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Research Order #1
Phase I - Progress Report #7

29 June 1954

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OBJECTIVE:

To study and evaluate the factors and components involved in the design of a portable infrared communicator.

GENERAL DATA:

The work to be performed according to Bid Proposal #76-1, Phase I, may be summarized as follows:

A. Evaluation of sources and sensitive elements

B. Determination of beam width requirements and evaluation of "find-operate" systems

C. Study of modulation methods and attendant optical systems

D. Evaluation of power sources

E. Study of required circuit characteristics

F. Manpower schedule report

The results of these studies will be used as the basis for recommending a system to be developed.

DETAILED DATA:

A. Evaluation of sources and sensitive elements

In the June progress report it was stated that we plan to use the lead sulfide cell as the detector in the system. A lead sulfide cell, manufactured by Eastman Kodak Company was used in our experimental work which involved the study of modulating a xenon arc by electronic means and determing the range of a system set up in the laboratory. in

The cell used has a dark resistance of approximately 0.4 megohms, an area of one square millimeter and a time constant of 200 microseconds. It was not possible to select a cell for optimum conditions since work has not progressed sufficiently far on the electronics system and the optical system. Nevertheless, the cell of one square millimeter gave quite satisfactory performance in operation as the receiver for a modulated xenon source.

As previously indicated the source used in our work is a xenon arc lamp. This lamp is type No. 2-C-1 manufactured by Hanovia Chemical and Manufacturing Company. The voltage for sustained operation is 25 volts d.c. at a current of 1.2 amperes. Complete details on the spectral energy distribution and radiation data are not yet in our possession. However, from Hanovia and ERDL information the lamp has a very high brightness and radiates high intensity infrared in the region of 1.1 microns. This radiation is superimposed over a radiation curve of approximate black body form.

B. Determination of beam width requirements and evaluation of "find-operate" systems

An optical system having a beam width of 3° was used in our experimental system to transmit light from the modulated xenon source.

It was decided to suspend further efforts on the "find-operate" system until more work had been accomplished on modulating systems. Consequently, there was no experimental work done on the "find-operate" system during the month of June.

Preliminary calculations indicate a find time not exceeding 12 minutes at a range of six miles and a beam width of 2°.

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Arbitrary positional accuracies were chosen as follows:

Horizontal $\pm 5^{o}$

Vertical $\pm 2^{o}$

It is expected that upon completion of our laboratory investigation we can verify both our calculations and experimental work by field observations. These field measurements are now scheduled for the end of July.

C. Study of modulation methods and attendant optical systems

A considerable amount of effort was put in on both theoretical and laboratory work in the evaluation of the modulated xenon arc for this application. Use of the xenon arc presents us with numerous problems in our application. The problems include the following:

1. Power requirements
2. Starting the arc discharge
3. Physical size and weight

Experimental work indicates 70 w. of required power for successfully operating a 35 w. xenon lamp. This includes losses in the d.c. supply and the ballast resistor.

The arc has been successfully established by means of an r.f. coil (Tesla coil) with its electrode placed near the positive electrode of the xenon lamp. Although this is probably the most effective way for us to start this arc discharge, it is not entirely positive and some trouble can be anticipated starting this sort of device.

Work has not progressed far enough to establish definitely the minimum size and weight of the equipment needed to modulate the xenon lamp. However, since we are operating from an 800 cycle power source, it appears that the unit may not exceed size and weight requirements.

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Current modulation of the lamp is limited to 75% modulation maximum, and this value varies from lamp to lamp. Some lamps are extinguished at 75% modulation.

Using very simple optics of only 4" aperture and a lead sulfide cell of the type previously described in this report, in 4" optics also, for a receiver, the xenon lamp modulated at 75% gave an average clear weather range of approximately 5 miles as simulated on the vacuum range system in the laboratory. Further work is proceeding on range measurements at the present time.

Based on previous calculations and design considerations for a system using a mechanical modulator, we have placed orders for two special galvanometers. These are modified series 101 galvanometers manufactured by Midwestern Geophysical Laboratories. The following modifications are to be incorporated:

1. Mirror size: 0.029" x 0.187"
2. Ang. deflection: 16°
3. Response: 3000 cycles - sec. - flat response ($\pm$ 5% at 3000 cycles)
4. Power consumption: 5 watts maximum

Midwestern Geophysical Laboratories have further agreed to determine the feasibility of furnishing us a galvanometer with a somewhat larger mirror, having the same performance characteristics as the above galvanometer.

Evaluation of the mechanical system will proceed using a tungsten source just as soon as we receive the galvanometers.

D. <u>Evaluation of power sources</u>

The problem of power sources was completely reviewed. Information is that kerosene will be available to operate a small internal combustion engine. This will necessitate a special engine which can be built at a cost of $5,000. We are awaiting a manufacturer's written proposal at this time.

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Given further consideration were the small steam engine and turbine. The steam engine was ruled out after preliminary calculations indicated the requirement of too much water. Weight factor alone ruled out a small turbine.

The small gasoline engine has been satisfactorily muffled as far as exhaust is concerned. However, further muffling is required on the intake system, and shock mounting and acoustic shielding will be required around the engine itself.

We feel that the problem of the power source has been resolved to the extent that we can successfully use this small engine and meet operating power and noise requirements.

E. Study of required circuit characteristics

This system will either be a linear modulating system, such as the current modulator used in the experimental work in modulating the xenon arc, or the infinite clipping circuit previously mentioned.

F. (See Manpower Schedule Report attached)

PROGRAM FOR NEXT INTERVAL

Either the tungsten source and mechanical modulator or the xenon source and electronic modulator will be chosen during this period of time. This decision will very nearly dictate the electronic system.

Problems regarding beam-width and find-operate will be pursued along with work on the optical system.

Feasibility of using transistors in the electronic system

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will be given consideration, and a decision reached as to whether they will be used in place of vacuum tubes.

A proposal will be submitted for the system to be developed. The proposal will review system requirements and describe components selected, giving reasons for the selection of the following:

1. source (radiation)
2. receiver (detector)
3. optical system
4. modulating system
5. electronics system
6. power source

Principles of the proposed system will be discussed, outlining expected system performance.

Pertinent data, calculations, sketches, circuit diagrams accumulated in the study phase will be attached to the appendix of the final study phase report.

25X1

Report prepared by

Report approved by

Report approved by

PTS/t
Attachment: Manpower Schedule Report

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MANPOWER SCHEDULE REPORT

As originally prepared for our proposal #76-1, our schedule called for 6 months for Study Phase I, 6 months to produce two design approval models in Phase IIa, and 4 more months to produce 20 developmental models in Phase IIb. It is now understood that the Study Phase I is to be completed 31 July 1954. With 5 months assigned to Phase IIa and 4 months to Phase IIb, the entire contract would then be completed by 30 April 1955. Our Contracts Administrator, [redacted] is requesting extension of the contract to that date. 25X1

Our original manpower schedule per #76-1 is given both in manhours and in manmonths as follows:

	Phase I		Phase IIa		Phase IIb	
	mh	mm	mh	mm	mh	mm
Electrical Engineering	3327	20.8	3323	20.8	2362	14.8
Mechanical Engineering	1576	9.8	1574	9.8	1574	9.8
Drafting	500	3.1	1500	9.8	3000	18.8
Model Shop	1050	6.6	1050	6.6	700	4.4
Components					200	1.2
Test Equipment					200	1.3
Technical Manuals					200	1.3
Totals	6453	40.3	7447	46.6	8236	51.6

Total Engineering: 22,136 manhours = 138.5 manmonths

Additional Direct Production Labor: 1,000 manhours = 6.3 manmonths

A table of manmonths actually used to date and scheduled to completion of Phase I on 31 July 1954 follows, broken down by engineering functions. Please note that until the month of April 1954 only the Infrared Section Manager [redacted] and 25X1
three of his men [redacted] were 25X1

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Manpower Schedule Report

cleared for work on this project. During the month of April the man who was assigned as project leader [redacted] two 25X1 more electrical engineers [redacted] and 25X1 two mechanical engineers [redacted] were cleared. Three model shop personnel were also made available to this project by clearance in April, and in June [redacted] and 25X1 [redacted] were also cleared for this project. Thus the Phase I 25X1 schedule will be completed with only about 45% of originally scheduled manmonths applied to this phase, although 72% of the scheduled electrical engineering manmonths were used.

Following the Phase I schedule is a detailed manpower assignment for the month of July. It is to be noted that our plant will be shut down for the first two weeks of July for our annual vacation period.

Used and Scheduled Manmonths								
	EE	ME	Draft.	Model Shop	Com-ponents	Test	Tech. Man.	Total
June-Nov. '53	.4							.4
Dec.	.8							.8
Jan. 1954	.3			.5				.8
Feb.	1.2	.2						1.4
March	2.3			.1				2.4
April	1.8	.2	.1					2.1
May	2.7	.4		.3				3.4
June	2.9	.5		.3				3.7
July	2.5	.5	.2	.3				3.5
Totals	14.9	1.8	.3	1.5				18.5

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MANPOWER ASSIGNMENT - JULY

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Electrical Engineers

[redacted] 40 hours 25X1
80 hours
80 hours
[redacted] (Clearance requested 11 Feb. '54) 80 hours 25X1
48 hours
40 hours
32 hours
400 hours = 2.5 Man Months

Mechanical Engineer

80 hours &&
80 hours = .5 Man Months

Drafting

32 hours
32 hours = .2 Man Months

Shop

48 hours
48 hours = .3 Man Months

The next charts shown below are man month schedules for Phase IIa and IIb, plus a detailed assignment of Electrical Engineering personnel for August, 1954, which will be typical of assignments for all the months to follow.

Personnel assigned to the other engineering functions are as follows:

Mechanical Engineers: [redacted] 25X1

Drafting Personnel: [redacted] (clearance requested); others to make a total of 5 available will be requested at once. 25X1

Model Shop: [redacted] 25X1

Components: [redacted] (requested) 25X1

Test Equipment: [redacted] (requested) 25X1

Technical Publications: [redacted] (requested) 25X1

Production Labor: Two to be requested at once.

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SCHEDULED MAN MONTHS

			Phase IIa					
	EE	ME	Draft.	Shop	Com-ponents	Test	Tech. Man.	Total
Aug. 1954	5.8	2.0	2.0	2.0				11.8
Sept.	5.7	2.0	2.0	2.0				11.7
Oct.	5.7	2.0	2.0	2.0				11.7
Nov.	5.1	2.0	2.0	2.0				11.1
Dec.	5.1	2.0	2.0	2.0				11.1
Total	27.4	10.0	10.0	10.0				57.4
			Phase IIb					
Jan. 1955	4.5	2.0	5.0	2.0	.3	.3	.3	14.4
Feb.	4.1	2.0	5.0	4.0	.3	.3	.3	16.0
March	4.1	2.0	5.0	4.0	.3	.3	.3	16.0
April	4.1	2.0	5.0	4.0	.3	.4	.4	16.2
Total	16.8	8.0	20.0	14.0	1.2	1.3	1.3	62.6

(plus 6.3 man months of production labor)

MANPOWER ASSIGNMENT - AUGUST

[redacted]

120 hours
160 hours
160 hours
160 hours
120 hours
80 hours
48 hours
80 hours
928 hours = 5.8 mm

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Finally, the following chart compares the original schedule in man months with that which has been used and is now scheduled for the balance of the contract. It is to be noted that while less man months were used in Phase I than originally planned it is now contemplated that more man months will be applied to Phases IIa and IIb to make up for this deficiency and that the total number of man months applied will be as originally scheduled. It is hoped that the new schedule can now be adhered to with reasonable accuracy.

PHASE I

Original Plan		As Used & Now Planned	Balance
EE	20.8mm	14.9 mm	+5.9 mm
ME	9.8	1.8	+8.0
Draft.	3.1	.3	+2.8
Shop	6.6	1.5	+5.1
TOTAL	40.3	18.5	+21.8

PHASE IIa

Original Plan		As Used & Now Planned	Balance
EE	20.8	27.4	-6.6
ME	9.8	10.0	- .2
Draft.	9.4	10.0	- .6
Shop	6.6	10.0	-3.4
TOTAL	46.6	57.4	-10.8

PHASE IIb

Original Plan		As Used & Now Planned	Balance
EE	14.8	16.8	-2.0
ME	9.8	8.0	+1.8
Draft.	18.8	20.0	-1.2
Shop	4.4	14.0	-9.6
Comp	1.2	1.2	0
Test Eq.	1.3	1.3	0
Tech. Man.	1.3	1.3	0
TOTAL	51.6	62.6	-11.0

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Manpower Schedule Report
prepared by [redacted] 25X1
Section Manager
Infrared Section

Approved by [redacted] 25X1
Manager,
Engineering Department