fully in the implementation of the National Airspace Utilization System (NAUS) being planned by FAA. It was also concluded that there was no sound reason, since SAGE was likely to cost $138 million more than NAUS over a 10-year period, for DOD to insist that FAA use SAGE.

As an immediate measure, CADS recommended that five long-range radars providing redundant coverage be phased out in FY 1965. Further, it was recommended

that dismantling of the radar equipment at four of the stations being deactivated in the FY 1964 reduction program be held in abeyance pending possible integration into NAUS. Actually, six inactivated radar stations were in this category at the end of 1963. These were Z-1 (Fort Lawton, Washington), Z-90 (Walker AFB, New Mexico), Z-125 (England AFB, Louisiana), Z-186 (Pyote, Texas), Z-187 (Ozona, Texas) and Z-191 (Rockport, Texas). All ADC long-range radars were given "Z" classification as of 1 July 1963.[5]

That part of CADS which recommended deletion of five additional long-range radars in FY 1965 was accepted by USAF in September 1963. ADC was also advised that it should prepare for the loss of 12 more radars in FY 1966, 12 in FY 1967 and 15 in FY 1968. No details were provided as to exactly which stations should go. Still later in 1963, ADC learned that DOD was considering the "checkerboard" operation of radars as an economy measure. Under this proposal, no radar would operate more than eight hours a day, but in a

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5. Ibid.; Continental Air Defense Study, 10 May 1963 [HRF].

random pattern. No firm ADC position had been reached on this matter by the end of 1963.[6]

As to the ability of FD radars to detect sea-launched ballistic missiles (SLBM), 1962 tests of the FPS-35 had not been too encouraging. But since the FPS-35 was relatively cheap, and could be made ready in a relatively short time, it (along with the FPS-24) continued to be considered. In a December 1962 message to USAF, General John K. Gerhart, NORAD commander, revealed that he agreed with General Lee that phased-array radars (such as the FPS-85 being constructed at Eglin AFB, Florida) would probably be superior to FD radars in SLBM detection capability, assuming that money was no object. If, however, the Air Force was to be limited to $25 million in the FY 1964 budget for development of all tactical warning devices -- BMEWS, gap fillers and sensors for space detection as well as SLBM detection capability -- General Gerhart was forced to the conclusion that the FPS-24 and the FPS-35 with a 60-foot antenna would have to do.[7]

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6. Msg AFSDC 97704, USAF to ADC, 26 Sep 1963 [HRF]; Weekly Activity Reports, ADLPP-G, 26 Sep 1963 and ADLPC, 26 Nov 1963 [HRF].

7. Msg NCHR X-149, 4 Dec 1962, as quoted in Msg NCHE 6, NORAD to USAF, 22 Mar 1963 [DOC 22].

Since practically nobody was satisfied that the FPS-35 was satisfactory for the SLBM mission, it was agreed among NORAD, SAC and ADC that no further action should be taken in this regard until ESD had had a chance to make a technical evaluation of the various possibilities. This review was completed in early March 1963 and the results presented to all interested parties. These results were so inconclusive that USAF proposed that the Air Defense Panel and Air Staff Board take another look at the problem at a meeting to be held 15-17 April 1963. At the ESD presentation, four possible methods of achieving anti-SLBM capability had been discussed: Modification of the FPS-24, modification of the FPS-35 and addition of a 60-foot antenna, procurement of additional numbers of the FPS-49 SPACETRACK radar similar to the one at Moorestown, New Jersey, and procurement of additional numbers of the FPS-85 phased array radar.[8]

The ADC preferences, as expressed at the April meeting, were: (1) FPS-49; (2) FPS-85; (3) FPS-35 with a 60-foot antenna (FPS-35/60); (4) FPS-24. ADC was also of the opinion that a mixture of phased array and

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8. NOFORN EX CANADA, Msg ADLPC 637, ADC to NORAD, 4 Mar 1963 [DOC 23]; Msg AFORQD 87865, USAF to AFSC, 26 Mar 1963 [DOC 24].

FD radars was possible. The Air Staff Board, however, did not find it possible to follow the wishes of ADC in this matter and, solely for economic reasons, recommended that the FD radars be used for SLBM detection purposes. On 16 May 1963, USAF accepted an AFSC suggestion that competitive bids be sought on modification of the FPS-24/35 for SLBM use.[9]

Despite the decision to proceed with plans for use of FD radars for SLBM purposes, interest in the FPS-49 and FPS-85 continued. In May 1963, ADC asked its Command and Control Defense Systems Office at Hanscom Field, Massachusetts, to look into the possibility of providing a computer program for the FPS-49 to permit its use for SLBM detection in an emergency. It was understood that the SLBM program would in no way detract from the primary SPACETRACK mission of the FPS-49. Unfortunately, it was discovered that it was likely to require five minutes for the FPS-49 to shift from the SPACETRACK mode of operation to the SLBM mode. Also, it was found that the FPS-49 could not operate in both modes at the same time. This was also expected to be the case with the FPS-85 unless additional

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9. ADC SLBM Briefing to USAF, 16-17 Apr 1963 [DOC 25]; Weekly Activity Reports, ADLPC, 23 Apr and 16 May 1963 [HRF].

computer program storage was provided. Nevertheless, ADC was still interested in both radars for possible future SLBM use.[10]

In recognition of the fact that ADC involvement in SLBM detection was sure to bring it into the anti-submarine warfare (ASW) field, ADC suggested in the summer of 1963 that it might be well to transfer Air Force responsibility in this area (known as a "collateral" mission in recognition of the fact that the Navy had primary responsibility) from TAC to ADC. When USAF agreed and prepared to make the necessary change in Air Force regulations, ADC backed off slightly, pointing out that it had made the suggestion when it looked as though AWACS was to have an SLBM capability. When the specifications for AWACS were eventually written, however, SLBM was not mentioned. Furthermore, the change might be premature, because none of the FD radars to be modified for SLBM detection would be ready until 1966, ADC would have no ASW capacity until that time. If, however, USAF thought the transfer of the ASW mission might serve as a basis for a requirement that AWACS, and other future systems, include ASW potential,

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10. Msg ADLPC 1964, ADC to CCDSO, 27 May 1963 [DOC 26]; Msg ADLPC 5421, ADC to ESD, 29 Oct 1963 [DOC 27].

ADC was ready to agree. Despite the partial ADC disclaimer, the transfer of the Air Force ASW mission from TAC to ADC was effected 30 December 1963.[11]

Although the number of ADC-controlled long-range radars within the United States decreased significantly during 1963, the number of stations used jointly by ADC and FAA increased. Twelve of the 15 stations added to the joint-use group, however, were FAA units equipped with ARSR-1/2 radars. The number of FAA radars earmarked for joint use increased from 14 to 16 during the year when FAA agreed to such use of Z-228 at El Paso, Texas, and Z-229 at Odessa, Texas. These two stations helped fill the gap left when ADC inactivated several stations along the southern border of the United States.[12] The 43 operational joint use stations at the end of 1963 were deployed as given in Table 30. Nearly half (19) of the joint use stations were equipped with FAA radar of the ARSR-1/2 types. Eleven had ECCM-modified FPS-20 sets bearing the FPS-65/66/67 designation. Ten had FPS-7/20 radars and

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11. Msg ADLDC 5625, ADC to USAF, 16 Nov 1963 [DOC 28]; AFR 23-9A, 30 Dec 1963.

12. ADC Control and Warning Equipment Report, 31 Dec 1963 [HRF]; Weekly Activity Report, ADLPC, 2 Jul 1963 [HRF].

three were equipped with FPS-35 FD types. At the end of 1963, plans called for 15 more (14 ADC and one FAA) joint use sites for a program total of 58 stations. In addition, five ADC joint use stations (Z-39, Z-62, Z-113, Z-147 and Z-163) were converting from ARSR-1/ FPS-20/FPS-66 radars to FD sets of the FPS-24/27 types.

The FAA/ADC plan for a test of the feasibility of the use of SAGE in air traffic control in the "Northern Tier" SAGE sectors of Minot, Great Falls and Grand Forks was thrown into some confusion as a result of the DOD decision to inactivate the Minot and Grand Forks sectors. After some study of the situation, FAA agreed, in May 1963, to proceed with the "Northern Tier" test in the Great Falls sector. Because of the delays induced by the necessity of coming to a new decision, the date when FAA would be ready to begin air traffic control operations at Great Falls was slipped from 1 September 1963 to 1 January 1964. Actually, however, the FAA Air Route Traffic Control Center (ARTCC) at Great Falls was commissioned on 1 December 1963.[13]

While it was established national policy that the air defense ground environment would be used to the

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13. Weekly Activity Reports, ADLPC, 20 Mar, 14 May and 1 Dec 1963 [HRF].

maximum for air traffic control purposes, the question of military primacy at a time of increased air defense alert arose during the Cuban crisis of October 1962. At that time, USAF directed certain changes in the operating procedures of joint use radars in the southeastern United States. FAA refused to honor the military directives because they abrogated joint use agreements and might have impaired FAA ability to control civilian air traffic.[14]

This matter was turned over to the ADC/FAA Joint Radar Planning Group (JRPG) for discussion, but through the early months of 1963 FAA was adamant that the Air Force not be allowed blanket authority to overturn joint use agreements at will. As far as FAA was willing to go by July 1963 was to agree to respond unequivocally to military directives issued following a declaration of Air Defense Emergency or a Presidential Proclamation of National Emergency. In lesser degrees of emergency, however, FAA would require adherence to existing joint use agreements and would not agree to changes in procedures without advance FAA concurrence.[15]

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14. Memo, DCS/Plans, ADC for C/S, ADC, "Clarification of Proposed ADC Policy on Deviation from Existing ADC/FAA Joint Use Agreements," 16 Oct 1963 [DOC 29].

15. Weekly Activity Report, ADLPC, 2 Jul 1963 [HRF].

In the ADC view, this stand was overly restrictive, so ADC informed FAA on 31 July 1963 that because of the difference of opinion, ADC was referring the matter to NORAD for possible further referral to JCS and DOD. ADC believed the question had become one that the JRPG could not decide. The FAA reply, written informally by Lt. Gen. Harold W. Grant, one-time ADC Deputy Chief of Staff for Operations, but in October 1963 Deputy Administrator of FAA, revealed that FAA was reviewing its stand, but that FAA would surely not agree to the preferred ADC version of joint policy so long as it said merely that FAA should be prepared to yield in cases of "overriding military necessity." FAA wanted a detailed clarification of this term.[16]

In an attempt to meet the FAA objections and at the same time "cover the almost infinite variety of possible situations which we may face in the future," Lt. Gen. Herbert B. Thatcher, ADC commander since 1 August 1963, returned a rewritten copy of the controversial portion of the statement of policy to General Grant on 21 October 1963. It read:[17]

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16. ADC to FAA, "Deviation from Established Agreements Pertinent to Operation of Joint Use Sites," 31 Jul 1963 [DOC 30]; Pers ltr, Lt. Gen. Harold W. Grant, Deputy Administrator, FAA, to Lt. Gen. Herbert B. Thatcher, Commander, ADC, no subj, 7 Oct 1963 [DOC 31].

17. Pers ltr, Thatcher to Grant, no subj, 21 Oct 1963 [DOC 32].

> When it is essential to the defense of the United States because of urgent military necessity, and when the Commander, ADC, CINCONAD or higher U.S. military authority so determines, and when prior notice thereof is given to the Administrator, such authority may authorize deviation from existing joint use agreements concerning the operating parameters, procedures, or equipments at joint use radar sites. Such prior notice shall be given to the Administrator at the earliest time practicable and, to the extent time and circumstances permit, every reasonable effort shall be made to consult fully with the Administrator and to arrange in advance for the required deviation on a mutually acceptable basis.

General Thatcher added that CONAD concurred with the new ADC version.

There was a meeting of the minds at this point and in January 1964 General Grant announced that FAA was willing to accept the revised statement, thereby ending a controversy that had existed for more than a year.[18]

The long road that began several years earlier with a proposal to erect 26 U.S. radars in the area between Canada's Mid-Canada Line along the 55th Parallel and the Pinetree Line along the Canada-United States border as Phase IV of the Mobile radar program came almost to an end in 1963. Three more of the seven radars which remained in the CADIN (Continental Air

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18. Pers ltr, Grant to Thatcher, no subj, 29 Jan 1964 [DOC 33].

Defense Integration North) program that succeeded the Phase IV plan became operational in 1963. This left only the FD FPS-27 radars at C-49 (Gypsumville, Manitoba) and C-54 (Penhold, Alberta) not operationally ready. These were expected to join the air defense network in January 1964.[19]

Although the total air defense long-range radar network within the United States increased in size from 131 to 133 stations during 1963, the degree of ADC control was lessened somewhat in that the military radars lost were replaced by FAA radars designed primarily for air traffic control and mostly manned and maintained by FAA personnel. On the other hand, the modernization of the ground environment and the provision of radars equipped to counter electronic countermeasures made great strides during 1963. The number of FD radars (FPS-24/27/35) in service grew from 11 to 24 and the number of ECCM-modified FPS-7 (ECP-91) and FPS-20 (FPS-64/65/66/67) radars increased from 57 to 71. Also in operation were 19 ARSR-1/2 types provided by FAA. The number of obsolescent radars (FPS-10, MPS-11, FPS-3 and GPS-3) still in operation correspondingly declined from 24 to 6. The Air National

19. ADC Control and Warning Equipment Report, 31 Dec 1963 [HRF].

Guard units at Denver and Salt Lake City were operational with older FPS-8 sets, while the surveillance station at Key West, Florida, had a Navy FPS-37 which was about to be replaced with an FPS-67. All that remained to be done was to bring to operational capability 19 more FPS-27 and two more FPS-24 FD radar, as well as complete the substitution of an FPS-20 for the GPS-3 at Brunswick, Maine, and an FPS-67 for the MPS-11 at Red Bluff, California. It was expected that these actions would be accomplished during the first half of 1964.[20]

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20. Ibid.

CHAPTER THIRTEEN

THE RADAR NETWORK FULLY OPERATIONAL
1964

The DOD-directed reduction of 15 ADC radars within the United States in FY 1964 was not the end of retrenchment in the ADC-controlled portion of the ground environment. The CADS effort of May 1963 had recommended the closure of five additional long-range radars in FY 1965. This recommendation was accepted by USAF in September 1963. At that time USAF

also told ADC to prepare for the further loss of 12 radars in FY 1966, 12 in FY 1967 and 15 in FY 1968.[1]

No further action was immediately taken on the recommendations of CADS. Instead, ADC was asked to prepare a list of "hard core" radar stations that would be required into the indefinite future. This list, forwarded to USAF on 9 March 1964, included 161 stations (100 ADC, 31 FAA and 30 RCAF). Eighteen ADC stations and 16 FAA sites were identified as not being required for permanent retention. In subsequent discussions, FAA agreed that six FAA stations could probably be released, but that it was not ready to agree (as of April 1964) on the other 10.[2]

The matter of retrenchment was then out of the hands of ADC while it was studied at USAF and DOD levels during the summer and autumn of 1964. The decision was announced by Secretary of Defense McNamara in a press conference of 19 November 1964. There was to be a further reduction in the size of the ADC long-range radar network, although it was not as drastic

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1. Continental Air Defense Study, 10 May 1963 [HRF]; Msg AFXDC 97704, USAF to ADC, 26 Sep 1963 [HRF].

2. Weekly Activity Reports, ADLPC, 8 Feb, 17 Mar, 6 Apr and 14 Apr 1964; ADOAC, 21-27 Feb 1964 [HRF].

as had been hinted by USAF in September 1963. Sixteen more radars were to be closed over the three-year period beginning with FY 1965. Reductions were scheduled as follows:[3]

FY 1965

Z-13	Brunswick, Maine
Z-24	Cut Bank, Montana
Z-55	Manassas, Virginia
Z-67	Custer, Michigan
Z-150	Cottonwood, Idaho
Z-177	Dickinson, North Dakota

FY 1966

Z-9	Highlands, New Jersey
Z-38	Mill Valley, California
Z-53	Rockville, Indiana
Z-57	Naselle, Washington

FY 1967

Z-15	Lompoc, California
Z-43	Guthrie, West Virginia
Z-74	Madera, California
Z-98	Miles City, Montana
Z-127	Winnemucca, Nevada
Z-149	Baker, Oregon

The first of the stations to be closed under the FY 1965 reduction program was Z-150 at Cottonwood, Idaho, removed from the air defense network on 15 December 1964. The FPS-24 at Cottonwood was not operational at the time because of a failed bearing in the antenna pedestal. It was decided not to go ahead with repair

3. Ibid., ADLPC, 19 Nov and 22 Dec 1964 [HRF].

of the antenna, because Z-150 was included in the stations to be closed in FY 1965. The other five stations in this group were expected to cease operations 1 March 1965. The last of the 15 ADC stations included in the FY 1964 reduction program (P-78 -- because of imminent closure it was not given a "Z" number -- at Duncanville, Texas) was closed on 1 July 1964.[4]

Although there was a continuing tendency at ADC to think of the FD radars, particularly the FPS-24 and FPS-35, as having only marginal capability in the detection of sea-launched ballistic missiles (SLBM), the search for an interim means of detection kept coming back to these radars. The possibilities in this field were examined again in March 1964 by a team of scientists representing the MITRE Corporation, ESD and CCDSO. While major improvements had been made in backscatter techniques used with over-the-horizon (OTH) radar since a MITRE/ESD study of February 1963, the new team was forced to conclude that there was insufficient evidence at hand to recommend halting

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4. ADC Control and Warning Equipment Report, 31 Dec 1964 [HRF].

consideration of FD radars while awaiting completion of OTH development.[5]

In light of this scientific opinion, ESD made ready to issue requests for competitive bids on SLBM modifications to FD radars on 12 June 1964, but the USAF Proposal Evaluation Board rejected the ESD request on technical grounds and asked that ESD re-think the entire proposal. The request for bids was actually issued on 10 July 1964.[6]

Within a week the request for bids had been withdrawn because DOD did not want to proceed until another study had been made of the feasibility of using OTH radar for SLBM detection purposes. USAF then produced a study which recommended that OTH ultimately be used for SLBM detection, but that a minimum-cost interim system was necessary. In stating its position in this matter, ADC, on 17 July 1964, again suggested that the FPS-49 SPACETRACK radar and the FPS-85 phased-array radar be used in the interim system. The ADC plan involved the use of the FPS-49 at Moorestown,

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5. Msg ADLPC 908, ADC to CCDSO, 7 Mar 1964 [DOC 34]; Weekly Activity Report, ADLPC, 24 Mar 1964 [HRF].

6. NOFORN EX CANADA, Msg ADLPC 1857, ADC to USAF, 1 Jul 1964 [DOC 35]; Weekly Activity Reports, ADLPC, 12 Jun and 7 Jul 1964; ADOAC 17-23 Jul 1964 [HRF].

New Jersey, to cover the East Coast, the FPS-85 at Eglin AFB, Florida to cover the Caribbean area and modified FPS-35 radars at Z-59 (Boron, California) and Z-149 (Baker, Oregon) to cover the West Coast.[7]

In early November 1964 the Research and Engineering Office of DOD (DDR&E) released $20.2 million for development of what it called Phase I of an SLBM detection and warning system. This involved, following the ADC recommendation, modification of the two FPS-35 radars at Z-59 and Z-149 and the FPS-49 at Moorestown. The FPS-85, however, was not mentioned. Phase II of the DDR&E blueprint called for the erection of an OTH backscatter radar at Diyarbakir, Turkey. If this radar succeeded in tracking Russian missiles and satellites it was to be considered for SLBM detection, with tentative sites in the Salt Lake City and Cincinnati areas. Cost of the Diyarbakir radar was estimated at $38 million.[8]

Meanwhile, ADC had become disabused with the FPS-49 and FPS-85 for SLBM detection, coming to the conclusion that they might interfere with their primary

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7. NOFORN EX CANADA, Msg ADLPC 2442, ADC to USAF, 31 Jul 1964 [DOC 36]; Weekly Activity Report, ADOAC-E, 21-27 Aug 1964 [HRF].

8. Weekly Activity Report, ADOAC, 8-12 Nov 1964 [HRF].

mission of space detection. Therefore, later in November 1964, ADC sought and received, through USAF, DOD permission to develop an interim SLBM detection system that would involve only long-range search radars of the types used by SAGE (FPS-7, FPS-24, FPS-27, and FPS-35) or the FD height-finder (FPS-26). The suggested FPS-35 network included not only the California and Oregon sites previously mentioned, but also the FPS-35 radars at Z-30 (Benton, Pennsylvania) and Z-197 (Thomasville, Alabama). The modified radars were expected to offer a range of 950 to 1,000 nautical miles. If the FPS-24 was to be used, four stations would also be required -- Z-37 at Point Arena, California; Z-110 at Bucks Harbor, Maine; Z-199 at Eufaula, Alabama; plus a new FPS-24 at Laredo, Texas. The modified FPS-24 could be expected to be effective at a range of 950 nautical miles. An interim system involving the third FD search radar -- FPS-27 -- would require five sites including the new location at Laredo. The four existing FPS-27 stations would be Z-32 at Condon, Oregon; Z-39 at San Pedro Hill, California; Z-65 at Charleston, Maine, and Z-113 at North Charleston, South Carolina. These stations, when modified with a parametric amplifier and increased power, would probably be effective at a range of from 900

to 950 nautical miles. Also, for the first time, an SLBM detection network using the FPS-7 was being considered. ADC figured that a modified FPS-7 would be capable of a range of 675 miles, so a six station network was tentatively selected. These stations included Z-2 (Cambria, California), Z-44 (Makah, Washington) and Z-118 (Burns, Oregon) on the West Coast and Z-10 (North Truro, Massachusetts), Z-115 (Fort Fisher, North Carolina) and Z-196 (Dauphin Island, Alabama) on the East and Gulf Coasts. At the end of 1964, ESD was again preparing to ask industry for competitive bids on the required modifications.[9]

Since it was clearly stated national policy that the air traffic control system being developed in the United States would use to the maximum the air defense resources of the Department of Defense, it was essential that mutual understanding and close cooperation in the attainment of joint goals be achieved by FAA and ADC. The matter of the degree of military primacy over the joint radar system in time of air defense emergency had apparently been solved by mutual agreement between FAA and ADC in 1963. The test of the use of SAGE in the control of civilian air traffic began

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9. Briefing, Maj. W. D. Balser, ADLPC, 10 Mar 1965.

in the Great Falls Air Defense Sector in December 1963. The Continental Air Defense Study of May 1963 recommended creation of a much more closely integrated radar surveillance system not necessarily using SAGE, which would meet both air defense and air traffic control requirements.

But in April 1964, CADS was nearly a year old and no action had been taken to create a high-level planning organization that would work toward implementation of the CADS recommendations. The ADC/FAA JRPG was adequate for the solution of day-to-day working-level problems, but was not adequate, in the ADC view, for long-range planning on a national basis. There had been no continuation of the joint planning that had existed during CADS and there was no USAF point of contact for planning of future integrated systems. The DOD Advisory Committee on Federal Aviation was considered an appropriate policy-making agency, but not an appropriate agency for detailed planning. Therefore, ADC suggested that USAF propose to DOD the creation of a group to put into operation the CADS recommendations.[10]

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10. ADC to USAF, "Joint Planning with the Federal Aviation Agency," 28 Apr 1964 [DOC 37].

The ADC suggestion was approved by USAF and passed along to DOD. Meanwhile, USAF wanted to know ADC thinking as regards the relationship between DOD and FAA in time of war and serious national emergency. It was the ADC position, stated in June 1964, that in time of war FAA should be placed under the operational control of an appropriate operating military command, presumably NORAD. If this concept was acceptable, ADC was of the opinion that realignment of the missions and structure of both NORAD and FAA would be required to reflect the new relationship. This would be done, ADC hoped, by the joint planning organization soon to be formed.[11]

The Department of Defense also saw the need for planning of future DOD/FAA integration and in a 30 May 1964 letter to the FAA Administrator the Secretary of Defense appointed Mr. John Klotz of DOD and Maj. Gen. Paul T. Preuss, ADC Deputy Chief of Staff for Plans, as DOD representatives. The first meeting of the negotiators occurred 2 July 1964 and four primary study areas were identified: (1) establishment of a common surveillance system, (2) possible extended joint use of

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11. USAF to ADC, "Joint Planning with FAA," 22 May 1964 [DOC 38]; ADC to USAF, "Joint Planning with FAA," 22 Jun 1964 [DOC 39].

control facilities such as SAGE, (3) re-examination of current and future cost-sharing policies and (4) clarification of relationships in the event of national emergency or war. On the latter question, discussed by ADC in the June 1964 letter to USAF, the Secretary of Defense asked the opinion of the Joint Chiefs of Staff on 13 August 1964. Executive Order 11161 of 7 July 1964 had directed establishment of a joint DOD/FAA position on this question. The JCS referred the matter to USAF and USAF declared ADC the executive agent for USAF. ADC prepared to consult with NORAD in September, but meanwhile DOD decided to defer further action on joint DOD/FAA planning until a decision had been reached on the future of SAGE and the subsidiary long-range radar network. There the matter stood at the end of 1964.[12]

Despite the lack of high-level planning for a future integrated surveillance system, station-by-station discussions on the joint use of ADC radars continued. Four more stations were added to the FAA/ADC joint use network in 1964, bringing the total at the end of the year to 47. The newly added stations

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12. ADC to USAF, "Joint Planning with FAA," 22 Jun 1964 [DOC 39]; ADC to NORAD, "DOD/FAA Planning for Emergency and Wartime Relationships," 27 Aug 1964 [DOC 40]; Weekly Activity Report, ADLPC, 9-15 Sep 1964 [HRF].

were Z-34 at Empire, Michigan; Z-50 at Saratoga Springs, New York; Z-157 at Red Bluff, California, and Z-226 at Garden City, Kansas. Eight more ADC stations were approved for later joint use; Z-63 at Gibbsboro, New Jersey; Z-76 at Mt. Laguna, California; Z-88 at Amarillo AFB, Texas; Z-100 at Mt. Hebo, Oregon; Z-110 at Bucks Harbor, Maine; Z-129 at MacDill AFB, Florida; Z-156 at Fallon NAS, Nevada, and Z-198 at Tyndall AFB, Florida. While the number of joint-use radars increased but slightly during 1964, the quality of the radars being used was upgraded. Although the number of FAA ARSR-1/2 radars remained steady at 19, the number of FD sets in joint use grew from three to six and the number of ECCM-modified FPS-20 radars (FPS-65/66/67) increased from 11 to 13.[13]

There was little doubt that the capability of the radar network increased significantly with the addition of FD radars. This increase in capability, however, was accompanied by maintenance difficulties that were not foreseen when FD radar was designed and developed. The principal problem arose as a result of the great weight of the antennas of the FPS-24/35 radars. The antenna of the FPS-35 weighed 70 tons

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13. ADC Control and Warning Equipment Report, 31 Dec 1964 [HRF].

and that for the FPS-24 weighed 85 tons. When operational experience was gained with these radars it developed that the ball bearings on which these antennas turned were incapable of bearing this immense weight for long periods of time. Bearing failures began to occur with increasing frequency. The bearings were so difficult to manufacture that failure began to mean radars were sometimes out of operation for several months. To indicate the increasing seriousness of this matter, while two FPS-24 bearings failed in 1961 and one in 1962, seven failed in 1963. In addition, two FPS-35 bearings failed in 1963.[14]

Aside from the growing shortage of spare bearings, installation of replacement bearings, because of the sheer weight of the antennas, was a major maintenance problem. The situation had become so serious by February of 1964 that General Thatcher felt impelled to ask that General Bernard Schriever, AFSC commander, give his personal attention to the matter. AFSC had no immediate solution, admitting that the shortage would probably continue until at least June or July of 1964. It was hoped that a high capacity

14. FPS-24/35 History of Bearing Failures [Docs 58 and 59 in Hist of ADC, Jan-Jun 1965].

roller bearing of improved materials would be available at that time. There was also the possibility that a permanent solution might be found in a new type of hydrostatic bearing, but that the first item would not be available to ADC for at least 18 months after development began.[15]

Meanwhile, the Materiel organization within ADC recommended, in March 1964, a reduction in FPS-24/35 operations, at least until the shortage of bearings could be relieved and the amount of heavy jacking equipment could be increased. ADC Operations found it impossible to agree, however, since ADC had come to be heavily dependent on FD radar.[16]

Nevertheless, despite considerable effort by everybody concerned, the bearing situation went from bad to worse in 1964. Seven FPS-24 bearings and an equal number of FPS-35 bearings failed during the year and the shortage of bearings grew ever greater. Again, in October 1964, ADC/Materiel attempted to dispose of the problem by recommending, this time, that all FD radars be phased out of the air defense system because

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15. NOFORN EX CANADA, Msg ADCCR 731, ADC to AFSC, 20 Feb 1964 [DOC 41]; Msg ADMME-RONCO 1218, ADC to ROAMA, 7 Apr 1964 [DOC 42].

16. Weekly Activity Report, ADOAC, 20-26 Mar 1964 [HRF].

of persistent bearing problems and low in-commission rates. ADC/Plans would not entertain this recommendation, though, because no other long-range search radar offered the high-altitude search capability of FD radars. Even so, Z-150 at Cottonwood, Idaho, was chosen as one of the radars to be closed in FY 1965, because, among other things, the FPS-24 at that location was non-operational for bearing failure. Thus the number of FPS-24 radar awaiting bearing replacement was reduced by one. And the proposed roller bearing answer to the problem was going to be a long time in coming. The first roller bearing was not available by July, as had been suggested by AFSC earlier in the year. The manufacturer, Messinger Company, had experienced considerable trouble in meeting specifications and had not made available the initial bearing by the end of 1964. Development of the proposed hydrostatic bearing had not begun.[17]

From the time the installation of FD radars began, ADC had been concerned with the possibility that the heavy radiation produced by these powerful radars

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17. Msg ADMME-CA 1491, ADC to ROAMA, 2 May 1964 [DOC 43]; NOFORN EX CANADA, Msg ADMME-CA 1888, ADC to ROAMA, 3 Jun 1964 [DOC 44]; FPS-24/35 History of Bearing Failures [Docs 58 and 59 in Hist of ADC, Jan-Jun 1965]; Weekly Activity Reports, ADLPC, 27 Oct 1964 and ADOAC-E, 20-26 Nov 1964 [HRF].

might have a disastrous effect on electro-explosive devices (EED) stored in the area. The command was particularly concerned about Selfridge AFB, Michigan, and Malmstrom AFB, Montana, where ADC interceptor squadrons stored nuclear air-to-air missiles. As a result, the FPS-35 at Selfridge was operated at greatly reduced power from the completion of installation in 1962. After a long series of tests at this site, everybody concerned (ESD, Air Force Weapons Laboratory, Sandia Corporation, GEEIA and ADC) agreed in June 1964 that there was no danger to nuclear weapons so long as stringent safety precautions were taken. Similar clearance was later extended to the FPS-24 at Malmstrom and the FPS-35 at Fallon NAS, Nevada, although the antenna tilt required at Fallon was so high that operations were definitely restricted. Use of full power was authorized at all three sites.

But these were only three of 30 sites where ADC thought a problem might exist and ADC was of the opinion that insufficient attention had been paid to this matter on the part of those obligated to do something about it. The possibility of FD radiation hazards to EED had been called to USAF attention in September 1962. The following month, USAF asked AFSC to begin investigations and suggest a solution if the possibility was

found to be a probability. Twenty months and many ADC communications later, AFSC asked its Research and Technology Division (RTD) to take the lead in research in this area. RTD then asked the Systems Engineering Group at Wright-Patterson AFB to prepare a rationale for attacking the problem and submit it to AFSC by 1 January 1965.[18]

The map of the long-range search radar system in the United States changed very little in 1964. Lost were P-78 (Duncanville, Texas), the last of the reductions in FY 1964, and Z-150 (Cottonwood, Idaho), the first of the reductions scheduled for FY 1965. Gained was Z-226, an FAA station at Garden City, Kansas. In total, therefore, the quantitative size of the network was reduced from 133 to 132 stations. In quality, however, and in spite of antenna pedestal bearing troubles and radiation hazards, the air defense network was considerably improved in 1964 by the addition of 19 FD radars (18 of them the FPS-27). The radar network was complete. On 1 July 1964 it was officially declared operational.[19]

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18. Weekly Activity Reports, ADOAC-E, 19-26 Jun and 9-15 Oct 1964 [HRF].

19. ADC Control and Warning Equipment Report, 31 Jul and 31 Dec 1964 [HRF].

CHAPTER FOURTEEN

SHAKEDOWN FOR THE LONG HAUL

1965 - 1966

Retrenchment, in accordance with the guidelines laid down by the Secretary of Defense in November 1964, continued in 1965 and early 1966. The five additional long-range radar stations scheduled for deletion in FY 1965 (Z-13 at Brunswick, Maine; Z-24 at Cut Bank, Montana; Z-55 at Manassas, Virginia; Z-67 at Custer, Michigan, and Z-177 at Dickinson, North Dakota) were removed from the air defense network

on 1 March 1965. The four stations in the reduction program for FY 1966 (Z-9 at Highlands, New Jersey; Z-53 at Rockville, Indiana; Z-57 at Naselle, Washington, and Z-74 at Madera, California) were deleted 1 April 1966. ADC had been successful in substituting Z-74 for previously scheduled Z-38 at Mill Valley, California, on the grounds that the Army required the Mill Valley site as part of its BIRDIE anti-aircraft control network. The station at Z-74 was originally scheduled to leave the system in FY 1967, but Z-58 at Mather AFB, California, was substituted for it.[1]

There was somewhat more difficulty with regard to the six ADC long-range radars scheduled for deletion in FY 1967 (originally listed as Z-15 at Lompoc, California: Z-43 at Guthrie, West Virginia; Z-58; Z-98 at Miles City, Montana; Z-127 at Winnemucca, Nevada, and Z-149 at Baker, Oregon). Early in 1965 it was agreed that five FAA radars at Lynch, Kentucky (Z-232); Mesa Rica, New Mexico (Z-234); Paso Robles, California (Z-236); Russellville, Arkansas (Z-237); and Silver City, New Mexico (Z-238) would be put to joint use to generally replace the lost ADC stations.[2]

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1. ADC Control and Warning Equipment Report, 31 Dec 1965, and Supplement, 31 Mar 1966 [HRF].

2. Weekly Activity Reports, ADLPC, 7 Jan 1965 and ADOAC, 22-28 Oct 1965 [HRF].

To be useful to ADC, this new group of FAA joint-use stations would have to have the Common Digitizer (AN/FYQ-40) required to make joint-use radar data from FAA stations intelligible to the Back-Up Interceptor Control (BUIC) system being established by ADC to offer dispersed support for the vulnerable SAGE system. And here a hitch in plans developed, since FAA was the contract manager for the Common Digitizer (CD) and would provide logistic support and maintain CD at all joint-use locations. It would be impossible, FAA said in the fall of 1965, to provide operational CD for the new joint-use stations before the end of 1968.[3]

A further blow was dealt the CD program in October 1965 when the Office of the Secretary of Defense announced that all Air Force funds for CD in Fiscal Years 1966 and 1967 ($11 million each year) had been cancelled. Unless Air Force funds were available, the whole CD program would have to be delayed or cancelled. Some of the force of the OSD October directive was dissipated in December 1965 when OSD rescinded the portion referring to funds for FY 1967. At the same time,

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3. Ibid., ADOAC, 29 Jan-5 Feb 1965 and ADLPC, 16 Sep and 23 Sep 1965.

however, there were rumors that all similar funds for FY 1967 would ultimately be diverted to projects in Southeast Asia.[4]

In this situation, ADC asked that the six ADC stations scheduled to be phased out in FY 1967 be retained through FY 1969. This initial request, made in December 1965, did not receive a favorable reply, but a similar request was made in February 1966. Whatever the results of the February reclama, the financial support for CD was restored by OSD and this cause for anxiety was removed.[5]

Meanwhile, OSD had asked for another study of the future of long-range radar for air defense purposes. This particular study covered the period after 1972, assuming a peacetime situation and the availability of the Airborne Warning and Control System (AWACS) and the F-12 interceptor. ADC completed the requested study in late May 1965, recommending that 124 long-range radars be retained in the United States after 1972. These were to include 36 ADC sole-use stations, 63 ADC stations jointly used with FAA and 25 FAA joint-use

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4. Ibid. ADOAC, 22-28 Oct and 10-16 Dec 1965.

5. Msg ADLPC-A 4116, ADC to USAF, 3 Dec 1965 [HRF]; Weekly Activity Report, ADOAC, 18-24 Feb 1966 [HRF]; Hearings, House Subcommittee on DOD Appropriations for FY 1967, 14 Feb 1966, p. 59.

stations. Forty-two of the radars to be retained were of the FD type, 34 were to be ECCM-modified FPS-20 sets designated FPS-64/67, 26 were to be FAA ARSR radars and 21 were to be of the FPS-7 type. One unmodified FPS-20 was also included. Shortly before the end of 1965, OSD handed down a decision on the shape of the air defense radar network to come. OSD said there would be 158 long-range radars used for continental air defense (including Canada and Alaska) at the end of FY 1966 and 151 at the end of FY 1967 (reflecting the deletion of six within the United States and one in Greenland) and thereafter. This decision buttressed earlier statements that no reductions were contemplated after FY 1967.[6]

The ADC study of long-range radar after 1972 included a proposal that the FPS-7 radars at Z-44 (Makah, Washington) and Z-179 (Kalispell, Montana) be replaced in the near future with available FPS-27 FD radars, but this suggestion did not receive a favorable reaction at OSD. In October 1965, OSD said that funds for such a substitution could not be made available before FY 1970. Since a delay of this magnitude would effectively kill the proposal, USAF insisted

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6. Weekly Activity Reports, ADOAC, 28 May-3 Jun 1965 and ADLPC, 30 Dec 1965 [HRF].

that it must have either FY 1966 or FY 1967 construction funds for this purpose. In the face of this strong request, OSD relented to the point of authorizing the use of FY 1968 funds. But this compromise suited neither ADC nor USAF and USAF included this project in its request for construction money for FY 1967. OSD, however, would not be further moved in this matter and in early 1966 deferred this item to the FY 1968 construction budget. In May 1966, when asked to identify possible savings in the budget for FY 1968, ADC agreed that the $2.5 million set aside for this project could be deferred to FY 1969.[7]

While the number of joint-use ADC/FAA radars continued to grow slowly during 1965 and early 1966, FAA was unable to make full use of the ADC radars available to it, because of a continuing inability to commission four FPS-27 radars by reason of side-lobe problems. Nothing attempted by Air Force agencies seemed to remedy the situation, so it was decided, in November 1965, to ask the manufacturer of the FPS-27 (Westinghouse) to suggest a solution. Westinghouse accepted the challenge and began studying the joint-use

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7. Ibid., ADOAC, 28 May-3 Jun, 8-14 Oct, 22-28 Oct, 10-16 Dec 1965 and 14-20 Jan 1966; NOFORN EX CANADA, Msg ADLPC-A 1536, 2 May 1966 [DOC 45].

FPS-27 at Z-39 (San Pedro Hill, California). Testing of the suggested Westinghouse improvements began in early February 1966.[8]

Another matter which arose to complicate the relationship between ADC and FAA was the increasing imbalance between the number of military radar technicians overseas and the number in the United States. This imbalance had been created by the loss (actual or impending) of 16 ADC radar stations in Fiscal Years 1965/67 and the growing use of FAA technicians at joint-use stations. This trend meant that the military radar maintenance technician returning from overseas was likely to face technological unemployment when he returned to the United States. In September 1965, therefore, ADC was forced to inform FAA that it could no longer sign joint-use agreements where FAA maintenance of the radar was a requirement.[9]

FAA acknowledged the justice of the ADC position on "blue suit" radar maintenance and in early 1966 was working out a maintenance concept which would vest maintenance responsibility in an FAA crew chief, but give him a mixed ADC/FAA, military/civilian crew.

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8. Weekly Activity Reports, ADOAC, 26 Feb-4 Mar, 13-19 Aug, 24-30 Sep, 5-11 Nov 1965 and 14-20 Jan 1966.

9. Ibid., ADLPC, 14 Sep 1965.

From the ADC viewpoint, this was probably the best solution to the problem, since complete ADC responsibility would mean that ADC would have to acquire the capability to maintain the common digitizer, essentially FAA equipment.[10]

The size of the joint-use ADC/FAA radar network increased from 47 at the end of 1964 to 50 as of 1 April 1966. Five stations (Z-76, Mt. Laguna, California; Z-88, Amarillo AFB, Texas; Z-110, Bucks Harbor, Maine; Z-156, Fallon NAS, Nevada; and Z-198, Tyndall AFB, Florida) joined the joint-use network during this 15-month period and two (Z-45, Montauk, New York and Z-196, Dauphin Island, Alabama) were dropped from this status. Three more (Z-63, Gibbsboro, New Jersey; Z-100, Mt. Hebo, Oregon; and Z-129, MacDill AFB, Florida) were close to joint-use readiness. Twenty-three others (18 ADC and 5 FAA) were scheduled for eventual joint use, but joint-use agreements were being held up by discussions of maintenance responsibility. The FAA stations were being held in abeyance because of probable long delays in provision of common digitizers. At any rate, the stations given in Table 31 were still being proposed for joint use as of 1 April 1966.

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10. Ibid., ADOAC, 12-25 Nov 1965 and 20 Jan-10 Feb 1966.

By the end of 1964 it had been fairly well established that over-the-horizon (OTH) radar would eventually be used in the detection of sea-launched ballistic missiles. Until OTH could be completely developed and deployed, however, it was thought necessary to utilize an interim system involving SAGE search radars of the FPS-7, FPS-24, FPS-27 or FPS-35 types or the FD height finder, FPS-26. Earlier tests involving the FPS-35 had not been very encouraging, but nevertheless the SAGE radars were the only ones offering even minimum capability in the anti-SLBM role. Therefore, industry proposals with regard to the modification of SAGE radars for SLBM detection were requested in the spring of 1965.[11]

In July 1965, the USAF SLBM Source Selection Board decided that the most promising proposal had come from the AVCO Corporation, builder of the FPS-26 FD height finder. The specifications which AVCO proposed to meet called for detection of an object at least two square meters in size at a range of 750 miles within six seconds after launching. Continuous tracking of the object was to begin within an additional 10 seconds. The NORAD Combat Operations Center was to

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11. ESD Briefing on SLBM, 31 Jul 1965 [Doc 30 in Hist of ADC, Jan-Jun 1965].

be notified within a total of 60 seconds. A network of seven SLBM detection sites was tentatively established -- Z-37 (Point Arena, California), Z-76 (Mt. Laguna, California) and Z-100 (Mt. Hebo, Oregon) on the West Coast; Z-65 (Charleston, Maine), Z-115 (Fort Fisher, North Carolina) and Z-129 (MacDill AFB, Florida) on the East Coast; and Laredo, Texas. Laredo was the site of an inactivated space sensor, newly designated Z-230 in the ADC catalog of radar locations. The SLBM-modified FPS-26 height finders were to be known as AN/FSS-7 radars and the total interim SLBM detection system was designated AN/GSQ-89. Operational date was given as August 1967. AVCO was awarded the necessary contract on 5 December 1965.[12]

The serious situation as regards the rapid failure of the ball bearings supporting antennas for FPS-24/35 radars did not improve until early 1966. As late as November 1965, five FPS-24 radars were non-operational by reason of bearing failures. But the concentrated effort to increase the supply of spare bearings and decrease the time required to change bearings achieved the desired results. At the end of

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12. Program Information Center (ADC) Briefing on SLBM, Oct 1965 [Doc 31 in Hist of ADC, Jan-Jun 1965]; Weekly Activity Reports, ADLPC, 17 Mar and 9 Sep 1965 and ADOAC, 16-22 Jul and 20 Dec 1965 [HRF].

March 1966 no FPS-24/35 radar were non-operational for bearing failure and spare bearings of both types were in storage, awaiting use when future failures occurred.[13]

. Meanwhile, action was being taken toward development and production of a hydrostatic bearing to replace ball bearings, but progress was slow. In February 1965 it was hoped that a development contract could be awarded by the coming June, but this did not prove to be possible because of continuing difficulty in the establishment of specifications. A special problem was determination of the proper thickness and quality of the oil film upon which the weight of the antenna would ride. At the end of 1965, USAF was hopeful that production of the first bearing could be achieved in January 1969. The sudden improvement of the situation as regards ball bearings, however, removed some of the impetus behind the drive for development of the hydrostatic bearing. In May 1966, when USAF was searching for possible savings in the budget for FY 1968, ADC suggested that the $5.7 million set

13. Weekly Activity Reports, ADOAC, 28 May-3 Jun and 19-25 Nov 1965 and 8-14 Apr 1966 and ADLPC, 5 Nov 1965 [HRF].

aside in the 1968 budget for the hydrostatic bearing might safely be deferred to FY 1969.[14]

The loss of nine operational radar stations in March 1965 and April 1966, reduced the number of long-range radar stations within the United States responsive to ADC direction from 132 to 123. Although ADC had long since ceased to think in terms of Permanent (P) Phase I Mobile (M), Phase II Mobile (SM) and Phase III Mobile (TM) stations, lumping all long-range radar locations within the United States under a "Z" classification, it is necessary to discuss the surviving radar network in these earlier terms in order to indicate the wide difference between the plans of the early fifties and the realities of 1 April 1966. The original "P" system involved 75 stations. Fifty-seven were active after 1 April 1966 and three were scheduled for inactivation in FY 1967. The initial Phase I program listed 38 sites in the United States. Twenty-two remained on 1 April 1966, with two to be dropped in FY 1967. Phase II began with 32 sites, of which 11 were operational at the end of the first quarter of 1966. One more was to go in FY 1967. Of the original 29 Phase III stations, 11 were

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14. Ibid., ADOAC, 29 Jan-4 Feb and 17-23 Dec 1965; NOFORN EX CANADA, Msg ADC to USAF, ADLPC-A 1536, 2 May 1966 [DOC 45].

operational on 1 April 1966. In all, 174 long-range radar stations were authorized for ADC in the various programs. Of this number, 101 were operational on 1 April 1966. In addition, ADC was operating four surveillance stations not included in any of the earlier programs and was receiving air defense information from 16 FAA stations and two operated by the Air National Guard, bringing the operational total to 123 within the United States. These stations were deployed and equipped as shown in Table 32.

By the spring of 1966, all but one of the ADC radars in the air defense network had been fitted with ECCM devices of a type designed to cope with the electronic countermeasures threat outlined in the Project LAMPLIGHT report of 1955. There was mounting evidence in early 1965, however, that the offense had again taken the lead over the defense in this field. In a February 1965 test involving the FPS-24 radar at Malmstrom AFB, Montana, and a KC-135 aircraft fitted with an AN/ALT-15 jammer rendered the radar completely useless even though the jammer was operated at reduced power.[15]

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15. Weekly Activity Report, ADOAC, 5-11 Mar 1965 [HRF].

Other such reports were received during the remainder of 1965, leading to ADC preparation, in early 1966, of a Qualitative Operational Requirement (QOR) for a radar capable of presenting a three-dimensional picture not only of the airspace above the North American continent, but of the airless space above this area as well. This advanced radar was expected to improve ECCM capability and was also expected to cost much less to operate than current radars because it would utilize manufacturing and assembly techniques that were within the present state of the radar art. Maintenance would be simplified by self-test capability and utilization of remove-and-replace modules in place of current tube-by-tube and wire-by-wire repair. In this manner, it was hoped that minimum manning and minimum operations and maintenance cost could be realized. Systems Development Corporation was asked, 1 March 1966, to analyze the proposed QOR in terms of manufacturing possibilities.[16]

Meanwhile, ADC was studying the possible air defense use of a proposed tri-service mobile three-dimensional radar. Early conclusions were that a fixed version of this radar would amount to an

16. Ibid., ADLPC, 15 Feb and 1 Mar 1966.

enhancement of the FD concept, with improved ECCM capability. It was possible that the cost of a dual-channel version of this radar could be amortized within three years through savings in operational costs. Additional savings could possibly be realized through cancellation of expensive ECCM modification programs involving existing radars. Such modifications were expected to cost $10.9 million in FY 1968 alone.[17]

And so it appeared that another step in the development of advanced search radar was about to be taken. Many such steps had been taken in the 20 years since ADC began creation of a post-war air defense radar network in 1946. The first radars used by ADC were CPS-5 and TPS-1B/D sets left over from World War II. Then came the CPS-6, the FPS-3, the MPS-7 (first proposed as a mobile version of the FPS-3), and the MPS-11. Then in the mid-fifties came the FPS-20, an improved version of the FPS-3, and the FPS-7, originally developed for the Navy by General Electric. Still later, when ECCM became important, the FD radars (FPS-24/27/35) were developed and ECCM modifications were provided for the FPS-20 (FPS-64/65/66/67 and

17. Ibid., ADOAC, 8-14 Apr 1966; NOFORN EX CANADA, Msg ADC to USAF, ADLPC-A 1536, 2 May 1966 [DOC 45].

FPS-91A) and the FPS-7. The first generation of ECCM-capable radars was in service in early 1966. While radar quality steadily improved, despite apparent overmatching by the offense again in 1965, the numbers declined after the development of the ICBM in the early sixties.

As Secretary of Defense McNamara put it to the House Subcommittee on Department of Defense Appropriations in February 1966:[18]

> ...the elaborate defenses which we erected against the Soviet's bomber threat during the decade of the 1950's no longer retain their original importance. Today, with no defense against the major threat, Soviet ICBM's, our anti-bomber defenses alone would contribute very little to our Damage Limiting objective and their residual effectiveness after a major ICBM attack is highly problematical. For this reason we have been engaged in the past five years in a major restructuring of these defenses.

Nevertheless, it was likely to be necessary to defend the national airspace against incursions by air-breathing objects as far into the future as anybody could see. The need for the best possible, if quantitatively limited, air defense radar network was still clear.

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18. Hearings, House Subcommittee on DOD Appropriations for FY 1967, 14 Feb 1966, p. 58.

APPENDIX

TABLES REFERRED TO IN THE TEXT

TABLE 1

FIRST 24 SITES OF THE P-SYSTEM,
BY PRIORITY

March 1950

Source: ConAC to AMC, "Assignment of Overall Project Number to Each Permanent ZI AC&W Site," 14 Mar 1950 [Doc 217 in AMC Case Hist of the AC&W System].

1.	P-1	McChord AFB, Washington
2.	P-6	Mt. Bonaparte, Washington
3.	P-7	Gonzales, New Mexico
4.	P-8	El Vado, New Mexico
5.	P-9	Navasink, New Jersey
6.	P-10	North Truro, Massachusetts
7.	P-13	Brunswick, Maine
8.	P-14	Bellevue Hill, Vermont
9.	P-16	Keweenaw, Michigan
10.	P-20	Selfridge AFB, Michigan
11.	P-21	Shawnee, New York
12.	P-30	Mud Pond, Pennsylvania
13.	P-31	Elkhorn, Wisconsin
14.	P-34	Empire, Michigan
15.	P-35	East Farmington, Wisconsin
16.	P-38	Mt. Tamalpais, California
17.	P-40	Saddle Mountain, Washington
18.	P-44	Bohokus Peak, Washington
19.	P-49	Watertown, New York
20.	P-51	Moriarity, New Mexico
21.	P-57	Naselle, Washington
22.	P-60	Colville, Washington
23.	P-66	Sault Ste. Marie, Michigan
24.	P-69	Finland, Minnesota

TABLE 2

SECOND SEGMENT OF THE P-SYSTEM,
BY PRIORITY

July 1950

Source: USAF to OCE, "Authorization--ZI AC&W System No. ZI-116-51," 21 Jul 1950 [Doc 265 in AMC Hist of the AC&W System].

25.	P-2	Cambria, California
26.	P-15	Santa Rosa Island, California
27.	P-19	Antigo, Wisconsin
28.	P-32	Condon, Oregon
29.	P-37	Hill Peak Road, California
30.	P-39	San Clemente Island, California
31.	P-42	Cross Mountain, Tennessee
32.	P-45	Camp Hero, New York
33.	P-46	Birch Bay, Washington
34.	P-50	Schuylerville, New York
35.	P-53	Rockville, Indiana
36.	P-54	Palermo, New Jersey
37.	P-55	Quantico, Virginia
38.	P-56	Fort Custis, Virginia
39.	P-58	Mather AFB, California
40.	P-59	Atolia, California
41.	P-61	Port Arthur, Michigan
42.	P-62	Brookfield, Ohio
43.	P-63	Blue Knob Park, Pennsylvania
44.	P-64	Sublette, Michigan
45.	P-65	Charleston, Maine
46.	P-67	Fort Custer, Michigan
47.	P-73	Bellefontaine, Ohio
48.	P-76	Mt. Laguna, California
49.	P-80	Caswell, Maine
50.	P-81	Waverly, Iowa
51.	P-82	Godman AFB, Kentucky
52.	P-85	Hanna City, Illinois

TABLE 3

THIRD SEGMENT OF THE P-SYSTEM
BY PRIORITY

July 1950

Source: ADC Command Data Book, Mar 1951.

53.	P-11	Yaak, Montana
54.	P-12	Reedsport, Oregon
55.	P-17	Leaf River, Minnesota
56.	P-18	Moulton, Minnesota
57.	P-24	Del Bonito, Montana
58.	P-25	Simpson, Montana
59.	P-26	Opheim, Montana
60.	P-27	Fortuna, North Dakota
61.	P-28	Velva, North Dakota
62.	P-29	Finley, North Dakota
63.	P-33	Klamath, California
64.	P-43	Guthrie, West Virginia
65.	P-47	Hutchinson, Kansas
66.	P-52	Tuttle, Oklahoma
67.	P-68	Fordland, Missouri
68.	P-70	Belleville, Illinois
69.	P-71	Omaha, Nebraska
70.	P-72	Olathe NAS, Kansas
71.	P-74	Madera, California
72.	P-75	Lackland AFB, Texas
73.	P-77	Bartlesville, Oklahoma
74.	P-78	Duncan NAS, Texas
75.	P-79	Ellington AFB, Texas

TABLE 4

THE LASHUP RADAR NETWORK

31 December 1950

Source: ADC Command Data Book, Feb 1951.

Dow AFB, Maine
Fort Williams, Maine
Fort Ethan Allen, Vermont
Grenier AFB, New Hampshire
Otis AFB, Massachusetts
Pine Camp, New York
Schenectady, New York
Seneca Ordnance Depot, New York
Indiantown Gap, Pennsylvania
Camp Hero, New York
Santini, New York
Twin Lights, New Jersey
Palermo, New Jersey
Fort Meade, Maryland
Fort Custis, Virginia
Connelsville, Pennsylvania
Selfridge AFB, Michigan
Ravenna Airport, Ohio
Fort Niagara, New York
Oscoda, Michigan
Sault Ste. Marie, Michigan
Lockbourne AFB, Ohio
Spokane AFB, Washington
Larson AFB, Washington
Richland, Washington
Paine Field, Washington
McChord AFB, Washington
Portland AFB, Oregon
Neah Bay, Washington

TABLE 4 [Cont'd]

Pacific Beach, Washington
Fort Stevens, Oregon
Mather AFB, California
Half Moon Bay, California
Minter Field, California
Edwards AFB, California
Camp Cooke, California
Port Hueneme, California
Fort McArthur, California
El Vado, New Mexico
Kirtland AFB, New Mexico
Walker AFB, New Mexico
McGhee-Tyson Airport, Tennessee
O'Hare Int. Aprt, Illinois
Limestone, Maine

TABLE 5

LASHUP-PERMANENT (LP) RADAR NETWORK

June 1951

Source: ADC Command Data Book, 30 June 1951 [HRF].

LP-2	Cambria, California
LP-6	Mt. Bonaparte, Washington
LP-7	Gonzales, New Mexico
LP-8	El Vado, New Mexico
LP-9	Navasink, New Jersey
LP-16	Keweenaw, Michigan
LP-20	Selfridge AFB, Michigan
LP-31	Elkhorn, Wisconsin
LP-32	Condon, Oregon
LP-33	Klamath, California
LP-37	Hill Peak Road, California
LP-40	Saddle Mountain, Washington
LP-45	Camp Hero, New York
LP-51	Moriarity, New Mexico
LP-54	Palermo, New Jersey
LP-56	Fort Custis, Virginia
LP-60	Colville, Washington
LP-61	Port Austin, Michigan
LP-66	Sault Ste. Marie, Michigan
LP-67	Fort Custer, Michigan
LP-69	Finland, Minnesota
LP-74	Madera, California
LP-80	Caswell, Maine

TABLE 6

INITIAL DEPLOYMENT OF PHASE I
MOBILE RADARS

1951

Source: ADC Command Data Book, 30 Nov 1951 [HRF].

M-87	Rapid City AFB, South Dakota
M-88	Miles City, Montana
M-89	Bismarck, North Dakota
M-90	Winner, South Dakota
M-91	Walker AFB, New Mexico
M-92	Clayton, New Mexico
M-93	Hereford, Texas
M-94	Sweetwater, Texas
M-95	Biggs AFB, Texas
M-96	Deming, New Mexico
M-97	Marfa, Texas
M-98	Del Rio, Texas
M-99	Davis-Monthan AFB, Arizona
M-100	Vicksburg, Arizona
M-101	Douglas, Arizona
M-102	Holbrook, Arizona
M-103	MacDill AFB, Florida
M-104	St. Augustine, Florida
M-105	Sebring, Florida
M-106	Miami, Florida
M-107	Barksdale AFB, Louisiana
M-108	Pine Bluff, Arkansas
M-109	Jackson, Mississippi
M-110	New Iberia, Louisiana
M-111	Kirtland AFB, New Mexico area
M-112	Portland, Oregon
M-113	Neskowin, Oregon
M-114	Beaufort, North Carolina
M-115	High Point, North Carolina

Table 6 [Cont'd]

M-116	Myrtle Beach, South Carolina
M-117	Parris Island, South Carolina
M-118	Comer, Georgia
M-119	Billings, Montana
M-120	Casper, Wyoming
M-121	Denver, Colorado
M-122	Spokane AFB, Washington
M-123	Selfridge AFB, Michigan
M-124	McChord AFB, Washington
M-125	Stewart AFB, New York
M-126	O'Hare AFB, Illinois
M-127	Kirtland AFB, New Mexico area
M-128	Otis AFB, Massachusetts
M-129	Topeka, Kansas
M-130	Hamilton AFB, California

TABLE 7

REVISED DEPLOYMENT OF PHASE I
MOBILE RADARS

January 1952

Source: ADC to USAF, "Mobile Radar Program" 18 Jan 1952 [Doc 19 in Hist of ADC, Jan-Jun 1952].

M-87	Amarillo, Texas
M-88	Stamford, Texas
M-89	Walker AFB, New Mexico
M-90	Texarkana, Arkansas
M-91	Davis-Monthan AFB, Arizona
M-92	Winslow, Arizona
M-93	Kirtland AFB, New Mexico
M-94	Las Cruces, New Mexico
M-95	Gila Bend, Arizona
M-96	Rapid City AFB, South Dakota
M-97	Miles City, Montana
M-98	Gettysburg, South Dakota
M-99	Neotsa, Oregon
M-100	Massena, New York
M-101	Trenton, Ontario
M-102	Berlin, New Hampshire
M-103	Wiarton, Ontario
M-104	Alpena, Michigan
M-105	Manitowoc, Wisconsin
M-106	Sultan, Ontario
M-107	Mattawa, Ontario
M-108	Munsing, Michigan
M-109	Corea, Maine
M-110	Sparta, Wisconsin
M-111	Savannah Beach, Georgia
M-112	Bull Island, South Carolina
M-113	Mayport, Florida
M-114	Carolina Beach, North Carolina

TABLE 7 [Cont'd]

M-115	Gulrock, North Carolina
M-116	Roanoke Rapids, North Carolina
M-117	Diablo, Washington
M-118	Fire River, Ontario
M-119	Peninsula, Ontario
M-120	Sedalia, Virginia
M-121	Des Moines, Iowa
M-122	Vida, Oregon
M-123	Lemon Springs, North Carolina
M-124	Jena, Louisiana
M-125	Pilotown, Louisiana
M-126	Flanagan, Nevada
M-127	Kingman, Arizona
M-128	MacDill AFB, Florida
M-129	Canaveral, Florida
M-130	Cherry Fork, Ohio

TABLE 8

INITIAL SITING OF PHASE II
MOBILE RADARS

1952

Source: ADC to USAF, "Mobile Radar Program (Second Phase)," 5 Jul 1952 [Doc 25 in Hist of ADC, Jan-Jun 1952]; ADC to USAF, "Mobile Radar Program (Second Phase)," 10 Sep 1952 [Doc 127 in Hist of ADC, Jul-Dec 1952].

SM-132	Taholah, Washington
SM-133	Monterey, California
SM-134	Snow Hill, Maryland
SM-135	Chelam, Washington
SM-136	Fort Klamath, Oregon
SM-137	Hampton, Oregon
SM-138	Ironsides, Oregon
SM-139	Winchester, Idaho
SM-140	Geiger AFB, Washington
SM-141	Fort Bidwell, California
SM-142	Nakusp, British Columbia
SM-143	Kamloops, British Columbia
SM-144	Birken, British Columbia
SM-145	Swan River, Minnesota
SM-146	Benson, Minnesota
SM-147	Sioux City, Iowa
SM-148	Falls City, Nebraska
SM-149	Baker, Oregon
SM-150	Berry Field, Tennessee
SM-151	Martin, Tennessee
SM-152	Pocahontas, Arkansas
SM-153	Delmar, Illinois
SM-154	Bowling Green, Missouri
SM-155	Grayville, Illinois
SM-156	Grenier AFB, New Hampshire

TABLE 8 [Cont'd]

SM-157	Stewart AFB, New York
SM-158	York, Pennsylvania
SM-159	Petrolia, California
SM-160	Red Bluff, California
SM-161	Fallon, Nevada
SM-162	Tonopah, Nevada
SM-163	Indian Springs, Nevada
SM-164	Yuma, Arizona
SM-165	Schafer, California
SM-166	Amboy, California

TABLE 9

COMPLETION OF THE PERMANENT
RADAR NETWORK

1952

Source: Map 2 in Hist of ADC, Jan-Jun 1952.

P-6	Mt. Bonaparte, Washington
P-8	El Vado, New Mexico
P-11	Yaak, Montana
P-12	Reedsport, Oregon
P-15	Santa Rosa Island, California
P-24	Del Bonito, Montana
P-25	Simpson, Montana
P-26	Opheim, Montana
P-27	Fortuna, North Dakota
P-28	Velva, North Dakota
P-29	Finley, North Dakota
P-32	Condon, Oregon
P-33	Klamath, California
P-39	San Clemente Island, California
P-40	Saddle Mountain, Washington
P-44	Bohokus Peak, Washington
P-45	Montauk, New York
P-46	Birch Bay, Washington
P-47	Hutchinson, Kansas
P-50	Schuylerville, New York
P-54	Palermo, New Jersey
P-55	Quantico, Virginia
P-56	Fort Custis, Virginia
P-59	Atolia, California
P-60	Colville, Washington
P-62	Brookfield, Ohio
P-63	Blue Knob Park, Pennsylvania
P-64	Sublette, Missouri
P-65	Charleston, Maine

TABLE 9 [Cont'd]

P-66 Sault Ste. Marie, Michigan
P-67 Fort Custer, Michigan
P-71 Omaha, Nebraska
P-72 Olathe, Kansas
P-73 Bellefontaine, Ohio
P-76 Mt. Laguna, California
P-81 Waverly, Iowa
P-82 Fort Knox, Kentucky
P-85 Hanna City, Illinois

Source: Map following page 2, Hist of ADC, Jul-Dec 1952.

P-17 Leaf River, Minnesota
P-18 Moulton, Minnesota
P-19 Antigo, Wisconsin
P-42 Cross Mountain, Tennessee
P-43 Guthrie, West Virginia
P-52 Tinker AFB, Oklahoma
P-53 Rockville, Indiana
P-61 Port Austin, Michigan
P-68 Fordland, Missouri
P-69 Finland, Minnesota
P-70 Belleville, Illinois
P-75 Lackland AFB, Texas
P-77 Bartlesville, Oklahoma
P-78 Duncanville, Texas
P-79 Ellington AFB, Texas
P-80 Caswell, Maine

TABLE 10

PROPOSED DEPLOYMENT OF PHASE I
MOBILE RADARS

End - 1953

Source: ADC Command Data Book, 31 Dec 1953 [HRF].

M-88	Amarillo AFB, Texas
M-89	Sweetwater, Texas
M-90	Walker AFB, New Mexico
M-91	Texarkana, Arkansas
M-92	Casa Grande, Arizona
M-93	Winslow, Arizona
M-94	West Mesa, New Mexico
M-95	Las Cruces, New Mexico
M-97	Rapid City AFB, South Dakota
M-98	Miles City, Montana
M-99	Gettysburg, South Dakota
M-100	Mt. Hebo, Oregon
M-101	Rochester, Minnesota
M-103	North Concord, Vermont
M-105	Alpena, Michigan
M-106	Two Rivers, Wisconsin
M-109	Grand Marais, Michigan
M-110	Bucks Harbor, Maine
M-111	Hallock, Minnesota
M-112	Hunter AFB, South Carolina
M-113	Charleston AFB, South Carolina
M-114	Fernandina Beach, Florida
M-115	Fort Fisher, North Carolina
M-116	Englehard, North Carolina
M-117	Roanoke Rapids, North Carolina
M-118	Burns, Oregon
M-121	Bedford, Virginia
M-122	Dallas Center, Iowa

TABLE 10 [Cont'd]

M-123	Berlin, Maryland
M-124	Aberdeen, North Carolina
M-125	Alexandria AFB, Louisiana
M-126	Houma NAS, Louisiana
M-127	Winnemucca, Nevada
M-128	Kingman. Arizona
M-129	MacDill AFB, Florida
M-130	Winston-Salem, North Carolina
M-131	Owingsville, Kentucky

TABLE 11

PROPOSED DEPLOYMENT OF PHASE II
MOBILE RADARS

End - 1953

Source: Hist of WADF, CADF and EADF, Jul-Dec 1953.

SM-132	Fort Dearborn, New Hampshire
SM-133	Elizabethtown, Pennsylvania
SM-136	Bowling Green, Missouri
SM-137	Carmi, Illinois
SM-138	Swan River, Minnesota
SM-139	Benson, Minnesota
SM-140	Sioux City, Iowa
SM-141	Falls City, Nebraska
SM-142	Nevada, Missouri
SM-143	Walnut Ridge, Arkansas
SM-144	Uniontown, Tennessee
SM-145	Joeltown, Tennessee
SM-147	Great Falls AFB, Montana
SM-148	Dublin, Georgia
SM-149	Baker, Oregon
SM-150	Cottonwood, Idaho
SM-151	Mica Peak, Washington
SM-155	Mt. Umunhum, California
SM-156	Fallon, Nevada
SM-157	Red Bluff, California
SM-158	Petrolia, California
SM-159	Trenton, South Carolina
SM-160	Poston, Arizona
SM-161	Bakersfield, California
SM-162	Yuma AFB, Arizona
SM-163	Las Vegas, Nevada
SM-164	Tonopah, Nevada
SM-165	Rising Fawn, Georgia
SM-166	Atlanta, Georgia

TABLE 12

PROPOSED DEPLOYMENT OF PHASE III
MOBILE RADARS

January 1954

Source: Hist of ADC, Jan-Jun 1954, page 170.

TM-173	Baudette, Minnesota
TM-174	Hastings, Nebraska
TM-175	Lake Andes, South Dakota
TM-176	Andover, South Dakota
TM-177	Belfield, North Dakota
TM-178	Roy, Montana
TM-179	Niarada, Montana
TM-180	Klamath Falls, Oregon
TM-181	Lukeville, Arizona
TM-182	Nogales, Arizona
TM-183	Cloverdale, New Mexico
TM-184	Porvenir, Texas
TM-185	Castelon, Texas
TM-186	Pyote, Texas
TM-187	Sonora, Texas
TM-188	Eagle Pass, Texas
TM-189	Zapata, Texas
TM-190	Port Isabel, Texas
TM-191	Rockport, Texas
TM-192	Rockdale, Texas
TM-193	Lufkin, Texas
TM-194	Lake Charles, Louisiana
TM-195	Crystal Springs, Mississippi
TM-196	Foley, Alabama
TM-197	Thomasville, Alabama
TM-198	Tyndall AFB, Florida
TM-199	Eufaula, Alabama
TM-200	Live Oak, Florida
TM-201	Gillette, Wyoming

TABLE 13

PROPOSED DEPLOYMENT OF PHASE I
MOBILE RADARS

End - 1954

Source: Bi-Weekly Status Report, ADC, 17 Dec 1954 [Doc 74 in Hist of ADC, Jul-Dec 1954].

M-88	Amarillo AFB, Texas
M-89	Sweetwater, Texas
M-90	Walker AFB, New Mexico
M-91	Texarkana, Arkansas
M-92	Tucson, Arizona
M-93	Winslow, Arizona
M-94	West Mesa, New Mexico
M-95	Las Cruces, New Mexico
M-96	Almaden, California
M-97	Ellsworth AFB, South Dakota
M-98	Miles City, Montana
M-99	Gettysburg, South Dakota
M-100	Mt. Hebo, Oregon
M-101	Rochester, Minnesota
M-103	North Concord, Vermont
M-104	Fort Dearborn, New Hampshire
M-105	Alpena, Michigan
M-106	Two Rivers, Wisconsin
M-108	Bowling Green, Missouri
M-109	Grand Marais, Michigan
M-110	Bucks Harbor, Maine
M-111	Dobbins AFB, Georgia
M-112	Hunter AFB, South Carolina
M-113	Charleston AFB, South Carolina
M-114	Jacksonville NAS, Florida
M-115	Fort Fisher, North Carolina
M-116	Cherry Point MCAS, North Carolina
M-117	Roanoke Rapids, North Carolina
M-118	Burns, Oregon

TABLE 13 [Cont'd]

M-121	Bedford, Virginia
M-122	Dallas Center, Iowa
M-124	Pope AFB, North Carolina
M-125	Alexandria AFB, Louisiana
M-126	Houma NAS, Louisiana
M-127	Winnemucca, Nevada
M-128	Kingman, Arizona
M-129	MacDill AFB, Florida
M-130	Winston-Salem, North Carolina
M-131	Owingsville, Kentucky

TABLE 14

PROPOSED DEPLOYMENT OF PHASE II
MOBILE RADARS

End - 1954

Source: Bi-Weekly Status Report, ADC, 17 Dec 1954 [Doc 74 in Hist of ADC, Jul-Dec 1954].

SM-132	Baudette, Minnesota
SM-133	Hastings NAD, Nebraska
SM-134	Lake Andes, South Dakota
SM-137	Carmi, Illinois
SM-138	Grand Rapids, Minnesota
SM-139	Willmar, Minnesota
SM-140	Sioux City, Iowa
SM-141	Falls City, Nebraska
SM-142	Nevada, Missouri
SM-143	Walnut Ridge, Arkansas
SM-144	Uniontown, Tennessee
SM-145	Joeltown, Tennessee
SM-147	Great Falls AFB, Montana
SM-148	Robins AFB. Georgia
SM-149	Baker, Oregon
SM-150	Cottonwood, Idaho
SM-151	Geiger Field, Washington
SM-156	Fallon, Nevada
SM-157	Red Bluff, California
SM-158	Ferndale, California
SM-159	Aiken, South Carolina
SM-160	Poston, Arizona
SM-161	Bakersfield, California
SM-162	Yuma AFB, Arizona
SM-163	Las Vegas, Nevada
SM-164	Tonopah, Nevada
SM-165	Chattanooga, Tennessee

TABLE 15

PROPOSED DEPLOYMENT OF PHASE III
MOBILE RADARS

End - 1954

Source: Bi-Weekly Status Report, ADC, 17 Dec 1954
[Doc 74 in Hist of ADC, Jul-Dec 1954].

TM-177	Dickinson, North Dakota
TM-178	Lewiston, Montana
TM-179	Kalispell Montana
TM-180	Klamath Falls, Oregon
TM-181	Ajo, Arizona
TM-182	Nogales, Arizona
TM-183	Douglas, Arizona
TM-184	Valentine, Texas
TM-186	Pyote, Texas
TM-187	Ozona, Texas
TM-188	Eagle Pass, Texas
TM-189	Zapata, Texas
TM-190	Port Isabel, Texas
TM-191	Rockport, Texas
TM-192	Gray AFB, Texas
TM-193	Lufkin, Texas
TM-194	Lake Charles, Louisiana
TM-195	Crystal Springs, Mississippi
TM-196	Foley, Alabama
TM-197	Thomasville, Alabama
TM-198	Tyndall AFB, Florida
TM-199	Eufaula, Alabama
TM-200	Cross City, Florida
TM-201	Sundance, Wyoming

TABLE 16

PROPOSED DEPLOYMENT OF PHASE II
MOBILE RADARS

End - 1955

Source: ADC AC&W Status Report, 28 Dec 1955 [HRF].

SM-132	Baudette, Minnesota
SM-133	Hastings NAD, Nebraska
SM-134	Lake Andes, South Dakota
SM-137	Carmi, Illinois
SM-138	Grand Rapids, Minnesota
SM-139	Willmar, Minnesota
SM-143	Walnut Ridge, Arkansas
SM-144	Uniontown, Tennessee
SM-145	Joeltown, Tennessee
SM-147	Malmstrom AFB, Montana
SM-149	Baker, Oregon
SM-150	Cottonwood, Idaho
SM-151	Geiger Field, Washington
SM-156	Fallon, Nevada
SM-157	Red Bluff, California
SM-159	Aiken, South Carolina
SM-162	Yuma AFB, Arizona
SM-163	Las Vegas, Nevada
SM-164	Tonopah, Nevada
SM-165	Flintstone, Georgia

SECRET

TABLE 17

PROPOSED DEPLOYMENT OF PHASE IV
MOBILE RADARS IN CANADA

March 1955

Source: Proposed Revised 4th Phase Radar Program, ADC, 18 Mar 1955 [Doc 21 in Hist of ADC, Jan-Jun 1955].

1. Anticosti Island, Quebec
2. Multon Bay, Quebec
3. Antikonak, Quebec
4. Knob Lake, Quebec
5. Great Whale River, Quebec
6. Nabuk Point, Ontario
7. Amery, Manitoba
8. Flin Flon, Manitoba
9. Waterways, Alberta
10. Fort Nelson, British Columbia
11. Massett, British Columbia
12. Lake Perdu, Quebec
13. Mistassini Post, Quebec
14. Lake Evans, Quebec
15. Moosonee, Ontario
16. Pekwako River, Ontario
17. Ekwan River, Ontario
18. North Caribou Lake, Ontario
19. Cairn's Lake, Ontario
20. Gypsumville, Manitoba
21. Carberry, Manitoba
22. Saltcoats, Saskatchewan
23. Davidson, Saskatchewan
24. Mantario, Saskatchewan
25. Acme, Alberta
26. Chip Lake, Alberta

TABLE 18

STATIONS PROPOSED FOR STANDBY STATUS
BY REASON OF FUND SHORTAGES

April 1957

Source: Msg ADHCP 1073, ADC to Defense Forces, 18 Apr 1957 [Doc 39 in Hist of ADC, Jan-Jun 1957].

P-18	Chandler, Minnesota
P-42	Lake City, Tennessee
P-64	Kirksville, Missouri
P-68	Fordland, Missouri
P-70	Belleville, Illinois
P-71	Omaha, Nebraska
P-77	Bartlesville, Oklahoma
P-81	Waverly, Iowa
P-85	Hanna City, Illinois
M-97	Ellsworth AFB, South Dakota
M-99	Gettysburg, South Dakota
M-101	Rochester, Minnesota
M-111	Marietta, Georgia
M-118	Burns, Oregon
M-122	Dallas Center, Iowa
M-127	Winnemucca, Nevada
M-128	Kingman, Arizona
SM-137	Carmi, Illinois
SM-139	Willmar, Minnesota
SM-143	Walnut Ridge, Arkansas
SM-144	Union City, Tennessee
SM-145	Joelton, Tennessee
SM-149	Baker, Oregon
SM-150	Cottonwood, Idaho
SM-156	Fallon, Nevada
SM-159	Aiken, South Carolina
SM-163	Las Vegas, Nevada
SM-164	Tonopah, Nevada
SM-165	Flintstone, Georgia

TABLE 19

ADC PLAN FOR INSTALLATION
OF FREQUENCY DIVERSITY
RADAR

September 1957

Source: ADC to USAF, "ADC Frequency Diversity Plan, Revised," 27 Sep 1957 [Doc 27 in Hist of ADC, Jul-Dec 1957].

FPS-24/35

Priority	Site	Date	Location
1	P-30	June 1959	Benton, Pennsylvania
2	P-45	September 1959	Montauk, New York
3	P-55	September 1959	Quantico, Virginia
4	TM-197	September 1959	Thomasville, Alabama
5	P-27	March 1960	Fortuna, North Dakota
6	P-20	March 1960	Selfridge AFB, Michigan
7	M-130	June 1960	Winston-Salem, North Carolina
8	P-13	June 1960	Brunswick NAS, Maine
9	P-19	June 1960	Antigo, Wisconsin

SECRET

TABLE 19 [Cont'd]

Priority	Site	Date	Location
10	SM-132	September 1960	Baudette, Minnesota
11	P-29	September 1960	Finley, North Dakota
12	P-46	September 1960	Blaine, Washington
13	M-100	September 1960	Mt. Hebo, Oregon
14	SM-150	September 1960	Cottonwood, Idaho
15	TM-178	September 1960	Lewiston, Montana
16	M-118	December 1960	Burns, Oregon
17	P-37	December 1960	Point Arena, California
18	M-96	December 1960	Almaden, California
19	SM-156	December 1960	Fallon NAS, Nevada
20	P-59	December 1960	Boron, California
21	SM-162	December 1960	Vincent AFB, Arizona
22	M-95	March 1961	Las Cruces, New Mexico
23	M-114	March 1961	Jacksonville NAS, Florida
24	M-93	March 1961	Winslow, Arizona
25	P-8	March 1961	Tierra Amarillo, New Mexico
26	M-89	March 1961	Sweetwater, Texas
27	P-75	March 1961	Lackland AFB, Texas
28	M-125	June 1961	England AFB, Louisiana
29	TM-190	June 1961	Port Isabel, Texas
30	SM-165	June 1961	Flintstone, Georgia
31	SM-139	June 1961	Willmar, Minnesota
32	P-82	June 1961	Fort Knox, Kentucky

SECRET

TABLE 19 [Cont'd]

Priority	Site	Date	Location
33	P-85	June 1961	Hanna City, Illinois
34	M-91	September 1961	Texarkana, Arkansas
35	M-97	September 1961	Ellsworth AFB, South Dakota
36	SM-134	September 1961	Pickstown, South Dakota
37	P-72	September 1961	Olathe NAS, Kansas
		FPS-28	
1	M-126	September 1960	Houma NAS, Louisiana
2	P-25	September 1960	Havre, Montana
3	TM-177	December 1960	Dickinson, North Dakota
4	P-7	December 1960	Continental Divide, New Mexico
5	M-90	December 1960	Walker AFB, New Mexico
6	TM-187	March 1961	Ozona, Texas
7	P-49	March 1961	Watertown, New York
8	TM-191	March 1961	Rockport, Texas
9	TM-193	June 1961	Lufkin, Texas
10	RP-62	June 1961	South Park Mil. Res., Pennsylvania
11	M-121	June 1961	Bedford, Virginia
12	M-116	September 1961	Cherry Point MCAS, North Carolina
13	M-110	September 1961	Bucks Harbor, Maine
14	M-103	September 1961	North Concord, Vermont

SECRET

TABLE 19 [Cont'd]

Priority	Site	Date	Location
15	P-67	December 1961	Fort Custer, Michigan
16	P-73	December 1961	Bellefontaine, Ohio
17	P-81	December 1961	Waverly, Iowa
18	SM-138	March 1962	Grand Rapids, Minnesota
19	P-18	March 1962	Chandler, Minnesota
20	P-1	March 1962	McChord AFB, Washington
21	TM-180	June 1962	Klamath, Oregon
22	P-82	June 1962	Condon, Oregon
23	SM-151	June 1962	Geiger Field, Washington
24	P-74	September 1962	Madera, California
25	RP-39	September 1962	San Pedro Hill, California
26	M-128	September 1962	Kingman, Arizona
27	M-113	December 1962	North Charleston, South Carolina
28	TM-200	December 1962	Cross City, Florida
29	TM-198	December 1962	Tyndall AFB, Florida
30	P-66	March 1963	Sault Ste. Marie, Michigan
31	M-111	March 1963	Marietta, Georgia
32	M-127	March 1963	Winnemucca, Nevada
33	SM-144	June 1963	Union City, Tennessee
34	P-68	June 1963	Fordland, Missouri
		FPS-27	
1	TM-195	June 1961	Crystal Springs, Mississippi
2	P-9A	June 1961	Gibbsboro, New Jersey

SECRET

TABLE 19 [Cont'd]

Priority	Site	Date	Location
3	TT-4	September 1961	Unnamed Shoal
4	P-50	September 1961	Saratoga Springs, New York
5	TT-2	September 1961	Georges Shoal
6	M-117	December 1961	Roanoke Rapids, North Carolina
7	P-65	December 1961	Charleston, Maine
8	P-61	December 1961	Port Austin, Michigan
9	P-43	March 1962	Guthrie, West Virginia
10	RP-31	March 1962	Arlington Heights, Illinois
11	P-69	March 1962	Finland, Minnesota
12	P-70	June 1962	Belleville, Illinois
13	P-17	June 1962	Wadena, Minnesota
14	M-99	June 1962	Gettysburg, South Dakota
15	M-98	September 1962	Miles City, Montana
16	P-57	September 1962	Naselle, Washington
17	P-33	September 1962	Klamath, California
18	P-24	December 1962	Cut Bank, Montana
19	P-40	December 1962	Othello, Washington
20	P-58	December 1962	Mather AFB, California
21	P-15	March 1963	Santa Rosa Island, California
22	SM-163	March 1963	Las Vegas, Nevada
23	TM-181	March 1963	Ajo, Arizona
24	M-94	June 1963	West Mesa, New Mexico
25	M-88	June 1963	Amarillo AFB, Texas

SECRET

TABLE 19 [Cont'd]

Priority	Site	Date	Location
26	SM-159	June 1963	Aiken, South Carolina
27	P-60	September 1963	Colville, Washington
28	TM-199	September 1963	Eufaula, Alabama
29	P-78	September 1963	Duncanville, Texas
30	P-79	December 1963	Ellington AFB, Texas
31	TM-188	December 1963	Eagle Pass, Texas
32	P-71	December 1963	Omaha, Nebraska
33	P-77	March 1964	Bartlesville, Oklahoma
34	SM-145	March 1964	Joelton, Tennessee

SECRET

SECRET

TABLE 20

PROPOSED DEPLOYMENT OF PHASE IV
MOBILE RADAR STATIONS
IN CANADA

End - 1957

Source: ADC ACW Status Report, 31 Jan 1958 [Doc 25 in Hist of ADC, Jul-Dec 1957].

C-38	Mutton Bay, Quebec
C-39	Burnt Lake, Quebec
C-40	Cape Observation, Quebec
C-41	Manvan Lake, Quebec
C-42	Mistissini, Quebec
C-43	Nemiscan, Quebec
C-44	Moosonee, Ontario
C-45	Ghost River, Ontario
C-46	Lansdowne House, Ontario
C-47	Windigo Lake, Ontario
C-48	Little Grand Rapids, Manitoba
C-49	St. Martin, Manitoba
C-50	Carberry, Manitoba
C-51	Yorkton, Saskatchewan
C-52	Dana, Saskatchewan
C-53	Alsask, Saskatchewan
C-54	Olds, Alberta
C-55	Ft. Assiniboine, Alberta

TABLE 11

DEPLOYMENT OF OPERATIONAL PHASE I
RADAR STATIONS

End - 1957

Source: ADC ACW Status Report, 31 Jan 1958 [Doc 25 in Hist of ADC, Jul-Dec 1957].

M-88	Amarillo AFB, Texas
M-89	Sweetwater, Texas
M-90	Walker AFB, New Mexico
M-91	Texarkana, Texas
M-92	Mt. Lemmon, Arizona
M-93	Winslow, Arizona
M-94	West Mesa, New Mexico
M-95	Las Cruces, New Mexico
M-97	Ellsworth AFB, South Dakota
M-98	Miles City, Montana
M-99	Gettysburg, South Dakota
M-100	Mt. Hebo, Oregon
M-103	North Concord, Vermont
M-110	Bucks Harbor, Maine
M-111	Marietta, Georgia
M-112	Hunter AFB, Georgia
M-113	North Charleston, South Carolina
M-115	Fort Fisher, North Carolina
M-117	Roanoke Rapids, North Carolina
M-118	Burns, Oregon
M-121	Bedford, Virginia
M-125	England AFB, Louisiana
M-126	Houma NAS, Louisiana
M-127	Winnemucca, Nevada
M-129	MacDill AFB, Florida
M-130	Winston-Salem, North Carolina

SECRET

TABLE 22

DEPLOYMENT OF OPERATIONAL
FPS-20 RADARS

End - 1958

Source: ADC ACW Status Report and ADC ACW Program Resume, 31 Oct 1958 [Doc 21 in Hist of ADC, 1958].

P-16	Calumet, Michigan
P-17	Wadena, Minnesota
P-18	Chandler, Minnesota
P-19	Antigo, Wisconsin
P-24	Cut Bank, Montana
P-27	Fortuna, North Dakota
P-28	Minot, North Dakota
P-29	Finley, North Dakota
P-32	Condon, Oregon
P-33	Klamath, California
P-37	Point Arena, California
P-40	Othello, Washington
P-43	Guthrie, West Virginia
P-45	Montauk, New York
P-46	Blaine, Washington
P-47	Hutchinson, Kansas
P-49	Watertown, New York
P-50	Saratoga Springs, New York
P-51	Moriarity, New Mexico
P-54	Palermo, New Jersey
P-57	Naselle, Washington
P-60	Colville, Washington
P-61	Port Austin, Michigan
P-63	Claysburg, Pennsylvania
P-65	Charleston, Maine
P-66	Sault Ste. Marie, Michigan
P-67	Custer, Michigan
P-69	Finland, Minnesota
P-71	Omaha, Nebraska

TABLE 22 [Cont'd]

P-72	Olathe, Kansas
P-73	Bellefontaine, Ohio
P-74	Madera, California
P-75	Lackland AFB, Texas
P-82	Snow Mountain, Kentucky
P-85	Hanna City, Illinois
M-88	Amarillo AFB, Texas
M-91	Texarkana, Arkansas
M-95	Las Cruces, New Mexico
M-96	Almaden, California
M-98	Miles City, Montana
M-99	Gettysburg, South Dakota
M-112	Hunter AFB, Georgia
M-113	North Charleston, South Carolina
M-121	Bedford, Virginia
M-125	England AFB, Louisiana
M-126	Houma NAS, Louisiana
M-129	MacDill AFB, Florida
SM-138	Grand Rapids, Minnesota
SM-144	Union City, Tennessee
SM-147	Malmstrom AFB, Montana
SM-151	Mica Peak, Washington
SM-159	Aiken, South Carolina
SM-163	Las Vegas, Nevada
TM-196	Dauphin Island, Alabama
TM-198	Tyndall AFB, Florida

TABLE 23

PROPOSED DEPLOYMENT OF FREQUENCY DIVERSITY RADARS

End - 1959

Source: ADC ACW Status Report and ADC ACW Program Resume, 31 Dec 1959 [Doc 6 in Hist of ADC, Jul-Dec 1959].

RP-1	Fort Lawton, Washington (FPS-27)
P-2	Cambria, California (FPS-7)
P-9	Highlands, New Jersey (FPS-7)
P-10	North Truro, Massachusetts (FPS-7)
P-12	North Bend, Oregon (FPS-7)
P-14	St. Albans, Vermont (FPS-7)
RP-15	Lompoc, California (FPS-27)
P-16	Calumet, Michigan (FPS-27)
P-17	Wadena, Minnesota (FPS-27)
P-18	Chandler, Minnesota (FPS-27)
P-19	Antigo, Wisconsin (FPS-35)
P-20	Selfridge AFB, Michigan (FPS-35)
P-21	Lockport, New York (FPS-7)
P-24	Cut Bank, Montana (FPS-27)
P-26	Opheim, Montana (FPS-7)
P-27	Fortuna, North Dakota (FPS-35)
P-29	Finley, North Dakota (FPS-35)
P-30	Benton, Pennsylvania (FPS-35)
P-32	Condon, Oregon (FPS-27)
P-33	Klamath, California (FPS-27)
P-34	Empire, Michigan (FPS-7)
P-35	Osceola, Wisconsin (FPS-7)
P-37	Point Arena, California (FPS-24)
P-38	Mill Valley, California (FPS-7)
RP-39	San Pedro Hill, California (FPS-27)
P-40	Othello, Washington (FPS-7)
P-44	Makah, Washington (FPS-7)
P-45	Montauk, New York (FPS-35)
P-46	Blaine, Washington (FPS-24)

TABLE 23 [Cont'd]

P-49	Watertown, New York (FPS-27)
P-50	Saratoga Springs, New York (FPS-27)
P-53	Rockville, Indiana (FPS-7)
P-55	Manassas, Virginia (FPS-35)
P-56	Cape Charles, Virginia (FPS-7)
P-57	Naselle, Washington (FPS-27)
P-58	Mather AFB, California (FPS-27)
P-59	Boron, California (FPS-35)
P-60	Colville, Washington (FPS-27)
P-61	Port Austin, Michigan (FPS-24)
RP-62	Oakdale, Pennsylvania (FPS-24)
RP-63	Gibbsboro, New Jersey (FPS-27)
P-64	Kirksville, Missouri (FPS-7)
P-65	Charleston, Maine (FPS-27)
P-66	Sault Ste. Marie, Michigan (FPS-35)
P-67	Custer, Michigan (FPS-27)
P-69	Finland, Minnesota (FPS-27)
P-73	Bellefontaine, Ohio (FPS-27)
P-74	Madera, California (FPS-27)
P-76	Mt. Laguna, California (FPS-7)
P-80	Caswell, Maine (FPS-7)
P-81	Waverly, Iowa (FPS-27)
P-82	Snow Mountain, Kentucky (FPS-27)
M-96	Almaden, California (FPS-24)
M-98	Miles City, Montana (FPS-7)
M-99	Gettysburg, South Dakota (FPS-27)
M-100	Mt. Hebo, Oregon (FPS-24)
M-103	North Concord, Vermont (FPS-27)
M-110	Bucks Harbor, Maine (FPS-24)
M-111	Marietta, Georgia (FPS-27)
M-113	North Charleston, South Carolina (FPS-27)
M-115	Fort Fisher, North Carolina (FPS-7)
M-118	Burns, Oregon (FPS-7)
M-121	Bedford, Virginia (FPS-27)
M-126	Houma NAS, Louisiana (FPS-28)
M-127	Winnemucca, Nevada (FPS-27)
M-129	MacDill AFB, Florida (FPS-7)
M-130	Winston-Salem, North Carolina (FPS-24)
SM-132	Baudette, Minnesota (FPS-24)

TABLE 23 [Cont'd]

SM-147	Malmstrom AFB, Montana (FPS-24)
SM-149	Baker, Oregon (FPS-35)
SM-150	Cottonwood, Idaho (FPS-24)
SM-156	Fallon, Nevada (FPS-35)
SM-159	Aiken, South Carolina (FPS-7)
SM-162	Vincent AFB, Arizona (FPS-27)
SM-163	Las Vegas, Nevada (FPS-27)
SM-164	Tonopah, Nevada (FPS-7)
TM-179	Kalispell, Montana (FPS-7)
TM-181	Luke-Williams, Arizona (FPS-7)
TM-195	Crystal Springs, Mississippi (FPS-27)
TM-196	Dauphin Island, Alabama (FPS-7)
TM-197	Thomasville, Alabama (FPS-35)
TM-199	Eufaula, Alabama (FPS-24)
TM-201	Sundance, Wyoming (FPS-7)
Z-211	Patrick AFB, Florida (FPS-27)

TABLE 24

PROPOSED DEPLOYMENT OF
FREQUENCY DIVERSITY RADARS

End - 1960

Source: ADC AC&W Operational Status Report, 31 Dec 1960 [Doc 1 in Hist of ADC, Jul-Dec 1960].

RP-1	Fort Lawton, Washington (FPS-27)
P-2	Cambria, California (FPS-7)
P-9	Highlands, New Jersey (FPS-7)
P-10	North Truro, Massachusetts (FPS-7)
P-12	North Bend, Oregon (FPS-7)
P-14	St. Albans, Vermont (FPS-7)
P-16	Calumet, Michigan (FPS-27)
P-18	Chandler, Minnesota (FPS-27)
P-19	Antigo, Wisconsin (FPS-35)
P-20	Selfridge AFB, Michigan (FPS-35)
P-21	Lockport, New York (FPS-7)
P-25	Havre, Montana (FPS-27)
P-26	Opheim, Montana (FPS-7)
P-27	Fortuna, North Dakota (FPS-35)
P-28	Minot, North Dakota (FPS-27)
P-29	Finley, North Dakota (FPS-35)
P-30	Benton, Pennsylvania (FPS-35)
P-32	Condon, Oregon (FPS-27)
P-33	Klamath, California (FPS-27)
P-34	Empire, Michigan (FPS-7)
P-35	Osceola, Wisconsin (FPS-7)
P-37	Point Arena, California (FPS-24)
P-38	Mill Valley, California (FPS-7)
RP-39	San Pedro Hill, California (FPS-27)
P-40	Othello, Washington (FPS-7)
P-44	Makah, Washington (FPS-7)
P-45	Montauk, New York (FPS-35)
P-46	Blaine, Washington (FPS-24)

TABLE 24 [Cont'd]

P-49	Watertown, New York (FPS-27)
P-50	Saratoga Springs, New York (FPS-27)
P-53	Rockville, Indiana (FPS-7)
P-55	Manassas, Virginia (FPS-35)
P-56	Cape Charles, Virginia (FPS-7)
P-59	Boron, California (FPS-35)
P-61	Port Austin, Michigan (FPS-24)
RP-62	Oakdale, Pennsylvania (FPS-24)
RP-63	Gibbsboro, New Jersey (FPS-27)
P-64	Kirksville, Missouri (FPS-7)
P-65	Charleston, Maine (FPS-27)
P-66	Sault Ste. Marie, Michigan (FPS-35)
P-67	Custer, Michigan (FPS-27)
P-69	Finland, Minnesota (FPS-27)
P-73	Bellefontaine, Ohio (FPS-27)
P-74	Madera, California (FPS-27)
P-76	Mt. Laguna, California (FPS-7)
P-80	Caswell, Maine (FPS-7)
P-81	Waverly, Iowa (FPS-27)
M-96	Almaden, California (FPS-24)
M-98	Miles City, Montana (FPS-27)
M-99	Gettysburg, South Dakota (FPS-27)
M-100	Mt. Hebo, Oregon (FPS-24)
M-103	North Concord, Vermont (FPS-27)
M-110	Bucks Harbor, Maine (FPS-24)
M-111	Marietta, Georgia (FPS-27)
M-113	North Charleston, South Carolina (FPS-27)
M-115	Fort Fisher, North Carolina (FPS-7)
M-117	Roanoke Rapids, North Carolina (FPS-27)
M-118	Burns, Oregon (FPS-7)
M-127	Winnemucca, Nevada (FPS-27)
M-129	MacDill AFB, Florida (FPS-7)
M-130	Winston-Salem, North Carolina (FPS-24)
SM-132	Baudette, Minnesota (FPS-24)
SM-147	Malmstrom AFB, Montana (FPS-24)
SM-149	Baker, Oregon (FPS-35)
SM-150	Cottonwood, Idaho (FPS-24)
SM-156	Fallon, Nevada (FPS-35)
SM-159	Aiken, South Carolina (FPS-7)

TABLE 24 [Cont'd]

SM-162	Yuma, Arizona (FPS-27)
SM-163	Las Vegas, Nevada (FPS-27)
SM-164	Tonopah, Nevada (FPS-7)
TM-179	Kalispell, Montana (FPS-7)
TM-181	Luke-Williams, Arizona (FPS-7)
TM-195	Crystal Springs, Mississippi (FPS-27)
TM-196	Dauphin Island, Alabama (FPS-7)
TM-197	Thomasville, Alabama (FPS-35)
TM-199	Eufaula, Alabama (FPS-24)
TM-201	Sundance, Wyoming (FPS-7)
Z-211	Patrick AFB, Florida (FPS-27)

TABLE 25

OPERATIONAL ADC/FAA JOINT-USE STATIONS

End - 1960

Source: ADC AC&W Operational Status Report, 31 Dec 1960 [Doc 1 in Hist of ADC, Jul-Dec 1960].

RP-1	Fort Lawton, Washington
P-47	Hutchinson, Kansas
P-54	Palermo, New Jersey
P-58	Mather AFB, California
P-71	Omaha, Nebraska
P-72	Olathe, Kansas
P-75	Lackland AFB, Texas
P-79	Ellington AFB, Texas
M-91	Texarkana, Arkansas
M-94	West Mesa, New Mexico
M-113	North Charleston, South Carolina
M-121	Bedford, Virginia
SM-147	Malmstrom AFB, Montana
SM-151	Mica Peak, Washington
TM-180	Keno, Washington
Z-210	Richmond NAS, Florida

TABLE 26

OPERATIONAL FPS-64/67 RADARS

End - 1961

Source: ADC Control and Warning Equipment Report, 31 Dec 1961 [Doc 1 in Hist of ADC, Jul-Dec 1961].

P-16	Calumet, Michigan (FPS-64)
P-17	Wadena, Minnesota (FPS-64)
P-18	Chandler, Minnesota (FPS-64)
P-28	Minot, North Dakota (FPS-66)
P-32	Condon, Oregon (FPS-66)
P-33	Klamath, California (FPS-66)
P-49	Watertown, New York (FPS-66)
P-50	Saratoga Springs, New York (FPS-65)
RP-63	Gibbsboro, New Jersey (FPS-66)
P-67	Custer, Michigan (FPS-66)
P-69	Finland, Minnesota (FPS-64)
P-73	Bellefontaine, Ohio (FPS-66)
P-74	Madera, California (FPS-66)
M-98	Miles City, Montana (FPS-66)
M-99	Gettysburg, South Dakota (FPS-66)
M-113	North Charleston, South Carolina (FPS-66)
M-127	Winnemucca, Nevada (FPS-66)
M-138	Grand Rapids, Minnesota (FPS-67)
TM-180	Keno, Oregon (FPS-67)
Z-211	Patrick AFB, Florida (FPS-66)

TABLE 27

OPERATIONAL ADC/FAA JOINT-USE RADARS

End - 1961

Source: ADC Control and Warning Equipment Report, 31 Dec 1961 [Doc 1 in Hist of ADC, Jul-Dec 1961].

RP-1	Fort Lawton, Washington (ARSR-1)
RP-39	San Pedro Hill, California (ARSR-1)
P-47	Hutchinson, Kansas (FPS-20)
P-54	Palermo, New Jersey (FPS-20)
P-58	Mather AFB, California (FPS-20)
P-59	Boron, California (FPS-20)
RP-62	Oakdale, Pennsylvania (FPS-20)
P-71	Omaha, Nebraska (FPS-20)
P-72	Olathe, Kansas (FPS-20)
P-75	Lackland AFB, Texas (FPS-20)
P-79	Ellington AFB, Texas (ARSR-1)
M-91	Texarkana, Arkansas (FPS-20)
M-94	West Mesa, New Mexico (FPS-20)
M-121	Bedford, Virginia (FPS-20)
SM-147	Malmstrom AFB, Montana (FPS-20)
SM-151	Mica Peak, Washington (FPS-20)
SM-163	Las Vegas, Nevada (FPS-20)
TM-180	Keno, Oregon (FPS-20)
TM-196	Dauphin Island, Alabama (FPS-7)
S-210	Richmond NAS, Florida (ARSR-1)
Z-211	Patrick AFB, Florida (FPS-66)

TABLE 28

NON-OPERATIONAL SITES IN THE
FREQUENCY DIVERSITY PROGRAM

End - 1962

Source: ADC Control and Warning Equipment Report, 31 Jan 1963 [HRF].

P-16	Calumet, Michigan (FPS-27)
P-18	Chandler, Minnesota (FPS-27)
P-19	Antigo, Wisconsin (FPS-35)
P-20	Selfridge AFB, Michigan (FPS-35)
P-25	Havre, Montana (FPS-27)
P-27	Fortuna, North Dakota (FPS-35)
P-28	Minot, North Dakota (FPS-27)
P-32	Condon, Oregon (FPS-27)
P-33	Klamath, California (FPS-27)
P-37	Point Arena, California (FPS-24)
RP-39	San Pedro Hill, California (FPS-27)
P-45	Montauk, New York (FPS-35)
P-46	Blaine, Washington (FPS-24)
P-49	Watertown, New York (FPS-27)
P-50	Saratoga Springs, New York (FPS-27)
P-59	Boron, California (FPS-35)
P-61	Port Austin, Michigan (FPS-24)
RP-62	Oakdale, Pennsylvania (FPS-24)
RP-63	Gibbsboro, New Jersey (FPS-27)
P-65	Charleston, Maine (FPS-27)
P-66	Sault Ste. Marie, Michigan (FPS-35)
P-69	Finland, Minnesota (FPS-27)
P-73	Bellefontaine, Ohio (FPS-27)
P-81	Waverly, Iowa (FPS-27)
M-98	Miles City, Montana (FPS-28)
M-99	Gettysburg, South Dakota (FPS-27)
M-100	Mt. Hebo, Oregon (FPS-24)
M-103	Lyndonville, Vermont (FPS-27)
M-110	Bucks Harbor, Maine (FPS-24)

TABLE 28 [Cont'd]

M-113	North Charleston, South Carolina (FPS-27)
M-117	Roanoke Rapids, North Carolina (FPS-27)
SM-132	Baudette, Minnesota (FPS-24)
SM-149	Malmstrom AFB, Montana (FPS-24)
SM-156	Fallon, Nevada (FPS-35)
SM-162	Yuma, Arizona (FPS-27)
SM-163	Las Vegas, Nevada (FPS-27)
TM-195	Crystal Springs, Mississippi (FPS-27)
TM-197	Thomasville, Alabama (FPS-35)
TM-199	Eufaula, Alabama (FPS-24)

TABLE 29

FPS-64/66/67 RADARS ADDED TO THE
AIR DEFENSE NETWORK
IN 1962

Source: ADC Control and Warning Equipment Report, 31 Jan 1963 [HRF].

P-24	Cut Bank, Montana (FPS-66)
RP-31	Arlington Heights, Illinois (FPS-67)
P-43	Guthrie, West Virginia (FPS-67)
P-47	Hutchinson, Kansas (FPS-66)
P-52	Oklahoma City, Oklahoma (FPS-67)
RP-54	Ft. Meade, Maryland (FPS-67)
P-57	Naselle, Washington (FPS-67)
P-82	Snow Mountain, Kentucky (FPS-67)
M-92	Mt. Lemmon, Arizona (FPS-67)
M-112	Hunter AFB, Georgia (FPS-67)
M-114	Jacksonville NAS, Florida (FPS-66)
M-126	Houma NAS, Louisiana (FPS-67)
SM-133	Hastings, Nebraska (FPS-67)
SM-134	Pickstown, South Dakota (FPS-66)
SM-151	Mica Peak, Washington (FPS-67)
TM-198	Tyndall AFB, Florida (FPS-64)
TM-200	Cross City, Florida (FPS-66)

TABLE 30

INITIAL FPS-7 RADARS PROVIDED
ECCM CAPABILITY

1962

Source: ADC Control and Warning Equipment Report, 31 Jan 1963 [HRF].

P-2	Cambria, California
P-9	Highlands, New Jersey
P-10	North Truro, Massachusetts
P-12	North Bend, Oregon
P-21	Lockport, New York
P-26	Opheim, Montana
P-34	Empire, Michigan
P-35	Osceola, Wisconsin
P-38	Mill Valley, California
P-40	Othello, Washington
P-44	Makah, Washington
P-53	Rockville, Indiana
P-76	Mt. Laguna, California
P-80	Caswell, Maine
M-118	Burns, Oregon
M-129	MacDill AFB, Florida
SM-164	Tonopah, Nevada
TM-179	Kalispell, Montana
TM-196	Dauphin Island, Alabama
TM-201	Sundance, Wyoming

TABLE 31

ADC/FAA JOINT-USE STATIONS

End - 1963

Source: ADC Control and Warning Equipment Report, 31 Dec 1963 [HRF].

Z-30	Benton, Pennsylvania (FPS-35)
Z-39	San Pedro Hill, California (ARSR-1)
Z-45	Montauk, New York (FPS-35)
Z-47	Hutchinson, Kansas (FPS-66)
Z-52	Oklahoma City, Oklahoma (FPS-67)
Z-54	Palermo, New Jersey (FPS-65)
Z-56	Cape Charles, Virginia (FPS-7)
Z-58	Mather AFB, California (FPS-20)
Z-59	Boron, California (FPS-35)
Z-62	Oakdale, Pennsylvania (FPS-20)
Z-71	Omaha, Nebraska (FPS-66)
Z-72	Olathe, Kansas (FPS-66)
Z-75	Lackland AFB, Texas (FPS-20)
Z-78	Perrin AFB, Texas (FPS-20)
Z-79	Ellington AFB, Texas (ARSR-1)
Z-91	Texarkana, Arkansas (FPS-20)
Z-94	West Mesa, New Mexico (FPS-20)
Z-111	Marietta, Georgia (ARSR-1)
Z-113	North Charleston, South Carolina (FPS-66)
Z-114	Jacksonville NAS, Florida (FPS-66)
Z-121	Bedford, Virginia (FPS-67)
Z-147	Malmstrom AFB, Montana (FPS-20)
Z-151	Mica Peak, Washington (FPS-67)
Z-163	Las Vegas, Nevada (FPS-20)
Z-180	Keno, Oregon (FPS-67)
Z-196	Dauphin Island, Alabama (FPS-7)
Z-210	Richmond NAS, Florida (ARSR-1)
Z-211	Patrick AFB, Florida (FPS-66)
Z-212	Denver, Colorado (ARSR-1)

TABLE 31 [Cont'd]

Z-213	Francis Peak, Utah (ARSR-1)
Z-214	Battle Mountain, Nevada (ARSR-2)
Z-215	Grand Junction, Colorado(ARSR-2)
Z-216	Cedar City, Utah (ARSR-2)
Z-217	North Platte, Nebraska (ARSR-2)
Z-218	Rock Springs, Wyoming (ARSR-2)
Z-219	Lusk, Wyoming (ARSR-2)
Z-221	Gallup, New Mexico (ARSR-2)
Z-222	Trinidad, Colorado (ARSR-2)
Z-223	Boise, Idaho (ARSR-2)
Z-224	Lovell, Wyoming (ARSR-2)
Z-225	Ashton, Idaho (ARSR-2)
Z-228	El Paso, Texas (ARSR-2)
Z-229	Odessa, Texas (ARSR-2)

TABLE 32

PROPOSED FUTURE ADC/FAA JOINT-USE STATIONS

April 1966

Source: ADC Control and Warning Equipment Report, 31 Dec 1965 and Supplements, 28 Feb and 31 Mar 1966 [HRF].

Z-18	Chandler, Minnesota
Z-21	Lockport, New York
Z-27	Fortuna, North Dakota
Z-29	Finley, North Dakota
Z-31	Arlington Heights, Illinois
Z-32	Condon, Oregon
Z-35	Osceola, Wisconsin
Z-64	Kirksville, Missouri
Z-69	Finland, Minnesota
Z-70	Belleville, Illinois
Z-73	Bellefontaine, Ohio
Z-81	Waverly, Iowa
Z-89	Sweetwater, Texas
Z-99	Gettysburg, South Dakota
Z-159	Aiken, South Carolina
Z-164	Tonopah, Nevada
Z-200	Cross City, Florida
Z-209	Key West NAS, Florida
Z-232	Lynch, Kentucky (FAA)
Z-234	Mesa Rica, New Mexico (FAA)
Z-236	Paso Robles, California (FAA)
Z-237	Russellville, Arkansas (FAA)
Z-238	Silver City, New Mexico (FAA)

TABLE 33

ADC LONG-RANGE SEARCH RADARS IN THE UNITED STATES

1 April 1966

Source: ADC Control and Warning Equipment Report, 31 Dec 1965 and Supplements, 28 Feb and 31 Mar 1966 [HRF].

Former "P" System

Z-2	Cambria, California (FPS-7C)
Z-10	North Truro, Massachusetts (FPS-7B)
Z-12	North Bend, Oregon (FPS-7)
Z-14	St. Albans, Vermont (FPS-7C)
Z-15	Lompoc, California (FPS-67)
Z-16	Calumet, Michigan (FPS-27)
Z-17	Wadena, Minnesota (FPS-64)
Z-18	Chandler, Minnesota (FPS-27)
Z-19	Antigo, Wisconsin (FPS-35)
Z-20	Selfridge AFB, Michigan (FPS-35)
Z-21	Lockport, New York (FPS-7)
Z-25	Havre, Montana (FPS-27)
Z-26	Opheim, Montana (FPS-7C)
Z-27	Fortuna, North Dakota (FPS-35)
Z-28	Minot, North Dakota (FPS-27)
Z-29	Finley, North Dakota (FPS-35)
Z-30	Benton, Pennsylvania (FPS-35)
Z-31	Arlington Heights, Illinois (FPS-67B)
Z-32	Condon, Oregon (FPS-27)
Z-33	Klamath, California (FPS-27)
Z-34	Empire, Michigan (FPS-7)
Z-35	Osceola, Wisconsin (FPS-7)
Z-37	Point Arena, California (FPS-24)
Z-38	Mill Valley, California (FPS-7C)
Z-39	San Pedro Hill, California (FPS-27)
Z-40	Othello, Washington (FPS-7C)
Z-43	Guthrie, West Virginia (FPS-67)

TABLE 33 [Cont'd]

Z-44	Makah, Washington (FPS-7A)
Z-45	Montauk, New York (FPS-35)
Z-46	Blaine, Washington (FPS-24)
Z-47	Hutchinson, Kansas (FPS-66)
Z-49	Watertown, New York (FPS-27)
Z-50	Saratoga Springs, New York (FPS-27)
Z-52	Oklahoma City, Oklahoma (FPS-67B)
Z-54	Palermo, New Jersey (FPS-65)
Z-56	Cape Charles, Virginia (FPS-7B)
Z-58	Mather AFB, California (FPS-20A)
Z-59	Boron, California (FPS-35)
Z-61	Port Austin, Michigan (FPS-24)
Z-62	Oakdale, Pennsylvania (FPS-24)
Z-63	Gibbsboro, New Jersey (FPS-27)
Z-64	Kirksville, Missouri (FPS-7C)
Z-65	Charleston, Maine (FPS-27)
Z-66	Sault Ste. Marie, Michigan (FPS-35)
Z-69	Finland, Minnesota (FPS-27)
Z-70	Belleville, Illinois (FPS-66A)
Z-71	Omaha, Nebraska (FPS-66A)
Z-72	Olathe, Kansas (FPS-66)
Z-73	Bellefontaine, Ohio (FPS-27)
Z-75	Lackland AFB, Texas (FPS-91A)
Z-76	Mt. Laguna, California (FPS-7C)
Z-78	Perrin AFB, Texas (FPS-66)
Z-79	Ellington AFB, Texas (ARSR-1)
Z-80	Caswell, Maine (FPS-7C)
Z-81	Waverly, Iowa (FPS-27)
Z-82	Snow Mountain, Kentucky (FPS-67B)
Z-85	Hanna City, Illinois (FPS-67B)

Former Phase I Mobile System

Z-88	Amarillo AFB, Texas (FPS-67B)
Z-89	Sweetwater, Texas (FPS-67B)
Z-91	Texarkana, Arkansas (FPS-91A)
Z-92	Mt. Lemmon, Arizona (FPS-67B)
Z-94	West Mesa, New Mexico (FPS-91A)

TABLE 33 [Cont'd]

Z-96	Almaden, California (FPS-24)
Z-98	Miles City, Montana (FPS-27)
Z-99	Gettysburg, South Dakota (FPS-27)
Z-100	Mt. Hebo, Oregon (FPS-24)
Z-110	Bucks Harbor, Maine (FPS-24)
Z-111	Marietta, Georgia (ARSR-1)
Z-112	Hunter AFB, Georgia (FPS-67B)
Z-113	North Charleston, South Carolina (FPS-27)
Z-114	Jacksonville NAS, Florida (FPS-66A)
Z-115	Fort Fisher, North Carolina (FPS-7C)
Z-117	Roanoke Rapids, North Carolina (FPS-27)
Z-118	Burns, Oregon (FPS-66)
Z-121	Bedford, Virginia (FPS-67)
Z-126	Houma NAS, Louisiana (FPS-67B)
Z-127	Winnemucca, Nevada (FPS-66)
Z-129	MacDill AFB, Florida (FPS-7E)
Z-130	Winston-Salem, North Carolina (FPS-24)

Former Phase II Mobile System

Z-132	Baudette, Minnesota (FPS-24)
Z-133	Hastings, Nebraska (FPS-67B)
Z-134	Pickstown, South Dakota (FPS-66A)
Z-147	Malmstrom AFB, Montana (FPS-24)
Z-149	Baker, Oregon (FPS-35)
Z-151	Mica Peak, Washington (FPS-67)
Z-156	Fallon NAS, Nevada (FPS-35)
Z-157	Red Bluff, California (FPS-67B)
Z-159	Aiken, South Carolina (FPS-7C)
Z-163	Las Vegas, Nevada (FPS-27)
Z-164	Tonopah, Nevada (FPS-7C)

Former Phase III Mobile System

Z-178	Lewistown, Montana (FPS-66A)
Z-179	Kalispell, Montana (FPS-7B)
Z-180	Keno, Oregon (FPS-67B)

TABLE 33 [Cont'd]

Z-181 Luke-Williams Range, Arizona (FPS-7C)
Z-195 Crystal Springs, Mississippi (FPS-27)
Z-196 Dauphin Island, Alabama (FPS-7A)
Z-197 Thomasville, Alabama (FPS-35)
Z-198 Tyndall AFB, Florida (FPS-64A)
Z-199 Eufaula, Alabama (FPS-24)
Z-200 Cross City, Florida (FPS-66A)
Z-201 Sundance, Wyoming (FPS-7C)

Other Air Defense Radars

Z-209 Key West NAS, Florida (FPS-67B)
Z-210 Richmond NAS, Florida (ARSR-1)
Z-211 Patrick AFB, Florida (FPS-66A)
Z-212 Denver, Colorado (ARSR-1) (FAA)
Z-213 Francis Peak, Utah (ARSR-1) (FAA)
Z-214 Battle Mountain, Nevada (ARSR-2) (FAA)
Z-215 Grand Junction, Colorado (ARSR-2) (FAA)
Z-216 Cedar City, Utah (ARSR-2) (FAA)
Z-217 North Platte, Nebraska (ARSR-2) (FAA)
Z-218 Rock Springs, Wyoming (ARSR-2) (FAA)
Z-219 Lusk, Wyoming (ARSR-2) (FAA)
Z-221 Gallup, New Mexico (ARSR-2) (FAA)
Z-222 Trinidad, Colorado (ARSR-2) (FAA)
Z-223 Boise, Idaho (ARSR-2) (FAA)
Z-224 Lovell, Wyoming (ARSR-2) (FAA)
Z-225 Ashton, Idaho (ARSR-2) (FAA)
Z-226 Garden City, Kansas (ARSR-2) (FAA)
Z-227 Ft. Meade, Maryland (FPS-67B)
Z-228 El Paso, Texas (ARSR-1) (FAA)
Z-229 Odessa, Texas (ARSR-1) (FAA)
Z-239 Greeley, Colorado (FPS-8) (ANG)
Z-240 Salt Lake City, Utah (FPS-8) (ANG)