By

RAYTHEON COMPANY
Communications and Data Processing Operation
Norwood, Massachusetts

for period

October 1, 1964 through October 31, 1964

for

Contract No. NAS 8-11604
GSO No. 48064

MONTHLY PROGRESS REPORT

Fast Scan Infrared Detection and Measuring Instrument

November 16, 1964

R. Vanzetti
P. Chunko
G. Mathis

Monthly Progress Report

FAST SCAN INFRARED DETECTION & MEASURING INSTRUMENT

November 16, 1964

1. SUMMARY

During the month of October, 1964, technical progress was further delayed by serious problems revealed by more detailed analysis of optical and scan systems. Extension of Phase I by six to eight weeks is indicated. Rate of expenditure is about 66% of plan. Primary achievement during this period was completion of all but a small part of the electrical requirements and determination of initial product design concept. Indefinite delay of preparation and publication of the Study Phase Terminal Report was ordered by Contracts Administration.

2. PROJECT ADMINISTRATION

Elapsed time schedule (attached) indicates schedule extensions required in Phase I for studies in optics, scan, detector, and product design. The problems discussed in Section 3 have delayed completion of optics and scan studies by four weeks and have prevented profitable studies in product design. The delay in detector study was explained in Section 3.3 of the prior report dated October 15, 1964. Electrical studies affecting system design are complete.

Technical personnel participating during the current period are:

Name & Title	Current Period	Previously Reported	Total to Date
G. Mathis, Project Manager	8 hrs.	164 hrs.	172 hrs.
P. Chunko, Project Engineer	160 "	504 "	664 "
W. Bauke, Senior Engineer	66 "	-	66 "
M. Hinkle, Mathematician	24 "	-	24 "
R. Powden, Technician	40 "	-	40 "
R. Gallipeau, Consultant	70 "	4 "	74 "

3. TECHNICAL PROGRESS

3.1 Optics

Quality profile analysis of the optical system defined in the September report has disclosed excessive blurr circle diameters when off-axis distances of 0.5 mm are required. Re-alignment of conjugates resulted in systems:

Objective	Original Spherical	Revised Aspherical		
Obj. dia.	200 mm	200	107	107 (200 mm stopped down)
Focal length	100 mm	200	200	200
Image distance	585 mm	1724	260	266.2
Convergence Angle	18° 40'	6° 38'	29°	23° 12'
Magnification	X5	X7.6	X1	X0.3
Refractive Element	None	———	One doublet	———

A refractive element was introduced to minimize blur circle diameter and achieve an effective spot diameter of .003 inch maximum across entire field. This addition affected scan requirements and resulted in a review of scan systems.

3.2 Scan

Introduction of the refractive element limits space allotted to scan system insertion to approximately five inches along beam axis between refractive element and detector aperture. At present it appears doubtful that this space is adequate for the reflective scanner originally made the prime choice. Reconsideration of diffractive scan by means of pierced drum (or disc) is a solution to the space problem. However, the penalty is limitation of scan versatility by rigorous coupling of line and frame frequency. In addition, the advantage of lower background noise attributed to the reflective system is being questioned on the basis of excessive modulation. Any reasonable background at or near ambient temperature appears to be acceptable if maintained at constant level. Qualitative study indicates the probability of unacceptable modulation components originating at the line scan element during fly-back time. Quantitative analysis of this effect is continuing.

3.2 Scan (Cont'd.)

The third choice scan method involving a vibrating optical fiber has undergone limited tests designed to check mechanical response and reliability of presently available fibers. Both coated (epoxy) and uncoated samples in lengths of 0.5, 1.0 and 2.0 inches have been vibrated harmonically under the following conditions:

a. Free fiber, uncoated, frequency 0 to 200 cps, tip excursion 0.5 inch max.

b. Steel encased fiber, uncoated, frequency 400 to 500 cps, tip excursion 0.4 inch max.

c. Free fiber, epoxy coated, frequency 0 to 200 cps, tip excursion 0.5 inch max.

During test (c) epoxy shedding was obvious. All tests indicated that no fiber breakage occurred until excursion exceeded 0.375 inch. Maximum time duration of test was 50 hours.

3.3 Detector

Design compatibility with the optical system has fixed the detector aperture dimensions at .0762 mm minimum diameter and divergency angle 3^{o} 19' (total angle 6^{o} 38'). This optical cone is usually achieved by a series of stepped cylinders, the maximum diameter being determined by enclosure wall thickness.

System sensitivity improvement by addition of a second detector element affected by background only has been given consideration. Although not proven experimentally, this step may more than justify cost and could possibly compensate modulation components to a point permitting further consideration of the reflective scan system.

3.4 Signal Processing

With the exception of circuit details of the logarithmic preamplifier between detector and voltage amplifier and the built-in test circuits, electrical design is complete. Commercially available units have been selected but not ordered. Issuance of purchase orders is being held until possible effects of unsolved optical and scan problems can be accurately determined.

3.5 Product Design

Initial concepts have been reviewed. It appears at present that the system will require a desk type console for the optical head and operating controls and a standard electronic cabinet for the larger signal processing, recording and synchronizing units and their power supplies. Final concept must await solution of the optical and scan problems.

3.6 Mathematical Model

Definition of a mathematical model for the difractive scan system and compatible optics is complete. This model covers energy balance from target through optics to the detector and defines the effectiveness of the drum or disc scan.

4. PLAN FOR NEXT PERIOD

4.1 Optics

Quality profile of the microscope optics will be determined, and type of asymmetry (conic section or figured) of the objective mirror will be defined. Shape and material for the refractive element will be determined. An experimental (breadboard) system will be constructed to check optical response. Parts will be ordered as soon as all known problems are satisfactorily solved.

4.2 Scan

The plan for October did not materialize. Therefore, the experimental scan system will be constructed in very preliminary form as part of the optical breadboard. Completion of construction and early test results during November is doubtful, but useful data will be seen early in December. Time will not permit investigation of both reflective and difractive methods. The conclusion of the effort under 4.6 will dictate the final choice of scanning system to be adopted as first solution.

4.3 Detector

Comparison study of Hg:Ge and Cu:Ge sensors will be completed and will guide final choice. The intended breadboard tests will use Au:Ge and/or Cu:Ge sensors now on hand.

4.4 Signal Processing

All circuit details will be completed.

4.5 Product Design

Initial concepts will be revised to accommodate optical and scan changes, and design guides (both isometric and orthographic) will be prepared. It is doubtful that detailed design will start on schedule.

4.6 Mathematical Model

Continuation of the mathematical model to include definition of a reflective scan system is planned.

4.7 Reports

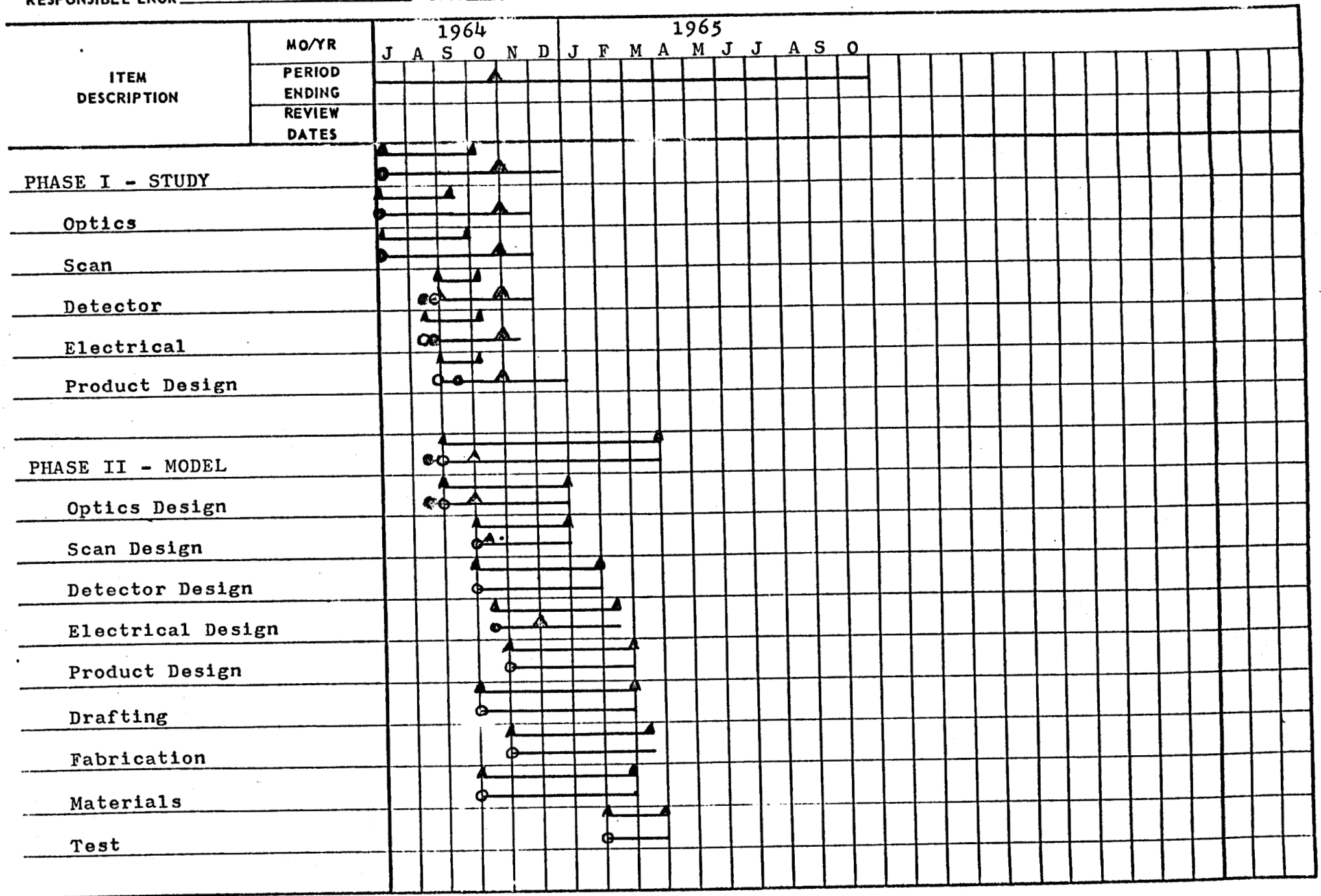
Notification to delay preparation and publication of the Study Phase Terminal Report was forwarded through Contracts Administration. Release of the hold order has not been received. Approximately two weeks will be required to edit and illustrate the material on hand.

RAYTHEON FORM NO. 4826 (VELLUM)

UNIT OR TASK SCHEDULE

SCHED. CLASSN _____

RESPONSIBLE ENGR _____ UNIT _____ PROJECT _____ D.O. NO. _____



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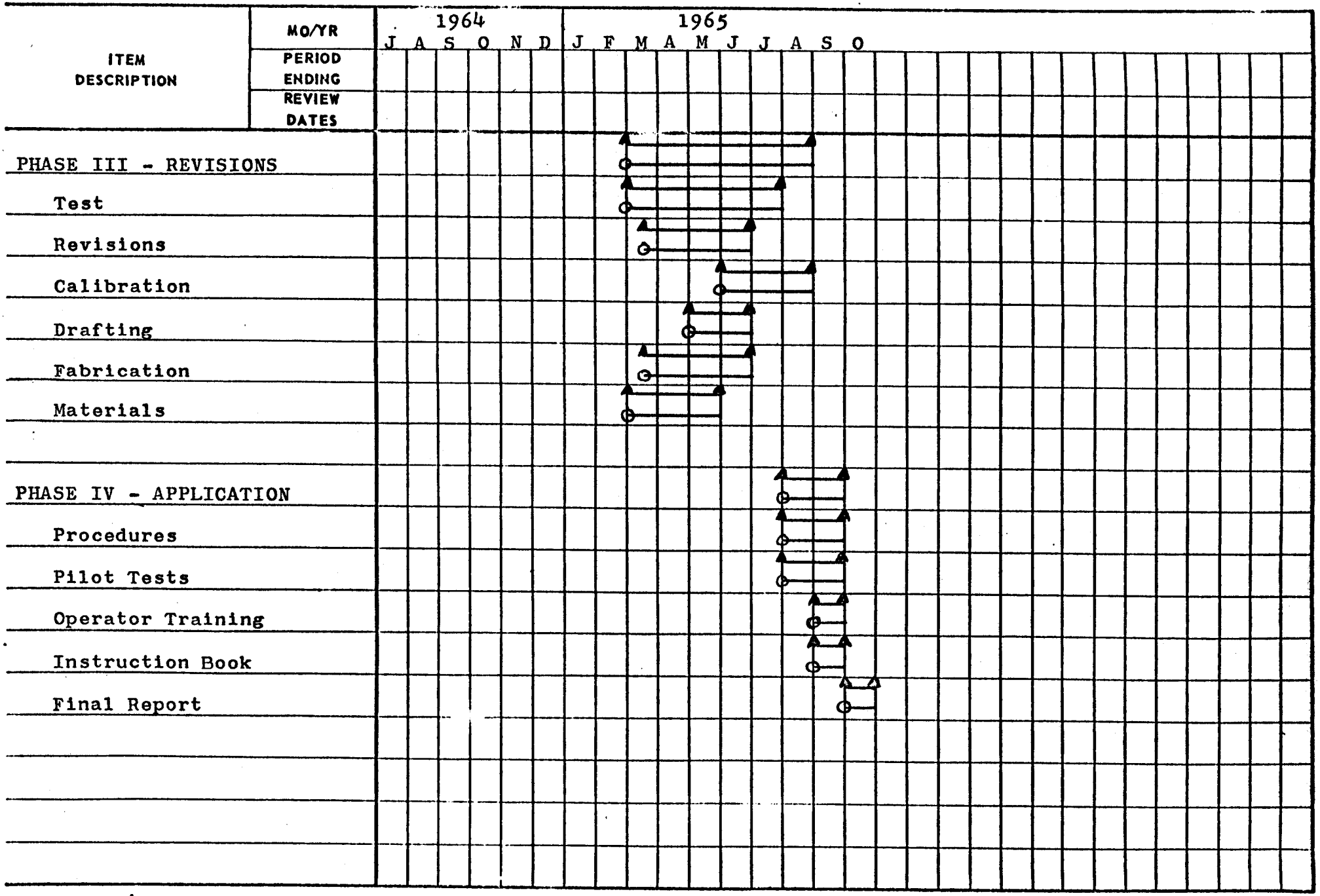

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