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20 August 1957

APD-File 101B

MEMORANDUM FOR: THE RECORD

SUBJECT : Visit to [redacted] Infrared Communications (P-101 Sub-Projects)

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1. TIME AND PLACE OF MEETING: A series of discussions and field trips were held at and near the [redacted] during the week of 29 July - 2 August 1957.

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2. ATTENDANCE:

[redacted] principal technical personnel:

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[redacted]

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[redacted] Administrative personnel:

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[redacted]

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TSS/APD/GP
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O/C - RDB
(8/2/57 only)

3. PURPOSE AND SCOPE: The general objectives of the visit were:

Field performance tests of equipment

Detailed discussions on the study, Task 9 of Contract RD-54

Clarification of the C-unit (1S-5) program

[redacted]

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Objectives were met,

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Objectives were met, as summarized below. In addition to first-hand observation of personnel capabilities and interests, a considerable dividend resulted from observing equipment performance and difficulties in the field and assessing field test potentialities in the area.

4. CONTRACT REQUIREMENTS - FIELD TESTS:

a. TASK 7. 18 D-units were tested. Contract merely referenced the [redacted] proposal whose only performance specification was for satisfactory operation at one mile against a B-unit. The D-units were actually tested against each other at slightly over 2 miles, daylight. Tests were based on exchange, with return confirmation, of information; this included two serial numbers (sight head and electronics-charger unit) for each unit, five entirely unrelated words, plus incidental conversation relative to the test procedures. Set up was by [redacted] with our assistance; tests were conducted between [redacted] and [redacted] Sight head serial B and electronics-charger serial 18 were marginal, were retested in fog-haze against the [redacted] 905 (approximately equivalent to B-unit) at about a mile and will be rechecked by [redacted] for cell noise and grounding, etc., before acceptance. They are considered acceptable, but not quite on a par with the other 17 D-units, and may be potential trouble-makers. On-site test notes are on file in APD, P-101D. 25X1 25X1 25X1 25X1 25X1 25X1

b. TASK 1. 4 B-units. 2 of the re-worked units were completed by 2 August. [redacted] reported excellent performance at 3 miles from tests the previous night. Unstable heavy to partially clearing fog and haze prevented a successful long-range (40,000 feet) over-water trial. A variety of infrared equipments (B, C, D, 905), handy-talkies, and several cars permitted three separate parties to be set along the coast and moved as required. D to D intelligible communication range seemed to correlate directly with visibility just under a mile (estimated on a meteorological range basis). C to B (on 905) was very good. "D" unit had vibrator noise; C-unit receiver was very quiet. 905's at 40,000 feet pointed up practical locating difficulties. Looking "up sun" (1630 to 1730 hours, PDT) into fog and haze, the base site could not be seen visually; a hand mirror reflecting the sun in a regular scan pattern caused the base 905 to beep; but, even with handy-talkie radio link, IR communication could not be established. The situation required study to outline operational doctrine and to delineate limiting factors in long range work. The whole field exercise provided practical cogency to topics encountered in the study discussion; the rapidity with which 905's can be put into operation, compared with the difficulties with the B-units, was especially noted. 25X1

c. TASK 8.

c. TASK 8. E-unit. Equipment was seen but could not be demonstrated. The new galvanometer has been promised by the manufacturer by August 15th; however, there have been several delays in delivery in the past. The amplifier has been changed from transformer to RC coupling between stages thereby decreasing the number of transistors used, and also the size and weight of the overall amplifier. Regulation of the power supply over large voltage input ranges remains to be a problem.

The design of the present unit appears to be well executed within the stringent contract conditions. For a stable long term inventory item, further development is clearly indicated. The present E units will be delivered for test and evaluation as soon as the galvanometer is received and checked out.

5. TASK 9. STUDY PHASE: The subjects of the continuing discussions, in order, were:

Functional Components - Sources, optics, galvanometers, detectors, electronics, et al.

Applied Research - [redacted] state of knowledge of atmospheric effects, their estimate of additional required information and interest in obtaining. These effects provide the natural limiting factors to which good equipment must be designed. 25X1

Equipment Goals - Ultimate equipment types and performances. Desirable refinements in present units. (C-units are reported in paragraph 6 below.) Notes from conference between O/C [redacted] 25X1
and APD [redacted] on 25X1
22 July 1957 were used as a basis.

Since full reporting of the talks would require a series of memos, highlights only are given below. Sub-paragraph 5.c. is of particular interest. One subject in need of careful exploration but not discussed was test equipment. Proper alignment of the optical systems, together with detailed mounting design features, are essential to insure maximum range.

a. Functional Components: The two lamps used in the four equipment types represent excellent selection by [redacted] better choices may be possible but are not apparent. Close tolerancing on filament alignment relative to base pins is mandatory to maintain range performance; [redacted] inspects the small non-standard C-unit lamps individually. Increased output or reliability are to be sought in careful attention to efficient collection and imaging of the light from the filament, (at infrared wavelengths), in optimum galvanometer design, and in the design and quality of the beam-forming mirror. 25X1 25X1

Spectral output of the

Spectral output of the lamps as a function of battery operating conditions is needed; [redacted] will not be equipped to take these data until November; APD may be able to get some data before then. 25X1

Optical characteristics of the IR glasses for the lead sulfide region are required; APD to supply, with (later) samples. For reference, the glasses are Bureau of Standards A-2059, C-601, F-158, and G. E. dehydrated fused quartz (low index).

Galvanometer performance and supply are not fully satisfactory. APD is to ascertain Signal Corps [redacted] findings, and should meet [redacted] this fall for an all-out discussion. Lateral contact to BuStds and NOL-White Oak is desired on galvanometer design and new magnetic materials. At present the actual frequency response peaks at less than 2,000 cps and does not meet advertised peak response of 4000 cps. Environmental effects are of strong secondary interest. 25X1 25X1

The mirror optics are reported satisfactory; field checks were not available (see 4.b. above). Refractive optics for the smaller units are subject to re-design, for maximum efficiency, using the special glasses. Full support should be given to considering square apertures. (Hidden costs here are to be balanced against range and duplex performance). The detectors used are EK Pbs cells. Reduction in sensitive area (to maximize signal to noise ratio) is being accomplished; additional reduction is of marginal potentiality because of cell characteristics and limiting optical factors. The Eastman commercial mounts are not satisfactory; tolerances are wide, size is too great, and humidity protection is essential. A [redacted] sandwich scheme seems very desirable but will need following up. 25X1

The major decision in the electronics assembly concerns transistorization with silicon, not germanium, transistors. The increased cost (at current prices, crudely estimated at $100 to $150 per unit) would provide for global storage and operation. Germanium transistors in the present circuit (C-unit) will not operate beyond 106° F; an operating temperature specification is 40° to 100° F. (Based on test performance range of 38° F to 106° F). No increase in size is foreseen; application to the B-unit would permit a reduction. Among other circuit design items were duplexing (not difficult) and dynamic range (requiring study).

b. Applied Research: Atmospheric attenuation (measured transmission with absorption and scattering included) data are reasonably well known. Refined data from NRL, et al, are to be obtained.

The prime consideration

The prime consideration of security evinced by all users dictates acquisition of field data to corroborate theory. To get numbers for scattered radiation will probably involve a heavy fog, an intense source with good collimating optics, and sensitive detection equipment. Data are sought in polar plots for several visual penetration ranges; from such numbers the equivalent amount of scattering may be calculated for the less intense beams actually used in signalling. The second security aspect is that of beam interception. Measurements of beam intensity along lines normal to the line of sight will have to be made. Naked-eye, and metascope, perception of the direct beam was not reviewed, but data should be taken and concurrence obtained on the compromise between such security and range performance.

The degree of penetration into murky atmospheres is, to my mind, an unsettled question; certainly the few field results witnessed did not agree with my mentally predicted ranges; this could be caused by a relative inefficiency in the D-units and/or by the definition of "visibility." A desirable quantity, to me, is the ratio of infrared penetration to visual penetration for the several available sizes of units.

Study has been initiated on shimmer (atmospheric "boiling"); preliminary oscilloscope pictures were seen which had been taken from tape-recorded signals.

Simple instrumentation is needed for reproducible measures of the degree of visibility, or attenuation, and shimmer as well as for temperature and humidity. A reasonable amount of field work with these quantities will give technical personnel a realistic grasp of the effects on IR communication and will add to the stock of basic information which is either lacking or too spotty in this wavelength region.

c. Equipment: The gamut of possible sizes of IR communication equipment was discussed. At the small end, [redacted] felt that a device the size of a large cigarette package could be made which could be used at ranges up to, possibly, 200 or 300 yards. At the other extreme, long range equipments are, provisionally, separated into two groups; one, for horizon-limited ranges of approximately 20 miles and a second for ranges less than 10 miles. Mirrors of 20 inch diameter or less should be adequate. The present B and C units represent the two intermediate sizes. 25X1

Pulse transmission was discussed. Galvanometer modulation of the beam, is of course, limited to a few thousand cycles per second. A refinement suggested by the Lichtsprecher offers promise of modulation to 100,000 cps. Here, light is normally totally reflected in a prism. If, however, an external surface is intimately contacted to the prism, at the area where the light is being internally reflected, and the contact is varied slightly, transmission will occur instead of reflection. Proper development of the principle might involve a considerable program.

Major design changes

Major design changes in the B-units (15-1) concern the following:

Case: Same size or smaller with appearance, materials, accessories to be determined later.

Tripod: Present [redacted] design is ingenious but not practical for rapid field set-up. 25X1

Alignment: IR viewer to be eliminated; a good optical telescope is to be retained. (6-power, 8 to 10 degree field perfectly feasible.) Azimuth and elevation scales should probably be retained; incorporation of compass and bubble level is undetermined but desirable. Duplexing is virtually essential for easier alignment.

Optics: Competing design requirements require study, layout, and possibly mock-up, and may be influenced by field work. Duplexing implies either shared optics or duplicate optics for transmit and receive. Maximum range varies with aperture. Focal length and aperture determine f/number, which must be commensurate with the f/number of the lens used to image the filament on the galvanometer mirror. The present type of large mirror construction (slumped glass over mold) appears satisfactory, but may require detailed environmental checks; the lightweight epoxy mirror construction is promising but manufacturing controls are not yet sufficiently developed.

In the power supply assembly, eliminate the battery charger, with provision of a connector for an external charger; provide for operation from any of the following:

(1) Self-contained battery

(2) External automobile 12-volt battery

(3) A-C line, 50 or 60 cps, 95 to 128 volts

Although the lamp consumes most of the power, a fractional reduction can be made by transistorization. The study should consider silicon transistors for a final long-term inventory equipment both for power reduction and for minimum packaging.

6. C-units (18-5): The rapidly changing, and unresolved, procurement requirement picture necessitated a careful briefing of [redacted] on the situation and several discussions on matters of more general contractual information in addition to the technical design questions. The latter were split into two phases covering respectively those changes mandatory in the next procurement and the longer range changes for optimizing performance. 25X1 25X1

a. Essential Design

a. Essential Design Changes:

(1) Close all open holes to prevent entry of sand, etc.

(2) Improve battery contacts. When mercury cells are used, contacts require frequent abrading.

(3) Easy lamp replacement.

(4) Lamp base mounting to be secured firmly when factory aligned (now cemented).

(5) Sturdier microphone cable and connector.

(6) Separable ear plugs, hearing aid type.

(7) Improve open sight mounting.

b. Desirable Design Changes:

(1) Connection to external 12-volt automobile battery.

(2) Silicon transistorization. Study need, basic design, time and cost estimates.

(3) New optics. Special glasses, square apertures, overall efficiency.

(4) Detector. Mounting study, specification of characteristics. Contractor acceptance testing.

(5) Environmental. Without jeopardizing size or weight, design to some type of water integrity; cite acceptable environmental specifications.

(6) Spare lamps. Possible provision for internal mounting of spares.

c. Quantity Procurement: Minimum immediate procurement is 74 (possibly 84) units without ATIC requirements. Next cost break after 50 is around 100 (50 system). Below 50 sand castings would be used. Above 50 the die castings would run unit costs down as such items were made in increasing quantity. Tooling quoted would handle lots up to 1000. A large fraction of the cost is in purchased parts where the cost is proportionate to quantity. Production (MIL-standards) type drawings will have to be procured together with handbooks and a final formal specification. Procurement on 100 units could start deliveries in 8 to 10 months; silicon transistorization might require an additional 3 to 5 months.

[redacted] is agreeable

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[redacted] is agreeable to an escalator clause for later increases in quantity and corresponding decreases in cost. The time factor could be balanced with a contingency phrase covering increased labor and material costs not under their control. 25X1

d. Spares: The following quantities of spare part requirements were estimated:

Operating Spares:	Bulbs	--- 600%
	Microphone cables	--- 100%
	Push-to-talk switch	--- 100%
	Head phone cables	--- 100%
Depot Spares:	Galvanometer	--- 25%
	Detectors	--- 100%
	Function switches	--- 25%
	Receiver & transmitter assembly boards	--- 25%
	Microphone & headphone jacks	--- 25%
	Filter Glass (Schott-UG-8)	--- 25%
	Lens caps	--- 25%
	Lamps	--- 300%

7. RECOMMENDED ACTION: Approval and support of the study program is recommended. Concurrence by the Office of Communications, Research and Development Branch, on the equipment study items is desired, together with guidance on the extent of effort desired on the "staff" size equipments and on the very small [redacted] unit. Otherwise, it is proposed to carry each through the "paper study" phase on feasibility, outline of design, time and cost estimates. 25X1

It is believed that re-design of the B-unit should be studied seriously before undertaking procurement of permanent units; interim procurement, if any, should be of B- or 905 types, with slight corrections. Further need for D-units cannot be forecast; apart from special packaging applications, the intermediate performance between B and C types seems difficult to justify.

The program outlined is believed sound in scope and essential to putting this phase of our infrared effort on a firm basis. It is also flexible enough to meet reasonably-scaled priority demands and much of it is of direct interest to opposite desks in the military. It is somewhat larger than that provided by the original task but contains the minimum factors for establishing lasting designs.

Immediate initiation of

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Immediate initiation of procurement of 100 (50 sets) of the C-units, with essential changes incorporated, is recommended on the basis of minimum present need for 72, unknown ATIC requirements, and advantage in price break at the 100 figure. Time delay in ascertaining a definite figure can soon become excessive.

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Distribution:
Orig. - P-101B
1 - P-101D
1 - P-101F
1 - DMM
1 - PGN
1 - Chrono

PGN:DMM/ls

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