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ADC HISTORICAL STUDY NO. 35

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COMMAND AND CONTROL

PLANNING

1958 - 1965

Declassified per
HQ NORAD/NDC
Ltr, 10 Jul 95

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Dec 1965

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FOREWORD

When the fighting in Korea focused attention on the state of the air defenses of the United States, the threat was the Soviet Long Range Air Force. The 1952-53 answer to the question of how to detect the approach of this enemy force and control the response to it was automation of the ground environment -- the Semi-Automatic Ground Environment (SAGE). Automation was an infant science at the time and the automatic computers that made it possible were relatively primitive. The threat of a world-wide Communist offensive was considered so great, however, that the National Security Council, in October 1953, thought it worthwhile to spend the time and money necessary to create SAGE.

SAGE was an ambitious undertaking. The required direction centers and combat centers were huge concrete blockhouses containing thousands of vacuum tubes, miles of wiring and a great assortment of the most modern electronic equipment. The cost ran into billions. Construction, development and testing time ran into years; the first SAGE sector, New York, becoming operational in June 1958. The result was a major increase in the efficiency of the ground-based surveillance system.

But a new equation was added to the air defense problem on 4 October 1957 when the Russians put Sputnik I into orbit. The development of an intercontinental ballistic missile suddenly became both feasible and probable. It was painfully obvious that SAGE would not be effective in the detection of an ICBM and therefore could not control the destruction of ballistic missiles. Moreover, SAGE blockhouses were conspicuous structures that dominated the terrain wherever they were located. A mere handful of enemy missiles, therefore, could severely cripple U.S. defenses against the manned bomber. Various methods for protecting the command and control system were considered in subsequent years. This study discusses these methods.

Although every effort has been made to make this historical study as accurate as possible, errors of omission or commission might have crept in. Consequently, readers are warned not to make the contents of this history the basis of official action.

CONTENTS

CHAPTER ONE

HARDENED SAGE

It was perhaps fortuitous, at a time when thoughts were turning to the exposed position of SAGE blockhouses, that International Business Machines (IBM) announced the development of a transistorized, or "solid state," computer in the spring of 1958. By substituting transistors for vacuum tubes the construction of a computer that would do more and occupy much less space was possible. Because the improved computer would occupy less space, the possibility that ground environment control centers might be placed underground and "hardened" against ICBM attack began to be

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explored. The ADC Plans organization began an investigation of the solid state computer in early May 1958. Following preliminary study, the ADC Vice Commander, Lt. Gen. Roy H. Lynn, said, on 27 May 1958, that while the hardening proposal was interesting and deserved further investigation, ADC would continue to support the provision of an automatic SAGE Mode III capability wherein small complexes of radar stations would be provided with a computer which would permit the automatic control of the local air battle in the event SAGE was rendered inoperative.[1]

Enthusiasm for the solid state computer quickly increased, however, when IBM claimed the new computer would offer computing speed seven times that of the AN/FSQ-7 currently programmed for use in SAGE. The SAGE Project Office thereupon undertook a comprehensive study of the solid state computer (AN/FSQ-7A) and ADC, 23 June 1958, asked all agencies involved with SAGE to support a proposal for procurement of a prototype AN/FSQ-7A. IBM did not recommend that all vacuum tube computers be immediately junked and the solid state model substituted. IBM instead suggested that the AN/FSQ-7A be incorporated in the last

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1. Weekly Activity Report, ADC, Dir/Plans, 7-13 May and 27 May 1958 [HRF].

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10 direction centers and substituted in earlier locations where it was deemed imperative.[2]

In late June of 1958 USAF announced that no further action would be taken to buy even a prototype until a thorough study had been made of the funding ramifications of the switch in computers. This study indicated that use of the AN/FSQ-7A would be financially feasible, so a Solid State Computer Study Group was formed from developmental and operational agencies (including ADC) in September 1958 and instructed to produce an Operational Employment Plan (OEP) for the new computer. The requested OEP was published 5 November 1958.[3]

This plan called for the establishment of the solid state computer in nine hardened Super Combat Centers (SCC) in the United States and one in Canada. Each SCC was expected to control an area about 1,000 miles square which would include from two to four direction centers (sectors).

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2. Semiannual SAGE Progress Report, 1 Jul 1958, p. 16 [HRF]; Weekly Activity Reports, ADC, ADLSI-D, 12 Jun and 23 Jun 1958 [HRF].

3. Weekly Activity Reports, ADC, ADLSI-D, 8-12 Sep, 22-24 Oct and 7 Nov 1958 [HRF].

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One salient feature of the SCC was its ability to act as a direction center in the event of the failure of one of its sectors, or perform the direction center function for all sectors within the SCC if necessary. In short, the nine hardened SCC's within the United States could conduct the detailed air battle anywhere in the country.

The OEP for hardened SAGE outlined the following organization of Super Combat Centers (divisions) and sectors within the United States:

St. Louis SCC
- St. Louis DC
- Montgomery DC

Raleigh SCC
- Miami DC
- Washington DC

Chicago SCC
- Chicago DC
- Detroit DC
- Sault Ste Marie DC
- Duluth DC

Minot SCC
- Great Falls DC
- Minot DC
- Grand Forks DC
- Sioux City DC

Phoenix SCC
- Phoenix DC
- Los Angeles DC

San Antonio SCC
- Albuquerque DC
- Shreveport DC
- Kansas City DC

Syracuse SCC
- Syracuse DC
- New York DC
- Boston DC

Spokane SCC
- Spokane DC
- Seattle DC

Portland SCC
- Portland DC
- San Francisco DC
- Reno DC

As to cost, it was anticipated that the system utilizing Super Combat Centers (in buildings hardened to withstand at least 100 feet of pressure per square inch) would cost $2.467 billions through Fiscal Year 1964. "Soft" SAGE, currently under construction, was costed at $2.195 billions through Fiscal 1964. Hardened SAGE, therefore, was expected to cost $272 millions more than the conventional system. It was anticipated that the new plan would offer full direction center capability by 1 January 1963; full combat center capability by 1 April 1963.[4]

The hardened SAGE concept was approved by USAF on 5 February 1959, although USAF provided a set of target operational dates that was at considerable variance with the dates provided in the OEP. The Ottawa combat center, said USAF, should become operational on 1 August 1962; Raleigh on 1 May 1963; St. Louis and Syracuse on 1 June 1963; Chicago on 1 July 1963; Minot on 1 September 1963; Spokane on 1 November 1963; Portland on 1 January 1964; Phoenix on 1 March 1964 and San Antonio on 1 June 1964.

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4. Operational Employment Plan for the Solid State Computer, ADC, 5 Nov 1958, pp. 1-7, III-6, IV-1 and 2, VII-2 and Annex F [HRF].

The SAGE Project Office was assigned the task of writing a new deployment schedule based on the dates provided by USAF.[5]

Because the Corps of Engineers could not promise building occupancy dates that would guarantee the SCC operational dates desired by USAF and because there was a lack of agreement as to the degree of hardness to be built into the Super Combat Centers, it was decided in USAF in April 1959 that the entire Operational Employment Plan should be rethought and rewritten. After a series of meetings involving NORAD, RCAF, ADC, FAA, USARADCOM, IBM, MITRE Corporation, System Development Corporation and the SAGE Project Office, another Operational Employment Plan for the Super Combat Center was published 19 June 1959.[6]

The new OEP was essentially a refined version of the old, although the deployment of hardened SAGE was changed appreciably and there was no mention of costs in the 1959 document. Added to the new OEP was an explanation of the

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5. Msg 55998, USAF to ADC, 5 Feb 1959 [HRF]; Weekly Activity Report, ADC, ADLSI-D, 6 Feb 1959 [HRF].

6. Weekly Activity Report, ADC, ADLSI-D, 24-25 Feb, 11-13 Mar, 20-21 Apr, 1 May 1959 and ADLPR, 5 May and 9 Jun 1959 [HRF]; USAF to ADC, "SAGE Operational Plan," 2 Apr 1959 [HRF].

six operational "options" of hardened SAGE as opposed to the four operational "modes" of soft SAGE. Option 1 was the normal situation, with both the SCC and the sectors in full operation. Option 2 obtained when the SCC was operating and the sectors were not. In this situation the SCC performed the direction center function for the entire division. Under Option 3, the direction center was operational, but the SCC was not. The scope of control over the air battle was considerably limited under Option 3. The situation in which one sector controlled an adjacent sector was Option 4. The last two options covered situations in which no part of SAGE was operational. Option 5 involved severely localized control by a NORAD Control Center. Option 6 covered completely autonomous operations on the part of interceptor squadrons.[7]

Ten Super Combat Centers (including one in Canada), controlling 27 sectors, were specified in the new OEP. The deployment schedule called for the first SCC (35th Air Division in Canada) to be operational by August 1963. The tenth (33rd Air Division) was to be ready by July 1964.

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7. Operational Employment Plan for the Super Combat Center, ADC, 19 Jun 1959, pp. II, 2-7 [HRF].

That the preparation of 10 Super Combat Centers for operational readiness in a period of 11 months would pose major administrative problems was recognized, but no acceptable alternative was discovered. As to the degree of hardness to be attained by SCC buildings, ADC gained a point. The 1959 plan mentioned a minimum hardness of 200 pounds per square inch. The 1958 plan called for a minimum of 100 pounds.[8]

The 1959 OEP gave the Super Combat Centers numerical designations as opposed to the geographical names used in the 1958 plan. Sectors retained geographical designations. Deployment of hardened SAGE, as seen in June 1959, was as follows:[9]

25 Air Division
- Spokane Sector
- Seattle Sector
- Portland Sector

26 Air Division
- Syracuse Sector
- Boston Sector
- New York Sector

27 Air Division
- Denver Sector
- Reno Sector

28 Air Division
- Phoenix Sector
- Los Angeles Sector
- San Francisco Sector

29 Air Division
- Great Falls Sector
- Minot Sector

30 Air Division
- Chicago Sector
- Detroit Sector
- Nashville Sector
- Sioux City Sector

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8. Ibid., Annexes E and F.

9. Ibid., pp. III, 5-31.

31 Air Division
Grand Forks Sector
Duluth Sector
Sault Ste Marie Sector

32 Air Division
Atlanta Sector
Norfolk Sector
Montgomery Sector

33 Air Division
San Antonio Sector
Albuquerque Sector

35 Air Division
Ottawa Sector
Bangor Sector

But the OEP of 19 June 1959 was a dead letter the day it was published, because the Department of Defense published, the same day, the Master Air Defense (MAD) Plan that authorized a somewhat less ambitious program for hardened SAGE. The MAD Plan, incidentally, was not an original effort on the part of DOD. It was demanded by Congress when Secretary of Defense Neil McElroy admitted at a budget hearing in the spring of 1959 that he had been unable to come to a decision on various aspects of air defense.

Although the MAD Plan did not indicate exactly which Super Combat Centers should be deleted from the program, it did say that the total program should be reduced from 10 to 7 hardened sites. It also said that hardened SAGE should be concentrated along the eastern, western and northern borders of the United States.[10]

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10. Memo, OSD for Sec/AF, "Continental Air Defense Program," 19 Jun 1959 [Doc 1 in Hist of ADC, Jan-Jun 1959].

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Though the MAD Plan bore the seal of the Department of Defense, ADC and NORAD were not ready to concede. Therefore, on 24 July 1959, ADC informed USAF, citing NORAD concurrence, that the proposed loss of three Super Combat Centers would seriously degrade continental air 'efense and asked that the MAD Plan be amended accordingly. USAF did not make immediate reply, but when it did, 20 September 1959, indicated agreement with the ADC/NORAD position. A USAF memo supporting the ADC reclama had gone forward to DOD and USAF expected a favorable answer in the near future.[11]

The favorable reply was not forthcoming, however, and in December 1959 USAF announced that the Air Force budget for Fiscal 1961 would not support hardened SAGE combat centers for the 27th and 33rd Air Division and that planning for these SCC's would have to be deferred. Further, USAF added, the Department of Defense had placed a hold order on the purchase of all SCC equipment pending evaluation.[12]

This DOD study, completed about 1 February 1960, recommended that SAGE assume an all-soft configuration,

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11. Weekly Activity Reports, ADC, ADLSI-D, 24 Jul 1959 and ADLSI-E, 20 Sep 1959 [HRF].

12. Ibid., ADLPG-E, 10 Dec 1959.

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because of the cost of hardening. An ADC/NORAD rebuttal of 12 February 1960 contended that, contrary to the conclusions of the DOD study, all-soft SAGE would cost more than the hardened version. It was admitted, though, that an all-soft SAGE system could be completed by early 1964, while the hardened version would not be ready until the middle of 1965. Meanwhile, ADC had tentatively located sites for eight Super Combat Centers.[13]

In the end, the DOD position prevailed. On 30 March 1960, USAF advised NORAD that "severe resource limitations coupled with higher priority military requirements have made it necessary to make further substantial reductions in current and planned USAF programs for defense against manned aircraft. The major changes on which decisions have been made include cancellation of all Super Combat Centers."[14] So, after about two years of discussion and planning, hardened SAGE was put away in the file reserved for discarded projects. But soft SAGE remained vulnerable to enemy ballistic missiles. Some other way of reducing that vulnerability had to be found.

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13. Ibid., ADLPD-S, 20-26 Jan 1960 and ADLPG-E, 11-12 Feb 1960.

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

CHAPTER TWO

THE QUEST FOR SURVIVABILITY

1960 - 1962

In the letter which announced the death of hardened SAGE, another means of carrying on the air defense mission following the destruction of SAGE was suggested by USAF. It might be possible, USAF thought, to flush manned interceptors on BMEWS warning and control them from 60 manual GCI stations located around the perimeter of the defended area of North America. This suggestion did not receive lengthy consideration, however, because NORAD almost immediately recommended that the previously planned SAGE Mode III be used. Basically, Mode III involved the use of nine NORAD Control Centers, each defending an area of about sector size and controlling manned interceptors through the AN/GPA-37, NIKE through Missile Master. NORAD was searching for some method of controlling BOMARC during Mode III operations.[15]

The NORAD concept was accepted by USAF in May and June 1960, although USAF stated flatly that it would not furnish automatic data link equipment for the NORAD Control Centers. Also, since USAF did not think that Mode III was the final answer to the problem, NORAD was asked to "undertake a comprehensive study of the entire concept of emergency backup to the primary control system."[16]

Although no hardware was bought, the matter of survival of the command and control system in the event of missile attack was given considerable attention during succeeding 18 months. The difficulty was that there was no

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15. 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].

16. 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].

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general agreement on the exact nature of the emergency back-up system required to support SAGE. The "comprehensive study" requested by USAF in early June 1960 went forward in July. Some idea of the cost involved was provided by the Burroughs Corporation that same month in a briefing given ADC personnel. Burroughs estimated that use of a Burroughs computer designed for the Polaris missile, tropo-scatter communications of a type offered by the Martin Company and display equipment manufactured by Marquardt would cost in the neighborhood of $60 million.[17]

But it was not yet time to think of specific sub-systems. General planning was still underway. USAF did not believe the July 1960 operational plan was sufficiently understandable, however, and asked in September 1960, that it be rewritten. The revised plan was furnished to USAF in November, but was still unsatisfactory. A second revision went to USAF in December 1960, followed, in February 1961, by an ADC statement of what it considered survivable. In March 1961, USAF detailed the shortcomings of the joint NORAD/ADC plan. In the first place, USAF felt that the

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17. Weekly Activity Reports, ADC, ADLPG-E, 28 Jun 1960 and ADOAC, Electronic Systems Div, 6 Jul 1960 [HRF].

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manual radar sites intended to control BOMARC should have been sited. Also, several listed sites appeared to have little probability of survival: P-80, Caswell, Maine; P-66, Sault Ste. Marie, Michigan; M-113, South Charleston, South Carolina; M-129, MacDill AFB, Florida; RP-1, Fort Lawton, Washington, for example. USAF further believed the function of the surveillance sites needed clarification and that gap-fillers should be limited to those required for BOMARC control. It was also noted that the new Department of Defense hierarchy had placed a high priority on the early establishment of a firm plan for emergency back-up operations and had suggested that $9 millions for this purpose might be available from Fiscal 1961 funds, with an additional $28 millions likely in Fiscal 1962. USAF wanted still another plan by 10 April 1961.[18]

The new president, John F. Kennedy, indicated that the recently installed national administration supported the creation of a manual back-up system for SAGE when, in his initial budget message, presented to Congress in March 1961, he asked for funds to finance such a system. The new

18. Ibid., ADLPG-E, 2 Sep, 15 Nov and 8 Dec 1960 [HRF]; ADC to USAF, "Air Defense Survivability," 15 Feb 1961 [HRF]; Msg AFOOP-DE-WC 93886, USAF to ADC, 15 Mar 1961 [Doc 312 in Hist of ADC, Jul-Dec 1961].

Secretary of Defense, Robert S. McNamara, explained to the House Armed Services Committee that he wanted to provide "a sustained manual GCI capability," at those radar stations located outside probable target areas.[19]

It was in this atmosphere that the new NORAD plan was forwarded to USAF on 7 April 1961. The Department of Defense had reduced the amount Congress was to be asked to spend on the back-up system in Fiscal 1961/1962 from $37 million to $23 million, so NORAD felt some constraint in devising the April plan. Because of these budgetary restrictions, NORAD pointed out, the plan was only an initial step in the direction of a realistic back-up system for SAGE. BOMARC control and interceptor dispersal had not been fully exploited in this plan and proposals for more sophisticated control and communications equipment were still under study.[20]

Meanwhile, Secretary McNamara was asking the Department of Defense Research and Engineering (DDR&E) organization some

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19. Summary statement by Charles J. Hitch, Asst Sec/Def (Comptroller) before the Subcommittee on Special Investigations, House Committee on Armed Services, 87th Congress, 2nd Session.

20. NORAD to USAF, "Manual Backup to SAGE (Expanded Mode III)," 7 Apr 1961 [HRF].

leading questions about SAGE. He wanted to know the advantages and disadvantages of operating SAGE as currently programmed, of supplementing it and of closing it out completely. In its May report, DDR&E recommended that the Air Force divert much of the money it planned to spend on improvement of the anti-bomber surveillance network to a survivable back-up system. It was also recommended that SAGE be continued, but only as a pre-battle system. On 5 June 1961, the Deputy Secretary of Defense, Roswell Gilpatric, directed the Air Force to proceed with a back-up system for the control of interceptors.[21]

Thereupon USAF informed ADC, 10 June 1961, that USAF approved the use of NORAD Control Centers, GCI sites and surveillance radars, as outlined in the April plan, in the creation of the sort of back-up system desired by the Department of Defense. Nevertheless, USAF wanted a refined version of the plan that would describe the transition from SAGE modes of control to Modes III and IV. Concurrently, the Secretary of Defense asked the Joint Chiefs of Staff to

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21. DDR&E Report on Project No. 23, 1 May 1961 [HRF]; Memo, Deputy Sec/Def for USAF, "SAGE Reorientation," 5 Jun 1961 [HRF].

undertake a thoroughgoing study of air defense in general and the JCS delegated the study to NORAD.[22]

The result was another in a series of plans on this subject, prepared during July 1961. Now, for the first time, automation of the back-up system was suggested. NORAD, in effect, wanted a little SAGE to back up the big SAGE, asking that 70 radar stations (NORAD Control Centers) be equipped with small solid-state computers and display consoles. Twenty-four of these would be Master Control Centers, with the remaining 46 being considered Associate Centers. The idea of a two-phase back-up system was also introduced at this time. In Phase I, said the NORAD proposal, radar stations outside primary target areas would be joined into a manual surveillance and control network that would operate until Phase II, the computerized system, was ready.[23]

The Air Defense Command did not foresee a back-up system of quite this magnitude. On 22 September 1961, ADC

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22. Msg AFOOP-DE-WC 77149, USAF to ADC, 10 Jun 1961 [Doc 313 in Hist of ADC, Jul-Dec 1961]; Msg 998495, JCS to NORAD, 5 Jul 1961 [HRF].

23. Msg ADLSP 1472, ADC to USAF, 14 Jul 1961 [Doc 314 in Hist of ADC, Jul-Dec 1961]; NORAD Air Defense Objectives Plan 63-73, 27 Jul 1961 [HRF].

forwarded to USAF a back-up plan which recommended deployment of 29 computerized control centers as opposed to the 70 suggested by NORAD. Within a week, USAF was able to report that DOD had approved, for planning purposes, general Air Force plans for a back-up system. It was obvious, USAF added, that the 70-center NORAD plan could not be supported. So, since there was apparently some confusion on the matter, USAF asked ADC to consult with NORAD to iron out the differences.[24]

In early October 1961, however, ADC was forced to report that the differences with NORAD remained. There was no meeting of minds, for one thing, on the proper number of NORAD control centers. ADC recommended the establishment of 29 computerized centers. USAF and DOD had mentioned 34 centers. NORAD was holding out for 70 centers, although it would accept 34 as an initial increment. Also, the ADC plan was designed to protect SAC ICBM sites, while NORAD proposed a back-up system configured to fit SAGE sectors. ADC planned to submit a detailed back-up plan in the near

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24. Msg ADLSP 2058, ADC to USAF, 26 Sep 1961 [Doc 318 in Hist of ADC, Jul-Dec 1961]; Msg AFOOP-WE-DC 66604, USAF to ADC, 29 Sep 1961 [Doc 319 in Hist of ADC, Jul-Dec 1961].

future, but warned USAF that the differences with NORAD would continue to exist.[25]

Within the next few days, though, partial agreement was reached with NORAD. When ADC submitted its detailed, but informal, back-up plan to USAF on 14 October 1961, it was noted that further discussions had been held with NORAD and agreement had been reached on some matters. ADC now agreed that the back-up system (beginning to be known as BUIC) should follow sector boundaries. NORAD and ADC had also reached agreement on the 34 computerized (Phase II) sites within the United States. ADC could not agree, that all survivable radars should be tied into a NORAD Control Center, or that when there were two NORAD Control Centers within a sector all radars within the sector should be tied into both NORAD Control Centers. The latter stand was taken, ADC pointed out, in conformance with a USAF limitation that no more than five radars should be tied into a single NCC in order to reduce the size, complexity and cost of NCC equipment. The quickly prepared ADC plan,

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25. Msg ADLSP 2191, ADC to USAF, 8 Oct 1961 [Doc 320 in Hist of ADC, Jul-Dec 1961].

showing NORAD Control Centers and their associated radars, by sector (but neglecting the Syracuse and Ottawa sectors),[26] was as follows:

1. Seattle Sector

   a. NCC P-44 (Makah, Washington)
      1. C-18 (Holberg, B.C.)
      2. C-19 (Puntzi Mountain, B.C.)
      3. P-46 (Blaine, Washington)
      4. P-57 (Naselle, Washington)

   b. Alternate NCC P-57 (Naselle, Washington)
      1. P-46 (Blaine, Washington)
      2. P-44 (Makah, Washington)

   c. NCC C-18 (Holberg, B.C.)
      1. C-19 (Puntzi Mountain, B.C.)
      2. C-20 (Baldy Hughes Mountain, B.C.)

2. Spokane Sector

   a. NCC P-40 (Othello, Washington)
      1. P-32 (Condon, Oregon)
      2. SM-150 (Cottonwood, Idaho)
      3. SM-153 (Kamloops, B.C.)

   b. NCC SM-153 (Kamloops, B.C.)
      1. C-20 (Baldy Hughes Mountain, B.C.)
      2. C-21 (Saskatoon Mountain, Alberta)

3. Great Falls Sector

   a. NCC P-25 (Havre, Montana)
      1. TM-178 (Lewiston, Montana)
      2. TM-179 (Kalispell, Montana)
      3. C-53 (Alsask, Sask)
      4. C-54 (Red Deer, Alta)

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26. Msg ADLDC 2257, ADC to USAF, 14 Oct 1961 [Doc 321 in Hist of ADC, Jul-Dec 1961].

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b. NCC C-53 (Alsask, Sask)
   1. C-54 (Red Deer, Alta)
   2. C-36 (Cold Lake, Alta)

4. Minot Sector

a. NCC P-27 (Fortuna, N.D.)
   1. P-26 (Opheim, Montana)
   2. TM-177 (Dickinson, N.D.)
   3. C-51 (Yorkton, Sask)
   4. C-52 (Dana, Sask)

b. Alternate NCC M-98 (Miles City, Montana)
   1. P-26 (Opheim, Montana)
   2. P-27 (Fortuna, N.D.)
   3. TM-177 (Dickinson, N.D.)
   4. TM-201 (Sundance, Wyoming)

5. Grand Forks Sector

a. NCC P-29 (Finley, N.D.)
   1. M-99 (Gettysburg, S.D.)
   2. P-17 (Wadena, Minnesota)
   3. C-49 (Gypsumville, Manitoba)
   4. C-17 (Beausejour, Manitoba)

6. Duluth Sector

a. NCC P-69 (Finland, Minnesota)
   1. SM-132 (Baudette, Minnesota)
   2. P-35 (Osceola, Wisconsin)
   3. C-15 (Armstrong, Ontario)
   4. C-16 (Sioux Lookout, Ontario)

b. Alternate NCC SM-132 (Baudette, Minnesota)
   1. P-69 (Finland, Minnesota)
   2. C-15 (Armstrong, Ontario)
   3. C-16 (Sioux Lookout, Ontario)

7. Sault Sainte Marie Sector

a. NCC P-16 (Calumet, Michigan)
   1. P-19 (Antigo, Wisconsin)
   2. P-34 (Empire, Michigan)
   3. C-14 (Pagwa, Ontario)
   4. M-119 (Lowther, Ontario)

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b. Alternate NCC P-34 (Empire, Michigan)
   1. P-16 (Calumet, Michigan)
   2. P-19 (Antigo, Wisconsin)
   3. C-14 (Pagwa, Ontario)
   4. M-119 (Lowther, Ontario)

8. Bangor Sector

   a. NCC P-65 (Charleston, Maine)
      1. C-5 (St. Margarets, N.B.)
      2. C-11 (Beaverbank, N.S.)
      3. M-102 (Barrington, N.S.)

   b. NCC C-5 (St. Margarets, N.B.)
      1. C-33 (Moisie, Quebec)
      2. C-34 (Sydney, N.S.)
      3. C-11 (Beaverbank, N.S.)

9. Boston Sector

   a. NCC P-50 (Saratoga Springs, N.Y.)
      1. P-14 (St. Albans, Vermont)
      2. M-102 (Barrington, N.S.)
      3. C-11 (Beaverbank, N.S.)

   b. Alternate NCC P-10 (North Truro, Mass)
      1. ALRI
      2. M-102 (Barrington, N.S.)

10. New York Sector

   a. NCC P-45 (Montauk, N.Y.)
      1. ALRI
      2. P-54 (Palermo, N.J.)

   b. Alternate NCC P-54 (Palermo, N.J.)
      1. P-45 (Montauk, N.Y.)

11. Washington Sector

   a. NCC P-56 (Cape Charles, Virginia)
      1. P-55 (Manassas, Virginia)
      2. M-121 (Bedford, Virginia)
      3. M-115 (Fort Fisher, N.C.)
      4. ALRI

b. NCC M-115 (Fort Fisher, N.C.)
   1. M-130 (Winston-Salem, N.C.)
   2. P-56 (Cape Charles, Virginia)
   3. ALRI

12. Montgomery Sector

a. NCC M-114 (Jacksonville, Florida)
   1. M-112 (Hunter AFB, Georgia)
   2. Z-211 (Patrick AFB, Florida)
   3. TM-200 (Cross City, Florida)
   4. Key West

b. NCC TM-198 (Tyndall AFB, Florida)
   1. TM-196 (Dauphin Island, Alabama)
   2. TM-197 (Thomasville, Alabama)
   3. TM-199 (Eufaula, Alabama)
   4. M-126 (Houma NAS, Louisiana)

13. Detroit Sector

a. NCC P-61 (Port Austin, Michigan)
   1. P-73 (Bellefontaine, Ohio)
   2. P-43 (Guthrie, West Virginia)

b. Alternate NCC P-73 (Bellefontaine, Ohio)
   1. P-61 (Port Austin, Michigan)
   2. P-43 (Guthrie, West Virginia)

14. Chicago Sector

a. NCC P-81 (Waverly, Iowa)
   1. P-64 (Kirksville, Missouri)
   2. P-70 (Belleville, Illinois)
   3. P-53 (Rockville, Indiana)

b. Alternate NCC P-53 (Rockville, Indiana)
   1. P-70 (Belleville, Illinois)
   2. P-82 (Snow Mountain, Kentucky)
   3. SM-143 (Walnut Ridge, Arkansas)

15. Sioux City Sector

    a. NCC P-72 (Olathe, Kansas)
        1. P-18 (Chandler, Minnesota)
        2. SM-134 (Pickstown, S.D.)
        3. SM-133 (Hastings, Nebraska)
        4. P-47 (Hutchinson, Kansas)

16. Phoenix Sector

    a. NCC M-93 (Winslow, Arizona)
        1. M-92 (Mt. Lemmon, Arizona)
        2. TM-181 (Luke-Williams AFB, Arizona)
        3. SM-163 (Las Vegas, Nevada)

17. Los Angeles Sector

    a. NCC P-59 (Boron, California)
        1. P-2 (Cambria, California)
        2. RP-15 (Lompoc, California)
        3. P-76 (Mt. Laguna, California)

    b. Alternate NCC P-76 (Mt. Laguna, California)
        1. RP-15 (Lompoc, California)
        2. P-59 (Boron, California)

18. San Francisco Sector

    a. NCC P-37 (Point Arena, California)
        1. SM-157 (Red Bluff, California)
        2. M-96 (Almaden, California)
        3. SM-156 (Fallon NAS, Nevada)

    b. Alternate NCC M-96 (Almaden, California)
        1. P-37 (Point Arena, California)
        2. SM-164 (Tonopah, Nevada)

19. Portland Sector

    a. NCC M-100 (Mt. Hebo, Oregon)
        1. P-12 (North Bend, Oregon)
        2. TM-180 (Keno, Oregon)

    b. Alternate NCC TM-180 (Keno, Oregon)
        1. P-33 (Klamath, California)
        2. P-12 (North Bend, Oregon)
        3. M-100 (Mt. Hebo, Oregon)

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This plan, including the Syracuse and Ottawa sectors inadvertently omitted from the 14 October message, called for 34 NORAD Control Centers in the United States and 5 in Canada. Three criteria were used by ADC in selecting back-up sites. The most important was vulnerability. All sites were at least 15 miles from expected targets. Radar coverage was also a consideration. Sites were chosen which would give the best radar coverage to the area. Finally, proximity to interceptor bases was considered. Control was of little value if there were no weapons available. Even so, the Electronic Systems Division of AFSC questioned the survivability of five sites listed -- M-112 (Hunter AFB, Georgia), P-14 (St. Albans, Vermont), P-72 (Olathe, Kansas), RP-15 (Lompoc, California) and M-92 (Mt. Lemmon, Arizona).[27]

As to the financing of BUIC, it was revealed in November 1961 that the money for the back-up system would have to come out of the hide of SAGE and other elements of the ground environment. The number of FPS-27 frequency diversity search radars remaining to be purchased was reduced from 17 to 12. Similarly, purchases of FPS-26 height

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27. Msg ADOOA 2569, ADC to USAF, 16 Nov 1961 [Doc 327 in Hist of ADC, Jul-Dec 1961]; Msg ESSGE 1-16-11-90-E, ESD to ADC, 17 Nov 1961 [Doc 329 in Hist of ADC, Jul-Dec 1961].

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finders were cut from 50 to 24. FPS-74 modifications to gap-filler radars were reduced from 136 to 86 and ADC was asked to study the possibility of eliminating 50 gap fillers in the interior of the United States. USAF was of the opinion that these, and other, reductions in the size and sophistication of the radar network would free about $100 millions for use in BUIC.[28]

The Electronic Systems Division (ESD) also took a hand in siting the back-up system. The December recommendations of ESD were similar to the ADC plan of October, in that both agencies named the same 34 sites as Phase II NCC locations within the United States. They differed somewhat as to which sites should be master sites and which should be alternates. They also differed as to the number and location of Canadian sites. ESD saw M-98 (Miles City, Montana), P-53 (Rockville, Indiana) and P-54 (Palermo, New Jersey) as master sites, while ADC listed them as alternates. On the other hand, ADC gave P-81 (Waverly, Iowa), P-45 (Montauk, New York) and P-27 (Fortuna, North Dakota) as master sites, while ESD showed them as alternates. With respect to Canada, ESD recommended deployment of seven Phase II NORAD Control Centers, while ADC planned five. Both agencies

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28. Msg AFODC-OP 75011, USAF to ADC, 1 Nov 1961 [DOC 1].

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agreed that master sites should be placed at C-18 (Holberg, British Columbia), C-53 (Alsask, Saskatchewan) and C-5 (St. Margarets, New Brunswick). ESD also recommended that SM-153 (Kamloops, British Columbia) should be a master site, but ADC listed it as an alternate. In the Ottawa sector, ESD thought the NCC should be located at C-2 (Lac St. Denis, Quebec), but ADC preferred C-8 (Santerre, Quebec). Master sites at M-119 (Lowther, Ontario) and C-17 (Beausejour, Manitoba) were also suggested by ESD, but ADC did not agree.[29]

Speaking of Canada, the Canadians were not in wholehearted agreement that 34 was the proper number of computerized NCC's for all of North America. Mainly on the grounds that operation and maintenance costs of 34 sites would be too high, the Canadians recommended that the back-up system be limited to one NCC per sector, or 22 rather than 34, even though it was acknowledged that this action would tend to make the NCC's themselves attractive targets.[30]

Despite the Canadian objections, the formal BUIC operations plan, published by ADC 19 January 1962, contained

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29. Msg ESSGE-1-1-12-3-E, ESD to USAF, 2 Dec 1961 [Doc 331 in Hist of ADC, Jul-Dec 1961].

30. Msg VCAS 50, Canadian Air Hq to USAF, 21 Dec 1961 [Doc 335 in Hist of ADC, Jul-Dec 1961].

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provisions for 34 Phase II NORAD Control Centers, including four in Canada. These amounted to 20 master sites and 14 subordinate sites. Because the grand total of Phase II sites was reduced, several proposed sites which appeared in early plans were missing from the formal operations plan. The approved deployment, as of January 1962, was as follows:[31]

Master Sites	Subordinate Sites
P-59 (Boron, California)	M-115 (Fort Fisher, N.C.)
P-37 (Point Arena, California)	M-114 (Jacksonville NAS, Fla.)
M-100 (Mt. Hebo, Oregon)	P-65 (Charleston, Maine)
P-44 (Makah, Washington)	P-76 (Mt. Laguna, California)
P-40 (Othello, Oregon)	SM-132 (Baudette, Minnesota)
P-25 (Havre, Montana)	P-73 (Bellefontaine, Ohio)
M-98 (Miles City, Montana)	P-30 (Benton, Pennsylvania)
P-29 (Finley, North Dakota)	P-10 (North Truro, Mass.)
P-69 (Finland, Minnesota)	P-45 (Montauk, New York)
P-16 (Calumet, Michigan)	M-96 (Almaden, California)
P-72 (Olathe, Kansas)	P-57 (Naselle, Washington)
P-53 (Rockville, Indiana)	P-27 (Fortuna, North Dakota)
P-61 (Port Austin, Michigan)	M-119 (Lowther, Ontario)
P-49 (Watertown, New York)	C-17 (Beausejour, Manitoba)
P-50 (Saratoga Springs, New York)	
P-54 (Palermo, New Jersey)	
P-56 (Cape Charles, Virginia)	
TM-198 (Tyndall AFB, Florida)	
C-5 (St. Margarets, New Brunswick)	
C-8 (Santerre, Quebec)	

The Phase II automated NCC was expected to be equipped with a computer that would be capable of processing 40 target

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31. Operational Plan for Back-Up Interceptor Control, ADC, 19 Jan 1962 [Doc 309 in Hist of ADC, Jul-Dec 1961]; Msg AFODC 91302, USAF to Canadian Air Hq, 9 Jan 1962 [DOC 2].

tracks and conducting 10 simultaneous interceptions. This computer was also expected to be capable of processing data from five long-range radars and from an unstated number of gap-fillers. The computer was also to be capable of providing data link instructions to both manned interceptors and BOMARC. The NCC computer would also accept ALRI information and (by manual insertion) information from the DEW Line, AEW aircraft and SAGE Direction Centers. It was expected to be able to accept target tracks from other NORAD Control Centers and transfer tracks to other NCC's.[32]

Meanwhile, the SAGE system was completed in December 1961 when the Sioux City Direction Center became operational. It was perhaps ironic that SAGE was completed at about the time plans for operating the ground environment following the destruction of SAGE became solid.

Department of Defense approval of BUIC came 13 March 1962. The approval document described the two phases of BUIC in this manner:[33]

> Phase I. A manual backup system exploiting manual operations with existing

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32. Ibid.

33. Memo, OSD for Sec/AF, "Objectives for Continental Air and Missile Defense Forces," 13 Mar 1962 [DOC 3].

equipment to become available to
to the operating commands this year.

Phase II. A semi-automatic back-up control system, at 34 stations, which would become operational at the first stations in 1963 and be completed in 1965.

The first order of business, obviously, was Phase I. Anticipating DOD approval, ADC informed its subordinate units in February 1962 that it figured most of Phase I could be completed by 1 July 1962 and completely operational by October 1962. A Phase I planning document, issued the same month, outlined a manual BUIC system encompassing 27 NORAD Control Centers, 37 GCI stations and 65 surveillance stations.[34]

Apparently the designers of the original Phase I plan had not anticipated any difficulty with Canada in this matter, since a significant number of Canadian radar stations were included in the basic plan. The ADC liaison group in Canada, however, flashed an immediate alert. The liaison unit, 20 February 1962, pointed out that Canada had agreed to BUIC only in principle and warned ADC to advise all air divisions that might initiate action involving Canadian sites that "until the RCAF formally agrees and

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34. NOFORN EX CANADA, Msg ADLSP 354, ADC to Air Divs, 6 Feb 1962 [DOC 4]; Change L, 6 Feb 1962, to ADCM 27-2, Vol II, 15 Apr 1961 [HRF].

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implements a program for BUIC support this plan essentially stops at the border."[35]

The question of Canadian participation in BUIC I remained open during the spring and summer of 1962. In May the ADC liaison group in Ottawa reported that the matter was being staffed in RCAF headquarters and might be presented to a meeting of the Canadian Air Council on 4 June. In July the Canadian Air Defence Command informed ADC that BUIC I was still under study at the RCAF/government level and decision was unlikely until August. It was then too late. BUIC I stopped at the border and thereby offered considerably less capability than had originally been planned.[36]

The February optimism as to operational dates for BUIC I had somewhat dissipated by April 1962 when slightly more realistic dates were established. In April it was anticipated that the 25th Air Division would achieve an initial operational capability (IOC) 15 September 1962; 26th Air Division -- 28 September 1962; 28th Air Division --

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35. Msg 46020AC-C, 4602 Spt Wg (ADC), Ottawa, to ADC, 20 Feb 1962 [DOC 5].

36. Msg ADLSP 936, ADC to 26 AD, 9 Apr 1962 [DOC 6]; Msg 46020AC-C 174, 4602 Spt Wg (ADC), Ottawa, to ADC, 7 May 1962 [DOC 7]; NOFORN EX CANADA, Msg ADLSP 1885, ADC to Air Divs, 17 Jul 1962 [DOC 8].

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9 October; 29th Air Division -- 28 August 1962; 32nd Air Division -- 17 November 1962; 30th Air Division -- 20 October 1962.[37]

These dates slipped further following a decision to adopt an interim switching system of communications, recently developed by the American Telephone and Telegraph Company, in place of the point-to-point system used in SAGE. The delay was not serious, however, and the complete BUIC I system reached IOC status by 1 December 1962. As to full operational capability, it was estimated that the 25th Air Division would reach this state 24 March 1963; 26th Air Division -- 15 December 1962; 28th Air Division -- 15 February 1963; 29th Air Division -- 7 January 1963; 30th Air Division -- 26 March 1963. No estimate was given for the 32nd Air Division.[38]

The manual and, hopefully, survivable BUIC I ground environment available at the end of 1962 was organized as follows:[39]

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37. Msg ADLSP 1060, ADC to ADC Command and Control Defense Systems Office (L.G. Hanscom Fld, Mass), 19 Apr 1962 [DOC 9].

38. Msg ADOAC-CE 1312, ADC to Air Divs, 11 May 1962 [DOC 10]; Msg ADLSP 1953, ADC to Air Divs, 24 Jul 1962 [DOC 11]; NOFORN EX CANADA, Msg ADLSP 2073, ADC to Canadian Air Hq, 3 Aug 1962 [DOC 12]; Weekly Activity Report, ADC, ADLSP-C, 13 Nov 1962 and Comm Sys Div, 16-21 Nov and 23-29 Nov 1962 [HRF].

39. Implementation Schedule for Phase I of Backup Interceptor Control Plan, ADC, 1 Sep 1962 [DOC 13].

25th Air Division

a. NCC TM-180 (Keno, Oregon)
    1. GCI P-12 (North Bend, Oregon)
        a. SS M-100 (Mt. Hebo, Oregon)
        b. SS P-33 (Klamath, California)

b. NCC P-44 (Makah, Washington)
    1. GCI P-57 (Naselle, Washington)
        a. SS P-46 (Blaine, Washington)

c. NCC P-40 (Othello, Washington)
        a. SS P-32 (Condon, Oregon)
        b. SS SM-151 (Mica Peak, Washington)

26th Air Division

a. NCC P-49 (Watertown, New York)
    1. GCI P-30 (Benton, Pennsylvania)
        a. SS P-21 (Lockport, New York)
        b. SS RP-62 (Oakdale, Pennsylvania)
    2. GCI P-65 (Charleston, Maine)
        a. SS P-80 (Caswell, Maine)

b. NCC P-50 (Saratoga Springs, New York)
    1. GCI P-10 (North Truro, Massachusetts)
        a. SS P-14 (St. Albans, Vermont)

c. NCC P-54 (Palermo, New Jersey)
    1. GCI P-45 (Montauk, New York)
        a. SS P-9 (Highlands, New Jersey)

d. NCC P-56 (Cape Charles, Virginia)
    1. GCI RP-54 (Fort Meade, Maryland)
    2. GCI M-130 (Winston Salem, North Carolina)
    3. GCI M-115 (Fort Fisher, North Carolina)
        a. SS M-116 (Cherry Point MCAS, North Carolina)
        b. SS M-113 (North Charleston, South Carolina)

28th Air Division

a. NCC TM-181 (Luke Williams, Arizona)
        a. SS SM-162 (Yuma, Arizona)
        b. SS SM-163 (Las Vegas, Nevada)
        c. SS M-92 (Mt. Lemmon, Arizona)
        d. SS M-93 (Winslow, Arizona)

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b. NCC M-127 (Winnemucca, Nevada)
   a. SS M-118 (Burns, Oregon)
   b. SS SM-156 (Fallon, Nevada)

c. NCC P-59 (Boron, California)
   1. GCI P-76 (Mt. Laguna, California)
   2. GCI P-15 (Santa Rosa Island, California)
      a. SS RP-39 (San Pedro Hill, California)
      b. SS P-2 (Cambria, California)

d. NCC P-37 (Point Arena, California)
   1. GCI M-96 (Almaden, California)

29th Air Division

a. NCC P-25 (Havre, Montana)
   a. SS TM-178 (Lewiston, Montana)
   b. SS TM-179 (Kalispell, Montana)

b. NCC M-98 (Miles City, Montana)
   1. GCI P-27 (Fortuna, North Dakota)
      a. SS TM-177 (Dickinson, North Dakota)
      b. SS P-26 (Opheim, Montana)

c. NCC P-29 (Finley, North Dakota)
   a. SS P-17 (Wadena, Minnesota)

d. NCC P-72 (Olathe, Kansas)
   1. GCI SM-134 (Pickstown, South Dakota)
      a. SS P-71 (Omaha, Nebraska)
      b. SS P-47 (Hutchinson, Kansas)
      c. SS P-18 (Chandler, Minnesota)
      d. SS SM-133 (Hastings, Nebraska)
      e. SS MSS-1 (Denver, Colorado)

30th Air Division

a. NCC P-69 (Finland, Minnesota)
   1. GCI SM-132 (Baudette, Minnesota)
      a. SS P-35 (Osceola, Wisconsin)

b. NCC P-16 (Calumet, Michigan)
   1. GCI P-34 (Empire, Michigan)
      a. SS P-19 (Antigo, Wisconsin)

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c. NCC P-61 (Port Austin, Michigan)
1. GCI P-73 (Bellefontaine, Ohio)
a. SS P-20 (Selfridge AFB, Michigan)

d. NCC P-53 (Rockville, Indiana)
1. GSI P-81 (Waverly, Iowa)
a. SS RP-31 (Arlington Heights, Illinois)
b. SS P-70 (Belleville, Illinois)
c. SS P-64 (Kirksville, Missouri)

32nd Air Division

a. NCC M-125 (England AFB, Louisiana)
1. GCI P-79 (Ellington AFB, Texas)
2. GCI M-91 (Texarkana, Arkansas)

b. NCC P-52 (Oklahoma City, Oklahoma)
1. GCI M-89 (Sweetwater, Texas)
a. SS P-78 (Duncanville, Texas)
b. SS M-88 (Amarillo AFB, Texas)

c. NCC P-75 (Lackland AFB, Texas)
1. GCI TM-191 (Rockport, Texas)
2. GCI TM-188 (Eagle Pass, Texas)
a. SS TM-187 (Ozona, Texas)

d. NCC M-95 (Las Cruces, New Mexico)
1. GCI TM-186 (Pyote, Texas)
2. GCI M-94 (West Mesa, New Mexico)
a. SS M-90 (Walker AFB, New Mexico)

e. NCC TM-198 (Tyndall AFB, Florida)
1. GCI M-114 (Jacksonville NAS, Florida)
2. GCI M-126 (Houma NAS, Louisiana)
a. SS SM-159 (Aiken, South Carolina)
b. SS Z-211 (Patrick AFB, Florida)
3. GCI Z-210 (Richmond, Florida)
a. SS TM-200 (Cross City, Florida)
b. SS TM-196 (Dauphin Island, Alabama)

f. NCC Z-209 (Key West, Florida)

Because Canadian stations were not included, the BUIC I network which eventually became operational was noticeably smaller than that planned in early 1962. A February 1962 plan called for the use of 27 NCC's, 28 GCI's and 44 surveillance stations.

As for BUIC II, it was necessary, after completion of the basic operational plan, to develop specifications for a computer and select a contractor to build it. The desired capability of the control equipment had already been decided. It was expected to accept data from a maximum of five radars, continually observe at least 40 target tracks and control at least 10 simultaneous interception actions. ADC was not satisfied with the original specifications prepared by Rome Air Development Center and MITRE Corporation, holding that these specifications were too restrictive. ADC preferred specifications that were sufficiently general in order that contractors who might have "off the shelf" equipment that was roughly adequate might feel free to offer it.[40]

This difference of opinion was ironed out during February and March 1962 and a conference of prospective bidders was held at Hanscom 12 April. Ten contractors were represented when bids were opened in late April. After the

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40. NOFORN EX CANADA, Msg ADLSP 248, ADC to ESD, 29 Jan 1962 [DOC 14]; Weekly Activity Reports, ADC Elec Sys Div, 12-18 and 19-25 Jan 1962 [HRF].

bids were analyzed, a Source Selection Board was convened 4 June 1962 and Burroughs was ultimately selected as the successful contractor. Basic to the Burroughs equipment was a military version of the Burroughs D825 computer, a solid-state simplex digital data processor. The complete NCC equipment package was named Radar Course Directing Group, AN/GSA-51.[41]

Once the computers went into production, the matter of operational priority became important and something that had to be settled long before hardware began coming off the production line, because it affected construction scheduling, training and numerous other aspects of the total system. In January 1962, ADC and NORAD agreed on the following priority list for computerized NORAD Control Centers:[42]

1. P-54 (Palermo, New Jersey)
2. P-56 (Cape Charles, Virginia)
3. P-49 (Watertown, New York)
4. P-50 (Saratoga Springs, New York)
5. C-8 (Senneterre, Quebec)
6. P-16 (Calumet, Michigan)
7. P-69 (Finland, Minnesota)
8. C-5 (St. Margarets, New Brunswick)
9. P-61 (Port Austin, Michigan)
10. P-53 (Rockville, Indiana)

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41. Msg AFOOP 91834, USAF to RCAF, 24 May 1962 [DOC 15]; Weekly Activity Reports, ADC, Elec Sys Div, 2-8 Feb 1962 and ADLSP-C, 13 Feb, 3 Apr and 29 May 1962 [HRF]; C&E Digest, ADC, Dec 1962 [HRF].

42. NOFORN EX CANADA, Msg ADLSP 189, ADC to ADC CCDSO (Hanscom), 23 Jan 1962 [DOC 16].

11. P-45 (Montauk, New York)
12. M-115 (Fort Fisher, North Carolina)
13. P-30 (Benton, Pennsylvania)
14. P-10 (North Truro, Massachusetts)
15. M-119 (Lowther, Ontario)
16. SM-132 (Baudette, Minnesota)
17. P-65 (Charleston, Maine)
18. P-73 (Bellefontaine, Ohio)
19. P-37 (Point Arena, California)
20. P-44 (Makah, Washington)
21. P-59 (Boron, California)
22. P-40 (Othello, Washington)
23. M-100 (Mt. Hebo, Oregon)
24. M-96 (Almaden, California)
25. P-57 (Naselle, Washington)
26. P-76 (Mt. Laguna, California)
27. M-98 (Miles City, Montana)
28. P-25 (Havre, Montana)
29. P-29 (Finley, North Dakota)
30. P-72 (Olathe, Kansas)
31. P-27 (Fortuna, North Dakota)
32. C-17 (Beáusejour, Manitoba)
33. TM-198 (Tyndall AFB, Florida)
34. M-114 (Jacksonville NAS, Florida)

ADC believed it was operationally desirable to have full capability in the vital northeastern section of the country before giving other areas computerized NORAD Control Centers.

Operational priority was juggled in May 1962, although the changes did no violence to the concept that the northeast needed BUIC II protection before the remainder of the country. The first two Canadian sites were given lower priority and the priority of M-98 (Miles City, Montana) was improved from No. 27 to No. 17. Only the first 17 BUIC II sites were considered in the May listing of priorities, because the initial Burroughs contract covered only the first half of the 34 approved BUIC II sites. No change was made in the first four sites in New York, New Jersey and Virginia. Beyond No. 4 the new priorities were as follows:[43]

5. P-16 (Calumet, Michigan)
6. P-69 (Finland, Minnesota)
7. P-61 (Port Austin, Michigan)
8. C-8 (Senneterre, Quebec)
9. C-5 (St. Margarets, New Brunswick)
10. P-45 (Montauk, New York)
11. P-30 (Benton, Pennsylvania)
12. P-10 (North Truro, Massachusetts)
13. M-119 (Lowther, Ontario)
14. SM-132 (Baudette, Minnesota)
15. P-65 (Charleston, Maine)
16. P-73 (Bellefontaine, Ohio)
17. M-98 (Miles City, Montana)

As for testing of the AN/GSA-51, ADC and NORAD agreed that the first three sets should be used for that purpose. The first was to be retained at the factory for contractor testing. The second was to go to P-50 (Saratoga Springs, New York) for Category II testing. Category III testing and operator training was to involve the third production model, to be located at TM-198 (Tyndall AFB, Florida). No further changes in priorities were made during the remainder of 1962.

To increase the survivability of BUIC II installations, it was considered necessary to provide fallout protection. There was general agreement on the principle, but some

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43. NOFORN EX CANADA, Msg ADLSP 1195, ADC to USAF, 1 May 1962 [DOC 16].

disagreement on the degree of protection and whether or not fallout protection should be extended to ground-to-air transmitters. A final position on the details of fallout protection had not been reached by the end of 1962.[44]

Although the Canadians took no part in BUIC I, there was solid evidence by the middle of 1962 that they intended to participate in BUIC II. At an RCAF-USAF meeting of 20 June 1962, the RCAF agreed to support the establishment of four BUIC II sites in Canada and expressed a willingness to share the expense involved. Before such cooperation could be effective, however, government-to-government agreement would have to be reached.[45]

A new dimension was added to BUIC II planning in the late summer of 1962 when the MITRE Corporation, at ESD request, studied the possibility of increasing BUIC II survivability by mounting the Burroughs equipment on vans and making each NCC a complex of three locations about

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44. Msg ADIRP-R 263, ADC to USAF, 30 Jan 1962 [DOC 17]; Msg AFOOP-DE-WC 99421, USAF to ADC, 7 Feb 1962 [DOC 18]; "Specific Operational Requirement for a Continental Air Defense Control and Warning System (SOR 79)," ADC, 16 Apr 1962 [DOC 19]; NOFORN EX CANADA, Msg ADLSP 1166, ADC to USAF, 27 Apr 1962 [DOC 20].

45. Msg AFOOP 65534, USAF to CANAIRHED, 12 Jul 1962 [DOC 21].

25 miles apart. The transportable computer would move from one location to another on a random schedule and thereby greatly increase the enemy's defense suppression problem. At the same time, it was suggested that the AN/GSA-51 be improved to the point where it would accept data from eight radars rather than five, provide eight scopes rather than six, provide information on 100 target tracks rather than 40 and control 20 interceptions rather than 10.[46]

NORAD adopted this proposal and gave it a name -- TRACE (Transportable Automated Control Environment). As planned by NORAD, TRACE was intended to replace SAGE rather than support it. NORAD, in a September 1962 report to the Secretary of Defense on "Manned Bomber Defense," recommended that 38 TRACE units (each covering three locations) be deployed. When this was done, NORAD believed SAGE and 28 long range radars could be deactivated.[47]

Although the Secretary of Defense found the TRACE proposal interesting and complimented NORAD on an imaginative

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46. Msg AD4-SY-Z8-559-E, ADC CCDSO (Hanscom) to ADC, 20 Aug 1962 [DOC 22]; Msg ADLSP 2213, ADC to ADC Computer Programming and Systems Training Office (APASTO) (Santa Monica), 21 Aug 1962 [DOC 23]; Weekly Activity Report, ADC, Comm Sys Div, 23-29 Aug 1962 [HRF].

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

approach to the problem, he chose not to recommend funding for any command and control system beyond BUIC in the Fiscal 1964 budget. At the same time, however, he recommended that significant reductions be made in the existing SAGE system. His initial recommendation to the Joint Chiefs of Staff, made in November 1962, was that 10 SAGE direction centers and 22 long range radars be closed in order to save $100 millions a year in operating expenses. The JCS argued that the reductions were too sharp and were premature, but McNamara was not totally sidetracked from his goal of reducing the size, and cost, of the ground environment. On 3 December 1962 he recommended to President Kennedy that six direction centers and 17 radars be closed by the middle of 1964. The President approved.[48]

Even more advanced than TRACE was an ADC proposal for development of an airborne system capable of performing the functions of a BUIC site. Work on this proposal, based on still earlier work on an Airborne Defense Command Post (ADCP), began in August 1962 and bore fruit in the form of a Qualitative Operational Requirement for an Airborne Surveillance and Control System (ASACS), submitted to USAF

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

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in October. Again, as in BUIC, ADC foresaw two-phase development. Phase I capability, representing the minimum required, was expected in 1966, Phase II capability in 1970 To cut the cost of the system, ADC proposed that only a limited number of these airborne surveillance and control stations be operated on peacetime patrol, manning assigned stations on a random basis. Additional aircraft would be maintained on 5 to 15 minute alert to greatly expand the system in an emergency. The inadequacies of the existing EC/RC-121 radar platforms in performance of such duty were detailed.

During Phase I, ADC would require an aircraft which, when loaded with equipment, would cruise at 35,000 feet, offer high subsonic speed at cruising altitude and be capable of spending at least 12 hours at a station 1,000 miles from the home base. The detection and tracking sensor aboard this aircraft would require the ability to detect a target as small as one square meter at 400 miles and track it at any altitude from the surface to 100,000 feet and at any speed from Mach .1 to Mach 3.

The Phase II system would require an aircraft offering increased altitude, range, endurance and speed capability. The Phase II airborne sensor was expected to provide a

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detection range of 500 miles against a target as small as one/tenth of a square meter, at altitudes up to 150 miles and at speeds from subsonic through hypersonic. The ability to cope with air-to-surface missiles, air-launched ballistic missiles and surface- or subsurface-launched ballistic missiles was anticipated. USAF had taken no action on the ASACS QOR by the end of 1962.[49]

By the end of 1962, therefore, considerable strides had been made toward the provision of a credible system to back-up, or replace, the vulnerable SAGE. BUIC I was almost completely operational. A contractor had been chosen to produce the semi-automatic AN/GSA-51 equipment for BUIC II and priorities for installation of the equipment had been established. The operational date for the first BUIC II site, however, had slipped from October 1964 to April 1965. The TRACE concept had been formulated and rejected. An operational requirement for airborne BUIC had been established.

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49. Msg ADLSP 2309, ADC to TAC; 29 Aug 1962 [DOC 24]; NOFORN, ADC to USAF, "Qualitative Operational Requirement for an Airborne Surveillance and Control System (QOR ASACS)," 19 Oct 1962 [DOC 25].

CHAPTER THREE

IMPROVED BACK-UP CONTROL SYSTEMS

1963 - 1965

The first major command and control action of 1963 produced a significant reduction in the scope of SAGE. By direction of the Secretary of Defense, the inactivation of six direction centers and 17 long range radars was to be accomplished by the end of Fiscal 1964. Since the handwriting on the wall was plain, there was nothing to be gained by waiting until the last possible moment, so the inactivation took place rapidly. The San Francisco, Minot and Spokane sectors were closed by early September 1963, the Sault Ste. Marie sector by 1 October. Sixteen of the required radar stations (including two Texas Towers) were closed by the end of 1963, with the 17th inactivated in early 1964.[50]

Even before the Fiscal 1964 reductions in SAGE could be completed, USAF was alerting ADC, in September 1963, about the additional loss of four SAGE direction centers and five radars in Fiscal 1965. USAF also passed along the informal information that 12 more radars were likely to go in Fiscal 1966, another 12 in Fiscal 1967 and 15 in Fiscal 1968. This suggestion was strongly opposed by ADC, but if required to do so, it recommended that the combat centers at Truax (30th Air Division) and McChord (25th Air Division) and the Los Angeles, New York and Chicago sectors be deleted rather than the four direction centers suggested.[51]

CONAD was also strongly opposed to the proposed reductions in SAGE in Fiscal 1965. In a strongly worded personal message to Lt. Gen. David A. Burchinal, USAF Deputy

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50. Msg ADLSP 4, ADC to ADC CCDSO (Hanscom), 1 Jan 1963 [DOC 26]; Msg ADCCS 12, ADC to USAF, 3 Jan 1963 [DOC 27]; NOFORN EX CANADA, Msg ADOAC-AN 237, ADC to USAF, 24 Jan 1963 [DOC 28]; Msg ADOAC-ER 303, ADC to ESD, 30 Jan 1963 [DOC 29]; ADC Historical Study No. 26, "Air Defense and National Policy, 1958-1964," p. 78.

51. Weekly Activity Report, ADC, ADLPC, 26 Sep and 8 Oct 1963 [HRF].

Chief of Staff for Plans and Programs, Gen. John K. Gerhart, CONAD commander, based his non-concurrence on the fact that removal of four more direction centers would completely eliminate SAGE's ability to back-up itself (Mode II operation), except for limited expansion of the Bangor sector. He added that BUIC II was intended to back-up a fully capable SAGE system. If SAGE was not fully capable, BUIC II could not be completely efficient. General Gerhart pointed out that at the end of Fiscal 1965, under current programming, the BUIC II system would consist of 10 automated control centers with the ability to control weapons over less than half of the available ground environment. Of even more concern was the fact that these 10 BUIC II centers, assuming full utilization, could control only about 100 interceptions, or less than 10 per cent of the total weapons inventory. In short, Gen. Gerhart did not favor the latest DOD proposal.[52]

Meanwhile, the Canadians belatedly decided to participate in BUIC I, but that system became fully operational within weeks after the Canadian decision of February 1963, so no Canadian radar stations were tied into the initial BUIC operation.[53]

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52. Msg CHCR X057, CONAD to USAF, 11 Oct 1963 [DOC 30].

53. Msg VCAS 4, CANAIRHED to NORAD , 26 Feb 1963 [DOC 31]; Msg 4602 OAC-C 27, 4602 Spt Wg (Ottawa) to ADC, 28 Feb 1963 [DOC 32]; Msg ADOAC-CC 752, ADC to 4602 Spt Wg,

As to BUIC II, 1963 was a period of changing operational priorities and slipping operational dates. Burroughs was busy developing and testing the AN/GSA-51, while NORAD, ADC and other agencies were busy developing operational concepts and a computer program.

An operational priority listing which had stood since May 1962 was juggled by NORAD in February 1963 to make allowance for the fact that Phase I BUIC would be inoperable during the time BUIC II equipment was being installed. Therefore, it seemed wise, wherever possible, to place BUIC II computers first at sites that were not BUIC I NORAD Control Centers. Other criteria considered in the February listing were the priority of the area to be defended, the vulnerability of the direction center and the ability to control BOMARC. A decision to place the first eight computers in the United States was also given consideration. How the new listing compared with that of May 1962 is shown below:[54]

[Cont'd] 12 Mar 1963 [DOC 33]; Msg ADSI 204, CANAIRHED to CANAIRDEF, 5 Apr 1963 [DOC 34]; RCS: ADC-V24, Control and Warning Equipment Report, 31 Dec 1963 [HRF].

54. Msg ADLSP 491, ADC to Air Divs, 14 Feb 1963 [DOC 35].

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Priority	February 1963	May 1962
1	P-45 (Montauk, New York)	P-54
2	M-115 (Fort Fisher, North Carolina)	P-56
3	P-30 (Benton, Pennsylvania)	P-49
4	P-10 (North Truro, Massachusetts)	P-50
5	SM-132 (Baudette, Minnesota)	P-16
6	P-65 (Charleston, Maine)	P-69
7	P-73 (Bellefontaine, Ohio)	P-61
8	C-119 (Lowther, Ontario)	C-8
9	C-17 (Beausejour, Manitoba)	C-5
10	M-96 (Almaden, California)	P-45
11	P-57 (Naselle, Washington)	P-30
12	P-76 (Mt. Laguna, California)	P-10
13	TM-180 (Keno, Oregon)	C-119
14	P-40 (Othello, Washington)	SM-132
15	P-27 (Fortuna, North Dakota)	P-65
16	P-25 (Havre, Montana)	P-73
17	P-53 (Rockville, Indiana)	M-98
18	P-72 (Olathe, Kansas)	P-53
19	C-8 (Senneterre, Quebec)	P-37
20	P-54 (Palermo, New Jersey)	P-44
21	P-56 (Cape Charles, Virginia)	P-59
22	P-49 (Watertown, New York)	P-40
23	P-50 (Saratoga Springs, New York)	M-100
24	P-69 (Finland, Minnesota)	M-96
25	C-5 (St. Margarets, New Brunswick)	P-57
26	P-61 (Port Austin, Michigan)	P-76
27.	P-16 (Calumet, Michigan)	M-115
28	P-29 (Finley, North Dakota)	P-25
29	P-37 (Point Arena, California)	P-29
30	P-44 (Makah, Washington)	P-72
31	P-59 (Boron, California)	P-27
32	M-98 (Miles City, Montana)	TM-198
33	TM-198 (Tyndall AFB, Florida)	TM-198
34	M-114 (Jacksonville NAS, Florida)	M-114

The priority listing of February 1963 was in effect only a short while, however, because it failed to take into account the Fiscal 1964 reduction of six direction centers and 17 radars. NORAD found it necessary, therefore, to

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issue a revised listing in April 1963. Six sites -- P-49, P-30, C-119, M-96, C-17 and P-29 -- had been dropped from consideration as computerized BUIC sites. Substituted were C-1 (Mt. Apica, Quebec), M-127 (Winnemucca, Nevada), P-81 (Waverly, Iowa), SM-134 (Pickstown, South Dakota), M-126 (Houma NAS, Louisiana) and TM-181 (Luke Williams, Arizona). After making these site changes, NORAD then produced a new priority list that went as follows:[55]

1. P-10
2. P-54
3. P-16
4. P-61
5. P-56
6. P-65
7. P-27
8. P-44
9. P-37
10. P-76
11. P-81
12. C-1
13. SM-132
14. M-115
15. M-98
16. P-73
17. P-40
18. TM-180
19. TM-181
20. C-5
21. SM-134
22. C-8
23. P-50
24. P-69
25. P-57
26. P-59
27. P-53
28. P-72
29. P-25
30. M-127
31. M-114
32. M-126
33. P-45
34. TM-198

NORAD again objected to the complete loss of BUIC I capability during the four-to-seven months required to install BUIC II equipment, especially since the loss of six direction centers would virtually destroy SAGE Mode II capability. NORAD wanted BUIC I retained during BUIC II installation, even if it involved a lash-up method of operation. Also,

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55. Msg NOOP-E X-156, NORAD to USAF, 15 Apr 1963 [DOC 36].

NORAD objected to an ESD plan for BUIC II which would leave computers idle four to five months while a computer program was prepared. This difference of opinion was an early indication that delays in the preparation of computer programs might prevent the realization of operational dates previously scheduled.[56]

Although ADC and USAF generally concurred with NORAD's BUIC II priority listing of 15 April, the ADC Command and Control Defense Systems Office (CCDSO) at L.G. Hanscom Field, Massachusetts, attacked the basic thinking behind the NORAD list. CCDSO (ADC liaison with AFSC's Electronic Systems Division) maintained that some locations might eventually prove unusable because no consideration had been given to possible future reconfiguration. Neither did CCDSO feel that NORAD priorities adequately reflected the possibility that USAF might not buy the second 17 AN/GSA-51 sets. Other objections included the conviction that the proposed NORAD deployment would not adequately provide for BOMARC control or the defense of major industrial and population centers, would not provide for the interception of

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56. Ibid.; Msg AD4SY-Z 3-157E, ADC CCDSO (Hanscom) to ADC, 27 Mar 1963 [DOC 37]; Msg ADLPC 1648, ADC to ADC CCDSO, 25 Apr 1963 [DOC 38].

enemy bombers sufficiently distant from target complexes and, where located on the coast, were not really survivable. CCDSO also furnished a priority listing for the first 17 sites, a listing it believed would meet its objections to the NORAD effort. CCDSO was of the opinion that the first 17 sites were critical and that the second 17 should be located so as to provide redundancy and added capacity for the first 17. The Hanscom agency proposed changing the first half of the NORAD list as follows:[57]

NORAD Priority List	CCDSO Recommendations
1. P-10 (North Truro, Mass)	1. P-10
2. P-54 (Palermo, N.J.)	2. P-30 (Benton, Pa)
3. P-16 (Calumet, Michigan)	3. P-16
4. P-61 (Port Austin, Mich)	4. P-61
5. P-56 (Cape Charles, Va)	5. P-56
6. P-65 (Charleston, Maine)	6. P-65
7. P-27 (Fortuna, N.D.)	7. SM-132 (Baudette, Minn)
8. P-44 (Makah, Washington)	8. P-27
9. P-37 (Point Arena, Calif)	9. P-40 (Othello, Wash)
10. P-76 (Mt. Laguna, Calif)	10. TM-180 (Keno, Ore)
11. P-81 (Waverly, Iowa)	11. P-76
12. C-1 (Mt. Apica, Quebec)	12. P-53 (Rockville, Ind)
13. SM-132	13. M-130 (Winston-Salem, N.C.)
14. M-115 (Fort Fisher, N.C.)	14. P-57 (Naselle, Wash)
15. M-98 (Miles City, Mont)	15. M-98
16. P-73 (Bellefontaine, Ohio)	16. TM-198 (Tyndall AFB, Fla)
17. P-40	17. C-8 (Senneterre, Quebec)

57. Msg 4D4SY-Z 4-216-E, ADC CCDSO (Hanscom) to ADC, 24 Apr 1963 [DOC 39].

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As to NORAD's concern over the hiatus between computer availability and program delivery, CCDSO shared that concern, but could recommend no solution to the problem. At any rate, CCDSO emphasized that firm agreement on site locations and installation priorities was needed quickly if BUIC II was to avoid still further operational delays.[58]

Although it had appeared in 1962 that Canada was ready to give prompt approval to participation in BUIC II, appearances were deceiving when it came to approval of the detailed NORAD priority list of 15 April 1963. Since Canadian concurrence with the location and priority of the three sites planned in Canada had not been obtained by the end of May, USAF did not believe it wise to wait any longer and on 4 June 1963 authorized everybody concerned to proceed with the first seven sites (P-10 through P-27). P-10 was given an operational date of 15 January 1965, with P-27 to reach operational status 1 July 1965. ADC augmented this information by asking the five affected air divisions to retain a Phase I capability as long as possible at those sites where a Phase I NCC was to be

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58. Ibid.; NOFORN EX CANADA, Msg ADLPC 1986, ADC to USAF, 29 May 1963 [DOC 40].

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replaced by a computerized Phase II NCC. How this was to be achieved at individual sites was left to the know-how and imagination of the divisions.[59]

Agreement was reached with the Canadians in July, although the accepted Canadian posture was different from that previously shown by NORAD. The Canadian position was that, short of clear evidence of a supersonic bomber threat, Canada did not want BUIC II in the Ottawa sector (C-1, Mt. Apica, Quebec and C-8, Senneterre, Quebec) to have high priority. Therefore, C-5 (St. Margarets, N.B.) was substituted for C-1 as Priority 12 and C-1 and C-8 were placed near the end of the priority list. Otherwise, USAF approved the whole NORAD priority list of 15 April, except that Z-99 (Gettysburg, S.D.) was substituted for Z-134 (Pickstown, S.D.). All ADC radars were converted to "Z" numbers, effective 1 July 1963.[60]

At this point in 1963, BUIC II became a reasonably firm program with buildings being built and hardware being procured. The priority list appeared solid, although at the

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59. Msg AFXOPM 67269, USAF to NORAD, 4 Jun 1963 [DOC 41]; NOFORN EX CANADA, Msg ADLPC 2198, ADC to Air Divs, 21 Jun 1963 [DOC 42].

60. Msg AFXOPN 80436, USAF to NORAD, 20 Jul 1963 [DOC 43].

end of the year ADC was attempting to substitute Z-46 (Blaine, Washington) for Z-44 (Makah, Washington) on the grounds that Blaine was a much more livable place than Makah, and just as survivable. Operational dates for BUIC II stretched from 15 January 1965 to 22 October 1966.[61]

Proposals for the improvement of programmed BUIC II began to surface during the summer of 1962 when ESD/MITRE produced a plan suggesting that the AN/GSA-51 could be improved to the point where it would accept data from eight radars rather than five, provide eight scopes instead of six, show information on 100 target tracks rather than 40 and control 20 interceptions as opposed to 10. This plan also recommended that the NCC be made more survivable by making it transportable. This proposal was adopted by NORAD and named TRACE (Transportable Automated Control Environment) and presented to the Department of Defense in September 1962.*

DOD failed to approve the idea, but the matter of Improved BUIC continued under study. This small-scale

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61. NOFORN EX CANADA, Msg ADLPC 5976, ADC to USAF, 18 Dec 1963 [DOC 44]; NOFORN EX CANADA, Msg ADLPC 5979, ADC to USAF, 18 Dec 1963 [DOC 45]; Hist of NORAD, Jul-Dec 1963, p. 23.

* See pp. 42ff above.

effort was overtaken in January 1963 when Secretary McNamara asked the Air Force to undertake a study, in depth, of air defense requirements through 1975. "I am particularly concerned," he wrote, "that we move toward a low fixed-cost ground environment that can be augmented or reduced as the bomber threat develops."[62]

The result was the Continental Air Defense Study (CADS), prepared under the direction of Maj. Gen. Arthur C. Agan, DCS/Plans, ADC, and completed in May 1963. This study looked beyond SAGE and BUIC II and recommended that SAGE be replaced, rather than backed up, by Improved BUIC and an Airborne Warning and Control System (AWACS) in the period between 1966 and 1975. The heart of Improved BUIC was expected to be a modified AN/GSA-51 that would accept surveillance data from 10 radar sites and offer a much expanded control capability. CADS also recommended that Improved BUIC be established at 46 rather than the 34 sites currently approved.[63]

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62. Memo, Sec/Def for Sec/AF, "A Study of Continental Air Defense," 7 Jan 1963 [HRF]; Msg ADLDC 246, ADC to USAF, 25 Jan 1963 [DOC 46].

63. Continental Air Defense Study, May 1963 [HRF].

USAF accepted the CADS recommendations as regards Improved BUIC and by June 1963 had drafted a Program Change Proposal (PCP) for submission to DOD. The initial proposal was not acceptable to ADC, because it was felt to be a piecemeal approach. The total CADS recommendations covered the Improved Manned Interceptor and AWACS as well as Improved BUIC. ADC believed the CADS proposals should be presented to DOD as a single package. Despite ADC objections, however, the formal PCP for Improved BUIC was forwarded to DOD on 21 October 1963.[64]

The Department of Defense, though, was not quite ready to forge ahead with Improved BUIC. On 27 November 1963, DOD announced that Improved BUIC was "deferred without prejudice" until such time as DOD got a clearer idea as to how the ADC and FAA radar networks would merge and what sort of air defense posture would be required in the years ahead. Meanwhile, DOD wanted USAF to continue work on definition of the Improved BUIC system. As a starter, the Program Review Committee of USAF suggested the current

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64. Msg AFOAPA 73045, USAF to ADC, 24 Jun 1963 [DOC 47]; Msg ADCCR 2630, ADC to USAF, 6 Jul 1963 [DOC 48]; Msg ADLDC 2723, ADC to ADC CCDSO (Hanscom), 17 Jul 1963 [DOC 49]; Msg CHCRX057, CONAD to USAF, 11 Oct 1963 [DOC 30].

BUIC II program of 34 sites be reduced to 28, with 22 continuing as BUIC II sites and six converting to Improved BUIC configuration. The Committee further suggested that the six Improved BUIC sites be used to replace the four direction centers of the 26th Air Division. This proposal was not warmly received by either NORAD or ADC. At any rate, a new study of what constituted a credible and survivable ground environment was called for. USAF wanted it by 1 June 1964.[65]

Always, when the talk turned to survivable command and control systems, the nagging question invariably arose: What happens to SAGE, BUIC or any other ground-bound system when an enemy possessing sophisticated intercontinental missiles decides on a determined defense suppression attack? The answer was obvious, as was one form of counteraction. In October 1962, ADC forwarded to USAF a QOR asking for an Airborne Surveillance and Control System (ASACS). The name of the system had been changed to AWACS, substituting <u>Warning</u> for <u>Surveillance</u>, by the end of 1962. The most radical feature of the ADC request was a sensor that

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65. Msg AFCAV 78217, USAF to ADC, 14 Dec 1963 [DOC 50]; Msg AFOAP 85377, USAF to ADC, 18 Jan 1964 [DOC 51]; Weekly Activity Report, ADC, ADLPC, 17 Dec 1963 [HRF].

would pick up a one-square-meter target at 400 miles. Tactical Air Command, which submitted a similar QOR at the same time, asked for a detection range of only 200 miles on the same target. The Aeronautical Systems Division of AFSC suspected that the ADC requirement had stemmed from conversations with contractors who were more optimistic than ASD over the state of the radar art. ASD also informed USAF that if development was to be limited to a 40-month period, the 400-mile requirement was unreasonable and would delay operational availability of AWACS about a year. As a result, the draft Specific Operational Requirement (SOR) circulated by USAF in January 1963 contained a statement about the 200-mile detection range.[66]

Although ADC objected to dropping the 400-mile detection range objective, the formal SOR published 12 June 1963 still mentioned the 200-mile range. Otherwise, the SOR called for an aircraft that could remain on station a minimum of eight hours while operating from a base 1,200 miles distant, cruise at 35,000 feet and be airborne within 10 minutes of notification. The speed was given as subsonic. Meanwhile the Continental Air Defense Study, published

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66. Draft Proposed System Program Package for AWACS, ASD, 19 Dec 1963, Sec. 14 (DOC 52].

a month earlier, had reiterated the need for an AWACS. Forty-two AWAC aircraft, the study said, would provide forward air battle surveillance and control that would be imperative in a war situation.[67]

One of the principal hurdles in the development of AWACS was likely to be the engineering of an airborne radar which would be effective over land. ADC had used airborne radar for years in its Airborne Early Warning aircraft, but this equipment operated only over water. Ground clutter had proven insurmountable in attempts to use AEW equipment over land masses. The AWACS SOR, however, claimed that overland airborne radar capability was technically possible. Because of differing opinions on this matter, Secretary McNamara, in June 1963, directed the Department of Defense Research and Engineering (DDR&E) organization to examine the feasibility of overland airborne radar. This study reached the conclusion that the concept was feasible and recommended that the Navy E2A aircraft be considered as an interim AWACS vehicle with larger aircraft being used eventually.[68]

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67. USAF SOR No. 206, Airborne Warning and Control System, 12 Jun 1963 [DOC 53]; Continental Air Defense Study, May 1963 [HRF].

68. Ibid.;Draft Proposed System Program Package for AWACS, ASD, 19 Dec 1963, Sec. 14 [DOC 52].

The Secretary of Defense concurred in the DDR&E conclusions and asked the Air Force, in July 1963, to probe the various combinations of aircraft (DC-8F, C-141, C-135B and E2A) and radar which might be used to perform the AWAC mission. ASD actually performed the comparative analysis and concluded that (1) the E2A could not perform the AWAC mission regardless of modifications because it lacked range, endurance and space; (2) the C-135B transport would provide the lowest-cost system; (3) all proferred radars showed merit in this application; and (4) the over-land clutter problem could be solved. ASD then recommended that USAF proceed with the AWAC program, using the C-135B as the basic vehicle, but buying the radar through competitive procurement.[69]

Despite the affirmative answers of the AWACS SOR, DDR&E and ASD, the discussion about the feasibility of over-land airborne radar would not die. Below the Department of Defense level,the Navy and ASD said it was feasible, while ESD and the MITRE Corporation took the opposite position. Therefore, the Undersecretary of the Air Force, in

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69. Draft Proposed System Program Package for AWACS, ASD, 19 Dec 1963, Sec. 14 [DOC 52].

August 1963, asked the Air Force Scientific Advisory Board to look into the matter. When the SAB completed its report in October 1963, it admitted to a lack of complete conviction on the practicality of overland radar and recommended that no commitment be made on AWACS until the capability of overland radar was demonstrated. The SAB recommended that two developmental paths be followed. First, existing equipment should be used to determine the magnitude of the ground clutter problem and evaluate clutter rejection techniques. The second path should follow phased array radar techniques with an eye to their AWAC use in the somewhat distant future.[70]

At about this same time, ADC requested a change in the AWACS SOR, pointing out that while CADS called for an aircraft which would remain 12 hours on a station 1,000 miles from the home base, the SOR specified an aircraft which would remain eight hours on a station 1,200 miles from base. ADC requested that the CADS specifications be adopted, because procurement against the SOR standard would require more than the 42 aircraft mentioned in CADS.[71]

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70. Ibid.

71. Msg ADLDC 4099, ADC to USAF, 16 Sep 1963 [DOC 54].

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Meanwhile, in September and before the Scientific Advisory Board had made known its thinking on AWACS, ASD proceeded to write a development program which assumed that the Boeing C-135B would be the AWACS vehicle. Sole source procurement was rejected by AFSC, however, and it was necessary to rewrite the program. An October 1963 program received AFSC approval, but was rejected by the Air Council on the grounds that all of the three aircraft being considered for AWACS use would be out of production before AWACS production began. ASD was again directed to rewrite the development plan to emphasize the development of components. The total AWACS effort was to be directed so as to apply to an aircraft that would be available after 1970. This meant, USAF told ADC, that there would be no near-term AWACS. AFSC was engaged in a limited development program, primarily aimed at overland airborne radar. If this development was successful, USAF added, the decision to postpone AWACS to post-1970 use might be re-examined.[72]

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72. Draft Proposed System Program Package for AWACS, ASD, 19 Dec 1963, [DOC 52]; Weekly Activity Report, ADC, ADLPC, 19 Dec 1963 [HRF]; Msg AFORQDC 74870, USAF to TAC, 3 Dec 1963 [DOC 55].

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Although no hardware was actually put into place, a certain amount of progress was made during 1963 in the campaign to provide a survivable back-up system or alternative for SAGE. Burroughs had been named as the BUIC II contractor and test models of the AN/GSA-51 automatic equipment were expected in 1964. Improved BUIC had been "deferred without prejudice" by DOD near the end of 1963, but studies continued. Airborne BUIC, or AWACS, had received a setback with the decision to consider it solely a post-1970 development, but there were hopes for reconsideration. At the end of 1963, however, command and control of air defense still rested with SAGE, supported by the manual BUIC I.

In 1964 and early 1965, further progress was made toward initial operational capability for BUIC II, although Burroughs fell far short of delivering the first AN/GSA-51 on schedule. Improved BUIC evolved into PAGE (Primary Automatic Ground Environment) and then into BUIC III, which looked so promising that plans were made to have BUIC III supersede BUIC II. The airborne version, AWACS, marked time while various contractors worked at development of an airborne radar that would operate successfully over land areas.

At the end of 1963 it was anticipated that the initial AN/GSA-51 would be delivered to North Truro, Massachusetts (Z-10) on 15 January 1964. In early January, however, this date was moved back to 19 February. The February date proved optimistic, too, and by March it was becoming painfully obvious that a further serious slippage of the entire BUIC II program was in prospect. The existing schedule called for Z-10 to be operational 1 July 1965, with the 34th site to reach that state 1 August 1966. It was felt that this schedule was no longer tenable. In April 1964 a new delivery date -- 15 August 1964 -- for the first AN/GSA-51 was established, but this proved to be no more dependable than earlier dates. The first BUIC II equipment was delivered to Z-10 on 21 September 1964. It was now possible to schedule initial operational capability for Z-10 for 1 September 1965, with the full 34-site BUIC II system to be fully operational by 30 June 1966. Actually, the total impact of the delay in the development of the AN/GSA-51 was not so great as had been feared earlier.[73]

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73. Msg ESSG 3-19-80-E, ESD to ADC, 19 Mar 1964 [DOC 56]; Msg ADLDC 1057, ADC to ESD, 24 Mar 1964 [DOC 57]; NOFORN EX CANADA, Msg ADLDC 1449, ADC to ESD, 29 Apr 1964 [DOC 58]; NOFORN EX CANADA, Msg ADLDC 1486, ADC to USAF, 2 May 1964 [DOC 59]; Msg ESSG-7-23-47-E, ESD to AFSC, 24 Jul 1964 [DOC 60]; Msg ADLPC 2436, ADC to ESD, 30 Jul 1964 [DOC 61]; Msg ADLDC 2456, ADC to ADC CCDSO (Hanscom),

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As part of the search for an adequate, but low-cost, ground environment for the years between 1964 and 1970, ADC, in late 1963, was asked to prepare a list of "hard core" radars that should not be considered for deletion prior to the latter year. Based on coverage criteria furnished by NORAD, ADC compiled a list of 161 radars (100 ADC, 31 FAA and 30 Canadian). USAF said this March 1964 list would be used as a basis for BUIC II planning, Military Construction Program planning, planning for defense against sea-launched ballistic missiles, Improved BUIC programming, implementation of Mark XII IFF, consideration of proposals for a phase-down of Canadian radar and implementation of the FAA National Airspace System (99 ADC, 16 FAA and 30 Canadian).[74] Later in 1964 the total was reduced to 145.

Although the Department of Defense had deferred consideration of Improved BUIC in late 1963, the Air Force

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[Cont'd] 3 Aug 1964 [DOC 62]; Weekly Activity Reports, ADC, ADLPC, 14 Jan, 17 Mar, 6 Apr, 28 Apr, 19 May, 28 Jul and 28 Sep 1964 [HRF].

74. Msg AFXOPM 89612, USAF to ADC, 5 Feb 1964 [DOC 63]; NOFORN EX CANADA, Msg ADLDC 432, ADC to USAF, 7 Feb 1964 [DOC 64]; Msg AFXOPM 60802, USAF to ADC, 14 Mar 1964 [DOC 65]; Weekly Activity Report, ADC, ADLPC, 17 Mar 1964 [HRF].

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had been enjoined to continue studying the matter and this ADC had done. The result was the PAGE proposal (PAGE -- Primary Automated Ground Environment -- being substituted for "Improved BUIC" beginning in March 1964) submitted to USAF in the summer of 1964. The complete PAGE document included a number of options offering various SAGE/PAGE combinations. Options I and III attracted most attention, however. Option I called for the total replacement of SAGE with 39 units of PAGE equipment (improved and expanded AN/GSA-51), 35 of them in NORAD Control Centers divided among 12 PAGE sectors. Four sets of equipment were to be placed in four PAGE Combat Centers. Option III provided for inclusion of radars of the FAA National Airspace System in a control network of 33 PAGE facilities (29 NCC's in 10 sectors, plus four combat centers). Approval of Option I was recommended by both NORAD and ADC.[75]

USAF approved the PAGE concept and spent much of July and August preparing an appropriate PCP for submission to DOD. Apparently the majority of the Air Staff favored Option I, although Asst. Under Secretary A. H. Flax was known to prefer Option III. The PCP actually forwarded to

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75. NOFORN EX CANADA, Msg ADLPC 1102, ADC to ESD, 30 Mar 1964 [DOC 66]; Hist of NORAD, Jul-Dec 1964, pp. 23-24.

to DOD in August 1964 recommended approval of Option III. At that level, the Joint Chiefs of Staff was given the first opportunity to study the proposal, concurring with the PAGE PCP on 22 September 1964.[76]

PAGE found the going much rougher in the Office of the Secretary of Defense. Dr. Eugene Fubini, Assistant Secretary of Defense for Research and Engineering, expressed doubt about the cost figures included in the PAGE proposal and ADC/ESD attempted to reassure him on this score during a briefing held 12 October 1964. Dr. Fubini was still not fully convinced, however, and on 22 October sent two members of the DDR&E staff, Mr. Fred Payne and Mr. John Klotz, to ADC headquarters for further discussion of PAGE. At this time it was revealed that OSD believed the cost of PAGE might amount to $200 millions and that an incremental approach might be less expensive. It was suggested that PAGE might be implemented in three steps. The first step would be the provision of 19 PAGE NCC's. Then all SAGE direction center computers would be replaced by PAGE computers. Finally, all SAGE combat center computers would be replaced by PAGE computers.[77]

76. Weekly Activity Reports, ADC, ADLPC, 19 May, 21 Jul, 28 Jul and 25 Aug 1964 [HRF]; Hist of NORAD, Jul-Dec 1964, p.25.

77. Weekly Activity Report, ADC, ADLPC, 13 and 22 Oct 1964 [HRF].

Before the implications of the incremental approach could barely be digested, ADC was asked to comment on three alternative configurations involving PAGE and SAGE/BUIC. Alternative I called for 10 PAGE combined NCC/direction center sites, 19 PAGE NCC's and two SAGE direction centers. The second alternative retained 12 SAGE direction centers and added 19 BUIC III (a new name for the equipment based on the PAGE computer) NCC's. Alternative III involved the same 12 SAGE direction centers, 10 BUIC II and 14 BUIC III NCC's.[78]

While ADC reiterated its preference for the more extensive PAGE configuration, the OSD decision on Improved BUIC, rendered 17 November 1964 and expanded in early December, generally followed Alternative II. Only 14 BUIC II sites were to be installed, the directive said, filling the SAGE back-up requirement during Fiscal Years 1966 and 1967. BUIC II would be replaced by 19 BUIC III installations. The first BUIC III site was expected to be operational by 1 July 1967, with the 19th to be ready by November 1968. BUIC III was expected to back-up SAGE during Fiscal Years 1968 and 1969 and was to use the earlier BUIC II

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78. Program Information Center Briefing on BUIC III, 25 Nov 1964 [HRF].

equipment. Twelve SAGE direction centers were to be retained, while the direction centers at Los Angeles and Reno were to close by the end of Fiscal 1966 and the New York and Chicago direction centers were to go at the end of Fiscal 1968. Also, the SAGE combat centers at Truax (30th Air Division) and McChord (25th Air Division) were to cease operations at the end of Fiscal 1966. The DOD directive explained that SAGE was to be considered the primary ground environment, at least through Fiscal 1969, with BUIC II and III filling the back-up role. DOD had decided that the SAGE/BUIC II/BUIC III plan offered roughly the same effectiveness and operational capability as PAGE, but at considerably less cost.[79]

In a companion announcement, the Secretary of Defense directed that 16 additional long-range radars be decommissioned in Fiscal Years 1965, 1966 and 1967. Six were to be lost in Fiscal 1965. By the end of 1964, ADC had designated these six -- Z-150 (Cottonwood, Idaho), Z-13 (Brunswick, Maine),

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79. Weekly Activity Report, ADC, ADLPC, 24 Nov 1964 [HRF]; Hist of NORAD, Jul-Dec 1964, pp. 25-26; Msg AFSPDEM 97470, USAF to AFSC, 11 Dec 1964 [DOC 67].

Z-24 (Cutbank, Montana), Z-55 (Manassas, Virginia), Z-67 (Custer, Michigan) and Z-177 (Dickinson, North Dakota).[80]

Sites and operational priority for the 14 BUIC II and 19 BUIC III locations had been determined by early December 1964.[81] These were as follows:

<u>BUIC II</u>

1. Z-10 (North Truro, Mass)
2. Z-198 (Tyndall AFB, Fla)
3. Z-54 (Palermo, NJ)
4. Z-16 (Calumet, Mich)
5. Z-61 (Port Austin, Mich)
6. Z-56 (Cape Charles, Va)
7. Z-65 (Charleston, Me)
8. Z-27 (Fortuna, ND)
9. Z-180 (Keno, Ore)
10. Z-46 (Blaine, Wash)
11. Z-76
12. Z-69 (Finland, Minn)
13. Z-25
14. Z-40 (Othello, Wash)

<u>BUIC III</u>

1. Z-50 (Saratoga Springs, NY)
2. Z-198
3. Z-115 (Fort Fisher, NC)
4. C-8 (Senneterre, Quebec)
5. Z-76 (Mt. Laguna, Calif)
6. C-5 (St.Margarets, NB)
7. C-153 (Kamloops, BC)
8. Z-25 (Havre, Mont)
9. Z-132 (Baudette, Minn)
10. Z-180
11. Z-61
12. Z-81 (Waverly, Ia)
13. Z-10
14. Z-56
15. Z-16
16. Z-27
17. Z-40
18. Z-69
19. Z-65

Because of the reduced scope of BUIC II, it was hoped, in December 1964, that the date when the complete system would be operational could be brought forward to 31 March 1966.

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80. Weekly Activity Reports, ADC, ADLPC, 19 Nov and 22 Dec 1964 [HRF].

81. NOFORN EX CANADA, Msg ADLPC 3850, ADC to ADC CCDSO (Hanscom), 4 Dec 1964 [DOC 68].

The first BUIC II site at North Truro was still expected to become operational 1 September 1965.[82]

The December listing of sites and priorities for BUIC II and III did not remain in effect very long. By January 1965, ADC was requesting that a 20th BUIC III be authorized at Z-156 (Fallon, Nevada) to replace the deactivating SAGE direction center at Reno. Still later, it was necessary to change the schedule in order to place Z-46 and Z-54 on the BUIC III list. Then doubts emerged concerning Canadian participation in BUIC III. In March 1965, USAF informed ADC that it might be several months before the Canadian Minister of Defence made a decision on RCAF participation. In this situation, USAF recommended that ADC prepare BUIC III contingency plans making allowance for (1) the deletion of C-153 and limiting Canadian participation to two sites and (2) deletion of all Canadian sites.[83]

The PAGE proposal of mid-1964 also suggested replacement of the AN/FST-2 video processor used by SAGE with a solid state model (AN/FYQ-40, Transmitting Set, Coordinate

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82. Msg AD4SY-Z 60070, CCDSO to ADC, 14 Dec 1964 [DOC 69].

83. Msg AFSPDEM 91923, USAF to ADC, 6 Mar 1965 [DOC 70]; Weekly Activity Reports, ADC, ADLPC, 19 Jan and 11 Mar 1965 [HRF].

Data, but better known as the Common Digitizer) at various sites in the common DOD/FAA radar network. This suggestion was approved by DOD and, in April 1965, DOD representatives met with those from USAF and FAA to work out an acceptable configuration for the Common Digitizer. An approved list of 82 joint-use radars had also been decided upon by that time. By late May it had further been determined that the first three sites to receive the Common Digitizer would be located in the southeastern United States -- Z-113 (North Charleston, South Carolina), Z-114 (Jacksonville NAS, Florida) and Z-198 (Tyndall AFB, Florida).[84]

Since it had been decided at levels of authority above ADC in late 1963 that development of an airborne warning and control system (AWACS) should be directed to achievement of operational capability some time after 1970, emphasis was concentrated on one essential AWACS sub-system -- overland radar. Of the $9 million available for AWACS development in Fiscal 1965, one million was to be spent by the Navy for further study of the APS-96. The other $8 million was to be released following a six-month study of the various overland radar techniques proposed.[85]

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84. Weekly Activity Reports, ADC, ADLPC, 26 Apr and 21 May 1965 [HRF].

85. Ibid., 21 Apr and 5 May 1964 [HRF].

Although the idea of a near-term AWACS had been largely squelched in late 1963, the concept was revived in early 1965 when Dr. Fubini of DDR&E asked AFSC if such a system might not be devised from readily available components. The Aeronautical Systems Division of AFSC replied in the affirmative in late January 1965 and outlined the actions necessary to achieve such capability. It would be necessary to define system characteristics by 15 February 1965, secure TAC/ADC coordination on these characteristics by 23 February and prepare a Technical Development Plan by 30 June 1965. Also, beginning in April 1965, it would be imperative that studies be conducted to determine the most suitable aircraft; the compatibility of airframe, radar and non-radar equipment; and the relationship between near-term AWACS and other TAC/ADC command and control systems.[86]

The Department of Defense subsequently approved two development programs expected to lead in the direction of a near-term AWACS. One involved the airframe. Three contractors (Douglas, Lockheed and Boeing) were awarded $250,000 study contracts to determine what sort of AWACS

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86. Ibid., 8 Jan 1965 and C&E 22-28 Jan 1965 [HRF].

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airframe could be developed from existing cargo jets. DOD had such aircraft as the DC-8F, 707 and C-141 in mind. It was anticipated that two AWACS prototypes would be available by the end of 1969, thus making the near-term AWACS not nearly as "near-term" as once thought. The second program in the AWACS area dealt with overland radar. Although there was still a wide difference of opinion among technical experts as to the feasibility of overland radar, it was proposed that the Systems Evaluation Group furnish a test aircraft in which contending manufacturers could demonstrate their radar clutter rejection techniques. One of the techniques to be so tested was the Coherent on Receive Doppler System (CORDS) offered by the Hughes Aircraft Company.[87]

Command and control of the air defense system as of the middle of 1965, was exercised by SAGE, supported by the manual BUIC I network. By 1 April 1966 it was anticipated that BUIC I would be replaced by the semi-automatic BUIC II, operational at 13 locations. BUIC II would accept data from all radars in southern Canada, provide coverage

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87. Ibid., C&E, 10 May 1965 and ADLPC, 13 May and 1 Jun 1965 [HRF]; Aviation Daily, 29 Jun and 30 Jun 1965.

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to a depth of about 300 miles along the west coast, about 300 miles south along the northern border of the United States and to the same depth along the east coast to approximately Jacksonville, Florida. By May 1969 it was hoped BUIC III, offering about twice the capacity of BUIC II, would be in operation at 20 sites, covering the same area, plus the Florida and the Gulf coasts as far west as New Orleans. Beginning in Fiscal 1967, the SAGE/BUIC II/III ground environment would be controlled by four numbered Air Forces (First, Fourth, Tenth and Fourteenth) reporting to ADC headquarters and the NORAD Cheyenne Mountain Combat Operations Center. AWACS was somewhat further in the future. While not programmed at mid-1965, ADC was of the opinion that if a satisfactory AWACS prototype airframe could be produced by 1969, an AWAC fleet might be operational by 1972.[88]

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88. Msg ADLPC 1637, ADC to ADC Special Weapons Office (Kirtland), 12 May 1965 [DOC 71].

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