Central Intelligence Agency

Washington, D.C. 20505

3 May 2022

John Greenewald, Jr.
27305 W. Live Oak Road
Suite #1203
Castaic, CA 91384

Reference: F-2018-01262

Dear Requester:

This letter is a final response to your 28 March 2018 Freedom of Information Act (FOIA) request for **records, electronic or otherwise, of the following: History of the Office of Research and Development, Volumes 1 through 6.** We processed your request in accordance with the FOIA, 5 U.S.C. § 552, as amended, and the CIA Information Act, 50 U.S.C. § 3141, as amended. Upon further review, we determined we were already processing a request for this information in connection with an earlier FOIA request received prior to yours. We cross-referenced your request to the earlier one in order to send you any records that were found to be releasable.

As a result of our search undertaken in connection with the earlier request, we located three documents, which comprise the complete History of the Office of Research and Development. We determined this material can be released in segregable form with deletions made on the basis of FOIA exemptions (b)(1), (b)(3), (b)(4), and/or (b)(6). Exemption (b)(3) pertains to information exempt from disclosure by statute. The relevant statutes are Section 6 of the Central Intelligence Agency Act of 1949, as amended, and Section 102A(i)(l) of the National Security Act of 1947, as amended.

As the CIA Information and Privacy Coordinator, I am the CIA official responsible for this determination. You have the right to appeal this response to the Agency Release Panel, in my care, within 90 days from the date of this letter. Please include the basis of your appeal.

Please be advised that you may seek dispute-resolution services from the CIA FOIA Public Liaison or from the Office of Government Information Services (OGIS) of the National Archives and Records Administration. OGIS offers mediation services to help resolve disputes between FOIA requesters and Federal agencies. Please note, contacting CIA's FOIA Public Liaison or OGIS does not affect your right to pursue an administrative appeal.

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Sincerely,

Anthony J. Capitos
Information and Privacy Coordinator

Enclosures

~~Secret~~

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CIA HISTORICAL STAFF

The Directorate of Science and Technology Historical Series

OFFICE OF RESEARCH AND DEVELOPMENT 1962-70

VOLUME I TEXT AND APPENDIXES

~~Secret~~

ORD-1

December 1972

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The DD/S&T Historical Series

ORD-1

OFFICE OF RESEARCH AND DEVELOPMENT 1962-70

VOLUME I TEXT AND APPENDIXES

by

Members of ORD Staff
edited by [redacted] (b)(6) (b)(3) CIAAct
and Helen H. Kleyla

December 1972

[redacted] (b)(6)

for Carl E. Duckett
Director for
Science and Technology

HISTORICAL STAFF

CENTRAL INTELLIGENCE AGENCY

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FOREWORD

"Research and Development" is a much-used phrase in this modern age. The application of new technology can be viewed in every aspect of daily life. However, advancing technology has also made the security of the United States more difficult to maintain. The Intelligence Community must use all available means, including the most sophisticated technological methods, to collect and analyze information from which intelligence estimates can be made.

The Central Intelligence Agency must provide the leadership and direction for the exploitation of advanced technology for intelligence purposes. A major responsibility of the Office of Research and Development is to assure that CIA is in the forefront of technology.

The writing of this history of the Office of Research and Development and the associated monographs was initiated at the end of 1967 and accomplished during 1968 through the efforts of many members of the ORD staff. The first draft of the history was prepared under the editorship of [redacted] Special Assistant

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to the Director of Research and Development. Special mention is made of the role played by [redacted] Secretary to the Director of Research and Development, in coordinating the preparation of graphs and charts, typing of manuscript, and other tasks related to this endeavor.

Following review and editing by the CIA Historical Staff, a revision of the main text of the history was produced by the Historical Officer of the Directorate for Science and Technology, Mrs. Helen H. Kleyla, to bring the history forward to 1970, and to standardize the format of the various sections for publication.

OFFICE OF RESEARCH AND DEVELOPMENT 1962-1970*

TABLE OF CONTENTS

*Cut-off date for Chapter IV, and Monographs in Volumes II and III, is 1968.

CHAPTER I

OFFICE OF RESEARCH AND DEVELOPMENT
1962-1970

I. Introduction

A. Directorate for Research Established, 1962

During the late 1950's, in an atmosphere of growing U.S. concern over Soviet technological advances, particularly in strategic weaponry, the Central Intelligence Agency was under pressure to improve the level and quality of scientific intelligence being produced for the guidance of top U.S. policymakers. White House level scientific advisers, in particular the President's Foreign Intelligence Advisory Board (PFIAB), encouraged the coordinated exploitation of all technological capabilities available, both inside government and in the industrial and academic scientific communities.

The creation of a separate directorate within CIA, in which all scientific and technical assets would be brought together under a Deputy Director immediately responsive to the DCI's needs, was one of the first organizational changes proposed by Mr. John A. McCone, Director of Central Intelligence, when he took office on 29 November 1961. The proposal was strongly supported by Dr. Herbert Scoville, then Assistant Director for

Scientific Intelligence, under the Directorate of Intelligence. On 16 February 1962, Headquarters Notice 1-9 announced the establishment of the Office of the Deputy Director for Research, and the appointment of Dr. Scoville as the DD/R, effective 19 February 1962.

The original concept of the DD/R was to encompass all scientific activities of CIA, without exception, from research and development being conducted in various offices of the DD/I, DD/S, and DD/P, through technical collection operations, including electronic and photographic reconnaissance, to the analysis and production of scientific intelligence. Between the announcement of the DD/R's establishment in February, and the end of July 1962, the decision was reached to limit the scope of the DD/R temporarily, in deference to the strong proprietary interests of the other Directorates.

B. Office of Research and Development Established Under DD/R

During consideration of the transfer of all research and development in CIA to the DD/R, the proprietary interests of the other Directorates were unequivocally upheld. In support of the position of Technical Services Division of the Plans Directorate, the DD/P, Mr. Helms, advised Mr. Lyman B. Kirkpatrick, Inspector General of CIA and Chairman of the Working Group on Organization established by Mr. McCone

> ...Although a good case can be made for placing responsibility for all research and development within one component of the Agency, there are sound reasons for leaving certain research and development activities within the Clandestine Services. For example, I think it is advantageous in the development of technical equipment for agent operations to have the developing component closely associated with the using elements of the Clandestine Services and immediately responsive to the operations officer's requirements. Furthermore, I think that a good case can be made for fixing total responsibility for sensitive clandestine operations on the Clandestine Services to include the developing, testing, and use of the hardware which supports them, particularly in those cases when despite the high degree of security observed, inadvertent reference to the technical aspects of an operation might destroy it. 1/

The Working Group on Organization recommended in its final report, issued in April 1962, that all TSD research and development be placed under the DD/R. However, in view of what was considered a necessary overlap between R&D and operations, it was suggested as a general rule (granting some exceptions) that when operations began, responsibility for them should be the DD/P's, but that the DD/R should retain responsibility for seeing that the equipment he had developed continued to function properly. 2/ This recommendation was not carried out.

A special plea was made for the retention by the National Photographic Interpretation Center (NPIC) of its technical development program as an integral component of NPIC lest its removal lead to a deleterious effect on the Center's state of readiness to receive any and all reconnaissance program materials for efficient and timely analysis. Mr. Arthur C. Lundahl, Director of NPIC, supported this plea with the promise of close working relationships in particular regard to budgetary and procurement matters of joint interest to the DD/R and NPIC. 3/

The Working Group on Organization recommended with regard to R&D of Sigint collection equipment, including agent equipment as well as airborne, that the question of which of these activities should be transferred to DD/R should be a matter of negotiation and agreement between the DD/I and the Director of Communications. The Working Group, on the other hand, recommended the transfer of all R&D in support of NPIC to the DD/R. 4/

In view of positions taken with regard to the various areas of research and development, and to the other scientific and technical assets of the Agency intended for transfer to DD/R, it was some time before the make-up of the new Directorate was firm enough to publish. On 30 July 1962, Headquarters Notice 1-23 announced the establishment within DD/R of three Offices: the Office of Elint, the Office of Special Activities, and the Office of Research and Development. In the case of all three Offices the assets and responsibilities transferred to them from other Directorates represented compromises to some degree. Unlike OEL and OSA, whose programs and personnel were transferred to them <u>en bloc</u>, ORD began as a paper concept with no table of organization and no budget, and with a small cadre [redacted] (b)(3) CIAAct seconded from TSD to ORD until the latter Office was organized and slots made available.

In the initial planning for ORD, the Assistant DD/R, Colonel Edward B. Giller,* was given the additional assignment of Acting Assistant Director of Research and Development, effective 29 November 1962,** and in that capacity furnished interim leadership to ORD in developing an organizational structure, establishing programs, and recruiting qualified staff.

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*Col. Giller, an Air Force assignee to CIA, served as Asst. Chief, and Chief, TSD, between 1959 and 1962. He previously served as Director of Research of AFSWP from 1954 to 1959.

**HN 20-73, 7 December 1962.

CHAPTER II

II. Organization of ORD

A. ORD Mission and Responsibilities

The drafting of a Mission and Functions Statement for ORD hung upon the reaching of an agreement among the parties involved as to which assets and responsibilities would be transferred to ORD from the other Directorates. A statement of mission as presented by Dr. Scoville, the DD/R, to the CIA Comptroller on 19 October 1962, in support of a request for authorization of manpower for ORD, read

> HN 1-23, published 30 July 1962, placed the responsibility on the Deputy Director (Research) to conduct in depth research and development in the scientific and technical fields to support intelligence collection by advanced technical means. This was to be exclusive of those research and development activities to support agent operations, NPIC, and the Office of Communications. In order to provide a capability to accomplish this mission, the Office of Research and Development has been formed in concept. While a preliminary Table of Organization and budget have been approved, the necessary manpower slots, funds, and physical space have not been authorized.
>
> At present, the mission of the Office of Research and Development is conceived to be that of developing intelligence applications from technological discoveries, the operation of such applications and the conception of ways and methods by which operational analysis may maximize the effectiveness of such collection operations...5/

The ORD Mission and Functions Statement, intended to be included with those of the other Offices of the Directorate in [redacted] (b)(3) CIAAct was first drafted late in 1962 and redrafted intermittently in succeeding years, but it remained in limbo until the end of 1970. The scope of ORD's responsibilities could not be agreed between the DD/R (later the DD/S&T) and the other Directorates, particularly the DD/P, who feared the intrusion of ORD into the area of overseas operations. In July 1967, the DCI approved a plan to give the DD/S&T responsibility for the central coordination of all Agency research, development, and engineering programs, while maintaining decentralized execution of projects. A particular objective of this procedure was to facilitate communications between elements of the Agency conducting research and exploratory development, those concerned with development and engineering directly supporting operational units, and those responsible for operations. After this procedure was established by [redacted] on 17 July (b)(3) CIAAct 1967, three more years passed before a revised version of the ORD Mission and Functions was agreed with the DD/I and the DD/P. It was sent to Regulations Control Branch for publication under [redacted] on 10 December 1970. 6/

(b)(3) CIAAct

The description of ORD functions as finally accepted excluded from ORD responsibilities "research and development activities which are specifically delegated to other Agency technical offices" and went on to list nine explicit functions assigned to the Director, ORD.*

The difficulties encountered in drawing up ORD's terms of reference and obtaining the consent of the other Directorates to publish them are indicative of the delays which slowed its organizational process and precluded a clear definition of its spheres of activity.

B. Original Components of ORD

The organizational structure** planned for ORD as its first mission statement was being drafted consisted of a research division, to be concerned with the broad scope of science and the uses of new advances and concepts for intelligence purposes; a systems division, responsible for translating promising ideas (other than those falling into OSA or OEL technical collection areas) into collection systems, their procurement, testing, and deployment to the field; and an analysis division primarily of in-house assets, concerned

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*See fig. 1, p. 9.

**See fig. 2, p. 11.

 [redacted] (b)(3) CIAAct

d. OFFICE OF RESEARCH AND DEVELOPMENT

(1) MISSION. The Director of Research and Development is responsible for the investigation of scientific and technological developments relevant to the accomplishment of the Agency's mission.

(2) FUNCTIONS. The Director of Research and Development fulfills his responsibility through the application of knowledge obtained from various technical disciplines. This responsibility does not include research and development activities which are specifically delegated to other Agency technical offices. The Director of Research and Development will

(a) develop and implement, in coordination with other RD&E offices of the Agency, basic and applied research, plans, and programs to support the intelligence process;

(b) provide conceptual analysis as to the technical feasibility of advanced intelligence systems;

(c) conduct research and feasibility studies on techniques, components, and systems of common technical concern;

(d) monitor research conducted by private enterprise and the academic community and, through appropriate adaptations, make its benefits available to the Agency and its mission;

(e) incorporate, as appropriate, the techniques, procedures, equipment and systems derived from an evaluation of world-wide research and development programs as well as scientific discoveries;

(f) conduct liaison with other U.S. Government agencies performing advanced research and development and identify those findings which may have an intelligence application;

(g) initiate and administer specific external contracts in support of approved research and development programs;

(h) provide appropriate support to the Agency Science and Technology Panel and other similar organizations;

(i) assist in the dissemination of new technology to other Agency components.

(3) ORGANIZATION. See organization chart, figure 6.

Figure 1

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with analysis of the complex priority target systems against which intelligence collection efforts were required (such as the Soviet ABM system).

Once the request for an ORD Table of Organization of (b)(3) CIAAct [redacted] positions had been approved by the DD/S in September 1962, and approval confirmed by the DDCI in November 1962, first steps were taken to organize ORD; however, rather than developing the three functional divisions first proposed to the Comptroller by Col. Giller and Dr. Scoville, ORD was reoriented along the lines of the principal scientific disciplines in which work was expected to proceed. In January 1963 several research projects were transferred to ORD from TSD and DPD, and (b)(3) CIAAct [redacted] TSD staff officers (in addition to Col. Giller) chose to accept transfer to ORD becoming the nucleus of its staff. One of these, Mr. Harry Woo, was named Acting Deputy Assistant Director of ORD, as well as Chief of the Optics Division. Under Col. Giller's direction, he set up the small ORD staff under five scientific disciplines: optics, electronics, physics, and life sciences, each staffed with [redacted] and earth sciences, (b)(3) CIAAct [redacted] and later dropped.* (b)(3) CIAAct

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*See fig. 3, p. 12.

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OFFICE OF RESEARCH AND DEVELOPMENT

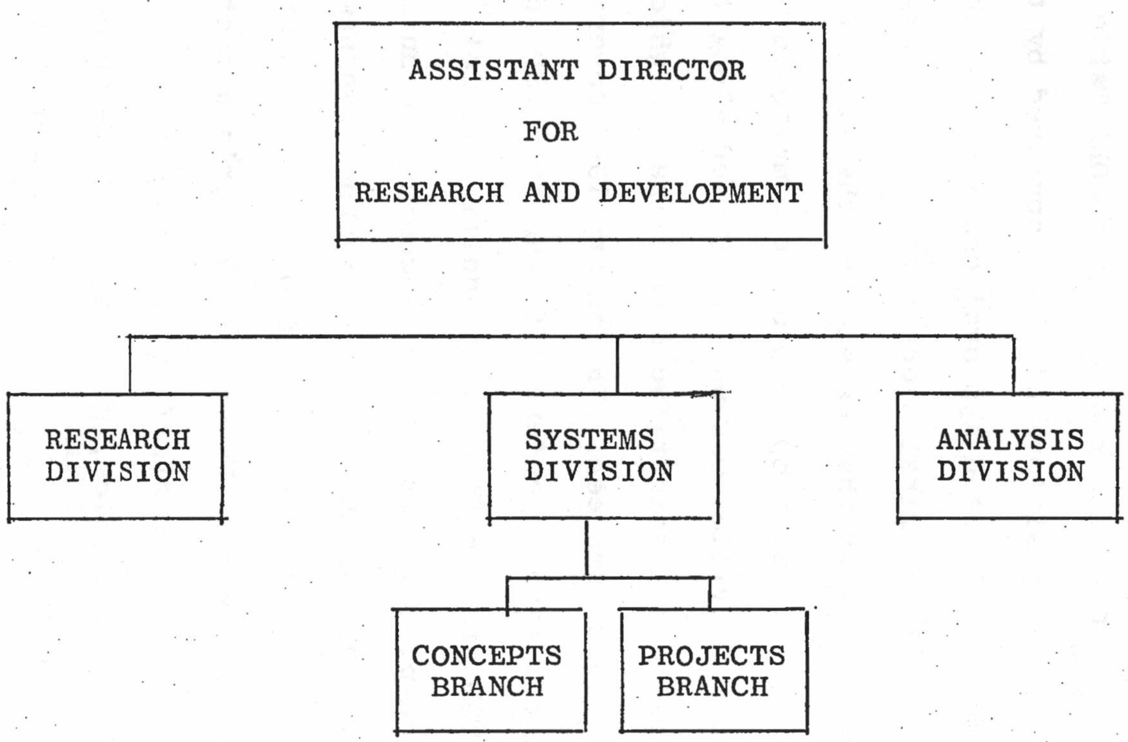

Figure 2 - Original Concept
September 1962

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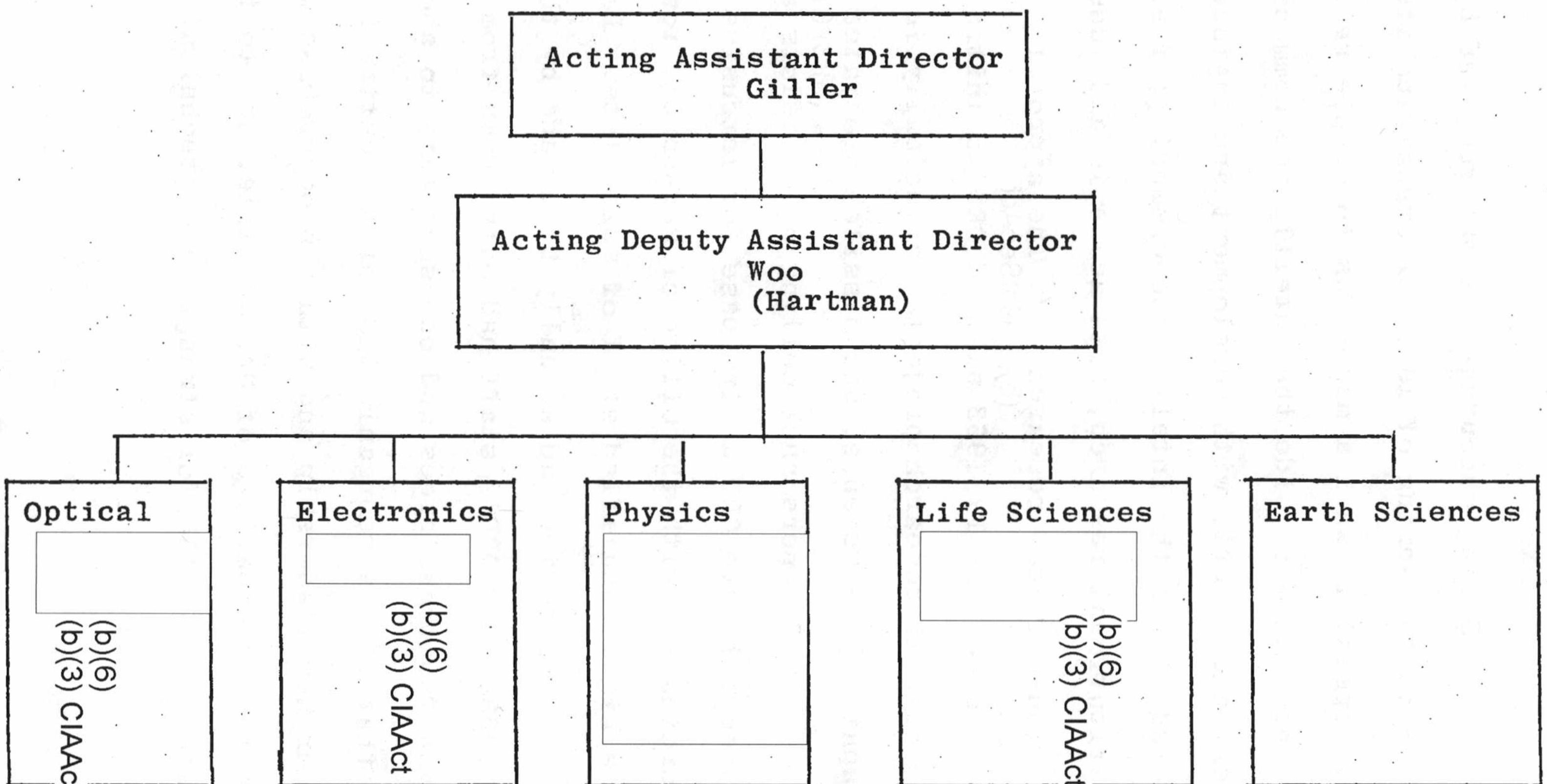
OFFICE OF RESEARCH AND DEVELOPMENT



Jacobsen - Full time student

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Figure - Working Concept
FY 1963

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Strong encouragement was received by CIA from PFIAB in the spring of 1963 for organizing its research and development in such a manner as to couple research (basic science) done outside the intelligence community, both overt and covert, with development and engineering conducted within the intelligence community; i.e., to join institutional research, both academic and industrial, to mission-oriented research. 7/ The approval [redacted] (b)(3) NatSecAct [redacted] budget for FY 1963 allowed ORD to initiate a program of external research projects, principally in the photographic, life science, and missile-associated areas.

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The personnel ceiling of [redacted] slots against which to recruit gave ORD a firm base for intensive efforts, in coordination with the Office of Personnel, toward building up a highly qualified staff of scientists. Little progress in this direction had actually been made by the end of FY 1963, when ORD's staff had only grown from the original seven TSD transferees and one secretary to about fourteen. At that time a reorganization of the entire Directorate under new leadership and with a broader base was foreseen, due to the departure of Dr. Scoville, and to the continued pressure by PFIAB for strengthening technical capabilities.

CHAPTER III

III. Development of ORD

A. Organizational and Staff Changes, 1963-70

The lively interest of Dr. Scoville in the build-up of ORD began slowly to fade as he became disillusioned with the prospects for molding the Research Directorate into its preconceived form and endowing it with centralized control of all scientific capabilities of CIA in support of the DCI's requirements. His frustration led him, in May 1963, to submit his resignation to the DCI, effective 14 June 1963. Colonel Giller was Acting Deputy Director (Research) for the next seven weeks, while plans were developed by the DCI and his staff to bring the Directorate up to the level originally envisioned for it, and urged upon CIA by the PFIAB.

The Directorate was reorganized as the Directorate of Science and Technology under the aggressive leadership of Dr. Albert D. Wheelon, eminent young physicist recruited from Space Technology Laboratories to succeed Dr. Scoville as AD/SI. The Office of Scientific Intelligence and the Agency's computer assets were added to the Directorate, and a foreign missile and space analysis center was promised for future development. At the same time a reexamination was held into the question of where the balance of TSD's research and development activities should be located. The DD/P, Mr. Helms, concluded in August 1963 that they should remain with TSD since their transfer to ORD would be no net gain to the Agency. He recommended that the DD/S&T, Dr. Wheelon, in the assumption of his new duties, satisfy himself personally on this point by a review of TSD personnel and programs, which were oriented strongly towards applications engineering and hardware development, providing close-in support for clandestine agent operations.

Dr. Wheelon's recommendations, at the time of the reorganization of the Directorate, had included placing on the DD/R responsibility for review of the total Agency R&D budget and the exercise of continuous technical and program surveillance through the R&D Review Board, which the DD/R would chair. The actual research would be carried out in the most appropriate Agency component, as determined by the DDCI and DD/R, jointly. Dr. Wheelon felt strongly that the entire R&D budget should be provided to the DD/R, who would distribute funds to the various R&D components according to a certified plan. 8/ A compromise arrangement, approaching but not going as far as the Wheelon recommendation, was carried out at the DCI's direction four years later, in July 1967, a year after Dr. Wheelon's departure from the Agency.*

The appointment of Mr. Robert M. Chapman as Deputy Assistant Director of ORD was announced with effective date of 9 September 1963, a month after Dr. Wheelon took over as DD/S&T. Mr. Chapman was recruited from the Geophysics Corporation of America where he had been a Vice President, and Manager of the Viron Division. His background included wide experience as a physicist and as a scientific manager in industry. Colonel Giller continued to wear two hats until his tour with the Agency ended on 2 May 1964, and Mr. Chapman was made Acting Assistant Director effective 4 May 1964. Mr. Chapman's availability to reinforce ORD's leadership in its build-up period, from the time of his appointment for several months afterward, was lessened somewhat by the pre-emption of his services on almost a fulltime basis by the DD/S&T for urgent special assignments.**

In November 1963, Dr. Wheelon approved an organizational concept for ORD encompassing four areas of research and development: Optics Division, Physics-Chemistry

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*See III-B-2, pp. 46-47, below, and p. 7, <u>supra</u>.

**See Monograph entitled "Photo Working Panel" appended to this history for an important assignment given Mr. Chapman.

Division, Radio-Physics Division, and Life Sciences Division.* In addition to Mr. Chapman, another Deputy Assistant Director (for Life Sciences), Dr. Stephen L. Aldrich, was appointed, being transferred to ORD from the Office of Scientific Intelligence in October 1963. At the same time, (b)(6) (b)(3) CIAAct [redacted] was added to the ORD Staff as Special Assistant to the Deputy Assistant Director for Life Sciences to provide liaison and administrative support.

By November 1963, the ORD Staff had increased to a total of 30, including clerical assistants. A new Scientific Pay Schedule had been instituted by the Agency at the DD/R's request, effective 13 April 1963 [redacted] (b)(3) CIAAct for scientific positions involving the major scientific programs, and research in specialized scientific fields, and ORD in July 1963 was awarded seven of these SPS slots, plus five Supergrades. The ability to compete salary-wise in the market for scientific personnel provided a more favorable atmosphere for acquiring the specialized talent needed by ORD.

From the time when ORD began to take form in late 1962, and continuing until October 1963, administrative

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*See fig. 4, p. 18.

OFFICE OF RESEARCH AND DEVELOPMENT

- **Acting Asst. Director** — Giller
  - **Deputy Asst. Director** — [redacted] (b)(6) (b)(3) CIAAct
  - **Deputy Asst. Director, Life Sciences** — [redacted] (b)(6) (b)(3) CIAAct
    - Asst. t[redacted]
  - **Admin. Officer** — [redacted] (b)(6) (b)(3) CIAAct
  - **Optics Division** — C - Woo [redacted] (b)(6) (b)(3) CIAAct
  - **Physics-Chemistry Division** — C - [redacted] (b)(6) (b)(3) CIAAct
  - **Radio-Physics Division** — C - [redacted] (b)(3) CIAAct (b)(6)
  - **Life Sciences Division** — Tech Mgr [redacted] (b)(6) (b)(3) CIAAct

Figure 4 - Table of Organization
November 1963

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functions were handled by the Support Staff of the Office of the DD/R (later the O/DDS&T). As activities in ORD increased, the need for an administrative officer assigned directly to ORD was felt, and Mr. James J. Connolly, who had been previously assigned as a technical officer in the Optics Division, was transferred to that position in September 1963. A Budget and Fiscal Officer, [redacted] (b)(3) CIAAct (b)(6) formerly of DD/P, was added in March 1964, due to increased financial activities, especially in regard to external research contracts. Support functions were thus transferred from the Directorate level to the Office level by mid-1964, except for Security, which was not added until August 1967, when [redacted] (b)(3) CIAAct (b)(6) formerly of the DD/S&T Security Staff, was appointed ORD Security Officer.

In March 1964, a Special Assistant to the Acting Assistant Director, Mr. Chapman, was assigned, namely Mr. W. Stanley Bull, Jr., who moved to ORD from the Office of Special Activities where he had been Planning Officer with responsibility for reconnaissance program requirements, support, and fiscal management. His transfer was for the purpose of strengthening ORD areas of management coordination and administration. He later became Executive Officer of ORD, with general responsibility for managerial support functions and for coordination of administrative and fiscal planning, and for internal and external liaison.

The first change in the organizational set-up of ORD at the divisional level after November 1963 was the institution of an Analysis Division in June 1964 under the leadership of [redacted] (b)(6) (b)(3) CIAAct. Its purpose was to fulfill the requirement for research into new procedures to aid intelligence analysts in the handling of the ever-growing masses of raw intelligence being collected.*

Another Special Assistant to the Acting Assistant Director for R&D was assigned effective 16 November 1964. [redacted] (b)(6) (b)(3) CIAAct who had been Chief of the General Sciences Division, OSI, was reassigned to ORD to provide guidance and assistance to the AD/RD in the formulation, definition, and execution of technical programs. This reassignment was made on the basis of [redacted] (b)(6) (b)(3) CIAAct previous experience in the analysis and production of intelligence which gave him the background needed to orient the technical project officers assigned to ORD in the performance of their R&D duties. [redacted] (b)(6) (b)(3) CIAAct title was changed early in 1967 from "Special Assistant" to "Scientific Advisor.")

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*See Chapter IV, Section A, below.

In February 1965, as a result of work initiated within the Radio-Physics Division in December 1963, an Audio-Physics Division was set up with Mr. David L. Christ as Chief. Its primary purpose was the fulfillment of requirements set by the National Security Council's NSAM-170 in October 1962, for audio surveillance and counter audio protection of the U.S. Government and its installations.

On 19 March 1965, Mr. Chapman was confirmed in his position as Assistant Director for Research and Development, effective 11 March 1965, by HN 20-197.

The Life Sciences Division in June 1965 was reorganized as two divisions: Biological Sciences Division, with [redacted] as Chief, and Medical and Behavioral Sciences Division, with [redacted] as Chief. This division of functions was due to the increasing size and complexity of Life Sciences Division's programs which it was believed would be more manageable if organized under the two separate disciplines.*

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The Table of Organization of ORD as of the end of June 1965 showed seven active Divisions, after the above-described changes were effected, with a staff of [redacted] on duty.**

(b)(3) CIAAct

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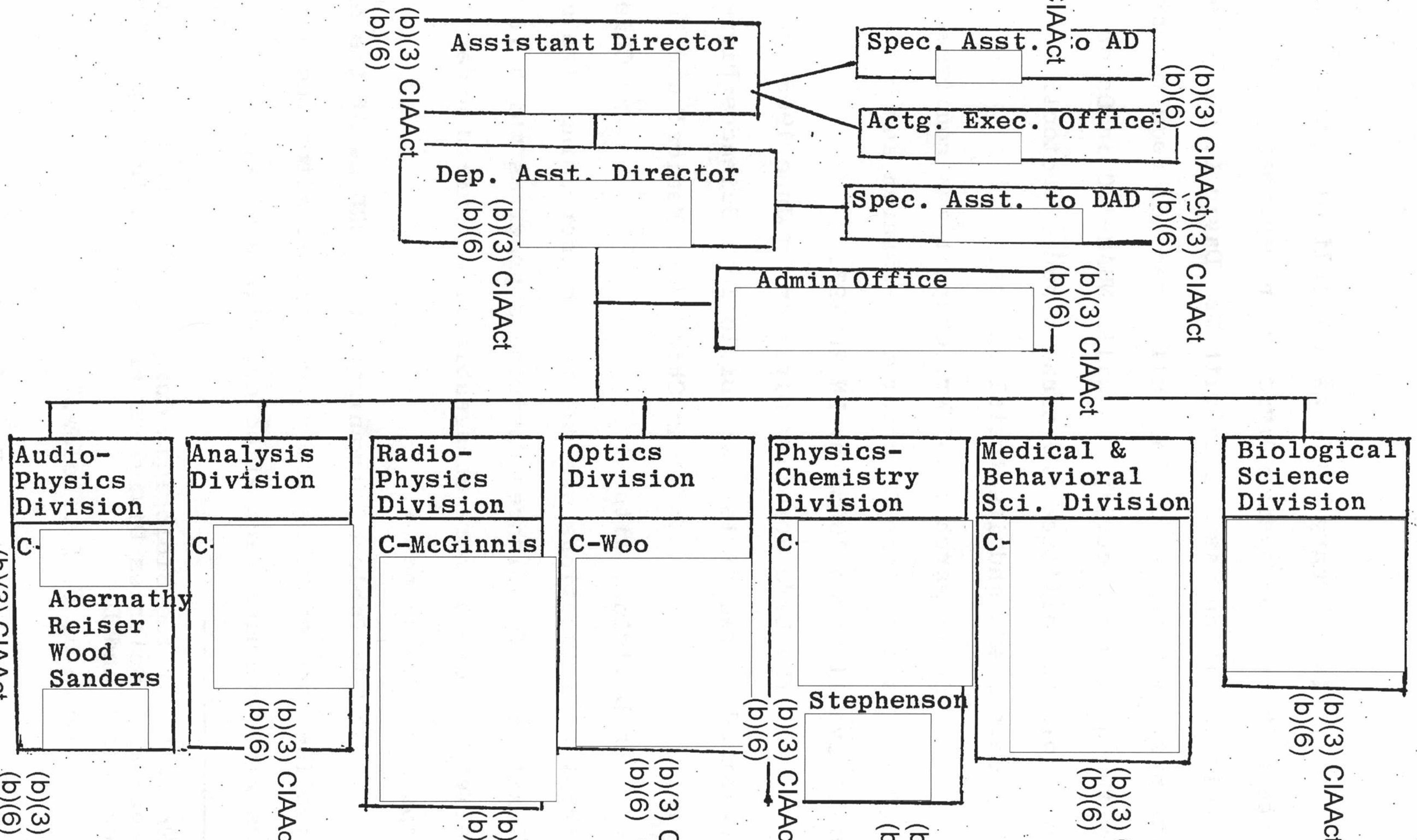
*The work of the Biological Sciences and the Medical and Behavioral Sciences Divisions are covered in Chapt. IV, Sections C and D.

**See Figure 5, p. 22, below.

OFFICE OF RESEARCH AND DEVELOPMENT



[redacted] (b)(3) CIAAct (b)(6) Jacobsen - Full time studen[redacted] (b)(3) CIAAct (b)(6)

Figure 5 - T/O, June 1965

Between June 1965 and June 1966, the organizational structure of ORD remained unchanged other than for a gradual growth of programs and staff. [redacted] joined ORD in April 1966 as Special Assistant to the Director of Research and Development. (Mr. Chapman's title was changed on 27 July 1965 from Assistant Director to Director, along with the other DD/S&T Office heads, by HN 1-58.) [redacted] transferred from his previous assignment as Chief of the Physics and Electronics Branch, General Sciences Division, OSI. He was assigned responsibility for providing technical management guidance and assistance to the D/RD in the emplacement and stay-behind equipment programs. His assignment was made on the basis of his past experience in systems engineering research and development, and in the production of intelligence.

(b)(3) CIAAct
(b)(6)

(b)(3) CIAAct
(b)(6)

Also in April 1966, the establishment of a small computer facility in ORD's Analysis Division brought the assignment of [redacted] to work on the Intelligence Processing Research and Development facility (IPRD).* He was named Laboratory Director for IPRD 17 November 1966.

(b)(3) CIAAct
(b)(6)

Figure 6, page 24, shows ORD's T/O as of the end of June 1966, at which time the staff numbered [redacted]

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*See Volume II, Monograph 6.

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OFFICE OF RESEARCH AND DEVELOPMENT

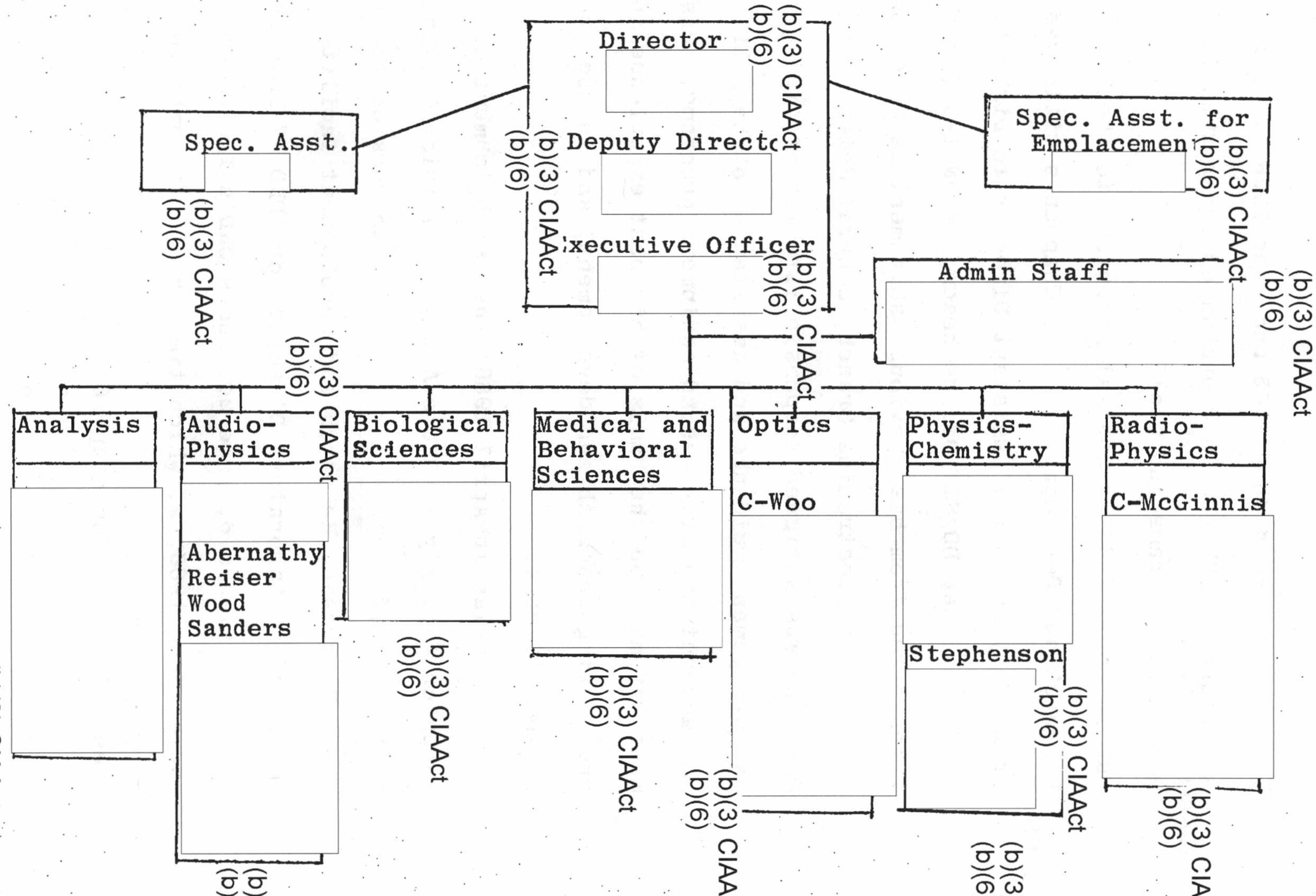

Figure 6 - T/O, June 1966

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(b)(3) CIAAct
(b)(6)

The divisional organization of ORD into seven areas of scientific research and development has remained constant since 1966. The name of the Audio Physics Division was changed, late in 1966, to Applied Physics Division in order to reflect the broadening of its program through the application of technological advances. [redacted] was reassigned in August 1967 to a newly created position as Technical Assistant for Plans and Programs, reporting directly to the Deputy Director, ORD, and having responsibility for ADP-associated problem areas throughout ORD, as well as for coordinating the planning, programming, and budgeting for all of ORD.*

One new component was added to ORD effective 12 August 1968—a "Special Projects Group" which was set up, with Mr. Frank Briglia as Chief, to develop by means of an industrial contract a long-range penetration device on which the original research was performed in Audio Physics Division under Mr. Christ. The position of Special Assistant for Emplacement held by [redacted] was then dropped and [redacted] became Special Assistant for Requirements in January 1969. A new Procurement Management Staff was

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*See Figure 7, p. 26, for T/O as of September 1967.

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OFFICE OF RESEARCH AND DEVELOPMENT

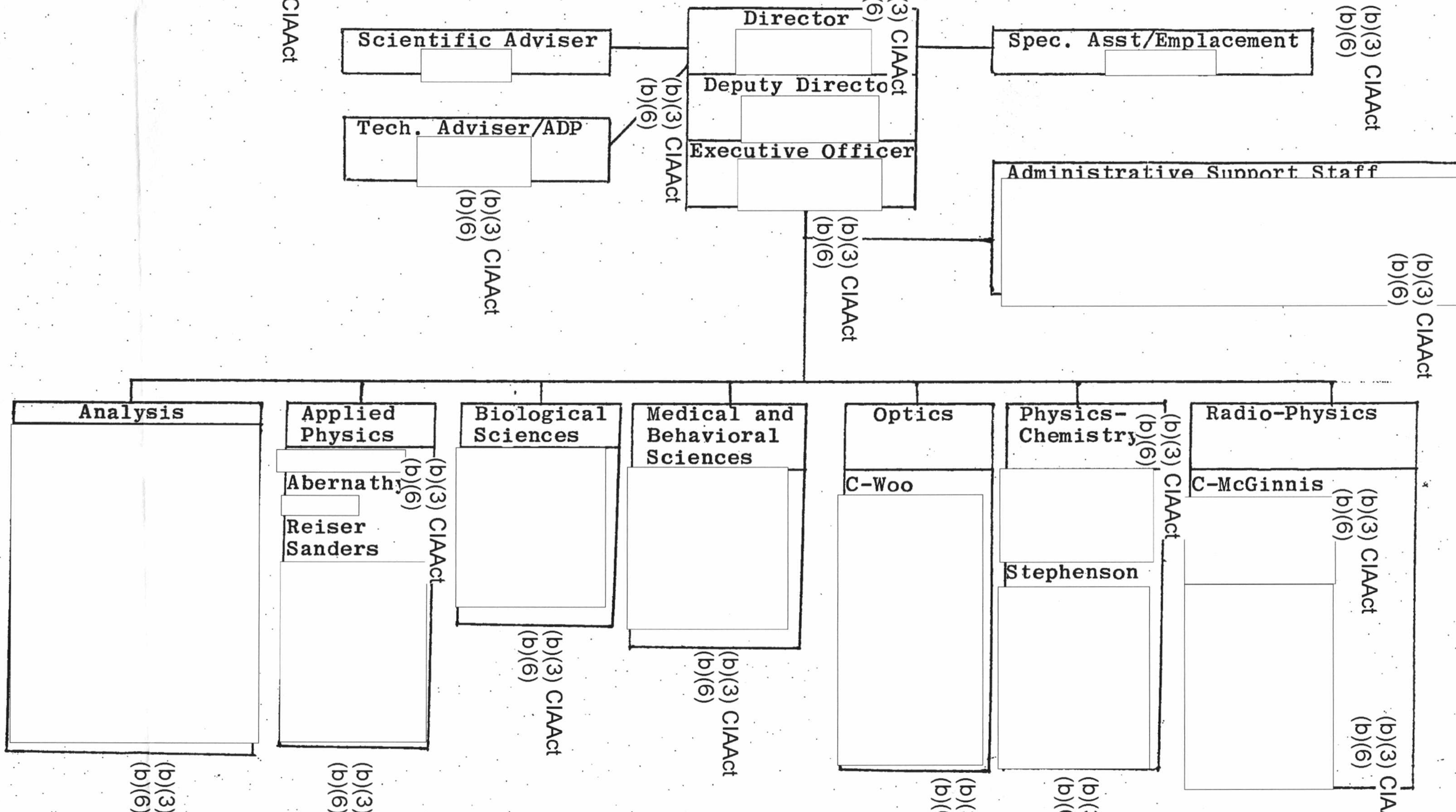


Figure 7 - T/O, September 1967

added to ORD in February 1969 to accomplish Agency-funded RD&E, external analysis, and other procurement for all ORD Divisions. With these few changes, the organization of ORD has remained constant since 1969, [redacted] (b)(3) CIAAct organization chart was finally published as [redacted] Fig. 6, in support of (b)(3) CIAAct [redacted] (the ORD Mission and Functions Statement), on 8 March 1971.* Through the collection of charts shown in Figures 2-8, above, it can be seen that ORD has evolved along the organizational lines approved by the DD/S&T late in 1963, with the principal growth being in the addition of the Analysis Division, the splitting off of Applied Physics from Radio-Physics Division, and the separation of Life Sciences into two divisions, each pursuing a broad program of diversified activities. (b)(3) CIAAct

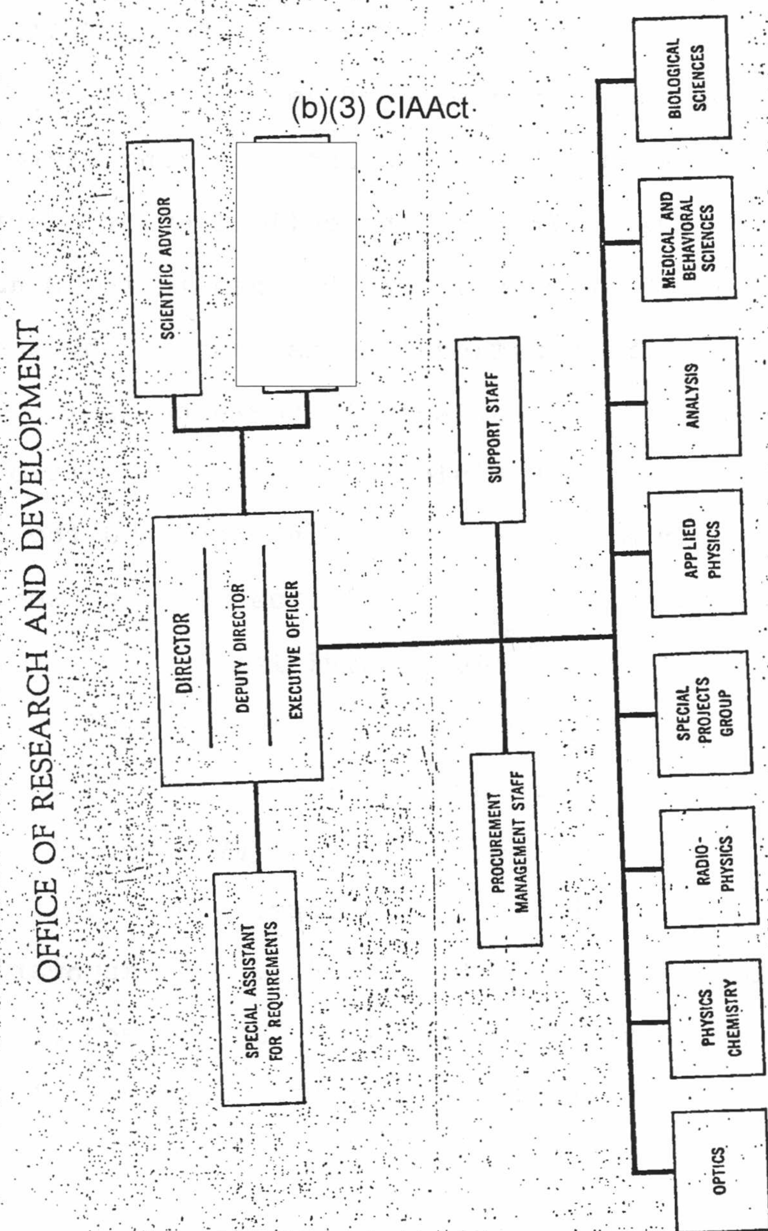
ORD grew from its original staff of seven officers and one secretary in January 1963 to a ceiling of [redacted] (b)(3) CIAAct with [redacted] on duty, at the end of FY 1970. A chart** showing positions established, ceilings, and on-duty strength by quarters indicates the growth of ORD manpower has been gradual, hitting a high of [redacted] at the end of FY 1968, since (b)(3) CIAAct when the authorized ceiling has been gradually reduced to (b)(3) CIAAct [redacted] for FY 1972.

*See Figure 8, p. 28.

**See Figure 9, p. 29.

HR 1, fig. 6

(b)(3) CIAAct



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510927 3-71 CIA

Figure 8

OFFICE OF RESEARCH AND DEVELOPMENT

Positions, Ceiling, and On Duty Strength of Staff Personnel

March 1963 - December 1971
Quarterly

Quarter Ending	Positions	Ceiling	On Duty
1963: March			
June			
September			
December			
1964: March			
June			
September			
December			
1965: March			
June			
September			
December			
1966: March			
June			
September			
December			
1967: March			
June			
September			
December			
1968: March			
June			
September			
December			
1969: March			
June			
September			
December			
1970: March			
June			
September			
December			
1971: March			
June			
September			
December			

(b)(3) CIAAct

Figure 9

~~SECRET~~

Plans for establishing the ORD Career Service Panel, to operate under the aegis of the "R" Career Service Board, were formulated in January/February 1964, with the Panel's first meeting being held on 9 March 1964. Voting members of the Panel were the heads of the four active Divisions of ORD at that time, while the Administrative Officer, Mr. Connolly, served as non-voting Chairman. In 1966, the membership of the Panel was altered to include all seven Division Chiefs, and the Chairman was made an elective position, by vote of Panel members, with a tenure of six months. A later change made the Deputy Director of ORD (then Dr. Aldrich) Chairman and permanent member of the Panel, as of 6 June 1966.

For the first year of its existence, ORD with its small staff was housed in the space assigned to the DD/R, since the Assistant DD/R, Colonel Giller, also acted as Assistant Director for R&D and it was convenient to keep both of his activities in close proximity. As ORD began to grow in the latter half of calendar 1963 from a staff (b)(3) CIAAct of [redacted] to about [redacted] (b)(3) CIAAct new space had to be obtained, and early in 1964 the ORD staff was moved to the first floor, D corridor, at Langley Headquarters.

~~SECRET~~

(b)(3) CIAAct

With continued gradual growth through 1964 and the expectation of reaching a total of possibly [redacted] staff members by mid-1965, ORD requested additional space to include room for an optical laboratory, a test area for electro-mechanical equipment, and the location of ORD in an area which would be accessible to the approximately 300 visitors per month expected to require access to ORD offices. Space problems at Langley precluded the allotment of such space to ORD, and during 1965 the DD/S&T agreed to accept the alternate solution of moving ORD to a new building which was being completed near Rosslyn Circle.

When ORD moved from Headquarters to the Ames Center Building at Rosslyn in March 1966, it became necessary to increase the scope of operations in the handling of its correspondence in order to comply with security regulations. A vaulted area was constructed in the new building and an ORD Registry established there, and designated a control point for special category documents. In April 1966 [redacted] was transferred from the DD/S&T Registry, where ORD's record requirements had previously been met, and became Chief of the ORD Registry.

(b)(3) CIAAct
(b)(6)

(b)(3) CIAAct
(b)(6)

The move away from Langley also necessitated setting up an ORD Library, which was first managed by a part-time assignee from the main CIA library, [redacted] until a full-time ORD Librarian, [redacted] was assigned in September 1966.

(b)(3) CIAAct
(b)(6)

The fact that ORD personnel were considered overt Agency employees, and the nature of ORD external contracting activities, which required the presence of numerous contractor representatives at ORD offices, led at times to a rather relaxed handling of visitors at the Ames Building during the first two years of occupancy there. However, in April 1968, ORD General Notice [redacted] announced that the presence in ORD offices of contractor representatives who did not hold Agency badges constituted a security violation, and adequate small and large conference rooms were set aside for the more secure handling of meetings with visitors to the Ames Building.

(b)(3) CIAAct

It had been predicted in the April 1962 report of the Working Group on Organization of CIA that the key scientists and technological experts who would staff the Offices of the new scientific directorate would have no professional intelligence operating experience and little background or interest in operational problems requiring thorough inter-agency coordination and careful attention to security. On the average, however, the research and development specialists of ORD have developed security-consciousness on a par with other Agency staffs in their intra-Agency and interdepartmental coordination activities, in dealings with contractors, and in their support to operations in the field.

B. Orientation of ORD Programs

The small staff transferred from TSD to ORD, beginning with the second half of FY 1963, engaged in a series of feasibility studies in newly emerging scientific developments having apparent potential for application to technical collection methods, and devoted a major effort in the application of known devices and techniques to more advanced collection systems.

The Executive Director's Action Memorandum A-161 of 11 January 1963 restated the President's directive that an all-out intelligence collection effort be pursued against Communist China and strongly emphasized the necessity for the development and employment of S&T collection techniques against the China Mainland. In consequence a major part of the ORD effort was directed toward that objective. [redacted]

(b)(1)
(b)(3) NatSecAct

1. Role of External Advisory Bodies

a. Scientific Advisory Board*

As a part of the plan for establishing the new scientific directorate in CIA, Mr. McCone, the DCI, in April 1962 requested that an advisory board of the best scientific brains available be set up to advise him on the entire scope of the Agency's scientific and research and development activities. Due to delays in reaching agreement on the assets and responsibilities to be assigned to the DD/R, Dr. Scoville felt the need for such an advisory group was not of immediate urgency to the DD/R. It was not until early in 1973 that purposeful efforts toward enlisting the membership and a chairman for such a body were carried out at the DCI's insistence.

(b)(3) CIAAct

The establishment of the Scientific Advisory Board effective 1 July 1963 was announced by [redacted] dated 16 July 1963. Dr. August B. Kinzel, Vice President of Union Carbide, was named Chairman of the Board, which was to advise the Director on the adequacy of the CIA R&D effort and point out possible applications of newly emerging scientific developments to the mission of CIA;

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*See also Vol. II, Monograph No. 3, "Scientific Advisory Board" by Dr. Stephen L. Aldrich.

conduct continuing review of internal and external R&D activities; recommend improvements in the programming and organization of the Agency's scientific efforts; and keep the DCI advised of significant scientific developments applicable to CIA's mission. 10/

Mr. McCone described the Board as an "impressive array of senior U.S. scientists" and expressed the expectation for a fall-out of suggestions and offerings by each member based on his comprehensive knowledge of the state of the art across a broad frontier of scientific discoveries and developments. 11/

The role planned for the Board in support of ORD's initial programming included the establishment under the Board of a series of specialized panels oriented toward scientific disciplines in which ORD's Divisions were working. The Board was also expected to work very closely with the Agency's Research and Development Review Board* which would in turn provide an effective internal mechanism for discussing and implementing recommendations of the Scientific Advisory Board which were approved by the DCI.

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*The R&D Review Board was established by HN 1-34 dated 16 April 1963. See pp. 44-48, below.

The panels under the Kinzel Board's aegis which reviewed and evaluated ORD programs and made recommendations regarding areas of promising investigation were the Optics Panel, the Life Sciences Panel, and to some extent the Covert Instrumentation Panel (although the latter dealt principally with TSD's programs). The deliberations of other panels dealing with atomic energy and guided missiles also affected the over-all orientation of ORD's programs along with those of the intelligence collection, analysis and production offices of the Directorate.

The Optics Panel operated between 1963 and 1965 under the Chairmanship of Dr. James A. Eyer, of the University of Rochester's Institute of Optics. [redacted] (b)(1)

The Life Sciences Panel developed from discussions initiated in October 1963 by Dr. Stephen Aldrich and became active in 1964-1965. The Panel reviewed ORD's Life Sciences program and recommended the order of priority of research as physiology and psychology of stress and human behavior; animal studies; physiological chemistry;

(b)(1)
(b)(3) NatSecAct

and biotechnology. Specific projects to be included in a Life Sciences research program [redacted] were recommended including particularly the investigation of audio and visual perception and the development of measurements of stress response.

When Dr. Wheelon took over responsibility for the activities of the Scientific Advisory Board late in 1963, he found it not broad gauge enough for the advisory role he envisioned for a small, but very senior, group of scientists to provide the DCI with an integrated opinion of the Agency's R&D effort. In July 1965 the tenures of the Kinzel Board and several of the panels set up under it were allowed to lapse and Dr. Wheelon reconstituted the S&T advisory panels in a framework wherein each was a separate entity responsible to the DCI.

The former Chairman of the Optics Panel, Dr. Eyer, was meanwhile brought into CIA to work on satellite photography problems in the Office of Special Projects (OSP) and therefore any special optics problems were handled subsequently through consultation with individual specialists on an occasional basis. Likewise, the Life Sciences Panel was not reactivated after the Kinzel Board

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[redacted]

(b)(3) CIAAct

was phased out in July 1965 since it was found to be more appropriate, in view of the large number of research areas included in Life Sciences on which expert advice might be required, to consult with individual specialists rather than hold formal meetings of an organized, but widely divergent, group of specialists.

(b)(1)
(b)(3) NatSecAct

[redacted]

(b)(1)
(b)(3) NatSecAct

SECRET

(b)(1)
(b)(3) NatSecAct

[redacted]

c. IDA-JASON Panel

The initial relationship between CIA and the Institute for Defense Analyses, JASON Division, was an informal arrangement by OSI (under an ARPA contract with IDA) for the use of five individual consultants in support of the Defensive Systems Division's work on the anti-ballistic missile, at no cost to CIA. The relationship began in July 1971, continuing for two years under the monitorship of

(b)(3) CIAAct
(b)(6)

[redacted] Chief of the Anti-Ballistic Missile Branch of DSD/OSI.

On 19 July 1963, Dr. Albert D. Wheelon, then AD/SI but soon to be the first Deputy Director for Science and Technology, met with a group of JASON scientists to discuss their possible participation in support of CIA's S&T activities across the board. Agreement in principle was reached with IDA-JASON, and Dr. Wheelon, in reporting on this important arrangement, said that CIA could look forward to a long and profitable partnership on its own terms with this exceptionally well qualified group of scientists. It was his desire that the assistance of the group should be available not only to OSI, but to the other S&T Offices, particularly ORD, which Dr. Wheelon called "our first line attack on new systems." 14/

A contract was negotiated with IDA (funded by CIA through ARPA) with the spadework being done by Dr. Karl H. Weber, DAD/SI, in December 1963. It called for a budget [redacted] for the balance of FY 1964, of which OSI furnished [redacted] (b)(3) NatSecAct. The contract for FY 1965 through 1967 was [redacted] (b)(3) NatSecAct Under the contract IDA-JASON was to support the DD/S&T's research, analysis and production of intelligence on foreign

(b)(3) NatSecAct

scientific and technical developments, as well as activities being pursued by OEL and ORD. The aid of the JASON group was sought because of the exceptional capabilities of its members and its strong background for consultation in scientific areas. The group was an amalgamation primarily of theoretical scientists and mathematicians, who had elected to serve the government in this unified way.

Between 1964 and 1968, deliberations of the selected panelists were more and more devoted to ORD's problems. The program for studies by the Panel for 1966, for example, listed 12 in the ORD areas of interest, including audio surveillance [redacted] (b)(1) isotopic ratios, optical techniques in character and pattern recognition, and others.

In February 1968 a revision in the arrangements with IDA-JASON reoriented the responsibility for CIA work done by the Panel from OSI to ORD, with Mr. Charles E. McGinnis, Chief of the Radio-Physics Division, assigned to support and monitor the Panel's activities. ORD was also given budgeting responsibility for support of the Panel (about $80,000 for FY 1971-72). The Panel continues to meet on a regular schedule with S&T officers and to make a valuable contribution, particularly to ORD's programs.

2. ORD Relations with Other R&D Components

During the early years of ORD, from 1963 through 1966, coordination of R&D activities among the various components engaged in such work was assigned to an Agency Research and Development Review Board. It was established 16 April 1963 following the shelving of the original plan of the DCI to centralize all R&D under the Office of Research and Development, and the acceptance of the *status quo*, in which R&D activities (other than those specifically assigned to ORD) remained within the functional organizations which they supported. The stated purpose of the new Board was to review and integrate R&D activities, and S&T efforts, in the various Agency components concerned; to ensure that all S&T activities were constantly related to the broadest interpretation of the Agency's mission; and to constitute a reviewing body for the Agency's R&D effort as a whole. The DDCI, who at that time was Lieutenant General Marshall S. Carter, was made Chairman of the Board and the Deputy Director for Research, Dr. Herbert Scoville, was named as a member; however, the other members were at the Office and Division level, the DD/P being represented by the Chief, TSD;

the DD/S by the Director of Communications; and the DD/I by the AD/SI and the Director of NPIC. ORD was not organized well enough at the time to speak for the DD/R. When Dr. Wheelon took over as Chairman of the R&D Review Board at its December 1963 meeting, he found that it had not yet assumed its role and position as the coordinator of all Agency R&D. Its progress was in part slowed to the pace of ORD in building up its staff, experience, and competency, thus delaying consideration of awarding further research functions to ORD until it was equipped to handle them. The Board became principally a forum for reviewing individual programs and making ad hoc compromises among the participating offices.

When ORD was organized, the understanding had been that it would do broad base research for the other Agency components such as TSD and NPIC who might require this assistance. The coordination between ORD and other elements was not governed by an over-all working arrangement, but took the form usually of sporadic coordination of individual efforts (particularly with TSD) in areas of common concern, such as the audio R&D program. As ORD increased its capabilities and the scope of its program, the DD/P had more reason to fear the encroachment upon what was considered to be TSD's bailiwick. The failure of the Research and Development Review Board to become active and useful led to duplication of effort and lack of communication among its members.

In September 1965 Dr. Wheelon, with the agreement of the DCI (then Admiral William F. Raborn) initiated discussions and drafting sessions looking to the eventual assignment to the DD/S&T of over-all coordination responsibility for all Agency R&D. Many drafts, and many meetings later, and after a change of incumbents of both the DCI and DD/S&T positions, Headquarters Notice [redacted] (b)(3) CIAAct "Coordination of Research, Development, and Engineering (RD&E)," was published on 17 July 1967. The DD/S&T was made responsible as a staff officer to the DCI for coordination of Agency RD&E programs, and was directed to convene a meeting of the other Deputy Directors at least annually to ensure the consistency of the proposed RD&E effort with the Agency's goals and objectives. Individual office programs and cost estimates were to be coordinated and consolidated by the DD/S&T into a single Agency RD&E plan. Previous to 1967, each Directorate had argued its own case separately before the PPB and the BOB.

In consonance with the RD&E coordination settlement, a signed agreement between the DD/P and the DD/S&T, dated 8 June 1967, recognized the dependence of TSD/ORD coordination on the settlement of the over-all R&D management question, and also expressed hope for enhanced efficiency and the elimination of inter-office friction previously experienced due to lack of top-level coordination of R&D. At the same time a formal Memorandum of Understanding was agreed by TSD and ORD concerning ORD performance of programs in support of TSD. 15/

Some dissatisfaction on the part of TSD continued to be felt under the new set-up. TSD officers were unhappy with the DD/S&T's dual role in the coordination of RD&E, wherein they contended the DD/S&T was both a protagonist, seeking approval of programs and funds for his own Offices, principally ORD, and a decision-maker, giving approval as to which projects would be funded. In addition, TSD from time to time expressed discontent with the support it received in broad-base research from ORD.

The coordination procedure under [redacted] (b)(3) CIAAct was renewed in August 1968 to August 1969, after which the notice expired.

In the Agency Planning Session of March 1970, the DD/S&T, Mr. Carl E. Duckett, reported considerable progress during the past few years in organizing and coordinating R&D programs, in bringing greater clarity to objectives and costs, and improving communication and technical cooperation among the components doing RD&E work. It was clear, however, that the coordinating body had not been completely successful in evaluating needs and establishing priorities for allocating resources among participating RD&E components.

When the DD/S&T attempted, in September 1970, to regularize the informal arrangements set out by (b)(3) CIAAct which were still being followed, with a proposal for formalizing the current ad hoc RD&E Board, his memorandum failed to receive the approval of the Executive Director-Comptroller as of the end of 1970, and was later overtaken by an exhaustive, Agency-wide review of the whole question of research and development. 16/*

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*The review initiated early in 1971 attempted to identify the intelligence and operational objectives pertinent to Agency R&D and to make recommendations regarding priorities. Guidelines were finally approved on 1 March 1972 by the Executive Director-Comptroller, then Mr. William E. Colby, detailing responsibilities for three areas of R&D: those in direct support of operations; those with multiple applications; and exploratory R&D (for which the DD/S&T retained programming, funding and management responsibility); and establishing an Agency R&D Board, chaired by the DD/S&T, with membership at the Assistant Deputy Director level, supported by a Technical Coordinating Committee with 14 panels at the working level. (DD/S&T-624-72)

A fact of life in ORD's planning and budgeting since the mid-1960's has been the imposition of funding restraints and the additional squeeze brought about by inflation. Whenever budget cuts have to be made, it is generally R&D which is the first item to feel the axe.

In considering the ORD program during the Quarterly Review held in January 1970, Mr. Duckett stated in strong terms that R&D in the S&T Directorate would focus on two areas: first, systems development in which at least a prototype would be produced which had a reasonably definite chance of being used; and second, the furthering of technology which had been shown, or could be shown, to have a likely use for Agency work. "In-between gadgeteering" was not to be encouraged. 17/ Primary attention has almost without exception been given by ORD to developing operational systems to meet intelligence requirements, rather than to exploratory research looking for possible breakthroughs—to development and engineering rather than to basic or applied research. There is actually no basic research in CIA, and in FY 1969 and 1970 only about 1½% of the total RD&E budget was spent on applied research.

A comparative table of RD&E obligations for ORD, for the S&T Directorate, and for the Agency as a whole, for Fiscal Years 1963 through 1970 shows ORD running at 50-60% of the S&T Directorate total, and the Directorate at about the same percentages of the total Agency RD&E expenditures.*

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*See Fig. 10, p. 51.

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OBLIGATIONS FOR RESEARCH, DEVELOPMENT AND ENGINEERING*

FY 1963-70

[redacted] (b)(1)
(b)(3) NatSecAct

	ORD	DD/S&T	AGENCY TOTAL
FY 1963	[redacted]		
FY 1964			
FY 1965			
FY 1966			
FY 1967			
FY 1968			
FY 1969			
FY 1970			

(b)(1)
(b)(3) NatSecAct

*Includes Personal Services and External Contracts.

~~SECRET~~

Fig. 10

CHAPTER IV

IV. ORD Division Programs

A. Analysis Division

The Analysis Division is the most recently formed division within the Office of Research and Development. One of the prime considerations in its formation was that the advanced technical collection systems under development in many of the other ORD divisions would ultimately provide a large volume of highly technical raw data which must be processed and significant intelligence (e.g. signals, patterns, changes, etc.) extracted. It was apparent that for reasons of speed, accuracy, and efficiency such data processing would be performed in an automatic or semi-automatic way. Also, the Analysis Division would provide R&D support to a variety of consumers within the Agency in accordance with the general mission of ORD. Hence, the Analysis Division was to be, and is, polarized about computers and computer-oriented processes.

The first professional employee of the Analysis Division, and its chief throughout its history, was (b)(3) CIAAct (b)(6) [redacted] entered on duty with the Agency on 28 June 1964, which date can be taken as the formal inception of Analysis Division activities. He has provided the planning and thrust of the Analysis Division program.

By mid-1965 the "data indigestion" problem was becoming increasingly evident to key officials in the intelligence community. This problem can be summarized as follows: the volume of raw intelligence data inputs of various sorts (overt publications, CS reports, reconnaissance and other types of photography, waveform data, etc.) continues to increase. Intelligence analysis resources available, both manpower and money, are asymptotically approaching limits. Intelligence to be useful must be timely. Hence, automatic and semi-automatic procedures must be developed to aid the intelligence analyst in the performance of his duties. These considerations were emphasized in the recommendations of the Communications Panel of the President's Foreign Intelligence Advisory Board (Memorandum from Mr. McGeorge Bundy to the Director of Central Intelligence, 15 July 1965, subject: U.S. Intelligence Community Capabilities for the Handling of Intelligence Information, USIB D-39.7/11).*

The Division program has been responsive to the aforementioned challenges. Some general comments concerning program rationale are in order before the details of

*Appendix C, Document No. 9.

the program are reviewed. The basic goal of the program is to develop procedures and techniques which allow more intensive intelligence analysis, interpretation and production with greater speed and efficiency and with the use of less manpower. The underlying technical basis of the program is the rapidly developing state-of-the-art in computer technology and associated peripheral equipment. Increased computing and processing power, lower computing costs and increasing accessibility of machine capabilities for the intelligence analyst and user are available in the current technology and much more is to come. To achieve operational intelligence systems with the newly available technology requires intensive development effort concerned with machines, procedures and data characteristics as well as the requirements of the human analyst. Complex and difficult problems exist at the interfaces between these components. The Analysis Division program is focused largely on these interface problems.

Perhaps the most important aspect of the Analysis Division program to date has been the planning and implementation of the Intelligence Processing Research and Development facility (IPRD). The facility (initially called Intelligence Sciences Laboratory) was formally proposed in

August 1965 as a new and important aspect of the Analysis Division's FY 1966 program.* The facility was designed to provide a focus for the development of specialized procedures, equipment and techniques for intelligence processing; the integration of components and procedures into operational subsystems; testing of subsystems with real intelligence data; and the generation of experience, know-how and technical specifications essential for planning and implementation of large operational systems.

Planning and design of the facility were completed in July 1966, and appropriate approvals obtained to proceed with its implementation. Delivery of IPRD equipment commenced in late 1966. On 17 November 1966, [redacted] (b)(3) CIAAct (b)(6) was appointed Laboratory Director and [redacted] (b)(3) CIAAct (b)(6) was appointed Assistant Laboratory Director. (b)(3) CIAAct (b)(6) Further historical details concerning the IPRD are outlined in a monograph in Volume II of this history.**

Initially, the Analysis Division program was divided into the following specific task areas: (b)(1)

[redacted]

*Appendix C, Doc. 10.

**Vol. II, Monograph 6.

Speech Processing
Indexing, Search and Retrieval
Text Processing
Signal Processing and Correlation
Pattern Recognition

The program was later restructured in accordance with DD/S&T long-range plans, and the end of FY 1967 saw a further reorganization, with spheres of activity enlarged to the following:

Organizing, Search and Modelling Processes:
- Computer On-Line Processes for Analysis
- Storage and Retrieval Processes for Text and Formatted Data
- Mathematical Modelling - Prediction Analysis
- Systems Design and Simulation
- Machine-Aided Translation
- Computer-Aided Instruction

Graphic and Display Processes:
- On-Line Processing System for Graphic Data
- Pattern Recognition Methods for Graphic Data Processing
- Display and Transmission of Graphic Data
- Advanced Methods for Data Storage and Retrieval

Speech, Analog, and Waveform Processes:
- Speech Processing
- Automated Pattern Recognition and Adaptive Control
- Security Systems - Processing and Control
- Recording Methods and Equipment
- Analysis and Interpretation Methods for Analog and Waveform Data (Audio, Acoustic, Seismic, EEG, Polygraph, etc.)

<u>FY 1965</u>. The Analysis Division program in FY 65 was relatively modest, totaling [redacted] Two externally

(b)(3) NatSecAct

SECRET

(b)(1)
(b)(3) NatSecAct

supported projects [redacted] were concerned particularly with problems involved in extracting semantic information from natural language text and making this information amenable to analysts for storage and retrieval of facts. Two projects in pattern recognition were established. Project CHAFFER-B was concerned with the development of a man-machine system for facial recognition. This effort was an outgrowth of work previously sponsored by TSD/DDP.

(b)(1)
(b)(3) NatSecAct

[redacted] was concerned with surveying the whole field of pattern recognition with a view toward determining those developments which had particular application to Agency problems. [redacted] was concerned with the development of devices for use by an analyst in an on-line mode of operation. In January 1965, [redacted] became the second professional employee of the Analysis Division. [redacted] subsequently initiated and monitored work in speech processing research and development.

(b)(1)
(b)(3) NatSecAct

(b)(3) CIAAct
(b)(6)

<u>FY 1966</u>. The addition of seven persons to the Analysis Division professional staff occurred in FY 1966. These included [redacted] who transferr from Optics Division, ORD; [redacted] who transferred from OCR/DDI;

(b)(3) CIAAct
(b)(6)

(b)(3) CIAAct
(b)(6)

(b)(3) CIAAct
(b)(6)

SECRET

SECRET

(b)(3) CIAAct
(b)(6) [redacted]

(since resigned), who transferred from NPIC/DDI; and (b)(3) CIAAct (b)(6) [redacted] (since resigned), an Agency career trainee. The FY 1966 budget increased to (b)(1) (b)(3) NatSecAct [redacted] Speech processing research and development was significantly expanded with the initiation of programs in speech intelligibility enhancement and key-word extraction from continuous speech. The speech processing program is targeted against CS and FBIS requirements. Project action was begun in predictive analysis techniques and on-line processing design and programming. A major portion of Division activity was directed toward the planning and design of the Intelligence Processing R&D facility. In addition, the following specific accomplishments can be reported:

Preliminary testing for a man-machine facial recognition system was begun.

The feasibility of recognizing key words in continuous speech in a speaker-independent fashion was demonstrated.

An extensive analysis was made of a FMSAC data base in order to determine the manner in which it could be in-put to a predictive modeling program (evolutionary programming).

SECRET

A project involving the ORR/MD data base was initiated. The project goal is to develop data processing tools to aid the ORR analyst in particular and the Agency analyst in general.

Final construction of a ground-based 10 mc recorder-reproducer was initiated. Final construction of a 50 mc airborne recorder, 50 mc ground-based readout was initiated. These programs are funded by the U.S. Air Force.

Two of the most promising approaches to very high density audio recording were identified and R&D contracts initiated.

FY 1967. During FY 1967 the following personnel joined the Division professional staff: Dr. Luther W. Rook, [redacted]

(b)(6)
(b)(3) CIAAct

who had previous Agency service at NPIC, [redacted] who transferred from OCS/DDS&T. In addition, four OCS personnel, headed

(b)(3) CIAAct
(b)(6)

by [redacted] were placed on full-time assignment to the IPRD facility. The budget for FY 1967 totaled [redacted] of which approximately one-third was for IPRD

(b)(1)
(b)(3) NatSecAct

equipment purchases and rentals and the remainder for external contract actions. During this period the bulk of the IPRD equipment was installed and debugged. In-house work was begun on the application of machine-assisted processes to problems of intelligence interest. The following representative accomplishments can also be listed:

Noise-stripping of audio operational tapes. New machine methods for stripping noise provide better intelligibility and intelligence output. Applied successfully to DDP samples of [redacted] tapes; further application proceeding in coordination with TSD/DDP.

(b)(1)
(b)(3) NatSecAct

Method for high-speed machine recognition of keywords in audio records. Recognition of keywords in continuous speech records achieved in order to pre-select only passages of intelligence interest. Spin-off for field-operable equipment is going forward in TSD/DDP program in FY 1968. Methods will relieve man-hour requirements for processing tapes.

High-speed computer-based capabilities for the individual analyst. New methods to query, analyze, and operate on large intelligence data files at high speed by the individual analyst have been achieved. Implementation of a test operation is being completed [redacted]

(b)(1)
(b)(3) NatSecAct

(b)(1)
(b)(3) NatSecAct

[redacted] which was not possible heretofore. Implementation is going forward in close cooperation with components of the Office of Communications.

An organization chart of the Analysis Division for FY 1967 appears at Figure 11, page 62, below.

ANALYSIS DIVISION/ORD/DDS&T

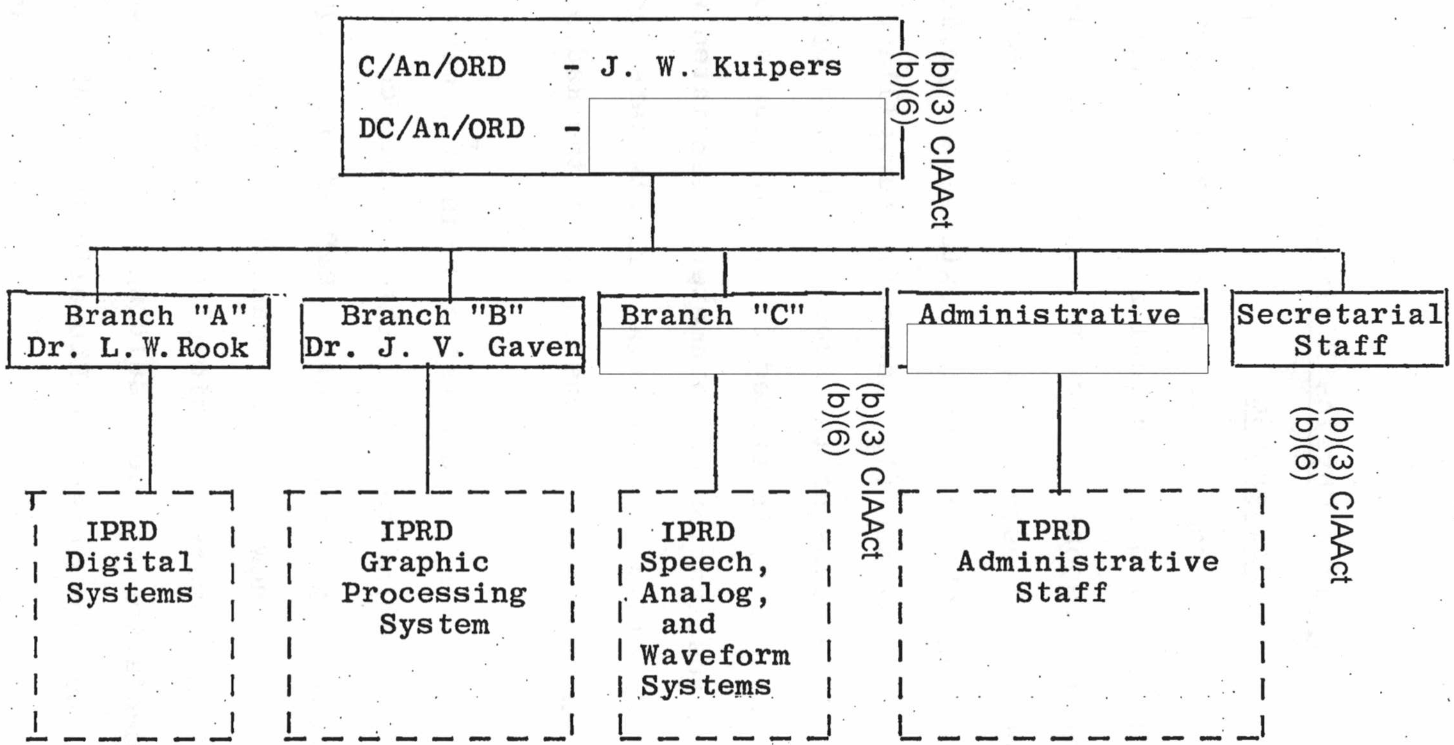

Fig. 11 - AnD/ORD Organization
FY 1967

B. Applied Physics Division

1. Background

Programs in the Applied Physics (formerly Audio-Physics) Division goal areas were initiated in FY 1964 in primary response to the findings of the CIA-DIA Scientific Guidance Panel established by NSAM-170 dated October 1962. Mr. David L. Christ, who had extensive experience in the audio surveillance (AS) and audio surveillance countermeasures (ASCM) needs of the Agency from both operational and R&D perspective, initiated the first year's efforts for a broad investigation of parameters associated with AS and ASCM technology. The initial efforts were begun in December 1963, while Mr. Christ was Chief of the Radio Physics Division.

Applied Physics Division's mission is to form new concepts for technical intelligence collection and countermeasures systems, identify R&D efforts required to make or prove the new concepts feasible, and pursue such R&D efforts necessary to achieve the desired capability and/or implementation of the resulting advanced systems. The Division pursues intensive R&D efforts in AS, ASCM [redacted] systems, and microtechnology.

(b)(1)
(b)(3) NatSecAct

The audio surveillance efforts emphasize micropower-microelectronics collection and non-detectable, long-range systems. The Division was specifically given the advanced R&D mission to support the Technical Services Division, DD/P, which continues to be responsible for the development, engineering, and application of these devices and techniques against DD/P operational needs.

The objectives of the countermeasures R&D programs are to support the Technical Division of the Office of Security, and to improve the security technology available to the Intelligence Community [redacted]

(b)(1)
(b)(3) CIAAct

[redacted]

(b)(1)
(b)(3) NatSecAct

[redacted]

2. Organization

The Audio Physics Division was established to continue the ORD Audio Surveillance and Countermeasures programs which were launched in December, 1963. Mr. Christ and Mr. C. V. Noyes laid the foundation for the Audio Physics Division as a branch of the Radio-Physics Division. The total money available for these initial efforts was FY 1964 year-end funds of [redacted] During FY 1964 and early FY 1965, approximately 20 ASCM and 20 AS contracts at a cost of [redacted] were administered by Mr. Noyes in coordination with appropriate elements of other members of the Intelligence Community. When Mr. Donald Reiser joined the group in July 1964, he assumed responsibility for all AS programs. During FY 1965, Audio Physics Division personnel

(b)(3) NatSecAct

(b)(1)
(b)(3) NatSecAct

(b)(3) CIAAct
(b)(6)

increased to [redacted] including [redacted] the Division secretary. (b)(3) CIAAct

By February 1965 the potential of the Audio Physics group had developed to the point where it assumed the status of a division. Mr. Christ, as chief of the new division, set up its organization including the establishment of an Audio Surveillance Branch under Mr. Donald Reiser, assisted by Mr. Harry Wood and Dr. John D. Sanders; the establishment of an Audio Surveillance Countermeasures Branch under Mr. C. V. Noyes, assisted by Messrs. Harry J. Peters and M. B. Abernathy; the beginning of spadework on [redacted] (b)(1) (b)(3) NatSecAct established under the direction of [redacted] (b)(3) CIAAct (b)(6) after he entered on duty in January 1966.

The AQUILINE program was initiated early in 1966 with Mr. Christ as project officer. In May 1966, Mr. Frank Briglia entered on duty and assumed responsibility for the program. He, together with [redacted] (b)(3) CIAAct (b)(6) [redacted] who entered on duty on 27 June 1966, formed the [redacted] which carried the primary (b)(1) (b)(3) NatSecAct responsibility for development of the AQUILINE program. The program was advanced from feasibility studies to practical R&D projects, many of which were initiated during the year.

During the latter part of 1966, the Audio Physics Division was renamed Applied Physics Division to more accurately reflect the broad technological programs then being pursued.*

3. Philosophy

The Applied Physics Division has placed heavy emphasis on thorough review of fundamental principles and state-of-the-art technology which could be integrated into an over-all system approach for the solution of AS and ASCM problems. The fundamental studies resulted in a better understanding of principles which could be further researched to produce results in the same areas plagued by a series of failures in the past. Examples of high pay-off achieved through using this approach are:

The laser probe systems which were developed and turned over to [redacted]

(b)(1)
(b)(3) NatSecAct

*See Figures 12a and 12b, pp. 68-69, for organizational evolution charts.

Organizational Evolution

Applied Physics Division

FY 1964

- ORD
  - RP
    Christ
    - AS
      ASCM
      Noyes
    - Other Programs
  - Other Divisions

FY 1965

- ORD
  - RP
    Christ
    - ASCM
      Noyes
      Abernathy
      [redacted]
    - AS
      Reiser
      Wood
      Sanders
    - Other Programs
  - Other Divisions

(b)(3) CIAAct
(b)(6)

February 1965

- ORD
  - AP
    Christ
    [redacted] (Sec'y)
    - ASCM
      Noyes
      Abernathy
      [redacted]
    - AS
      Reiser
      Wood
      Sanders
    - Adv. Components
      Christ
    - Emplacement
      Christ
  - Other Divisions

(b)(3) CIAAct
(b)(6)

(b)(3) CIAAct
(b)(6)

Figure 12a

FY 1966/1967

AP*

(b)(3) CIAAct
(b)(6)

Christ
[redacted] (Sec'ys)

ASCM
Noyes
Abernathy
Peters
Noe (FY 67)

Microtechnology

AS
Reiser
Wood
Sanders
[redacted]

(b)(3) CIAAct
(b)(6)

(b)(1)
(b)(3) NatSecAct
[redacted]
[redacted]

(b)(3) CIAAct
(b)(6)

(b)(3)
NatSecAct
(b)(1)
[redacted]
Briglia
[redacted]

(b)(3)
CIAAct
(b)(6)

* Changed from Audio-Physics to
Applied Physics - late 1966

Figure 12b

SECRET

(b)(1)
(b)(3) NatSecAct

[redacted]

(b)(1)
(b)(3) NatSecAct

The development of an effective practical [redacted] in a modest [redacted] study, after many past efforts having the same objectives had been unsuccessful. (b)(3) NatSecAct

Proved the practicability of developing an advanced bird-like intelligence collection system using state-of-the-art technology.

(b)(1)
(b)(3) NatSecAct

The first over-all system approach was the [redacted] concept of making [redacted] (b)(1) (b)(3) NatSecAct [redacted] in the field for analysis at a headquarters central processing center. The [redacted] concept was found to yield too low a cost-effectiveness in its full application using today's state-of-the-art. However, the work in this area pointed out the advantages of using a centralized support and guidance facility to improve current CM operational techniques.

(b)(1)
(b)(3) NatSecAct

(b)(1)
(b)(3) NatSecAct

Applied Physics Division's over-all system approach to AS and [redacted] proved to be very fruitful. For example, the [redacted]

(b)(1)
(b)(3) NatSecAct

*Vol. II, Monograph 7.

**Vol. II, Monograph 11.

SECRET

(b)(1)
(b)(3) NatSecAct

[redacted]

The AQUILINE* concept has developed into a program for the development of a prototype system having the capability to [redacted]

4. <u>Major Accomplishments</u>

(b)(1)
(b)(3) NatSecAct

a. <u>Audio Surveillance</u>

(b)(1)
(b)(3) NatSecAct

[redacted]

*Vol. II, Monograph 10. /Note: This project was canceled by the DCI effective 12 November 1971, before the system had been proven operationally, as a necessary economy measure./

(b)(1)
(b)(3) NatSecAct

[redacted]

(2) <u>Micropower-Microelectronics</u>: During 1966, long-term programs were begun in this field. These programs are directed toward increasing the effectiveness of electronic equipment in audio surveillance by reducing the dependence upon large power sources. Extremely low power electronic circuitry is being pursued on two major fronts. Basic technology advancements have made possible the following achievements during FY 1967:

(b)(1)
(b)(3) NatSecAct

[redacted]

(3) Microminiature Long-Life Battery

Sources: Work has been initiated in R&D programs for ultraminiature power sources which would be compatible in size to the microelectronic circuits being

[redacted]

(b)(1)
(b)(3) NatSecAct

(b)(1)
(b)(3) NatSecAct

[redacted]

SECRET

(b)(1)
(b)(3) NatSecAct

The development of a [redacted] Information on this device was given to OC/SPS for their consideration and evaluation.

(b)(1)
(b)(3) NatSecAct

The feasibility of [redacted] was demonstrated to representatives of the Office of Security, the Office of Communications, and the DDP.

(b)(1)
(b)(3) NatSecAct

Various [redacted] equipments were tested to determine their [redacted] techniques. These tests included [redacted] and the data has been furnished to OC/SPS and OSI.

(b)(1)
(b)(3) NatSecAct

A parametric modulator equipped with a lead zirconate high frequency acoustic sensor was developed and turned over to OC/SPS for evaluation. Further development of this system is underway.

c. <u>Technical Surveillance Countermeasures</u>

(b)(1)
(b)(3) NatSecAct

(1) <u>General Protection Techniques</u>: The feasibility [redacted] was investigated and successfully demonstrated. A handbook describing the general [redacted] (b)(1) (b)(3) NatSecAct approach was prepared. TSD/DDP is currently developing methods of applying this technique to field problems in response to a DDP requirement of July 1967.

Several improved conferencing systems were developed and demonstrated to the TSCC in October 1967, to a COS seminar, and to representatives of other Government agencies. A catalog describing present systems is being prepared for dissemination by the SSU/DDP to DDP field units to assist in procurement decisions.

Typical building materials, including commercial window glass, were evaluated for use as (b)(1) (b)(3) NatSecAct [redacted] countermeasures. The results of this study will be furnished to the DDP and OS/DDS for application.

The effect of various (b)(1) (b)(3) NatSecAct [redacted] and the relative effectiveness of (b)(1) (b)(3) NatSecAct [redacted] sounds were evaluated in April 1967, and used to provide guidance to field personnel by TD/OS.

(2) <u>Detection</u>: A significantly improved (b)(1) (b)(3) NatSecAct [redacted] system was produced and demonstrated to TSD and OS. This is the best [redacted] (b)(1) (b)(3) NatSecAct [redacted] system produced to date in the Intelligence Community, but much remains to be desired.

The ability to produce a microwave hologram was demonstrated. Attempts will be made to apply this technique for real time non-destructive inspection of opaque bodies for surveillance devices.

~~SECRET~~

(b)(1)
(b)(3) NatSecAct

An evaluation was completed of relative merits of on-site versus [redacted] countermeasures systems, from which the following results were obtained:

Relative advantage of on-site processing systems was demonstrated.

The use of computer techniques for handling signal data was demonstrated and simulated in a computer-aided intelligence game that demonstrated machine-aided information organization techniques.

(b)(1)
(b)(3) NatSecAct

[redacted] was demonstrated in March 1967, and is undergoing continued technical evaluation.

(b)(1)
(b)(3) NatSecAct

A [redacted] scheme was demonstrated in November 1967 which utilized analog to digital signal processing techniques for greatly improved sensitivity over previous techniques and provided the capability of automatic real time processing.

(b)(1)
(b)(3) NatSecAct

An operating prototype of the [redacted] detector was produced and delivered to the Department of Defense in response to the emergency requirement of [redacted] (b)(1) (b)(3) NatSecAct This system performed well under field conditions in Viet Nam during September. An improved version is to be delivered in January 1968.

~~SECRET~~

(b)(1)
(b)(3) NatSecAct

A state-of-the-art, [redacted] amplifier was provided to TD/OS in September 1967, and has been adopted for production.

Several improved prototypes of the efficient [redacted] (b)(1) (b)(3) NatSecAct transmitter (SWS) were delivered in February 1967 to OC and OS for use in their programs.

(b)(1)
(b)(3) NatSecAct

An improved [redacted] (b)(1) (b)(3) NatSecAct detection system [redacted] was produced and demonstrated. This system is modulation independent and exhibits reduced false alarm rate over other similar systems. [redacted] (b)(1) (b)(3) NatSecAct

(b)(1)
(b)(3) NatSecAct

d. [redacted] Countermeasures

[redacted] (b)(1) (b)(3) NatSecAct was demonstrated to the various Agency security components, including OC/SPS, OC/Security, OS/TD, FID/DDP and FI/SIG.

[redacted]

(b)(1)
(b)(3) NatSecAct

(b)(1)
(b)(3) NatSecAct

[redacted] Distribution of these results has been made to OC/SPS, OC/Security, OS/TD, and the TSCC where appropriate.

(b)(1)
(b)(3) NatSecAct

[redacted] OC/SPS representatives have witnessed a demonstration of the first laboratory model and are following its current development.

e. <u>Advanced Emplacement</u>

Conceptual studies have established the feasibility of developing advanced emplacement systems. The initial studies were concerned with the over-all vehicle for emplacement and a general look at the subsystems which would be used in any particular emplacement system. Subsequent studies and developmental efforts have been directed toward the subsystems. Some of the outputs of these studies and developmental efforts are

Establishment of payload weights and configurations.

Flight tests of initial versions of some vehicle systems were accomplished. In addition, wind tunnel tests were completed on the initial vehicle configurations.

Completed studies on applicable navigation systems to provide unlimited range navigation capability.

Developed slow scan TV camera for use in midcourse and terminal guidance and surveillance.

(b)(1)
(b)(3) NatSecAct

[redacted]

Completed a series of detailed mission analysis studies attesting to the efficiency of advanced emplacement systems in the collection of technical intelligence critical to the security of the U.S. Government.

[redacted]

(b)(1)
(b)(3) NatSecAct

(b)(1)
(b)(3) NatSecAct

[redacted]

Completed the design of a four-cycle internal combustion engine which would provide medium operational range capability of 2400 nautical miles.

[redacted]

(b)(1)
(b)(3) NatSecAct

5. <u>Problems</u>

Applied Physics Division has had very few problems in planning and implementing its programs. One exception is the unusually high degree of coordination required to clear some of the audio surveillance programs with TSD/DDP and educate potential operational groups concerning the value of the emerging techniques.

Much extra effort has been required to keep up with the ever-changing and flexible budgets we have had to work with—particularly in FY 1967.

C. Biological Sciences Division

1. Organization and Direction

In 1963, during the formative phase of the Office of Research and Development, Office efforts were roughly divided into Life Sciences and Physical Sciences. At that time no divisional organization existed. This situation remained in effect, insofar as Life Sciences were concerned, until June 1965.

Life Sciences efforts were dichotomous—first, to carry out required research and development efforts, and second, to carry on a continuing program of educating various Agency components in the ways in which Life Sciences could be used to exploit the vast potentials of the "living world" as a complement to Physical Sciences in the technical aspects of intelligence collection. The Life Sciences mission as promulgated at that time was "to undertake R&D in the Life Sciences which will assist the Agency in the collection, collation, analysis and dissemination of intelligence; to undertake promising research in support of other offices of the Agency where adequate research capabilities were nonexistent, with particular emphasis on efforts which might be applicable to the problems of several Agency components, e.g., measurement of physiological and psychological stress."

The initial Life Sciences organization consisted of a Technical Manager reporting directly to the Assistant Director and Deputy Assistant Director of ORD. The position of Technical Manager was occupied by (b)(3) CIAAct (b)(6) [redacted] from the inception of ORD until June 1965. During this period, the Life Sciences area grew to a working group of [redacted] technical officers and support personnel. (b)(3) CIAAct

Initially the research and development was directed toward such areas as laser effects on living systems, brain mechanisms, psychochemicals, animal studies and the like. This R&D program evolved and developed into more directed efforts related to stress measurement, human behavior, animal studies related to emplacement, physiological chemistry and bio-engineering of a variety of types. Finally, specific applications began to evolve, such as development of sensor and data display techniques for stress measurement; exploitation for intelligence of specific animal sensory, motor, and cognitive functions; animal training for operational tasks; interpersonal and environmental manipulations; polygraph studies; and a number of diversified studies of living system physiology and biochemistry.

During this period a number of accomplishment milestones were achieved, as detailed below. The major milestones are related directly to missions and requirements; minor milestones were achieved in support of other Agency or Federal components.

2. Major Milestones

(b)(1)
(b)(3) NatSecAct

[redacted]

c. Demonstrated feasibility of utilizing animals' ears as high-fidelity microphones. Supportive electronic gear and refinement of surgical techniques are underway.

d. Demonstrated that low-level continuous laser radiation does not produce detectable damage to photosynthesis in plants.

(b)(1)
(b)(3) NatSecAct

[redacted]

(b)(1)
(b)(3) NatSecAct

[redacted]

~~SECRET~~

(b)(1)
(b)(3) NatSecAct

3. <u>Minor Milestones</u>

[redacted]

~~SECRET~~

~~SECRET~~

(b)(1)
(b)(3) NatSecAct

~~SECRET~~

(b)(1)
(b)(3) NatSecAct

[redacted]

4. Reorganization of Life Sciences

In June 1965 the Life Sciences program was reorganized as a result of a more clearly defined set of missions and requirements and to facilitate support in terms of management and coordination. Also it was apparent that the Technical Manager was no longer able to maintain an adequate and efficient overview of the total Life Sciences program because of its size, diversity and complexity. Accordingly, the position of Technical Manager was abolished and two line organization divisions were established.

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(b)(3) CIAAct
(b)(6)

Schism of personnel and program followed essentially disciplinary lines. The two divisions were titled Biological Sciences Division, under the direction of [redacted] and Medical and Behavioral Sciences Division, under the direction of [redacted] (a career Medical Staff employee).

(b)(3) CIAAct
(b)(6)

The Biological Sciences Division was assigned responsibility for programs in animal studies biotechnology, [redacted] and advanced concept feasibility studies. Significant efforts have evolved in [redacted] animal emplacement systems design, development and fabrication; estimation of crop yields and vigor through [redacted] macromolecule studies. Further details are given in the monographs entitled Operational Use of Biological Systems, Remote Crop Yield Determination, and [redacted]

(b)(1)
(b)(3) NatSecAct

As a consequence of the breadth of the programs falling under the generic heading of Biological Science, the limited number of biological scientists within the Agency, and the interface of these projects with related work in other Government agencies, there has been

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*Vol.III, Monographs 14, 13, and 15 respectively.

SECRET

considerable inter-agency interaction between the Biological Sciences Division and Army, Navy, Air Force and other research components.*

(b)(3) CIAAct The Biological Sciences Division as of FY 1968 had a staff of [redacted] with an anticipated growth to [redacted] (b)(3) CIAAct by FY 1970. The FY 1968 budget was twice the initial total budget for Life Sciences, for an integrated growth rate of approximately 25% per year. It was anticipated that by FY 1970 another 50% increment would be realized. An indication of the growth of the Division's activities is shown in the following annual budgets:

(b)(1)
(b)(3) NatSecAct

FY 1963
FY 1964
FY 1965
FY 1966
FY 1967
FY 1968

[redacted]

The personnel roster of the Division at the close of FY 1968 included the following:

[redacted] (b)(3) CIAAct (b)(6)

Dr. James P. Lynch

[redacted] (b)(3) CIAAct (b)(6)

---

*A listing of the Biological Sciences Division's inter-agency coordination is attached to Monograph 1, ORD/DOD Interface, Volume II.

5. <u>Accomplishments</u>

Noteworthy accomplishments of the Biological Sciences Division from its inception through 1968, in addition to the milestones previously listed, are cited below, grouped by study areas.

(b)(1)
(b)(3) NatSecAct

[redacted]

~~SECRET~~

(b)(1)
(b)(3) NatSecAct

~~SECRET~~

(b)(1)
(b)(3) NatSecAct

[redacted]

f. [redacted] (b)(1)

(b)(1) [redacted] combination for the detection of low vigor (disease, mineral deficiency, mineral

Approved for Release: 2022/01/31 C06767618

toxicity, physical damage, etc.) in rice, wheat, and sugar cane has been established.

(b)(1) Low vigor signatures can be detected on [redacted] taken at 20,000 feet and on simulated [redacted] up to 300,000 feet (approximate orbital altitudes). (b)(1)

Data reduction techniques have been proposed and implemented.

(b)(1)

Preliminary [redacted] for accurate yield estimations have been formulated. Yield estimates from these keys have permitted estimates with little or no ground truths to [redacted] of the actual yield data. (b)(1) (b)(3) NatSecAct

D. <u>Medical and Behavioral Sciences Division</u>

1. <u>Organization and Direction</u>

The Medical and Behavioral Sciences Division of the Office of Research and Development was established in June 1965. The creation of this Division and the simultaneous establishment of the Biological Sciences Division, was brought about as a result of the growing complexity and rapidly expanding diversity of their parent organization, Life Sciences, ORD. The Life Sciences group existed from 1963 until June 1965. During this time, the group initiated a wide variety of priority research tasks which were representative of Life Science disciplines ranging from human psychology and decision theory to biological sub-systems, such as microimmunology and particle physics. Because of this exaggerated diversity, it was believed that a division of Life Science activities into separate but closely coordinated working groups responsible for behavioral activities and for biological activities would be more efficient and productive. Accordingly, the Medical and Behavioral Sciences Division was established and tasked with the primary responsibility of carrying out research and development operations in support of intelligence requirements in the behavioral activities area. Behavioral Activities was therefore established as an Agency research and development sub-element. Under this sub-element, three Agency R&D projects were established: Stress Measurement and Interpretation, Behavior Control, and Human Factors.

The initial Medical and Behavioral Sciences Division consisted of a Division Chief [redacted] technical officers, and [redacted] secretary. Professional disciplines represented were [redacted] Medical Doctor, [redacted] Ph.D. Physiologist, [redacted] Ph.D. Psychologists, and [redacted] Pharmacologist. During the period June 1966 to 1 January 1968, the Pharmacologist resigned, a Ph.D. Physiologist with a background in pharmacology joined the Division staff, and [redacted] secretary was added, bringing the Division complement to [redacted]

(b)(3) CIAAct (b)(3) CIAAct (b)(3) CIAAct (b)(3) CIAAct (b)(3) CIAAct (b)(3) CIAAct

2. Programs

Research projects initiated by the Life Sciences Group and continued by the Medical and Behavioral Sciences Division were: polygraph program; stress measurement support; baseline stress measurements; vulnerabilities of special behavioral groups; hypnotic susceptibility; and biological effects [redacted] (b)(1) (b)(3) NatSecAct 'With the exception of the polygraph and baseline stress measurement studies, these initial projects were subsequently redirected or discontinued. Stress measurement support and biological effects [redacted] (b)(1) (b)(3) NatSecAct were discontinued, the latter responsibility going to the Department of Defense.

The vulnerabilities of special behavioral groups effort was redirected to a study of undercover agent characteristics, con men, and provocation, elicitation, interrogation techniques while the hypnotic susceptibility work was redirected to a study of sleep suggestibility. Meanwhile, the stress measurement project was expanded to include indirect or remote physiological monitoring, and the polygraph program was enlarged from three to six research contracts. This latter effort was coordinated and directed by a team within MBSD that performed most of the data analysis and that prepared and published reports of polygraph program developments.

The Behavior Control project was expanded to include a drug acquisition and screening program, exploratory and developmental work on techniques for improved direct and indirect assessment of individuals and small groups, work on covert provocation and elicitation techniques, and new efforts in the area of ethnocultural factors concerned with communication barriers within and between selected cultural groups, national issues and tribal issues among nomads and other minority groups.

The Human Factors project has developed during the period since June 1965 to include a coordinated multitask effort to improve photo-interpreter performance in target detection, to improve audiotranscriber performance, to improve performance of the Agency training system, to analyze and define the role of transfer functions of the human in the intelligence process, and to develop means of optimizing his performance with particular emphasis to date on the intelligence analyst and the decision-making process, and to identify and exploit factors influencing learning, memory, and fatigue.

(b)(1)
(b)(3) NatSecAct

Starting in June 1965, with a budget of [redacted] and a program of eight projects, the Medical and Behavioral Sciences Division by FY 1968 had established twenty-five procurement contracts and three personal services contracts amounting to [redacted] (b)(1) (b)(3) NatSecAct

In spite of the small size of the Medical and Behavioral Sciences Division, during this developmental phase its officer personnel were successfully monitoring two projects for other ORD Divisions, serving as consultants on three Department of Defense committees, and as consultants to various Agency components or activities. MBSD personnel, both as a group and as individuals, were actively involved in a collaborative effort with other Agency components to identify Agency problems and related requirements. With the Office of Security and the Office of Training, these relationships centered about the polygraph program and the training systems study, both of which were carried forward with the assistance of outside contractors. With the Office of Current Intelligence, MBSD initiated research to identify problems associated with the role of the intelligence analyst. MBSD initiated work with BAB/TSD/DDP and A&E Staff, Office of Medical Services, to better define problems associated with assessment of individuals and groups.

As a result of these efforts, problems of access and of cooperation between offices based on habits and established practices have been largely overcome. The principal example of progress in this area was the polygraph program jointly undertaken by the Interrogation Research Division, Office of Security, and MBSD. This example-setting effort, along with the training system survey, has gone a long way toward establishing precedence for future cooperative efforts between MBSD and other Agency components. It is expected that the current method employed by MBSD of establishing procedures for the identification of Agency problems will be the first step toward a definition of the various human roles in the intelligence analysis process.

Immediate plans of the MBSD include a moderate growth in personnel and funds to complete the work now under way and to support new work needed in the Stress Measurement, Behavior Control, and Human Factors areas. It is also planned to increase the in-house effort with respect to the on-going analysis of Agency problems. At the same time it is planned to systematize and adapt special analytical techniques, Bayesian, contextual, and others, to the Agency's peculiar problems and to implement their use as appropriate.

Long-range plans call for careful analytical studies and preparations for the probable needs of the

Agency in the years to come. If predictors, for example, indicate that human group behavior is to become increasingly more emotional and violent for the foreseeable future, requirements concerning the struggle for men's minds could change radically. To survive and succeed in a rapidly changing world, it may be that the Agency will have to have some means of instant self-analysis of any one or more of its various components and a means of quickly instituting changes as needed.

3. Accomplishments

At this point, a number of accomplishments may be cited as milestones toward the achievement of established goals:

> Polygraph program results have yielded findings with respect to polygraph utility, reliability, and validity.
>
> Automatic measurement of polygraph signals was accomplished. The method could be used to assist the examiner.
>
> An improved Galvanic Skin Response (GSR) design was developed and demonstrated.
>
> An improved respiratory sensor was developed. The improved design has yet to be demonstrated as superior in operation.
>
> An improved blood pulse sensor is under development.
>
> A pulse wave velocity sensor is under development.

The Electroencephalogram (EEG) was shown to be a sensitive indicator of stress.

The Electrooculogram (EOG) was shown to be a sensitive indicator of "yes" and "no" answers and hence potentially an indicator of deception.

Three new stress indicators, parotid fluid flow, electromyographic potentials, and muscle micro-vibration, were investigated and discarded as potential polygraph parameters.

Significant new developments in indirect physiological monitoring were identified and re-directed for Agency application.

Sleep suggestibility as distinct from hypnotic suggestibility was demonstrated as a phenomenon.

Some characteristics of individuals more successful in resisting polygraph interrogation were identified.

Methods that con men use to identify susceptible targets were studied and classified.

Two first operation health hazard radiometers were developed and deployed to the field.

(b)(1)
(b)(3) NatSecAct

A dosemetry slide-rule for safe operation of [redacted] was developed and disseminated to users.

Preliminary design specifications were developed for a system to determine critical parameters in photointerpreter detection of targets.

E. Optics Division

1. Organization

Activity in the Optics area was initiated prior to the formalization of the Office of Research and Development (ORD). This occurred due to the request of General (then Colonel) Edward B. Giller, Assistant Deputy Director (Research), that Mr. Harry W. Woo of TSD/DDP investigate the state of technology of [redacted] (b)(1) scanning systems and prepare recommendations for research and development in that field. The work was initiated in October 1962, approximately three months before Mr. Woo, the second scientific member of ORD, reported for duty with ORD/DDR; the first member, [redacted] (b)(3) CIAAct (b)(6) preceded him by several days. The more formalized shape of an organization did not develop until Mr. Robert M. Chapman and Dr. Stephen L. Aldrich reported aboard as the Assistant Director and Deputy Assistant Director, respectively, of ORD. At that point, Mr. Woo was designated Chief of the Optics Division, with two staff members. Messrs. [redacted] (b)(3) CIAAct (b)(6) (b)(3) CIAAct (b)(6) [redacted] and [redacted]

From the initial concept, the mission of ORD was to provide research and development capability in technical and scientific fields, and to intelligence requirements in general. In the optics area it was specifically directed to optical collection devices and ancillary activities, and to direct support to the Office of Special Activities in research and development of advanced overhead collection systems. For the most part, Optics Division has adhered to its original mission.

2. Philosophy of Management

Optics Division's main preoccupation has been in applied research and development, even though it has established the state-of-the-art in [redacted] (b)(1) and magnetic detection. With the establishment of the Optical Sciences Laboratory in Optics Division, the trend is toward in-house analysis of optical phenomena prior to external contracting for optical manipulations.

One of the questions posed to Optics Division is: "How do you accomplish your developments so rapidly?" The technique is to do total contracting for all phases, the philosophy being that at some point in a phase prior to phase completion, there is sufficient data to render a decision to go ahead. If the decision is made at that time to proceed with the next phase, six months to a year can be saved, depending on the complexity of the system under development. Also, the philosophy is to design for an operational prototype, which means that the first model is designed to be used operationally, if necessary. There is a large risk factor involved, but if the project engineer is sufficiently knowledgeable and is close to the development, the risk is not as great as it appears to be. The first 1/2 mrad IR scanner produced was used operationally.

3. Major Programs

(b)(1) The report by Mr. Woo relative to the state of [redacted] scanning systems and his recommendations for research and development in this area resulted in a major contribution to the Intelligence Community. A new state-of-the-art was established, resulting in the practical [redacted] (b)(1)

The first high resolution [redacted] scanner was produced by (b)(1) the Optics Division in thirteen months with a tenfold increase in resolution over then-existing [redacted] scanners. (b)(1) This accomplishment was deemed to be five years away by knowledgeable scientists. Five months later it collected the first substantive intelligence data toward a National Intelligence Objective requirement. For this feat, the Intelligence Medal of Merit was awarded to Messrs. Woo and [redacted] and, more mundane, cash awards totaling [redacted]

(b)(3) CIAAct
(b)(6)

(b)(3) CIAAct

(b)(1)

Unfortunately, this [redacted] scanner with a 1/2 milliradian resolution was lost several weeks later on another operational mission.

Even before the first operational mission with the 1/2 milliradian scanner was undertaken, however, the design for an unheard-of 1/10 milliradian resolution scanner was underway, with a radical change in the scanning mode to permit obtaining [redacted] (b)(1) through the one system. The design was sufficiently good that a 1/20 milliradian resolution system was initiated at the same time. Thus, with the initiation of the [redacted] (b)(1) program in June 1963, a series of high resolution scanners was produced, with the 1/2 mr delivered in July 1964, the 1/10 mr breadboard in March 1966, the 1/20 mr breadboard in August 1966, and a 1/10 mr operational prototype scheduled for February 1967.

In June 1966, an in-house design study for (b)(1) [redacted] was underway. Through this bold and aggressive program, Optics Division established the Central Intelligence Agency in the forefront of [redacted] (b)(1) technology in the nation, and has made, and is continuing to make, significant contributions to the [redacted] capability of the U.S. military services.

(b)(1)

Further details of these amazing achievements may be found in "Studies in Intelligence," Volume II, No. 3, Summer 1967.*

[redacted]

(b)(1)
(b)(3) NatSecAct
(b)(3) CIAAct
(b)(6)

*See also Volume III, Monograph 17.

**See also Volume III, Monograph 18.

SECRET

In 1965 Optics Division work was directed toward tactical intelligence by the Director of Central Intelligence, the Honorable William F. Raborn, who requested a foliage penetration study and recommendations as to how this might be accomplished. The word was received by Mr. Woo the night of 10 July 1965, and on Sunday, 11 July, Mr. Woo and (b)(3) CIAAct (b)(6) [redacted] met to discuss this problem. From this meeting came the [redacted] concept which later became known as [redacted] in CIA and [redacted] (b)(1) (b)(3) NatSecAct in the Department of Defense. On 16 July, ORD submitted the "Report to the Director: Techniques for Foliage Penetration in Reconnaissance and Technical Recommendations for Agency Programs."

(b)(1)
(b)(3) NatSecAct

(b)(1)
(b)(3) NatSecAct

The DD/S&T and staff met with Dr. Harold Brown (then Assistant Secretary of Defense for Research and Engineering) to brief and coordinate Agency and DOD programs and to prepare a coordinated report to the Bureau of the Budget. At that meeting it was agreed that [redacted] was to be an Agency effort, with ORD coordination to be effected through DD/R&E and ARPA. A series of briefings and coordination meetings was held with Navy Liaison, CNO, Bureau of Weapons, Joint Chiefs of Staff, Vietnam Task Force, and elements of the BOB. On 7 September 1965, the BOB provided the first funding for Project [redacted]

(b)(1)
(b)(3) NatSecAct

(b)(1)
(b)(3) NatSecAct

SECRET

(b)(1)
(b)(3) NatSecAct

The name [redacted] is an acronym derived from (b)(1) (b)(3) NatSecAct [redacted] and is essentially the original concept [redacted] (b)(1) (b)(3) NatSecAct [redacted] concept was later removed from the system. While this program was directed toward operations in Southeast Asia, the systems and technology are applicable in other areas of dense foliar coverage, e.g., portions of Latin America, Africa, and the Caribbean Islands. The concept was designed around Agency proprietary equipment developed in Optics Division in the (b)(1) [redacted] and active magnetics sensor disciplines. The concept found such favor in the military services that both the Navy and Air Force allocated large multi-millions toward building similar systems. The Navy, for instance, has eleven systems under contract, eleven systems under negotiation, and plans for twenty additional upgraded systems.

In 1966 a change in policy occurred with the new DCI. CIA financial support was withdrawn, and [redacted] (b)(1) (b)(3) NatSecAct [redacted] was almost abandoned, but was rescued by the Assistant Secretary of Defense for Research and Engineering, Dr. John Foster, who directed DOD support, in his words, "for this worthwhile development."

(b)(1)
(b)(3) NatSecAct

Under his sponsorship [redacted] was to obtain the necessary data relative to sensors, navigation, and tactics to guide the development of similar follow-on military systems. As of the writing of this history, (b)(1) (b)(3) NatSecAct [redacted] was being tested in the Southeast Asian environment.

It appeared that Optics Division, because of its unusual conceptual approaches toward problems, had a permanent position as the center of controversy. In the development of the Airborne Active Magnetic Sensor (ABACUS) test flights were flown against submerged objects with sufficient signal return that it may be able to detect submerged submarines. Previous analysis of active magnetics by magnetic experts ruled this technique out as a non-feasible approach. However, arrangements were made through the auspices of the CNO to run tests against the conventional submarine <u>Redfin</u> off the coast of Norfolk, on 8 November 1966. The tests were scheduled during darkness in order to test a theory of Mr. Woo's relative to the use (b)(1) of [redacted] equipment against submarine wake detection. The results of the tests showed clear signals of the submarine by the ABACUS device and recorded wakes created by the submarine at depths to 300 feet. These results caused a furor, since numerous studies indicated that detection of submarines by active magnetics and [redacted] (b)(1) at such depths was not possible. It is almost a year, at this writing, since these results were obtained and no further tests have been conducted. However, controversial discussions are still under way, especially with the Abacus system, where top scientists of the Nation are stating that "it's no damn good and can't work." At this point we are trying to develop a mathematical model and obtain additional data to convince the scientists that Abacus does not violate the laws of physics.

Unfortunately, anti-submarine warfare (ASW) has been deemed not part of the Agency's responsibility, and we were directed not to investigate further. It is unfortunate because our ballistic missile submarines are presumed to be undetectable and serve as our first line of defense; therefore, any system which offers a possibility of detection should be investigated to determine its capabilities and limitations so that suitable countermeasures can be devised. The picture of the [redacted] (b)(1) wake is contained in "Studies in Intelligence," Volume II, No. 3, Summer 1967.

4. Problems

The major problem facing Optics Division is the top-level decision that large reconnaissance systems will not be undertaken. This reverses, somewhat, the original mission of the Optics Division, and at present (1968) Optics is restructuring its roles and mission. Funding is a problem, and the tendency is to fund those R&D projects which have the least amount of risk. While this is understandable in the light of tight money, it does stifle bold approaches toward solution of problems. Certainly fewer state-of-the-art systems will be developed if this tendency continues.

In the final analysis, however, there are not as many restrictions placed on the technical people when compared to those of the military. Although there are frustrations, the work is most challenging, diversified, and most enjoyable.

F. Physics-Chemistry Division

1. Organization

What was later to become Physics-Chemistry Division, ORD, had its beginnings early in the winter of 1962-63. [redacted] (b)(3) CIAAct (b)(6) Engineer, Mr. Robert L Butenhoff, a Nuclear Chemist from AEC having instrumentation and analytical background (both of whom were transferees from TSD/DDP), [redacted]

(b)(3) CIAAct
(b)(6)

The Division first took form in the summer of 1963 when part of the growing ORD staff was located within the Langley Headquarters. At that time [redacted] (b)(3) CIAAct (b)(6) was assigned supervisory responsibilities for the physical area housing Messrs. Nicholas Garofalo and [redacted] (b)(3) CIAAct (b)(6) (b)(3) CIAAct (b)(6) and [redacted] in addition to those named above. [redacted] was the group secretary.

(b)(3) CIAAct
(b)(6)

The growth of a divisional role in Physics-Chemistry and the appointment of [redacted] (b)(3) CIAAct (b)(6) as Division Chief resulted from a number of pressures: the requirement for supervision of the group, for programming and budgeting, and for recruiting. A homogeneous, interdisciplinary capability was generated and the establishment of the division was approved by the Deputy Director for Science and Technology, Dr. A. D. Wheelon, in November 1963.*

(b)(3) CIAAct (b)(6) [redacted] transferred to the embryonic division from General Sciences Division, OSI, and brought with him a unique concept [redacted] (b)(1) (b)(3) NatSecAct By late 1964, Physics-Chemistry Division was a functioning organization.

Professional staff changes since that time show the following gains and losses:

Dr. John L. Stephenson, Physical Organic Chemist, from TSD (formerly with AEC, Sandia), in July 1964.

[redacted] (b)(3) CIAAct (b)(6) (b)(1)

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*See pp. 16-17 and Figure 4, above.

(b)(3) CIAAct
(b)(6)
(b)(1)

[redacted]

Mr. Robert L. Butenhoff, Nuclear Chemist returned to AEC, May 1967.

(b)(3) CIAAct
(b)(6)

[redacted]

In March 1967 the Chief of Physics-Chemistry Division established a branch structure within the Division to facilitate programming and supervision of on-going activities. Three branches were set up: Systems Branch, with [redacted] heading this branch in addition to his duties as Deputy Chief of the Division; Materials Branch, headed by Dr. Stephenson; and Research Branch, headed by [redacted]

(b)(3) CIAAct
(b)(6)

(b)(3) CIAAct
(b)(6)

2. Programs

The principal program areas in which Physics-Chemistry Division worked during its first four years are outlined below with a description of typical projects in each area.

(b)(1)
(b)(3) NatSecAct

[redacted]

~~SECRET~~

(b)(1)
(b)(3) NatSecAct

~~SECRET~~

SECRET

(b)(1)
(b)(3) NatSecAct

[redacted]

SECRET

(b)(1)
(b)(3) NatSecAct

[redacted] using active and passive systems ranging across the electro-magnetic spectrum. [redacted] (b)(3) CIAAct (b)(6) Stephenson [redacted] have been the leaders in this work. [redacted] (b)(1) (b)(3) NatSecAct

(b)(1)
(b)(3) NatSecAct

*See also Volume III, Monograph 21.

**See Volume III, Monograph 19.

(b)(1)
(b)(3)
NatSecAct

[redacted]

c. <u>Geophysical Techniques</u>

(b)(1)
(b)(3) NatSecAct

[redacted] with Dr. Stephenson as project officer, involved [redacted]

(b)(1)
(b)(3) NatSecAct

*See Volume III, Monograph 23.

(b)(1)
(b)(3) NatSecAct

[redacted] During the course of these tests, the DCI requested that P-C Division turn the technique over to the military. This was done at a series of high-level briefings at the Pentagon conducted by Dr. Stephenson and

(b)(3) CIAAct
(b)(6)

[redacted] As a result, the Air Force conducted a large-scale test in Vietnam with, again, inconclusive results. Since the technique was designed for

(b)(1)
(b)(3) NatSecAct

[redacted] there is some possibility

(b)(1)
(b)(3) NatSecAct

[redacted]hat the target requirements overrode the requirement for proper [redacted] conditions. This would cause poor results. General William Westmoreland's Scientific Adviser, Dr. William G. McMillan, personally commented upon the unsatisfactory nature of the Air Force evaluation. There was evidence of the use of bamboo mats and logs in the drop zone after the military drop, but the effect on traffic movement could not be assessed. The military stopped operational testing.

ARPA took over the R&D management of the military aspects of this program and had work done at [redacted]

(b)(3) NatSecAct
(b)(1)

The basis of the work remains sound, but what is needed is a method to improve mixing of the chemicals with the soil to give more effective mud-making. Since there were some chemicals left over, it was hoped to have them re-tested the following spring in the research and development area in Southeast Asia, using an improved mixing technique.

(b)(3) CIAAct
(b)(6)

The second earth sciences project, under the direction of [redacted]

(b)(1)
(b)(3) NatSecAct

(b)(1)
(b)(3) NatSecAct

[redacted]

(b)(1)
(b)(3) NatSecAct

d. Systems Engineering

[redacted]

e. Power Sources

Secondary, or auxiliary, power is largely battery work. Emphasis is on (1) low-power systems compatible with printed and micro-electronics, (2) secondary systems for audio, (3) solar cells and fuel cells for black box systems, and (4) propulsive power engines for ORD emplacement systems. Messrs. [redacted] (b)(3) CIAAct (b)(6) were responsible for guiding these support projects. A successful endeavor in this area was conducted

(b)(1)
(b)(3) NatSecAct

[redacted]

f. Materials Technology

A number of projects managed by [redacted] (b)(3) CIAAct (b)(6) Dr. Stephenson, with Messrs. [redacted] include an [redacted] (b)(1) (b)(3) NatSecAct Special support on materials with unique properties, such as [redacted] (b)(1) (b)(3) NatSecAct is provided. [redacted] (b)(3) CIAAct (b)(6) is also active in the broad field of camouflage where interaction of energy and matter set the technology. Requirements cover audio, [redacted] (b)(1) visible, and radar camouflage for a variety [redacted] (b)(1) (b)(3) NatSecAct

g. [redacted] and Analysis (b)(1) (b)(3) NatSecAct

(b)(1) (b)(3) NatSecAct This program supports several highly sophisticated approaches: [redacted] for example, for instrumental analyses. Work is also done on foreign materiel and specially collected items to get at the technology of threat nations by exploiting in depth both chemical and

*Volume III, Monograph 24.

physical analytical methods. Dr. Stephenson, with the aid of [redacted] manages these efforts.

(b)(3) CIAAct
(b)(6)

To summarize, Physics-Chemistry Division is a highly interdisciplinary division. Systems approaches requiring an engineering rather than scientific outlook motivate the staff against requirements which find a greater focus in nuclear capabilities, including delivery systems, than any other field. The total effort is circumscribed by the size of the annual budget, which for FY 1968 was approximately [redacted]

(b)(1)
(b)(3) NatSecAct

G. <u>Radio Physics Division</u>

1. <u>Organization</u>

The Radio Physics Division was initiated in February 1963 when Mr. Nicholas R. Garofalo transferred from TSD/DDP to the Directorate for Research. In December 1963, Mr. David L. Christ assumed responsibility as Chief of the Division and at the same time started organizing the mission for the Audio Physics Division. Mr. Charles E. McGinnis entered on duty in February 1965 to become Chief of the Radio Physics Division, and Audio Physics was set up as a separate entity.

Radio Physics Division was organized to conduct applied R&D in the electro-magnetic (EM) antenna and propagation field, in over-the-horizon (OTH) radars, advanced sensors, EM surveillance systems, stay-behind systems using advanced microminiaturization techniques which can gather intelligence in a remote fashion, and secure retrieval of data from stay-behind devices. The charter was later expanded to include stand-off emplacement vehicles for emplacing these remote sensing devices, non-linear joint detection studies and applied research.

The operating budget of the Division in all the above-listed areas of discipline, covering the period from FY 1963 through FY 1968, is shown below.

FY 1963	[redacted]
FY 1964	
FY 1965	
FY 1966	
FY 1967	
FY 1968	

(b)(1)
(b)(3) NatSecAct

2. Major Programs

The following chronology sets forth major milestones achieved under projects in the areas mentioned above which are particularly worthy of mention; however, it by no means covers all the tasks accomplished and underway in the Radio Physics Division.

OTH Radar. In the over-the-horizon radar field, Radio Physics Division has developed, fielded, and operated a major radar installation [redacted] (CHECKROTE).

More than 500 tons of sophisticated radar equipment was designed, procured, integrated, shipped half way around the world, assembled, and put on the air in less than fifteen months. This development was the outgrowth of the prior work on the EARTHLING OTH radar evolved and operated [redacted] (b)(1) (b)(3) NatSecAct Since its initial operation, in the fall of 1966, CHECKROTE [redacted] (b)(1) (b)(1) (b)(1) The OTH radars were shown to have a capability for tracking cooperative aircraft reliably out to a [redacted] program. (b)(1) (b)(3) NatSecAct

The CHECKROTE radar may be considered to be a very high powered, high frequency transmitter (3.2 megawatts) with a very sensitive receiver connected to a 600-by-150-foot directional antenna. As such, it could be used to communicate with emplacement vehicles such as AQUILINE and with unmanned stay-behind intelligence collection devices emplaced in denied areas of the world. A transponder breadboard was designed and tested in 1966 [redacted] (b)(1) (b)(3) NatSecAct

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*See also Volume III, Monograph 25 (CHECKROTE) and Monograph 26 (EARTHLING).

(b)(1) (b)(3) NatSecAct [redacted] Another transponder was developed and used with the CHECKROTE [redacted] (b)(1) (b)(3) NatSecAct Other transponders providing greater security in smaller packages are currently under development by Radio Physics Division.

<u>Stay-behind Collection Systems</u>. Stay-behind intelligence collection systems for detecting and tracking missiles and the R&D of the subsystems necessary for these stay-behind devices have been conducted. A small, general purpose computer was developed and tested—smaller than 3"x4"x7" and weighing less than 4½ pounds. This computer has been integrated with [redacted] (b)(1) (b)(3) NatSecAct and tested as part of the early [redacted] system* as an [redacted] (b)(1) (b)(3) NatSecAct The QUADRANT program** is more fully described in a separate monograph. A smaller computer, 3/4 of a pound in weight, with 25 times the storage capacity and a lower power drain, is being developed.

Starting in 1964, techniques for packaging stay-behind devices so that they can withstand emplacement from both high and low altitude emplacement vehicles were

*Volume III, Monograph 29.

**Volume III, Monograph 27.

(b)(1)
(b)(3) NatSecAct

studied and tested. Earth-penetrating vehicles of the [redacted] include non-penetrating vehicles with crushable noses, drogue chutes or balloons or air vanes for slowing them down, motor-driven and gravity erection systems for leveling the emplaced package, [redacted]

(b)(1)
(b)(3) NatSecAct

Communications subsystems for transmitting commands to the stay-behind devices and for retrieving data collected by the stay-behind systems have been developed. These include high frequency radio receivers and transmitters for OTH communication; UHF/VHF transmitters and receivers for communication line-of-sight through airborne relays or through satellites have been constructed. Antennas, sensors, and power supply subsystems have been developed.

These subsystems have been assembled into working systems, such as the OXIDANT, [redacted] (b)(1) (b)(3) NatSecAct [redacted] systems. The OXIDANT program was started in January

1964 to gather definitive intelligence on enemy missile performance, to digest pertinent information using a logic computer, to store the information, and to transmit data in a secure fashion upon demand.*

(b)(1)
(b)(3) NatSecAct

The [redacted] system was started in January 1965 to provide a passive sensing system to accurately [redacted] during the early launch phase by means [redacted] In October 1965 this breadboard system was field tested [redacted] flight. Activities since that time have been devoted to increasing the range, designing and developing [redacted] systems, and performing operational system program definition studies.

(b)(1)
(b)(3) NatSecAct

(b)(1)
(b)(3) NatSecAct

(b)(1)

(b)(1)

(b)(1)
(b)(3) NatSecAct

(b)(1)
(b)(3) NatSecAct

<u>Propagation Programs</u>. A number of propagation programs have been conducted since the inception of

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*See also Monograph 28 in Volume III.

the Division. VLF propagation studies were conducted with the National Bureau of Standards and the Naval Ordnance Test Station at China Lake, California. High frequency propagation studies have been a continuing output from the EARTHLING and CHECKROTE programs. This work has contributed much to the understanding of high frequency propagation, ray-tracing, ray-focusing, ionospheric tilt, and ground backscatter phenomena. A study of an anomalous VHF propagation phenomenon is presently underway [redacted] VHF propagation [redacted] heretofore thought unattainable.

(b)(1) (b)(3) NatSecAct

A new technique [redacted] (b)(1) (b)(3) NatSecAct has been under investigation since January 1966. This method involves [redacted] (b)(1) (b)(3) NatSecAct The system in its breadboard form has detected [redacted] (b)(1) (b)(3) NatSecAct Development work now in progress should extend this range to several thousand feet and thereby

(b)(1)
(b)(3) NatSecAct

provide a reliable means for detecting the [redacted]

Stand-off Emplacement. In the stand-off emplacement areas, in which work was begun in 1966, are included studies directed toward establishing the feasibility of and program definition for [redacted]

(b)(1)
(b)(3) NatSecAct

[redacted] and acoustic signatures. Studies have demonstrated the feasibility of these approaches.

SOURCE
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(b)(1)
(b)(3) NatSecAct

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(b)(1)
(b)(3) NatSecAct

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(b)(3) CIAAct

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[redacted]

(b)(1)
(b)(3) NatSecAct

SECRET

(b)(1)
(b)(3)
NatSecAct

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(b)(3) CIAAct
(b)(6)

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APPENDIX A

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OFFICE OF RESEARCH AND DEVELOPMENT
1962-1970

CHRONOLOGY

1962

14 February — HN 1-8 announces the anticipated establishment of a Directorate for Research and Development, with transfer of certain DDP R&D functions to the new Directorate.

16 February — HN 1-9 establishes the Office of Deputy Director for Research and appoints Dr. Herbert Scoville, Jr., as Deputy Director; it also indicates future placing of R&D activities under the DD/R.

12 June — Chief, Operations, DD/P, requests the new Directorate for Research to initiate long-range programs in operational techniques for audio surveillance of targets at distances greater than current capabilities.

30 July — HN 1-23 states the mission of the DD/R, and establishes under his jurisdiction the Office of Research and Development (ORD).

21 September — The Deputy Director, Support, approves an ORD T/O of [redacted] positions; approval confirmed by DCI in November 1962. (b)(3) CIAAct

7 December — HN 20-73 designates Colonel Edward B. Giller, USAF, as Acting Assistant Director, ORD, effective 29 November 1962, in addition to his position as Assistant DD/R.

1963

19 February — DD/R 20-1 establishes the "R" Career Service and directs the Acting Assistant Director, ORD, to set up a Career Service Panel to implement career service policy within ORD.

(b)(1)
(b)(3) NatSecAct

[redacted] February — [redacted] is transferred to ORD from Development Projects Division and Technical Services Division, DD/P. Name is changed July 1964 to Project EARTHLING.

(b)(1)
(b)(3) NatSecAct

~~SECRET~~

<u>1963</u> (cont'd)

(b)(3) CIAAct

13 April — [redacted] establishes a special category of payscales for specially qualified scientific personnel called Scientific Pay Schedule (SPS) which greatly facilitates recruiting for ORD.

(b)(3) CIAAct

16 April — [redacted] establishes the Research and Development Review Board to review and integrate R&D activities Agency-wide.

14 June — Dr. Herbert Scoville, Jr., resigns as DD/R and Colonel Edward Giller is named Acting DD/R for next seven weeks.

June — ORD Optics group initiates first [redacted] (b)(1) contract for 1/2 mr scanner; successfully tests prototype in August, 1964.

(b)(3) CIAAct

1 July — [redacted] 16 July 1963, establishes a Scientific Advisory Board, effective 1 July, to advise the DCI on the Agency's R&D activities. Dr. Augustus B. Kinzel is named Chairman.

July — ORD Physics-Chemistry group begin tests on gamma ray spectroscopy collection techniques and systems.

5 August — Directorate for Research renamed Directorate for Science and Technology, and Dr. Albert D. Wheelon is named Deputy Director for Science and Technology.

19 August — CIA/DIA Scientific Guidance Panel interim report on survey of audio surveillance capabilities in the Intelligence Community recommends substantial basic research; final report rendered 3 February 1964 reinforces those findings and sees little prospect for successfully achieving audio surveillance at very long distances.

9 September — HN 20-115, 13 September 1963, appoints Mr. Robert M. Chapman as Deputy Assistant Director, Office of Research and Development.

<u>1963</u> (cont'd)

September Mr. James J. Connally is assigned as Administrative Officer, ORD.

October Dr. Stephen L. Aldrich transfers from Medical Division, OSI, to ORD as Deputy Assistant Director for Life Sciences, bringing with him as Special Assistant [redacted] (b)(3) CIAAct (b)(6)

November DD/S&T, Dr. Wheelon, approves ORD organizational concept comprising four divisions: Optics, Physics-Chemistry, Radio-Physics, and Life Sciences.

18 November Photo Working Panel (also known as Drell Panel) with Mr. Robert M. Chapman as Chairman, is formally established by the Acting DCI, Lt. Gen. Marshall S. Carter, USA. Panel meets first on 13 November 1963 and submits its final report on 8 February 1964.

December Optics Panel begins work with Dr. James A. Eyer as Chairman, supported by ORD Deputy Director for Life Sciences, Dr. Stephen Aldrich.

<u>1964</u>

9 March ORD Career Service Panel holds first meeting with Mr. James J. Connolly acting as non-voting chairman.

March Life Sciences Panel begins work with Dr. W. Ross Adey as Chairman, supported by ORD Deputy Director for Life Sciences, Dr. Stephen Aldrich.

March [redacted]

(b)(1)
(b)(3) NatSecAct

1964 (cont'd)

March	Mr. W. Stanley Bull, Jr., is named Executive Officer, ORD; [redacted] is named Budget and Fiscal Officer, ORD. (b)(3) CIAAct (b)(6)
2 May	Colonel Edward B. Giller completes his tour with CIA as Assistant DD/S&T and Acting Assistant Director, ORD, and returns to the Air Force.
4 May	Mr. Robert M. Chapman is appointed Acting Assistant Director for Research and Development (DD/S&T General Notice [redacted] 5 May 1964). (b)(3) CIAAct
May	Dr. A. D. Wheelon, DD/S&T, assumes responsibility as project officer for Scientific Engineering Institute (proprietary) which had been monitored by ORD during 1963-64.
May	Physics-Chemistry Division's mercury battery program succeeds in finding the key to improved design capacity from 30% to 90%+.
June	ORD initiates program to improve techniques in the CIA polygraph system.
28 June	ORD adds Analysis Division, with [redacted] as Chief. (b)(3) CIAAct (b)(6)
July	First 1/2 mr [redacted] scanner is delivered for testing. (b)(1)
August	Microminiaturized serology technology is developed.
August	Testing of 1/2 mr [redacted] scanner is successful. (b)(1)
October	ORD initiates computerization of its contract information within the S&T Management Information System.
October	Physics-Chemistry Division develops analytical method for detection and identification of [redacted]

(b)(1)
(b)(3) NatSecAct

~~SECRET~~

(b)(3) CIAAct
(b)(6)

1964 (cont'd)

16 November — [redacted] is assigned as Special Assistant to the Acting Assistant Director for Research and Development from former position as Chief of General Sciences Division, OSI. (His title becomes "Scientific Adviser" early in 1967.)

(b)(1)
(b)(1)
(b)(3) NatSecAct

November — The 1/2 mr [redacted] system deploys to [redacted] for overflight collection operations.

23 December — Technical Surveillance Countermeasures Committee is created by DCID 1/12; Countermeasures R&D Subcommittee under TSCC chaired by the D/RD, Mr. Robert M. Chapman.

1965

January — [redacted] (b)(1)

January — [redacted]

(b)(1)
(b)(3) NatSecAct

February — Mr. Charles E. McGinnis becomes Chief, Radio-Physics Division. Audio-Physics Division is set up as separate Division under Mr. David L. Christ. (Name of Audio Physics Division is changed to Applied Physics Division late in 1966.)

11 March — Mr. Robert M. Chapman is confirmed as Assistant Director for Research and Development (HN 20-197, 19 March 1965).

March — Advanced audio surveillance program using microwaves begins (Project CHAMFRON). ORD submits an integrated program to DD/P in the fall of 1965 for action.

11 May — Working model of 100-foot audio surveillance laser probe [redacted] is demonstrated.

(b)(1)
(b)(3) NatSecAct

~~SECRET~~

1965 (cont'd)

(b)(1)
(b)(3) NatSecAct

4 June [redacted]

15 June PFIAB recommendation that Intelligence Community improve its capabilities for handling intelligence information becomes basis for ORD Analysis Division's establishment of its Intelligence Processing Research and Development facility (IPRD).

(b)(3) CIAAct
(b)(6)

30 June Life Sciences Division splits into Biological Sciences Division (with [redacted] as Chief) and Medical and Behavioral Sciences Division (with [redacted] as Chief).

(b)(3) CIAAct
(b)(6)

30 June Seven active divisions are operational in ORD.

June Regular computer runs of ORD contract information begin under the DD/S&T Management Information System.

27 July Mr. Robert Chapman's title is changed from Assistant Director, ORD, to Director, ORD (HN 1-58, 16 August 1965).

(b)(3) CIAAct
(b)(6)

11 August [redacted] outlines proposal for Analysis Division's IPRD facility.

(b)(1)
(b)(3) NatSecAct

August [redacted]

(b)(1)
(b)(3) NatSecAct

7 September Bureau of the Budget approves funding for [redacted] method of foliage penetration in overhead reconnaissance.

(b)(1)
(b)(3) CIAAct
(b)(3) NatSecAct

3 September EARTHLING over-the-horizon radar operated [redacted] is closed down [redacted]

(b)(1)
(b)(3) NatSecAct

14 October Contract for CHECKROTE over-the-horizon radar system is initiated with [redacted]

(b)(1)
(b)(3) NatSecAct

1965 (cont'd)

November — Dr. Stephen Aldrich is named Deputy Director of ORD.

December — Polygraph evaluation analysis by computer is initiated.

1966

(b)(1)
(b)(3) NatSecAct

15 March — [redacted]

(b)(3) CIAAct
(b)(6)

March — [redacted] is named Deputy Chief, Physics-Chemistry Division.

March — The 1/10 mr [redacted] scanner breadboard has successful flight. (b)(1)

March — ORD moves to the Ames Center Building at Rosslyn.

April — ORD Registry is established in Ames Center Building with [redacted] (b)(3) CIAAct (b)(6) as Chief.

(b)(3) CIAAct
(b)(6)

April — [redacted] is appointed Special Assistant to D/RD for Emplacement.

May — Micropower VHF receiver with two orders of magnitude improvement in efficiency over conventional receivers is produced.

May — Equipment using solar reflection spectra for intelligence collection is first used operationally [redacted] (b)(1) (b)(3) NatSecAct

May — Mr. Frank Briglia is assigned to ORD and named Project Officer for AQUILINE (vice Mr. David L. Christ).

6 June — Dr. Stephen Aldrich is named Chairman and permanent member of ORD Career Service Panel.

(b)(1)
(b)(3) NatSecAct

1966 (cont'd)

June — Feasibility study is completed [redacted] for intelligence collection.

June — Field demonstrated, rechargeable, 1-mile telemetry system is totally implanted in an animal, using animal's ears as stereo/hi-fidelity microphones.

July — [redacted] (b)(1) (b)(3) NatSecAct

1 August — [redacted] (b)(1) (b)(3) NatSecAct

August — DCI approves IPRD facility program and initial construction begins.

August — The 1/20 mr [redacted] (b)(1) scanner breadboard flies successfully, proving design feasibility.

September — [redacted] is assigned as Librarian for the ORD Branch Library in Ames Center Building. (b)(3) CIAAct (b)(6)

26 September — Mr. Carl E. Duckett is appointed Acting DD/S&T, vice Dr. A. D. Wheelon, resigned.

17 November — [redacted] is named Laboratory Director, IPRD facility; [redacted] is detailed from OCS as Assistant Laboratory Director.

(b)(3) CIAAct
(b)(6)

(b)(3) CIAAct
(b)(6)

1967

March — Physics-Chemistry Division organizes into Systems, Materials, and Research Branches.

20 April — Mr. Carl E. Duckett is confirmed as DD/S&T.

7 May — [redacted]

(b)(1)
(b)(3) NatSecAct

<u>1967</u> (cont'd)

June — Three field models of a 100-foot audio surveillance laser probe contracted for by ORD are delivered to TSD.

(b)(3) CIAAct

17 July — [redacted] establishes centralized coordination of Research, Development and Engineering by the DD/S&T as staff officer to the DCI, with decentralized execution of projects.

(b)(3) CIAAct
(b)(6)

August — [redacted] is assigned to ORD as its [redacted] full-time Security Officer.

(b)(3) CIAAct
(b)(6)

August — [redacted] is assigned to newly designated position of Technical Assistant for Plans and Programs, reporting to the Deputy Director, ORD.

September — [redacted] provided by ORD to the Technical Division, [redacted] is adopted for production.

(b)(1)
(b)(3) NatSecAct

10 October — ORD contracts for warm fog dispersal research at request of Vietnam Affairs Staff, CIA; system resulting is accepted by the military in February 1968.

7 November — [redacted]

(b)(1)
(b)(3) NatSecAct

November — [redacted] detection scheme is demonstrated using analog-to-digital signal processing techniques for improved sensitivity.

(b)(1)
(b)(3) NatSecAct

<u>1968</u>

16 February — ORD assumes responsibility for IDA-JASON panel of consultants; Mr. Charles E. McGinnis is responsible officer for support and monitoring of this activity.

1968 (cont'd)

12 August — ORD establishes Special Projects Group with Mr. Frank Briglia as Chief; first effort is the development of AQUILINE.

1969

(b)(3) CIAAct
(b)(6)

3 January — D/RD names [redacted] Special Assistant for Requirements.

February — ORD adds Procurement Management Staff for contracting assistance.

(b)(3) CIAAct
(b)(6)

20 September — [redacted] retires from his position as Special Assistant to the D/RD.

1970

10 December — ORD Mission and Functions Statement in approved draft, fully coordinated, goes to Regulations Control Branch for publication. (Published as [redacted] 8 March 1971.)

(b)(3) CIAAct

APPENDIX B

~~SECRET~~

MAJOR ACCOMPLISHMENTS - ORD *

Optics and [redacted] (b)(1)

(b)(1) [redacted]

[redacted] (b)(1) (b)(1) (b)(3) NatSecAct

1/10 milliradian infrared scanner developed and now being prepared for Air Force use in the DMZ.

[redacted] (b)(1) (b)(3) NatSecAct now being evaluated in Viet Nam area.

High speed densitometer for rapid readout and [redacted] (b)(1) (b)(1) [redacted] tied to 360 computer in IPRD, has been developed.

[redacted] (b)(1)

(b)(1) (b)(3) NatSecAct [redacted] Day and night navigational drift sight for high altitude aircraft use.

Biological Sciences

(b)(1) (b)(3) NatSecAct [redacted]

Demonstrated feasibility of utilizing animals' ears as high-fidelity microphones and developed supportive electronic gear and surgical techniques for long-term body implant.

Demonstrated that birds, cats, and dogs can be trained to perform tasks of operational significance and developed supportive gear for transport and guidance.

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*Prepared at the end of 1968.

~~SECRET~~

Developed ultra-sensitive methods for detection of [redacted] (b)(1) (b)(3) NatSecAct

Developed technique for remote determination and prediction of crop yields.

Demonstrated feasibility of remote detection of BW/CW activities.

Electromagnetic Research and Development

CHECKROTE [redacted] (b)(1) (b)(1)

EARTHLING over-the-horizon radar developed and operated against the Russian missile test ranges.

IR-AC radiometer for static and dynamic missile test firings developed and tested.

(b)(1) (b)(3) NatSecAct [redacted]

Developed microwave radiometry techniques now being used by other services for passive navigation and for iceberg detection.

Developed integrated active antennas now being used by Army field units.

High frequency radio systems developed for interrogation of stay-behind systems.

Acoustic missile re-entry and impact locator designed.

Missile trajectory stay-behind system designed and demonstrated.

(b)(1) (b)(3) NatSecAct [redacted]

Missile tracking system designed and tested using

(b)(1) (b)(3) NatSecAct [redacted]

(b)(1)
(b)(3) NatSecAct

[redacted]

Designed and now developing world's smallest micro-power-microminiature radio data relay link having 1/4 cubic inch.

(b)(1)
(b)(3) NatSecAct

[redacted]

Authored comprehensive handbook on maximum efficient use of solar energy for ground-based equipment.

<u>Microminiaturization and Micropower</u>

(b)(1)
(b)(3) NatSecAct

[redacted]

Developed a class of transistors which are an order of magnitude better than anything commercially available.

(b)(1)
(b)(3) NatSecAct

[redacted]

Developed analog circuitry for high performance receiver using power reduced by 3 orders of magnitude.

(b)(1)
(b)(3) NatSecAct

[redacted]

(b)(1)
(b)(3) NatSecAct

IPRD

Established first secure R&D computer facility to apply new computer technology to attack the indigestion problem using:

On-line real-time display for analyst.

Computer controlled scanner of graphic data.

Time-shared retrieval system.

Ordering and structuring large data files.

High-speed machine recognition of keywords in audio tapes for intelligence search.

Noise-stripping from audio operational tapes to provide better intelligibility and intelligence output.

Method for analysis of business machine emanations for recognition of product of machine.

(b)(1)
(b)(3) NatSecAct

[redacted]

Technical Surveillance Countermeasures

Protection (Nullification and Isolation)

Developed demonstration model and application handbook for a [redacted] (b)(1) (b)(3) NatSecAct

Developed several demonstration models of secure conferencing systems.

(b)(1)
(b)(3) NatSecAct

Developed demonstration models of two lightweight, easily transportable and erected [redacted] to be delivered to TD/OS/DDS and OC/DDS early in 1968.

(b)(1)
(b)(3) NatSecAct [redacted]

Detection (Link, Device, Objects)

Conducted studies of the RF audio surveillance threat and possible detection philosophies which have become community standards.

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*See separate Monograph.

(b)(1)
(b)(3) NatSecAct

Completed evaluation of [redacted] countermeasures systems. [redacted]

Developed techniques and demonstration model of radiometer [redacted] (b)(1) (b)(3) NatSecAct

Developed and delivered to TD/OS new techniques of telephone system protection.

Demonstrated feasibility of microwave holography techniques to produce usable images [redacted] (b)(1) (b)(3) NatSecAct

Developed technique and delivered demonstration model of field gradient transmitter detector with significantly lower false alarm rate than existing equipment.

(b)(1)
(b)(3) NatSecAct

Developed and delivered prototype permanent [redacted]

ORD organized CM R&D Subcommittee of TSCC.

<u>Special Projects</u>

[redacted]

(b)(1)
(b)(3) NatSecAct

Fog dissipation - developed and prepared for deployment in Viet Nam a method for fog dissipation permitting aircraft landing and clandestine operations.

[redacted]

(b)(1)
(b)(3) NatSecAct

Battery - mercury battery operational reliability improved from 30% to better than 90%.

[redacted]

(b)(1)
(b)(3) NatSecAct

<u>Behavioral and Medical Activities</u>

Established validity and reliability of the polygraph in security screening. Development of improved sensors and analytic techniques for an improved polygraph.

Surveyed selected OTR schools and incorporated greater use of program assisted instruction.

Developed and deployed a sensitive wideband radiometer for measuring microwave radiation hazards.

Developed and deployed a "slide rule" for [redacted] (b)(1) (b)(3) NatSecAct [redacted] calculation.

[redacted] (b)(1)

APPENDIX C

~~SECRET~~

APPENDIX C - VITAL DOCUMENTS

1. HN 1-8, 14 February 1962, announced the DCI's intention to transfer certain of the research and development functions of the Deputy Director (Plans) to a new Deputy Director for Research and Development. (Confidential)

2. HN 1-9, 16 February 1962, established the Office of Deputy Director for Research, effective 19 February 1962, and appointed Dr. Herbert Scoville, Jr., as Deputy Director (Research). (Secret)

3. HN 1-23, 30 July 1962, outlined the mission of the Deputy Director (Research) and announced the establishment under his jurisdiction of the Office of Research and Development (ORD). (Secret)

4. HN 20-73, 7 December 1962, designated Colonel Edward B. Giller, USAF, as Acting Assistant Director, Office of Research and Development, in addition to his current position as Assistant Deputy Director (Research), effective 29 November 1962. (Confidential)

5. HN 20-115, 13 September 1963, appointed Mr. Robert M. Chapman Deputy Assistant Director, Office of Research and Development, effective 9 September 1963. (Confidential)

6. Directorate of Science and Technology General Notice No. 12, 5 May 1964, appointed Mr. Robert M. Chapman Acting Assistant Director for Research and Development, vice Colonel Giller, returned to the Air Force, effective 4 May 1964. (Secret)

7. Directorate of Science and Technology General Notice No. 25, 9 November 1964, assigned [redacted] former Chief, General Sciences Division, OSI, as Special Assistant to the Acting Assistant Director for Research and Development, effective 16 November 1964. (Secret) (b)(3) CIAAct (b)(6)

8. HN 20-197, 19 March 1965, appointed Mr. Robert M. Chapman Assistant Director for Research and Development, effective 11 March 1965. (Confidential)

~~SECRET~~

9. Memorandum for the Director of Central Intelligence from the Special Assistant to the President, 15 July 1965, sub: U.S. Intelligence Community Capabilities for Handling of Intelligence Information, enclosing Memorandum for the President from the PFIAB, same subject, dated 15 June 1965. The recommendations of the PFIAB were the basis of the establishment of ORD's Analysis Division, and the Analysis Division's plans for its Intelligence Processing Research and Development facility (IPRD). (Secret)

(b)(3) CIAAct
(b)(6)

10. Memorandum for the Director of Research and Development from [redacted] Chief, Analysis Division, ORD, submitting a proposal for an ORD Intelligence Sciences Laboratory and outlining the principal elements of the Analysis Division's program; ORD-2227-65, dated 11 August 1965. (Secret)

11. HN 1-58, 16 August 1965, designated the head of ORD as Director of Research and Development (in lieu of Assistant Director, as previously designated), effective 27 July 1965. (Secret)

DOC. 1

~~CONFIDENTIAL~~

ORGANIZATION

HN 1-8
14 February 1962

1. Effective 17 February 1962, Mr. Richard Helms is appointed Deputy Director (Plans) vice Mr. Richard Bissell who has submitted his resignation.

2. The organization of the DD/P is currently being studied and certain changes are contemplated. There will be created a Deputy Director for Research and Development and certain of the Research and Development functions now administered by the Deputy Director (Plans) will be transferred to that Deputy.

3. Additional announcements will be made in the near future.

John A. McCone
JOHN A. McCONE
Director of Central Intelligence

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SECRET

DOC. 2

ORGANIZATION

HN 1-9
16 February 1962

1. There is established effective 19 February 1962 the Office of Deputy Director for Research. Certain of the activities of the Development Projects Division, DD/P, will also be transferred to DD/R. In the interest of strengthening the Agency's technical and scientific capabilities by centralizing such effort in one division, other activities in Research and Development will be placed under DD/R as appropriate.

2. Effective 19 February 1962, Dr. Herbert Scoville, Jr., is appointed Deputy Director (Research).

3. Dr. Scoville will continue to act as Assistant Director for Scientific Intelligence.

JOHN A. McCONE
Director of Central Intelligence

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~~S-E-C-R-E-T~~

This Notice Expires 1 August 1963

ORGANIZATION

HN 1-23
30 July 1962

DEPUTY DIRECTOR (RESEARCH)

DOC. 3

1. The mission of the Deputy Director (Research) is to conduct in depth, research and development in the scientific and technical fields to support intelligence collection by advanced technical means, exclusive of those R&D activities to support agent operations. The Deputy Director (Research) will carry out those operations strictly in the scientific and technical fields which do not involve clandestine agent operations, or those functions of the Office of Communications as contained in HR 1-14g except ELINT activities. The Deputy Director (Research) will coordinate such operations carried out overseas with the Deputy Director (Plans) and through the Chief of Station concerned. There is established under the jurisdiction of the Deputy Director (Research) the Office of Research and Development (ORD).

2. The Deputy Director (Research) will have primary responsibility for Agency ELINT activities, including requirements, subject to policy guidance from the Agency SIGINT Officer. Clandestine agent operations and liaison with representatives of the intelligence or security organizations of foreign governments will remain under the direct control of the Deputy Director (Plans). Accordingly, there is established immediately under the jurisdiction of the Deputy Director (Research) the Office of Elint (OEL) to which all such activities will be transferred.

3. The Office of Special Activities (OSA) is hereby established under the Deputy Director (Research). All functions and personnel of the Development Projects Division of the Deputy Director (Plans) are hereby transferred to OSA except those of the Air Support Branch and its supporting staff elements which remain the responsibility of the Deputy Director (Plans).

[redacted]
(b)(6)
(b)(3) CIAAct

Marshall S. Carter
Lieutenant General, USA
Deputy Director

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~~C-O-N-F-I-D-E-N-T-I-A-L~~

This Notice Expires 1 July 1963

PERSONNEL

HN 20-73
7 December 1962

DOC. 4

ANNOUNCEMENT OF ASSIGNMENT TO KEY POSITION

OFFICE OF THE DEPUTY DIRECTOR (RESEARCH)

1. Effective 29 November 1962, Colonel Edward B. Giller, USAF, was designated Acting Assistant Director, Office of Research and Development, DD/R.

2. This designation is in addition to his present position as the Assistant Deputy Director (Research).

FOR THE DIRECTOR OF CENTRAL INTELLIGENCE:

L. K. WHITE
Deputy Director
(Support)

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GROUP 1
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ORD

~~C-O-N-F-I-D-E-N-T-I-A-L~~

This Notice Expires 1 December 1963

PERSONNEL

HN 20-115
13 September 1963

ANNOUNCEMENT OF ASSIGNMENT TO KEY POSITION

OFFICE OF THE DEPUTY DIRECTOR
FOR SCIENCE AND TECHNOLOGY

DOC. 5

Effective 9 September 1963, Robert M. Chapman is appointed Deputy Assistant Director, Office of Research and Development.

FOR THE DIRECTOR OF CENTRAL INTELLIGENCE:

L. K. WHITE
Deputy Director
for Support

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~~S-E-C-R-E-T~~

DIRECTORATE OF SCIENCE AND TECHNOLOGY

GENERAL NOTICE NO. 12

5 May 1964

Mr. Robert M. Chapman is appointed Acting Assistant Director for Research and Development, effective 4 May 1964. Effective the same date, he will also serve as the Acting DD/S&T Representative to the Agency Research and Development Board.

DOC. 6

[redacted] (b)(6) (b)(3) CIAAct

Deputy Director
for
Science and Technology

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DIRECTORATE OF SCIENCE AND TECHNOLOGY

GENERAL NOTICE NO. 25

9 November 1964

The following personnel reassignments are effective 16 November 1964: (b)(3) CIAAct (b)(6)

a. [redacted] Chief, General Sciences Division, Office of Scientific Intelligence, is assigned as Special Assistant to the Acting Assistant Director for Research and Development.

(b)(3) CIAAct (b)(6)

b. [redacted] is assigned as Chief, General Sciences Division, Office of Scientific Intelligence.

DOC. 7

[redacted] (b)(6) (b)(3) CIAAct

Deputy Director
for
Science and Technology

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~~C-O-N-F-I-D-E-N-T-I-A-L~~

(This notice is NOT to be filed in Agency manuals. Please destroy after reading.)

PERSONNEL

HN 20-197
19 March 1965

ANNOUNCEMENT OF ASSIGNMENT TO KEY POSITION

OFFICE OF THE DEPUTY DIRECTOR FOR SCIENCE AND TECHNOLOGY
OFFICE OF RESEARCH AND DEVELOPMENT

Effective 11 March 1965, Robert M. Chapman was appointed Assistant Director for Research and Development.

FOR THE DIRECTOR OF CENTRAL INTELLIGENCE:

DOC. 8

L. K. WHITE
Deputy Director
for Support

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~~C-O-N-F-I-D-E-N-T-I-A-L~~

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~~SECRET~~

THE WHITE HOUSE
Washington

July 15, 1965

MEMORANDUM FOR THE DIRECTOR OF CENTRAL INTELLIGENCE

SUBJECT: U.S. Intelligence Community Capabilities for the Handling of Intelligence Information

Enclosed herewith is a report and recommendations which the President's Foreign Intelligence Advisory Board submitted to the President under date of June 15, 1965.

The President has approved the three recommendations contained in the report.

It is requested that Recommendations 1 and 2 of the report be carried out by the intelligence community under your coordination, and that you submit to this office and to the President's Board by October 1, 1965 a progress report reflecting the actions taken.

With respect to Recommendation No. 3, this office will look to the President's Foreign Intelligence Advisory Board and the Special Assistant to the President for Science and Technology, for periodic reports concerning the activities of the Panel to be established pursuant to that recommendation. To assure proper linkage of the Panel with the broader interests of the Bureau of the Budget in automatic data-processing generally, it is suggested that the Director of the Bureau of the Budget designate a representative of the Bureau to maintain liaison with the Panel.

DOC. 9

(Signed)
McGeorge Bundy

Enclosure

cc: The Secretary of State
The Secretary of Defense
The Director, Bureau of the Budget
The Special Assistant to the President for Science and Technology
The Chairman, President's Foreign Intelligence Advisory Board

SecDef Cont Nr.X-3934.

~~SECRET~~

THE WHITE HOUSE
Washington

~~SECRET~~

PRESIDENT'S FOREIGN INTELLIGENCE ADVISORY BOARD

June 15, 1965

MEMORANDUM FOR THE PRESIDENT

SUBJECT: U. S. Intelligence Community Capabilities for the Handling of Intelligence Information

This report is based on a study made by the Communications Panel of the President's Foreign Intelligence Advisory Board. The study included consultations with knowledgeable representatives of the departments and agencies making up the U. S. intelligence community, and briefings supplied by the Committee on Documentation of the United States Intelligence Board (USIB) which, under the chairmanship of the Director of Central Intelligence, has been pursuing the current exercise known as SCIPS (Staff for Community Information Processing Study).

Our Panel's study leads us to the following conclusions and resultant recommendations for action in an area of U. S. intelligence activities which we consider to have a most important bearing on the national defense and security.

The principal objective of these recommendations is the prompt initiation by the U. S. intelligence community of positive steps toward the achievement of an improved capability for the efficient storage and retrieval of the intelligence product, through an appropriate combination of machine and human techniques for the management and control of the massive volume of intelligence information involved.

CONCLUSIONS:

1. Information-handling methods occupy a pervasive position in the whole administrative framework of the U. S. intelligence community. Present methods for handling the huge quantity of intelligence information, which is generated from day to day by a vast array of collection resources, are a determining factor in the effectiveness of our entire intelligence system to meet national security needs at policy and command levels of the Government.

~~SECRET~~

2. The systems problems involved are so massive and in many cases so expensive, in both money and human resources, that customary routines have often been rigidly embodied and retained. The systems problems of intelligence information access will continue to be of the most difficult type, heightening the importance of great improvements in the depth of understanding and of skills in tackling the wide variety of such problems which confront all levels of Government personnel concerned with access to the national intelligence base.

3. There is a necessary relationship of the United States Intelligence Board SCIPS study to the existing practices of information handling which are variously applied within the respective agencies engaged in the U. S. intelligence effort, particularly in regard to such matters as file format and file control methods. However, the present great demands for effective handling of information within the intelligence community require that additional actions go forward concurrently with those presently approved by the United States Intelligence Board.

4. The additional actions which are required provide the only foreseeable means of extending to the massive operations of the intelligence community the advantages of high-speed machine processing of both numerical and non-numerical information in a way which has already been applied in such specific areas of intelligence as cryptanalysis. Unless strong and immediate actions are undertaken in this area, there is danger that the efficiency of the production and dissemination of intelligence within the intelligence community will decline progressively, and that the already high costs involved will climb so steeply as to jeopardize national support of the broad intelligence effort.

5. Positive action is required now to supplement the longer-range Task Force projects being pursued by the United States Intelligence Board. A large share of the needed technical support will come from automatic data-processing machinery and methods, and from the resources of modern science and technology which are presently available to assist in meeting intelligence community needs for document handling all the way from initial production to final distribution. The need for new intelligence community actions for the handling and routine processing of intelligence

information is not regarded as a direct consequence of the rise of the electronic computer. The need for such actions is more deeply the result of the growth of the intelligence community effort and the greater growth of the information which it must handle. The role of the computer is in offering a new way to assist in the reduction of greatly increasing problems in the intelligence field. The existence of these problems and the need to do things about them would have confronted the intelligence community in any event.

6. All the technical areas which must contribute to the problems of handling intelligence information are advancing very rapidly at present. The intelligence community, with its strong nucleus concerned with the use of computers in cryptanalytic and communications operations, has a real advantage in undertaking early and skillful planning in the information-handling area. (It would, however, be a mistake to assume that this experience can be easily applied to the use of computers in the handling of intelligence information.) The required planning and actions can be not only of great value to the intelligence community, but can be a broad and effective stimulus to improvement in other Federal Government computer operations whose importance is reflected in the President's recent message to the Congress on the use of automatic data-processing equipment.

7. The problems of the intelligence community in connection with information access and retrieval include, but are not restricted to, those common to all who must maintain very large bodies of information in accessible form. This is even true in the handling of information from unclassified sources. The importance of negative information, and of patterns of information, requires that access to intelligence information produce a completeness of response beyond that which is expected from many large files of stored information. Like statistics, intelligence cannot be satisfied with the highly anecdotal, but requires that all available items of information are allowed to contribute their part to the final summary or other intelligence product.

8. As a consequence of intelligence community requirements for high recall, the mechanized and automated means of access to many sorts of intelligence files cannot be required to meet simultaneously, rigid requirements as to relevance. Accordingly for some time to come the mode of gaining access to intelligence information will be through

combined machine-human systems that will seek the machine retrieval of stored intelligence information in order that its relevance may be established by human examination. It is this combined machine-human factor which generates systems problems of great difficulty and dimensions.

9. Ways and means must be sought by the intelligence community to enlarge the proficiency of personnel presently engaged in information-handling activities, either through (a) the retraining of personnel so engaged, or (b) the addition of new personnel having experience with systems work, preferably (but not necessarily) in the information sciences and technologies.

10. The scope of the intelligence community's problems in the information-handling field is such that it requires the guidance of a Panel of Technical Experts in the development of methods and facilities for information-handling and access.

11. In the area of experimental approaches to the adaptation of machine processing to the storage and retrieval of intelligence information, an encouraging beginning has been made within the National Security Agency where the Technical Information Processing System (TIPS) study is presently under way. This experiment, although on a limited scale and confined to a selected number of organizational units and information files within the National Security Agency, is producing important lessons for the achievement of a realistic system for the interrogation of a computer by remote users requiring access to a common information base.

RECOMMENDATIONS:

We recommend that the following actions be undertaken immediately within the intelligence community:

Recommendation No. 1: That selected personnel among the departments and agencies making up the U. S. intelligence community be provided specialized training and advanced studies at a university center or centers where systems thinking and systems skills are understood and imparted, and which at the same time possess adequate background in conventional bibliography and other more classical approaches to literature and information management.

/An example of the type of specialized training center we have in mind is the Library School at the University of Chicago, headed by Dean Don W. Swanson. His background in mathematics and physical sciences, and his current emphasis on increased systems thinking in library education, accent the combination of educational capabilities and background which are considered necessary for purposes of meeting the objective of this recommendation. Arrangements involving this and perhaps other institutions might be made so that both senior administrative personnel and more junior operating people could acquire new abilities and attitudes which in the times ahead will be demanded in the discharging of responsibilities for the enormous file and distribution systems of the intelligence community./

Recommendation No. 2: That the Technical Information Processing System (TIPS) project, now under way within the National Security Agency, be expanded to include participation by other member agencies of the intelligence community in an experimental operating system constituting a first step toward interagency (and interbuilding) information handling. Since results should be sought from the experiment as promptly as feasible, the participation of other agencies should be achieved by September of 1965; the capability for extensive handling of the Russian [redacted] problem should be available in the community-wide system by the summer of 1966; and by the summer of 1967 it should be possible to exchange outputs from various mechanized sources in the fashion pioneered by the TIPS project.

(b)(1)
(b)(3) NatSecAct

/Only through such experimental operational trials can the intelligence community come to grips with the wide variety of program problems involved, including those of security compartmentation, the encryption of communications between the computer/information base and the user locations, and other problems. In order to make such a trial effective, it may be necessary to expand the scope of the information maintained in the TIPS system and, if so, this should be done with caution as to the total amount of material thus added. The intention should be to establish a system that will in fact be used by workers in at least a few agencies as a better way to meet day-to-day tasks; however, the system should be regarded as experimental and there should be no attempt to insure that in its experimental form its operation can be economically justified./

Recommendation No. 3: That there be established a Panel, under the joint sponsorship of the Special Assistant to the President for Science and Technology and the President's Foreign Intelligence Advisory Board, having responsibility for: (a) providing guidance to the intelligence community in the forwarding of methods and facilities for information handling and access; (b) evaluating in technical terms the true meaning of the enormous and somewhat heterogeneous growth of the intelligence community's information pool.

/This recommended action is an urgent consequence of the USIB's Community Information Processing Study involving actions which, although helpful, are far from meeting the needs accented by the study. It is emphasized that the proposed panel of technical experts would not be tasked with the too obvious assignment of simply applying modern machine methods to the existing, specialized, and rigidly-maintained activities of processing and distributing information within the intelligence community. The panel would have the over-all task of guiding the necessarily large, and presently ignored, planning for the realistic and long-term development of mechanized facilities for the processing of information in the manifold forms in which it is encountered within the intelligence community. Thus, the composition of the panel and its individual skills should permit a concurrent approach to the overwhelming volumes of photographic, electrical and typographical material with which the intelligence system is presently flooded. It is noted that in such parts of the Government as the Bureau of the Budget, and in the Departments of State and Defense, attempts are being made to introduce automatic data-processing and information-handling systems into complex Government operations--and the panel of technical experts could provide invaluable linkage among these detached efforts which now find some coherence only through the science and technical information people in the Office of Science and Technology and the Federal Council for Science and Technology. Finally, it is evident that the concept of the range of activities of the expert panel includes not only drawing on all the information handling programs and activities in other parts of the Government, but also being available for over-all counsel in ways which might be especially useful to the Bureau of the Budget in understanding the role of mechanized information handling throughout the Executive Branch of the Government.7

For the Board

(Signed)

Clark M. Clifford
Chairman

ORD-2227-65

11 August 1965

MEMORANDUM FOR: Director of Research and Development

SUBJECT: ORD Intelligence Sciences Laboratory Facilities for Analysis Division Program

1. We attach a summary of the principal elements of the proposed Analysis Division/ORD program which we have discussed in the last few weeks. We urge the adoption of the general plan of this program and the consideration of increased funding for FY66.

2. A new and important aspect of our program is concerned with the implementation of the analysis portion of an ORD Intelligence Sciences Laboratory to be set up in Headquarters Building. The tasks to be carried out by means of this facility, funding and manpower requirements, and additional background information are summarized in the attached material.

3. We suggest that the Analysis Division program, which has been in process of formulation for the past year, is a pertinent and important element to be included in a possible Agency response to questions raised by the recent PFIAB memorandum and studies of the NPIC operations.

DOC. 1(

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(b)(6)

Chief, Analysis
ORD/DD/S&T

Attachment:
An/ORD Summary Program

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Analysis Division/ORD

General Summary of Program Objectives

I. OPERATIONS AND SYSTEMS RESEARCH

Program Objectives:

To describe and update an integrated model of the overall intelligence process for purposes of management control and R&D planning.

To determine by a continuing study, the impact on the intelligence process of new advances in technology; e.g., mass memories, time-shared computers, multiple terminals, new recording, input, and display methods, new automated recognition methods, etc.

To design new intelligence processes and systems by the application of predictive analysis methods, statistical decision theory, mathematical modeling and operations analysis techniques.

II. RESEARCH AND DEVELOPMENT ON MAN-MACHINE PROCESSES

Program Objectives:

To design, develop and show feasibility of processes and equipment for support of human intelligence processing, interpretation, and production from textual, speech, graphic and waveform input data by application of available time-shared computer technology involving specialized remote terminals and displays.

III. RESEARCH AND DEVELOPMENT ON LANGUAGE AND TEXT PROCESSES

Program Objectives:

To design, develop, and show feasibility of processes and equipment for improved collection, interpretation, and production operations concerned with textual and language data. The R&D program shall include work on the following:

Textual Input and Transcription Processes
Representation and Indexing Processes
File Organization - Search - and Retrieval Processes
Automated Formatting, Summation, and Reporting
Logical Analysis and Automated Inference
Automated Classification
Machine-Aided Translation
Machine Translation

IV. RESEARCH AND DEVELOPMENT ON SPEECH PROCESSES

<u>Program Objectives:</u>

To design, develop, and show feasibility of processes and equipment for optimization of intelligibility of speech records, and for implementation of an audio pre-processing system with capabilities for automated phoneme, work and speaker recognition.

To design, develop, and show feasibility for operational use of a speech recognizer and phonetic typewriter for the continuous input of speech into data-processing systems.

V. RESEARCH AND DEVELOPMENT ON PATTERN RECOGNITION

<u>Program Objectives:</u>

To design, develop, and show feasibility for operational use of pattern recognition processes and equipment for intelligence interpretation and production operations. The R&D program shall include work on:

Facial Recognition Processes
Handwriting Recognition Processes
[redacted]

(b)(1)
(b)(3) NatSecAct

Recognition and Signature Determination Processes for Waveform Data
Universal-font Character Recognizer

VI. RESEARCH AND DEVELOPMENT ON AUTOMATA, SELF-ORGANIZING AND ADAPTIVE PROCESSES

Program Objectives:

To design, develop, and show operational feasibility of processes and equipment which can sense, operate on and use intelligence data in remote and unaccessible locations and which function as automata, self-organizing processors, or processors which adapt to environment or to incoming sensory data.

ORD/DD/S&T

Intelligence Sciences Laboratory - Analysis Program

SPECIFIC TASK AREAS

Laboratory facilities under this program are required for the development, testing, and evaluation of man-machine procedures, equipment, and subsystems in the following areas:

I. Documentary Analysis - Intelligence Production:

Processes which exploit the potential of on-line keyboards, displays, text analyzers, text recognizers, formatting, and editing routines, are to be developed and integrated to provide machine aids for th[redacted]elligence analyst.

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(b)(3) NatSecAct

II. [redacted]

(b)(1)

(b)(1)
(b)(3) NatSecAct

III. Speech Processing:

Processes using converters, dynamic filtering, CRT displays, spectrum displays, voice control, audio output, pattern recognition processes, pitch tracking analysis, are to be developed and integrated into on-line operational subsystems for enhancing the intelligibility of speech in audio records, for optimizing speech signals in noisy records, for automated recognition methods for words, phonemes and speakers.

IV. Indexing, Search and Retrieval:

Processes using on-line keyboards, CRT displays, automated dictionary files, automated syntactic analyzers and parsers,

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recent developments in logical representation, file organization, and search strategy are to be developed and integrated into an on-line indexing, search and retrieval subsystem for documentary intelligence data.

V. Text Processing:

Processes using keyboards, CRT displays, input tablets, and printers are to be developed and integrated into on-line subsystems for editing, formatting, correcting, composing, and report generating from textual input data.

VI. Signal Processing and Correlation:

Processes using converters, signal correlators, comparators, keyboards, CRT displays, transient and delay analyzers, sensor inputs, computer-controlled cameras, recorders, signal and pattern recognizers are to be further developed and integrated into an on-line subsystem for reduction, analysis, and interpretation of waveform and multisensor data.

VII. Pattern Recognition:

Processes using data input devices, keyboards, input tablets, computer-controlled scanners, converters, correlators, visual, video and CRT displays, pre-normalization, property classification and discriminant analysis methods, are to be further developed and integrated into subsystems for automated and human-monitored subsystems for recognition and interpretation of patterns of interest in graphic and waveform intelligence data.

ORD/DD/S&T

Intelligence Sciences Laboratory - Analysis Program

Program Emphasis:

Emphasis is on exploitation of newly available computer technology with remote terminals, program-controlled devices and time-shared processors for intelligence analysis and interpretation.

Emphasis is on design and further development of basic man-machine functions in order to provide essential design and planning data for full systems implementation. Basic functions will be integrated into operational subsystems, tested, and demonstrated in order to show feasibility for application in Agency operations.

Why Action on this Program is Urgently Recommended Now:

1. New developments in man-machine technology can provide better tools to deal with the difficult problem of increased intelligence collection and limited man-power resources.

2. Major changes will be made in intelligence operations because of the inpact of man-machine technology. Steps should be taken to lead in this period to the greatest extent possible.

3. There is danger that large systems applications will be attempted before the basic processes required in these systems have been sufficiently developed. This can be extremely costly and may actually impede desired progress.

4. There should be an adequate base of technical know-how and experience within the Agency in order to provide guidance for management and planning in a very complex and costly change-over period.

5. The intelligence community has specialized requirements which are not being taken care of by developments for the military and for business applications. The Agency should take a lead in initiating appropriate R&D for its specialized needs and it should maintain a position in this area.

6. Recently certain scientific advisory groups, including the Communications Panel for the PFIAB, have urged that more positive action be taken in the man-machine area in the intelligence community. Studies of the NPIC operation urge action in the same direction. The program proposed for the Analysis Division/ORD has been formulated over the past year. The program demonstrates that the Agency has been resourceful and active in this important area; however, expansion and implementation of the program should now be carried forward.

ORD/DD/S&T
Intelligence Sciences Laboratory
Analysis Program

Facilities:

The following types of computer on-line devices and terminals are to be developed, improved, or evaluated in the analysis program:

typewriters, keyboards, control consoles
CRT displays with light pen input and control
computer-controlled cameras, recorders, and video displays
computer voice-controlled units and audio outputs
computer-controlled graphic scanners
input tablets with scriber input and control
printers, plotters
acoustic dynamic filtering equipment
signal correlators, signal comparators
spectrum display equipment
A-D and D-A converters
signal recognizers and transient analyzers
various sensors and transducers
pattern recognition and signature determination equipment
character recognition equipment
manual character reader unit
dynamic and static wall display equipment for graphic and alphanumeric data

Central processor facilities will be provided with capacity to drive terminals and devices under development and with sufficient memory to permit testing and evaluation of experimental pre-operational systems.

Relation to OCS Facilities:

It will be a policy in the planning and implementation of this facility to establish linkages with the OCS facilities where this is feasible and desirable. Available OCS services are to be used particularly for input keying and processing of data and for programming tasks of common interest.

ORD/DD/S&T

Intelligence Sciences Laboratory - Analysis Program

Funding and Manpower Requirement:

	FY66	FY67	FY68	FY69	FY70
An/ORD Supporting R&D Contracts	[redacted]				
Intelligence Sciences Laboratory - Analysis Program *					
An/ORD Technical Staff					

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* Includes processor rentals, procurement, and maintenance including commercially available terminals and computer-controlled devices. Development costs for specialized equipment is covered under supporting R&D contracts.

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ORD/DD/S&T

Intelligence Sciences Laboratory

Analysis Program

Action Schedule FY66

August 1965 Install Teleprinter terminal in An/ORD, Headquarters Building, in order to carry out querying, searching, retrieval, analysis and programming experiments with remote time-shared centers [redacted]

(b)(1)
(b)(3) NatSecAct

September 1965 Install terminal in An/ORD to link with NSA RYE and TIPS systems for evaluation and experimentation concerned with the search and retrieval of highly structured and formatted intelligence data.

(b)(1)
(b)(3) NatSecAct

October 1965 Initiate projects with [redacted] concerned with development of on-line processes for text processing, search and retrieval. Install console linked with time-shared system at [redacted] New York.

(b)(1)
(b)(3) NatSecAct

November 1965 Complete study of specifications for processor and essential terminals and computer-controlled devices for analysis program for the ORD Intelligence Sciences Laboratory.

Spring 1966 Install processor and on-line terminal equipment in ORD, Intelligence Sciences Laboratory at Headquarters Building.

C06767618

Analysis Division/ORD

Consultants
(Agreements & clearances in process as of 1 Aug 65)

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[redacted]

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Analysis Division/ORD

Personnel Availability FY66

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[redacted]

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[redacted]

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Analysis Division/ORD

CONTRACTOR SUMMARY:

(Note: The following key is used in the summary below: 1 - active contract, 2 - contract being negotiated, 3 - proposal received or under discussion, 4 - potential identified.)

Operations and Systems Research:

[redacted]

(b)(1)
(b)(3) NatSecAct

R&D on Man-Machine Processes:

[redacted]

(b)(1)
(b)(3) NatSecAct

R&D on Language and Text Processes:

[redacted]

(b)(1)
(b)(3) NatSecAct

R&D on Speech Processes:

[redacted]

(b)(1)
(b)(3) NatSecAct

R&D on Pattern Recognition:

[redacted]

(b)(1)
(b)(3) NatSecAct

R&D on Automata, Self-Organizing Processes:

[redacted]

(b)(1)
(b)(3) NatSecAct

ANALYSIS DIVISION/ORD

Program Area A

ORGANIZING, SEARCH AND MODELLING PROCESSES

1. Computer On-Line Processes for Analysis

   Design of Integrated On-Line Processes
   Textual Analysis - Text Editing
   System design and security requirements
   Low-cost terminals, CRT's

2. Storage & Retrieval Processes for Text and Formatted Data

   File input and update methods
   Indexing and Representation Methods
   File Organization - Data Structuring
   File querying, Retrieval and Search Methods
   Associative Processing Methods
   On-Line analysis of large formatted data bases

3. Mathematical Modelling - Prediction Analysis

   Predictive Modelling Methods
   Early Warning Indicators
   Econometric Models
   Statistical and Mathematical Modelling Methods

4. Systems Design & Simulation

   Intelligence Process Model
   Systems simulation - support for AQUILINE
   [redacted] (b)(1) (b)(3) NatSecAct

5. Machine-Aided Translation

6. Computer-Aided Instruction

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Program Area B

GRAPHIC AND DISPLAY PROCESSES

1. On-Line Processing System for Graphic Data

   Integrated on-line processing module for graphic data analyst
   Program-controlled scanning methods
   High speed graphic processing methods
   Graphic languages and representation of graphic structures

2. Pattern Recognition Methods for Graphic Data Processing

   Target detection-change detection methods
   Recognition methods for personal identification from graphic data, facial recognition, handwriting recognition
   Recognition processes for stereo graphic input data
   Automata theory and application

3. Display and Transmission of Graphic Data

   Cost, bandwidth, speed, and resolution factors for graphic data transmission
   Experimental graphic transmission subsystem
   High resolution graphic output for digital computer systems
   Video technology for graphic processing; digital-video interface
   Display multiplexing technology
   Computer-controlled 3-dimensional display

4. Advanced Methods for Data Storage and Retrieval

   Multiple-image storage
   High-density recording methods
   Wide-band thermoplastic recording
   Novel photosensitive materials

Program Area C

SPEECH, ANALOG, AND WAVEFORM PROCESSES

1. Speech Processing

   Noise removal from audio tapes
   Recognition of speech
   Speaker recognition
   Keyword extraction
   Speeded-speech playback techniques
   Speech intelligibility enhancement

2. Automated Pattern Recognition and Adaptive Control

   Design and development of new methods for feature generation classification, recognition decision logic
   Application and testing of learning and adaptive control methods
   Evaluation and testing of methods, systems, and equipment for pattern recognition
   Signature determination methods
   On-line recognition methods for waveform signals

3. Security Systems - Processing and Control

   Evaluation and specification of equipment methods and systems in support of O/Security requirements
   Intrusion alarm systems
   Security badge system

4. Recording Methods and Equipment

   Evaluation and testing of methods and equipment
   Liaison with developments and standardization in the community

5. Analysis and Interpretation Methods for Analog and Waveform Data: Audio, Acoustic, Seismic, EEG, Polygraph, etc.

   Development of on-line analysis processes
   Transformational analysis methods
   Non-parametric processing
   Design and development of methods and equipment for analysis
   Experimental processing for data and requirements of in-house operations: O/COMMO, OEL, FMSAC, ORD, DD/P Components

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This Notice Expires 1 August 1966

ORGANIZATION

HN 1-58
16 August 1965

DEPUTY DIRECTOR FOR SCIENCE AND TECHNOLOGY
CHANGE IN TITLE OF OFFICE HEADS AND DEPUTIES

1. Effective 27 July 1965 office heads in the Directorate for Science and Technology and their deputies were designated as follows:

	Office	Abbreviation
a.	Director of Scientific Intelligence	(D/OSI)
	Deputy Director of Scientific Intelligence	(DD/OSI)
b.	Director of Special Activities	(D/OSA)
	Deputy Director of Special Activities	(DD/OSA)
c.	Director of Computer Services	(D/OCS)
	Deputy Director of Computer Services	(DD/OCS)
d.	Director of ELINT	(D/OEL)
	Deputy Director of ELINT	(DD/OEL)
e.	Director of Research and Development	(D/ORD)
	Deputy Director of Research and Development	(DD/ORD)
f.	Director of Foreign Missile and Space Analysis Center	(D/FMSAC)
	Deputy Director of Foreign Missile and Space Analysis Center	(DD/FMSAC)

2. There will be no changes in the titles of the heads of the subordinate components within the directorate; i.e., staffs, divisions, branches, and sections.

DOC. 11

FOR THE DIRECTOR OF CENTRAL INTELLIGENCE:

R. L. BANNERMAN
Deputy Director
for Support

DISTRIBUTION: AB

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GROUP 1
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[redacted] (b)(3) CIAAct

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CIA HISTORICAL STAFF

The Directorate of Science and Technology Historical Series

OFFICE OF RESEARCH AND DEVELOPMENT 1962-70

VOLUME II MONOGRAPHS: 1-12

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ORD-1

December 1972

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The DD/S&T Historical Series

ORD-1

OFFICE OF RESEARCH AND DEVELOPMENT 1962-70

VOLUME II MONOGRAPHS: 1-12

by

Members of ORD Staff
edited by [redacted] (b)(3) CIAAct (b)(6)
and Helen H. Kleyla

December 1972

[redacted] (b)(6)

for Carl E. Duckett
Director for
Science and Technology

HISTORICAL STAFF

CENTRAL INTELLIGENCE AGENCY

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OFFICE OF RESEARCH AND DEVELOPMENT 1962-1970*

Volume II - Contents

Monographs

General:

Applied Physics:

*Cut-off date for Monographs in Volume II is 1968.

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MONOGRAPH NO.]

ORD/DOD INTERFACE

by

[redacted] (b)(3) CIAAct
(b)(6)

ORD/DOD Interface

by

[redacted] (b)(3) CIAAct (b)(6)

Technical intelligence collection today is directly dependent upon the pace of technology. Future intelligence collection systems will come from today's research and development in the primary technologies, i.e., physics, chemistry, electronics, engineering, etc. The Department of Defense (DOD), because of the nature of its responsibilities, is required to support in a large measure basic and applied research and development, with the emphasis on applied R&D. The Office of Research and Development (ORD) in CIA also has responsibility for carrying out and exploiting basic and applied research and development for intelligence purposes. However, ORD has a limited budget to carry out these functions, whereas DOD, because of its responsibilities in the defense area, is able and required to support research and development. Therefore, ORD as well as other offices in the DD/S&T, coordinates activities with DOD to take advantage of DOD efforts and to have DOD take advantage of ORD's efforts as well as to prevent duplication.

ORD interfaces and effects coordination with a large number of components within the DOD. However, the agencies and components which are most involved in this activity are the Advanced Research Projects Agency, the REWSON office of the Navy, the Office of the Assistant Secretary of the Air Force for R&D, and the major offices in DD/R&E. In the Department of the Army, ORD's major efforts have been with Dr. William MacMillan, the Scientific Advisor to General Westmoreland. Some major project areas that have been involved in this coordinated effort have been the micropower-microtechnology program, optics programs, the ASW activities, and the animal programs.

There have been a number of accomplishments from this coordinated effort. ORD's scientists and engineers have suggested new ideas and programs that were intelligence-oriented as well as defense-oriented, but ORD was not able to fund these projects and programs. Through coordination with DOD, especially ARPA, projects were DOD-funded through a transfer of funds to ORD. In many areas ORD has been able to push the state-of-the-art to the advantage of both the Intelligence Community and DOD. In other areas, we have been able to transfer suggested projects and ideas directly to DOD for their funding and management. ORD has developed the feasibility and often the prototypes which were then made available to DOD for further exploitation.

In summary, by effecting close coordination and having a close interface between ORD and DOD, many projects that otherwise could not have been carried out have produced very useful results. This has resulted in a savings of funds and manpower as well as reducing the time span in the research and development cycle. In the monographs which describe the major projects conducted in ORD over the past several years, those projects which were joint efforts or which were DOD-funded are described in more detail. Further details on ORD/DOD interface are given also.

/Attachment: Biological Sciences Division, Inter-Agency Coordination/

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BIOLOGICAL SCIENCES DIVISION
INTER-AGENCY COORDINATION

ARMY:
Assistant Chief of Staff Force Development - BW/CW
Biological Laboratory - BW/CW and crop photography
Cold Region Laboratory - Remote sensing and crop photography
Deseret Test Center - BW/CW
Edgewood Arsenal Research Laboratory - BW/CW
Engineering Research and Development Lab - Remote biological sampling
Limited War Laboratory - Bird guidance
Research Office - Bird guidance
Walter Reed Medical Center - Bio-control (EMG) of apparatus

NAVY:
Bureau of Naval Weapons - Dolphin performance
Chief of Naval Operations - Project GREEN RIVER
Key West Naval Station - Dolphin training and performance evaluation
Naval Missile Center - Dolphin performance
Naval Ordnance Test Station - Marine mammal sonar
Office of Naval Research - Underwater Swimmer guidance
Scientific and Technical Intelligence Center - BW/CW

AIR FORCE:
Cambridge Research Laboratory - Remote sensing instrumentation
Directorate of Armament Development - Artificial clouds
Office of Research and Development - Animal behavior studies
Office of Scientific Research - Programs of mutual interest
Rome Air Development Center - Propellant detection

(b)(1)
(b)(3) NatSecAct

[redacted]

U.S. Department of Agriculture - Crop photography

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MONOGRAPH NO. 2

Approved for Release: 2022/01/31 C06767619

PHOTO WORKING PANEL
(Drell Committee)

by

Joseph V. Gaven, Jr.

PHOTO WORKING PANEL
(Drell Committee)

by

Joseph V. Gaven, Jr.

The Photo Working Panel was established for the following reason: A preliminary analysis of the product of a particular overhead reconnaissance system had indicated that a wide variation in the quality of the product existed. This variation in product quality was a good deal wider than might have been anticipated due to normal statistical variations in operating conditions and system components. Hence the question arose as to the existence of unrecognized factors which adversely influenced product quality.

In late 1963 the Photo Working Panel was established to address itself to the aforementioned problem. The basic background data is summarized in a letter from Dr. Albert D. Wheelon, DD/S&T/CIA, to Dr. Brockway McMillan, dated 5 November 1963. The Panel was formally established under the provisions of a memorandum dated 18 November 1963, signed by Lt. General Marshall S. Carter, Acting Director of Central Intelligence. (See Attachment A.)

The original objectives of the Panel were set forth as follows:

"The objective of this group shall be to examine existing reconnaissance photography in detail and to explore the following points:

"a. To conduct a detailed examination of the photography and the system which produced it in order that:

"(1) A statistically meaningful quantitative model of the present image quality can be derived.

"(2) The various factors affecting image quality can be clearly identified and understood.

"b. To combine the data obtained into a system model which satisfactorily represents the observed performance, including the effects of the atmosphere.

"c. To use the system model derived to examine the possibility for system optimization in order to minimize the effects of the various contributors to image degradation.

"d. To plan such experiments as may be required to gain needed additional insight.

"e. To recommend system or operational improvements for the present systems which will significantly improve the distribution of quality.

"f. To make a careful study of the interaction of the photo interpreters with the film so as to establish a quantitative measure of the significance of stereo coverage, color photography, film contrast and resolution.

"g. To exploit the understanding gained to devise ways in which the basic area search and high resolution spotting requirements can be accomplished with significantly improved resolution with high confidence and to suggest new systems to fulfill these requirements.

"h. To determine the relationship between the various measures of image quality.

"i. To generate an operationally useful objective measure of image quality."

Subsequently, objectives e. and g., above, were deleted and effort was concentrated on a particular system.

The first meeting of the panel took place on 13 November 1963. The final meeting, on 8 February 1964, coincided with the submission of the Panel's final report. During its lifetime the Panel met in formal session nine times, each session lasting typically two or three days. During the interim periods the Panel members worked independently, either at their official location or at NPIC where the product was readily available. Minutes of the formal sessions were generated.

It should be emphasized that the Panel operated under the following constraints: From an ex post facto examination of the product of a reconnaissance system, identify and ameliorate, if possible, significant causes of system performance degradation. It was quickly determined that no satisfactory objective and quantitative measure of product image quality existed. Attention was focused, accordingly, on two candidate techniques. The first, edge gradient analysis, in theory allowed the determination of system modulation transfer functions from an analysis of microdensitometer tracings across edges (runway, building, etc.) existing in the product photography. The second, GEMS (Graded Estimated Measuring Samples), involved the subjective comparison of operational photography against a carefully prepared library of standards of known quality.

The conclusions and recommendations are contained in the final report. In brief, the Panel recommended that:

a. Work continue toward the construction of an objective and quantitative measure of image quality.

b. An in-flight and ground measurement program be implemented to obtain engineering data to check on system performance in the operational environment.

c. More emphasis be placed on engineering passes of operational systems over properly-designed domestic, ground-based targets.

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Attachment A

OGC 63-3427

18 NOV 1963

MEMORANDUM FOR: Deputy Director (Science & Technology)

SUBJECT: Photo Working Panel

REFERENCES:
a.
b. Executive Order 11007

1. In accordance with the provisions of reference b, I have determined that an industry advisory committee be established in the public interest in connection with the performance of the duties imposed on the Central Intelligence Agency by law. The membership of this committee is as follows:

Chairman: Mr. R. M. Chapman, CIA

Alternate Chairman: Dr. Joseph V. Gaven, CIA

Members: [redacted]

(b)(3) CIAAct
(b)(6)

Lockheed Aircraft Corporation

[redacted]

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Members continued:

[redacted]

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NPIC

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[redacted]

NRO

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(b)(6)

[redacted]

Westover

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[redacted]

2. The committee will be known as the Photo Working Panel and its functions will be solely advisory to the Agency. Determinations of actions to be taken with respect to matters on which the Panel may advise or recommend will be made solely by the Central Intelligence Agency. The Chairman will represent the Agency, and no meetings shall be held except at the call of the Chairman and each agenda shall be approved by him. Meetings will be in his presence, and he shall have the authority and is required to adjourn any meetings whenever he considers adjournment to be in the public interest.

3. I hereby determine that a verbatim transcript would be impractical, and that the waiver of a requirement of verbatim transcripts is in the public interest. The Chairman will keep minutes which shall contain a record of persons present, a description of matters discussed and conclusions reached, and copies of all reports received, issued, or approved by the Committee. He shall certify the accuracy of such minutes.

4. In accordance with section 10(a) of Executive Order 11007, I determine that it would be impracticable to publish the composition of this committee, any description of its functions, and the dates of its meetings.

[redacted] (b)(6)

MARSHALL S. CARTER
Lieutenant General, USA
Acting Director

OGC:LRH [redacted] (b)(3) CIAAct
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MONOGRAPH NO. 3

~~SECRET~~

SCIENTIFIC ADVISORY BOARD

by

Stephen L. Aldrich, M.D.

~~SECRET~~

SCIENTIFIC ADVISORY BOARD

by

Stephen L. Aldrich, M.D.

The Scientific Advisory Board was established in July of 1963 to replace the CIA Research Board, which was responsive to specific needs of the Clandestine Services. The purpose of the Scientific Advisory Board was to review and advise the Director on the total scientific functions of the Agency. More specifically, the SAB was charged with:

> Advising the Director on the adequacy of the Agency research and development effort and pointing out possible application of newly emerging scientific developments to the mission of the Central Intelligence Agency;
>
> Conducting a continuing review of all the research and development activities and policies of the Agency, including all research and development being undertaken through external contracts as well as internal research and development activity.
>
> Recommending to the Director changes designed to improve the Agency research and development program and the organization of the scientific effort of the Agency, with particular emphasis on new scientific developments which might have application to the Agency mission; and
>
> Keeping abreast of significant scientific and technical developments in American industry, academic circles and other agencies of the Government, especially projects related to intelligence, and advise the Director of Activities which might have application for CIA.

The SAB was to work closely with the Research and Development Review Board, which was established at the same time. The R&D Review Board was set up to provide an effective internal mechanism for discussing and implementing those recommendations of the SAB which were approved by the Director of Central Intelligence.

Dr. Augustus B. Kinzel, Vice President for Research at Union Carbide Corporation, was appointed Chairman of the Scientific Advisory Board. Other members included Dr. James A. Eyer, University of Rochester; Dr. John R. Pierce, Bell Telephone Laboratories, Inc.; Dr. Arnold O. Beckman, Beckman Instruments, Inc.; Dr. Leo Brewer, University of California; Dr. H. Guyford Stever, Massachusetts Institute of Technology; and Dr. Cornelius A. Tobias, University of California at Berkeley.

To assist the SAB in accomplishing its objectives, three panels were organized to review specific areas of R&D effort: The Optics Panel, the Covert Instrumentation Panel, and the Life Sciences Panel. Descriptions of these panels are attached.

In mid-1965, when Admiral William F. Raborn, USN, replaced Mr. John McCone as Director of Central Intelligence, the Scientific Advisory Board and its panels were superseded by more specialized panels related to more specific areas.

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~~S-E-C-R-E-T~~ ATTACHMENT 1

This Notice Expires 1 August 1964

ORGANIZATION

HN 1-35
16 July 1963

SCIENTIFIC ADVISORY BOARD TO THE DIRECTOR OF CENTRAL INTELLIGENCE

1. Effective 1 July 1963 there was established a Scientific Advisory Board to the Director of Central Intelligence. This Board will be responsible for reviewing and advising the Director about total scientific functions of the entire Agency, replacing the CIA Research Board which was responsive to the specialized needs of the Clandestine Services.

2. Effective the same date, Dr. Augustus B. Kinzel was appointed Chairman of the Scientific Advisory Board. The other members of the Board who will serve with him will be announced later.

3. The Scientific Advisory Board shall:

a. Advise the Director on the adequacy of the Agency research and development effort and point out possible application of newly emerging scientific developments to the mission of the Central Intelligence Agency.

b. Conduct a continuing review of all the research and development activities and policies of the Agency, including all research and development being undertaken through external contracts as well as internal research and development activity.

c. Recommend to the Director changes designed to improve the Agency research and development program and the organization of the scientific effort of the Agency, with particular emphasis on new scientific developments which might have application to the Agency mission.

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d. Keep abreast of significant scientific and technical developments in American industry, academic circles, and other agencies of the Government, especially projects related to intelligence, and advise the Director of activities which might have application for CIA.

4. The Scientific Advisory Board will meet at the call of the Chairman as frequently as necessary. It will work closely with the Agency Research and Development Review Board (HN 1-34) which will provide an effective internal mechanism for discussing and implementing those recommendations of the Scientific Advisory Board which are approved by the Director of Central Intelligence.

[redacted] (b)(6)

MARSHALL S. CARTER
Lieutenant General, USA
Deputy Director of Central Intelligence

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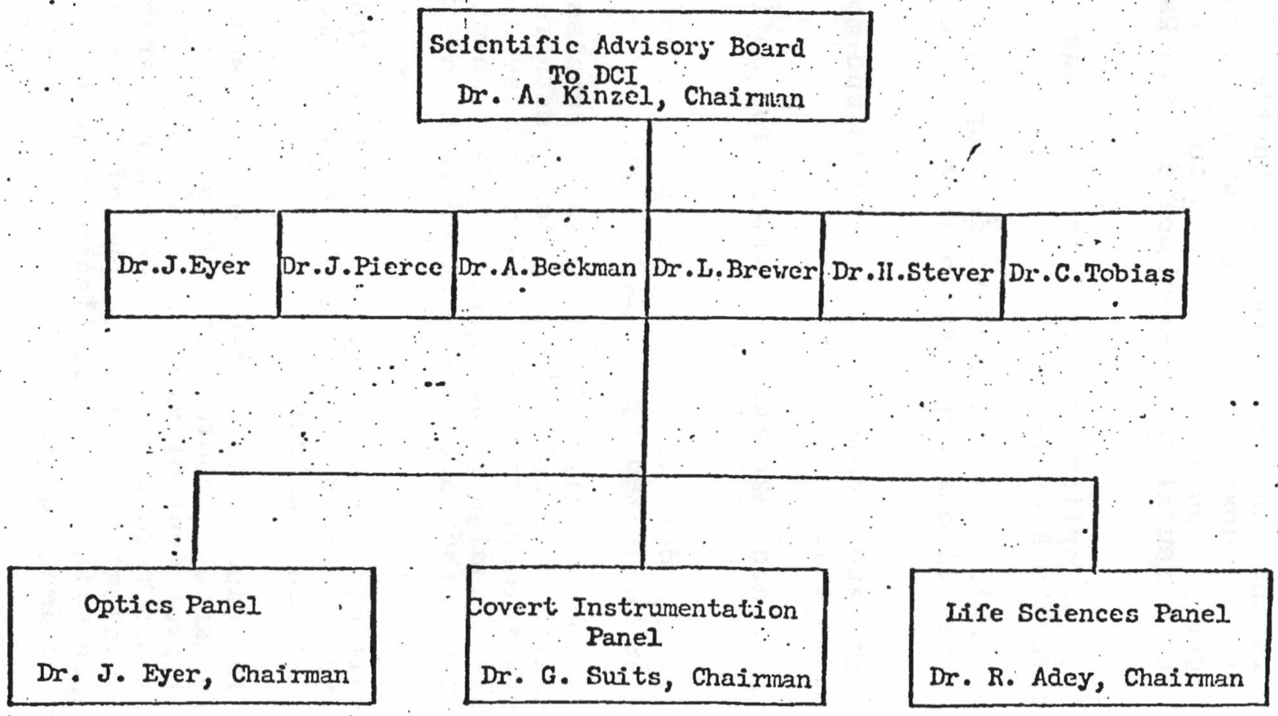

Dr. S. Duntley
Dr. A. Meinel
Dr. W. Siegmund
Mr. H. Gewertz

Dr. F. Lindvall
Dr. C. Tobias
Dr. W. Lovelace
Dr. C. Draper
Dr. T. Malone
[redacted]

(b)(3) CIAAct
(b)(6)

Dr. C. Tobias
Dr. A. Sabin
Dr. W. Lovelace
Dr. K. Killam

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ATTACHMENT 2

OPTICS PANEL

The Optics Panel was created in December 1963. The Chairman of the Panel was Dr. James A. Eyer, and members included Dr. Walter Siegmund, American Optical Company; Mr. Harry Gewertz, Bulova Laboratories; Dr. Aden B. Meinel, University of Arizona; and Dr. Siebert Q. Duntley of the Scripps Institute of Oceanography. The Panel was to investigate the Agency's optics program and to make recommendations to the Scientific Advisory Board. The Panel was to

Review the optical programs on-going and proposed to the Agency;

Investigate state-of-the-art developments and make recommendations relative to intelligence applications;

Evaluate and recommend improvements and modifications to existing systems;

Evaluate and make recommendations for optical programs;

Accomplish detailed review of specific optical problems as requested by the DCI.

Consideration was given to overhead reconnaissance systems, diagnostic data collection systems, data reduction systems, imagery interpretation equipment and techniques, optical analysis techniques and imagery data transmission systems as well as other areas determined to be of importance.

As a result of the Panel's investigations, the following items were included in the recommendations made to the Scientific Advisory Board:

a. The Panel recommended methods for enhancing the performance of photointerpreters, primarily through improvement of viewing conditions. They recommended a research program combining careful psychophysiological studies of photointerpreter performance with more sophisticated objective measures of image quality.

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b. The Panel recommended that Dr. James Harris of the Scripps Oceanographic Institute be given adequate support to investigate the theoretical/feasibility demonstration side of image reconstruction. Further, they recommended a program to marry computer technology to optics in order to produce instruments for routine image reconstruction.

c. The Panel recommended that the Agency establish an in-house training program to increase the number of technically competent and skilled individuals in the areas of optics and photography. They also suggested an in-house laboratory to keep ahead of the state-of-the-art in optics and also to attract and hold the optical specialists the Agency needs.

d. The Panel stated its willingness to serve as a clearinghouse for advanced state-of-the-art information for the entire community in order to avoid waste, duplication of effort and "leap-frogging" in the areas of optics and reconnaissance.

e. The Panel suggested, in accordance with conservative projections, that detailed planning for expanding NPIC facilities be initiated in the near future. They also posed the question of whether recent advances in image processing would mature to the point where certain very specialized facilities would be required.

f. The Panel suggested that a study group be convened to assess state-of-the-art of "black boxes" as they pertain to Agency problems and that this group be charged with identifying crucial gaps in technology and recommending appropriate action.

g. The Panel recommended that the GEMS effort in simulated photography be continued in an attempt to close the loop between system designer and user. They further recommended that future work in image quality emphasize psychophysical experiments to develop a satisfactory objective correlate to subjective impressions of image quality.

Items a, b, and g were implemented in accordance with the Panel's recommendations. Although item f was not implemented specifically as suggested, a Special Assistant to the Director of Research and Development was charged with the responsibility of reviewing black box programs and recommending to the Director activities that should be undertaken in this area. He was further charged with coordinating the black box research efforts carried out in various divisions. This Special Assistant was also assigned the additional task of overseeing programs directed toward the development of emplacement platforms, thereby bringing about more effectively the marriage of the black box and emplacement platform.

COVERT INSTRUMENTATION PANEL

The Covert Instrumentation Panel was organized in 1963 for the purpose of reviewing programs in the Technical Services Division of DD/P. The Chairman of the Panel was Dr. Chauncey G. Suits, General Electric Company; other members included Dr. Charles D. Draper, Massachusetts Institute of Technology; Dr. Frederick C. Lindvall, California Institute of Technology; Dr. W. Randolph Lovelace, Lovelace Foundation; Dr. Thomas F. Malone, Travelers Insurance Company; and Dr. Cornelius A. Tobias, University of California at Berkeley.

LIFE SCIENCES PANEL

The Life Sciences Panel was created in March 1964 to investigate the Agency's Life Sciences programs and to make appropriate recommendations concerning these programs. Membership included Dr. W. Ross Adey, UCLA (Chairman); Dr. Cornelius A. Tobias, University of California at Berkeley; Dr. Albert Sabin, Children's Hospital Research Foundation; Dr. W. Randolph Lovelace, Lovelace Foundation; and Dr. Keith F. Killam, Stanford University.

The Panel discussed and approved the general activities of the Life Sciences program in ORD and recognized the following areas of research in the order of their immediate importance: physiology and psychology of stress and human behavior; animal studies; physiological chemistry; and biotechnology. In addition to reviewing these general areas, the Panel also examined specific projects in lasers, microminiaturized serology techniques, the polygraph, audio/counteraudio measures, marine mammals, cochlear microphonics, and BW/CW.

On the basis of extensive Agency briefings and individual expertise, the Panel submitted the following recommendations to the DCI regarding BW/CW:

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[redacted]

(b)(1)
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[redacted]

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[redacted]

The Panel recommended names of individuals to serve as a leader in Life Sciences research. It was emphasized that appropriate selection would only be possible if the problem areas were clearly identified and selection was based on the directed pursuit of these areas. The individual should be aware of the need to pursue other areas of Life Sciences research considered ancillary to the main program.

Both of these items were implemented. The Life Sciences program at the Scientific Engineering Institute was redirected in line with the areas suggested by the Panel. In addition, Dr. James H. Wakelin, formerly Assistant Secretary of Navy for Research and Development, was installed as President of the Institute.

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MONOGRAPH NO. 4

Countermeasures Research & Development Subcommittee

of the

Technical Surveillance Countermeasures Committee

by

C. V. Noyes

~~SECRET~~

Countermeasures Research & Development Subcommittee
of the
Technical Surveillance Countermeasures Committee

by

C. V. Noyes

(b)(1)
(b)(3) NatSecAct

The Technical Surveillance Countermeasures Committee was created [redacted] effective 23 December 1964, as the successor to the NSC Audio Countermeasures Committee. TSCC has, in addition, two subcommittees: the Audio Countermeasures Subcommittee and the Countermeasures Research and Development Subcommittee. The CIA member of the CM R&D Subcommittee is designated by charter as the Chairman. Mr. Robert M. Chapman is the designated CIA member; Mr. C. V. Noyes functions as secretary. Representation to the TSCC and its subcommittees includes DIA, Army, Navy, Air Force, Department of State, FBI, NSA, CIA, AEC, plus observers from Secret Service and ARPA and invited guests.

Over the approximate two and one-half years' life of the TSCC, the CM R&D Subcommittee, as required by its charter, coordinated interchanges of information on audio surveillance countermeasures research and development projects. In addition, by the mechanisms of various working groups, an excellent threat model has been produced and an evaluation facility has been established for use in demonstrations and tests by the individual members. Such efforts serve to provide a uniform standard for evaluation of the National program. Under the leadership provided by ORD, the CM R&D Subcommittee has served to stimulate an aggressive, expanded countermeasures research and development program. This National program has been closely coordinated to provide maximum benefit to the U.S. National security at minimum cost.

During this period, the Subcommittee has achieved significant advances in all areas, including areas previously considered impossible such as microphone detection and development of new protective techniques. The Subcommittee has functioned in an informal atmosphere, with many honest discussions which have greatly contributed both to the stimulation of the members and to improvements in the National program.

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MONOGRAPH NO. 5

PROJECT TUMS

by

C. V. Noyes
and
Donald Reiser

PROJECT TUMS

by
C. V. Noyes and Donald Reiser

Project TUMS was launched by the Technical Surveillance Countermeasures Committee under the executive officership of Department of State to be an all-Agency program toward the resolution of the infamous Moscow signal. This signal may be generally described as a 5 to 7 component complex modulation S-band irradiation of the rear of the United States Embassy in Moscow. The individual components come and go with varying forms of modulation in an irregular program pattern.

The signal was first detected in approximately 1954, and had been the subject of various agencies' interests since. This signal had been investigated solely by ARMY ACSI during the 1954-1960 period. At that time, the State Department (SY/T) became aware of the existence of the signal and began an in-house investigation. As more data became available concerning the signal, it became increasingly obvious that this signal could represent a major threat to the U.S. National security both as a threat to operations in Moscow and as evidence of Soviet use of technology greatly advanced over U.S. capability.

To provide a National attack on this problem, Joint Task Force 7 was created under the USIB TSCC and was chaired jointly by the Department of State and CIA/ORD. This Task Force evaluated the problem, developed a program to resolve the signal, and allocated responsibilities to various agencies. High priority was given to determining that the signal was part of a technical surveillance attack since that possibility was judged to present the greatest threat to U.S. interests.

As part of Project TUMS, ORD (specifically, Mr. Reiser Mr. Noyes) [redacted]

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(b)(3) NatSecAct

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MONOGRAPH NO. 6

~~SECRET~~

Intelligence Processing Research and Development Laboratory

(IPRD)

by

[redacted] (b)(3) CIAAct
(b)(6)

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Intelligence Processing Research and Development Laboratory

(IPRD)

by

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The objective in establishing the IPRD (Intelligence Processing Research and Development) Laboratory has been to provide a limited experimental machine-processing facility which would permit the following functions to be carried out:*

> To adapt machine-aided processes to intelligence requirements to permit either more or better intelligence recovery to take place.
>
> To provide such new capabilities as are practically feasible from base-technology-in-being, where intelligence problems are not presently being answered adequately.
>
> To provide a secure environment concomitantly with the above where intelligence data bases of a sensitive nature could be studied in a reasonably creative approach using machine-assisted techniques, which are readily accessible.
>
> To provide machine capabilities as direct as feasible to the intelligence analyst in an open-shop environment not encumbered by production requirements.

The design philosophy for the IPRD was carried out to implement the above functions in the supportive role which the Office of Research and Development occupies in the intelligence system.

Figure 1 shows one possible block diagram representation of the information flow for intelligence. These items are in general consistent with the Program Call categories which set forth the vital activities of the Agency. They are:

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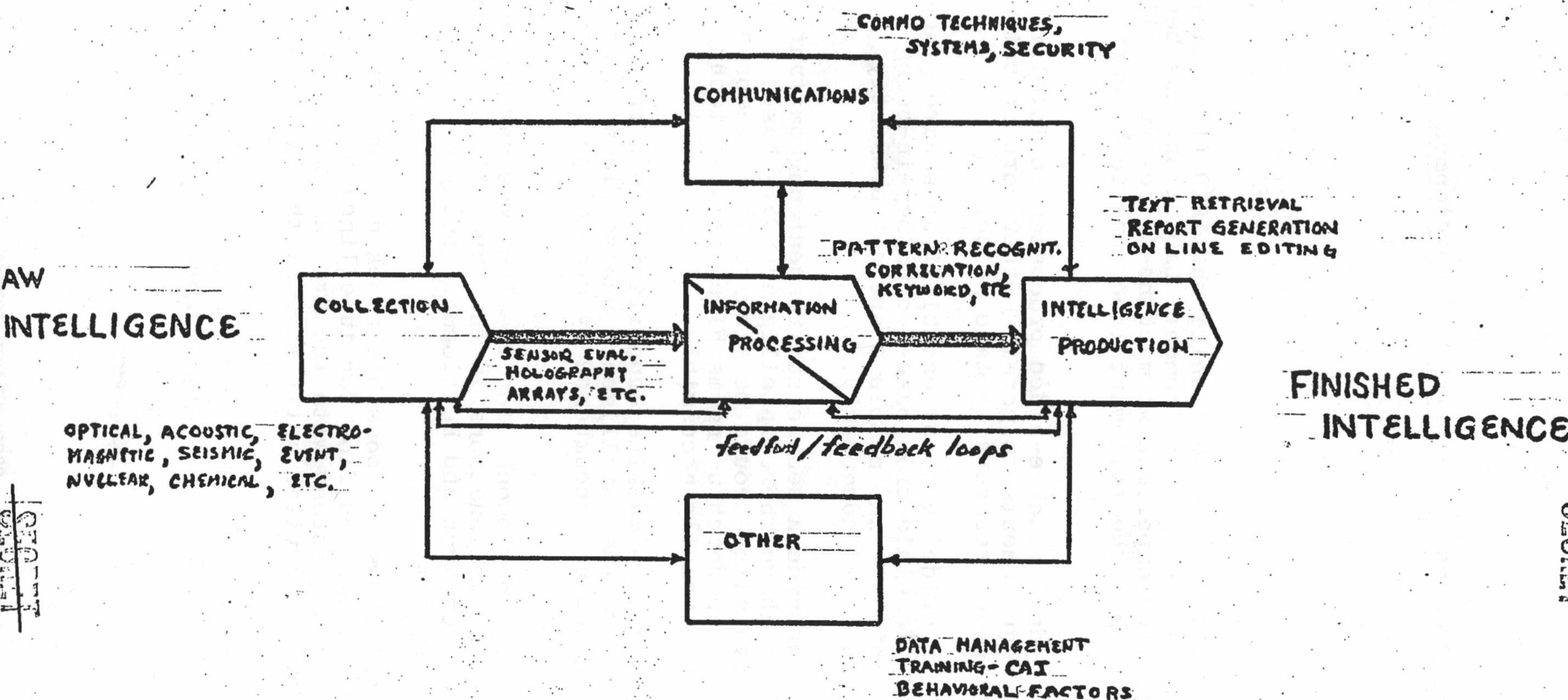

FIGURE 1 - INTELLIGENCE PROCESS - FLOW DIAGRAM
SHOWING EXAMPLES OF GENERAL PURPOSE MACHINE FUNCTIONS

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a. Collection of Intelligence

b. Information Processing

c. Intelligence Production

d. Communications

e. Other (training, support, etc.)

The block diagram depicts the main flow of raw intelligence through processing, then to production and finally, the finished form for its end purpose. Requirements of communications straddle all activities, as does a group of other related activities. The last set would include items such as medical support, unique training, etc.

A portion of the effort in each activity must be addressed to development of new responses and future techniques. A future effort is necessary in any viable system in order to permit its capabilities to remain abreast of current technology; thereby, the system may mutate with changing scientific patterns. In many cases, mathematical modelling or simulation offers a low cost appraisal for an emerging technique. For instance, a collection subsystem simulation may predict its deployment performance; a communication technique may be inexpensively modelled in-house by computer implementation; information processing routines may be tested or sample collections may be evaluated; finished intelligence generation may be aided by machine manipulation of data bases in massaging the information by a variety of methods to produce the desired result. There have been dramatic examples in each of the above examples for the use of machine processing to aid problem solution.

The IPRD design, therefore, was aimed at focusing a maximum of machine-aided capability upon a wide range of intelligence problems. The approach was to attack these problems with three generic types of main equipment configurations, which are:

General Purpose Digital Processors, with appropriate peripherals.

General Purpose Imagery Processors, with appropriate peripherals.

General Purpose Hybrid Equipment, with appropriate peripherals.

An alternative to the IPRD concept was a special purpose testing of specific systems hardware. This approach would have required a multiplicity of "one-shot" equipments which could not be reconfigured into flexible patterns to conform to new requirements and advances. The general purpose computer, however, was felt to be especially relevant to a constantly changing technology. Programming software is independent, to a great degree, of hardware and is oriented toward particular problem solution. It can be reconfigured, modified, updated or adapted and can be tailored precisely to intelligence requirements of the immediate problem. Thus, the need is eliminated for a constantly changing special-purpose structure of hardware devices of only limited scope.

The Intelligence Processing Research and Development Laboratory (IPRD) was completed during Fiscal Year 1967, following a year of preparation and planning. [redacted]

(b)(3) CIAAct
(b)(3) NatSecAct

The security requirements of "need-to-know" militate against a completely free developmental environment; furthermore, the Agency's RD&E requirements are almost <u>in toto</u> solidly related to current application areas. Thus, the usual problem is close to operational developments which, in turn, are tied to Agency methods of collection, information processing, intelligence production, communications, etc. It follows that security aspects are likely to be sensitive. Provision was made in the day-to-day operation of the laboratory to provide for many small user groups, in a generally compartmented mode. To retain accessibility of equipment, there are no production commitments which would limit schedule of users.

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The need for machine-aided techniques in design of new collection systems or in the development of new processing routines is an obvious requirement. As the sophistication of the intelligence craft rises, the "bandwidths" of analysts of many disciplines must be extended by available processing tools so that human analytic capabilities can be expanded through proven, tested, machine-aided approaches. The disparity of techniques to be tested indicates that a maximum of problem flexibility be provided for by utilization of the general purpose equipment wherever feasible.

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(b)(3) NatSecAct

[redacted]

There are provisions for maintenance, for instrumentation, and for general purpose experimental setup. Additionally, space is provided for contractors, maintenance, and support personnel.

ATTACHMENT A

IBM 360/40 GENERAL PURPOSE COMPUTER

Applications

This processor is a medium-sized general purpose digital computer used for research and development techniques generally concerned with discrete textual and numeric data. In the typical problem, the equipment will be used for developing an on-line capability for the intelligence worker so that by means of input keyboards, function keys, "soft-copy" displays and other I/O he will be equipped to search, interrogate, and order data bases of immediate interest. Application areas include the following:

a. Analyst querying of large data files; on-line report generation; editing; IO techniques.

b. Deep indexing processing.

c. Associated processing techniques.

d. On-line programming.

e. Computer-aided instruction.

f. Predictive analysis and modelling.

g. Data management.

The full gamut of scientific processing is available for non-real-time computational problems in signal processing, simulation, etc.

Hardware

Figure 3 shows the functional configuration details of the 360/40 and associated equipment. The annotated numbers are the IBM designations for the equipment. A summary is given below:

a. Central Processing Unit (CPU): For an 8-bit byte organization, the basic timing cycle is .625 /u; a two-byte "width," 16 bits, is accessed in one cycle. Main core is 262,144 bytes for the Model H40.

b. Printer: 600-750 lines/minute, hard copy paper output with 132 print positions.

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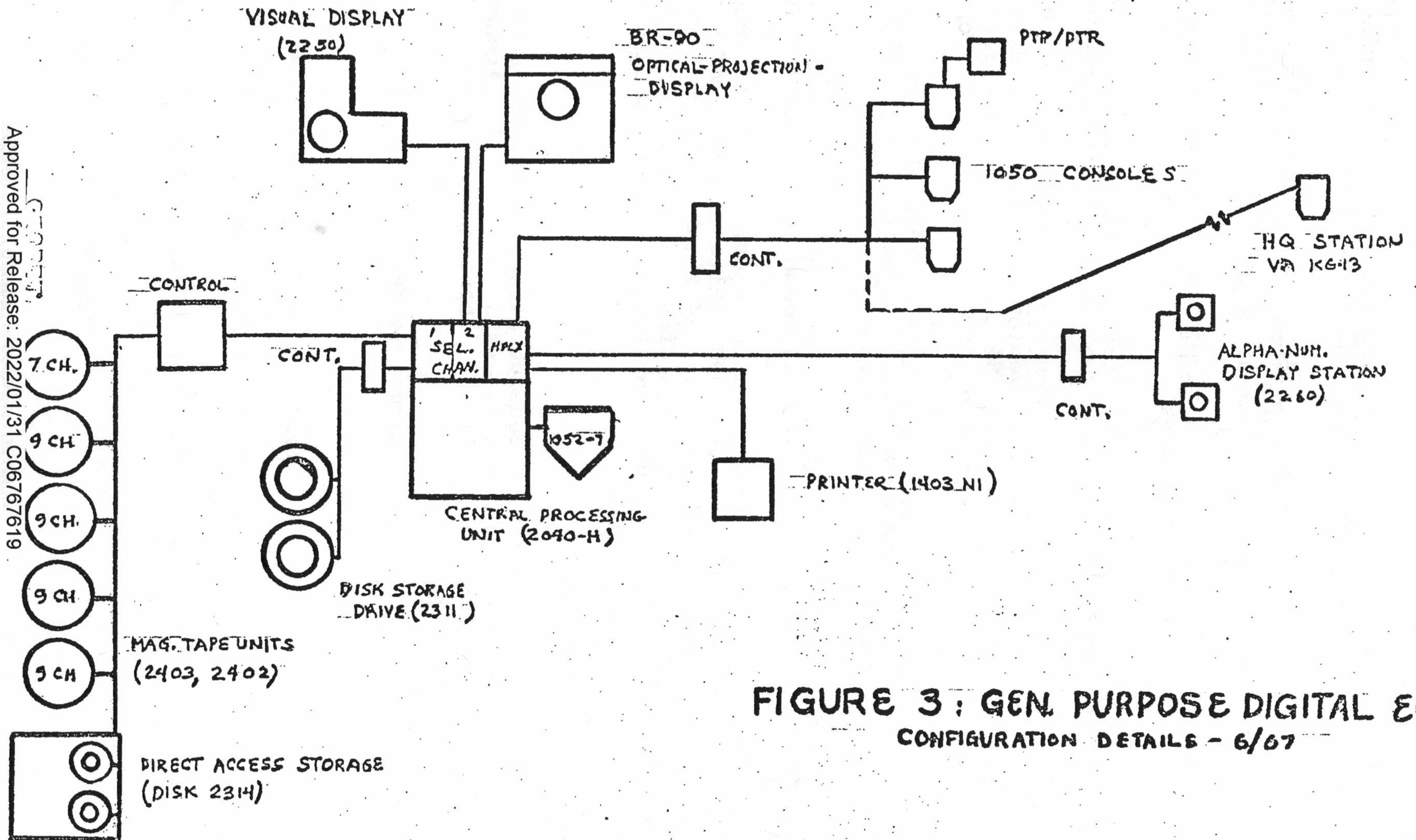

FIGURE 3: GEN. PURPOSE DIGITAL EQUIPM'T
CONFIGURATION DETAILS - 6/67

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c. Card Reader/Punch: 1,000 cards/minute read; 300 cards/minute punch. Interpretive feature available.

d. Magnetic Tape: Seven- and nine-channel 1/2" magnetic tape; normally 800 bits/inches at 112.5 inches/ per inch NRZ format at 90 KHz transfer rate.

e. Disk Storage: 75-135 ms access time; 7.25 megabytes on each disk.

f. Direct Access Storage (Disk): 75-135 ms access time for 330 megabytes; for bulk memory storage.

g. Display Console: This offers a 12"x12" display area alphanumeric, vector and point mode displays on a 1024 x 1024 matrix; 32 programmable function keys, standard typewriter keyboard; light pen; for "soft copy" I/O.

h. Display Station; This features 240 alphanumeric characters on a scope face with typewriter keyboard for "soft copy" computation.

i. Typewriter Console: Alphanumeric, computer-driven typewriter for two-way communication and "hard copy" I/O.

j. BR-90*: Computer-driven special scope with coaxial slide optics; 4000 twelve-bit words of memory in stand-alone mode. A 1024 x 1024 scope matrix handles 3x5 slide for back-projection of graphic, cartographic, or pattern-type data for soft copy I/O, limited light pen capability.

Software

Software consideration for the IBM equipment involved development of a time-shared system for Agency 360/40 used by OCS, in addition to the standard support. Some of these are listed below:

a. FORTRAN IV (H), (G)

b. PLI

c. COBOL

d. Assembly language

---

*Mfgr: Bunker Ramo Corp., Canoga Park, California.

e. Scientific subroutines package (SSP)

f. GPAK 2250 - BR-90 interface software modified as GPAK-compatible language.

g. Miscellaneous - system, utilities, linkage, data management software.

The normal flow for implementation of IPRD techniques is to the OCS computer center following feasibility development in ORD, to be consistent with allocating production items exterior to the IPRD.

ATTACHMENT B

GRAPHICS/OPTICS EQUIPMENT

Applications

Separate imagery problem areas are found in two major functions of the intelligence flow process. Figure 1 shows feedback for both intelligence collection and intelligence production. The former function addresses optical sensor system control and design approach; the second, production, is concerned with processing of intelligence take to produce meaningful security information. Alternately, collection optics deals directly with raw intelligence, whereas production techniques interface primarily with the human analyst. Thus, the objectives of each problem area are different in that collection evaluation systems require fine precision, special-purpose optical devices and extensive general purpose computer capability. The information processing requirements for the analyst feature less stringent resolution but more flexible processing capability with limited computer memory. Thus, a few examples of application problems would include:

a. Collection

[redacted] (b)(1)
Holographic Manipulation
Fresnel Transformations
Computer Simulation
Image Reconstruction and Analysis
Sensor System Performance

b. Production Technique Development

Scanning of Photographic Data; retrieval schemes
Pattern recognition for fingerprints, handwriting, and feature extraction
Analyst systems performance
Band compression; S/N improvement

Hardware

The isodensitracer (IDT) is shown in a functional layout in Figure 4a. The principal components* are as follows:

*Mfgr. Beckman-Whitley Division, Technical Operations, Inc., Mountain View, California.

a. Optics Scanning Unit: Air bearing-XY drive designed to generate a 400 x 500 matrix; mechanical oscillation of mounted image is to scan and convert on the linear segments of the sinusoidal sweep; it is temperature compensated; 128 levels of A/D conversion of light intensity; 7 bits positional of data are available; 400 lines/mm, 2 μ resolution.

b. Control Electronics: Electronic counters for step control, conversion clock, D/A conversion interface to 360/40, 2701. The full hardware/software complex of the 360/40 is thus available to the IDT.

c. Alden Printer: Driven from D/A output for editing, for analog monitoring of processing.

The PFR-3* (Programmable Film Reader) is shown functionally in Figure 4b, which shows the basic block diagram as follows:

a. Optical-Mechanical: Film handling equipment, primary reference and projection optical systems, with photo multiplier and ancillary control of image focus, size and orientation angle; 12 μ resolution, 75 mm photography, 64 levels of gray.

b. Signal Processing and Logic Unit: Circuitry to handle photo multiplier outputs and perform density comparison; performance monitoring functions.

c. Programmable Light Source: Eight bits of intensity for a point plotting CRT.

d. PDP-7: Operates film reading system in accordance with programmed scan. General purpose digital computer 8000 words of 18 bits each; 1.75 μ memory access time with an ADD time of 3.5 μ. Assembly language instructions total over 70, to give a complete general purpose repertoire.

e. Magnetic Tape Dectape I/O: This consists of a Dectape System; 260' reels of 3/4" on mil magnetic tape; transfer rate is one 18-bit word per 200 μ.

f. Magnetic Tape Transport: This consists of a 7-channel 45"/sec., 1/2" magnetic tape in 2400' reels

*Mfgr. Information International, Inc., Los Angeles, California

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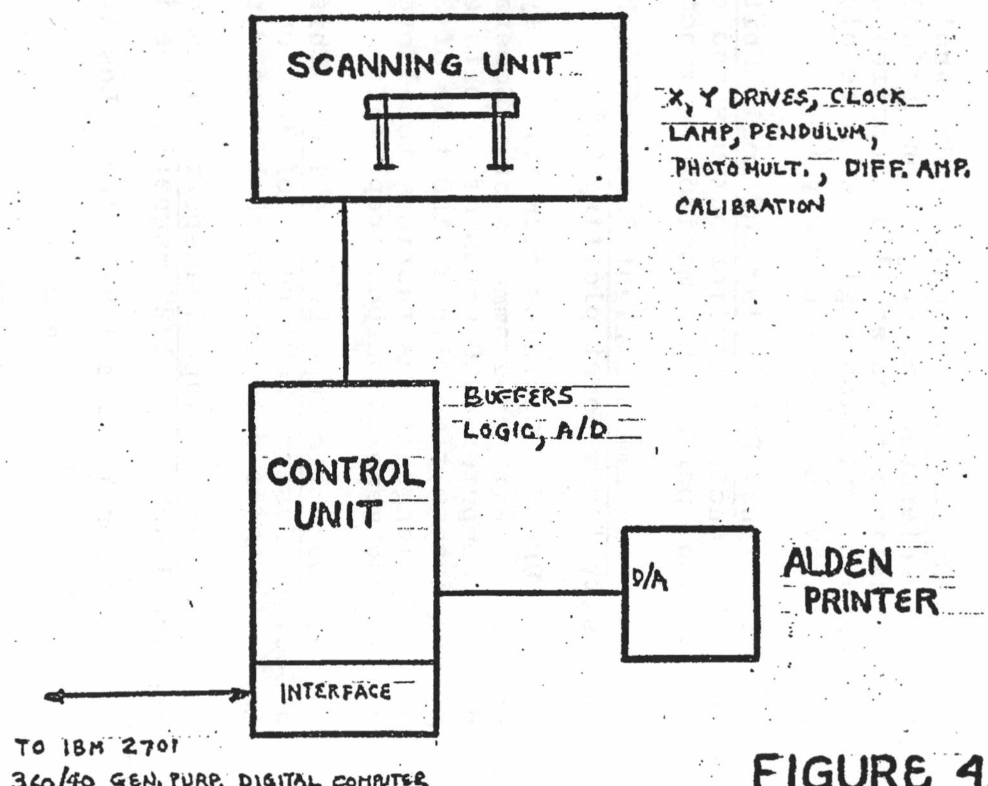

DESIGN FEATURES

- LARGE SCALE IMAGE ANALYSIS
- 128 LEVEL INTENSITY
- LARGE ARRAY MEMORY - 360/40
- 2 MICRON RESOLUTION
- OPTICAL COLLECTION SYSTEMS ANAL.
- 400 X 500 ELEMENT MATRIX
- 400 LINES/MM

FIGURE 4A - ISODENSITRACER
(EQUIPMENT BLOCK DIAGRAM)

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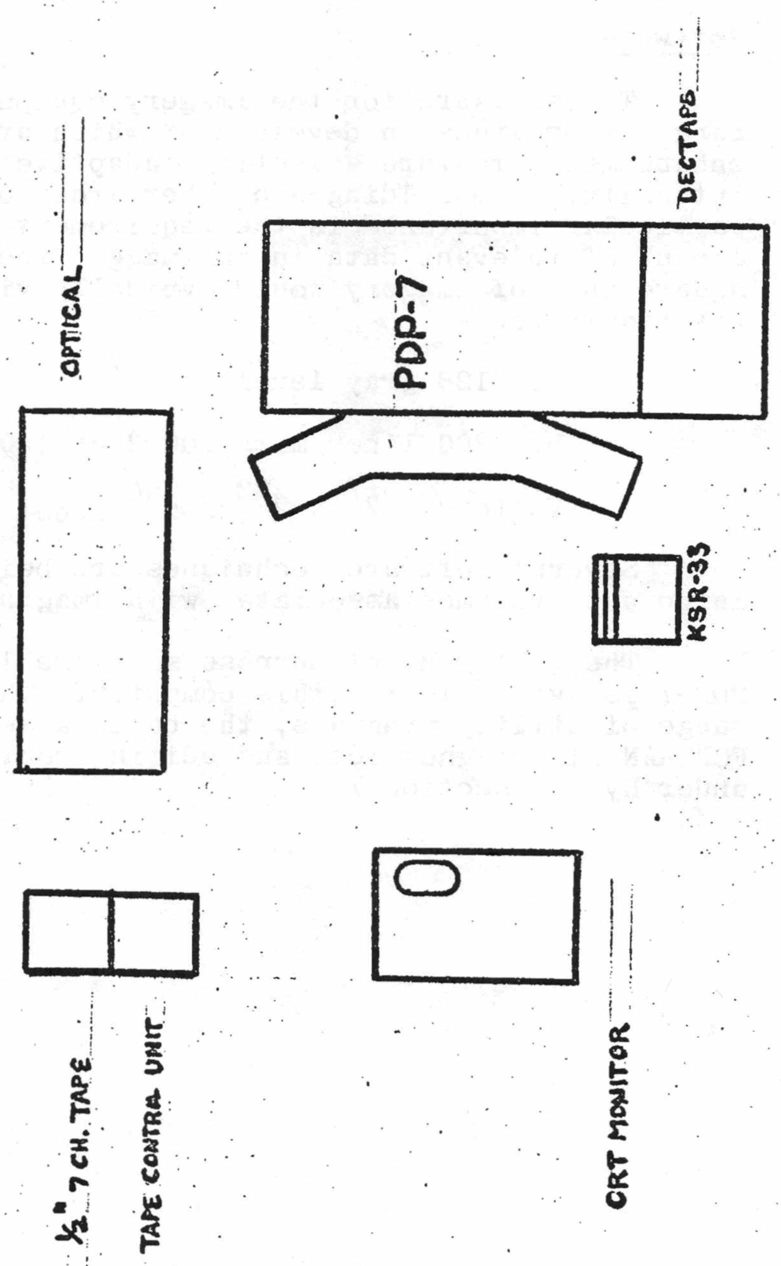

FIGURE 4B: PROGRAMMABLE FILMREADER
(PFR-3 EQUIPMENT LAYOUT)

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at 200 bits/inch. Consists of a Dec type 57A control with a type 581 tape drive. This is IBM compatible to permit intercommunication with the 360/40.

Software

The software for the imagery equipment includes a range of programs in development which are aimed at image enhancement, feature selection, adaptive scanning, selective intensity, thresholding and other areas of interest. Of particular importance is the requirement to compress the amount of relevant data in an image. The data for a single square inch of imagery would typically yield the following bit requirements:

a. 128 gray levels

b. 200 lines/mm $\approx$ .0002 or $(5000)^2$ data points

Vectors = $2^7 \times 2^{22} \approx 2^{30}$ about 10^9

Several software techniques are being tested to reduce large data volumes associated with imaging.

The full general purpose software library of the PDP-7 is available for this computer. This includes a range of utility programs, the basic assembly language, FORTRAN II, diagnostics, and editing routines. (See PDP-7 under Hybrid section.)

ATTACHMENT C

ANALOG/HYBRID

Applications

There is a wide range of computational processes where either the analog computer or the digital machine offers outstanding capability to the exclusion of the other type of machine. In such a situation, it is advantageous to marry the two types of equipment together to form a "hybrid" where the two generic devices are linked together, as shown in Figure 5. Table 1 gives a breakdown of the principal characteristics which would be applicable to any signal. In summary, the analog offers wide bandwidth capability (in real time), limited accuracy, continuous correlation capability and "zero" memory, and a very limited logic capability. The digital machine offers small bandwidth capability in real time, high accuracy, sampled correlation processing, high memory ability, and very extensive logical powers.

Application problems that would exploit these capabilities in a single processor are found in seismics, acoustics, electromagnetic and optical areas of effort, as well as in biomedicine, space simulation, weapons evaluation and modelling. These are all of interest to intelligence systems; some are of vital concern.

Hardware

Figure 5 shows a block diagram of the installed hybrid equipment. Major components are as follows:

a. Hybrid Console (EAI-8800) and ancillary equipments with timing, I/O, patchboard panels for analog and control/logic, power supplies, potentiometer panel, interconnection trunks. The critical configuration was selected to give about 80 amplifiers (expandable to 400), 12 multipliers, 3 resolvers, several function generators and miscellaneous non-linear components.

b. XY Recorder: Plotter for analog computer, 11x17 (EAI-8851).

c. Paper Chart Recorder: Eight channels (EAI-8875).

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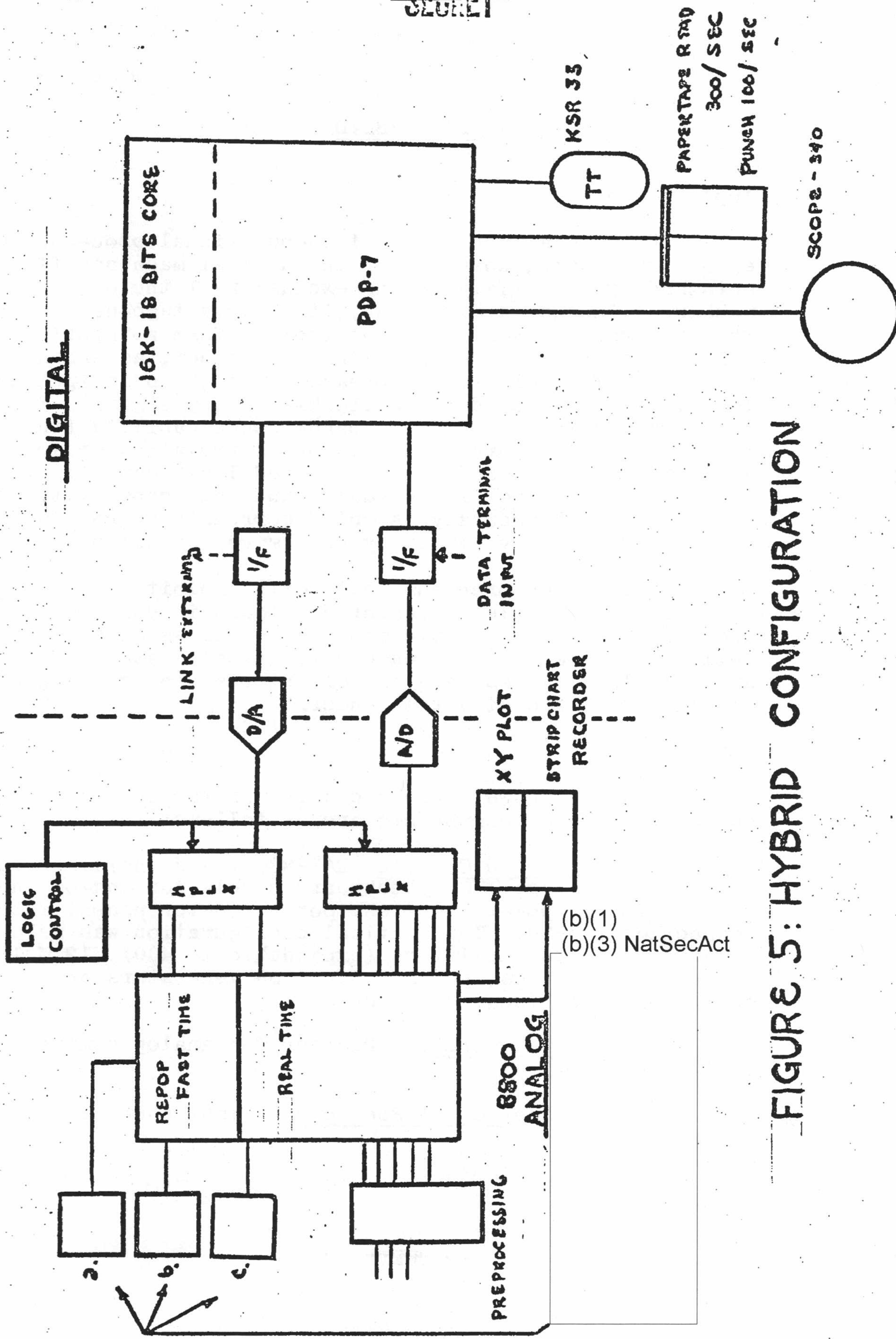

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FIGURE 5: HYBRID CONFIGURATION

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TABLE I

Signal Characteristic	TYPE OF PROCESSING: Analog	Digital	Special Purpose
Bandwidth	50 khz	memory-limited to 100 hz	all applicable
Data rate	continuous	sampled-requires special analysis for adequacy	all applicable
Delays	coarse grid or cont. swept REOP	fine grid	all applicable
Freq. Transl.	patch program	complex software	(excellent)
Logical Decision	relay limit.	subhuman - excellent	all applicable
Phonic Descript.	possible	possible off line	(excellent for lim. voc.)
Dynamic range	$1/10^4$ (.01%)	$1/10^9$ (30 bits)	$1/10^4$ (tapes $1/10^2$)
Power Spectrum	10 narrow bands continuous	10^4 ultra narrow bands, weakly sampled	
Correlation	coarse grid on-line	fine grid off-line	excellent

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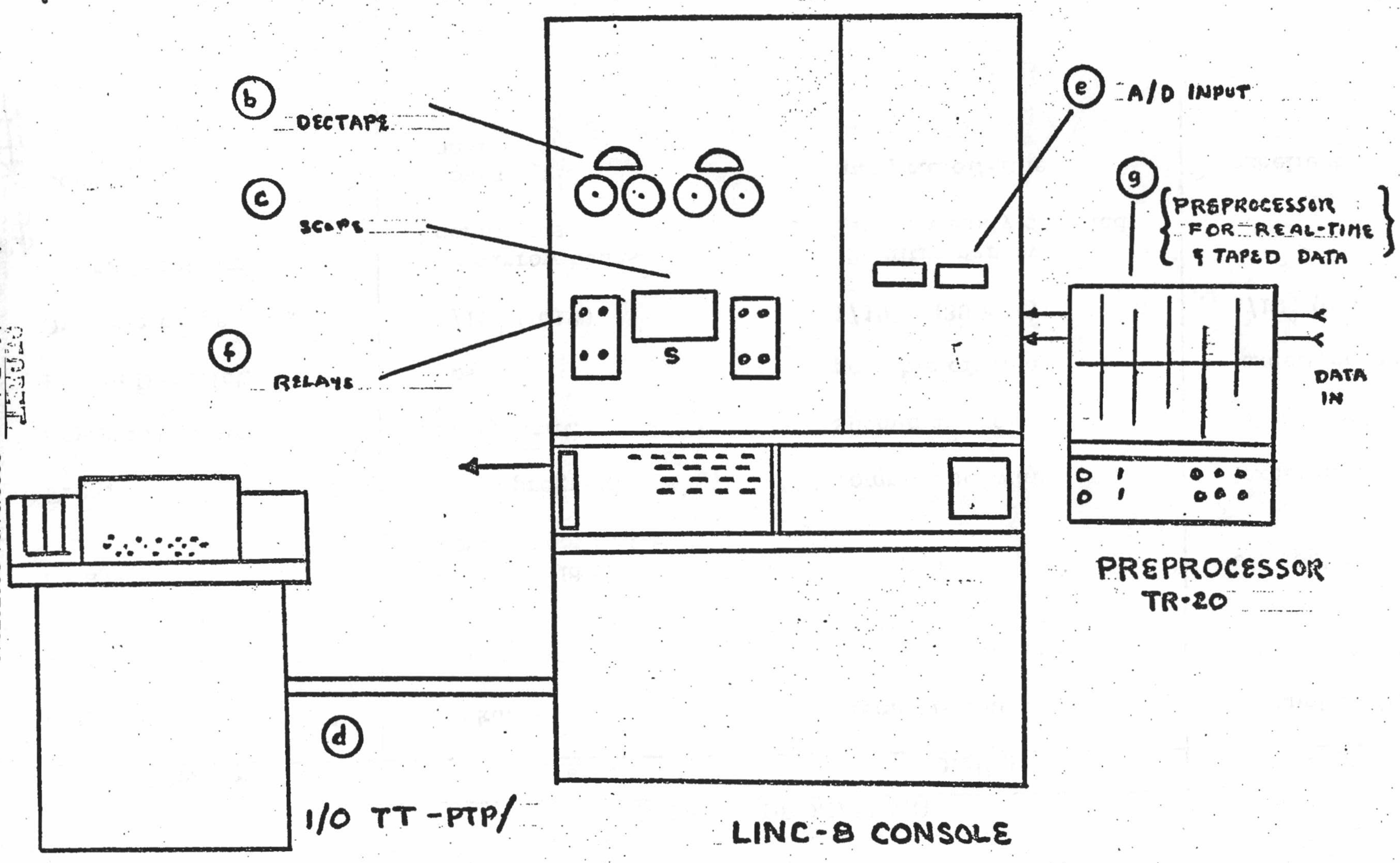

FIGURE 6: LINC-8 CONFIGURATION

d. CRT Display: A 16" tube, 1024 x 1024 points in plotting matrix, 35 µ/point in random plot. For characters, lines, vectors, and patterns. (DEC 340) Driven from digital computer.

e. Teletype I/O: Eleven unit serial code (HSR-33) ASC II eight levels at ten characters/sec.

f. Paper-Punch and Reader: Eight level fan fold perforated tape at 300 characters/sec. in read mode and 63.3/sec. for punch.

g. Digital Computer (PDP-7): This is a general purpose, high speed machine; word length is 18 bits, at a 1.75 µ core access time. Memory is 8192 words. ADD time is about 4 µ and with extended arithmetic logic it can perform multiplication in 6 µ.

Figure 6 shows a block diagram layout of the LINC-8 computer installed in the Life Sciences area of the IPRD. This rather versatile processor was developed originally for analysis of biomedical data such as EEG's, EKG's, and for other physiological studies. However, the data reduction and analysis techniques applicable to this device are directly transferable to many other Agency problem areas. Major components are as follows:

a. General Purpose Computer: 5096 words of length 12 bits; about 1.5 µ memory access time, with interrupts and sense switches. The design of the LINC-8 contains the PDP-8 standard computer as a central processor with modifying interfaces connecting it to external peripherals in a manner to extend its utility to the user problem.

b. DEC Tape: A 3/4" 10-track magnetic tape, 3-1/2" diameter, 420 bits/inch; 150", 60"/sec. 512 blocks and 256 words/block.

c. CRT Scope: 512 x 512 matrix, 5" tube.

d. Teletype I/O: Keyboard-typewriter with paper tape reader and punch at 10 character/sec.

e. A/D Input: 8 bits and sign conversion at about 30 µ/word.

f. Relays: Digital feedback output six switches.

g. Analog Preprocessor: The EAI TR-20 is a small, 20 amplifier, analog computer which is here configured for carrying out on-line correlation or other routines which are not tractable by digital processing. It has a function generator and multiply and squaring components.

Software

The software for hybrid computation can be considered in three parts: hybrid, digital, and analog.

a. Hybrid Software consists of utility, control and applications programs. General requirements for setting potentiometers, program calibration setting up A/D conversion, etc., involve rather tedious iterative adjustments which lend themselves to digital logical processing in a utility program. Hybrid control programming typically involves periodic or interrupt-sampling of a set of analog variables, a logical decision and a programmed jump to a digital sequence. Applications hybrid programming, of course is a function of the type problem being solved on the machine. This can be a multiple degree of freedom problem, such as vehicle simulation, a statistical parameter problem, an adaptive problem in acoustics, seismics, electromagnetics or optics, where the raw data is fed into the machine for on-line analysis in real time.

b. Analog Software: This consists of patch board schematics which depict the circuit topography for problem solution. These are markedly different from the usual digital program flow diagrams in that they relate directly to the signal flow diagrams for the basic problem.

c. Digital Software: This consists of the gamut of generalized programming, assembly language, FORTRAN II and utility software for carrying out basic functions, etc. Examples of some generalized application routines for the LINC-8 are found in the routines. "DATAM," for data manipulation program, permits the digital tape to be viewed on the scope, to be manipulated, filtered, sized, etc., for a scope photograph. FRQANA, for frequency analysis, permits a set of data to be resolved into frequency components, into co-spectrum and quado spectral components for phase determination, etc. DECAL, for desk calculator, permits a range of operations to be performed on data, using the machine to multiply, divide, perform square roots, functions, etc.

Naturally, all of these special purpose, modular programs, can be written in either FORTRAN or, more basically, in assembly language specifically tailored to the problem under study.

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MONOGRAPH NO.

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PROJECT CHAMFRON

by

David L. Christ
Applied Physics Division

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PROJECT CHAMFRON

by

David L. Christ

CHAMFRON is the cryptonym for the DD/S&T portion of an accelerated audio surveillance program which started in Fiscal Year 1965. A description of the program and the basis for its conception can best be presented by quoting a memorandum for the Deputy Director for Science and Technology, dated 4 November 1965, which initiated the program:

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The program in the form presented was supported by the DD/P and approved by the DCI for Fiscal Year 1966, and work proceeded on these fundamental technologies. For Fiscal Year 1967, additional funds were provided for audio surveillance research and development but as a part of the normal budget rather than as a special item from the DCI Reserve Fund.

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Progress made could best be defined in terms of the technologies advanced and devices produced as a consequence of this effort. In summary, as of 1 January 1968, they have achieved the following status:

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RESEARCH AND DEVELOPMENT STUDY

by

Harry R. Wood
Applied Physics Division

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RESEARCH AND DEVELOPMENT STUDY

by

Harry R. Wood
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PROJECT AQUILINE

by

Frank Briglia
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Applied Physics Division

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TABLE OF CONTENTS

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PROJECT AQUILINE

by

Frank Briglia
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I. Introduction

The AQUILINE system is a new concept in the collection of intelligence which encompasses development of the vehicle as well as the associated subsystems.

Research and development on the AQUILINE system was initiated to increase our capability for collection of intelligence against prime targets. Our present airborne collection systems are large and must fly very high and very fast to survive. The AQUILINE concept is to have a small vehicle which will fly low and slow and still have sufficient range. The successful development of the AQUILINE collection system depends heavily upon our ability to develop advanced microtechnology, microminiature sensors and power sources, sophisticated communications and control systems as well as an efficient, small aircraft.

This study is organized into four major sections. Section II presents a history of the program through fiscal year 1967, including a description of its intelligence collection potential. Section III outlines the planned development program for fiscal years 1968 and 1969. Section IV presents a detailed description of the basic technology involved in the development and a summary of the development concept. The final section presents operational concepts and estimates program costs and timing.

II. History

A. Program Initiation

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B. Program Concept

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The AQUILINE concept encompasses a very small, bird-like [redacted] collection system. To determine AQUILINE system feasibility, internal and external studies were conducted. The early conceptual studies were conducted by the Naval Ordnance Test Station (NOTS), Douglas Aircraft Company, and others (see Figures 1 and 2). Mission analyses and cost effectiveness studies indicated that the AQUILINE concept was feasible and held great promise as an advanced [redacted] collection system. Further, the studies established that the vehicle could exist for long periods of time in target areas and would be practically undetectable. Even if detected, it would be expensive and difficult to countermand. Its low altitude and low speed characteristics added to a long-loiter-time capability would permit detailed examination of the target areas and permit a

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wide variety of intelligence missions. Further, its small size and innocuous nature would make it more politically palatable in tense situations than conventional aircraft. It would be unmanned, smaller and cheaper and, therefore, expendable on special missions. Because of these characteristics, it would be deployable against targets not accessible by any means at the present time. In early stages of development, it could complement existing high altitude systems by providing more detailed examination of selected short-range targets by flying below the cloud cover.

Concentrated studies have been performed on a wide range of aerodynamic lift devices including balloons, ballistic glider, powered glider and helicopter types for this application. The powered glider was selected because of the following considerations:

1. <u>Vehicle</u>. A small aerodynamically clean vehicle can be produced which will contain the miniature payloads and subsystems required for the mission contemplated.

2. <u>Propulsion</u>. A variety of propulsion systems such as two-cycle engines, four-cycle engines, fuel cell d [redacted] powered systems can be used to propel the vehicle. The four-cycle and [redacted] powered systems have a potential range of thousands of mile

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3. <u>Observability</u>. Tests of mockup models demonstrate that such a vehicle and its subsystems could have low enough observability (visual, acoustic, radar and IR) to immerse itself in the indigenous signal environment of the target area, loitering unobtrusively while performing its mission.

4. <u>Guidance and Navigation</u>. Several guidance and navigation systems such as CHECKROTE, radio direction finding, transit satellites and Loran or Omega could direct this vehicle to within a few miles of the distant target.

5. <u>TV Eye</u>. The development of a subminiature TV eye is feasible both in the visible and IR. The TV eye can be employed for guidance and navigation as well as surveillance duties.

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6. Communication Link. Secure communications for data transmission and vehicle control can be achieved at line-of-sight ranges and are feasible over the longer ranges by using relays such as a small vehicle of the same type, satellites or CHECKROTE.

7. Payloads. Photographic, IR, ELINT, audio, [redacted] being developed by various divisions in ORD can be employed in this system.

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8. Mobility and Flexibility. Because of its size, weight, and speed, the vehicle can be launched from a small boat or aircraft or a simple portable launcher.

9. Range. A range of 600 n.m. for the Initial Operational Capability (IOC)* version can be achieved. However, with a four-cycle internal combustion engine or fuel cells, ranges of thousands of miles can be provided. [redacted] versions could have unlimited range (30-day flight duration, 36,000 miles).

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10. Operations Research. Computer programs for vehicle configuration systems integration, systems vulnerability and mission analysis have been initiated and can be further developed to insure the effectiveness of operational systems. Eventually the computer programs can be carried out in the Intelligence Processing Research and Development (IPRD) facility of ORD.

C. FY 1967 Development Program

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[redacted] During fiscal year 1967, development of a [redacted] collection system configured as a small powered glider (AQUILINE) began with a budget of [redacted] dollars. The development concept of the AQUILINE system was refined and improved with:

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1. The initiation of an IOC prototype development program.

2. The continuation of advanced system studies by [redacted] (system contractor).

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*Used to designate first generation vehicle and associated subsystem.

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3. Institution of development programs in the subsystem areas of aerodynamics, propulsion, navigation, communications, antennas, survivability studies, intelligence collecting payloads, and ground control equipment.

A flight test range was established and instrumented to allow flight test of the airframe, its subsystems, and payloads under development. The flight of the fully instrumented IOC system is scheduled for October 1967. The IOC system will include remotely controlled autopilot, navigation and communications equipment (including a slow-scan TV camera and associated radio transmitter) and will be equipped to carry test payloads up to five pounds to a range of 600 n.m.

III. Program Objectives

A. Overall Objective

The AQUILINE development program is designed to be evolutionary, i.e., its collection capability will be increased as advances in technology become available. Specifically, the program will require advances in the state-of-the-art in the critical areas of aerodynamics, propulsion, navigation, communication and payload instrumentation. A major goal of the program is the ability to define an optimum collection system to be employed against a particular intelligence target using the technology currently available (see Figure 3). A more detailed description of this aspect of the program is contained in Section IV, below.

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Computer programs have been developed to supply the detailed design information needed to construct an AQUILINE vehicle and its subsystems. The computer program will optimize the vehicle and payloads for a specific mission against a specific target, and gives the probability of success for the mission.

B. FY 1968 Goals

During fiscal year 1968, research and development on an Advanced Operational Capability (AOC) will be initiated. This program will consider four-cycle internal combustion engine designs, advanced subsystem elements, and payload instrumentation resulting from current microelectronics research and development efforts. The initial AOC goal [redacted]

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C. FY 1969 Goals

The AQUILINE system capabilities for fiscal year 1969 will be increased by an advanced four-cycle engine which will extend the range [redacted]

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D. Ultimate Goals

During the fiscal year 1970 and beyond, research and development will be oriented toward increasing the range, navigational accuracy, data communication and storage capacities, loiter time at target and the overall reliability of the system. Improved payloads which are lighter in weight will be under development to collect a wider range of intelligence data under varying conditions. In addition, initial operational experience obtained from earlier deployed AQUILINE systems will be used to guide future AQUILINE development.

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Reference 1

FINAL REPORT SUBMITTED BY CIA/DIA SCIENTIFIC
GUIDANCE PANEL

[redacted] (b)(6)

Dr. Douglas H. Ewing, Chairman [redacted] (b)(6)

(b)(6) [redacted] (b)(6)

Prof. Luis W. Alvarez, Member [redacted] (b)(6)

[redacted] (b)(6)

Dr. Franklin S. Cooper, Member

[redacted] (b)(6)

Dr. Edward E. David, Member

[redacted] (b)(6)

Dr. Raymond L. Garman, Member

[redacted] (b)(6)

Prof. Claude E. Shannon, Member

[redacted] (b)(6)

Prof. John W. Tukey, Member

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Date: 3 February 1964

FINAL REPORT

CIA/DIA SCIENTIFIC GUIDANCE PANEL

1. The Panel is pleased to submit herewith the final report of its study of audio surveillance problems. The work of the Panel since submission of its Interim Report of 19 August 1963 has not modified, but rather strengthened, the findings and recommendations enumerated in that report. Accordingly, the Interim Report is appended as a part of this Final Report.

2. Additionally, there are appended two other documents, One discusses the establishment, staffing and operation of a fundamental research group whose establishment the Panel regards as essential. The second lists several fields of technical activity relating to the CIA R&D program for audio surveillance devices and the intelligence community program for counter audio devices. It also contains the Panel's recommendations of relative emphasis to be put on these several fields.

3. Although this is a final report of their efforts, the Panel would appreciate and specifically requests the opportunity to reconvene after another six to nine months. The purpose of this additional meeting would be to review, assess, and perhaps comment upon the progress of activities resulting from these recommendations.

4. In conclusion, the Panel believes that a competent job of audio surveillance apparatus design and development has been done by CIA within the limitations imposed by manpower, funds, and priority. Major advances in collection will come only as a result of serious, long-range research. The Panel sees little possibility of achieving audio surveillance at very long distances.

5. Serious attention must be devoted to countermeasures. Specifically, study of the radiation at the U.S. Embassy in Moscow must be continued until the uses of these signals by the Soviets is understood.

GROUP 1
Excluded from automatic downgrading and declassification

6. The Panel is appreciative of the cooperation given it by the CIA, DIA and State Department in briefings on operations and equipment. The Panel feels that FBI participation would also have been useful.

Attached:
1. Appendix A - Interim Report dated 19 August 1963
2. Appendix B - Fundamental Research Group
3. Appendix C - Applied Research and Development

APPENDIX A

INTERIM REPORT

CIA/DIA SCIENTIFIC GUIDANCE PANEL

19 August 1963

I. During the past five months, the Panel has begun to familiarize itself with the technical and operational capabilities of audio surveillance within the Intelligence Community, and to compare these capabilities with the state of current technology and with the inherent limitations imposed by nature. This familiarization has led to certain findings and recommendations, offered below, that are appropriate for submission at this time. The Panel plans to make further studies of selected audio surveillance development projects and to offer informal technical suggestions during this study. The Panel expects to conclude its work by suggesting scientific guide lines for the program of basic research recommended below.

II. FINDINGS

1. The Panel finds that there has been a lack of a long-range basic scientific effort in support of audio surveillance.

2. The Panel has carefully considered the objective of extracting audio information from targets which are inaccessible to installation operatives. The Panel finds that audio surveillance of inaccessible targets is extremely difficult and may well be impossible. The only foreseeable possibility appears to be through the results of a major, long-range, basic scientific effort which may point the way to radically new approaches. It may be possible to accomplish some audio surveillance of inaccessible targets using techniques now under development but this will be possible only under special circumstances and at the expense of severe operational limitations.

3. The Panel has reviewed carefully a large number of specific audio surveillance projects and in general finds them well planned and executed. However, this work has, not surprisingly, been concentrated on relating current technology to easily recognized operational possibilities.

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4. The Panel, in reviewing audio surveillance techniques, has necessarily considered countermeasures to such techniques. It is alarmed by the lack of countermeasure sophistication in our operating procedures, by the technical deficiencies of the protective measures that are applied, by the situation in the Moscow Embassy, and by the lack of aggressive active countermeasures. It appears that policy level personnel are not sufficiently aware that they may well be under almost constant audio surveillance by as yet undiscovered equipment and methods.

III. RECOMMENDATIONS

1. The Panel recommends creation of a very substantial basic research effort relevant to audio surveillance and countermeasures.

2. The Panel recommends increased emphasis on those projects that offer some prospect, however limited, of effecting surveillance of inaccessible targets. These are described in the attachment.

3. The Panel recommends greatly increased attention to security procedures and to countermeasures. Improved sweep procedures and equipment, and active countermeasures are especially important, and should be undertaken at the earliest possible time.

4. The Panel recommends continued support of current audio surveillance development programs. The Panel has made numerous technical suggestions directly to the technical staffs for incorporation in these programs. These suggestions do not, however, represent a major change in the orientation of current work nor do they offer any alternative to a substantial basic research program.

IV. DISCUSSION

The following discussion gives further details pertaining to the recommendations above.

1. Research

a. The Panel recommends creation of a very substantial basic research effort relevant to audio surveillance and countermeasures. It recommends also that overall R&D activities be tailored to insure a balance among the needed long-term scientific research, the existing short-range development and exploratory efforts, and the essential technical liaison between operating and research personnel.

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b. The case for basic research can be made in these terms: The fundamental principles behind current capabilities come largely from basic work in industry and the universities; work which was not directed to intelligence objectives. If radically new principles are to be had for audio surveillance, they are most likely to come from research that is generally oriented toward intelligence as an objective, though this research must remain basic in nature. Mechanisms to accomplish this include in-house staff or laboratories, captive research facilities, and only in special instances, study groups or panels. While the most appropriate details of the mechanism can be debated, it is clear to the Panel that radical departures leading to greatly enhanced capabilities -- as well as a substantial increase in the rate of improvement of more routine capabilities -- can come only from a full-time group of highly competent devoted, and inspired people working steadily over an extended period of time with only <u>general</u> requirements, objectives, and deadlines. The time constant of such activity is long - one could hardly say that its establishment within the year is a life and death matter -- yet the Panel is unanimous in feeling a quality of deep urgency.

c. Any effective long-range research effort will require close technical liaison between long-range research, development, and operations. This is needed both to ensure that the results of long-range basic research are brought to bear on operating problems, and to provide the research personnel engaged in basic research with a realistic understanding of practical audio surveillance requirements. The calibre of the individuals is the primary consideration, although adequate laboratory facilities and access to the personnel of operating units is also required.

d. We are aware that CIA has established the organizational framework for a substantial effort in basic research and advanced technology for a variety of intelligence problems. We understand that, in the present fiscal year, this unit is operating with a budget of [redacted] and an authorized strength of [redacted], of which about 15% are currently employed. This framework deserves consideration as one of the plausible mechanisms for implementation of substantial basic research on audio surveillance.

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2. Countermeasures

a. The Panel recommends that active countermeasures and improved sweep procedures should be undertaken at the earliest possible time. Specifically, protection on both the acoustic and electromagnetic levels, using masking techniques well within the current technology, should be investigated and used as protection at sensitive installations. Secure rooms should be used on a widespread basis.

b. Sensitive installations require both maintenance of strict security measures and intensive search for enemy installations. This implies adequate briefing for the resident security officer; effective, rather than nominal control of uncleared personnel; effective control of all sensitive conversations; and a resident sweeper of high technical competence. To have the maximum chance to detect operating systems, sweep operations must be covert. Sweepers should be provided with the most advanced, even experimental, search equipment. In particular critical situations the sweepers should be highly qualified technicians authorized to try new approaches.

c. Consideration should be given to the creation of a special covert field research team composed of several competent and imaginative scientists and adequately equipped with versatile, even experimental, equipment to explore critical situations thoroughly. The experience of the special covert field research team could form a basis for new operating procedures for other sweep teams.

d. Active countermeasures should be introduced in situations such as now exist at the Moscow Embassy, which has been known to be irradiated by microwave energy for over eight years.

e. Countermeasures at the present time are carried out by six different organizations operating independently. The Panel is of the opinion that improved coordination of these activities, as well as policies is urgently needed and that this is a topic to which the President's Foreign Intelligence Advisory Board might wish to give its attention.

f. It may appear that the Panel's interest in countermeasures is outside the scope of its terms of reference. Three reasons account for our interest and concern. First, countermeasure problems are inseparable from the positive side of intelligence. Second, as U.S. citizens we are concerned over what seems to be a serious jeopardy to the security of operations. Third, we are interested in the opposition's capabilities in order to evaluate his techniques for our own use.

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APPENDIX B

FUNDAMENTAL RESEARCH GROUP

1. The Panel sees a need for the establishment of a program of fundamental research into the technical bases of audio surveillance. These include sound to light or electrical transduction, information recording and transmission, signal processing and power generation as well as countermeasure technique. Also included should be studies of the basic disciplines involved in audio surveillance: sound transmission in rooms and turbulent media, electromagnetic propagation in buildings, electromagnetic reflections from non-uniform surfaces, etc. While it is probable, once a program is formulated, that much of the research can be carried out under contract, it is vital that there be a central, working group of scientists engaged in exploratory investigations. In addition to carrying out their own researches, members of this group would establish and maintain rapport with research teams under contract.

2. To recruit and retain the imaginative, first rate scientific talent that a research group of the sort described must have, the Panel feels that it can only be established outside the Government framework. Specifically, it could be established in the manner of the Wartime Radiation Laboratory at MIT, that of the Rand Corporation, or that of Aerospace Corporation.

3. In size, the central group should be large enough to allow internal discussion and mutual appraisal of ideas. Its maximum size will be dictated by the difficulties of finding able men. In any case, the group should be small at the outset and should grow in size only as sufficient, worthwhile ideas are generated and as qualified researchers are found.

4. There should be diversity in the skills and backgrounds of the members of the central research group although it is to be expected that the majority would come from the disciplines of mathematics, physics, chemistry and electrical engineering. It is less important that the group have broad disciplinary coverage than that its members have ability, experience and imagination.

5. It is of the greatest importance that the research group have access to operational information. This should include, e.g., the

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characteristics of targets, the living and working habits of the people one wishes to overhear and the nature of field operations and operatives. Only on the basis of such information can fundamental research be undertaken. It should be observed in passing that the results of research will lead not only to new devices and techniques but, in all probability, to new or modified operational methods. One need recall only the modifications in military operations required to make the transition from optical to radar fire control to see the possible necessity of operational modifications.

6. In formulating and carrying out its program, the group must take advantage of other research in progress under governmental and industrial sponsorship so as to duplicate work only when special requirements dictate. While the group should have primary responsibility for formulation and review of the research effort, it should not be the final authority. The research administration to whom the group reports (or perhaps a review committee) must monitor the research program and review its progress vis-a-vis the long-range objectives of the operation it serves.

APPENDIX C

APPLIED RESEARCH AND DEVELOPMENT

1. A wide range of research and development topics was considered by the Panel. Some were reported to it as already underway or under consideration; others grew out of the Panel's discussions. The following list arranges these topics under seven main headings:

a. Group I. Special Apparatus and Systems
b. Group II. Counter-Audio Surveillance
c. Group III. Radio Frequency Transmitters
d. Group IV. Microphones
e. Group V. Recorders
f. Group VI. Power Sources
g. Group VII. Car Bugging and Tailing

2. Distribution of Effort.

The research topics in the following list are of various kinds. Some require only straightforward development effort or implementation at the operational level, whereas others require basic research or even pencil-and-paper feasibility studies. Likewise, some are of much greater importance, at least potentially, than others. The Panel would hesitate to attempt the assignment of priorities but feels, nevertheless, that some indication of relative levels of effort appropriate to the major categories might be useful.

SUGGESTED LEVELS OF EFFORT

		Feasibility Studies	Research and Development
Group I.	Special Apparatus and Systems	30%	15%
Group II.	Counter-Audio Surveillance	20%	20%
Group III.	Radio Frequency Transmitters	15%	20%
Group IV.	Microphones	15%	15%
Group V.	Recorders	10%	10%
Group VI.	Power Sources	5%	15%
Group VII.	Car Bugging and Tailing	5%	5%

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[redacted]

4. <u>Group II - Counter-Audio Surveillance</u>

   a. Application of correlation techniques

   b. Improvement in HUSHAPHONE

   c. Improvement in secure rooms

   d. Use of multiple antennas (inside-outside)

   e. Touring sweep teams and equipment

   f. Telephone indicator for "Hot-Mike" condition

   g. Regular sweeping "war games"

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[redacted]

(b)(1)
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[redacted]

10. <u>COMMENTS ON RESEARCH AREAS OF SPECIAL IMPORTANCE.</u> In considering specific projects within the above categories, the Panel feels that certain areas deserve special emphasis. The following comments are intended to point to these areas, but without prejudice to topics that are not discussed.

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[redacted]

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(b)(3) CIAAct

[redacted]

(6) Signal processing methods, using computers and other devices and procedures, may well permit the retrieval of important information from recordings that are now considered sub-marginal. The available art should be re-examined and the application of known methods should be given a thorough trial.

b. <u>Counter-Audio Surveillance</u>

(1) In view of the very low yield from sweep teams, the Panel recommends that high priority be given to counter-surveillance, both as to the improvement of present procedures and the search for non-conventional methods that may be in use against us.

(2) Feasibility studies are needed on new methods of detection: electrical, optical, X-ray, ultrasonic, etc. The composition and operating procedures of sweep teams need critical review and possible modification.

(3) The regular use of secure rooms is highly recommended, but attention should be given to possible "bugging" by methods which are not presently thought to be in use. Improvement in Husha-phone techniques should be undertaken to provide a device which is easy to use.

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Reference 3

CENTRAL INTELLIGENCE AGENCY

MEMORANDUM OF CONVERSATION

ORD-1369-65

Date: 13 May 1965

Subject: Informal Meeting with ARPA, 7 May 1965 (Micropower-Microelectronics)

Participants: Dr. R. L. Sproull, ARPA
Dr. S. Koslov, ARPA
Mr. D. L. Christ, AP/ORD
Mr. D. Reiser, AP/ORD

Copies to: DD/S&T
AD/ORD

---

1. This informal discussion was held for the purpose of determining the current work and interest which ARPA might have in regard to the advancement of the technology of micropower-microelectronics.

2. It was immediately determined that ARPA was not supporting any work in this area (i.e., micropower technology).

3. The ARPA people were apprised of the survey which is being carried out by AP/ORD of the industry and of the tentative conclusions reached to this time. Principally, we indicated that it was our feeling that significant technological advances could be achieved in low power semiconductor performance through the support of R&D effort in this field. The work and capability of some of the companies surveyed, such as [redacted] was reviewed.

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4. The situation at [redacted] was discussed in the light of the fact that it is our opinion that this

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Form No.1132
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laboratory is approximately one year ahead of competing companies in the field of micropower-microelectronic R&D. However, this laboratory was just recently closed by the [redacted] due to the lack of adequate contract support from Government and industry. Dr. Sproull felt that, in his estimation, it would be better to not consider the possibility of opening the [redacted] by supporting work there and obtaining management approval (a [redacted] year effort), since there were too many semiconductor manufacturers in the country and it would be better for the industry not to reestablish another source.

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(b)(1)
(b)(3) NatSecAct

5. Data which indicated the performance of limited work carried out by a number of manufacturers in the micropower area was reviewed. The performance of a selected circuit: [redacted] considerable interest on the part of the ARPA people.

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6. The need for micropower advancement was expressed in terms of two obvious inadequacies in current microelectronic technology:

a. Many equipment items being designed for current field use will be produced in a packaged volume considerably smaller than the associated battery or power pack required for the equipment's operation.

b. The density of packaging which can be accomplished through the use of current microelectronic techniques is now limited by the power dissipation requirements of the circuits.

7. Dr. Sproull expressed two reservations concerning our tentative conclusions; they dealt with: a) the theoretical maximum resistivity of the semiconductor surface treatment water, and the significance of its contribution to micropower semiconductors, and b) the anticipated life limitations of the active micropower devices. These matters were generally discussed at that time; but we felt it important to derive more detailed information about them. It has been reaffirmed, since the meeting, that these two

problems do not represent a serious limitation in the pursuit of a micropower effort.

8. It was explained to Dr. Sproull and Dr. Koslov that two kinds of support was needed for this technological area—one to advance the state-of-the-art at such places as [redacted] (b)(1) (b)(3) NatSecAct by one to two orders of magnitude (advanced development) and another more fundamental aspect—the solid state research with respect to materials, surface cleanliness and microarea techniques at such places as [redacted] (b)(1) (b)(3) NatSecAct It was further explained that we had broad spectrum of immediate needs for micropower devices, that we had started with some advanced development funding, but that an expanded, but considerably more expensive, effort was required. It was emphasized that this visit was exploratory in nature, that we had more survey of industry to perform, that we had not yet proposed to our top management an overall program for consideration and funding, but were asking if ARPA would be interested in participation if and when the appropriate time came.

9. Drs. Sproull and Koslov indicated that ARPA would be very interested in pursuing a program concerned with the advanced research of technology in micropower-microelectronics. Dr. Koslov further indicated that if such a program was carried out, it could be arranged to have one of the ORD Staff act as the cognizant project officer so as to permit direct program output to be obtained by our organization. A 500 K effort was felt to be reasonable within the program plans of ARPA.

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10. With respect to the advanced development programs at such places as [redacted], they would undoubtedly be happy to help if they were officially asked. In this type of program they would simply transfer funds to us and we would provide them with technological output.

11. This whole micropower area is a significant one, which would have considerable impact upon many Agency and DOD programs. Long term operation of various sensor devices without the need for replenishment of power battery supplies over extremely extended periods can be achieved. Orders of

magnitude of improvement in power drain of many equipments can be achieved. To our knowledge, this area is not being pursued in a very active manner by any of the Defense Agencies or by NASA. ARPA's interest is quite high at this time, and they may proceed to consider programs in this area whether or not we request it of them.

12. The following important actions should take place as soon as possible:

a. General briefing of the DD/S&T.

b. Preparation within one month of a technical paper for circulation in DD/S&T, and possibly Office of Communications and DD/P/TSD.

c. Possibly a micropower symposium.

(Signed)

DAVID L. CHRIST
C/AP/ORD/DD/S&T

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AP/ORD/DD/S&T/D Reiser:am (12 May 1965) 4251.

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Reference 4

DD/S&T-2868-65

MEMORANDUM FOR: Advanced Research Projects Agency

SUBJECT: Micropower-Microelectronic Technology

1. I believe that the technology of micropower-microelectronics represents an area where advanced research would prove fruitful. A review of our programs and the status of technology among the top microelectronic companies in the United States has revealed the desirability and feasibility of improving the operating power efficiency of solid-state devices and circuits by three or four orders of magnitude. This advance would have tremendous impact not only in most types of intelligence collection systems utilizing electronics, but also in weapons systems, space systems, and other electronic systems requiring complex information processing and analysis.

2. On 7 May 1965, Messrs. Reiser and Christ of this organization met with Dr. Sproull and Dr. Koslov, presenting the tentative results of the survey. They reported to me that there were areas of definite mutual interest and that your Staff expressed a tentative interest in carrying out fundamental research activities leading to new micropower devices.

3. As a result of the survey which my Staff carried out, a number of very promising areas of endeavor which involve advanced research and development were found. By its fundamental nature, this type of endeavor appears to be a logical long range effort for your Agency. Areas which could be profitably pursued are:

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[redacted]

4. I believe an effort in improving micropower technology will serve the national interest with respect to economy and in most efficiently applying advanced R&D to Department of Defense and Intelligence Community needs. This Agency would be desirous of closely following your efforts in this field and deriving the benefit of advances in this technology. With this in mind, Messrs. Christ and Reiser are made available to provide details of background acquired to date and to effect any coordination that might be necessary.

ALBERT D. WHEELON
Deputy Director

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C/AP/ORD/DD/S&T:am (23 June 1965) 4251

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Reference 5

ORD-3431-65

13 December 1965

MEMORANDUM FOR: Deputy Director for Science and Technology

SUBJECT: DD/R&E Liaison - Micropower Microelectronics

1. You will probably be interested in the nature and extent of the micropower R&D program we are conducting in association with ARPA -- this with respect to your liaison with DD/R&E, Dr. John Foster.

2. The Audio Physics Division made a survey of sixteen top microelectronic companies, produced the Staff Paper on Micropower Microelectronics (copy attached) and generated the area described herein. The attached General Project Statement, passed recently to ARPA, gives more details on the contractors involved.

3. AP/ORD personnel negotiated proposals with [redacted] for a cost-shared research program involving the Government and those companies. In addition, [redacted] who started his own company, [redacted] was contracted as a key micro-technology expert; the following figures define the program now being funded by ARPA, and project-monitored by AP/ORD:

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[redacted]

4. Tentative plans also call for a joint ARPA-ORD Technical Seminar in the Washington, D. C. area to be conducted in mid-1966; which will be devoted solely to Micropower Microelectronic technology.

(Signed)
ROBERT M. CHAPMAN
Director of Research and Development

3 Attachments (w/orig. only)
1. Staff Paper
2. General Project Statement
3. List of Companies

C/AP/ORD/DD/S&T:am (9 December 1965 - 4251)

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GENERAL PROJECT STATEMENT

Proposed Contracts with:

[redacted] (b)(1) (b)(3) NatSecAct

1. In brief, the contracts proposed [redacted] (b)(1) (b)(3) NatSecAct [redacted] (b)(1) (b)(3) NatSecAct cover efforts to improve the general technology now used in semiconductor manufacture to permit the development and production of micropower circuitry. This involves an improvement in the state-of-the-art technology and would provide early fall out or improved performance through a rapid evolutionary process. Such devices are needed today.

2. The proposed contract with [redacted] (b)(1) (b)(3) NatSecAct [redacted] (b)(1) (b)(3) NatSecAct involves a longer range approach which will attempt to achieve technological breakthroughs in a number of areas involved in the development of micropower devices. This program while somewhat "blue sky" would, if successful, provide the means for rapidly realizing orders of magnitude improvement which are theoretically achievable.

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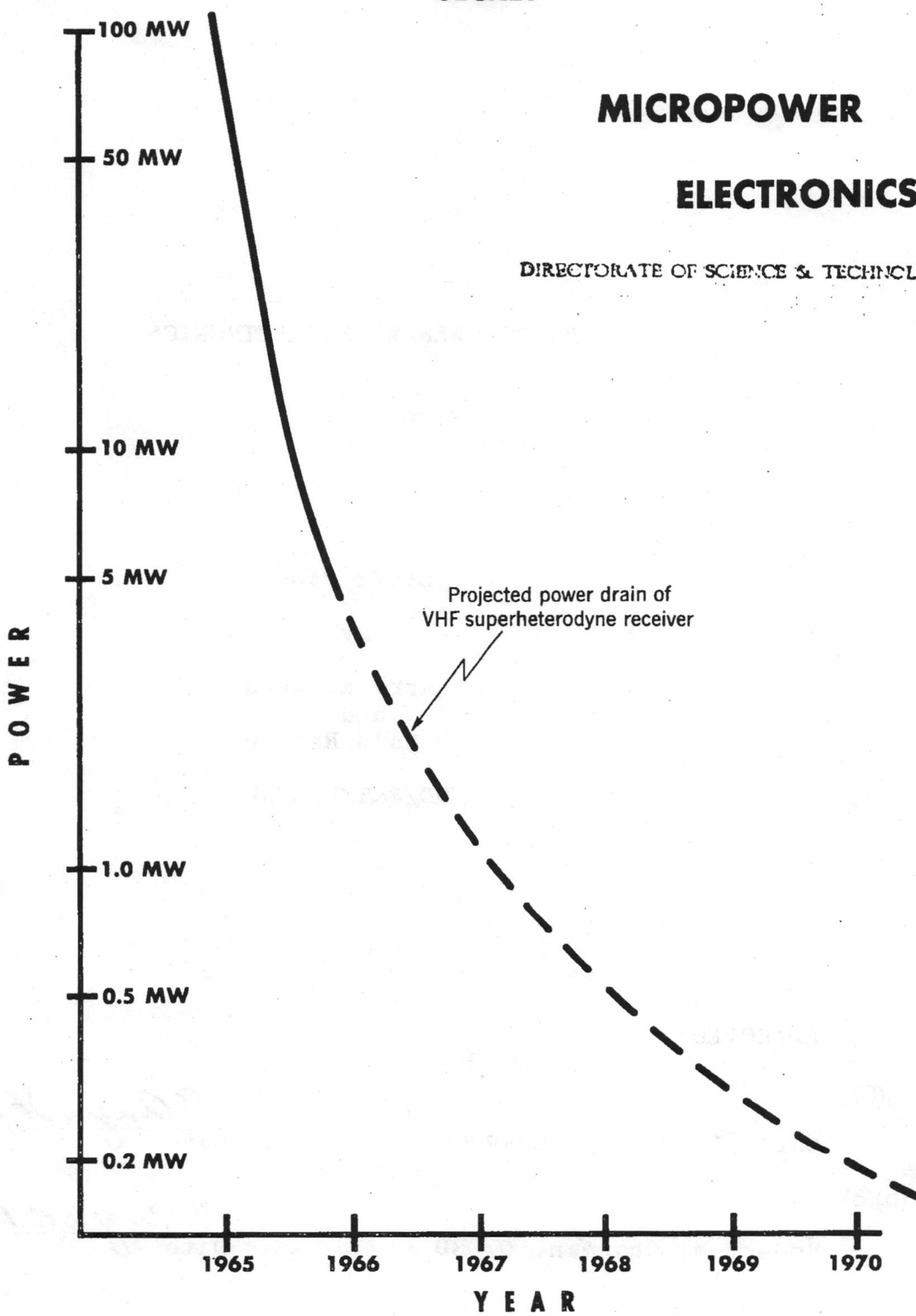
MONOGRAPH NO. 12

MICROPOWER ELECTRONICS

DIRECTORATE OF SCIENCE & TECHNOLOGY



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MICROPOWER-MICROELECTRONICS

Staff Paper

by

Harry R. Wood
and
Donald Reiser

DD/S&T/ORD/AP

APPROVED:

(b)(6) [redacted]
David L. Christ, C/AP/ORD — Date: 9 August 1965

(b)(6) [redacted]
Robert M. Chapman, D/ØRD — Date: 9 August 1965

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ABSTRACT

The conclusions of a study of micropower technology and a survey of the state-of-the-art capabilities of the U.S. semiconductor industry in this field are presented.

Micropower high frequency circuits are discussed in regard to the problems which will be encountered in functional realization. Present technological standards for active devices and passive elements are presented. Areas where improvements are needed and possible means for achievement are discussed. Isolation techniques for microcircuits are compared.

An experimental micropower circuit is presented and evaluated in accordance with a defined "figure-of-merit."

Micropower program plans and actions which are being carried out in this important field are also discussed.

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TABLE OF CONTENTS

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TABLE OF ENCLOSED ITEMS

I. Introduction

Intelligence gathering and processing equipment is highly dependent upon the field of electronics. This dependency is likely to increase as techniques become more sophisticated and technology continues to improve. Microelectronics, one specialized branch of the electronics field, seems particularly applicable to technical covert intelligence gathering. Actually, microelectronics implies many of the characteristics that are of primary concern to this type of an intelligence effort.

The requirement that a device will support covert intelligence gathering understandably implies that, in many important cases, it will be given little or no maintenance. In addition, it would generally be highly desirable to confine the device to a diminishingly small volume. Given these requirements one finds that microelectronics can be an extremely valuable tool. Obviously, no single discipline will suffice universally; however, because of its importance, microelectronics will soon be utilized, to some degree, in the majority of equipments.

One specifically difficult and important use of microelectronics is its application to high frequency, micropower circuitry. In order to obtain firsthand information pertaining to this important area, ORD personnel conducted extensive discussions with R&D scientists, application engineers, etc., from the semiconductor industry. The results of these discussions and general conclusions based on present information are presented here.

II. Problem Definition

Microelectronics, as the term is currently used, does not necessarily imply micropower. In fact, state-of-the-art circuit functions involve the contrary (small size has been achieved by sacrificing power efficiency). Philosophically, the definition of microelectronics can be broadened to include micropower concepts by specifying a high density of functions, (i.e., circuit functions are to be confined to diminishingly small volumes). With this understanding it then becomes obvious that micropower is implied because a high density of function implies high heat dissipation per unit volume for a given supply power. To protect devices from heat damage and still maintain high function density, the supply power must be reduced. For the remainder of this paper, we shall, therefore establish that the goal is to establish the basis for the more stringent definition of microelectronics.

III. Problem Orientation

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With notable exceptions, such as [redacted]

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[redacted] the semiconductor researcher has not been overly concerned with micropower concepts. The larger manufacturers' interest in this area is only that which has been stimulated by the space and computer industries. Representative circuitry is the switching circuit built around the Motorola 2N3493. Item 1 shows some of the pertinent characteristics of this device. Item 2 shows similar data for a Sperry Complementary Microwatt Logic Circuit. These curves have been taken from data sheets and laboratory reports obtained from the respective companies.

Note that the circuits of Items 1 and 2 both operate at a relatively low frequency, and that normal functional operation is carried out with a collector voltage on the order of three volts. These circuits, in addition, are designed for digital operation.

A circuit of more immediate concern is high frequency, low power analog circuits. While digital circuitry appears to be receiving some attention and gravitating toward low power operation, analog circuit functions are receiving practically no consideration along these lines. A typical

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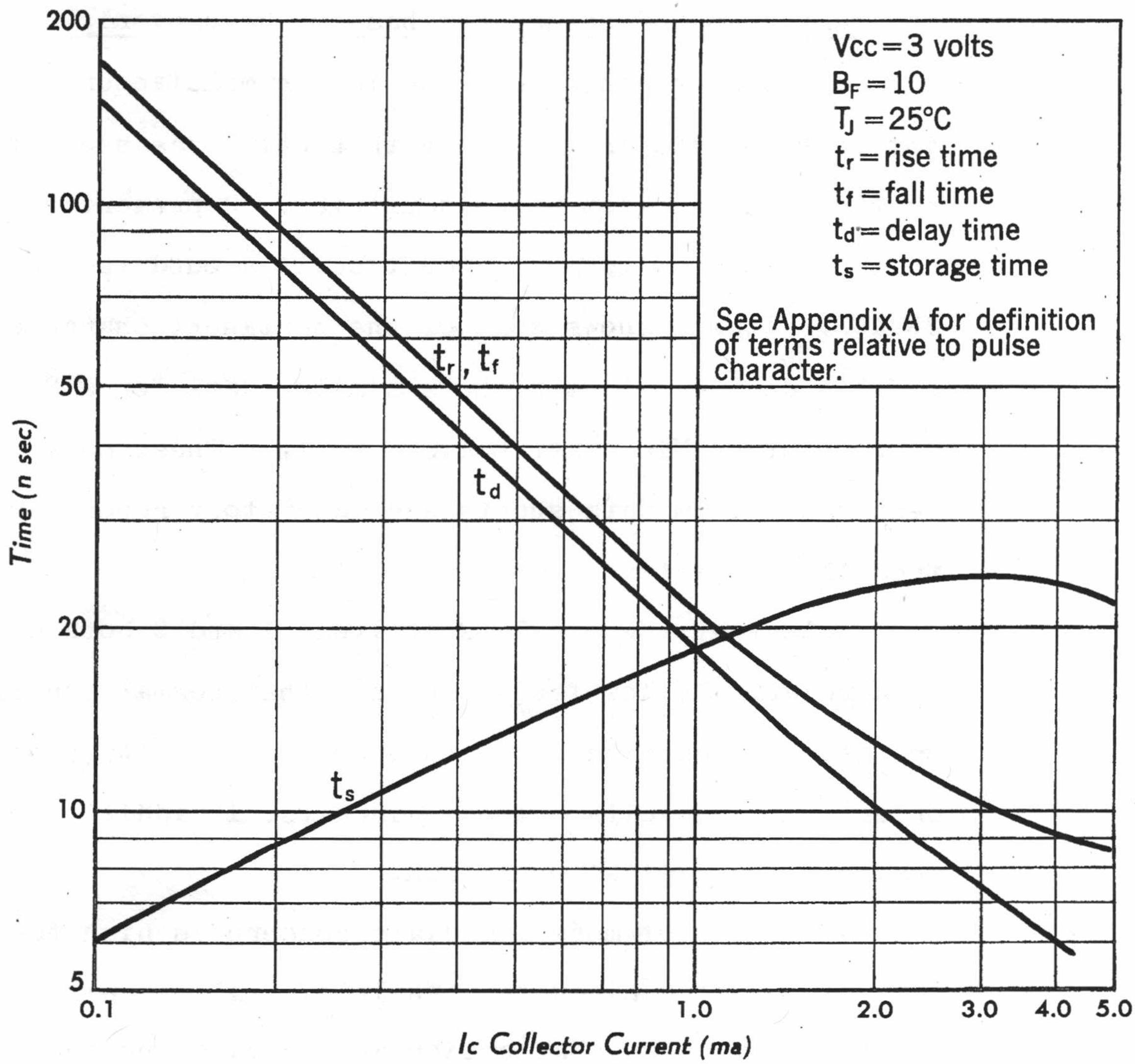
Item 1

Transient Response of Micro-Power Circuits Using the Motorola 2N3493 Transistor



Typical circuit using these devices is the 1 Mc flip-flop with an overall power drain of 6.6 milliwatts. (See spec. sheet for 2N3493 micropower switching transistor, Motorola semiconductors).

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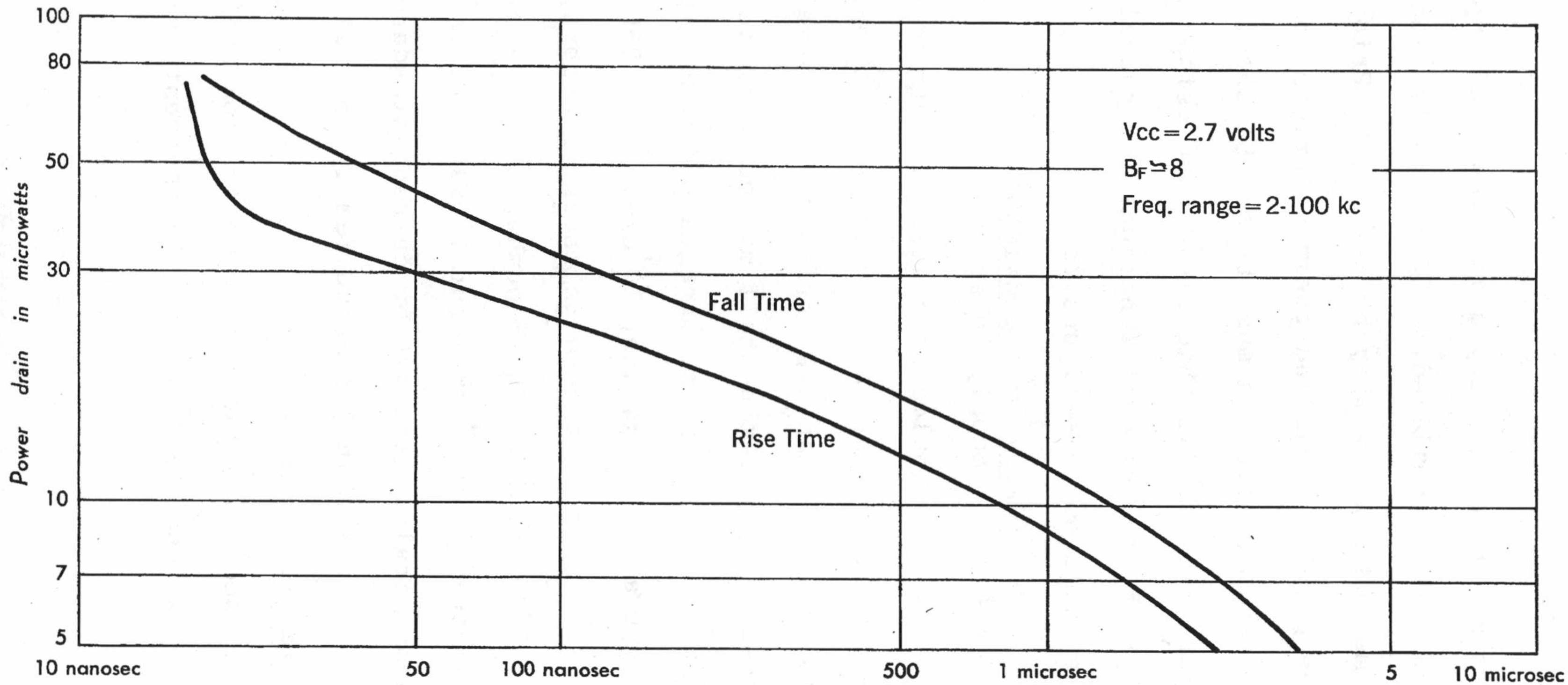
Complementary Microwatt Logic Circuits

Item 2



Nandgate switching time vs power drain
(Sperry semiconductor)

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problem might be "how may a micropower RF amplifier in the UHF band be realized." Specifically, what are the problems and how may they be overcome? Prior to considering the problem areas and their solutions some means of rating various circuits must be established.

Early workers in this field have established a figure of merit, F, for circuit functions in general. W. W. Gaertner defines this figure to be

$$F = \frac{(\text{Gain})^{\frac{1}{2}} \times (\text{Bandwidth})}{\text{Supply Power}}$$

for small signal analog circuits. The upper limit of this has been predicted by Gaertner to be 10^{16}/Joules.

To illustrate an evaluation of the above expression for present day off-the-shelf microelectronic amplifier performance, consider the Sprague Wideband Amplifier whose parameters are: Bandwidth, 10^7 c/s; gain, 250; and supply power, 0.15 watts (Interim Engineering Report, Contract No. AF 33(657-8785). The F number for this circuit is approximately 1×10^9 or about 7 orders of magnitude below the theoretical limit, but by current standards this circuit falls within the broad family generally referred to as microelectronics.

Equipped with this reference for comparing microcircuits, it becomes apparent that present available circuits are far from the limit predicted by theory. The cause for such low figures of merit are many, varied, and in general, complex. The problem areas involved divide themselves quite naturally into three problem groups; (1) active elements, (2) passive elements, and (3) interconnection techniques. These areas will be discussed separately in following sections.

IV. Active Elements

1. General

High frequency micropower transistors are not presently available. Realization of such devices will require advancing technology past its present highly sophisticated state. Present technology can, however, develop devices which exhibit these desirable characteristics separately (i.e., either low power or high frequency performance) by using the most advanced methods. These methods have yielded commercial high frequency transistors such as the Fairchild 2N3563. Also very low power devices have been produced for operation at low frequencies (CBS Laboratories, Motorola, Sperry, etc.).

The Fairchild 2N3563 is a high frequency transistor which exhibits high gain (max. 200, min. 20) to an f_T of 900 Mc (f_T is the frequency at which the device gain in a common emitter circuit configuration falls to one). The required bias current is 5 ma however. In this unit, high frequency operation is achieved by utilizing relatively high power. Motorola, on the other hand, has achieved low power operation at lower frequencies. Item 3 shows gain versus collector current for the 2N2219 experimental transistor. Here reasonable gain is achieved at current levels of less than 100 nanoamperes. The f_T frequency

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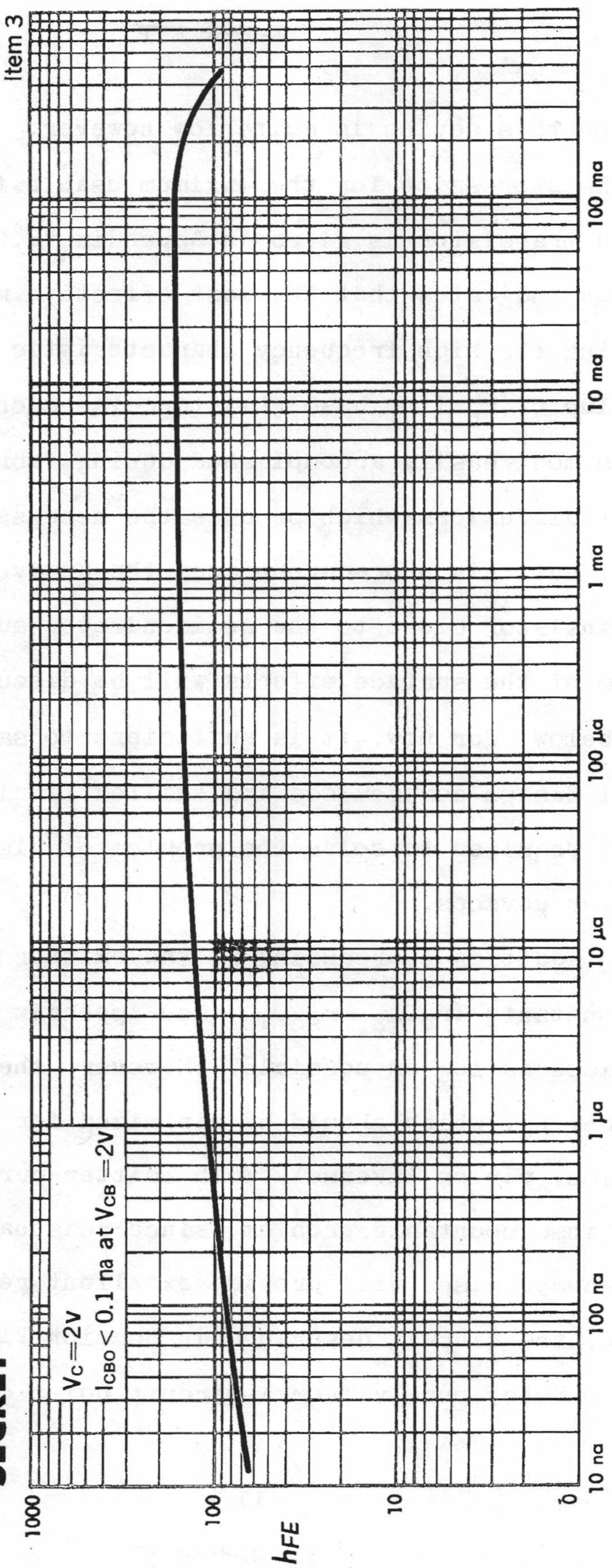
Item 3



I_C Collector Current 2N2219 (#2)

h_{FE} vs I_C

Motorola 2N2219

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limit on this device is quite low however.

The expression for the maximum usable frequency for a given transistor is given in Appendix "B." This expression indicates that the most effective means for improving the high frequency characteristic is to reduce the value of r_b' (the base resistance)as much as possible. This is most easily accomplished during fabrication by shallow diffusions which produce the necessary high impurity levels, but this procedure places the active portion of the transistor close to the semiconductor surface. The problem of the surface effects will be discussed more fully below; for now, it is sufficient to say that very careful design compromises and skilled fabrication methods will be required to solve the problem of high frequency, low power devices.

In addition to reducing r_b' the emitter and collector time constants ($r_e C_{Te}$, $r_{sc} C_{Te}$)(see Appendix "B") should be maintained as low as possible. However, the emitter resistance, r_e, which should be minimized for low power operation, varies inversely with emitter current. This is not an insurmountable problem, since reasonable engineering design compromises will provide excellent results, see, for example, the circuit described in Section VI. Another point to note, purely from a circuit point of view, is that an increase in the emitter resistance, which is essentially the input resistance to the device, requires an increase in matching resistance. This constraint has some important, practical implications which are discussed in Section V, under Resistors.

The capacitances C_{Te} and C_{Tc} should also be minimized to realize high values of f_{max}. The collector capacitance is most effectively reduced by scaling to extremely small sizes. There is a limit to the permitted scale reductions, however, since the base resistance r_b' can be adversely affected by severe geometry constrictions. C_{Te} requires strict control of impurity concentrations at the emitter-base junction. Furthermore, C_{Te} is functionally dependent on the potential gradients $|\phi_o - V|$ (where ϕ_o is the built-in junction potential and V the applied voltage). (See Appendix "B")

The above mentioned items, in addition to the other parameters, can be adjusted to yield maximum frequencies which exceed 1 Gc. Problems arise, as previously indicated, in trying to incorporate micropower operation with high frequency performance. The reason for this is partially apparent from the f_{max} expression. A less apparent aspect of the problem, mentioned briefly before, is that the surface character of the semiconductor begins to dominate its performance in high frequency, low power operation. Before considering the combined problem, surface concepts will be discussed briefly.

2. Surface effects

Simply expressed, the surface is the termination of the periodic lattice structure. As such, it would be expected to have vastly different characteristics than the regular atomic structure of the bulk material and, in fact, it does. Shockley predicted that additional energy levels, or surface states, would be present due to the lattice termination, the presence of oxides, and absorbed chemical species. This prediction proved to be quite true.

The surface states, acting as electron donors and acceptors, result in the bending of the energy bands and the creation of local space charge regions just at the surface. These regions modify the surface conductivity and recombination rates, thus adversely affecting ideal p-n junction operation. It is because of these surface effects that current gain falls off at low currents. Item 4 illustrates the type of falloff to be expected at low currents when no particular precautions have been taken to ensure low current operation. (See also Item 5 for tabulated data from another source.)

Other problems also arise because of these surface states. These include channel currents, junction area

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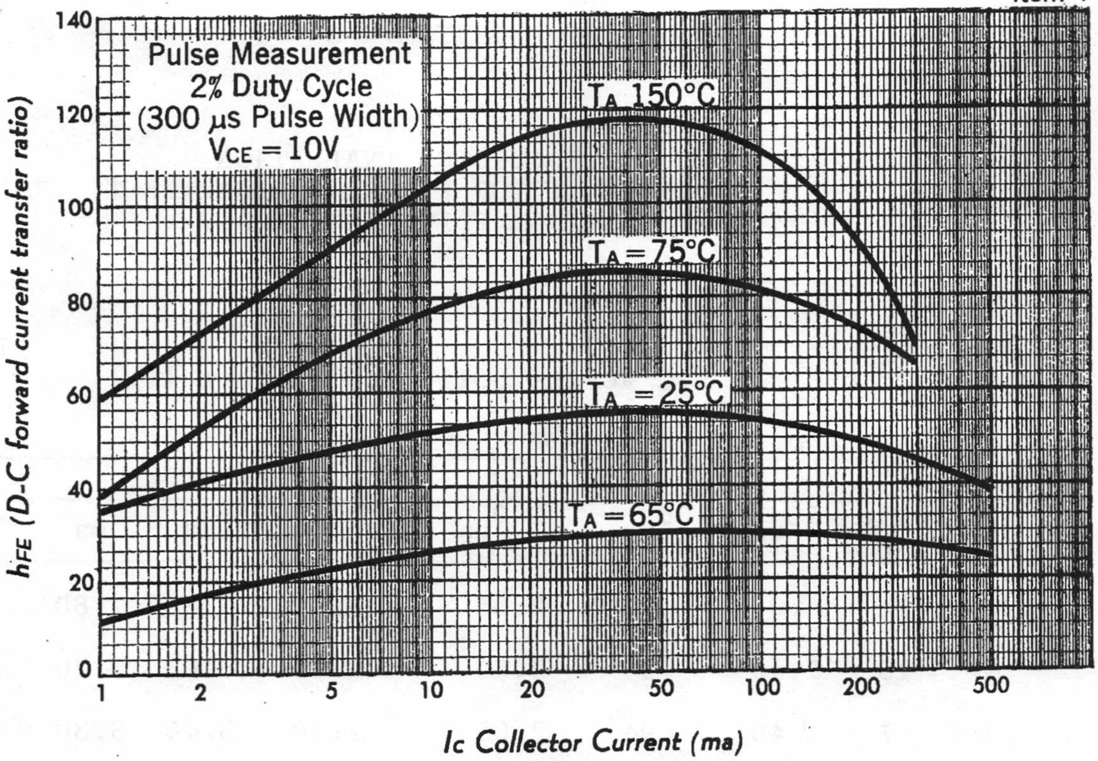
Item 4



Texas Instrument 2N697 Transistor

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ITEM - 5

TRANSISTOR EVALUATION
SEMICONDUCTOR PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
(2N918)

h_{fe} versus collector current (I_c)

	I_c							
Unit No.	10 ua	50 ua	200 ua	1 ma	3 ma	4 ma	5 ma	6 ma
14	.80	.93	2.55	6.40	7.80	7.80	7.40	6.50
18	1.40	.8	2.50	6.60	8.00	8.20	8.00	7.40
7	.40	.94	2.95	7.50	8.40	6.30	2.45	
17	.60	.92	2.90	7.70	8.90	7.90	5.50	

Conditions: V_{ce} = 5V

f = 100 mc

distortion, leakage currents, and electrical parameter change with age. The problem of transistor noise can also be traced in part to the surface. Although the much discussed $^1/f$ noise question is not completely settled, much evidence connects it with surface associated problems.

3. Surface Problem Areas

A considerable amount of R&D work has been done in controlling the surface properties and some very promising results have been obtained. The experimental Motorola transistor shown in Item 3 was produced by careful surface control. These characteristics when compared with the Texas Instruments 2N697 (standard production equivalent) in Item 6 demonstrate the gains that can be achieved through careful control of surface effects. Although these results are encouraging, the problem is by no means under complete control.

Some of the problem areas that should receive attention in the future efforts are:

a. Effects of surface defects. The interaction of these defects with device parameters is not presently well-known.

b. Oxide charge formation and its distribution. The effect of the distribution on the surface states.

c. Effects of metallic and other fast moving species at the silicon surface and in the oxide.

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Item 6

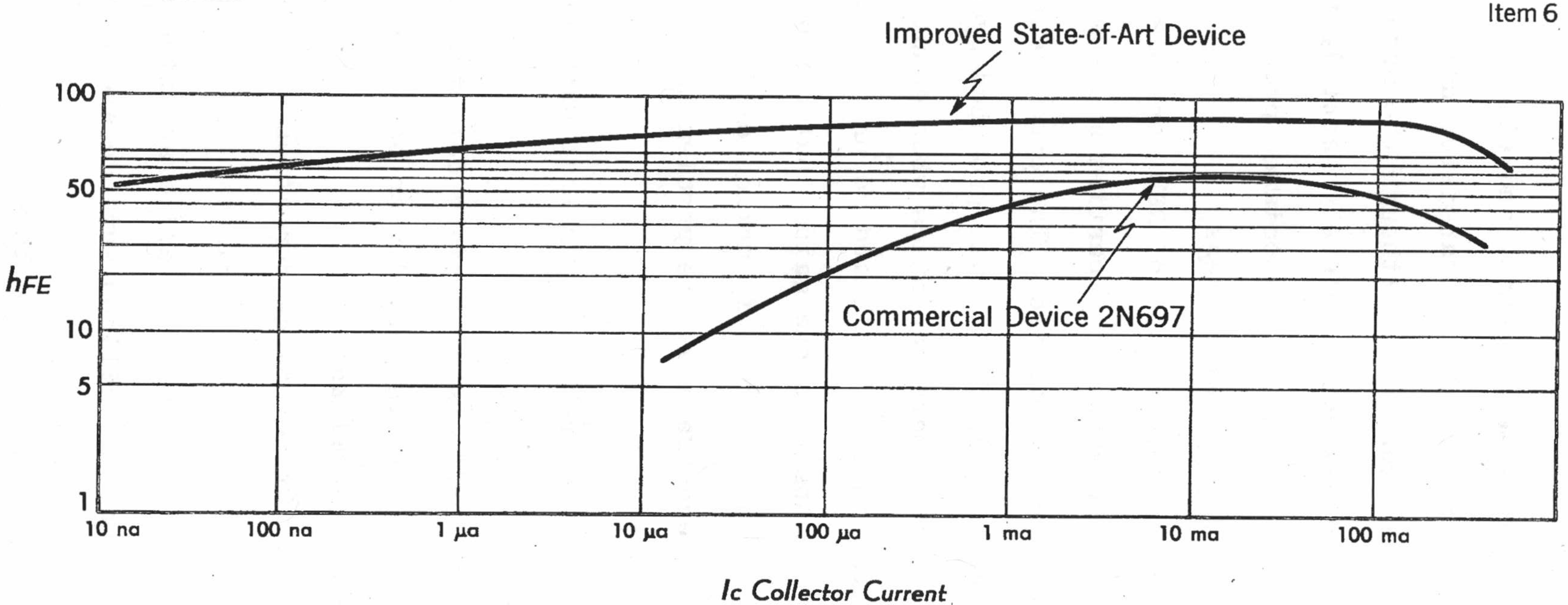

Illustration of Active Device Performance Improvement Attainable by Latest Technology

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This list is not to be considered to be complete by any means but merely indicates the scope of fundamental work required.

4. Total Problem

Returning to the primary task of combining high frequency and low power operation in one device, we see that one of the major problems will be surface control. Shallow diffusions will be required for the high frequency operation; however, this causes the surface condition to dominate the transistor. When surface conditions control transistor action, the classical function theory no longer applies. The more apparent solutions to improvement in performance of surface dominated devices involves extremely careful surface control. Strict control in chemical processing has provided a substantial portion of the surface improvement required, but the degree of control demanded and the additional improvements desired, necessitates a considerably greater R&D effort.

Geometry scaling has also provided good results in improvement of frequency response and power efficiency. This is an area where additional progress can be expected. As an example of what improvement in geometry can afford, recall, for example, the technological advance derived from the development of the planar technology as compared to earlier transistor configurations.

Surface control and geometry are the two most readily apparent methods of improving present devices; however, other variations of transistor first principles deserve consideration as well. Different host materials might be considered and, in fact, much work is going on along these lines (e.g., GaAs). Also different impurities offer somewhat different characteristics as do different doping profiles. These and other less apparent variations need to be considered in the realization of the desired devices.

Specifically omitted from this discussion are the MOS, FET, and other recently developed devices. This has been done since they are not backed by the technology that conventional transistors are. Also these newer devices, in general, operate most satisfactorily at voltages which are considered high in this context. At the present it appears dubious that these items will be developed into truly micropower performance devices.

V. Passive Elements

1. Resistors

In microelectronics, the most widely used resistor arrangement is the thin film type. The fundamental reason for this is that the higher values of resistance are more easily obtained by this technique. Resistance values obtained from the thin film type range up to the thousands of ohms per square and, in general, exceed the diffused type by about an order of magnitude.

The resistance is given by $R = \frac{x\rho}{wd}$ where x is the path length, w the width, d the thickness, and ρ the sheet resistivity. The term ohms per square is obtained by considering x = w. Thus, the total resistance is increased by increasing the number of squares or the resistivity for a given d. Materials in general used today are nichrome (10-400 ohms/square), tantalum nitride (50-500 ohms/square) and Cermet (100-10,000 ohms/square).

In order to accommodate high resistance values, relatively large areas are required. Assuming spacing equal to the line width the total required area can be expressed as $A = 2R\, w^2/\rho$. Hence, the higher the required resistance, the larger the area. Higher resistivities are urgently needed for micropower circuits since the input resistance to micropower transistors varies inversely as collector current. Without these, the microsize concept will be defeated by the physical size of matching resistors alone.

The thin film resistor is beset by stray capacitances. Since the resistor is deposited on a protective oxide grown over the substrate, a distributed capacitance along its length is formed. An equivalent circuit would be similar to that of a distributed transmission line. The thin film resistor does, however, exhibit a considerably lower stray capacitance than that obtained from diffused semiconductor resistors of similar dimensions (largely since its dielectric separation will be thicker).

It should be pointed out that these passive elements offer no convenient means for adjusting resistor values. Those techniques that are available involve physically altering the structure in some manner. This is a one-way adjustment. Hence, it is of paramount importance to have good stability inherent in the element. Temperature coefficients as low as 20 parts per million have been reported. Careful circuit design can be employed in many cases to ensure that only differential changes between matched components are important.

The technology being discussed here offers tremendous advantages as far as versatility is concerned. The fabrication of passive elements is by-and-large independent of that of the transistors and diodes through the use of masking techniques. It is thus possible to optimize circuit design by the choice of passive element parameters. This will be more obvious as the discussion of passive elements continues.

2. Capacitors

The most immediate means of obtaining capacitance would be to employ the p-n junction since it is at the heart of semiconductor devices. To do this, however, would be to give up some of the versatility claimed above, since a diode would have to be fabricated for every capacitor. Another argument against its use in the present context would be that a bias voltage for operation is required, and the capacitance value would depend upon voltage. Therefore, junction capacitors will not be considered.

Thin film capacitors can be deposited on the same substrate as the transistor just as the resistor is. Two basic thin film configurations are in general use. One involves the deposition of both electrodes and the dielectric, while the other uses a doped portion of the substrate as one electrode. In either configuration, the single most important variable is the dielectric.

The dielectric must be chosen so that it can be put down by evaporation techniques and be compatible with the electrode both during and after its deposition. Silicon oxide is the most commonly used film-capacitor dielectric.

Its dielectric constant is 6.0, is strongly dependent upon deposition conditions, and can be reproduced to about only ±10%. Magnesium fluoride is one of the better dielectrics from a reproducibility point of view.

A need for more work in this area is evidenced by the demand for highly reproducible capacitance values. This is especially true since these elements again are not readily adjustable once fabricated. Temperature stability is also an important consideration in regard to capacitive elements. Mobile oxide ions are most troublesome in this respect and can give rise to serious performance variation.

3. Inductors

Inductors have not yielded to the microelectronic concept as have the other basic devices. Since these components almost certainly will be required in high frequency RF circuits, it is worthwhile to consider an example to illustrate the problem.

Ferrite toroids are widely used to confine the magnetic field to the core thereby reducing unwanted coupling. These toroids may have a diameter of 3/16 inch, and hence, an area of about 0.03 square inches. W. W. Gaertner, CBS Laboratories, has built an entire circuit containing four transistors and their associated thin film resistors in approximately 0.015 square inches of area. The approximate thickness of the coil and the substrate on which the amplifier resides are respectively 1/16" and 0.001". This represents a volume ratio (circuit function to coil) of about 100 to 1.

Coils are not presently amenable to any form of integration. Their use is generally avoided by utilizing active filters (active filters in a feedback arrangement or complex digital sampling networks which are comb filter equivalents).

VI. Circuit Realization

From what has been said it might be inferred that the problem is hopelessly complicated. This is not true and substantial improvement in the field can be realized by utilizing today's techniques. At the urging of ORD personnel, an experimental micropower circuit was built [redacted] (shown in Items 7 and 8).

(b)(1)
(b)(3) NatSecAct

The circuit, a cascode RF amplifier, represents some of the most advanced work available today. Circuit parameters are as follows: 200 Mc operating frequency, 22 Mc bandwidth, 13 db gain, power drain 200 μwatts, and a noise figure of 3.5 db. It is instructive to calculate the figure of merit for this circuit. The merit figure is about 5×10^{11} or approximately 4 or 5 orders of magnitude below the theoretical limit.

This circuit was constructed using discrete components and no advanced solid state isolation techniques were employed. Note particularly the use of inductors and recall the previously made comments concerning the size of these elements. Also note that in addition to low power drain that the circuit operates with a supply voltage of 1 volt.

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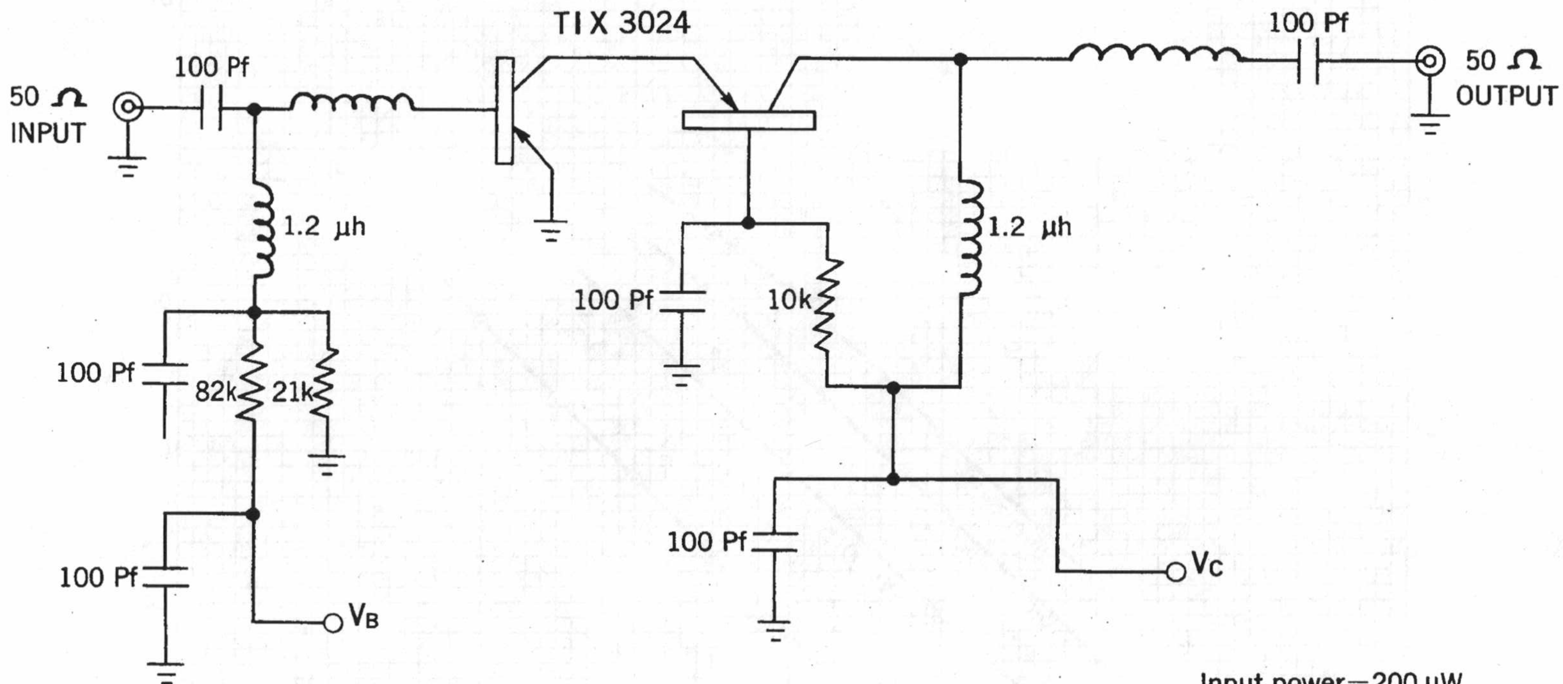
Item 7

195 mc Cascode Amplifier



Input power=200 µW
Power supply voltage=−1.0V
Power supply current=−200 µA
Center frequency=195 mc
Band width=22 mc
Power gain=12.9 db
Noise figure =3.5 db
150 Ω source

51954 8-65 CIA

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Item 8

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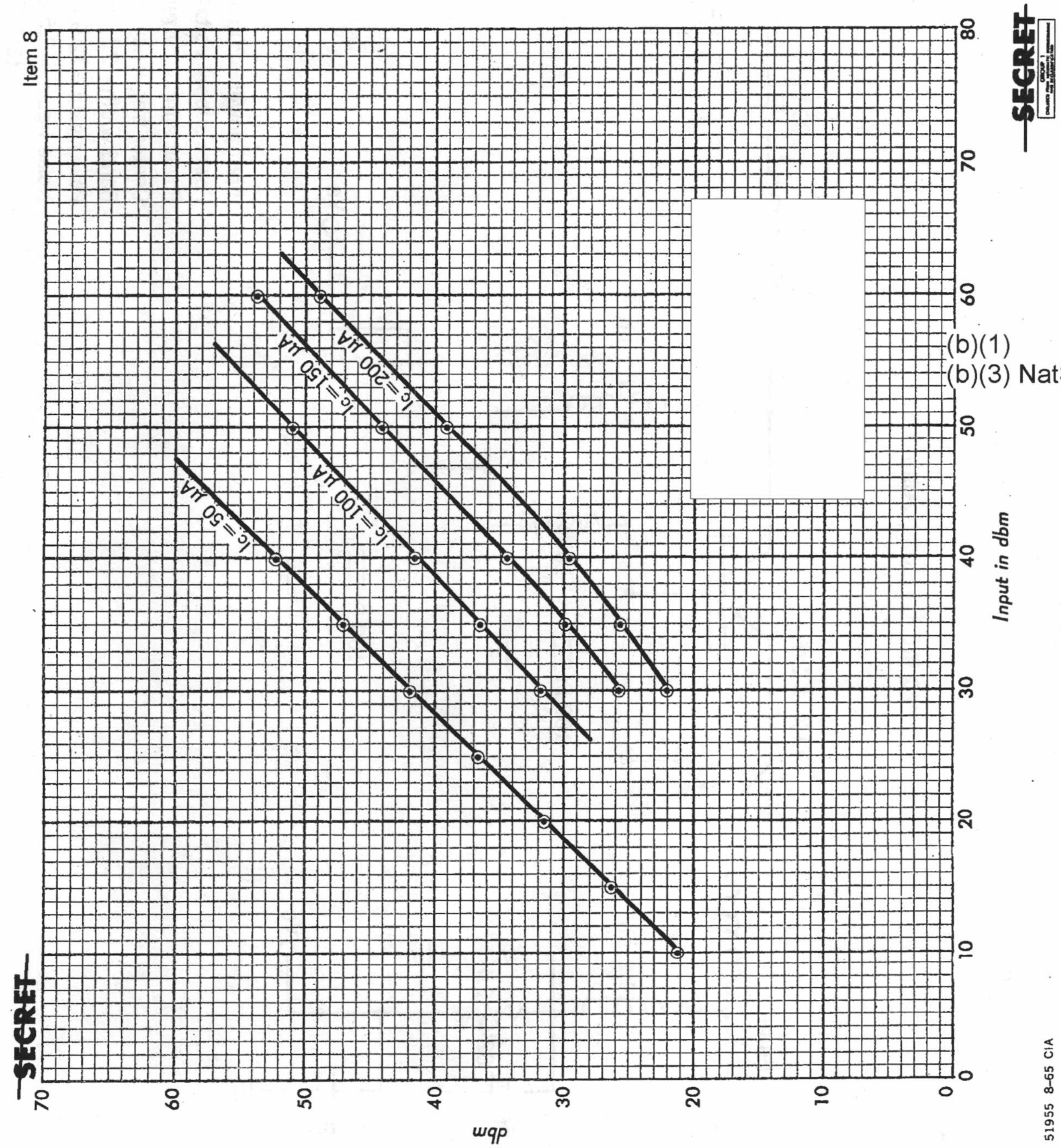

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VII. Isolation

1. General

Fully integrated circuits meeting reasonably low operating power requirements are unlikely with present technology. The alternative is the combination thin film integrated circuit (hybrid) discussed in connection with passive elements. Whichever type circuit is chosen, isolation will be a serious problem. Isolation is the process where circuit elements are separated electrically but hopefully remain in close physical proximity.

The type of circuits desired here contain parasitics at almost every juncture. Capacitive coupling to the substrate exists through the oxide separation as was previously mentioned. Inter-substrate coupling is also to be considered as is the magnetic coupling from inductors. To reduce parasitic effects, the physical layout of circuit elements must be made such that parasitics are either minimized or made part of the circuit parameters. The applicability of utilization of the parasitic capacitance depends to a large extent on the function being formed.

Coupling through the oxides is a difficult problem that requires thorough analysis and evaluation before fabrication. Because the oxide is in direct contact with the semiconductor substrate, mobile ions in the oxide will tend to interact with the surface states of the transistor. This interaction coupling can produce inversion layers and add to already complex surface problems if impurities are trapped within the oxide. Careful and controlled growth of these oxide layers is especially important when used in micropower applications.

2. Junction

Inter-substrate coupling has been dealt with by a number of techniques. The most common method is the reverse biased junction method. The method involves arranging the diffusions into the substrate such that back-to-back diodes exist between any two devices. The distinguishing aspect of this method is that the host crystal is utilized in achieving isolation. Care must be taken to avoid p-n-p-n actions.

3. Dielectric

Another method of isolation that has received considerable attention is the "dielectric isolation." In this method pockets of host crystals are grown such that they are separated by dielectric from the substrate crystal. Thus small islands are isolated from each other and the islands are used to form the devices.

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Discussions held with [redacted] on this subject revealed that this method of isolation provided small improvement over the junction method. The findings of the experimental program are given in detail in Appendix "C." It was found that a 10-20% improvement could be realized at the cost of developing proficiency in the necessary technology.

(b)(1)
(b)(3) NatSecAct

4. Beam Lead

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A more recent means of gaining isolation is the "Beam Lead" approach [redacted]. In this technique, the connections serve the dual purpose of mechanically supporting the devices and providing electrical continuity. Intervening material is removed. The concept is given in more detail in Items 9, 10, and 11. (Items 9 and 10 shown in Appendix "D.")

A sound experimental comparison of the Beam Lead method with the other types has not yet been reported. It is known, however, that other methods suffer at high frequencies and improved methods of obtaining the desired isolation are being actively sought.

It might be well at this point to mention the fully integrated circuit concept. From what has gone before, it can be appreciated that realization of the necessary elements (active and passive) low power, high frequency circuits is

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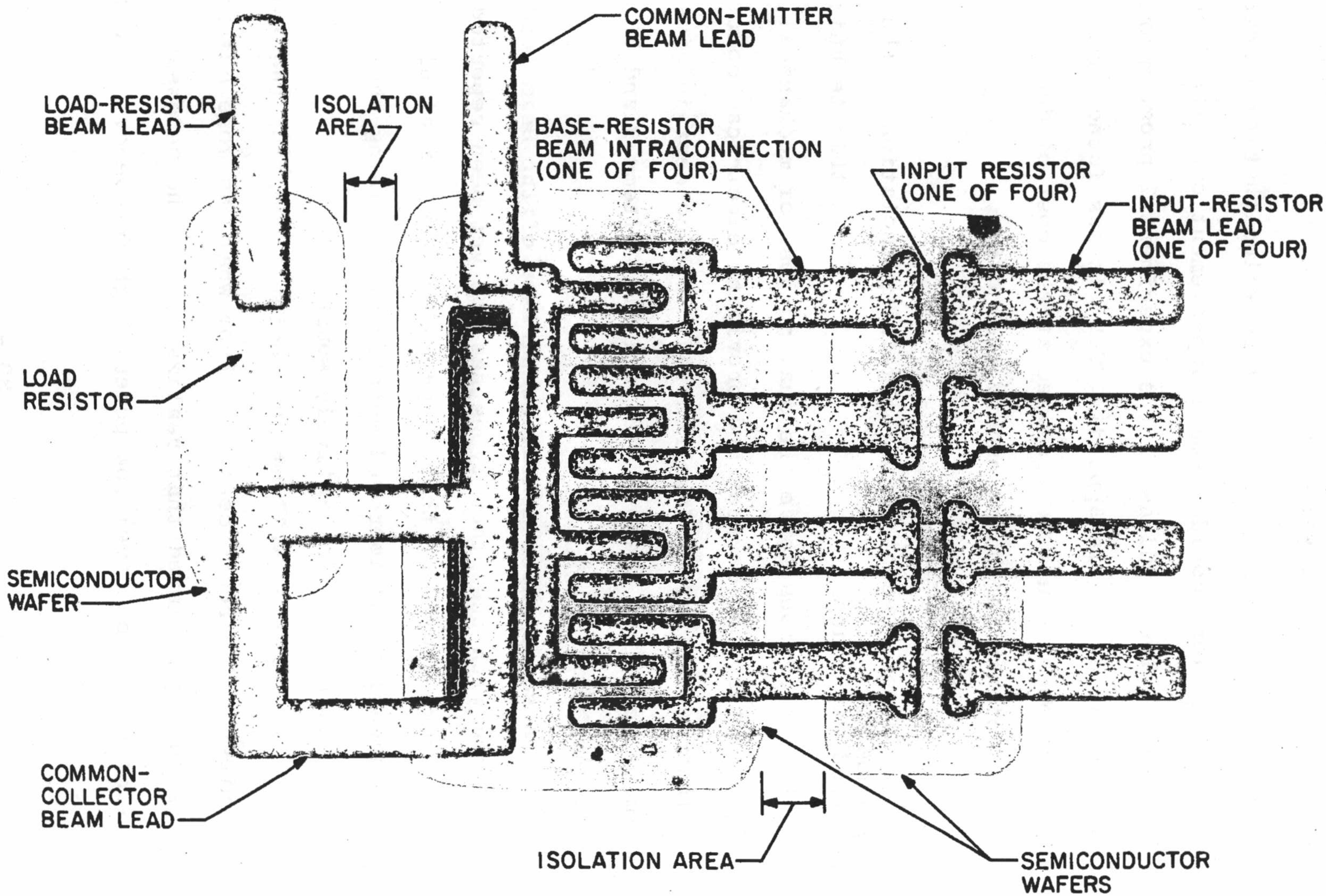
Item 11



Beam Lead Circuit Concept

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difficult. This is indeed the case, however, another serious problem is that of isolation. Item 12 shows the performance that was achieved [redacted] in an experimental, fully integrated, video amplifier. This circuit has a bandwidth of 30 Mc, however, it requires a relatively high supply voltage which is prohibitive from the micropower point of view.

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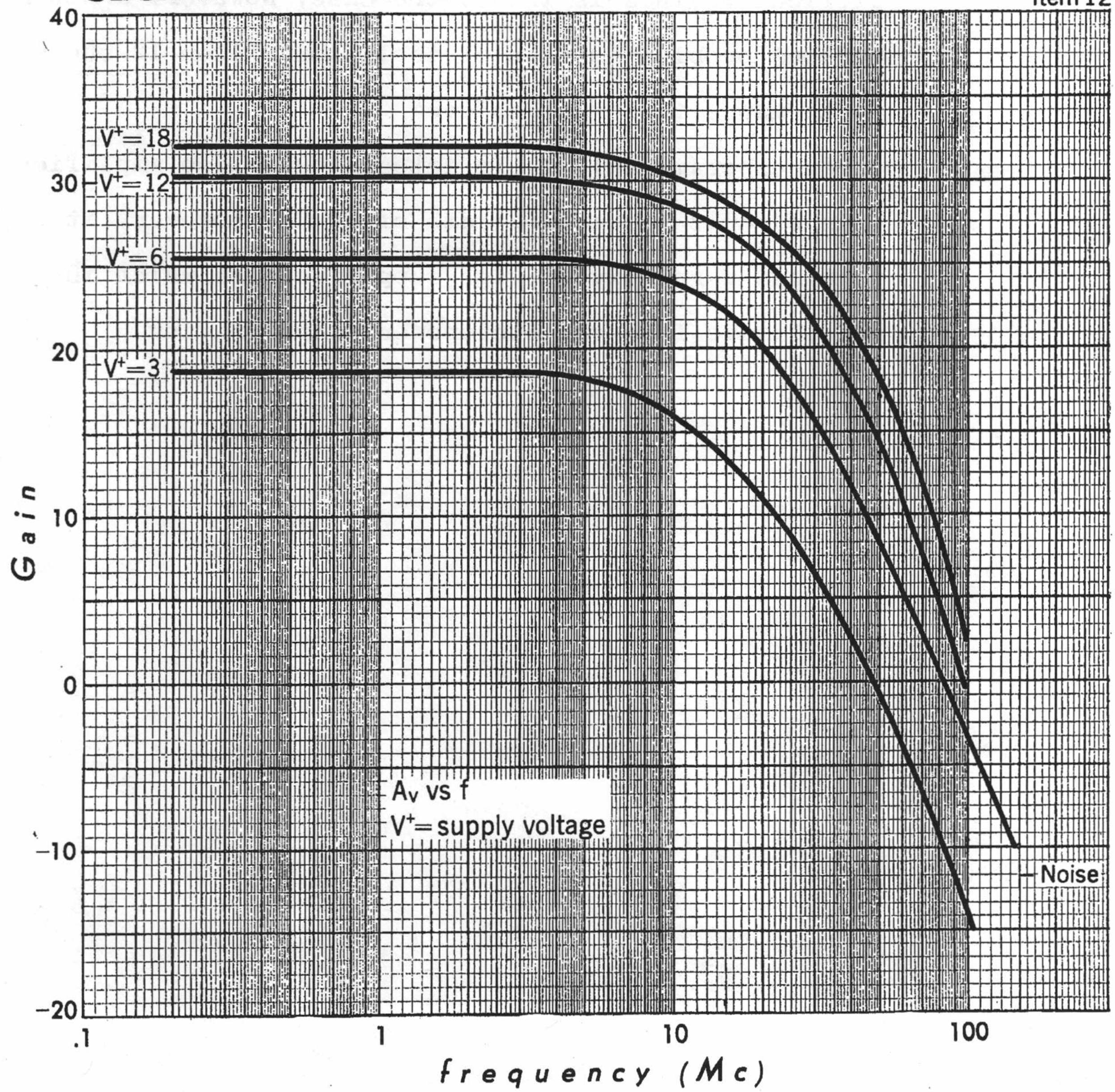
Item 12



[redacted] Integrated Amplifier

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VIII. Technological Goals

Apart from the requirements mentioned in other sections, general technological methods will have to be pushed beyond the present "state-of-the-art." Such things as optical resolution will require constant improvement to realize ultra-precise geometries. Along these specific lines various approaches may be taken.

One such approach is to use electron and/or ion beams to replace the conventional light source. This is necessary since the finite wavelength of light as derived from usual sources introduces too large an uncertainty in relation to the tolerances required here. CBS Laboratories, for one, is proceeding along these lines.

Careful alignment of various layers of material is a never ending problem as device and circuit size is reduced. This problem will become even more important as the density of functions is increased. One of the more novel, and yet unproven, technologically speaking, methods is the ion implantation method. This technique, however, is not developed to the point where it might be used for ultra-precise geometries.

Diffusion processes and epitaxial growth are the major structural methods in use today. Both of these methods have limits in the amount of impurity that may be placed in a specific area. Thin layer devices can be limited by this and by diffusion during some other required processing step. Low temperature epitaxial deposition methods are needed to overcome this problem. This requires that the chemistry and technology for catalyzing solid state surface reactions in the 200^{o} C - 700^{o} C range be developed. (Current conventional processing is carried out at temperatures in the order of 1200^{o} C.) Another area to be looked at closely is the etch process. For extremely small geometries, the uneven etch presently obtained can no longer be tolerated. The imperfections in the etched boundries of small devices would represent major portions of the device junctions.

Much work is also called for in evaluating thin film materials at high frequencies. These evaluations then need to be correlated with techniques for utilizing the materials. For example, silicon dioxide exhibits a linear dielectric coefficient to at least 25 Kmc. Other materials can be expected to have different functional relationships.

As technological methods improve it becomes obvious that the problems inherent in any form of micropower microelectronic circuit are vastly different from those of simple discrete devices. It is not possible to look at design concepts for any single device or even a single parameter. The overall problem must be treated. Realization of the micropower microelectronic concept will depend upon many different technologies.

IX. Summary

1. Conclusions

As a result of the previous discussions, it becomes quite clear that the semiconductor industry in general is not presently addressing itself to the problem of high frequency, low power circuit operation. However, a peripheral amount of experimental work has been done on various aspects of the problem. Item 13 illustrates low power developmental projects [redacted] for (b)(1) (b)(3) NatSecAct device that will provide high frequency gain and low noise figure. Also recall the low power work at CBS and Motorola mentioned previously.

Neglect of the combined problem, in part, stems from the required degree of conceptual and technological sophistication. There is little doubt that from a commercial point of view that at present the task is prohibitive. However, another part of the neglect of this area arises from a lack of user interest. Excellent results have been achieved by educating the proper personnel to micropower concepts.

Following micropower talks [redacted] (b)(1) (b)(3) NatSecAct during which emphasis was placed on the combined problem, the receiver in Item 14a was proposed. A 33% power drain reduction was predicted after further development as depicted

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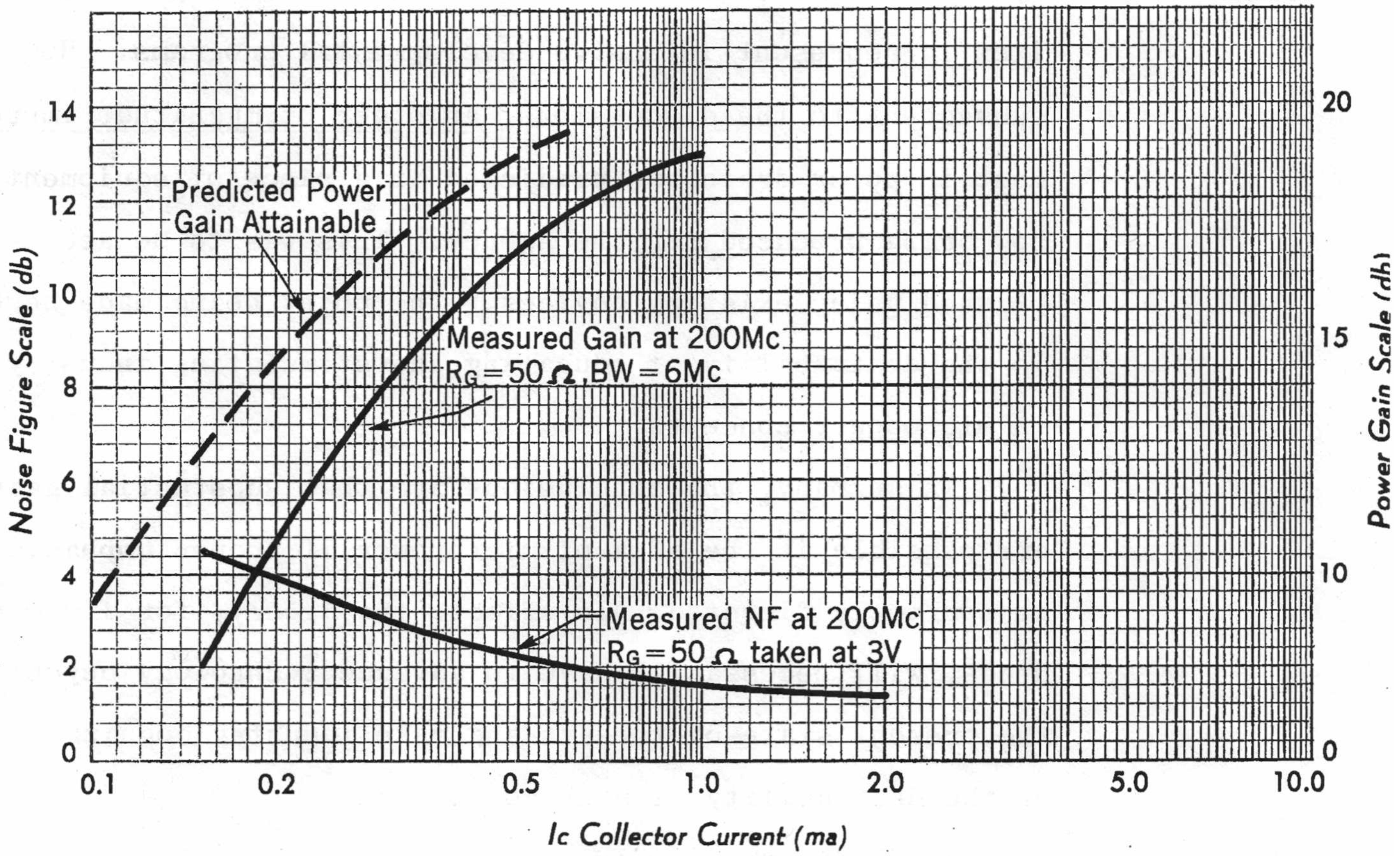
Item 13



Developmental Transistors

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by the comparison of 14b to a. Both receivers shown in Item 14 represent intensive developmental programs. However, subsequent to the discussions, an order of magnitude improvement in power drain was predicted in a piece of equipment now being produced for the Agency. This was to be accomplished using existing devices. The point being made here is the desirability of educating and stimulating industry in micropower concepts.

In summary, the conclusions are that substantial gains are possible in the area of micropower if proper emphasis is correctly directed. In effect, the Agency, for its own needs, will necessarily have to advance technology beyond the present state-of-the-art and make industry cognizant of the desirability of such goals.

2. Actions

At the request of DD/S&T, ARPA will be funding an extensive, long range program aimed toward achieving the micropower microelectronic technological goals set forth by AP/ORD.

To provide additional background for all interested groups, AP/ORD has arranged for a series of lectures by outstanding semiconductor scientists. These speakers will be chosen from select R&D groups in the semiconductor field who have definitive concepts on how to pursue the

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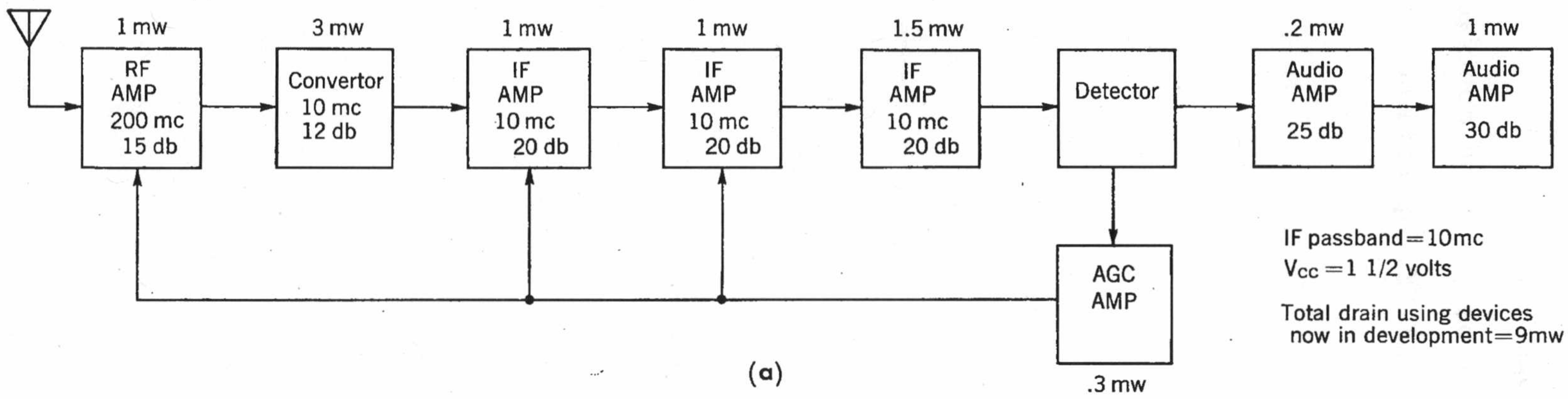
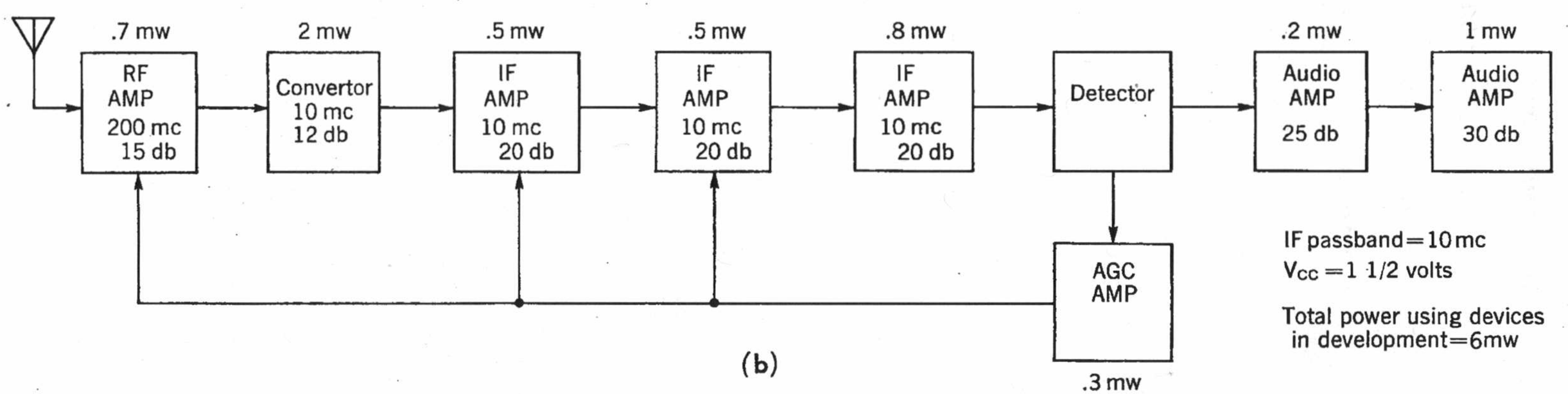
Item 14

VHF Receiver



(a)



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Experimental Receivers

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elusive goal of micropower operation.

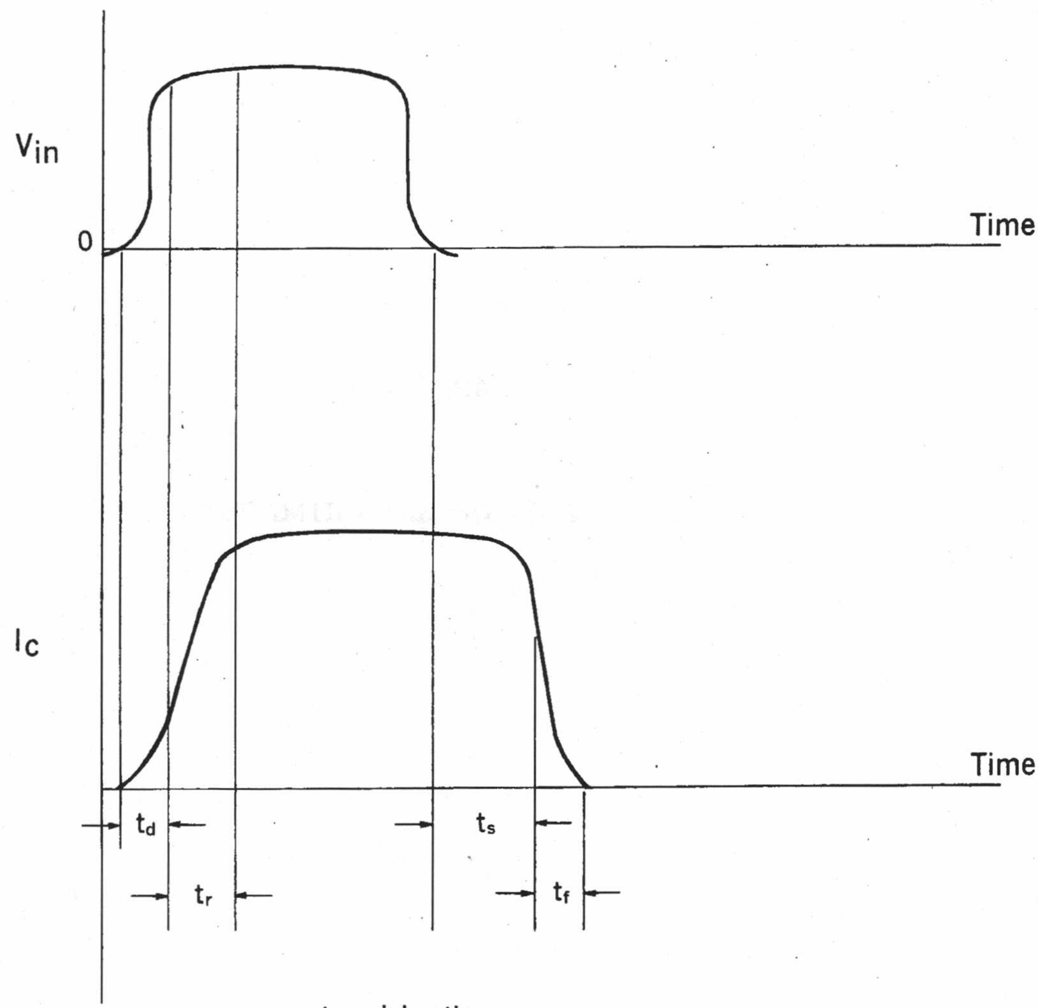
In addition, AP/ORD will be pursuing contract work in the advanced development of VHF-UHF operation micropower devices.

APPENDIX A

DEFINITION OF SWITCHING TIMES

Appendix A

Switching Time Definitions



t_d = delay time
t_r = rise time
t_s = storage time
t_f = fall time

APPENDIX B

EXPRESSION FOR MAXIMUM OPERATING FREQUENCY

APPENDIX B

EXPRESSION FOR MAXIMUM OPERATING FREQUENCY

$$f^2_{max} = \frac{1}{(4\pi)^2} \; \frac{\alpha_o}{r_b' \; C_c} \; \frac{1}{r_e C_{Te} + \frac{W^2}{5D_{pb}} + \frac{Xm}{2V_{sc}} + r_{sc} C_{Tc}}$$

o is the low frequency current gain

r_b' is the base resistance and proportional to resistivity divided by base width (ρ/W)

C_c is the collector junction capacitance and is the sum of the depletion layer capacitance plus diffusion capacitance.

r_e is the emitter resistance and inversely proportional to emitter current. $r_e = \frac{KT}{q} \; \frac{1}{I_E}$

C_{Te} is the emitter barrier capacitance and is a function of donar concentration, material, and the potential profiles.

$$C_{Te} = \left| \frac{qe \quad N_D}{2\,|\phi_o - V|} \right|^{\frac{1}{2}}$$

where,

N_D is the donar concentration in the base

W is the effective base width

D_{pd} is the diffusion constant in the base region

X_m is the depletion layer width

V_{sc} is the scattering limited velocity (8.5 x 10^6 cm/sec)

r_{sc} is the series resistance of the collector

C_{Tc} is the depletion layer capcitance of the collector junction

ϕ_o is the built-in emitter junction voltage

V is the applied emitter voltage

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APPENDIX D

ITEM 9

BEAM LEAD DESCRIPTION

W. P. Shvidrik
Bell Telephone Laboratories
(Oct. 29, 1964)

A new type of structure for semiconductor devices and circuits has been devised at Bell Telephone Laboratories. The structure uses strong electrical leads--called beam leads--to provide mechanical support for the semiconductor and to make electrical connections. This development is expected to simplify fabrication and assembly procedures for many types of semiconductor devices and circuits--including transistors, diodes, and integrated circuits. Electrical performance is equivalent to that achieved with present-day structures.

The development was described today at the IEEE Electron Devices Meeting in Washington, D.C., in two Bell Laboratories papers: "Beam-Lead Devices," by M. P. Lepselter and R. W. MacDonald, and "Beam-Leaded and Intraconnected Integrated Circuits," by M. P. Lepselter, H. A. Waggener, and R. E. Davis.

Beam leads are integral parts of devices and circuits and extend out from the structure like cantilever beams to form both the electrical and mechanical connection to a header or substrate. For integrated circuits, they also form the electrical intraconnections between components. The beam-leads are made of gold and are approximately 10 microns or 4/10,000 of an inch thick.

One of the main features of beam-lead integrated circuits is the simple way in which electrical isolation of components is accomplished; all unwanted material between components is removed at the same time that individual circuits are being separated. The beam-lead intra-connections are then left to support and electrically connect the components. Unlike other techniques in use today, no additional diffusion or processing steps are required to isolate components; the beam-lead structure provides isolation as a bonus. Parasitic capacitance between components is negligible, making beam-lead integrated circuits suitable for ultrahigh-speed switching applications.

Another feature of the beam-lead structure is that semiconductor wafers or "chips"--which may contain either single devices or entire circuits--can now be connected directly to headers by beam-leads. Previously, semiconductor wafers were first bonded to the header to keep them in place, and then extremely fine wires were individually connected to circuit elements on the wafer; these two steps are unnecessary with beam-lead devices or circuits.

Diodes, moderate and ultrahigh-speed transistors, and ultrahigh-speed logic circuits have been built and tested at Bell Laboratories. These beam-lead devices and circuits have indicated their physical ruggedness by successfully passing tests which include thermal aging in 360°C steam and centrifuging to greater than 100,000 times the force of gravity.

ADDITIONAL INFORMATION

Features of the Beam-Lead Structure

1. Simple Assembly

   a. eliminates brazing of semiconductor chip to header substrate

   b. eliminates internal wires for making electrical connections -- beam-leads are built into the structure of devices or circuits

   c. heating of the circuit as a whole is not required to make electrical connection -- beam-leads can be connected by thermo-compression bonding or various types of welding

   d. beam-leads are precisely oriented with respect to each other -- for example, all three leads from a transistor can be positioned and connected at one time.

2. Rugged Structure

   a. withstands centrifuging to greater than 100,000 times the force of gravity -- this tests the adhesion of the beam-lead to the semiconductor device or circuit, the tensile strength of the beam-lead itself, and the bonding of the beam-lead to the header

   b. corrosion resistant -- beam-leads have been thermally aged in 360°C steam for 1000 hours without failure

c. flexibility -- beam-leads withstand twenty 90° bends without failure.

3. <u>No Electrical Penalties</u>

a. electrical performance is at least equivalent to present semiconductor devices and circuits

b. integrated circuits can be made from conventional epitaxial material such as used in making single devices.

4. <u>Different Shaped Leads Possible</u>

a. tapered beam-leads can be used to make smooth impedance matches

b. wide beam-leads can be used as heat sinks.

5. <u>Multiple Arrays Possible</u>

devices or circuits can be fabricated in arrays, connected together by beam-leads, for easy handling or testing -- it is not necessary to handle the semiconductor chip itself.

6. <u>Good Isolation for Integrated Circuits</u>

a. good electrical isolation is easily achieved

b. parasitic capacitance is negligible.

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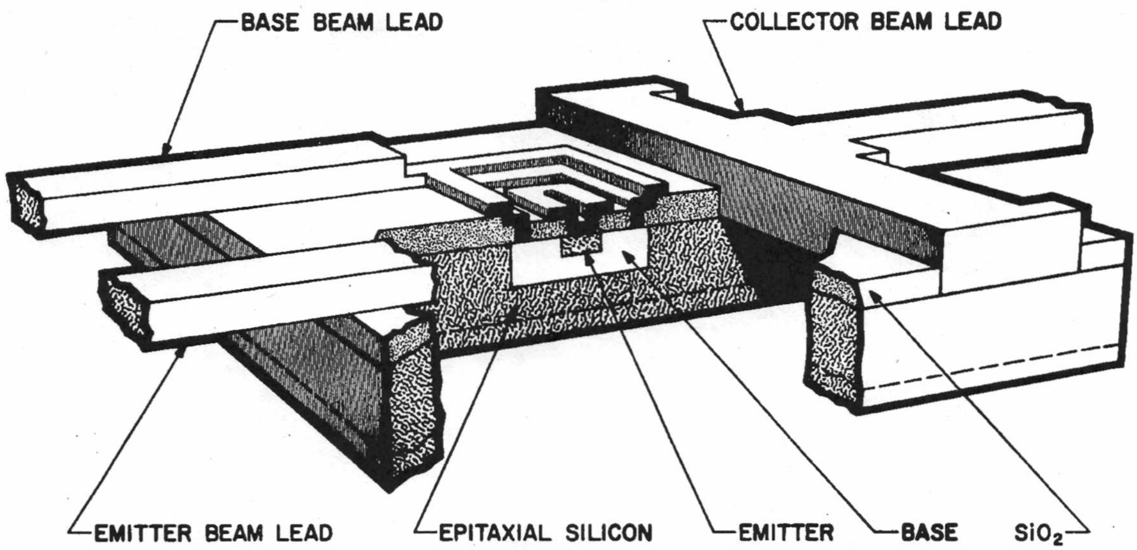
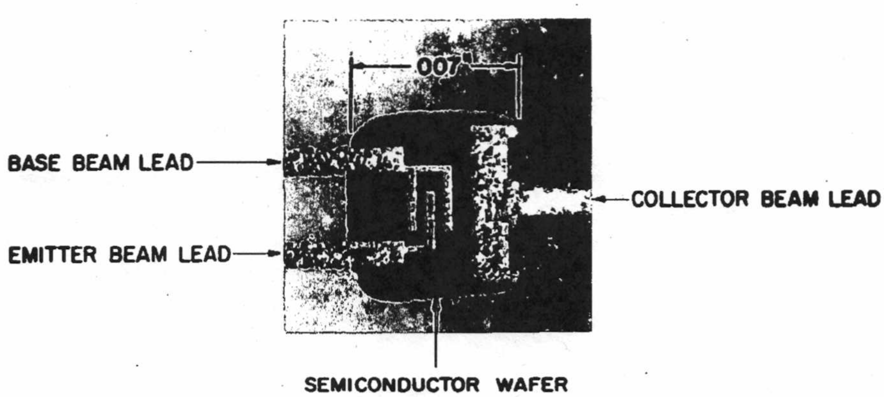
Item 10





Beam Lead Concept and Realization

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by

Members of ORD Staff
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December 1972

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for Carl E. Duckett
Director for
Science and Technology

HISTORICAL STAFF
CENTRAL INTELLIGENCE AGENCY

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OFFICE OF RESEARCH AND DEVELOPMENT
1962-1970*

Volume III - Contents

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*Cut-off date for Monographs in Volume III is 1968.

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MONOGRAPH NO. 13

Approved for Release: 2022/01/31 C06767620

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Remote Crop Yield Determination

by

James P. Lynch
Biological Sciences Division

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Remote Crop Yield Determination

by

James P. Lynch
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One of the most critical problems facing the Communist world is providing their populations with an adequate supply of food. Production setbacks and a continued increase in population have seriously dampened economic growth in recent years. Recent agricultural problems have forced the Communists to spend an average of more than $1 billion a year for the past three years to purchase grain from the West. These purchases of grain have placed a serious strain on Communist reserves of gold and foreign exchange. Undoubtedly, such setbacks and deficiencies influence considerably the domestic politics and economics of Communist countries and, indirectly, the policies and expenditures associated with exporting Communism to smaller nations.

The leaders of the Communist countries now realize that agriculture must be accorded a higher priority than in the past, even though this may mean some diversion of investment funds from defense and heavy industry. The record agricultural output in the USSR in 1966 reflects, in part, the improved priority allocated to agriculture.

The collection of intelligence on agricultural production within the Communist Bloc is certainly a worthwhile intelligence objective. Current yield estimates are made using a variety of sources of information, such as detailed weather information, reports from the press, [redacted]

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[redacted] For the USSR, estimates of grain production are based on figures obtained for earlier years when crop and weather conditions in the different regions were similar to those prevailing the year in question. In any event, the intelligence analyst faces very difficult problems when he attempts to evaluate the current agricultural situation in these countries. His sources of information are inadequate and his estimating procedures much less refined than desirable.

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A research program [redacted] was initiated in FY 65 to determine the operational feasibility of providing reliable yield determination for crops through the use of high altitude, multi-spectral, small scale aerial photography. This project was co-monitored by the Biological Sciences and the Optics Divisions.

The scientific premise upon which the program is based is that light reflectivity and, consequently, the photographic characteristics of a plant are influenced by the condition or vigor of that plant. The ultimate objective [redacted] is to develop crop photography techniques which are compatible with current satellite operations.

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Earlier investigations [redacted] clearly demonstrated that yield influencing factors can be detected and identified using photographic techniques. Additionally, he demonstrated that certain factors will express themselves much earlier on properly obtained photography than can be determined by

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experts in the field. The expression of yield influencing factors on photography as viewed by the photointerpreter is a function of the factor itself. Photographic signatures of crop vigor range from the obvious, such as that caused by physical disruption (hurricanes, floods, poor seeding, low seedling survival), to the more subtle signature as, for example, tonal variations on the photography due to physiological disruptions (disease, soil toxicity, mineral deficiency, drought). [redacted] (b)(1) (b)(3) NatSecAct

(b)(1) (b)(3) NatSecAct [redacted] is the first attempt to correlate these photographic signatures to crop yield.

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The objectives of the first year's effort were to define the factors which influence the yield of rice, sugar cane, and wheat; the period when these factors can be recorded photographically; the degree and accuracy to which these factors can be identified on the aerial photography at various periods during the growth cycle of the crop; the optimum spectral bands for identification of these factors; and the precision with which these data can be used to perform yield estimates.

In FY 65 sequential and simultaneous aerial photography was (b)(1) (b)(3) NatSecAct collectively obtained for whea [redacted] (b)(1) (b)(3) NatSecAct [redacted] and sugar cane [redacted] [redacted] under both controlled and uncontrolled

(b)(1) (b)(3) NatSecAct (b)(1) (b)(3) NatSecAct growing conditions. Additionally, the crops were grown below a 150 ft. water tower with a camera station located at the top of the tower. Due to equipment limitations, flight altitudes were confined during the test flights between 5,000 and 20,000 feet, restricting the evaluation of atmospheric effects on high altitude operations. Selective photography was obtained at lower altitudes than 5,000 ft. to establish ground truth data at times when appropriate. The range of photographic scale factors was from 1:20,000 to 1:300,000. Imagery was obtained in various portions of the spectrum from 520 mu to 900 mu in 6-80 mu cuts. Color, infrared, panchromatic and camouflage detection (color infrared) films were employed during the program.

The reduction and correlation of the data extracted from the aerial photographs taken of the agricultural crops during the FY 65 program was based on the scientific premise that each crop area planted has a potential yield of producing the maximum yield for that crop in the region being studied. This enables the preparation of a particular crop yield estimate by area, even before that area is planted. Starting at the planting date, all factors which influence or contribute to gross crop yields are considered and reviewed, and formulae prepared to reduce that maximum yield potential by a degree corresponding to factors observed on the photograph. The selection of the potential yield therefore becomes of primary importance as all yield estimates are derived from this figure. The potential yield is defined as that amount of yield which would be produced if all yield influencing factors were at the most favorable level for the region concerned. Thus, each region will have potential yield for a particular crop, and reduction in the potential yield is prepared from factors observed on the photograph, or known from other external data sources such as weather conditions, variety planted, and [redacted] ground truth information.

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The general results derived from the 1965 program indicate the feasibility of obtaining by remote photography a measure of crop yield through the application of selective film/filter combination and photo-interpretation techniques. The techniques used for data collection and correlation and yield analysis generally have permitted accuracies (in estimated yield compared to actual yield) of 3-6% error. In stating this accuracy, it must be emphasized that this degree of precision was obtained under very closely controlled experimental conditions, coupled with considerable low level ground truth photo coverage. Without question, the accuracy of predicted yield values increased measurably with the acquisition of repetitive or sequential photography.

Phase II was intended to exploit the results of the Phase I feasibility tests performed in 1965 in which it was shown that crop yield estimates can be made accurate to as little as 3-6% error, from multi-spectral aerial photography obtained under carefully controlled conditions. The period of the contract, [redacted] in FY 66, was 18 months [redacted].

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The objectives of the 1966 [redacted] program were twofold and directed toward development of a consistent set of techniques and procedures for reliable crop yield prediction based on imagery of commercially grown crops, i.e., under comparatively uncontrolled conditions. The first of these objectives was to determine the prediction reliability or accuracy as a function of variation in data collection and reduction parameters. The purpose of this objective was to determine which of the many indicators or observational procedures developed during the 1965 program were the most significant in predicting yield and what were the effects on accuracy of prediction when any or all of the most significant data collection procedures varied from the controlled experimental conditions of the 65 program.

Prediction accuracies as a function of sample frequency, sample size, scale factor, and altitude were determined. The importance of these determinations is self-evident as eventual operational use of the prediction techniques cannot be expected to occur under the carefully controlled conditions inherent in an experimental program.

A second objective was the development of photographic specifications and data reduction procedures for use in defining operational system requirements. The purpose of this second objective is evident in that such data collection programs and yield predictions will ultimately be conducted by operational personnel and therefore a formal formulation of procedures and specifications must be prepared to assist in the definition of such operational programs.

The basic flight operations were similar to those conducted in 1965. Data was collected for the three primary crops of interest, wheat, rice, and sugar. The schedule of photography was planned at a higher frequency than 1965 to provide sufficient data to assess the optimum time(s) of photography for each crop. A flight schedule of one every two weeks was conducted for the 1966 tests as opposed to the one flight per month schedule maintained during 1965. Rice crops were surveyed in the [redacted] (b)(1) (b)(3) NatSecAct [redacted] (b)(1) (b)(3) NatSecAct (b)(3) CIAAct sugar cane in [redacted] and wheat in the [redacted] (b)(1) (b)(3) NatSecAct Film/filter combinations employed during 1966 were similar to those of 1965. (b)(1) (b)(3) NatSecAct (b)(3) CIAAct In most cases the altitude did not exceed 20,000 feet. However, in one instance, a U-2 reconnaissance aircraft obtained a limited amount of photography of one of the test areas at a higher altitude. The purpose of this flight was to test the validity of basing our developmental program on low altitude, simulated, small-scale photography. Preliminary spectral correlations between high altitude and low altitude photography were conducted.

In addition to flights over the [redacted] (b)(1) (b)(3) NatSecAct test areas, several multi-spectral flights were conducted over the wheat rust production fields located [redacted] (b)(1) (b)(3) NatSecAct (b)(3) CIAAct These flights were conducted to obtain imagery of fields expressing symptoms of the wheat rust disease, a definite yield reducing factor of wheat in many parts of the world.

The interpretation techniques used in this phase were those developed during the 1965 program. These techniques essentially involved analysis of the photo images to determine the extent of various crop yield limiting factors, the severity of these factors, the time when each occurs and the resultant yield reduction. The development of photointerpretation keys and a statistical analysis program were also undertaken during this period.

While the complete data reduction and reporting effort on the 1966 program have not been completed as of this writing, a number of conclusions can be drawn from the current results. Low level large scale coverage permits the determination of individual causes of yield reduction, i.e., differing types of disease, chlorosis due to soil condition, drought, etc. Thus, each causative factor may be evaluated separately and the total reduction computed with good accuracy. At high altitudes and/or small scales, these factors cannot be exclusively defined and separated, hence a degree of empiricism enters into the data reduction process. Interpretation of high altitude imagery has been found to require more subtle treatment in order to obtain high prediction accuracies.

One element of consistency has remained through the 1965 and 1966 programs, and that concerns those parts of the photographic spectrum most useful to the overall prediction problem. Camouflage detection (CD) film is the most valuable for rapid monitoring of a crop's health and, once the yield reducing factors are suspected, the black and white film/filter combinations are the most valuable for individual factor discrimination.

Another useful output of the 1966 program has been the verification that the various tone signatures of interest to predicting crop yields are

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effectively independent of altitude once the aircraft has exceeded 20,000 feet. In summary, the 1966 program has, to a considerable extent, bridged the gap between controlled feasibility studies and operational prediction over large commercial producing regions. It was to this latter purpose that the follow-on work for FY 1967 was proposed.

The 1967 program was based upon the selection of wheat as the test [redacted]

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The basic objective of the 1967 [redacted] program is to validate recommended operational acquisition techniques, data reduction procedures and system parameters required to develop a yield prediction capability for a major national food crop against a set of uncontrolled crop growing conditions covering a broad geographic area.

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-2 overflights are to be undertaken of selected sections [redacted] at selected times throughout the 1967 growing cycle of wheat, and aerial photography obtained. Additionally, photography of the [redacted] will be obtained en route [redacted]

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From the photographs obtained during the individual flights, yield prediction factors and annual production harvest estimates will be developed for the entire state without benefit or recourse to any ground truth information; subsequently, these yield predictions will be compared with independently obtained crop data on actual yields, comparative analyses made, and operational photointerpretation keys and data reduction procedures developed.

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Using these latter procedures, a statistical computation program will then be carried out to determine the optimum selection of sample size and distribution for given levels of prediction accuracy.

The first U-2 flight took place 16 June 1967. The results of this and subsequent flights were not available at the time of this writing. (b)(1) (b)(3) NatSecAct

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MONOGRAPH NO. 14

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Operational Use of Biological Systems

(Animal Systems)

by

[redacted] (b)(3) CIAAct (b)(6)

Biological Sciences Division

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Operational Use of Biological Systems

(Animal Systems)

by

[redacted] (b)(3) CIAAct (b)(6)

Biological Sciences Division

The charter of the Biological Sciences Division encompasses a much broader area than is indicated by the title of this monograph. In addition to the utilization of the whole animal as a component of an intelligence system, the role of the organization also includes the area of Bionics, which has been defined as the study and development of mechanical and electronic analogues of biologic systems. In addition, the Biological Sciences Division is also concerned with the utilization of the unique sensory capabilities of living organisms for the identification, analysis, and quantification of data relevant to the intelligence community.

However, recognizing the diverse contributions of biological systems to the intelligence area, this monograph will be concerned with the operational use of intact whole organisms (birds, dogs, dolphin, etc.) as components of systems designed to enhance the efficiency of intelligence collection and accomplishment of other Agency goals.

Although recognizing the sensitivity of various biological organisms to detect, collect, and provide intelligence data to the user, bio-systems may also perform various useful clandestine activities. The biological contribution is merely one component of a total system which may include

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The essential requirement for the initiation of R&D animal studies is presented in the mission statement of the Biological Sciences Division,

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[redacted] operating over relatively short distances. That is, in many cases clandestine personnel can easily reach the perimeter of a missile's site or the entrance to a protected harbor, but the last few hundred yards presents an impenetrable obstacle to mission accomplishment. The primary requirement for the use of animal systems is to produce [redacted]

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In addition to the unique Agency requirements, other Government organizations have complementing requirements for the operational use of biological systems. ORD has coordinated thoroughly with the Limited Warfare Laboratories (LWL), Advanced Research Projects Agency (ARPA), Office of Naval Research (ONR), Army Research Office (ARO), the Deputy Director for Research and Engineering, Department of Defense (DD/R&E/DOD), and Air Force Office of Aerospace Research (AFOAR).

In 1963, under the auspices of the newly established Office of Research and Development, several studies were undertaken by [redacted] (b)(3) CIAAct (b)(6) [redacted] (b)(3) CIAAct (b)(6) to determine if general requirements existed which would justify exploratory research of animal emplacement in support of operational missions. These studies indicated that general requirements did, and do, indeed exist. This conclusion led to a number of conferences with various DD/P components to obtain sufficient details for identification of a generalized problem which animal emplacement might help. The generalized problem was formulated as follows:

> "Operational collection efforts are frequently frustrated because of inability of human agents to penetrate small terminal geographic segments and emplace various technical collection sensors and related hardware. Is it possible to utilize mobile animal platforms to bridge these small geographical gaps and emplace and/or retrieve operational hardware, or carry necessary sensors and associated hardware, thus to function as primary collection of relay platforms?"

Responsibility for designing and implementing a program of Animal Systems Studies was assigned to the Life Sciences Divisions in the Office of Research and Development. This group was later segmented into two divisions with program responsibility transferred to the Biological Sciences Division. The responsible technical officer was and is [redacted]

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It was soon realized that these "terminal geographic segments" involve many diverse environments and sets of conditions which might be encountered in operational situations. Thus, formulation of an overall experimental approach to feasibility study was predicated in terms of the major environments in or through which humans might operate; viz., land, sea, and air.

Further preliminary study indicated that it was highly advisable to involve potential "users" of developed platforms and technology early in the various studies, and to keep them continually apprised of progress. The decision was based on several realizations:

a. The concept of utilization of animals in intelligence missions, while not new, is nevertheless highly innovative from an operational viewpoint.

b. Formulation of meaningful feasibility tasks required participation of operationally oriented people.

c. Development of potentially useful systems required operational "tailoring".

d. Advanced feasibility studies and developments would require direct participation and commitments of operational component support and people.

Thus, based on specifications derived from direct dialog with operational components, a series of tasks were derived which would explore feasibility of utilizing endemic animals in land, sea, and air environments. It was further decided that, in terms of animal guidance and control, no positive reinforcement techniques would be employed; for instance, brain implantation. The decision was based on requirements to:

a. Keep operational prototype systems as simple as possible.

b. Determine, if possible, practical limitations of animal training using both standard and innovative training methods.

Experimental tasks were promulgated for the listed environments in terms of available animals, known state-of-the-art, and available contractor talent. These are summarized in Table I. It can be easily seen that th(b)(1) (b)(3) NatSecAct operational requirements call for [redacted] (b)(1) (b)(3) NatSecAct It is implicit in all the tasks that the major objective is to extend human capabilities and hardware systems rather than replace systems. An equally important general objective was, where possible, to ameliorate frustration of current operational systems.

Because of the necessity for specialized hardware developments to implement both animal training and operational prototype systems, it was necessary to involve physical scientists and sciences from very early stages of the work. Unique requirements have been difficult to fulfill because of lack of common concepts and language through which biological and physical scientists could communicate. For example, the biologist realizes that tasks and hardware must be "tailored" to the capabilities of the animal involved in the system rather than taking state-of-art devices and technology

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and attempting to adapt the animal. This is not an obvious or easy concept for an electronics engineer, for example, to comprehend. Furthermore, in one outstanding instance [redacted] there was a total breakdown of communication because the prototype functioned as predicted "on the bench" but was completely non-functional when implanted in the animal. Advances in this highly specialized discipline of bio-engineering have been difficult, but highly rewarding, and must be an integral part of any such program.

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Finally, it was realized that, because of the interlocking and mutually contingent nature of needed component developments, a total prototype system development was required rather than a fragmented approach. To this end, sufficient funds, facilities, manpower, and effort have been devoted to assure program viability and definitive data acquisition. The fact that two of three systems have been successfully demonstrated and indications are strong for successful demonstration of the third by the end of 1967, bears witness to the soundness of this approach. In addition to goal achievement, a number of highly significant advances in state-of-art in Biology and Bio-Engineering have accrued. These are listed by project area in Table II.

There are two general approaches to R&D effort directed toward the operational utilization of biological systems. The first approach is to ask oneself what are the sensory and response characteristics of various selected animals which might allow them to perform a useful Agency mission.

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Obviously, such a survey of the entire animal kingdom would be a herculean task and, in fact, not within the scope of Agency functions. Consequently, only minor effort has been directed toward this approach and then only on specific animals which from a priori knowledge seem to possess characteristic that would make them a reasonable candidate for intelligence activities.

The second major approach, and the one which has received the greatest effort, is to demonstrate feasibility capability concept. For instance, [redacted] Naturally, the procedure varies somewhat with the particular requirements and animal vehicle utilized. However, in all cases, but not necessarily in sequential order, the procedure includes:

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a. Selection and procurement of the most promising animal subject.

b. Establishment of facility and procedures for maintenance of health and care.

c. Initiation of domestication training.

d. Procurement and/or development of hardware components.

e. Mission training and systems integration.

f. Feasibility demonstration.

g. Training of operational personnel in the maintenance and utilization of the [redacted] (b)(1) (b)(3) NatSecAct

h. Test and evaluation and system up-dating.

i. Demonstration of operational capability.

The three major animal systems which have been under study have been, or shortly will be, brought to feasibility demonstration. The state-of-art at the time of prototype demonstrations is such that follow-on work would be classed as advanced development. Since the prototype systems represent only limited operational potential at this stage of development, specific answers to many of the questions put forth in the terms of reference for this study cannot be meaningfully answered. It appears that the operations-oriented components concerned feel that progress on these studies is satisfactory. They also feel that, although specific missions requirements do not exist as of now, work should not be halted on these systems. Their answers further indicate that generation of "hard" requirements for direct operational utilization of these systems will involve a certain "training" period for field personnel to make them aware of the systems capabilities and to give operatives for some firsthand experience with the systems under simulated mission conditions. To this end they desire that BSD/ORD maintain facilities and capabilities to permit time for meaningful operational evaluation of potential field utility. From the viewpoint of the Biological Sciences Division, continuity is most desirable to avoid loss of capabilities, skills, personnel, and facilities. Repetitive experience always shows that shut-down and restart costs are fiscally more expensive than capability maintenance.

It thus seems that the major point requiring resolution before further developmental progress can be achieved is clear definition of operational requirements by DD/P operational components and their commitments, both fiscal and personnel, to development of field systems in concert with DD/S&T components.

Aside from direct operational requirements, experiences to date have shown that basic studies on a long-term basis produce many unpredictable meaningful discoveries and data, and they should be maintained.

The following recommendations can thus be made with some assurance:

a. That animal systems feasibility studies be continued.

b. That current capabilities be at least maintained until operational requirements have been decided and written.

c. That funding of current programs in animal studies be continued for a period of time sufficiently long to permit demonstrations of simulated operations based on "scenarios" developed by the DD/P and DD/S&T personnel. The context of the "scenarios" would be directly related to potential targets.

d. That a portion of the total animal studies effort be permitted on a non-aligned basis, i.e., not necessarily mission oriented.

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BW/CW

Remote Detection Studies

by

James P. Lynch
Biological Sciences Division

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BW/CW

Remote Detection Studies

by

James P. Lynch
Biological Sciences Division

Current National Intelligence Estimates credit the Soviet Union with an existing chemical weapon capability, including research and development, field testing facilities, agent and weapons production, stockpiling, and troop training. In contrast, the estimate with regard to biological weapons [redacted] than definite.

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MONOGRAPH NO. 16

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CIA Polygraph Research Program

INTERIM REPORT
1964-1967

Directorate of Science & Technology
OFFICE OF RESEARCH & DEVELOPMENT

Directorate of Support
OFFICE OF SECURITY

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CIA POLYGRAPH RESEARCH PROGRAM

INTERIM REPORT

Office of Research and Development

1964 - 1967

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MONOGRAPH NO. 17

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[redacted] (b)(1)

by

[redacted] (b)(3) NatSecAct (b)(6)

Optics Division

/Date of preparation unknown, but believed to be 1968./

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[redacted] (b)(1)

by

[redacted] (b)(3) NatSecAct
(b)(6)

Optics Division

As indicated in the Optics Division History, the first big effort toward high resolution infrared scanners was brought about by the disbelief of the Air Force and the scientific community, including Texas Instruments who produced the equipment for us, that a magnitude jump to 1/2 milliradian system was possible. Mr. Woo personally spent a good part of three months walking the passageways of the Pentagon, attending conferences and meetings, trying to convince the DoD that a 1/2 mrad system could be produced in one year's time. The fact that [redacted] (b)(1) are available to the Defense and Intelligence communities today can be attributed to Colonel (now Brigadier General) Edward B. Giller, who was Acting Director of ORD at the time. In the face of reports that such a system could not be built for at least another five years, Col. Giller authorized Mr. Woo to initiate the development of the 1/2 mrad system. This authorization was based solely on faith, because where a new state of the art is being pursued, there is no data available which can prove the feasibility of such art -- otherwise it would be the state of technology.

By late 1962 [redacted] (b)(1) as such, had been under development for about a decade. Essentially all development had been under Department of Defense sponsorship. The concentration of effort had been, fittingly, directed toward

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low level reconnaissance in tactical military situations. The effort to be made by ORD was in using [redacted] (b)(1) from the more traditional (i.e., Agency) high altitudes.

ORD's first [redacted] (b)(1) contract was dated June, 1963; the initial product, a 1/2 milliradian scanner, was tested successfully from 60,000 ft. altitude in August 1964. In September and October, [redacted] (b)(1) (b)(3) NatSecAct the scanner demonstrated that [redacted] (b)(1) from these altitudes could answer whether or not certain nuclear production facilities were operating. The [redacted] (b)(1) equipment was subsequently transferred from ORD to operational use, and in January, 1965, it was successfully used to prove that the suspected gaseous diffusion plant at [redacted] (b)(1) (b)(3) NatSecAct was in operation. This was, to the best of our knowledge, the first time in history that [redacted] (b)(1) of denied territory was obtained and used successfully.

(b)(1) Among the lessons ORD has learned, perhaps the most important is that there is no substitute for spatial resolution in [redacted] (b)(1) Toward this end, contracts were written in the Spring of 1965 leading toward spatial resolutions of 1/10 and 1/20 milliradian (i.e., 5 and 10 times better, respectively, than the original 1/2 milliradian scanner). In 1966, breadboard models of both of these new scanners were demonstrated. An operational follow-on to the 1/10 mrad instrument will be delivered in late 1967.

Figure 1 plots the resolution achieved by a number of [redacted] (b)(1) systems versus the year such systems were first successfully (b)(1)

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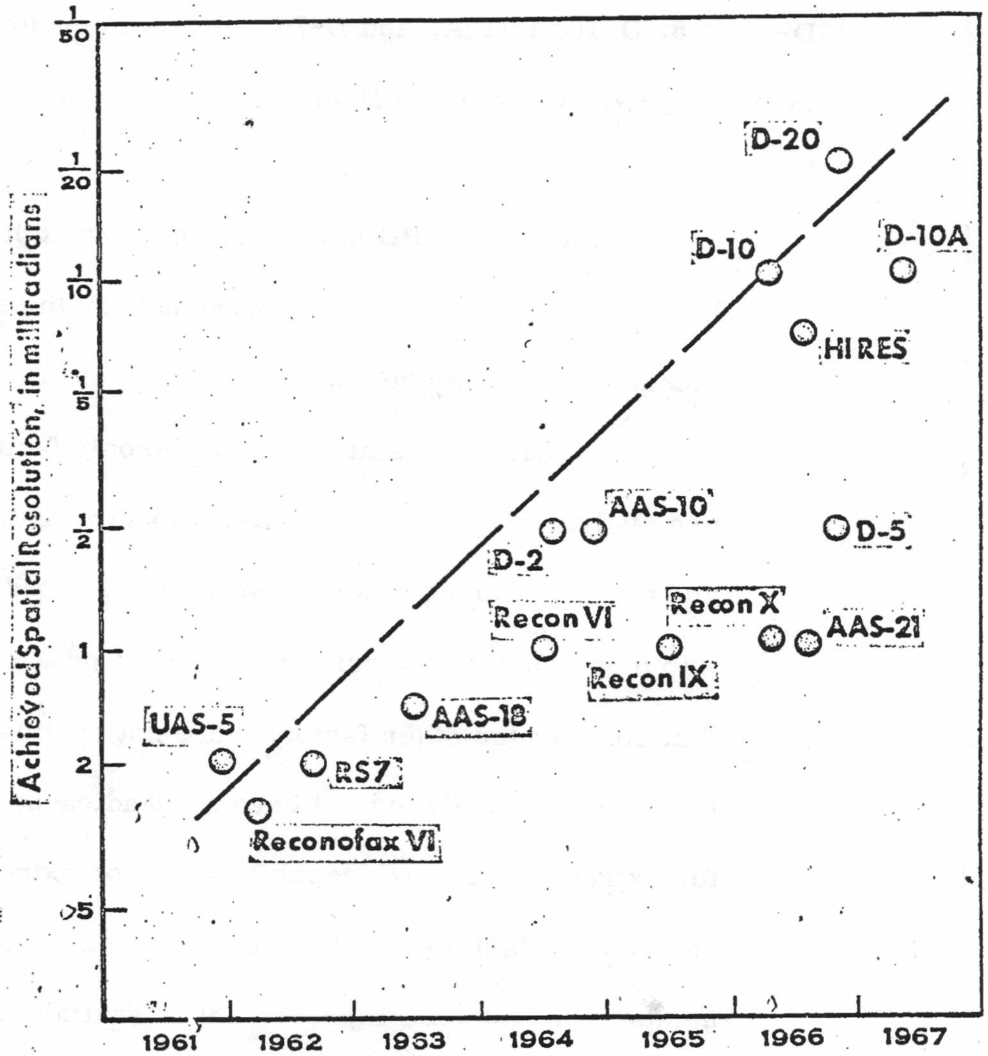

Figure 1.

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demonstrated. The systems labled with a "D" on this graph, namely, D-2, D-5, D-10, D-10A, and D-20, were all developed by ORD; the remaining systems were DoD developments. Two points need to be made here:

a. Neither ORD nor anyone else could have produced the D-series of (b)(1) [redacted] if it were not for the solid foundation in [redacted] (b)(1) technology that had been prepared by prior DoD contracts.

b. Spatial resolution is not the only factor by which [redacted] (b)(1) systems are evaluated [redacted] (b)(1) resolution, weight, size, v/h capability, and cost are among other considerations), and the thrust forward into high resolution territory was made possible by the realization that some of the other factors were not applicable to CIA problems. In particular, ORD did not become handicapped by specifications for extremely high v/h capability nor for extreme [redacted] (b)(1) sensitivity, factors which have compromised several Dod developments. The 40-fold improvement in spatial resolution achieved in the short period that ORD has been operating is the greatest single factor making [redacted] (b)(1) an attractive tool for high altitude overhead reconnaissance.

The graph does not show a family of 1/2 mrad scanners that is currently being procured by DoD. These DoD 1/2 mrad scanners are strongly based on technology resulting from the D-5 scanner, and hence fall to the right of the point D-5 on the graph.

The graph also fails to show that the rate of growth in resolution is going to be much slower for improvements beyond 1/20 mrad. Two explanations are available for the slowing down in growth:

a. Systems must become larger in order to achieve better resolution, and the larger systems do not fit into some of the traditional reconnaissance aircraft.

b. The cost for new systems increases somewhat (but less than linearly!) with improved resolution. The tight budgets in FY 67 and FY'68 are preventing the initiation of contracts for the development of the desired 1/50 mrad [redacted] (b)(1) system.

Along a different line, in 1965 an Air Force contract resulted in the first real-time [redacted] (b)(1) converter, which was dubbed the "forward looking [redacted] (b)(1) system" [redacted] (b)(1) because of its intended use as a [redacted] (b)(1) for aircraft. In the Spring of 1966 ORD initiated its own program for [redacted] (b)(1) viewers with a contract for a 1/2 mrad [redacted] (b)(1) ORD has imposed an additional requirement upon its [redacted] (b)(1) the development must be along lines that will result in technological feedback of use to future imaging systems. The profitable use of this feedback came sooner than expected -- the development of a 100-detector array for the [redacted] (b)(1) made it possible to upgrade the aforementioned 1/10 mrad scanner sooner than would have been thought possible otherwise.

Finally, as the resolution of [redacted] (b)(1) systems becomes better, the size and weight of the systems increases. At the other end of the scale, ORD

(b)(1)

has also begun the development of a family of small specialized [redacted] systems, primarily for use in small guidance packages -- here the emphasis is on minimum weight rather than maximum resolution. None of these systems has yet been demonstrated in flight, but parallel contracts are scheduled to produce two such "cigar box" scanning systems next winter.

Note: see CIA Publication <u>Studies in Intelligence</u>, Vol. 11, No. 3 (Summer 1967), pp. 17-40.

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by

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Physics-Chemistry Division

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MONOGRAPH NO. 21

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Sponge Collection Research and Development

by

[redacted] (b)(3) CIAAct (b)(6)

Physics-Chemistry Division

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Sponge Collection Research and Development

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(b)(6) [redacted]

Physics-Chemistry Division

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MONOGRAPH NO. 22

GAMMA RAY SPECTROMETERS

by

[redacted] (b)(3) CIAAct
(b)(6)

Physics-Chemistry Division

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GAMMA RAY SPECTROMETERS

by

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Approved for Release: 2022/01/31 C06767620

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RESEARCH & DEVELOPMENT REPORT

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DIRECTORATE of SCIENCE & TECHNOLOGY
Office of Research and Development

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Research and Development Report

[redacted] (b)(1)
(b)(3) NatSecAct

by

[redacted] (b)(3) CIAAct
(b)(6)

5 April 1968

Central Intelligence Agency

Directorate of Science and Technology

Office of Research and Development

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Approved for Release: 2022/01/31 C06767620

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MONOGRAPH NO. 24

MERCURY BATTERIES IN AUDIO APPLICATIONS

by

(b)(3) CIAAct
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[redacted]

(b)(3) CIAAct
(b)(6)

In the summer of 1963 [redacted] explored Agency requirements for battery power to establish the need and nature of any research and development to be initiated by DD/R in a support role to using components. One requirement existed in the inadequate performance of the Mallory mercury primary battery in wide us[redacted] (b)(1) (b)(3) NatSecAct

The mercury cell was invented in 1942 by Samuel Ruben and was promoted by his organization, Ruben Laborato (b)(1) (b)(3) NatSecAct Yonkers, New York. The [redacted] (b)(1) (b)(3) NatSecAct [redacted] captured almost the total market. The basic cell is very stable electro-chemically. Further, its electrical performance, efficiency and energy density fitted it uniquely to many applications for which the old faithful LeClauche dry cell was unacceptable.

The manufactured products were designed and formulated to supply an area of need which either reflected a relatively high, steady-state current as in the hearing aids of the day and in certain radio applications or were applied to instrument uses under pulse loads. In each case cells were sized in terms of capacity so that near 100% materiel efficiencies were obtained in these uses. The TSD experience with audio applications showed initial failures when but 25-30% of the reactive chemicals had been electro-chemically utilized. A significant problem existed for the operational situation demanded [redacted] power-wise, in line with this efficiency. Accordingly [redacted] [redacted] use of three to four times the number of batteries which should have been the case.

(b)(1) (b)(3) NatSecAct

(b)(3) CIAAct (b)(6)

With [redacted] CB/TSD/DDP, [redacted] reviewed the peculiarities of the audio application. The electrical loading was totally different in two basics, namely, a very long period of service (many months to years) and a condition requiring a steady state microampere background current upon which was superimposed pulses at tens of milliamperes.

Here now was a clear situation wherein the Agency's peculiar demand on a highly successful commercial product produced totally unacceptable performance.

(b)(1) (b)(3) NatSecAct

In November 1963, a [redacted] contract was written with the [redacted] for work to be conducted by [redacted] The scope of the effort was:

(b)(3) CIAAct (b)(6)

<u>Problem</u>: Mercury cells of the military type (BA1030/U) are used in a pulse application in which

a minimum voltage must be maintained. Performance testing characteristically shows failures when only 25-30% of the reactive materials have been electrochemically utilized. Representative environmental conditions and duty cycle are:

(1) Conditions are basically human ambient with no extremes of any kind being involved.

(2) Duty cycle involves a 25 microampere background current with 50 millisecond pulses being required every 2.5 seconds. Pulse heights are 10, 40, or 60 milliamperes. The two higher pulses are required no more frequently than hourly. A minimum of 1.0 v/cell must be maintained.

Failure is defined as the inability to maintain the one-volt minimum under the instantaneous pulse requirements.

Objective: The objective of this research is to generate and report firm guidance for technological action leading to a substantially improved conversion efficiency, or materials utilization, in cells under the described use.

Task: The conduct of theoretical and experimental research on mercury cells (BA1030/U) for the purpose of identifying failure modes in the electrochemical materials, structure, or system (under the described conditions of use) is required. The identified failure modes are then to be interpreted technologically. (Cells tested to failure under an approximation of the duty cycle will be available as raw material.) (b)(3) CIAAct

Fate was kind. In a few months [redacted] had elimin (b)(6) chemical problems of electrode polarization and shelf instability of material substances. Either of these possibilities would have been most difficult to overcome. The cause of failure was found to be mechanical; it appeared in two forms. In some cases the lead from the anodes to the negative terminal was inadequately protected; it corroded through and produced a failure through an open circuit. The more subtle, and dominant failure mode was the internal shorting of cells. Upon cell discharge free metallic mercury appears at each electrode. Under design uses, this free mercury is immobilized by the electrode, matrix characteristics and is restrained by the use of physical barriers between the electrodes, i.e., the well-known role of the battery separator. The Agency condition of use simply provided time for minute mercury droplets to grow and combine; the increased masses of mercury then penetrated the separator barrier at lap joints, causing a short circuit.

The balance of the technical program was simple and direct. Knowing the cause of failure, several positive actions were immediately evident. A variety of design and material changes were incorporated into test cells. Electrochemical efficiency rose to better than 90%, and, with this demonstration our work was done. (b)(1) SD wrote an engineering and test program with [redacted] (b)(3) NatSecAct proved out the improvement on a statistical basis, and then revised operational procec (b)(1) [redacted] (b)(3) NatSecAct then reflected a confident design criteria for the mercury cells of 90% utilization of available capacity rather than the uncertain 30% level in use prior to this project.

MONOGRAPH NO. 25

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CHECKROTE

by

Nicholas R. Garofalo
Radio-Physics Division

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CHECKROTE

by

Nicholas R. Garofalo
Radio-Physics Division

(b)(1)
(b)(3) CIAAct

[redacted] carried a very high priority within the U.S. and allied intelligence communities since 1964 when intelligence was first developed concerning th [redacted]

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MONOGRAPH NO. 26

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EARTHLING

by

Nicholas R. Garofalo
Radio-Physics Division

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EARTHLING

by

Nicholas R. Garofalo
Radio-Physics Division

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MONOGRAPH NO. 27

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QUADRANT

by

Burnice A. Herring
Radio-Physics Division

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QUADRANT

by
Burnice A. Herring
Radio-Physics Division

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Approved for Release: 2022/01/31 C06767620

MONOGRAPH NO. 28

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OXIDANT

by

Burnice A. Herring
Radio-Physics Division

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OXIDANT

by

Burnice A. Herring
Radio-Physics Division

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The purpose of this program was to develop [redacted] [redacted] system which can gather definitive intelligence on enemy missile performance, digest pertinent information using a logic computer, store it, and transmit data in a secure fashion upon demand.

(b)(1)
(b)(3) NatSecAct

In January, 1964, Mr. N. R. Garofalo and Mr. B. A. Herring held numerous meetings with representatives from FE/[redacted] OSI, and TSD/D&E [redacted]

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Approved for Release: 2022/01/31 C06767620

C06767620

MONOGRAPH NO. 29

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by

Burnice A. Herring
Radio-Physics Division

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Approved for Release: 2022/01/31 C06767620

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(b)(3) NatSecAct
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(b)(1)
(b)(3) NatSecAct

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INDEX

INDEX*

A

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*Note: Unless otherwise specified, entries are in Vol. I.

(b)(1)
(b)(3) NatSecAct
(b)(1)
(b)(3) NatSecAct

D

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