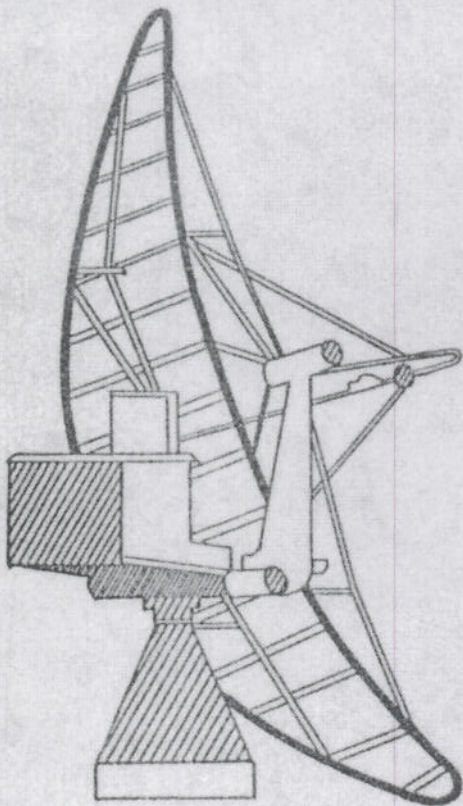


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HISTORY

Rome Air Development Center
Air Research & Development Command
United States Air Force



Griffiss Air Force Base,
New York

PROJECT CORONA HARVEY

DO NOT DESTROY

0000632

1 July 1957
31 December 1957

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[REDACTED]

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(UNCLASSIFIED)

HISTORY

OF

ROBE AIR DEVELOPMENT CENTER

GRIFFISS AIR FORCE BASE

NEW YORK

1 July

31 December

1957.

VOLUME I

NARRATIVE

Approved by:

Prepared by:



D. F. GAULT
Brigadier General, USAF
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AIR RESEARCH AND DEVELOPMENT COMMAND
United States Air Force

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C8-34630


Forward

The Center history makes no attempt to trace the progress of all of the hundreds of projects or activities of each of the offices at Rome. Rather it strives to present broad topics of general significance to the Center whether in the field of administration or in the more technical areas. Where ever possible, the historian has endeavored to focus attention on the fact that the project and system work of the Center is a function of many individuals and many groups working together as a team. Not infrequently it arises that even those persons directly engaged on a particular project are not fully aware of the efforts that other groups are contributing nor are they always entirely clear as to where the project fits into the general picture of the Center research and development program. It is hoped that the Center history may serve to set in better perspective the general research and development activity of the Center.

In order to bring the RADC historical program up to date, the present history has been prepared concurrently with the preceding volume which covers the period 1 January 1957 - 30 June 1957. The chronological limits for the two histories have consequently been interpreted liberally. Although both histories respect the strict chronological limits for topics which are discussed in both, other chapters draw rather freely on events which occurred throughout 1957. In the former category are the chapters on Center management and Missile Defense. In the latter category are all the other chapters which, it will be noticed, treat topics that do not repeat in the two histories. Thus the chapter in the January-June History on the "Scientist at RADC" will include materials from the rest of 1957 too. While the chapter on the "DEW Line" in the July-December 1957 History will provide background activity from the earlier period. Since these chapters are in the nature of special studies, it is believed that this treatment will, under the circumstances, give a better grasp of the topics and provide a fuller coverage than otherwise possible.

Copies of the RADC semiannual histories are forwarded to Headquarters of the Air Research and Development Command and to Air University along with the accompanying volumes of supporting documents. Inside the Center, distribution is made to staff and directorate heads for their reference.

The historian would like to express his appreciation to the members of the staff at all echelons of authority in the Center for their patient and invaluable willingness to discuss the operations of their offices and clarify points of uncertainty. Although it would be impractical to mention all those who have aided in the preparation of this history, the historian would like to single out Lt. George F. Alexander, the Information Services Officer at RADC for his never failing cooperation and Mrs. Betty Bulcko for her editorial skill and her dexterity in typing the manuscript for publication.


PHILIP A. KNACHEL
Center Historian

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CHRONOLOGY

- 23 January 1950 - Air Research and Development Command established
- 26 September 1950 - President Truman signed bill authorizing move of Watson Laboratories to Rome, N.Y.
- 11 February 1951 - Transfer of Watson Laboratories to Rome, N.Y. completed
- 2 April 1951 - Griffiss Air Force Base shifted from jurisdiction of AMC to ARDC
- 1 June 1951 - Rome Air Development Center designated
- 1 July 1951 - Griffiss Air Force Base transferred back to jurisdiction of AMC
- 1 July 1956 - Directorate of Communications activated
- 1 July 1957 - Colonel Daniel B. White relieved Major General Stuart P. Wright of command of RADC
- 15 July 1957 - Captain Henry F. Spinney becomes commander of Headquarters Squadron Section
- 1 August 1957 - Brigadier General D.F. Graul assumed command of RADC
- 1 August 1957 - Colonel Daniel B. White becomes Deputy Commander of RADC
- 16 August 1957 - Lt. Colonel Harry W. Coggeshall becomes DCS/Comptroller
- 25 September 1957 - 2nd Lt. George F. Alexander becomes Information Services Officer

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- 22-24 October 1957 - Electronic Countermeasures Symposium
- 30 October 1957 - Joint Agreement Letter drafted by commanders of RADG & AFCRG
- 6-7 November 1957 - Aeronautical Communications Symposium
- 13 November 1957 - Visit of Lt. General Samuel Anderson, Commander of ARDC to Center
- 16 November 1957 - Mr. Warren Dunn becomes acting Director of Intelligence and Electronic Warfare

CHAPTER I

CHAPTER MISSION & PERSONNEL CHANGES

Mission

A perennial problem of the Air Research and Development Command has been the parcelling out of responsibilities among the Centers without creating areas of overlap, either of mission or of projects. This has been particularly troublesome in the domain of electronics in which ARDC maintains three Centers charged with various phases of the Air Force electronic research and development effort. Through the years, two of the Centers, Rome Air Development Center and the Cambridge Research Center, have come under unusually close scrutiny in this regard.

Prior to the transfer of Watson Laboratories at Redbank, New Jersey to Rome in 1950-1951, it had been planned at one time to include the research laboratories at Cambridge, Massachusetts in a consolidation of Air Force electronic activity. At the last moment, however, the Cambridge transfer was quashed and the Watson group moved into Rome unaccompanied by their colleagues from Cambridge.

The picture at that point did not appear too complex. Rome concerned itself with research and development of ground electronic equipment and systems while Cambridge concentrated on basic and applied research. Wright Air Development Center, the third point of the electronics triangle, assumed responsibility for airborne equipments and systems. But then in June of 1952 the Cambridge mission was expanded to include not only research but development and test. Talk of a Rome-Cambridge duplication began to revive sharply. By 1953 both Centers were at work on tasks associated with air defense ground environment systems, tactical air control systems and data links.² Confusion mounted and the storm clouds of a new crisis in the relationship of the two Centers had gathered by 1954 when on July 1st of that year Rome was converted into a tenant organization at the Griffiss Air Force Base. A plan to carry the reorganization a step further and subordinate RADC to Cambridge was on the verge of execution. Although it was not intended that RADC be physically moved to Cambridge, it was proposed that RADC be placed under Cambridge supervision instead of reporting directly to Headquarters of the Air Research and Development Command. This would have spelled the end of RADC as an independent Center. Before the change could be effected this proposal, too, was countermanded.³

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But though both Cambridge and Rome had weathered successive attempts to merge their activities, an ultimate solution to the basic problem of overlap was still to be found. Revised mission statements governing the two Centers did nothing to lessen the fear. Understandably enough, Center leaders were as anxious as those at higher command levels to eliminate the confusion, whether real or apparent. At a meeting 17 April 1957 between the Commanders and Technical Directors of the two Centers, this question came under discussion. The two commanders, Major General William S. Morgan of Cambridge and Major General Stuart Wright then heading RADC, determined upon a fresh study to identify any undesirable duplication in the technical programs of the two Centers. A three man committee was created, composed of Mr. Irving Mirman, Associate Director of Research and Development at RADC, Mr. Robert W. Barrett, Deputy Director, Electronics Research Directorate, Cambridge and Dr. Alan Gerlach of the Geophysics Research Directorate, Cambridge.⁴

For eight weeks in May and June 1957 the committee subjected the programs of the two Centers to the most searching examination,⁵ but even as the committee was formulating its final conclusions and recommendations, several important changes of command took place. At the local level Brigadier General D. J. Graul assumed command of RADC in replacement

of General Wright, 1 August 1957, while General Anderson similarly relieved General Power as commander of the Air Research and Development Command. In spite of these shifts in authority, the work of the committee continued uninterrupted to its proper conclusion. On August 13, 1957, members of the staff of the Commander ARDC attended a verbal briefing on the findings of the committee. A written summation was assembled later.⁶

The committee discovered no significant technical overlap between the two Centers which it could not resolve. In areas where overlap was identified, mutual agreements were arrived at for the transfer of the work to one or the other of the two Centers. As a result, the build-up of a High Power Test Facility at Cambridge was eliminated and the equipment transferred to RADC. A similar transfer of responsibility for the development of the "Identify a Friend or Foe" program to RADC was arranged. And it was further understood that the Electronics Research Directorate of Cambridge and RADC together would handle future Geophysics Research Directorate electronics requirements.⁷

The principal overlap was found to be an artificial one - a problem of semantics - in that the mission statements for the two Centers did not correctly define their actual capabilities

or existing work. This confusion of mission was noted in the areas of Communications, Air Traffic Control, Intelligence and Aircraft Control and Warning. And in some cases, it was observed, the missions were not properly implemented by directives from Headquarters AFDC. Committee members after establishing these and other facts of life, boldly advanced nineteen recommendations to help clarify the relationship of AFDC and Cambridge.⁸

There was no doubt, they felt, but that new mission statements were required - mission statements at once definitive and free of ambiguities. They were further convinced that, once published, the mission statements must demand conformity from all those concerned in research, technical development and systems. Although the committee was grappling at the moment with the relationship of Rome and Cambridge, it underscored the futility of trying to solve the whole problem if the Wright Air Development Center were not also brought under consideration. In short, Wright needed a new mission statement just as did the other two Centers.⁹

In principle the committee recommended that all Electronics Research and Technical Development work be the responsibility of Cambridge while all Electronics Operational Development, Systems Requirements and

Electronic Supporting Systems work - at the charge of
EMC. It emphasized that prime responsibility for these
functions should fall upon a specifically designated Center.
While the responsible Center could have a significant portion
of the program conducted at another Center, the task of
planning, coordinating and managing the program would be its
own.¹⁰

The Committee endorsed the organizational separation
of research from operational development, but it pointed out
that this simply intensifies the need for an adequate inter-
change of scientific information and personnel between the
Centers. Both Centers recognized this as a particularly
difficult management problem. Working level liaison and
coordination groups were clearly a must. Active work
groups for Antennas, Radomes, Tubes and System 219L already
in operation had demonstrated how desirable and indeed
necessary it was to have similar groups in other fields.¹¹

The Committee did not feel that a relocation of
facilities would be required and it did not envisage a
physical move during what was termed the Phase I period.

it did, however, recommend that no new work or new facilities be started beyond fiscal year 1958 that were not in harmony with the newly assigned mission statement. For long range planning, the committee suggested that in from five to seven years the center of gravity of electronic work be shifted to one Center.*

*Report, RADC-CRC Study, May-June 57. Compare the new and old mission statements of RADC as contained in the "Organization and Functions of the Rome Air Development Center."

A) The old - 1 Dec 56: a) To accomplish applied research, development and testing of electronic systems, ground electronic techniques, components and equipments in the functional area of detection, control identification, countermeasures, navigation, communications, data transmission, and radio intelligence collection and processing, as directed.

b) To perform applied research and development of ground based intelligence and reconnaissance systems and components. To perform system engineering on air-ground data transmission systems for intelligence and reconnaissance purposes. (Note: Research and development of aircraft and missile-borne equipments are the responsibility of the Wright Air Development Center.)

c) To establish and operate an ECM test facility to support all ARDC centers in accordance with existing instructions and to support other agencies as directed by Headquarters ARDC.

B) The new - 3 Jan 58: a) To accomplish operational development and test of electronic supporting systems, subsystems, components, and associated equipment, as directed; and provide related engineering and procurement data support to AEC. To conduct technical development as directly connected with and required to accomplish the operational development of mission. (Note: Development of aircraft and missile-borne equipments are specifically excluded.)

b) To provide and operate an electronic countermeasures (ECM) test facility to support ARDC centers and other government agencies in ECM and ECM vulnerability testing.

In an interesting side light to the Committee findings, Dr. Harry Davis, Scientific Director of RADC wrote 27 August 1957 in a Center Newsletter that the Committee had discovered the electronic effort at RADC to be "several times greater than that of AFRC and that we do the bulk of the electronic work for AFRC." Referring to the committee's recommendation that a single Air Force electronic Center should be established later, he noted, "While we would be the main Center under such a plan, it would not be necessary to move the Research Directorate here..." This is where the situation stood in early August.¹²

Meanwhile General Anderson, the new commander of the Air Research and Development Command, evinced interest of his own in the possibility of combining RADC and Cambridge and he directed the two Center Commanders, Generals Graul and Morgan, to work on the problem.¹³ There followed a period of more study and review of the findings of the three man committee. Finally an understanding by the two Center commanders was reached 30 October 1957 to send a Joint Agreement Letter to Headquarters AFRC outlining their common views on the subject. On November 9, 1957 the letter, over the signatures of General Graul and General Morgan, was on its way to Baltimore.¹⁴

Although members of General Anderson's Staff had been briefed on the earlier RMC-Cambridge committee report in August, an opportunity had not presented itself to bring the report to the personal attention of General Anderson. In their joint letter to him, the two Center Commanders based their own conclusions on the findings of the committee and extracted for this purpose the basic outline of the report with its bare salient recommendations. These followed closely the points already mentioned. No reference was made, though, to the committee's long range suggestion to shift the center of gravity ultimately to one Center.¹⁵

Indeed, the more responsible leaders of the two Centers wrestled with this nagging problem, the more firmly they rejected either the possibility of moving Cambridge to RMC or RMC to Cambridge. Instead both Centers chose to seek a modus vivendi, satisfactory to both yet free of overlap and confusion. The original committee report and the later Joint Agreement Letter had detailed various ways in which improvement could be achieved. Many of these required action by Headquarters AFPC. In the meantime it had been possible to brief General Anderson more fully on the situation at the time of his visit to RMC November 13, 1957.¹⁶

The Joint letter of the two Center Commanders received a careful review by appropriate members of General Anderson's staff at Baltimore. On January 17, 1958 the AFSC Commander sent to General Grant of RADC an outline of the actions already taken or underway by his headquarters. Most important, General Anderson disclosed that his staff endorsed the fundamental premise upon which Generals Grant and Morgan had based all their recommendations - the conclusion that "no significant technical overlap between the two Centers remains unresolved." Turning then to specifics, General Anderson's reply showed that some, though by no means all, of the recommendations forwarded to him by the commanders of RADC and Cambridge had been accepted at Headquarters.¹⁷

On the positive side, General Grant was informed that a new mission statement had been published for the Wright Air Development Center and that new mission statements had been written for RADC and Cambridge and would be published two weeks hence. According to word from Baltimore, the statements were definitive "and will clearly indicate where this Headquarters desires both the mission responsibility and the Center competence to reside." RADC was designated the primary Ground Electronic Development Center in the new mission statements.¹⁸

Baltimore agreed with the objection that the Centers should not undertake construction of new facilities or major reorganization unless in consonance with the intent of the new Center visions. It was added that such a policy is now in effect.

In addition to the existing working groups created for the interchange of information, Headquarters announced it was considering the establishment of an effective Working Group to cover the field of electronics generally. This group would coordinate the efforts of the individual area groups and would consider problems larger in scope than the responsibilities of the area groups.²⁰

In answer to the request for a clarification of the authority to be exercised by Centers assigned specific Center responsibility for I. B. s., Baltimore cited the RMC Manual 9C.4. In instances where responsible and supporting centers could not thrash out mutually agreeable solutions to problems arising from this work, the responsible Center was directed to bring the problem to Headquarters for resolution.²¹

On the negative side, however, Baltimore rejected the neat partition of effort recommended by RMC and Cantrige which would have apportioned Electronic Research and Technical

Development to Cambridge and Ground Operational Electronic Development to RADC. Headquarters preferred, it said, to assign work which was consistent with demonstrated Center competence and mission responsibility. This meant among other things that RADC will not be restricted from technical development in direct support of its mission or from the early phases of technical development outside the responsibility of Cambridge.²² Baltimore also rejected the assignment of prime responsibility to a specific Center of RDC's, TRD's and of systems since it believed that they embraced so wide an area and were of such complexity that their overall management should be the responsibility of Headquarters MRDC.²³

Nor did ARDC believe that when Research or Technical Development is required as part of a Weapon System or Supporting System, it should be assigned for management control to the Center having responsibility for that particular Research or Technical Development program. ARDC argued that frequently technical decisions are not the determining factors. Therefore Headquarters affirmed that while all technical recommendations from the laboratories will be taken into consideration, the systems office will study other factors as well in order to arrive at the best possible decision.²⁴

The details and certain essential points relative thereto are contained in the supporting documents in volume II of this history. Naturally, the effectiveness of these decisions reached at headquarters JRC cannot be assessed at this early date.

Key Personnel Changes

While the organizational structure of the Center remained with only slight modification as it had stood, some rather important personnel changes could be noted. On July 1, 1957 Colonel Daniel E. White, Deputy Commander of WADC, relieved Major General Stuart P. Triest of command of the Center.²⁵ A month later Colonel White relinquished command in turn to Brigadier General D. F. Graul on 1 August 1957 and returned to his assignment as Deputy Commander.²⁶ Mr. Harry Davis, the Scientific Director, continued in that function.

Several new faces could be observed on General Graul's staff by the end of 1957. Captain Henry P. Sperry relieved Major John Kiernan of his duties as commander of the Headquarters Squadron Section 15 July 1957²⁷ and Major Kiernan was similarly relieved of his extra duty as Information Services Officer on 25 September 1957 by 2nd Lt. George F. Alexander.²⁸ Direction of the Comptroller's Office was shifted when Colonel John F. Donlay left his post there as Deputy chief of staff and was

succeeded by Lt. Colonel Harry W. Coggeshall²⁹ 16 August 1957.
 Colonel Robert E. Bentley, the deputy chief of staff/Operations
 was replaced by Mr. William F. Bethke, acting deputy chief of
 staff/Operations.³⁰ Finally, Colonel James W. Anderson,
 Director of Intelligence and Electronic Warfare, was succeeded
 by Mr. Warren S. Dunn³¹ on 16 November 1957 was named
 Acting Director of Intelligence and Electronic Warfare.^{31*}

* Key Center Personnel as of 31 December 1957

Brigadier General E. F. Brack	Center Commander
Colonel Daniel E. White	Deputy Commander
Mr. Harry Davis	Scientific Director
Mr. James Dayman	Inspector General
Major John Kiernan	Adjutant
2nd Lt. George F. Alexander	Information Services Officer
Captain Henry F. Spawney	Commander, Hqs Squadron Section
Major Verle T. Hopkins	DCS/Personnel
Mr. William F. Bethke	Acting DCS/Operations
Lt. Colonel Leo E. Fielder	DCS/Material
Lt. Colonel Harry W. Coggeshall	DCS/Comptroller
Colonel Howard Burbank, Jr.	Director of Procurement
Colonel Otto Quasrud	Director of Control & Guidance
Mr. Warren S. Dunn	Acting Director of Intelligence & Electronic Warfare
Mr. Oliver Tallman	Director of Technical Services
Colonel Daniel A. Harvey	Director of Communications
Major Robert E. Barney	Director of Flight Test

REFERENCES

CONTENTS

1. Interview by the author with Mr. James Wayman, Inspector General, 16 Jan 58.
2. History of Air Force Cambridge Research Center, 1 Jan 55 - 30 Jun 55, p. 6.
3. Interview by the author with Mr. James Wayman, Inspector General, 16 Jan 58.
4. Ltr, Comdr. AFCEC and Comdr. RADC to Comdr. ARDC, subj: (U) Duplication in Electronics Research and Technical Development, 30 Oct 57.
5. Ibid.
6. Ibid.
7. Ltr, Comdr. AFCEC and Comdr. RADC to Comdr. ARDC, subj: (U) Duplication in Electronics Research and Technical Development, 30 Oct 57.
8. Report, RADC - CEC Study, May-June 57.
9. Report, RADC-CEC Study, May-June 57.
10. Ibid.
11. Ibid. See also Ltr, Comdr. AFCEC and Comdr. RADC to Comdr. ARDC, subj: (U) Duplication in Electronics Research and Technical Development, 30 Oct 57.
12. Technical Information Letter RADC, 15 Aug 57, p. 4.
13. Interview by the author with Mr. Irving Mirman, Associate Director of Research & Development, 16 Jan 58.

14. Ltr. E. W. Richardson Cdr. AFSC to Mr. Harry Davis, Scientific Director RAEC, subj: (U) Duplication in Electronic Research and Technical Development, 1 Nov 57, also ltr and by Lt. Mary Lewis to Comdr AFSC, 5 Nov 57.
15. Ltr. Comdr AFSC and Comdr RAEC to Comdr AFSC, subj: (U) Duplication in Electronic Research and Technical Development, 30 Oct 57.
16. Interview by the author with Mr. Irving Mirman, Associate Director of Research and Development R-10, 16 Jan 58.
17. Ltr. Comdr AFSC to Comdr R-10, subj: (U) Duplication in Electronic Research and Technical Development, 17 Jan 58.
18. Ibid. with incl. #1, pp. 1,3.
19. Ltr. Comdr AFSC to Comdr R-10, subj: (U) Duplication in Electronic Research and Technical Development, 17 Jan 58.
20. Ibid.
21. Ibid.
22. Ltr. Comdr AFSC to Comdr R-10, subj: (U) Duplication in Electronic Research and Technical Development, 17 Jan 58.
23. Ibid.
24. Ibid.
25. RAEC General Order #8, 27 Jun 57.
26. Ibid. #11, 1 Aug 57.
27. Ibid. #10, 24 Jul 57.
28. Ibid. #15, 1 Oct 57.
29. Ibid. #12, 24 Aug 57.
30. Ibid. #13.
31. RAEC General Order #16, 18 Nov 57.

CONCLUSION

Approved: W. B. Smith

Overseeing all research and development activities of the Army Air Development Center in the latter half of 1957 was the all important state of the Center budget. The quantity of research and development, the particular projects to be continued and initiated, even the manner in which the research was to be carried on, depended in the final analysis on how many dollars the Center could spend.

Prior to fiscal year 1956 the general trend of the Center had been one of expansion as it was called upon to accept additional responsibilities. Ideally it would be desirable to measure Center growth by the increase in research and development which this expansion had made possible and the increased capabilities which resulted for the United States Air Force. But since research and development often involve intangibles it is difficult to represent statistically, the picture can be shown only indirectly and rather inadequately by indicating

A decrease in Center obligations.

On July 1, 1954 the Research Development Center had a personnel total of 1102 compared with 1070 in 1953 and employees.⁴ Two years later that figure rose to 1411 and slipped back only slightly to 1397 by June 30, 1957.²

Obligation of R D C research and development funds followed a similar upward trend. During fiscal year 1954 obligations totaled \$12,155,000 and still rose sharply thereafter until a figure of \$34,730,000 was reached during fiscal year 1957.³

The rise in Center obligations is particularly significant because obligations of a given year did not mean the actual expenditure of that sum in the same year. Rather it meant that the Center had contracted contractual obligations for which bills or invoices might not be presented for payment by the contractor until a later time.⁵ Frequently contracts ran for at least eighteen months at the Center in which cases a sizeable proportion of the obligation might not be paid off until the following year or indeed even later. Clearly one fiscal year was closely related to another and heavy obligations in one implied correspondingly heavy expenditures the following year. Therefore, since the period prior to July 1, 1957 was one in which obligations had steadily increased, fiscal year 1958 could not escape the shadow of

bills that would inevitably follow.

The general trend, from, at least to July 1, 1957 can be described as one of expansion. The Center had grown internally and it had increased its outside obligations. Under normal circumstances it could be assumed that in fiscal year 1958 the Center would require a relatively large expenditure authorization to discharge previously incurred obligations and would also require a relatively large budget for the expanded program.

Adjustments to Expenditure Limitations

With the arrival of the new fiscal year 1958, however, the pattern was to alter abruptly. In rapid succession a series of expenditure ceilings were imposed upon the Center in August and September of 1957, each one lower than that which had preceded. Just prior to these limitations the office of the Controller had prepared estimates which looked to the spending of \$43,732,000 in R-600 research and development funds during fiscal 58.⁶ But at a conference held August 27, 1957 by Progress and Budget personnel of Headquarters, Air Research and Development Command, representatives from Rome learned that these estimates would have to be discarded.⁷ A follow up teletype from

Headquarters AEC dated August 13, 1957 set a limit of 39.4 million dollars of I-600 funds that could be expended by Rome during fiscal year 1958. This amounted to a ceiling of 19.7 million dollars for the first half of fiscal 58.⁸ Instructions which accompanied the ceiling limit set off in quick and continuing reaction, drastic adjustments of all kinds as the Center strove to pull anticipated expenditures down to the 19.7 million dollar limit.

For purposes of analysis the actions taken by the Center might be placed in two categories: actions to lower expenditures within the Center and actions to reduce expenditures on research and development contract work outside the Center.

In the first category, civilian payroll cuts at the Center figured high on the list. Even before, Rome had planned a gradual decrease in the number of assigned civilian personnel throughout fiscal year 1958 to level off at 1239 assigned positions by June 30, 1958.⁹ However, the teletype from Headquarters AEC of August 13, 1957 directed a five percent or more reduction in payroll expenses by 31 October 1957.¹⁰ Not only did the Center have to accelerate its planned reduction of personnel, but it had to shift emphasis from a decrease in the numbers of positions to a reduction in the actual payroll expenditure.

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... resulted decrease in expenditures of approximately \$750,000 for the first half of fiscal 58. Since 233 contracts were practically completed and awarded only final invoicing, this left but 237 active contracts compared to the 473 active 1,600 contracts of June 30, 1957.¹¹

These results had been achieved by use of suitably precautionary measures. The entire fiscal 58 program was wiped out with the exception of only four contracts for which no expense was to be spent before January 1, 1958. Many of the contracts awarded in June 1957 were cancelled and a large part of the fiscal 57 program also scrapped. In all, only 43 contracts at the Center escaped cancellation, reduction or straight-out.¹²

Predicted Impact of Expenditure Limitations on Center

It was generally agreed at Rome in October 1957 that the limit on expenditures would set back Center research and development at least eighteen to twenty-four months. This was true in part because of the reduction and outright termination of numerous projects previously undertaken. However, the inability to initiate important new research and development contracts in the months ahead was viewed with equal or even ~~more~~

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project via being of scientific leadership. The program requiring disbursement of funds could be undertaken in fiscal year 1958 and only an estimated 3-1/2 million dollars would be available for that purpose in the first half of fiscal year 1958. Focusing the avenues of research to improve the "state-of-the-art" work that is explored because there, other than those contracted to Federal contracts which had survived the cut-backs, were non-existent.³³ [REDACTED]

Overall Center efforts, the Center Commander indicated on October 4, 1957, would be reduced by fifty percent through loss of contractor services. Obviously the Center would have to reorient to an in-the-house approach to research and development. However, on October 4, 1957, the Center Commander stated that it would take about thirty days to sift out the effects of the contract terminations and stretch-out and produce a reoriented in-the-house oriented Center program.³⁴ [REDACTED]

The Center hoped to finish in-the-house approximately fifty percent of the PI contracts which had been cancelled. In general it expected to emphasize completion of those contracts whose goal was a hardware item. Although the Center planned to embark on a limited amount of effort type work, too, where the goal was not hardware, but a research

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study. It was feared that this area would suffer particularly.

In one case in the future orientation could meaningfully place even greater amount of responsibility on the Center itself. The assumption of projects previously carried on by private contractors would demand Center supplies and support to carry them through. However as mentioned above, the Center has at the present of reducing its available support. To meet the payroll requirements in stations and had previously trained the budgets of the various staffs and dis-terminated within the Center. This while possibly a greater in the house effort would seem to fall in a more response and material support, the budget in this case had actually demanded Center resources.

The reduction in force undertaken at the Center had repercussions over and beyond the simple elimination of 30 positions. It created a feeling of uncertainty among those who remained and an understandably poor reaction on employee morale. The reduction in force also set off a chain reaction of "jumping" throughout the Center as more senior employees affected by the reduction in force jumped their seniors who, in turn, then proceeded to jump their juniors. In each instance of an employee shifted to a new job, a certain amount of retraining

for the responsibility to inevitable expenses by a loss of time as well as an valuable experience to the center.

Contractors to the center are naturally not affected by the economy measures, the case of university contractors is particularly delicate. In instances of outright cancellation of university contracts, the impact was such that graduate students and faculty of the university explored on work of this kind found themselves caught with the school year beginning a year ahead of time for such other personal arrangements. This produced an outright reaction in some of the institutions. Future work of this kind. In absence of a policy of deferred payment also brought forth unhappy comment since university budgets were ill designed to absorb the shock. Some universities were indicating a reluctance to accept Air Force contracts in the future.

Commercial contractors are affected in a variety of ways. Some small firms which had depended almost entirely on Air Force contracts, now faced with cancellations, would be forced to close their doors. Some larger contractors whose interests were more diversified were nevertheless displaying a desire to place greater emphasis on commercial work. The Air Force would consequently have a smaller pool of firms from which to draw for future contract work.

But the step which seemed to arouse the greatest resentment was the proposal to defer payment of bills. Ordinarily companies did not possess sufficient reserves of cash on hand to tide them over a period of any length. In the event of deferred payment, they would be obliged to turn to their normal sources of finance. This meant they would have to borrow money because of the government's action. Yet because of Armed Services Procurement Regulations, they could not obtain reimbursement from the government for their interest. Contractors were therefore of the opinion that in effect they were being asked by the government to lend it money until payments were resumed after January 1, 1958. As an alternative, some of the larger companies were threatening to pass along deferred payments to their own vendors or subcontractors. If the threat were put in execution, it would thus be small business, least able to roll with the punch, which would be hit hard. This again might force some of them out of business. Center leaders were understandably worried about the unfavorable reactions which these various actions had aroused.³⁹

It might be added that there was some questioning at the Center, too, of the ultimate economy of some of the recent cuts. Project cancellation could mean in some instances the total loss of funds which had already been invested in them.

Projects whose natural rhythm had been interrupted by stretch-out or cancelled projects which would be resumed at a later date might actually cost the Air Force more in the long run than would have originally been the case. It should be added as well that time is a precious commodity which should be figured in the overall cost. Even if all the previous Center programs should be suddenly reinstated, the original time schedules and target dates could not be restored.

Sputnik and After

During those months when Center leaders were most gravely disturbed about the setbacks in Center operations, the beep-beep of Russia's first satellite launched October 4, 1957 electrified the world. With the successful launching of a second even larger satellite a month later on November 3rd, the public clamor for economy had disappeared as by magic. Many who only a short time before could not comprehend the reason for spending billions of dollars on research and development now demanded to know why the United States seemed to have fallen behind the Soviet Union in the race for space. In concrete terms the awakened public interest took away much of the pressure which had attended Air Force research and development spending for fiscal '58. It did not, however, miraculously eliminate all economy measures. With these

letter, the leaders of AEC had still to contend,

Lt. Col. Harry W. Wagnon, Deputy Chief of Staff/Comptroller, succeeded in the course of a visit to Headquarters AEC in late October in obtaining authorization to push up the basic spending ceiling from 13.6 million dollars to approximately 14.1 million dollars for the first half of fiscal '58. This ceiling was raised further until it stood at 16.5 million dollars by the end of 1957.⁴⁰ As a matter of fact a change of terminology reflected the new mood. "Ceilings" were replaced by "targets" in correspondence and conversation of late 1957 and as the change of wording implies, the rigid limitation on spending was removed. While this did not mean the Center could blithely obligate funds for all sorts of new projects, it did mean that it could disburse funds with relative freedom for those obligations already on the books.⁴¹

The Center showed remarkable accuracy, however, in hitting its "targets" for the first half of fiscal '58. The Comptroller estimated that as of 31 December 1957 the Center had actually spent about 16.4 million dollars in P-500 research and development funds, slightly under the target figure of 16.5 million dollars. Of its authorized P-690 "overhead" expenses including salaries of Center personnel and similar items, it had actually

expended \$4,604,139 or an allowance \$11,333,400 for the entire fiscal year.⁴²

because SAIC was freed from its strait jacket of 13.6 million dollars, not all of the pessimistic predictions made in October came to pass. For example it was unnecessary by and large with the 16.5 spending "target" to ask contractors to accept deferral of payment in December as originally planned. This avoided a situation which, as previously mentioned, Center leaders had viewed with particular misgiving.⁴³

The number of active research and development I-600 contracts which had sunk to a low of 297 in October, had now bounced back to 326 in early January 1958 as the more important of the terminated contracts were reinstated.⁴⁴

While this was still well below the 473 active I-600 contracts of July 1, 1957, it was a decided improvement.⁴⁵

The problem of morale at the Center took a turn for the better, too, as a result of the new budget outlook. Promotion actions of deserving persons at the Center were unfrozen and some ninety-four civilians were promoted in November and December 1957. Hiring at the Center was unblocked and twenty-five civilians were taken into the Center during these same months. The Center, whose total civilian and military personnel ceiling was 1300, actually counted 1280 persons at work at the

[REDACTED]

Department's view of the situation.

Nevertheless, even though the earliest part of expenditures had not been of long duration and many of the October predictions did not as a consequence need to pass, there were still some delay, there certainly would be to the launch effort. Whether it would amount to the projected eighteen to twenty four months was impossible to determine for several reasons. However, in the first place, changes were being indicated and those made were largely when it finally appeared in the program of late October. It also must be pointed out that the launch was preparing itself to launch and for an expected reservation to "space." This would undoubtedly have meant a res and resignation of other activities. It also had to be noted that in precisely the same direction in 1954 it was in 1957, the problem of evaluating overall delay for the program became clearly hypothetical.

[REDACTED]

But if an estimate of overall delay was no longer feasible, it was equally clear that designs were unworkable in certain projects. It could not be forgotten that even the \$1.5 billion dollar target was still considerably below the first ceiling of \$2.5 billion dollars set August 11, 1957 and still further below the estimates which had been originally prepared as necessary for the

[REDACTED]

Fulfillment of obligations

Of the thirty one contracts which had been killed in the economy section, twenty six were to have been largely paid and would not be restated.⁴⁸ For contracts cancelled and then restated there were delays equal at least to the period of cancellation and in many cases delay beyond that as contractors sought to rehire or find replacements for needed personnel and get up a full need of stock again for the interrupted project. And as predicted, the cancelled contracts except those which will in some instances have only dollars out of the taxpayer's pocket when, which have been the case of cancellations that never been touched in the first place.⁴⁹

It is true that when you begin to begin the project projects for fiscal 1968, the projects whose virtual elimination probably had caused some deep concern at the Center. Although they were being approved, there was not time following the necessary steps of the procedure to let any appreciable number of these contracts by the end of 1967. The delay caused by the procurement cycle was started so late, and the time was so intransigent to the budget policies imposed on the Center in early fiscal 1968.⁵⁰

Faint, illegible text covering the majority of the page, possibly bleed-through from the reverse side.

This was accomplished in part by eliminating some established positions and by ordering the withdrawal of all unestablished positions and cancellation of positions vacated while promotion in force procedures were underway. To facilitate the reduction in force, all promotion actions were frozen until 30 September 1957 with position actions at GS-12 and below to continue frozen until October 31, 1957.¹¹ Later an order was issued, however, freezing all position actions until further notice. These measures had succeeded in eliminating thirty nine class set and fourteen wage board positions for a total of fifty-three positions.¹²

For those who remained, strict controls on overtime were included in a Financial Plan drawn up for each staff agency on a monthly basis.¹³ An exact cost record was also opened for each civilian employee with an itemized breakdown including wage pay, social security, civil service retirement and Federal employees group life insurance.¹⁴

Travel funds were severely limited for each staff agency and a strict control assured by requiring a review of all travel requests for essentiality by the staff agency concerned. In this connection too, the Accounting Division was directed to make a recording of estimated travel costs at the time of issuance of a request for travel.¹⁵

The requisition in supplies in support of the various staff agencies was restricted in the first instance to a first quarter ceiling of \$300,000 and was subjected, additionally to minute scrutiny by assistance upon a system of triple review. The staff agency in question had to pass on the essentiality of the item, and the request had then to be reviewed by the DCS/Material for inventory availability, and by the FSS/Controller for fund availability.¹⁶

The Center strove to do more, however, than guarantee that each dollar spent was applied to greatest advantage. A determined effort was made to realize economies even beyond those planned for by operating less than the allowable maximum. An example of this could be found in the Directorate of Flight Test and Instrumentation. The Directorate was allotted \$500,000 for the flight test program in fiscal year 1956. This figure was not too much lower than the amount actually spent for this purpose the previous year, by avoiding excessive use of the more expensive to operate aircraft such as the B-47 and by insuring that only the most essential flights were authorized. It was hoped that the flight test requirements of the Center would be adequately served without need to expend the entire sum. Whether successful or not, certainly all possible economy was extended to accomplish this.¹⁷

Perhaps the greatest difficulty today, as expressed
in the cut back of expenditures for defense contractors engaged
in research and development projects for the Center, as
previously explained, the Center inherited in fiscal year
1955 a large backlog of obligations dating from past years.
The Center now finds itself squeezed on the one hand by large
anticipated expenditures and on the other hand by the ceiling
on such expenditures.

Under the present instructions in a teletype the
headquarters, HQ, August 11, 1957, Headquarters to initiate
three types of contract action: 1) new contracts to be
re-estimated; 2) old contracts to be "terminated" so that bills
originally anticipated for fiscal 58 would not be received
until later; 3) effect type contracts not involving hardware
development and to be reduced in cost by five percent or
more.¹⁸ This would naturally require a survey of the
contracts held by the Center to determine what actions if
any were appropriate for each contract. Since there are
and 57 I-FCG contracts listed on the Center's books
July 1, 1957, the magnitude of this operation can be appreciated.¹⁹

Thoroughly well organized administrative machinery for
processing the contracts and following expenditures afterward
was a first order of business. On August 11, 1957 the Directorate

of program included a detailed plan covering the various phases of the operation.⁷⁰

In the contract survey, the plan demanded an investigation to determine what costs had already been incurred under the contract, but which the government had not yet been asked to pay. These costs represented fixed charges which had already been incurred under the contract, but which the government had not yet been asked to pay. These costs represented fixed charges which had to be provided for in the allocation of funds. It was especially necessary for planning purposes to know what expenditures were contemplated in the future by the contractor. Fortunately the Economic Development Center had for approximately one year required of all its contractors a forecast of future expenses at the time of letting the contract. At monthly intervals thereafter the contractor was obliged to submit a record of his actual expenditures for the month. If the contractor observed within any reporting period that the original forecast of expense for the contract would have to be revised, he was required to submit a non-standard forecast of his expenses. This information, which made it for easier to anticipate actual disbursement of funds, had proved an

outstanding success and worth of our help at this point as various refinements were introduced to bring forecasted expenses closer together.²⁰

With this contract cost information available, the Center then proceeded to examine the contract in terms of its priority of importance. The JCS/Operations already maintained a Center priority listing of Center projects but for this operation a revised evaluation was undertaken. The estimate furnished pay off of the contract and the record of its past successes and failures was considered along with the policies in this regard of the Air Research and Development Command and the United States Air Force. Study of all of these factors then made it possible to arrive at a decision on contract action.²¹

Making a decision was only the first step. Complex controls had to be provided for to see to it that authorized spending was not exceeded. Charge orders were dispatched to all contractors informing them of their expenditure limits. It was made quite clear to the contractor that if he spent beyond the authorized amount, he would run the risk of not being reimbursed. Thus in the first instance it was to the contractor's own best interest not to exceed the limit. Since the contractor would continue to furnish monthly expenditure

reports and data as to forecast of appropriate, an additional element of land. Nevertheless a complex system of interlocking responsibility to various military agencies was defined, including specific duties of control assigned to the procuring contracting officer, the payment contracting officer, the accounting officer and the finance officer. In at a later time as regards to the contract allocation was authorized by proper authority, certification had to be reviewed nonetheless from the accounting officer that the funds were actually available.

The administrative machinery was purposely designed as flexible as possible to permit rapid adjustment to change of all kind. Center precedence lists were maintained on a current basis to note big change in the priority of contracts which might in turn cause a revision of expenditure allocation. The payment contracting officer and accounting officer were keeping records of expenditures and rates of expenditures and in the center the Center was receiving the monthly expenditure reports and revision of expenditure forecasts from contractors. The Center consequently had available to it up-to-date information which would permit quick adaptation to changes in technical priorities, to changes in contract expenditures as well as to changes in Center expenditure

authorization of the... for... authority.

The provision for fiscal 1957 was indeed...
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...dollars...
...September 26, 1957...
...dollars.⁸⁵
Needless to say, the...
...greatly added to the problem.

In spite of the economies which had been registered in these first... of effort, the Center found itself in early September faced with the prospect of a 3.9 million dollar deficit by 31 December 1957. So critical had the situation become that it appeared the Center would have no choice but to inform contractors that bills could not be honored after October 15, 1957 until the first of the year. Luck was particularly... at the adverse effect this would have on contractors if bills were the first or only

Center to assist in such a manner. General representatives
discussed this question in early September at Headquarters
AICG in the hope that the ceiling could be raised or some
other solution found. Headquarters personnel felt sympathetic
due to the matter, but they were unable to authorize an up-
ward revision of expenditure limitation. Representatives from
Base were told, though, that their Center's plight was by
no means unique and that other centers of the Com. and would
unavoidably be in the same economic boat at about the same
time. The command advised the Center to notify contractors
that their bills had been received, but that payment could
not be made until after January 1, 1958. If the contractor
was unwilling to accept deferred payment, the contract should
be terminated. Obviously called for too, were additional cuts
in expenditures, a need made more imperative by the new ceiling
of September 26, 1957.²⁶

The measures adopted by the Base Center during the months
of August and September resulted in a steady lowering of the
anticipated debt for the first half of fiscal year 1958 in spite
of the progressively lower ceilings. At the beginning of
September the anticipated debt had shrunk to 5.9 million
dollars and by the end of September it had diminished still
further to 3.9 million dollars as a result of further re-
ductions, stretch cuts and terminations.²⁷

It is difficult to see clearly the improvements that had been registered. For example, the total number of P-600 contracts listed on Center books as of September 30, 1957 was 621, somewhat more than the 579 P-600 contracts listed for July 1, 1957. On the basis of these figures alone, one might easily conclude that the Center had stepped up its contractual activity instead of diminishing it. The discrepancy results from the fact that contracts which have been completed or cancelled cannot necessarily be wiped off the Center books immediately. Questions of patent rights, legal points and especially the processing of the final voucher may prevent final disposition of the contract for up to six months and sometimes as much as two years. Thus insofar as numbers of contracts are concerned, the true picture is represented not by the total number of contracts shown on the Center books but by the number of active contracts. Using these latter figures it is revealed that on July 1, 1957 there were 473 active contracts and by September 30, 1957 only 315.²⁸

A similarly distorted picture would be gained if only the face value of the contracts is examined without supplementing it with figures of the unrevoked dollar balance. Thus the total face value of Center P-600 contracts as of July 1, 1957 was \$5.9

million dollars on September 30, 1957 had jumped to 100 million dollars - again an apparent increase of contractual activity. But as before the real story is told by the decline in unvoiced dollar balance from 78.6 million dollars on July 1, 1957 to 75.9 million dollars by September 30, 1957.²⁹

Yet even when the statistical confusion was cut away and the real improvements of Center position revealed, it was still not enough. Representatives of the Rome Air Development Center who attended another meeting at Headquarters AFPC in early October 1957 were told that under a new policy, the Center could not defer bills over thirty days. For the Rome Air Development Center this meant that the debt could not rise above 2.3 million dollars if this requirement were to be observed. Still more drastic cuts were, therefore, in order.³⁰

By 14 October the Center succeeded in reducing its anticipated deficit for the first half of fiscal year 1958 to 2.3 million dollars. By October 15, 1957 it had terminated 31 contracts at an estimated reduction of expenditures by \$1,841,000 for the first half of fiscal 58. It had cut fifty-two effort type contracts expenses from five to thirty percent for a reduction of \$347,000 for the first half of fiscal 58. Twelve other contracts were "stretched-out" with

Report of the DCS regarding the development
Eastern Department of Technical Education from 1 Jul 64
to 30 June 67, p. 5.

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11. Report of the DCS regarding the development
and control of the Eastern Department of Technical
Education from 1 Jul 64 to 30 June 67, p. 5.

12. Report of the DCS regarding the development
and control of the Eastern Department of Technical
Education from 1 Jul 64 to 30 June 67, p. 5.

13. Report of the DCS regarding the development
and control of the Eastern Department of Technical
Education from 1 Jul 64 to 30 June 67, p. 5.

14. Report of the DCS regarding the development
and control of the Eastern Department of Technical
Education from 1 Jul 64 to 30 June 67, p. 5.

15. Report of the DCS regarding the development
and control of the Eastern Department of Technical
Education from 1 Jul 64 to 30 June 67, p. 5.

16. Report of the DCS regarding the development
and control of the Eastern Department of Technical
Education from 1 Jul 64 to 30 June 67, p. 5.

17. Report of the DCS regarding the development
and control of the Eastern Department of Technical
Education from 1 Jul 64 to 30 June 67, p. 5.

18. Report of the DCS regarding the development
and control of the Eastern Department of Technical
Education from 1 Jul 64 to 30 June 67, p. 5.

19. Report of the DCS regarding the development
and control of the Eastern Department of Technical
Education from 1 Jul 64 to 30 June 67, p. 5.

20. Report of the DCS regarding the development
and control of the Eastern Department of Technical
Education from 1 Jul 64 to 30 June 67, p. 5.

21. Report of the DCS regarding the development
and control of the Eastern Department of Technical
Education from 1 Jul 64 to 30 June 67, p. 5.

22. Report of the DCS regarding the development
and control of the Eastern Department of Technical
Education from 1 Jul 64 to 30 June 67, p. 5.

13. DF, SAC to SAC, subj: FISC Expenditure Controls, 23 Aug 57, p. 1.
14. Interview by the author with Lt. Col. [REDACTED] DCS/Comptroller, 23 Oct 57.
15. DF, SAC to SAC, subj: FISC Expenditure Controls, 23 Aug 57, pp. 1-2.
16. Ibid.
17. Interview by the author with [REDACTED] Director of Flight Test and Instrumentation, 21 Oct 57. Also interview by the author with Maj. [REDACTED] SAC, 21 Oct 57.
18. Interview by the author with Col. Howard Burhanna, Director of Procurement, 21 Oct 57.
19. Msg. Comdr FISC to Comdr AIC, 22 Oct 57.
20. DF, SAC to all Staff/Directorate, 15 Aug 57.
21. Interview by the author with Col. Howard Burhanna, Director of Procurement, 21 Oct 57.
22. DF, SAC to all Staff/Directorate, 15 Aug 57.
23. Interview by the author with Lt. Col. [REDACTED] DCS/Comptroller, 23 Oct 57.
24. Msg. Comdr FISC to Comdr SAC, 5 Sept 57.
25. Msg. Comdr FISC to Comdr AIC, 20 Sept 57.
26. Interview by the author with [REDACTED] Associate Director of Research and Development, 24 Oct 57.
27. Ibid.
28. Ibid. See also msg. Comdr FISC to Comdr AIC, 22 Oct 57.
29. Msg. Comdr FISC to Comdr AIC, 22 Oct 57.
30. Interview by the author with Col. Howard Burhanna, Director of Procurement, 21 Oct 57.

31. Interview by the author with Lt. [REDACTED] Associate Director of Research and Development, 24 Oct 57. See also Lt. Comdr RABO to Comdr AEMC, 21 Oct 57.
32. Interview by the author with Lt. [REDACTED] Associate Director of Research and Development, 24 Oct 57.
33. Interview by the author with Lt. John Burgess and Col. Otto Quarrod, Technical Director and Director of the Directorate of Control and Guidance, 22 Oct 57. Also interview by the author with Lt. Irving Harman, Associate Director of Research and Development, 24 Oct 57.
34. Lt. Comdr RABO to Comdr AEMC, subj: (U) Preparation of Replies to 1957 Technical Requirements, 4 Oct 57.
35. Interview by the author with Lt. John Burgess and Col. Otto Quarrod, Technical Director and Director of Directorate of Control and Guidance, 22 Oct 57. Also interview by the author with Lt. Irving Harman, Associate Director of Research and Development, 24 Oct 57.
36. Interview by the author with [REDACTED] ECS/Materiel, 21 Oct 57.
37. Interview by the author with Lt. [REDACTED] Assistant ECS/Personnel, 21 Oct 57.
38. Interview by the author with Lt. John Burgess, Technical Director, Directorate of Control and Guidance, 22 Oct 57.
39. Interview by the author with Col. Howard Burhanna, Director of Procurement, 21 Oct 57 and also with Lt. Col. Harry W. Coggshead, ECS/Comptroller, 23 Oct 57.
40. Interview by the author with Lt. Col. [REDACTED], ECS/Comptroller, 8 Jan 58.
41. Interview by the author with Col. Howard Burhanna, Director of Procurement, 14 Jan 58.
42. Interview by the author with Lt. Col. [REDACTED], ECS/Comptroller, 8 Jan 58.
43. Interview by the author with Col. Howard Burhanna, Director of Procurement, 14 Jan 58.

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REPORT FOR THE BOARD

ALLEGED

The following information was obtained from a report dated 1944
concerning the activities of the Soviet Union, particularly
of the Party of Labor which were reported to have
been furnished to the United States. Professor Alexander had
always reported the activities of this party to the
State Department in connection with the report. The
of the Party of Labor in the United States is known to have
been the Party of Labor and was reported to be the
mainstay of the Party of Labor in the United States.
The Party of Labor is reported to be the mainstay of
the Party of Labor in the United States. [REDACTED]

A study report submitted by the President through the
National Security Council to the President in the
summer of 1944, which report which mentioned among other
things - the Party of Labor in the United States - the Party of
Labor (1944) - and the Party of Labor in the United States
and the Party of Labor in the United States. For more information please consult

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arrive over their targets in the United States, such a line could flash back a report of the penetration.¹ ■

A DEW line would clearly pose difficult problems of a technical and logistics nature, however. It would have to stretch 3,000 miles through some of the most rugged and inaccessible terrain in the world. Equipment and personnel would be subjected to extremes in cold, snow, ice and wind conditions. Aerial disturbances and other phenomena peculiar to the Arctic threatened to play havoc with some of the electronics equipment. This latter problem was grave because of its impact on communications in the region. A radar line incapable of sending back word of a penetration was obviously of no use to anyone. Yet ordinary Low Frequency radio communication was unreliable in the Arctic because of aerial disturbance. On the other hand the terrain was so difficult, that it would be impractical to lay and maintain wire connection or construct and maintain microwave relay stations at the line of sight distances they required. Fortunately, scatter radio techniques just being brought forward in that period appeared to make possible adequate communication support for a DEW line. Tropospheric scatter communication had proved successful in the NILE VAULT operation linking up Baffin Island and Newfoundland. Nevertheless there were still honest doubts on the part of some whether a DEW line could be successfully built and operated.² ■

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consequently were assigned to investigate and report
to construct a radar line with long range radar station
in the Point Barrow Alaska area in 1951 to test
feasibility. The project was assigned to Western Electric
Company because of their past experience in integration
work and in dealing with difficult terrain and climatic
conditions. After completion of the experimental Alaska
segment completed in November 1951 and after the completion
of area surveys of the Far North Headquarters USAF and the
Royal Canadian Air Force it was decided that the 1400 mile
DGN Line be started immediately. Mile's for the operation
were issued 7 September 1951. [REDACTED]

A prime contract was awarded to Western Electric to
engineer and install the DGN Line including the radar, its
radar and communications equipments. This was intended to
serve as a quick fix interim solution to provide an operational
radar force by July 1952. [REDACTED]

Western Electric, the prime contractor, later to call
signals for over 4,500 United States and Canadian suppliers
for the necessary equipments, relied on its own Bell Telephone
Laboratory for technical counsel. In a parallel move by
the Air Force, the Air Materiel Command which represented
the Air Force on the contractual and logistic phase of
the effort called in the Air Research and Development Command

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Administrative History

Because of the wide range of projects which the Agency could handle in this important area of specialists from appropriate fields of the Agency was identified to assist. To coordinate the team [REDACTED] from D.S. Operations was designated as "team captain" to which he remained until the summer of 1952. At that point it was determined to call Mr. [REDACTED] of the [REDACTED] Directorate already familiar with the [REDACTED] of the OSW team into the role of Coordinator following an SDC assistance to OSW. [REDACTED]

A small part of the [REDACTED] [REDACTED] later claim for having expedited the OSW [REDACTED] was due to the procedures by which the [REDACTED] was conducted in practice. This was particularly significant because OSW responsibilities were assigned to [REDACTED] in addition to their normal [REDACTED] [REDACTED] report was not only desirable, but absolutely essential. The Coordinator who represented the Center was also the OSW Project Officer in New York City, was authorized to coordinate directly with the members of his team regarding all [REDACTED] they happened to be in. He was in a position to brush aside the usual "through channels" requirements which in an operation of this kind could have proved to [REDACTED] [REDACTED]

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In fact, wide dispersal of responsibility for those administering the BEW project characterized the program from top to bottom. Members of the RADC team dealt directly, mostly on matters of technical impact with the contractor or sub-contractors. Frequently they reached informal or tacit agreements of a technical nature with the contractor, allowing "go-ahead" on production in absence of the more formal, continuing official confirmations which had to be traced through channels. This involved a certain amount of calculated risk on the part of the contractor and the Center, the risk of course would be confined to the progress of the project appeared to have no structure. This procedure worked out very well in practice. ■

Intensification of procedures to hasten production was thus the keynote for all concerned. Close cooperation by the RADC coordinator and a representative from the BEW Project Office with personnel of Bell Telephone Laboratories were reflected all along the line in frequent face-to-face meetings of both centers with the contractors for BEW. ¹⁰ ■

This is not to say, though, that Bell simply bypassed the BEW Project Office. Close cooperation was at all times maintained with this office and far reaching problems referred to it for resolution. The Center also turned to the office for ferreting out difficulties to locate parts so that production of various equipments could get on. Indeed, the

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Function and work of the DEM Project Office is a separate story of its own because of the scope of its overall coordinating activities. ■

Master Plan for DEM

One of the fundamental technical problems for the DEM line was not only the production of the "black boxes" and pieces of hardware to make it up, but, because of the complexity of the underpinning, the way in which the equipments were to be integrated into an efficient, workable system. DEM line along with the subsequent White Alice communication net in Alaska also under Rose's guidance, was one of the first attempts by the Air Force to rise above the development of isolated pieces of hardware and undertake systems engineering.¹¹ This too was an area where Rose could give valuable counsel although, of course, some of the planning had already been completed before Rose entered the scene. It should be added too, that in the great haste to start producing the equipments needed to make DEM operational by July 1957, systems planners had to run hard to keep ahead.¹² Conditions were, therefore, not ideal, but much was accomplished in spite of this. ■

From both an engineering and management point of view, it was considered necessary to divide the line into repeating segments of approximately 600 mile lengths. The coverage by means which was then limited to ■

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... systems and the development of further the list of needs ... the advantages of systems planning ... provision was made ... developed ...

AN/FP-19 Radar

Having agreed upon a system philosophy for DEW and ... which radar developed for DEW was the AN/FP-19. The ... would be needed ... subsequently ... into the picture ... IFF information. As later developed, the set could reach an altitude of ... availability and easy maintenance were ... employed in areas where aircraft were normally a rarity.

[REDACTED]

[REDACTED]

The AF was...
...operational...
...[REDACTED]

It was...
...[REDACTED]

[REDACTED]

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In addition to supervising the project for the Center, RADC also maintained a plant engineer at Raytheon to help expedite production. Subject to certain limitations, the field engineer could make on the spot decisions. Although the delivery schedule of the AN/FPS-19 was tightened several times during the course of the following month, Raytheon still succeeded in completing the set a month ahead of schedule in May of 1955. Production of the set with antenna system, components and carriage was completed in September 1955.

AN/FPS-21

To back up the AN/FPS-19, RADC went to work on the task of providing an omnidirectional radar. The Center in cooperation with Lincoln Laboratories and the Bell Telephone Laboratories prepared specifications for a CW Doppler radar for the AN/FPS-21, a highly efficient low-altitude set. Differing from the conventional pulsed-type searching radar, this radar was to have transmitter and receiver separated by

technical information were not to be designed into the set, although it was to provide an automatic alarm in case of penetration and indicate the general direction of the penetration. The radar was to operate efficiently down to

[REDACTED]

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General N. 58-1733

[REDACTED]

[REDACTED] important factors
to note that the failure of the [REDACTED] were particularly

Contract for the AN-25 [REDACTED] was not awarded until
November 1955 and the contractor, Kometala Inc, thus
had less than a year to complete the job. Since time
was of the essence, the [REDACTED] had to be taken.
In March of 1956 SAC, and Bell Telephone Laboratories gave an
informal first article acceptance to Kometala to permit
immediate production. While this was an unusual procedure,
it was considered virtually necessary to insure that the
rush delivery schedule of production units be met.
Kometala had previously set up a limited production line
having a calculated time that they would have to perform
in view of modification of manufacturing of the vehicle
units when official acceptance was finally obtained. This
would, of course, require flight testing and other detailed
interference, environmental tests and vibration tests before
the official acceptance would be conferred by RAC. The
vehicle paid off, however, and official acceptance followed
later with only minor adjustments necessary. Consequently
a number of airplanes were ready to leave for shipment by
sea in the summer of 1956 and the [REDACTED] were certified later.
Final production was completed October 1956.

[REDACTED] SECRET [REDACTED]

SECRET

Conditions in the Far East, and other peculiar
problems for the proper operation of systems in that environ-
ment, which had to be anticipated, anticipated, and anticipated
to any extent. It was discovered, for example, that if the
antenna of the AN/SPS-19 [REDACTED]

[REDACTED]

Both the AN/SPS-19 and AN/SPS-21 were found to be plagued

[REDACTED]

target indicator equipment for the radar, therefore, had
to be designed in such a way that they would not hit targets
such as [REDACTED]
the birds." (S)

Summary

DADS support of the [REDACTED] one-officer [REDACTED] [REDACTED]
workshop varied and particularly significant in the field
of tropospheric scatter. As previously pointed out, [REDACTED]
had already prepared specifications for military [REDACTED]
[REDACTED] scatter equipment which it was found could, with
only minor changes, be adapted to the purposes of the USN
Line. Bell Telephone took over these specifications to
under the name [REDACTED] [REDACTED] [REDACTED]

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Exchange techniques. The inter-divisional manufacturing, engineering, and design of the "troop" equipment went along smoothly. There was frequent interchange of Collins' technical personnel with their counterparts from Collins and from the Bell Telephone Laboratories. Along with day to day telephone consultations materially speeded up production. [REDACTED]

Some was called in for the development of equipment. The limited state of the art of transport weather had at least the virtue of narrowing down what could be done with the techniques and materials available. [REDACTED]

Structural Problems

The technical people involved were quick to point out their limitations in regard to engineering the air regarding structural problems. The STAFF 73 was a low speed aircraft. Because it was designed for maximum [REDACTED]

[REDACTED] conditions of the aircraft under accelerated conditions of the aircraft. In [REDACTED] the [REDACTED] by the Structural Engineering Section of RMC [REDACTED]. The various items by means of [REDACTED] the aircraft be stiffened with [REDACTED]. [REDACTED] present flexing of the aircraft. Recommendations also went out for structural [REDACTED] [REDACTED] as high as a six story building. The maximum speed was 150 miles per hour. [REDACTED]

~~SECRET~~

[REDACTED]

The section was made up of several types of strengthening treatments for the steel structure. Some type of treatment was applied to the steel, the weight of the steel, the weight of the structure, and the structure to which the treatment was applied. After that, RADI came up with several attractive proposals which could be adopted in the particular case of the steel structure. Refrigeration of the steel structure was considered a possibility to prevent corrosion. Insulation treatment might, however, prove more helpful in some places and in a third possibility the use of paint was suggested. The contractor recommended the use of three types of paint, reported that details of the project of anti-corrosion treatment had been completed.

[REDACTED]

RADI also conducted research with members of DEW recommending certain suspensions for a rigid radome. The EN-36000S for covering the Arctic. To accelerate the erection of the radome, three contractors, General Radio Products, Signal Standard and L. G. Strauss were assigned to specified sections of the radome which was fabricated together, made up the completed radome.

Contract No. 50-1734

[REDACTED]

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Part Eight

The above information relating to the types of power equipment specified for generating electricity at the JEM Line stations had been made known to SACD officials entering the project. Nevertheless the center was still in a position to give counsel of value. The proposed generators planned and being built for the proposed JEM stations, those on which the AFPS (Atomic Fuel Power System) were being operated at that time. In practice it was found that when the power equipment was running at peak cycles, [redacted]

[redacted]

of the early development equipment was being built, the first one out of the series, it was decided, was to be

[redacted]

Under SACD action in preparing specifications for Bell Telephone Laboratories for their power generators in late 1955 and early 1956. When Labco produced the equipment proved highly efficient and reliable. [redacted]

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[REDACTED]

Test Facilities

Would the electronics components being produced for GEW actually work properly when placed in the harsh environment of the Arctic? A rather important consideration, this, as everyone agreed, and another example of how RADC, this time through the Test Facility Lab being, was able to bring a hand to the GEW understanding. [REDACTED]

A report had come to Base in February 1945 from the Bell Telephone Laboratories for help in testing the antenna of the AN/SPS-19 radar under low temperature conditions. This antenna, measuring thirty eight feet across the face and not the sort of thing that could be casually slipped into the ordinary cold chamber, obviously. But since the large though lightly constructed antenna was delicate, it was particularly important to have adequate test data for it. [REDACTED]

RADC could not provide facilities at the Center for testing the antenna either. But though Test Facilities personnel at Base were accustomed to in-the-house work, they immediately started about to find a suitable facility. One was finally located at the Detroit Tank Arsenal in March 1945. When the antenna was ready to leave the contractor's plant in August 1945, RADC personnel were on hand to examine it. They were also present in Detroit

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When the aircraft arrived to correct the installation in the test chamber and make the necessary arrangements for testing. The tests carried out at this time were successfully completed a week and a half ahead of schedule.

Test Facilities Laboratory personnel, supplied with Collins Radio Company in the summer of 1955 about engineering suitability of so-called non-standard components for which Joint Army Navy (JAN) standards did not exist. Ross was able to show Bellini that the Air Force selected components or circuit elements did not meet. At first RADC attempted to test non-standard components for Center, but the proximity of the task and the lack of sufficient time made the task clearly impractical and it was later abandoned. Nevertheless, the contact given Collins Radio in this area was believed to have paid handsome dividends in the quality of non standard components later used.

Test Equipment

For purposes of day-to-day maintenance and for special testing purposes, the DEM Line electronic hardware naturally required adequate testing gear so that its behavior could be properly monitored. RADC in close cooperation with the Bell Telephone Laboratories determined what testing devices were suitable for these purposes. Over one hundred different test equipments to meet varied needs were selected. In instances

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[REDACTED]

where military and commercial testing equipment was readily available, the military equipment was, of course, leased, but in cases where military equipment could not be obtained or where RADC wanted use of commercial devices to save time, RADC effort here was one of helping Bell Telephone reach decisions acceptable to the Air Force and did not involve monitoring progress of the sub-contractors (after selected by Bell) or any other unrelated equipment. [REDACTED]

Engineering Laboratory

Perhaps a final remark will be made here as to the soundness of the rule applied by RADC in support of JEM. It appeared unobjectionable to the JEM hearing this month. This branch had the responsibility of assigning responsibilities to the JEM equipment to bring about as much standardization as possible for interchange and servicing. In collaboration with the JEM in test office, it was determined that equipment of a highly commercial nature could meet the military requirements and which would not be of a specially commercial type. The majority of equipment fell into this latter category. But here the JEM line posed some very special problems. Previous experience had been limited to designing pieces of hardware which, therefore, could be tested with similar but very specialized JEM equipment. The line equipment for example, equipment which

[REDACTED]

[REDACTED]

might have to be altered slightly depending on the special
experiences of a particular area. But the addition of the
above features to a design, for example, require an out-poly
different nomenclature. After wrestling with these and
similar problems, RADC decided instead to devise a special
variable nomenclature to cover variations of this kind,
retaining the basic nomenclature of equipments but also pro-
viding for variation in design. This was done to suit
The result was that for all equipment in the branch,
which had also been developed in the cooperation
and review of "NEW WEST" contractors and with making
type classification of "NEW" equipments to determine their
suitability for various Air Force uses, continued this
report activity for "NEW" and "NEW" [REDACTED]

Completion of 1957

By July 1957, less than a year and a half after RADC
joined the DSA program, the line had been built, installed and
was in operation in schedule. The line was expected to be
fully technically operational by AFSCM or Mr. [REDACTED] and had
already been turned over to the Maintenance and Operations
contractor. Meanwhile the decision was reached to extend
DSA line coverage further to the East and the West of the
originally established terminal points. The "Stretch-out"
or "NEW WEST" extension of the line to the West coast in

Contract No. 33-114

[REDACTED]

[REDACTED]

January 1957 to run from King Salmon, Alaska to Etah, at western terminus, was scheduled for full operation in April 1959. In actual fact, it was become operational by late 1958. At the other end of the Dew Line, an extension from Cape Dyer was planned to a point still to be determined precisely in Iceland. Named "DEW East", this extension was programmed for operation in the summer of 1960. Some unexpected delay developed in 1957 but it was hoped that "DEW EAST" importance to the newly created Ballistic Missile Early Warning System (BMEWS) would result in the original goal being attained after all. In any case there seemed no doubt but that "DEW EAST" would be operational by 1961 at the latest. RADC personnel continued to provide the same kind of technical support for these extensions of the DEW Line they had given to the original project.⁴⁰ [REDACTED]

Future Planning

But even as Rome and the other organizations concerned in the DEW program were coming within sight of their original goal - a DEW Line operational by July 1, 1957, - planning was already underway for modification of the line. Military capability obviously cannot remain static. A DEW Line able to meet an enemy challenge in 1957 could easily become obsolescent within a few years time unless altered to keep pace. It was this consideration which prompted the Air Force to let two important six month study contracts in early 1956.⁴¹

[REDACTED]

[REDACTED]

Document No. 08-1730

[REDACTED]

The Bell Telephone Laboratories and AT&T agreed that a
feasible program of research in the area of [REDACTED] was
not. They differed significantly in their estimates
of quantities of [REDACTED] which would be needed. RAND received
the assignment of analyzing the reports and they sub-
mitted their own report to Bell Telephone ASD. Work
of this assignment, coordinated by [REDACTED] was hosted
by [REDACTED] of the Directorate of Control and
Inspection. It was RAND's conclusion that the Bell Telephone
was maintaining the [REDACTED] [REDACTED] over all AT&T [REDACTED]

[REDACTED]

[REDACTED]

Requirements and would cost considerably less than the AN/SPS-19
procedures. [REDACTED]

According to the Bell conception, all AN/SPS-19 search
radars would be replaced by a new type radar called the
"Advanced Sentinel." The "Advanced Sentinel" was to be an
extensively modified version of the "Sentinel" radar (later
designated the AN/SPS-30) developed by Lincoln Laboratories
for the original DEW Line. The "Sentinel" AN/SPS-30
had not been used on the original DEW Line because production
could not be accomplished quickly enough. As modified, the
AN/SPS-30 would be only as [REDACTED]

[REDACTED] examining the Bell plan
more closely, it became apparent to my hosts at Rome that
the modified AN/SPS-30 could be fitted into the DEW Line in
such a way that only every other AN/SPS-19 would have to be
replaced by the AN/SPS-30 instead of all. This was a decided
advantage since it required procurement of only half as many
new search radars and allowed salvage of half of the AN/SPS-19
radars as spares for those which would remain in the Line at
Alternate Search sites. [REDACTED]

Bell also recommended development of a special "Assess-
ment Radar" at a cost of roughly seven million dollars to
be installed at each search radar site. Purpose of this
radar, a back up to the others, was threefold. It would

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[REDACTED]

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Although revision of the detection equipments held the center of the stage, it was also believed that communication support would have to be reworked. Improvements were envisaged for lateral communication in the DEW Line. Improvement in the rearward communication of POLE VAULT running from Eaffin Island to Newfoundland as well as more thorough integration of the DEW complex into the WHITE ALICE Alaskan communication system appeared to demand attention. Thus while Mr. [redacted] and his associates were studying the detection problem at the Rome Center, Mr. [redacted] DEW Line coordinator, and Mr. [redacted] Jr., Chief of the Operational Planning Branch of the Communication Directorate, analyzed communication deficiencies and prepared a series of recommended requirements. ⁴⁸ [redacted]

After a number of meetings of RADC personnel and Headquarters ARDC people beginning in March of 1957, an abbreviated system development plan for DEW - System 714 had been hammered out and sent forward to USAF for approval in August 1957. By early 1958 a formal System Development Directive had been received at RADC. However, it was anticipated at the Center that the newly consolidated Ballistic Missile Early Warning System - 774A would probably incorporate the communication changes into its own system. The recommendations, then, would probably be

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carried out but as a part of the Defense Department's Early Warning System rather than as a part of USM. The actual result would, of course, be the same either way. The entrance of the Ballistic Missile Early Warning System onto the scene simply reflected an attitude that the greater threat of the future would come from ballistic missiles instead of from manned bombers and the BMD Line had been designed to meet this threat. ■

Control No. 18-171

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NOTES

1. Interview by the author with Mr. [REDACTED] RONG,
6 Dec 57.
2. Interview by the author with Mr. [REDACTED]
RONG, 30 Jan 58.
3. Interview by the author with Mr. [REDACTED] RONG,
6 Dec 57.
4. Interview by the author with Mr. [REDACTED]
ROERSO, 29 Jan 58.
5. Interview by the author with Mr. [REDACTED]
6 Dec 57.
6. Interview by the author with Mr. [REDACTED]
6 Dec 57.
7. Interview by the author with Mr. [REDACTED]
27 Jan 58.
*Since a great number of persons at the Ross Center contri-
buted to the DEM project to a greater or lesser degree,
it would be impractical to list all. However on 7 Aug 57
Major General J. W. Sessums, Jr., Vice Commander of AFDC,
wrote letters of appreciation to certain individuals at the
Center who had made particularly significant contributions.
These individuals are: Mr. [REDACTED] DEM Line Coordinator
Mr. [REDACTED] Detection Systems
Mr. [REDACTED] Detection Equipment
Mr. [REDACTED] CW Detection Equipment
Mr. [REDACTED] Radar Equipment
Mr. [REDACTED] Test Equipment
Mr. [REDACTED] Equipment Nomenclature
Mr. [REDACTED] Terminal Equipment
Mr. [REDACTED] Structural Equipment
Mr. [REDACTED] DEM Line Coordinator
8. Interview by the author with Mr. [REDACTED] 6 Dec 57.
9. Ibid
10. Interview by the author with Mr. [REDACTED] ROWIO,
27 Jan 58.

11. Interview by the author with Mr. [REDACTED] 4 Jan 57.
12. Interview by the author with Mr. [REDACTED] ACUAT, 10 Jan 58.
13. Interview by the author with Mr. [REDACTED] RDUO, 6 Dec 57.
14. Interview by the author with Mr. [REDACTED] 6 Dec 57.
15. Interview by the author with Mr. [REDACTED] 27 Jan 58.
16. Technical Report RADC, sub. IV Supplement #1 to Ground Radar Sets, Systems and Related Components, Feb 57, pp. 25-31.
17. Interview by the author with Mr. [REDACTED] 27 Jan 58. Also written memo of Mr. [REDACTED] 11 Feb 58 in files of Center Historian.
18. Interview by the author with Mr. [REDACTED] RCRDM, 29 Jan 58.
19. Interview by the author with Mr. [REDACTED] RDUO, 6 Dec 57.
20. Interview by the author with Mr. [REDACTED] RCRDM, 27 Jan 58.
21. Technical Report RADC, sub. III Supplement #2 to Ground Radar Sets, Systems and Related Components, Feb. 57, pp. 28-31.
22. Interview by the author with Mr. [REDACTED] RSRDA, 27 Jan 58.
23. This
24. RADC Activity Report
25. Interview by the author with Mr. [REDACTED] 22 Jan 58.
26. Technical Report RADC, sub. IV Supplement #1 to Ground Radar Sets, Systems and Related Components, Feb 57, p. 43.

22. Interview by the author with Mr. ██████████
██████████, 27 Jan 58.
23. Interview by the author with Mr. ██████████
██████████, 30 Jan 58.
24. Ibid.
25. Interview by the author with Mr. ██████████
██████████, 30 Jan 58.
26. Ibid.
27. Interview by the author with Mr. ██████████ ██████████,
██████████, 30 Jan 58.
28. Interview by the author with Mr. ██████████ ██████████,
██████████, 30 Jan 58.
29. Interview by the author with Mr. ██████████ ██████████,
██████████, 30 Jan 58.
30. Interview by the author with Mr. ██████████ ██████████,
██████████, 30 Jan 58.
31. Ibid.
32. Interview by the author with Mr. ██████████ ██████████ and
Mr. ██████████ ██████████, 30 Jan 58.
33. Interview by the author with Mr. ██████████ ██████████,
██████████, 29 Jan 58.
34. Interview by the author with ██████████ ██████████,
██████████, 24 Jan 58.
35. Interview by the author with ██████████ ██████████ ██████████,
██████████, 24 Jan 58.
36. Interview by the author with ██████████ ██████████ ██████████,
██████████, 7 Feb 58.
37. Interview by the author with Mr. ██████████ ██████████,
██████████, 29 Jan 58.
38. Interview by the author with ██████████ ██████████ ██████████,
██████████, 7 Feb 58.
39. Ibid.
40. Interview by the author with ██████████ ██████████ ██████████,
██████████, 29 Jan 58.
41. Ibid. Also written comments of Mr. ██████████ ██████████ ██████████,
dated 11 Feb 58 in the files of Senior Historian.

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CHAPTER IV
Long Range Communication
Introduction

Extending the effective distance of radio communication was not one of many concerns which occupied those of the Communications Directorate at the Rome Air Development Center. Integrated communication systems, communication support for missile work and dozens of other special projects made important claims on time and effort. Nevertheless long range radio communication projects of various sorts enjoyed high priority. This chapter will attempt to pick out highlights of accomplishment in the research and development of equipments in this area during 1957 and will indicate broadly some of the advanced thinking being done at the Center of still more radical techniques to be explored for future application.

Single Sideband

One of the big areas of research and development in the Communications Directorate was a program to determine the best system of modulation under various conditions of operation.

In this connection the Center was testing single sideband suppressed carrier, synchronous detection, compatible single sideband and reduced carrier phase-locked single sideband equipments.

Single sideband was the long distance voice radio communication system for which Rose had prime responsibility. This was the system for which Collins Radio Company had contracted in the fall of 1955. A system intended to operate initially at distances of the order of 2,000 miles and eventually up to 7,000 miles. Toward the end of 1957 it appeared that single sideband had made progress such that it could be recommended for standard classification by the fall of 1958. This meant that all the single sideband equipment would have been fully tested and that it could be ordered into production. Already by early 1958 testable standard classification had been ordered for the emitters, transmitters, receivers and for the airborne ARC-19 single sideband unit. Thus these equipments were awaiting only final testing. Service testing was programmed for June 1958. Tests began in July 1957 which were to continue into the summer of 1958 had already satisfied the Center that single sideband suppressed carrier was tolerable for voice for any applications programmed within the Air Force in the foreseeable future. Climatic hot and cold tests of the single sideband amplifier and flight tests of the airborne set.

AN/ARC-28 had also given good results.

One of Rome's main concerns in 1957 had been to ready the sites for the single sideband test program. Three major ground sites had been planned; the Ava/Stockbridge, New York site, the Offutt Air Force Base site in Nebraska and the Thule site in Greenland. These plans were altered somewhat though to substitute for the Thule site a location at the Barksdale Air Force Base in Louisiana. Equipment originally earmarked for shipment to Thule was thus redirected to Barksdale instead. Because both the Offutt and Barksdale sites were also Strategic Air Command bases, directives were issued that the capabilities of these two single sideband sites should be increased and that they become operational as soon as possible. Contracts to accomplish this were about to be let in early 1958.

The Ava/Stockbridge site in New York, the particular concern of the Rome Center, had been scheduled for completion 1 November 1957. Unfortunately, however, the economy exercises of 1957 resulted in crippling fund cancellations. To ready the site, some personnel were obliged to work in temporary buildings at first without heat, and in general under distinctly adverse conditions. A directive arrived rather late in the game, too, requiring installation of microwave facilities between Ava and Stockbridge. At the close of 1957 these microwave facilities

[REDACTED]

were still not satisfactory. For this combination of reasons the Ava/Stockbridge single sideband site was not expected to be completed until May 1950 - amounting to a slippage of about seven months. Meanwhile Rome was arranging for single sideband sites which were expected to participate in the test plan drawn up jointly by the Air Research and Development Command and the Air Proving Ground Command.⁵

Long Arm and Quik Silver

Two other important long distance radio communication systems, Long Arm and Quik Silver, though the primary responsibilities of the Wright Air Development Center received the active support of RADC regarding their ground equipment requirements.⁶ [REDACTED]

Both Long Arm and Quik Silver differed from the RADC Single Sideband System in that they were designed for transmission of binary information, such as teletype, whereas Single Sideband was to accommodate voice transmission. This difference reflected the difficulty of arriving at a basic communication system satisfactory for all purposes. Operations people in the Air Force frankly favored voice transmission because of its psychological advantages. Pilot and ground operator could communicate by voice in a more personal, humanly satisfying way. This advantage was particularly desirable in pilot training exercises. On the other hand the binary systems

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such as Long Arm and Quick Silver could boast of greater efficiency through narrower band width requirements and they offered a better chance that the transmission would get through to its destination. As high speed teletypes are perfected, binary systems will also offer higher transmission speeds than possible by voice. ~~_____~~

Because both voice and binary communication systems had advantages and disadvantages peculiar to their nature, the Air Force had resolved to proceed with the development of both. This decision engendered at the outset a somewhat negative competition between the proponents of voice and binary transmission and led to a certain amount of rivalry among the Centers responsible for them. As late as mid 1956 those working on these programs at Rome expressed hope for a redirection of effort "toward a mutual and unbiased search for the best long range communication system" and that... "the operational requirements should be the directing factor, not the various individual systems themselves." As mentioned in the 1956 RADC History, efforts to merge all these programs had failed. Nevertheless attempts to bring about maximum compatibility of all the systems were yielding concrete results as will be seen. ⁸ ~~_____~~

Long Arm, initiated approximately 1954, was intended as a long range (3,000 - 5,000 mile range) highly reliable binary communication system with good anti-jam features. Information

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rates of sixty words per minute via teletype were planned. Originally conceived to meet requirements of the Strategic Air Command, the system was being adapted to meet other requirements as well. [REDACTED]

By mid 1957 the experimental and developmental stages of the Long Arm program had terminated. In August of 1957 the service test phase of the program could begin after a contract was awarded to Hughes Aircraft for that purpose. Hughes was scheduled to start installation for the service test in October of 1958. [REDACTED]

The RADC Avia/Stockbridge New York sites being readied for the Single Sideband test program were to be pressed into service also for Long Arm. This was somewhat symbolic of the efforts being made to insure as much compatibility as possible between Long Arm and Single Sideband. The Communications Directorate at RADC in addition to its duties of monitoring the ground equipment for Long Arm also acted as coordinator between Hughes Aircraft, the contractor for Long Arm and Collins Radio Company contractor for Single Sideband. This coordination paid off through utilization in Long Arm equipments of Single Sideband excitors, transmitters and remote control devices. [REDACTED]

A more advanced binary system, similar to Long Arm, was Quick Silver and for which RADC gave similar support to the

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Wright Air Development Center. Employing techniques similar to those of Long Arm to achieve reliability and anti-jam capabilities, Quick Silver was designed to accommodate much higher data rates - on the order of 2,000 bits per second compared to Long Arm with a maximum of 1,000 bits per second. This would give Quick Silver a theoretical capability to transmit up to 2,000 words per minute if such high speed teletypes could be developed. Or, Quick Silver could digitalize voice information by use of a "vocoder."¹² [REDACTED]

A unique by product of both the Long Arm and Quick Silver contracts is the method of packaging components and sub-assemblies. The design layout and assembly method chosen allow the minute modules to be assembled, connected and soldered by automatically controlled machinery according to the latest concepts of automation. A large percentage of these modules will be of the "throw-away" type. This means that if a module becomes defective it will be replaced by another one - rather than repaired. The modules are so designed that both time and money will be saved in maintenance by replacing defective modules rather than trying to repair them. [REDACTED]

Quick Silver was running about one to one and a half years behind the schedule of Long Arm. At the close of 1957 Quick Silver was still in the development stage while Long Arm had since August 1957 begun to prepare for the Service Test phase.

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1 7 2 3

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Hughes Aircraft Company was contractor for both Quick Silver and Long Arm. RADG has provided assistance to the Wright Air Development Center in the ground aspects of the Quick Silver program through the preparation of exhibits and purchase requests and it has coordinated the ground aspects of Quick Silver with those of Long Arm and the Single Sideband Program.¹³

Tropospheric Scatter Communication

The newly developed technique outlined in the 1956 RADG History, of bouncing radio signals off the troposphere for point-to-point long distance communication continued to advance in 1957.¹⁴ One of the tropospheric equipments being developed for RADG on contract by RCA was the AN/FRC-39(V) - a [redacted] set. After some initial delay, the target date for delivery had been placed at January 1958. Work during 1957 proceeded on schedule and permitted the delivery of the equipment at the appointed time. Installation of the equipments at sites in Iceland and in Labrador to serve as gap fillers for the Pole Vault Communication line could thus get underway. Shake-down tests at the Iceland sites were expected to begin in March of 1958. Similar tests were also projected for the Labrador sites, which in early 1958 were already fifty percent completed.¹⁵

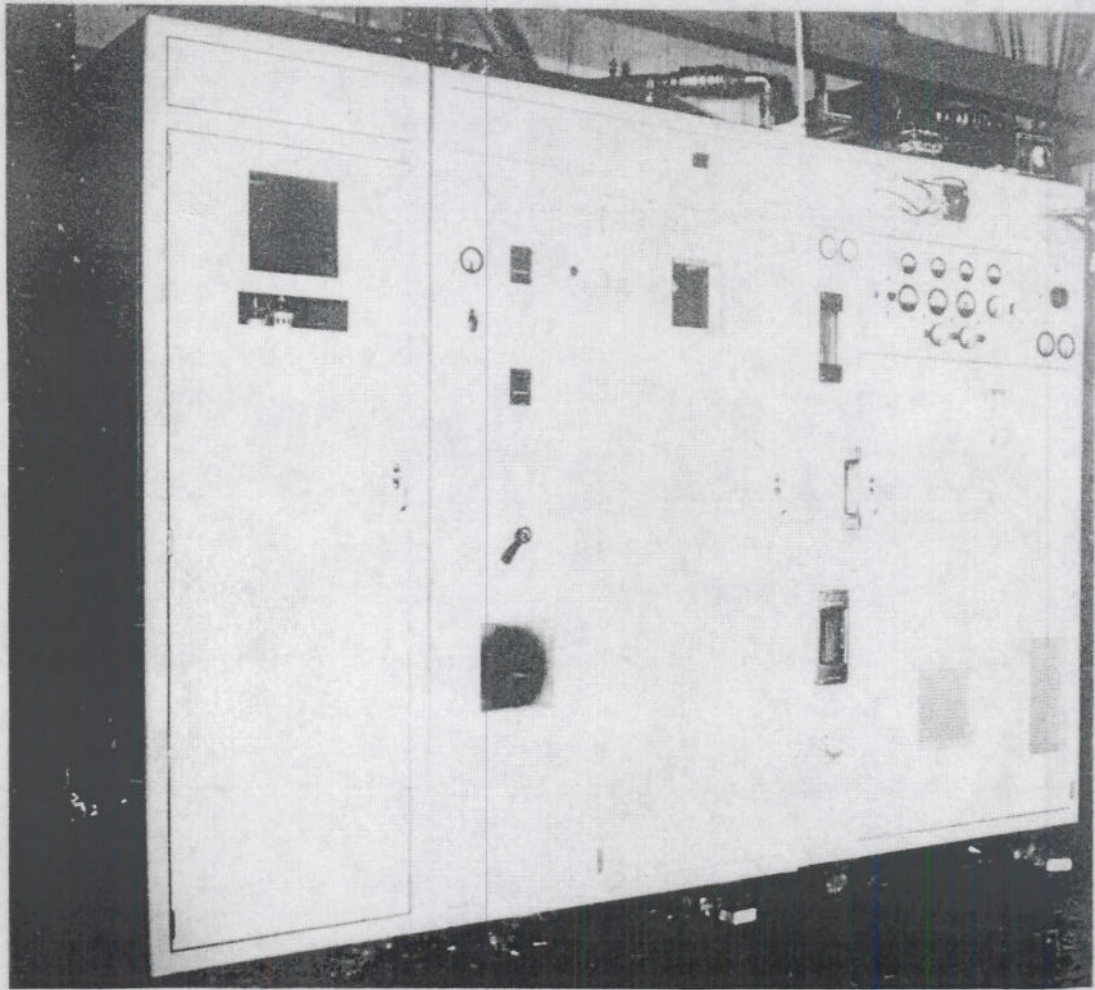
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A second tropospheric equipment, the AN/FRC 50(7), virtually identical with the AN/FRC 39(V) except for frequency [REDACTED] had been initiated by RDA for the Center in early 1957. The equipment, intended for use at Texas Tower installations, was virtually completed by early 1958. Shakedown tests for this equipment were expected to begin shortly.¹⁶

Interest for future development centered on a set, probably to be redesignated the AN/FRC 68(V), that would satisfy requirements laid down in late 1956 by the Tactical Air Command. Needed was an equipment that could double for tropospheric or microwave line of sight transmissions, light enough to be transportable by helicopter, reliable and versatile for field use and so constructed that it could be set up in a matter of time. RADC in 1957 outlined a system that could be designed around these requirements, employing a [REDACTED] which was considered more suitable for short one hundred mile hops. A fourteen foot inflatable paraboloon antenna that could be erected and aligned in less than an hour was also a possibility under consideration.¹⁷

At the Rome Air Development Center specifications had been written for the paraboloon antenna which may be incorporated in the set. The fact that the paraboloon antenna appeared so expensive (somewhere between \$100,000 and \$150,000 compared to an aluminum antenna in the neighborhood of \$5,000) cast some doubt as to whether the weight and bulk reduction actually would justify the very appreciable difference in cost. However, the



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fact that the price of the communication systems seemed to be shrinking, gave some hope that it might still be considered financially practical. The Center had also drafted specifications for the radio net itself. This planning and advance spadework accomplished by the Center in 1957 made possible the submission of a purchase request for the equipment in early 1958, preliminary to awarding a contract for the work.¹⁸

The Center was further interested in obtaining data on tropospheric communication techniques which could help give direction to planning for future work in the field. Tropospheric communications experts were somewhat uncertain as to the relative merits of using Frequency Modulation or Single Sideband techniques of transmission in their equipment. Anxious to have actual operational data on the comparative performance of the two techniques to complement their theoretical estimates, RADC engineers resolved in 1957 to institute a test link between Verona (an off-base site near Rome) and Liberty Dam, Maryland -- a distance of 256 miles. Plans called for transmission to Liberty Dam by FM and reply to Verona by Single Sideband and at 2,000 megacycles. Westinghouse Electric Corporation had built for RADC in 1957 the appropriate equipments for the experiment. These included the AN/FRC-53 Single Sideband Tropospheric equipment and its counterpart the AN/FRC-54, an FM Tropo set which had been adapted specially for the experiment from an AN/FRC-43. Both of these

equipment, the AN/SPS-3 and the AN/SPS-4 were being installed at the two sites in 1957. Installation was complete by the close of the year. Operational testing began in January 1958 to collect comparative data.¹⁹

Ionospheric Scatter

In the realm of ionospheric scatter, the transmission method which could hop still farther than tropospheric scatter, the Center was principally occupied in establishing a VHF ionospheric test link. One of the first orders of business of the link would concern the improvement of ionospheric scatter equipments already developed. The Collins ionospheric IS-101 used in the COM Line as a case at point of an equipment which was not entirely satisfactory and which needed some modification.²⁰

In June 1957 the Center contracted with Page Communications Engineers to set up the link. A site at Carolee, Florida some eighty miles from the Tyndale Air Force Base was selected as the southern terminus. Collins IS-101 equipments, made available without cost to the Center by the Home Air Force Depot, were installed and were being modified as required. Preparations were also in progress to erect antennas on two hundred foot high towers.²¹

The northern terminus of the link to be in New York State had not, however, been firmly decided in the 1957 period. Original calculations looked to the use of Sarason, New York, a former U. S. Government installation, for the program, but

[REDACTED]

this land was acquired in 1944 by the State of New York. By the end of the year, Story Point, New York appeared to be the most logical place and the Air Materiel Command decided that the contract should go ahead for this phase could be given in early 1955. Meanwhile the Collins II JPL equipment for the proposed site was being installed at Edna's off base Floyd site to minimize delay. If the contract for the Story Point site were let by May 1955 it was believed that the test link could begin to function by August 1955. A nine month test program was envisaged.

Meteoric Scatter

Meteoric scatter radio communication is a system which would reflect radio signals off of the ionized trails of meteors over long distances. It is outlined in the 1946 RAD History and aroused great interest at the Center in the applicability of meteoric scatter techniques to long range communication.

The Directorate of Intelligence and Electronic Warfare saw a further application of this long range communication technique to its own special requirements. It was in March of 1956 that a contract was let to Radian Laboratories for the desired meteoric scatter equipment. [REDACTED]

Meteoric Scatter was selected as the best communication technique for this particular task because of the long distances

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over which it could transmit up to 2000 miles, and the security of transmission due to the short time the transmission would be on the air. Unless one knew when and where to look it would be extremely hard to pick out. Also meteoric scatter required lower average power for transmission because of the on-off keying method used and because of the lower path losses from meteor trail propagation. [REDACTED]

The Communication Directorate, concerned of course simply with the communications aspects of the meteoric scatter, had pinned an original target date for equipment completion of May 1957 on the contractor, Hoffman Laboratories. Slippages occurred through which set the completion date back to March 1958, in the opinion of RADC. The slippage had resulted in part from a four month delay in receiving the proper frequency allocation from the Federal Communications Commission. The remainder of the delay occurred in large part because of difficulties in setting up the two test sites necessary for the program. One site located near Los Angeles, California at Palms Verdes formed the western terminus, the eastern terminus was located at Lubbock, Texas a distance of approximately one thousand miles. RADC furnished personnel to assist the contractor in the technical aspects of setting up the Lubbock site. Nevertheless the actual beginning of tests between the two sites could not begin until approximately 1 January 1958. It was anticipated that extensive debugging would

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have to be accomplished far beyond the expected March 1958 completion date. [REDACTED]

As a matter of fact, RADC was already planning an improvement program for the AS/GRC-73. By early 1958 purchase requests for the program had been submitted by the Communications Directorate.²⁶ [REDACTED]

The Center was interested too in combining the best features of ionospheric transmission with those of meteoric scatter. Previously ionospheric designers had attempted to avoid the effects of meteors in transmission because of fear that reflections of the transmissions would cause poor reception in ionospheric equipment.²⁷ [REDACTED]

However, in 1957 feeling at the Communications Directorate was that a combination of the best points of the two systems could be devised which would at least double the information handling capacity of the ordinary ionospheric equipments. Under this conception meteoric scatter techniques would be used to take advantage of meteors when present. When they were not present ionospheric transmission would then carry the load in a continual switching back and forth between the two techniques.²⁸ [REDACTED]

This meteoric capability could be incorporated in the Collins IS-101 ionospheric equipment previously referred to by the addition of black boxes. A modification kit, MK-385 (X4 L) FRC-60 seemed to be the solution. Contract processing

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by June in late 1957 and early 1958 was sufficiently advanced that RAND expected to be able to go ahead by April or May 1958 on this project. Testing of the combined atmospheric and meteoric equipment could then take place in the Ionospheric Scatter Test Link between Story Point, New York and Carabell, Florida.²⁹

Advanced Communication Analysis

The projects described above relating to communications hardware in various stages of research and development do not, however, reveal the most advanced theoretical work being done at the Center. An Advanced Analysis Branch of the Communications Directorate had as its express purpose the determination and exploration of areas in communication where major contributions or "break through" could be made. Experience seemed to show that most communication equipments were developed to meet more or less immediate Air Force needs or were improved versions of an existing piece of hardware. As a result by the time the plans have been developed, engineered for field use and debugged, the equipments might be two or more years behind.³⁰

While this branch was busy with numerous problems besides that of long range communication in 1957, it was exploring several new theories or techniques which could have real impact in the field of long range communications.

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Preliminary discussions, for example by personnel from the Advanced Analysis Branch with Dr. Jack Olliver of the Lamont Geological Observatory, indicated that a communication channel may exist along rock boundaries underneath the earth's surface. Instead of operating above the earth, then, long range communication might run from one point on the earth to another following these underground rock channels. This manner of communication seemed to have several advantages to recommend it. The mode of propagation being mechanical rather than electromagnetic, no new spectrum space would be required. Nor would rock channels communication interfere with other types of communication or be interfered with by them. Finally, by its nature, rock communication may be a low loss channel since the losses are a function of range rather than the range squared.³¹

Other theories of interest were heard of with the utilization of ionized gases in communication. Vehicles traveling in space at high speeds will collect the gas around them and thereby become enshrouded in an ionic sheath. This sheath, it was proposed, might be used as an antenna for reception and transmission for communication in the coming space age.

Or again simultaneous filtering in time and space might be used to increase the range of communication. This theory was predicated on the assumption that internal receiver noise was

not as commonly assumed, the location factor of reception, called
it is electromagnetic radiation from directions which are indifferent
with the source generating the signal. Operating on these revised
assumptions, a new configuration for an antenna receiver might be
created which by reducing interference could increase the range
of communication.¹²

These are only a few examples of thinking in the house at
the Rome Air Development Center which was intended to provide
the Air Force with an advance with the latest communication
theory around which equipments for the Space Age could later be
fabricated.

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CHAPTER V

Ballistic Missile Defense

Introduction to the Problem

Those who must plan for ballistic missile defense have repeatedly confronted baffling unknowns that have made hard and fast decisions difficult to render. As more information becomes available, decisions may have to be made in greater confidence, but objectives and target goals, unknown of the scientific nature and those who have first followed involving as they do little known fields such as propagation, high range equipments and the like and which the world is generally expected to face first in an endeavor as new as this. And indeed there are many of this category, but they have not been alone in creating areas of doubt or uncertainty for the planners.

Deciding on a target date for an operational ballistic missile defense system is, for example, more than a purely scientific or engineering problem since it depends as well on



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the Soviet threat which is to be countered, or how urgently
the action is needed and to how much the American people are
willing to spend. It follows, then, that among other things a
greater knowledge of Soviet missile capability would be of
great aid to our planners, its lack, a corresponding handicap.
A conference held at Baltimore 27 June 1957 had presented
evaluations of the Soviet missile threat in the 1950 plus
recommendations to missile defense planners. Nevertheless, details
of the day to day progress of Soviet rocketry were not always
as complete as one might wish ideally. In a briefing



The "ifs" and "maybes" contained in these two sentences point
up rather clearly the areas of doubt which existed on Soviet
rocketry in the summer and fall of 1957. The launching of two
Sputniks a short time later in October and November 1957

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generally threw a brighter light on Soviet progress
in this area which was to have the most understanding
enough, in missile defense area. [REDACTED]

There was another item that could hardly be disregarded.
Once again it was difficult to chart a course too far ahead.
Priority measures set in motion by the Department of Defense in
the fall of 1958, followed by when post Sputnik second look
at standing P-10 in late 1959, troubled the waters of
ballistic missile defense planning. Security officials, however, lean more
for other, lower priority projects. [REDACTED]

In the final analysis, decisions on fundamental questions
had to be reached at Headquarters of the Air Research and Develop-
ment Command or orders by Headquarters USAF with the Home Air
Development Center as a guide. The framework
of these decisions, however, the higher headquarters depended
on recommendations from Center. The SACD in turn had reach
with the Air Force and the Department of Defense. On all matters
there was a need for coordination and decisions
and an equal need at the lower level and Headquarters level
to be in step of every major activity. The Air Force perceived the
significance of the program posed by ballistic missile defense
as a new security vital to the nation's defense in the future.

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system, assuming funds were available. ■

This altered technical relationship of System 2191 (passive detection) and System 220A (active defense) prompted Lt. General H.L. Felt, Deputy Chief of Staff/Development, Headquarters USAF, to outline for the commander of the Air Research and Development Command the revised thinking of Headquarters USAF in a letter of 25 July 1957. General Felt expressed belief that the ballistic missile defense system should be developed as a systems team with both passive detection (System 2191) and active defense (System 220A) integrated into one system. Both developmental and operational aspects of ballistic missile defense should be dictated by this conception. This approach, he wrote, would allow the development agencies to make maximum use of the state-of-the-art in one part of the system while relaxing certain requirements in other parts of the system and would allow the ground environment and the weapon to receive simultaneous attention. Greater economy was anticipated, then, from an integrated systems approach. So it was that the Command of ARDC was advised to consolidate System Line Items 2191 (passive detection) and 220A (active defense) into one Line Item, to allow maximum exploitation of funds for a systems attack and of any breakthrough that might come about during the course of systems

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studies. ■

Preliminary notice of the integration of the two systems was received by the Commander of RADC from Headquarters Air Research and Development Command 11 September 1957. A teletype from Headquarters ARDC dated 27 September 1957 made the change over official, instructing the Commander at RADC to combine passive detection (219L) and active defense (222A) into a single integrated system to be known as Ballistic Missile Defense System 224A. At Rome the ballistic missile team which had been organized the previous November and placed under the charge of ■ had already, however, done much to integrate the two systems, insofar as Rome itself was concerned. ■

Setting the Dates

In the summer of 1956 it had been concluded at Headquarters ARDC that even a passive ballistic missile warning system could not be made operational in 1960 without involving huge expenditures of money and incurring large technical risks. The OGR issued in 1956 had accordingly dropped 1960 as the target date. When it came, then, to an evaluation by RADC of studies prepared by

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General Electric, Sylvania and Hughes in 1956. The 1960 operational date could be officially assured, nevertheless, Rome Air Development Center preferred not to lose sight of the date in the event 1960 should reappear as a requirement. RADC people pronounced the view in July 1957 that the General Electric proposal was closest to meeting a 1960 date. Even there the possibility of meeting the date was thought to be small. At the same time, however, the General Electric proposal was considered the least desirable by other ways of the three. A still smaller possibility existed that Sylvania could meet an 1960 operational date. The Hughes system could not be expected to become operational until 1967. ■

Assuming that the 1960 target date was not unrealistic, the Sylvania proposal drew the most favorable notice at RADC, although it was conceded that the antenna techniques proposed by Sylvania might not prove feasible. RADC therefore suggested that the Sylvania warning system be constructed but that the long lead time required by the General Electric and Hughes systems should be fabricated and tested first. This procedure would afford a maximum probability of having a system operational independent of date. ■

As a matter of fact the approval at RADC in seeing some way

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of a warning system operational in the 1960 period triggered the preparation of a technical report at the Center by [redacted] [redacted] for a Quick Fix ballistic missile warning system. As explained in the report, even though the 1960 operational date for the 21st detection system had been eliminated because of complexities of various kinds and funding difficulties, the ability of the Soviet Union to mount an ICBM attack against the United States by 1960 appeared to remain unchanged. Suggested in that report was a system of reduced capability. It was stated that most of the ICBM detection and early warning systems thus far proposed were designed to detect every ICBM fired against the United States and to predict the impact point of each detected ICBM.

[redacted]

false alarm warning rate to the Strategic Air Command. The cost would be negligible, at war addit, compared to the originally

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proposed System 114 (now at one and a half billion dollars).
A detailed analysis attempted to evaluate the argument further.
However, in the summer of 1957 the climate of opinion was for
a variety of research proposals outside of the quick-fix interim
solution. General Butt had written to the Commander of the Air
Research and Development Command in July 1957 that "since we are to
attack the Ballistic Missile defense problem on a systems basis,
it is not felt that the main effort should be expended on studies
and developments leading to a very limited operational capability
of an early warning system. General Butt continued that "before
considering any system for early warning, whether an IOC (Initial
Operational Capability) or the ultimate capability, your headquarters
must be convinced by data to become available from the Trinidad,
Lincoln and Canadian sites that a radar system dependent upon
brute-force techniques is as inoperable and can offer some
advantages as a part of the overall active system." ■

Even before Soviet satellites were circling the globe in the
fall of 1957 Soviet ■

to the 1960 operational date for a ballistic missile warning
system appeared to be imperative. And in spite of the earlier
objections which had surrounded the question, Air Council

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directed that the 1960 operational date be restored.¹⁰ Meetings of RADC personnel, along with those of other organizations, were being held at Headquarters of the Air Research and Development Command in August 1957 to review the objectives of the program in the light of the expedited activity called for.¹¹ In a later meeting at Headquarters ARDC at which RADC again participated, word was brought back to the Center that about sixty million dollars for System 224A was to be released immediately. January 1, 1958 was then proposed as the contract date for the system. In the meantime RADC was to come up with an initial program and plan for the whole system by 12 November 1957.¹²

The official timetable which was to govern System 224A at the close of 1957, noted as System 224A OPR #126 and issued 7 December 1957, divided the problems of ballistic missile defense into two phases. Phase I of the OPR was concerned with the requirements for ballistic missile early warning while Phase II which will be discussed later dealt with active defense. Some of the more outstanding points covered in the Phase I detection contained the 1960 operational date, a ten minute minimum warning for ICBM detection and identification, detection for all possible trajectories, 100 percent reliability

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anticipated complications. The SSMMS system would not, however,

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Drawn from experience acquired from the DEW Line and similar undertaking, the Pentec envisaged turning over to a prime contractor the responsibility for planning, designing, fabricating, testing, installing, operating and maintaining the complex system. Just as in DEW, sub-contractors could be employed as necessary. To prepare for a phase over to military operation of the system, the prime contractor would be expected to train military personnel who would then man the system two years after its release operations. [REDACTED]

The system planned by PAM would utilize three principal sites. One would be located in the Fairbanks, Alaska area, another in the Thule, Greenland area, and a third in Scotland. Work had already been quite active for some time in planning for Far Northern sites. Representatives of the Pentec missile team headed by [REDACTED] had spent sixteen days in mid August 1957 in the Fairbanks and Anchorage areas of Alaska looking over possible site locations. Their reconnaissance mission was labelled a success in that it was found that no major design changes in equipments proposed for a ballistic missile

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selection information would be limited. Availability of construction material and possible location of possible site locations were also being taken into account in the report of the group. Regarding other far B-ther sites, the Commander of RADC had been advised as far back as the 30 April 1957 by Colonel Paul S. Whelan, Chief of the Ballistic Missile Defense Office at Headquarters of the Air Research and Development Command, that the [redacted]

[redacted]

RADC personnel conducted a reconnaissance mission in the Thule Greenland area just prior to the Alaska mission. Scotland was selected as the third site for point in accordance with the advice of Headquarters ARDC. [redacted]

At the three sites, RADC specified the installation of parabolic horn reflectors of the same configuration as the one being programmed for the Snow Range site at Itanaded under Rome's supervision. Because of the early operational date, Rome desired that proven techniques and equipment designs be used whenever possible. This again reflected the view presented in General Pitt's letter of 22 July 1957 to the Commander of the Air Research and Development Command. Rome recognized, however,

Colonel R. S. [redacted]

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that the system would have an over-growth potential, so that it could handle threats throughout the 1960's and early 1970's as presently foreseen. And it was further recognized that to increase the reliability of the system to make positive identification of all targets, it would be imperative that within one year [REDACTED]

[REDACTED]

The system would also have to be tied to the central monitoring station in the United States for receipt of satellite data and give data of "hot" targets as they are detected. The communication from each site, it was specified, would have a primary direct link and an alternate separate routed link. The whole operation from detection to the actual display of an enemy target after correlation at the central monitoring station would have to be fully automatic with no human in the chain. ■

As with other aspects of the system, SACD had subjected the communication needs of the missile warning system to searching inquiry. Communications had been critical to the success of the SEM Line and promised to be equally vital in this use. The Operational Planning Office of the Directorate of Communications was furnishing active support in this area. At a meeting at

Washington, D. C., 1961

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components for maximum reliability. Where standard parts were not available or their procurement would delay the operational date, components meeting high quality commercial standards might be used through, as had been done in the IEM Line project. Reflecting, too, RADC's interest in radiation hazards of high power equipments, were directions for the minimizing of such hazards. An expansion of counter-counter measures would naturally

[REDACTED]

Down Range Site

Significant back up for BMBWF efforts was anticipated from experiments work of various kinds. The Down Range site at Trinidad under BAIC surveillance was expected to add anticipated data from observation of missile firings at Cape Canaveral and by other experiments. General Pugh of Headquarters USAF had 25 July 1957 urged that development and installation of the Trinidad Down Range site facilities be accelerated particularly in order that data can be accumulated for the development and procurement of an operational system. Reference to the previous semi-annual history of BAIC will recall that the Center in mid 1957 had eyed early fiscal year 1958 as the point at which

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the site would be fully operational. General Anderson, Commander of ARDC, pointed out, however, 10 September 1957 that while ARDC agreed that "delayed action proceed at an accelerated pace, a delay in construction of the Trinidad facilities had been generated by withdrawal of construction funds, undiligated as of 30 June 1957, in accordance with Headquarters USAF. Should the funds be made available by 15 September 1957, which appeared to be the earliest available date, a delay of approximately three months in the readiness date of the Trinidad facilities could be expected. This was an instance where budgetary difficulties were causing a disruption in the program schedule. ■

Summary of Support of EXOGENE

One major concern of the technical uncertainty included in the time efforts at ARDC particularly in the field of propagation and related effects. One of the problems of this category was solar noise or large aperture antennas such as those that would be used at the defense sites. Solar noise data was obtained by Rome from European Solar Patrol Stations and was being compared with over-the-air radar film data. Although the data collected was rather scanty since solar burst occurrence rate is relatively small and unpredictable, it was anticipated

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that eventually, enough data could be collected so that statistical conclusions could be drawn. On contract for RADIC

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Contract Terminations

Mention has been made before that System 274A was not immune to the vagaries of budget adjustment which struck the Center in the fall of 1957. By 15 October 1957 there were three casualties among the contractors who had been working for RADIC on aspects of the ballistic missile detection problem because of the ceilings placed on R-600 research and development funds, Sylvania's Electronic Stacked Beam Radar, Stanford Research Institute's Upper Atmospheric Clutter study and AVCO's SARAC. These contracts were among those directly connected with missile detection, this does not include other contracts indirectly related. Three contracts continued active, however, University of Alaska's Aurora Phenomena, Cornell University's Radio Noise and Atmosphere Refraction at UHF and VHF and the Down Range Facility contract of the General Electric Company. ³⁰ [REDACTED]

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When the Department of Defense began its second look at defense spending cuts following the fiasco over Sputniks, some contracts were reinstated, however. Among these was the Stanford Research Institute's Upper Atmospheric Clutter study in November, ³¹ [REDACTED]

Active Defense 222A

A meeting at the Pentagon 5 August 1957 attended by representatives of Rome in company with those of the Scientific Advisory Board and the ARDC Evaluation Committee was held to evaluate System 222A, active defense against long range ballistic missiles. A number of topics discussed at the meeting were naturally of vital interest to Rome's participation in the active defense program. It was noted, for example, that none of the three contractor teams which had completed studies for a ballistic missile defense in December 1956, had proposed a solution entirely satisfactory to the Air Force. At this meeting, however, it emerged that the Scientific Advisory Board and the ARDC Evaluation Committee were both agreed that the most logical course of action was to initiate immediate development of a system based on the Convair/RCA concept as offering the best chance of providing a defense of the Strategic Air Command in the

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1963-1965 period, Convair/RCA, as was explained in a previous RADC history, had devoted considerable attention to the countermeasure decoy problem. Failure to make adequate provision for countermeasure tactics from the enemy had obliged experts at RADC to reject as unsophisticated the suggested approaches of several other groups.³²

The meeting brought out too the requirement for active USAF budget support of a vigorous and expanding research and development program aimed at gathering basic 272A data and the critical information required for evolution of area defense capability

[REDACTED]

CORA

In furtherance of the objectives set forth at the August Pentagon meeting, RADC was already moving ahead as planned on the Coherent Radar Array. A contract had been signed by the Center with Hughes Aircraft on 11 July 1957 for a twelve-fourteen month feasibility study program.³⁴ It must be added, though, that in the fall the CORA contract with Hughes was among the victims of the Department of Defense economy drive, the contract was cancelled.³⁵ The period of contract reinstatement which then followed

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were highlights of the new directive. ■

Dimensions of the Recommended Rome
224A Program

On the basis of the new G.O.R. and the study and analysis at the Rome Center, RADC was in a position to present at a meeting at Headquarters ARDC 16 December 1957, a suggested program of research and development in support of Phase I and Phase II of System 224A to be carried on by the Rome Air Development Center. All told, the RADC recommended program would cost approximately 280 million dollars. This in itself is suggestive of the dimensions of the task which RADC envisaged before it. And it was recognized at the Center that if these recommendations were accepted by higher headquarters, a tremendous work load and responsibility may be placed on this Center. Admittedly this would depend too on what activity would be picked to manage the program. In an event, Rome was eager to assume whatever additional responsibilities might be delivered to it. ■

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Although placed here after the discussion of System 224A,

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logically ORDIR might better precede it - this because ORDIR precedes in time of origin the 22LA system and because development of the ORDIR program has had great impact on System 22LA. Unlike System 22LA, lodged in the Directorate of Control and Guidance, ORDIR was a program upon which the [REDACTED]

The program took its beginning from the 1951 period, arising initially from collective thinking by [REDACTED] Scientific Director of the Center and [REDACTED] the Directorate of [REDACTED] effort widened as a team of scientists from the Electronics Research Laboratories at Columbia University were put to work on these ideas through contract to the Rome Air Development Center. The ORDIR program could be considered launched. [REDACTED]

[REDACTED]

study. Briefly, however, it may be said that ORDIR has devised

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underlined the satellite danger. Required was an exploratory study of a weapon system to combat hostile satellites. There has already appeared in the press so much speculation on the possible military uses of satellites that no attempt will be made here to enlarge upon the obvious. ARDC set as its major requirements a system that could render useless satellites orbiting around the earth at heights up to at least 500 miles. This would have to be done on or before the second pass of the satellite over the defense system. ^{b7} [REDACTED]

An in-the-house study of the problem at the Rome Air Development Center produced a technical report by [REDACTED] [REDACTED] of the Directorate of Control and Guidance and which was published by the Center in December 1957. The report outlined a typical anti-satellite system and provided estimates of the types and parameters of the equipments that would be required in the system. ^{b5} [REDACTED]

[REDACTED]

Sufficient information concerning each area was lacking. The

[REDACTED]

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[REDACTED]

locking. Finally, the problem of efficient out of the atmosphere decay discrimination had yet to be solved. The

[REDACTED]

such a system, were better defined. [REDACTED]

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1. Ltr. [redacted] Hq. ARDC to Comdr RADC, subj: (U) System 222A Evaluation, 9 Jul 57.
2. Memr. [redacted] (Classification given) Report [redacted] 2 Oct 57.
3. Ltr. Lt. Gen. D. L. Pitt, Deputy Chief of Staff USAF to Comdr ARDC, subj: (U) Ballistic Missile Detection Program, 25 Jul 57.
4. Ltr. [redacted] to Comdr RADC, subj: (U) RADC Experimental Radar Program 219L, 11 Sept 57.
5. Msg. Comdr ARDC to Comdr RADC, 27 Sept 57.
6. Memr. subj: (U) Evaluation of Proposal 219L - July 1956, in files of RCNR, 2 Aug 57.
7. Ibid.
8. Technical Report RADC [redacted] subj: (U) A Quick Fix Ballistic Missile Warning System.
9. Ltr. Lt. Gen. D. L. Pitt, Deputy Chief of Staff USAF to Comdr ARDC, subj: (U) Ballistic Missile Detection Program, 25 Jul 57.
10. Msg. Comdr ARDC to COFS, Hq (USAF), 18 Nov 57.
11. Memr. [redacted] RADC to RCNR, subj: (U) Report of trip to Hq ARDC on 29 Aug 57, 6 Sept 57.
12. Memr. [redacted] RADC to RCNR, subj: (U) Report of Trip to Hqs ARDC on 29 Oct 57, 20 Dec 57.
13. Rough Draft Work Statement, subj: (U) System 224A, probably Dec 57.
14. Ibid.
15. Ibid.
16. Ibid.
17. Ibid.
18. Memr. [redacted] RADC to RCNR, subj: (no Class. given) Report of Trip to Alaska, 3 Aug 57.

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[REDACTED]

- 1. Monthly Activity Report, RDM, 30 Dec 57.
- 2. Rough Draft with Distribution, RDM, System 204, probably Dec 57.
- 3. Ibid.
- 4. Ibid.
- 5. Memo [REDACTED] RADM to RADM, subject: "Staffing Report of RADM to RADM", 30 Dec 57.
- 6. Memo [REDACTED] RADM to RADM, subject: "Staffing Report of RADM to RADM", 30 Dec 57.
- 7. Rough Draft with Distribution, RADM, System 204, probably Dec 57.
- 8. Ltr, Ltr, Sec, to RADM, "Security Order of Staff, USAF, to Comdr ARDC, subject: "Ballistic Missle Defense Program", 29 Oct 57.
- 9. Ltr, Ltr, Sec, to RADM, "Security Order of Staff, USAF, to Comdr ARDC, subject: "Ballistic Missle Defense Program", 10 Sept 57.

- 10. Monthly Activity Report, RDM, 30 Dec 57.
- 11. Ibid.
- 12. Ibid.
- 13. Monthly Activity Report, RDM, 30 Dec 57.
- 14. Ibid.

[REDACTED]

- 15. Ltr [REDACTED] RADM to RADM, subject: "Class given, System 204", 30 Dec 57.
- 16. Rough Draft with Distribution, RADM, System 204, probably Dec 57.
- 17. Memo [REDACTED] RADM to RADM, subject: "Staffing Report of RADM to RADM", 30 Dec 57.

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[REDACTED]

40. Interview by the author with [REDACTED]
2 Apr 58.

41. Report, ORDIR - An ICBM Defense Radar, prepared by Columbia University, Electronics Research Laboratories.

42. DD Form 613, subj: U. S. Great Range Digital Radar Techniques,
2 Jul 57.

43. Interview by the author with [REDACTED]
2 Apr 58.

44. Report, ORDIR - An ICBM Defense Radar, prepared by Columbia University, also interview by the author with [REDACTED]
RCWIL, 2 Apr 58.

45. Ibid.

46. Interview by the author with [REDACTED] 2 Apr 58.

47. Technical Report RAD [REDACTED]
subj: (U) [REDACTED] Dec 57.

48. Ibid.

49. Ibid.

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CHAPTER VI

The Electronic Warfare Threat

Admittedly, electronics have come to occupy a crucial position in our defensive-offensive capability. Because of this one of our prime objectives in time of attack will be to jam the enemy's electronic equipments and particularly his radars. We can confidently say that the enemy will seek just as fervently to jam our own. The struggle then, will in part resolve itself into an electronic duel or test of strength between our efficient jammers and more jam resistant radars.

Ideally, of course, we should black out the enemy's radars while maintaining our own in perfect operating condition. While this ideal may not be completely attainable, the Rome Air Development Center strove with equal vigor in 1957 to provide the Air Force with less jamable radars and more effective jammers and electronic countermeasures (not to mention counter counter measures) equipments.

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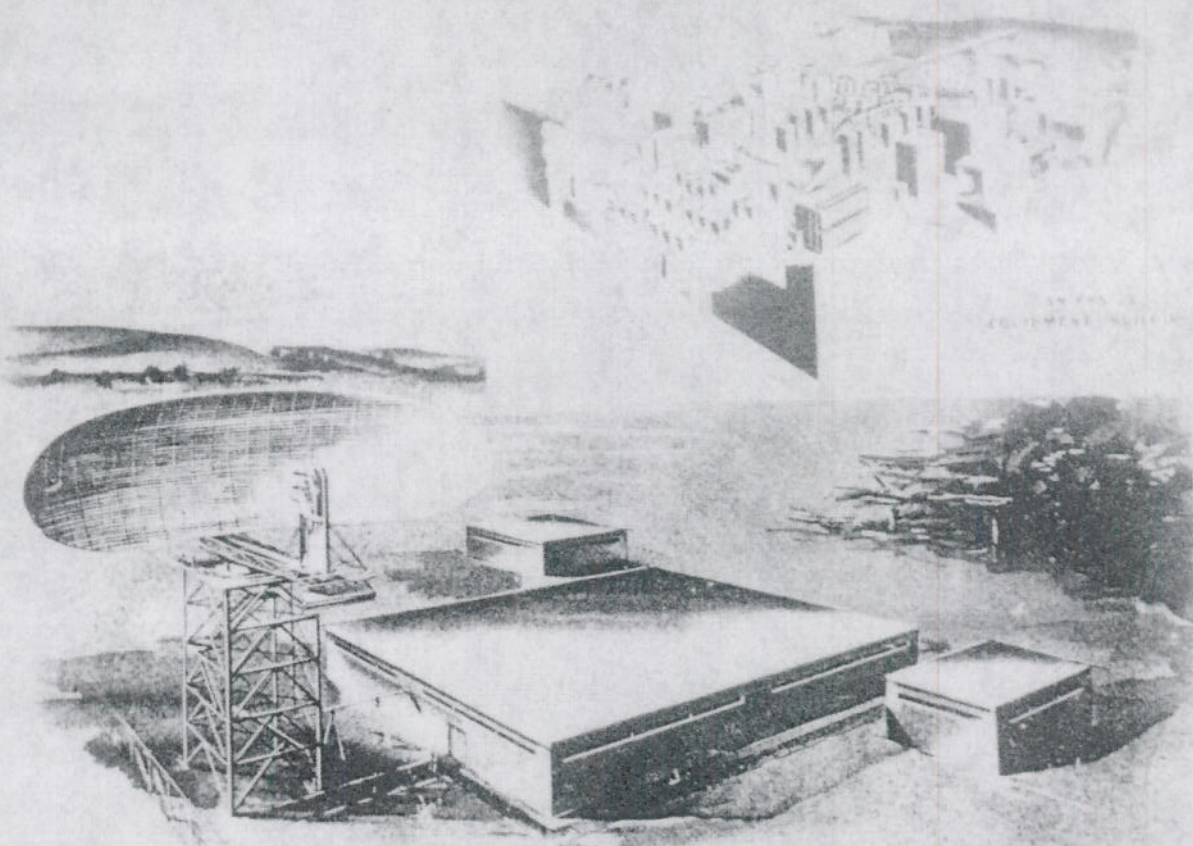
Frequency Diversity Radar

Wherever possible and feasible RADC attempted to engineer Air Force radars as jam proof as science could make them. But beyond this the Center, through its Directorate of Control and Guidance, supervised a special radar program which was particularly well suited to reduce the jamming threat. This was the Frequency Diversity Radar Program. ■

Some idea of the significance attached by the Air Force to the Frequency Diversity Radar Program can be gained from a statement of the Commander of the Air Research and Development Command in mid 1957. In the annual effectiveness report of 31 July 1957 dispatched to the Chief of Staff, Major General Sessions then commanding ARDC noted most significantly that in the field of radar, the frequency diversity program was most outstanding. ■

This program, begun in 1955 under supervision by the Rome Center, was intended to furnish frequency diversity radars for operation at widely scattered frequencies and so force the enemy to spread his total available jamming power over the widest possible spectrum. Of the seven frequency diversity radars which had come under study, the list of those for which service test models were to be procured had narrowed to five by 1957.² These five radars collectively made up a family of frequency radar capability and included the AN/FPS 11. ■
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AN FPS-16 RADAR SYSTEM

AN FPS-16 RADAR SYSTEM

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[REDACTED]

Progress By Mid Year 1957

The frequency diversity program was being managed at the beginning of 1957 with the idea of having components of the first four radars mentioned previously completed by September 1958.⁴ In reviewing the progress of the program at the half way point in 1957, the Center noted that some slippages were showing up in the schedule. [REDACTED]

The AN/FPS-26 was generally on schedule but the rather slow delivery of tubes from Sperry Gyroscope Company had aroused concern at the Center that a slippage might ensue. For the AN/FPS-27, under contract to Westinghouse Electric Corporation, a slippage of four to five months seemed a reasonable estimate because of a hold order placed on the antenna design and fabrication in January 1957.⁵ Headquarters of the Air Research and Development Command had informed the Center in January that before proceeding to the antenna design for this radar, which Headquarters would like to see with stacked beam capable of height finding and high angle coverage, a delay should intervene until data from flight test of the AN/MPS-20 stacked beam radar was in. The opinion was expressed that the AN/MPS-20 flight tests would be conducted in time for this purpose.⁶ However, by late June 1957 the flight tests had still not begun - hence the delay in the AN/FPS-27.⁷ Work by Raytheon Manufacturing Company, contractor for the AN/FPS-28, was advancing on schedule.

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Unfortunately though some contractual snarls were encountered in negotiating plant rearrangement funds and Rome anticipated some slippage from this cause. The contractor was then estimating a three month delay.⁸

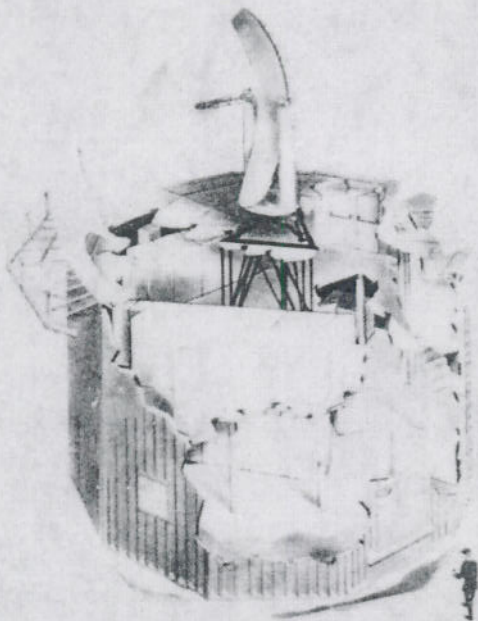
The AN/FPS-35 occupied a somewhat special place in the RADG program since this radar had until early 1957 been the responsibility of Lincoln Laboratory. Headquarters of the Air Research and Development Command had transferred this radar to the Rome Frequency Diversity Program, though, by a letter of 21 March 1957. In the weeks following that date Rome set up close liaison with Lincoln Laboratories to insure a smooth transfer with minimum loss of time on the project.⁹ By the summer of 1957 the Center had completed the specifications for [REDACTED] was being taken at the Center to expedite the procurement and installation of four AN/FPS-35's in the SemiAutomatic Ground Environment.¹⁰ What happened to the AN/FPS-35 was important too because of its impact on another frequency diversity radar, the AN/FPS-24. This latter radar under contract by the General Electric Company was generally on schedule with the exception of the antenna components. A stop order had been placed on its antenna and rotary joint work in April. Headquarters had previously recommended that

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ENGINEERING DEPT. CHIC

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3 1774

[REDACTED]

the AN/FPS-24 and AN/FPS-35 radars be designed to use a compatible antenna system. This action had resulted in a two month slippage by mid 1957 and was entailing additional cost in order to keep the contractor on "stand-by" during this period. ¹¹ [REDACTED]

Video Processors

Personnel at Rome had observed previously that practically all of the contractors engaged in frequency diversity work had recommended use of the same kind of moving target indicator devices. RADC personnel were also aware that normally all of the contractors involved subcontracted their moving target indicator units. At the same time the Center wanted something that went beyond the normal moving target indicator and would tie into the data processing of the Semi-Automatic Ground Environment and enhance its capability. The latest techniques which Rome wanted to see engineered into the moving target indicator, or Video Processor as the equipment was to be known because of its required added qualities had been proven out by the Airborne Instruments Laboratory. Putting all of these considerations together, it was concluded at the Center that rather than have each of the frequency diversity contractors independently design his own video processors, a single contract with Airborne Instruments Laboratory, already thoroughly conversant with the techniques, would be the better course. ¹² [REDACTED]

Control No. 58-4732

[REDACTED]

[REDACTED]

A number of important advantages pointed to this decision. Manpower both of the Center and of the several contractors would be economized by bulking all of the video processor work into a single package rather than asking for separate units from each contractor. Additional profit would be reaped in having a common nomenclatured video processor for all the frequency diversity radars which would simplify logistics and maintenance. It would allow use of common technical orders, too. These actions would, of course, force costs down. Consequently Rome let a contract to Airborne Instruments Laboratory for the video processors in May 1957.¹³ [REDACTED]

Frequency Interference

The problem of frequency interference and frequency allocation was a generally difficult one for the program. The previous history of the Rome Air Development Center has discussed some of the questions raised on this score in 1956. The problem continued to haunt the program in 1957.¹⁴ [REDACTED]

Representatives of the Center attended a conference at Headquarters USAF 10 July 1958 to justify the use of the AN/FPS-28 frequency. The Center stressed the advantages of a radar at this frequency in terms of moving target indicator capability against chaff and remarked further that in normal peace time

[REDACTED]

band since frequency jumping would be needed only in case of

Control No. 58-1732

[REDACTED]

[REDACTED]

enemy jamming. The Center's primary objection to a change of frequency to late, though, arose from the delay in delivery and the increase in costs which a change of system parameters would certainly cause. [REDACTED]

Actually, though, the more serious difficulty of frequency

[REDACTED]

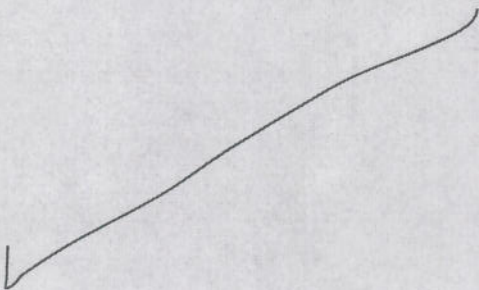
for a decision on the matter, a directive at length came from Headquarters ARDC in December 1957 changing the frequency of

[REDACTED]

Test Program and Site

Originally it was intended to test the frequency diversity equipments at the plants of the contractors. In January 1957, however, the plan was altered to allow testing of the equipments in an Air Defense Command environment in an area yet to be selected. This shift of tactics was expected to bring savings of time and money to the Air Force. The test program would cover not only all normal performance and environmental conditions but would emphasize flight and laboratory tests against diversified types of jammers to assure effectiveness under jamming conditions. The first phase of the test program

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[REDACTED]

was planned to test each of the radars separately. The second phase of the program would test the marriage of each of the radars to the SemiAutomatic Ground Environment System. In the third and final phase of testing, all of the frequency diversity radars would be tested as an integrated system with SAGE.¹⁷

Following a conference held at the Rome Center 21 May 1957, Rome personnel drafted a proposed test plan for submission to headquarters of the Air Research and Development Command. This plan, drawn up with the cooperation of Lincoln Laboratories and the ADES Project Office, was submitted to headquarters 19 June 1957. It outlined a program general in nature that could be applied to any area designated by the Air Force for the purpose. The Center emphasized, however, that the frequency diversity radars to be used in the test were to be service test types not operational equipments.¹⁸ [REDACTED]

In the summer of 1957 representatives of Rome in company with their counterparts from the Eastern Air Defense Force, Corps of Engineers and 657 Air Control and Warning Squadron under took a survey of the proposed frequency diversity sites in the Montgomery Air Defense Sector to define more clearly the installation requirements and to locate the frequency diversity radars on the proposed sites. The usual complex of problems associated with radar site location had to be carefully

Control No. 38-1731

[REDACTED]

[REDACTED]

considered such as interference with commercial and other communication media. [REDACTED]

In order to expedite testing and provide frequency diversity contractors with definite locations for the erection of the radars, the Center urged that a decision be reached in several letters in September and October 1957. These decisions were forthcoming 8 November 1957 by joint action of the Air Research and Development Command and the Air Defense Command. [REDACTED]

Year End Status of the Frequency Diversity Radars

By the end of 1957 the Center appeared to be coming close to achievement of the basic obligation of delivering component tested frequency diversity equipments by September 1958. Looking at the program as a whole the slipage from this date was on the order of two months with November 1958 now tagged as the date for delivery. [REDACTED]

The remarkable thing about the frequency diversity program was the relative absence of major technical problems. Most of the delays which had occurred were traceable to administrative causes, not technical ones. Considering that the frequency diversity radars were being built at frequencies never before employed in radar equipments, the comparative smooth sailing met in the technical execution of the program is indeed pleasant to record. [REDACTED]

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Jammer Locations

Countering jamming against enemy jamming means not only radar better designed to operate in a jamming environment but electronics counter/countermeasures equipments to work actively against the enemy jammer.

An example of this is the Jammer Locator Equipment AN/TLD-30 under development by the Defense Directorate of Intelligence and Electronic Warfare, 7th AF (HQ: USAF) for jammer locator equipment capable of being integrated with existing and future radars. Unattended remote receiver stations will be required for operation of this system. The stations may be located 25 to 50 miles from the radar site itself. These remote sites are adequate to provide full coverage; however, four stations provide overlapping coverage with various additional advantages.²¹

The AN/TLD-30 jammer locator technique is capable of a large simultaneous traffic capacity of approximately one hundred jamming attempts. It has good accuracy and can be associated with existing search radars. It is not effective against chaff or other passive countermeasures, however.

A contract with Ramo Wooldridge Corporation for this equipment was signed 30 April 1957 and progressed satisfactorily throughout 1958. Demonstrations to prove flexibility of the technique were

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Blinding enemy radars. Under this concept a number of unattended jammers could be directed in a given area on past findings that the enemy's target and enemy jamming which might be used to locate the target would be jammed by a jammer. The jammers to be employed would be low powered equipments considerably cheaper to produce than the old fashioned high power jammers. (C)

The answer to these and other stringent requirements by the Center was the AN/ULP-2 jammer which incorporates the parametron. When it can complete the total operation of receiving a radar signal, analyzing it and transmitting a properly tuned and

[REDACTED]

into kind of speed, enemy radars could not jump fast enough to another frequency to avoid a jamming blackout. [REDACTED]

Farnsworth, principal contractor for the AN/ULP-2, had delivered the first of its twenty-six equipments in February 1957. By May all twenty-six AN/ULP-2s had been completed and delivered. [REDACTED]

The relatively large number of equipments were needed in support of a Distributed Area Jam System test program for 1957. There had been designated in September 1956 to draw up the overall test plan in coordination with representatives of the Strategic Air Command, the Air Defense Command and the Air Training Ground Command. Although

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[REDACTED]

[REDACTED]

originally scheduled to start on July 1971. The date for the test has later moved back to September 1971. A test requirement directive had been formally approved by 4 May 1970. (S)

To save time that would otherwise be required in establishing fixed installations for the jets, it was decided to mount them in vans for rapid deployment at the individual sites chosen for the Springfield, Mass. tests. Each van would be powered for each of the jets by a separate generator mounted on the engine generator van. The engine control system and all staging for the jets are to be accomplished from the engine Air Force Base, Massachusetts. Personnel from the AFM were actively engaged in helping to complete the engine generator van for permission to use the van. It is expected that the test equipment are only a few weeks away from being delivered. [REDACTED]

The test is expected to last approximately sixty days and involve roughly one hundred jets. Strategic Air Command aircraft are being used for the test. [REDACTED]

[REDACTED]

[REDACTED]

of aircraft weapons and installations could serve as a kind of

[REDACTED]

[REDACTED]

[REDACTED]

As reported in the 1956 July Report, when RADC history, the

[REDACTED]

1956 and early 1957 with an aircraft whose [REDACTED]

[REDACTED]

could fully meet Air Force requirements. Various Centers of the
Air Research and Development Command [REDACTED]

[REDACTED]

[REDACTED]

Re: [REDACTED]

The Center was planning to participate in a joint services
program for evaluation and development [REDACTED]

[REDACTED]

requirements were to be followed by firing tests at the Marine
Corps Development Center, Quantico, Virginia in 1958. (2)

[REDACTED]

had an RADC contractor investigated and activities required for

Control No. [REDACTED]

[REDACTED]

[Redacted]

[Redacted]

[Redacted]

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[REDACTED]

NOTES

1. Ltr. Maj. Gen. J. W. Sessums, Jr., Comdr ARDC to Gen. Thomas D. White, Chief of Staff, subj: (U) Headquarters ARDC Annual Effectiveness Report, 31 Jul 57.
2. History of RADC 1 Jul 56 - 31 Dec 56, pp. 72-75
3. Briefing Session attended by author, of RCER, 13 Aug 57.
4. Ltr. Maj. Gen. J. W. Sessums, Jr., Comdr ARDC to Gen. Thomas D. White, Chief of Staff, subj: (U) Headquarters ARDC Annual Effectiveness Report, 31 Jul 57.
5. Ltr. Comdr RADC to Comdr ARDC, subj: (U) Status of Frequency Diversity Radars, 19 Jun 57.
6. Memorandum, Headquarters ARDC, subj: (no classification given) Frequency Diversity Program, 14 Jan 57.
7. Ltr. Comdr RADC to Comdr ARDC, subj: (U) Status of Frequency Diversity Radars, 19 Jun 57.
8. Ibid.
9. Ltr. Col. Otto G. Quarrud, Director of Control & Guidance RADC to Comdr ARDC, subj: (U) AN/FPS-35 Radar, 17 Apr 57.
10. RADC Activity Report, Sept. 57, p. 8.
11. Ltr. Comdr. RADC to Comdr. ARDC, subj: (U) Status of Frequency Diversity Radars, 19 Jun 57; also Memorandum Headquarters ARDC, subj: (no classification given) Frequency Diversity Program, 14 Jan 57; also Ltr. Col. Otto G. Quarrud, to Comdr. ARDC, subj: (U) Status of Frequency Diversity Radars, 19 Jun 57.
12. Interview by the author with Mr. Arthur Frohlich, RCERHM, 3 Apr 58.
13. Ibid.
14. History of RADC 1 Jul 56 - 31 Dec 56, pp. 74-75.
15. Ltr. Mr. William T. Pope, RCER to Maj. L. Wynne, Hdqs USAF, subj: (no classification given) Justification for AN/FPS-28 Frequency, 17 Jul 57 and incl Memo.

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- 18. Interview by the author with Mr. Arthur Friedman, RSCM, 1 Apr 57.
- 19. Interview by the author with Mr. Arthur Friedman, RSCM, 21 Aug 57.
- 20. Mr. Friedman, RSCM to Comdr. ANCS, draft copy date not given, in files of RSCM, in Nov 57.
- 21. RADM Activity Report, Sept. 1957.
- 22. Mr. Friedman, RADM to Comdr. ANCS, draft copy, date not given, but in Nov 57.
- 23. Interview by the author with Mr. Arthur Friedman, RSCM, 1 Apr 57.
- 24. Ibid.
- 25. ANCS Form 11, subject: "The Distributed Area Learning of Four Space-Integrated Elements," 29 Aug 57.
- 26. Ibid.
- 27. ANCS Form 11, subject: "The Distributed Area Learning of Four Space-Integrated Elements," 29 Aug 57, also see Form 11, subject: "The Distributed Area Learning of Four Space-Integrated Elements," 29 Aug 57, 4 Dec 57.
- 28. History of RADM, 1957-1958, 1958, 1959, 1960.
- 29. Ibid.
- 30. Interview by the author with Mr. Irving Pincus, RSCM, 21 Sept 57.
- 31. Directorate (D) Test Directorate for Deployment and Sustainability Test of a Distributed Area Learning System, The CDR Robert A. Elder, ANCS to Comdr. RADM, subject: "Test Directorate for Deployment and Sustainability," 17 Oct 57.
- 32. Directorate (D) Test Directorate for Deployment and Sustainability Test of a Distributed Area Learning System.

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1. [Redacted]
 2. [Redacted]
 3. [Redacted]
 4. [Redacted]



REPORT ON THE PROGRESS OF THE WORK OF THE BOARD OF DEFENSE ENGINEERS

The Board of Defense Engineers was organized in 1917 to coordinate the work of the various engineering organizations in the Government and to advise the War Department on all matters pertaining to the engineering profession. The Board has since that time held numerous conferences and has issued many reports to the War Department. The following is a summary of the work of the Board during the year 1918.

The Board has held a number of conferences during the year, the most important of which were those held at the War Department in Washington, D.C., on the following dates:

January 15, 1918 - Conference on the subject of "The Engineering Profession in the War." This conference was attended by representatives of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Board of Defense Engineers. The subject of this conference was the position of the engineering profession in the war and the duties of engineers in the war.

February 1, 1918 - Conference on the subject of "The Engineering Profession in the War." This conference was attended by representatives of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Board of Defense Engineers. The subject of this conference was the position of the engineering profession in the war and the duties of engineers in the war.

March 1, 1918 - Conference on the subject of "The Engineering Profession in the War." This conference was attended by representatives of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Board of Defense Engineers. The subject of this conference was the position of the engineering profession in the war and the duties of engineers in the war.

April 1, 1918 - Conference on the subject of "The Engineering Profession in the War." This conference was attended by representatives of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Board of Defense Engineers. The subject of this conference was the position of the engineering profession in the war and the duties of engineers in the war.

May 1, 1918 - Conference on the subject of "The Engineering Profession in the War." This conference was attended by representatives of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Board of Defense Engineers. The subject of this conference was the position of the engineering profession in the war and the duties of engineers in the war.

June 1, 1918 - Conference on the subject of "The Engineering Profession in the War." This conference was attended by representatives of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Board of Defense Engineers. The subject of this conference was the position of the engineering profession in the war and the duties of engineers in the war.

July 1, 1918 - Conference on the subject of "The Engineering Profession in the War." This conference was attended by representatives of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Board of Defense Engineers. The subject of this conference was the position of the engineering profession in the war and the duties of engineers in the war.

August 1, 1918 - Conference on the subject of "The Engineering Profession in the War." This conference was attended by representatives of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Board of Defense Engineers. The subject of this conference was the position of the engineering profession in the war and the duties of engineers in the war.

September 1, 1918 - Conference on the subject of "The Engineering Profession in the War." This conference was attended by representatives of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Board of Defense Engineers. The subject of this conference was the position of the engineering profession in the war and the duties of engineers in the war.

October 1, 1918 - Conference on the subject of "The Engineering Profession in the War." This conference was attended by representatives of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Board of Defense Engineers. The subject of this conference was the position of the engineering profession in the war and the duties of engineers in the war.

November 1, 1918 - Conference on the subject of "The Engineering Profession in the War." This conference was attended by representatives of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Board of Defense Engineers. The subject of this conference was the position of the engineering profession in the war and the duties of engineers in the war.

December 1, 1918 - Conference on the subject of "The Engineering Profession in the War." This conference was attended by representatives of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Board of Defense Engineers. The subject of this conference was the position of the engineering profession in the war and the duties of engineers in the war.

[REDACTED]

Electronic Countermeasures Engineering Test Facilities

The mission statement for the Base Center explicitly directs that the Center will "provide and operate an electronic countermeasures (ECM) test facility to support ARDC Centers and other government agencies in ECM and EWM vulnerability testing."

It should be emphasized, however, that the facilities are to obtain engineering data on the equipment under test rather than to provide operational testing. Work on development of this activity had begun with a directive from Headquarters ARDC on 28 July 1962 when Base and the Wright Air Development Center were ordered to study jointly the requirements for a facility of this kind and to recommend a location for it. An ECW turned out. Base was selected in February 1963 to establish, maintain and operate a test site that could be used by all organizations responsible for research and development testing of airborne and ground electronic countermeasures equipment. Work on the site which was placed at Verona, New York, a few miles to the South West of Rome, began a short time later in May 1963. [REDACTED]

Employing a total of roughly sixty persons spread evenly between military and civilian, the ECM Test Branch of the Directorate of Intelligence and Electronic Warfare ran tests for approximately fifty different projects during 1963. The tests varied in length of time anywhere from one day to several weeks. About one half

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The procedures of the test were followed at the Virginia test site, and the test were conducted at the Center. █

The overwhelming majority of the tests conducted were on behalf of Air Force projects, since both the Navy and the Army have ECM test facilities of their own. Nevertheless the Center has been able to assist the Navy in its project through unique possession of the facilities of the AN-SPS, which were highly valued as targets of a test aircraft. Several assistants have also been given to the Army in carrying for their certain ground facilities. █

To provide the facilities for the lengthening range of new experiments to be conducted, the test center has had to expand and improve its ECM test facilities. In January, 1964, a major expansion program was initiated which placed considerable emphasis on the Center's capability to conduct the test of the latest chief test site at Ft. Belvoir. The test site at Ft. Belvoir was considered ideal for testing "high" altitude test ranges by the Royal Air Force, and the test site was expanded to include the test site at Ft. Belvoir. The test site at Ft. Belvoir was considered ideal for testing "high" altitude test ranges by the Royal Air Force, and the test site was expanded to include the test site at Ft. Belvoir. The test site at Ft. Belvoir was considered ideal for testing "high" altitude test ranges by the Royal Air Force, and the test site was expanded to include the test site at Ft. Belvoir. The test site at Ft. Belvoir was considered ideal for testing "high" altitude test ranges by the Royal Air Force, and the test site was expanded to include the test site at Ft. Belvoir.

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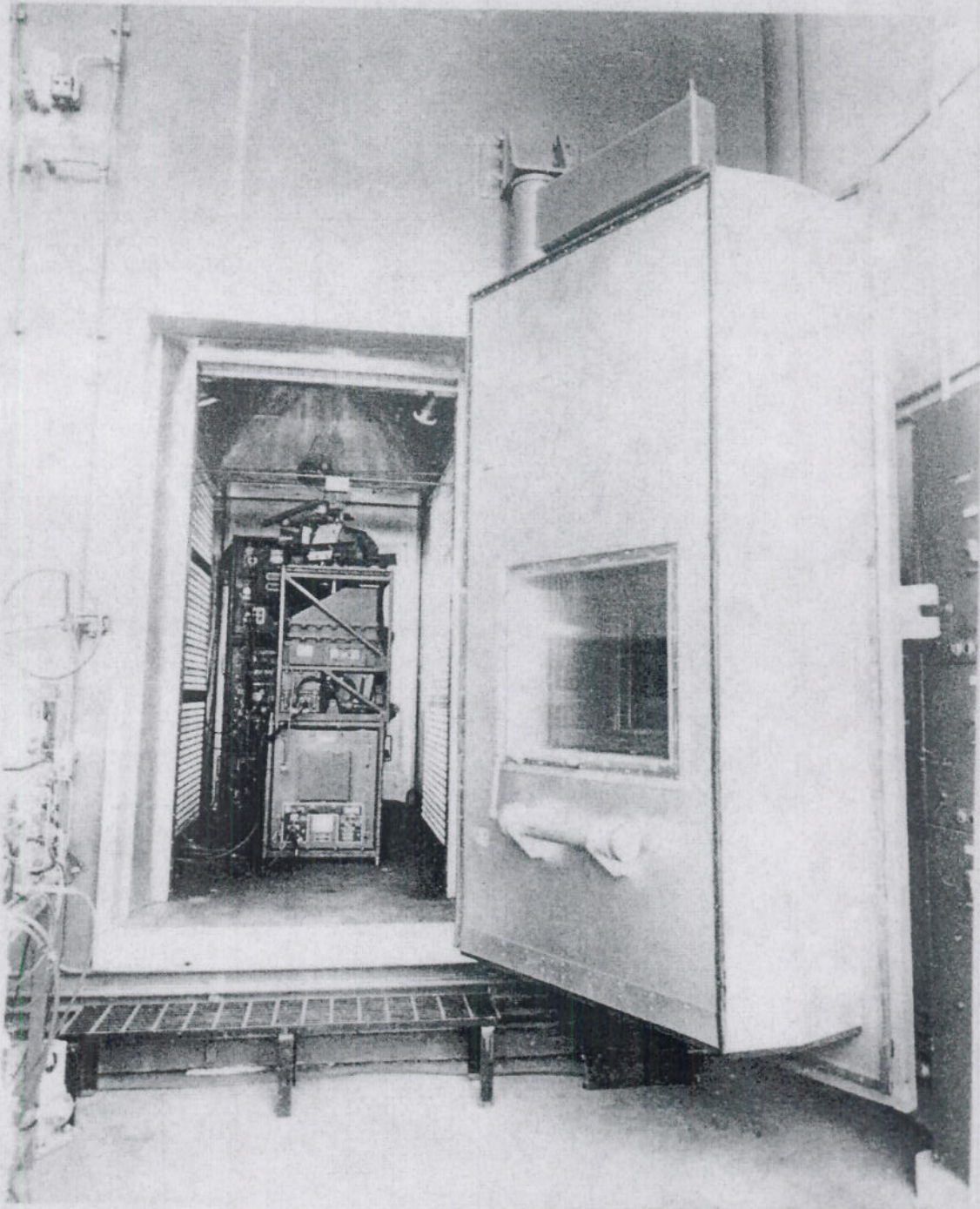
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A laboratory of the Department of Technical Services at the Royal Ordnance Factories, located at the site of the former Ordnance Factories, was established in 1944. This laboratory, which is now known as the Ordnance Research Laboratory, is intended to provide three main types of service in relation to the testing of explosives and pyrotechnics. The laboratory is divided into three main sections: (a) Explosives, (b) Pyrotechnics, and (c) Environmental and General Testing. The Explosives section is concerned with the development and testing of new explosives and the improvement of existing ones. The Pyrotechnics section is concerned with the development and testing of new pyrotechnics and the improvement of existing ones. The Environmental and General Testing section is concerned with the testing of explosives and pyrotechnics under various environmental conditions and the testing of the materials used in their manufacture. The laboratory is also concerned with the development and testing of new methods of testing explosives and pyrotechnics. The laboratory is staffed by a number of highly qualified scientists and technicians and is equipped with the latest testing equipment. The laboratory is open to the public and is a valuable source of information on the testing of explosives and pyrotechnics.

Approximately 75% of the present staff of the laboratory is employed on the testing of explosives and pyrotechnics. The remainder of the staff is employed on the testing of materials and the testing of the equipment used in the testing of explosives and pyrotechnics. The laboratory is also concerned with the development and testing of new methods of testing explosives and pyrotechnics. The laboratory is open to the public and is a valuable source of information on the testing of explosives and pyrotechnics.



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The results of these tests have been summarized in the Report
entitled "Development of a General Purpose Test Facility for the
Evaluation of the Performance of the Various Parts of the
Engine". This report is being prepared by the Engine Division
of the General Electric Company, and is being submitted to the
General Electric Company, and is being prepared by the Engine
Division of the General Electric Company.

During the past few years, the Engine Division of the
General Electric Company has been engaged in a program of
development of a general purpose test facility for testing
the various parts of the engine. This facility will enable
the various parts of the engine to be tested under conditions
which are similar to those which exist in the engine.
The results of these tests will be reported in a separate
report.

The results of these tests will be reported in a separate
report. This report is being prepared by the Engine Division
of the General Electric Company, and is being submitted to the
General Electric Company, and is being prepared by the Engine
Division of the General Electric Company.

between the radars of the U.S. Navy and the test
facilities Laboratory at Vicksburg, Mississippi, at the
site a radar complete installation, including radar
Dome equipment may be used in conjunction with flight tests
actual interference tests, radar in actual testing and a
variety of other purposes. The radar operators were
first class to Center engineers who have performed testing
and important themselves. Highly skilled workers and one of
hand the installation, main engine and research in the facility.

By the close of 1957, a great deal of the laboratory
facilities are available for use by the U.S. Navy and assigned
to the Vicksburg. This figure represents a great deal
of work during the budget year. The U.S. Navy
has cancelled the contract for the work of the workers.
The work of the workers is being done at a rapid pace
and it is hoped that the work will be completed.

How Engineers Help the Navy

Engineers have provided the means whereby the
location of each piece of equipment, water development and other
applications, and many other things. The Navy has
made available research facilities at the Naval Engineering
Laboratory of the Directorate of Technical Services to help
researchers solve the problems.

Prior to October 1957, the Basic Engineering Laboratory had only limited facilities to carry out these projects. Often it had to rely on a university contract or else utilize the laboratories in the Center and set up the special equipment necessary to carry out the research. In October 1957, however, a special research facility of the Basic Engineering Laboratory was established to help expedite these projects. A principal and technical staff were given full-time duties to assist in the design, operation and maintenance of the equipment placed in the special facility. The Basic Engineering Laboratory which three years before had research equipment valued at around \$10,000 had by early 1958 increased significantly. \$10,000 worth of gradual accumulation over the period. Since October 1957, the work out standing inventory of equipment in the facility was equipped with such items as signal generators, and amplifiers.

The research facility, reflecting the role of the Basic Engineering Laboratory, existed primarily to support the projects carried on by the Directorate of Intelligence and Electronic Warfare, Control and Guidance, and Communications. At any given moment, the research facility was ordinarily being used by members of the Basic Engineering Laboratory in support of a dozen or so projects for these various categories.

Organization of the new facility brought an appreciable saving of time and money to the Air Force. On the average it permitted fifty percent of time spent on a research problem in Human Engineering to be lepped off with an accompanying reduction of man hours and dollar savings. This was so because frequently equipments could be used many times for different projects without need to be reconstructed or reassembled each time a new problem arose. In instances where new equipments had to be provided, the head of the research facility, often in coordinated effort with other psychologists from the Human Engineering Laboratory, with project engineers and with members of the General Engineering Laboratory, arranged as best suited individual requirements for the design and construction of the equipment in the house at RADC.¹⁶

To give some appreciation of the nature of the facilities, there is for the study on vision, a light-sealed, air-conditioned dark chamber with an RADC visual sensitometer at hand. Adjoining this chamber is an acoustically treated and air-conditioned sound chamber and an audiometer for investigating characteristics of human hearing. Various other facilities involving such instrumentation as projectors, timing devices, simulated radar displays are similarly available.¹⁷

Flight Test and Instrumentation

One entire directorate at SACV composed of 243 military and civilians provided flight test support for Center groups and for other agencies. Missions flown by planes of the directorate covered virtually all sections of the United States and ranged out to areas as far from home as Trinidad, Bermuda, Panama, the Azores and Alaska. In the last half of 1957 some 3200 flight hours were logged, only a slight reduction from the past due primarily to budget restrictions.

To give more efficient and effective support the policy of the directorate in 1957 has been to phase out reciprocating engine aircraft for obvious reasons and to cut the inventory of single engine aircraft. The principal advantage of single engine aircraft for testing purposes in the past had been the higher altitudes to which they could fly. But with the delivery of B-47's to the Center this advantage had become negligible and of course multi engine craft could boast of greater range of operation. Elimination of single engine aircraft would also have the advantage of reducing the number of types of aircraft needed by the directorate and would lessen problems of maintenance and supply in proportion. A year and a half previously, the Center had maintained twelve different types of aircraft. By the close

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[REDACTED]

of 1957 that figure had been pared to seven; the ultimate goal was to settle at three or four types. This was to be accomplished in part by phasing out the single engine F-102's at the Center and the C-97.¹⁹

Aircraft available to the directorate at the close of 1957 included four B-47's, one C-97, two C-47's, one VC-47, four C-131's, one T-33 and three F-102's. To fly these aircraft the directorate could count on twenty-four duty pilots and four navigators. Maintaining the aircraft occupied 111 airman and 92 civilians of the directorate.²⁰

Off Base Developmental Sites

An important adjunct to research and development at the Rome Air Development Center are the off base sites which the Center uses to further its developmental program. Four of them, the AN/FPS-17 high power radar site at Laredo, Texas, the ionospheric communication facility at Carrabelle, Florida, the chaff test site at Malabar, Florida and the Down Range Missile observation site at Trinidad were located at obviously considerable distances from the Center. However, in the Rome area, the Center also maintained 14 off base sites. These sites close to the Center represented an acreage of 3,073 whose cost of replacement was estimated at \$12,798,000, including installations and equipment. Frequent reference has been made in other sections of the RADC history to the specialized (S)

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functions performed by these sites and an attempt will be made here to give a detailed breakdown of the developmental activities being performed at each.

For the local sites, material support was provided through the DCS Material of the Center. Technical aspects of developmental programs were of course under the supervision of the project engineers whose project was utilizing the site facilities. If the usefulness of the site for a given project should come to an end, the site can be transferred for use to other projects, or if the site has no further usefulness to the Center, steps can be taken to dispose of it as surplus property.

A list of the local off base sites including their size and cost of replacement as represented in the records of the DCS Material will supply a better idea of the extensive nature of these off base site facilities.

Off Base Sites

Distant Sites (5)

- | | | |
|--------------------|---|--------------------------------------|
| Laredo, Texas | - | AM FPS 17 site |
| Malabar, Florida | - | Chaff testing site |
| Carabelle, Florida | - | Atmospheric communication site |
| Trinidad, B.W.I. | - | Down Range Missile Observation Point |

(Cont'd on next page)

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Local Off Base Sites*

<u>Site</u>	<u>Acres</u>	<u>Cost to Replace</u>
Verona	511	\$1,000,000
Floyd	51	150,000
Forestport	187	1,500,000
Jervis Avenue	985	111,000
Navarro	228	1,000,000
Newport	25	300,000
Ava	150	900,000
Stockbridge	100	
Junker Hill	7	25,000
Starr Hill	7	25,000
Vienna	7	25,000
Dean Hill	7	
Clark Hill	7	
Peterboro	7	

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1. Technical Report, SFB Engineering Test Facility by S. D. Gorman, June 1957, pp. 22.
2. Interview by the author with Mr. Samuel Zadorny, ROWEE, 28 Feb 58.
3. Ibid.
4. Ibid.
5. Ibid. See also Technical Report, SFB Engineering Test Facility by S. D. Gorman, June 1957, pp. 1-2.
6. Ibid.
7. Ibid.
8. Ibid.
9. Interview by the author with Mr. John M. Thompson, RIST.
10. Ibid.
11. Ibid.
12. Ibid.
13. Ibid.
14. Interview by the author with Mr. Larry Thomas, RSM, 21 Mar 58.
15. Ibid.
16. Ibid.
17. NAA Technical Information Bulletin, Vol. 2, No. 40, Feb 1957, p. 3.
18. Interview by the author with Mr. Harold F. Patrick, RCF, and Capt. Edwards, RCF, 22 Mar 58.
19. Ibid.

20. Ibid.

21. Taken from files of RCMP, 21 Jan 58 by the author.

22. Interview by the author with Mr. Carl Taron. RCMP
21 Jan 58.

23. Taken from files of RCMP, 21 Jan 58, by the author.

GLOSSARY

AFORC	Air Force Cambridge Research Center
AFR	Air Force Regulations
AICBM	Anti-Intercontinental Ballistic Missile
AMC	Air Material Command
AM & F	American Machine & Foundry Company
AFPGC	Air Proving Ground Command
ARDC	Air Research and Development Command
Asst	Assistant
BMD	Ballistic Missile Defense
BMEWS	Ballistic Missile Early Warning System
Brig Gen	Brigadier General
Col	Colonel
Comdr	Commander
Comm	Communications
CGRA	Coherent Radar Array
DCS	Deputy Chief of Staff
DD	Development Directorate
Dep	Deputy
Dir	Director or Directorate
ECM	Electronic Countermeasures
EW	Electronic Warfare
GAFB	Griffiss Air Force Base
GE	General Electric Company
Gen	General
GOR	General Operation Requirement
ICBM	Intercontinental Ballistic Missile
Ind	Indoctrination
Intell	Intelligence
JAN	Joint Army Navy
Lt	Lieutenant
Ltr	Letter
Maj	Major
MC	Military Characteristics
Mem	Memorandum
GRACE	Professional & Scientific Recruiter
WRACT	Civilian & Military Career Development Branch

MAG	Teletype
MTI	Moving Target Indicator
No.	Number
PPI	Position Plot Indicator
RADC	Rome Air Development Center
RAFD	Rome Air Force Depot
R & D	Research & Development
RCA	Radio Corporation of America
RCA	Ajutant
RCC	DCS/Comptroller
RCE	Directorate of Control & Guidance
RCSM	Missile Support Laboratory of above
RCSM	Ballistic Missile Branch of above
RCSMI	Missile Instrumentation Branch
RCSMS	Missile Systems Implementation Branch
RCEM	Control Laboratory
RCEMG	Control Equipment Branch of above
RCENG	Guidance Branch
RCENS	Special Devices Branch
RCEP	Radar Laboratory
RCEPA	Antenna & Microwave Components Branch
RCEPD	Advance Development Branch
RCEHF	Search & Height Finding Branch
RCEHB	Radio Frequency Transmitter Branch
RCEP	Directorate of Flight Test
RCH	Commander, Headquarters Section
RCI	Inspector General
RCK	Director of Procurement
RCM	DCS/Materiel
RCN	Office of Information Services
RCNH	Center Historian
RCC	DCS/Operations
RCP	DCS/Personnel
RCS	Directorate of Technical Services
RCSG	General Engineering Laboratory of above
RCSH	Human Factors Laboratory of above
RCSST	Technical Information & Intelligence Branch
RCSSTL	Library Services Section
RCST	Test Facilities Laboratory
RCT	Scientific Director
RCYD	Director of R & D
RCYIM	Associate Director, R & D

BCU	Directorate of Communications
BCVA	Advanced Development Laboratory - Dir Comm
BCVE	Equipment Laboratory - Dir Comm
BCIQ	Operational Planning Office - Dir Comm
BCW	Dir of Intelligence & Electronic Warfare
BCWE	Electronic Warfare Laboratory - Dir Intell & EW
BCWI	Intelligence Laboratory - Dir Intell & EW
BFO	
Bp	Report
S	Secret
SARAC	Strategic Army
SD	Supporting Document
SJ	Staff Journal
SP	System Measurement
SPJ	Subject
TACAN	Tactical Control System
TPD	Tactical Plans & Programs Documents
TR	Tactical Report
U	Unclassified
UHF	Ultra High Frequency
USAF	United States Air Force
Vol-	Volume
WADC	Wright Air Development Center
WSPO	Weapons System Project Office

Personal symbol identification has in general been carried only to bracket level. This is adequate for identification of personnel cited in the notes as sources of information to the historian.

G A L L E R Y

Alpine, New Jersey
 Anchorage, Alaska
 Ave. New York
 Azores, North Atlantic Ocean

 Baffin Island, North East Canada
 Baltimore, Maryland
 Bermuda, West North Atlantic

 Cambridge, Massachusetts
 Cape Canaveral, Florida
 Cape Dyer, Arctic
 Carvabala, Florida

 Detroit, Michigan

 Fairbanks, Alaska
 Floyd, New York

 King Salmon/Nakolec, Alaska

 Laredo, Texas
 Liberty Dam, Maryland
 Los Angeles, California
 Lubbock, Texas

 Malabar, Florida
 Montgomery, Alabama
 Munich, Germany

 New York City, New York
 Nikolski, Arctic

 Palos Verdes, California
 Point Barrow, Alaska

 Quantico, Virginia

 Redbank, New Jersey

 Saugan, New York
 Springfield, Massachusetts
 Stockbridge, New York
 Stony Point, New York

Isle, Greenland
Trinidad, British West Indies
Verona, New York
Westover AFB, Massachusetts

APPENDIX A

Technical Reports, Notes, and Memoranda published at RADC
(July 1, 1957 - December 31, 1957)

July 1957

- RADC-TR-56-152 - Subj: (U) First Article Approval of Electron Tube Tubes (Electron) No. F. V. 4728 & V. 4729.
- RADC-TR-57-101 - Subj: (U) Investigation of Properties of Neutronic Materials for the Microwave Region Journal 3-16 - Abstract.
- RADC-TR-57-105 - Subj: (U) High-Power Radar Operations Frequency Effects.
- RADC-TR-57-110 - Subj: (U) A Self-Contained Interference Filter for Radar Receivers.
- RADC-TR-57-144 - Subj: (U) RADC Reliability Program, Past, Present, & Future.
- RADC-TR-57-156 - Subj: (U) The RADC Visual Spectrometer.
- RADC-TR-57-1 - Subj: (U) A Low Noise HEP Amplifier.

August 1957

- RADC-TR-57-211 - Subj: (U) Radio Visual Interference Tests.
- RADC-TR-57-2 - Subj: (U) Preliminary Study on the Implementation of the Miles Projector Research System.
- RADC-TR-57-2 - Subj: (U) Use of Z-Plane in Determining Velocity Responses for Staggered IIR.
- RADC-TR-57-1 - Subj: (U) Regulatory Interpolation Achieved with aid of High Speed Digital Computer

September 1952

- RADC-TR-57-109 - Subj: (U) Theory of Generation & Evaluation of Two- and Three-Dimensional A/P-R-IT.
- RADC-TR-57-157 - Subj: (U) A Further Investigation of Tropo-spheric Microwave Refraction at 3000 Mc.
- RADC-TR-57-201 - Subj: (U) Site Survey for Microwave Relay Station.
- RADC-TR-57-202 - Subj: (U) Cloud Coverage at Point B. J.
- RADC-TR-57-303 - Subj: (U) The Effects on Radio-Propagational Characteristics Due to Ionospheric Fluctuation in the Presence of Field-Aligned Ionization.

October 1952

- RADC-TR-57-217 - Subj: (U) Analysis of Various Electronic Instruments Reliability & Equipment Techniques from the User's Viewpoint.
- RADC-TR-57-214 - Subj: (U) Visual Acuity & Light Adaptation.
- RADC-TR-57-215 - Subj: (U) The Electroforming Technique Used in the Fabrication of A Broad Band Single Picked Intake.
- RADC-TR-57-317 - Subj: (U) Constant Amplitude Search.

November 1952

- RADC-TR-57-248 - Subj: (U) High Loss Microwave Filters.
- RADC-TR-57-257 - Subj: (U) Evaluation of 9TL-118 Traveling Wave Tube.
- RADC-TR-57-256 - Subj: (U) Modulated Microwave Tubes.
- RADC-TR-57-249 - Subj: (U) The Self Late 1174 Program.

Inventory List

- RDIC-77-7-165 - Subj: (U) Methods of Soil Sampling - Environmental
and Agricultural.
- RDIC-77-7-163 - Subj: (U) Non-Degraded and Stable Storage
in a Weather Site.
- RDIC-77-7-169 - Subj: (U) Available Recommendations for In-
struction and Repair Work in
the Soil/Soil Layers.
- RDIC-77-7-174 - Subj: (U) Technical Evaluation of a Field
and Construction Site.
- RDIC-77-7-373 - Subj: (U) Investigation of a Soil Sample
Report - Construction Site, USA, 1974.
- RDIC-77-7-394 - Subj: (U) Investigation of a Soil Sample Since
some Problems in Initial Report.
- RDIC-77-7-393 - Subj: (U) Field Soil Sampling Techniques.
- RDIC-77-7-383 - Subj: (U) Investigation of the
Field, Chemical Laboratory, USA.
- RDIC-77-7-2 - Subj: (U) Development Reports for Ground
and Phase of Inert Location.
- RDIC-77-7-4 - Subj: (U) Notes on Techniques and Developments.
- RDIC-77-7-6 - Subj: (U) Investigation of an Initial Report, some
notes.
- RDIC-77-7-2 - Subj: (U) Investigation on the Chemistry of
Soil Sampling.
- RDIC-77-7-1 - Subj: (U) Notes on the various reports and
related reports.

APPENDIX B

Civilian Personnel Status As Of 30 November 1957:

Total Permanent Authorization	1293
Total Assigned Personnel	1204
Percentage Of Engineer Assigned	28%
Percentage of Engineering Aide Assigned	3%
Percentage of Engineering Technicians Assigned	6%
Percentage of Admin & Clerical Assigned	38%
Percentage of Wage Board Assigned	19%
Number and Percentage of Promotions	27 2%
Number and Percentage of Usins	9 .01%
Number and Percentage of Loss	24 2%
Downgrades	0
Rate of Turnover	1.2%
Total Vacancies	1

Statistics Taken From a Report of the Office of DCS/Personnel
of 30 November 1957.

APPENDIX C

Military Personnel Status as of 4 October 1957*I. Personnel:

<u>Strength</u>	<u>Authorized</u>	<u>Assigned</u>
R & D Officers	76	65
Pilots	26	20
Navigators	5	7
Other	46	38
	<u>153</u>	<u>130</u>
Airmen	138	154
Civilians	1301	1339

* Statistics Taken from Monthly Personnel Status Report
issued by DCS/Personnel, 4 Oct 57.

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