Brief notes on a visit to Australia, New Guinea, Ceylon and India, December 7, 1943 to March 12, 1944

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BRIEF NOTES ON A VISIT TO AUSTRALIA, NEW GUINEA, CEYLON AND INDIA

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C O N T E N T S

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These somewhat disconnected notes form a summary of the author's impressions during a visit to the South-West Pacific Area war theatre, to Radiophysics Research Laboratories in Sydney and several manufacturing firms. Also included are some notes on a brief trip through Ceylon and India. Operational experience was gained largely in New Guinea, and the India trip served in the main to confirm the difficulties encountered under tropical conditions in New Guinea as being also common to the South-East Asia Command and to assist in formulating a policy for design of future radar equipment for both these areas.

The chief object of the mission was to ascertain what was wrong with the equipment now in the field, what could be done to existing equipment to make it more suitable to tropical conditions, both climatic and operational, and what specifications were reasonable and desirable for the design of new radar sets for this general area. In this report most of the irrelevant details of the trip have been omitted, though these might be of rather more interest from the entertainment view-point, and names and personalities have beer left out except where necessary to the discussion. Considerable attention was given to ground radar equipment because it was apparent that the operational requirements in this field were not being met satisfactorily.

1. REPORT ON RADAR IN NEW GUINEA:

R.E.G. (SCR-588) at Port Moresby - This station is situated in a valley in the vicinity of Port Moresby and was put into operation on 7th December, 1942. The site is very poor for GCI; the ground is level for from 50 to 300 yards, and then foothills rise to several hundred feet over large sectors. The station is intended mainly to cover a pass through the Owen Stanley Mountains. Almost unbroken P.E.'s extend in the desired northern sector to 50 miles, yet the operators track aircraft and furnish height information and number of planes with amazing skill. They were able to track targets solidly through the P.E.'s which I was rarely able to see. Practical experience under "have-to-do-it" conditions appears to be responsible for this efficiency.

The transmitter is R.E.L. SCR-588 Serial #1 as built for U.S.S.C. and the receiver is Serial #13 as built for the R.C.A.F. Total hours on the transmitter as of January 17th, 1944, were 9088. Average life of VT-98's is 4000 hours at 18 KV. One thyratron only is used in the speed control, together with a reversing switch, because one of the filament transformers burned out. No spares.

The original range c.r. tube is still in the set after 9000 hours. The third PPI tube is now in use. There was a small amount of sweep jitter and selsyn stickiness in the PPI system but the operators have become so used to it that they did not notice its presence.

A British Air Ministry preamplifier has been fitted using two CV-66's and one RL-7 which has improved signal-to-noise about 3 or 4 db. They had received adverse reports about the R.E.L. preamplifier and so obtained one from England. The R.E.L. glow gap type #2 has been very satisfactory with an average life of 1700 hours. Some insulation fractures have occurred in the framework of the T-R boxes.

Three Diesels are used, two at a time, and only minor troubles have been encountered during the 6000 hours each has run. They are mounted on cement blocks under a roof hut with no enclosing sides. Spare supplies for the stations are kept on open shelves under this roof to allow free ventilation. No difficulties whatever have been encountered with fungi or moisture at this station, both because the Port Moresby area is reasonably dry and because of the sensible precautions taken in maintenance and storage. The maintenance schedule calls for the routine checks plus a bit of extra cleaning and dusting. The station is shut down one hour out of 24 for this purpose. Apart from this one hour daily lay-off there have been only six hours lost in the last five months due to breakdown.

LW/AW Mk. I(a) at Koitaki - This station is located about 2000 feet above sea level 30 miles north of Moresby in the Owen Stanley Mountains. The purpose of this installation is to plug the gap through which the Jap planes used to come to bomb Moresby. The P.E.'s are extremely bad in the desired northern sector. Mountains subtend 4° - 5° elevation. This station has been on the air since September 9th, 1943, with a total of eight hours lost time due to breakdowns. The daily maintenance period is 45 minutes. The power supply is 10 h.p. Ford engine with a Westinghouse Roseberry 50 cycle, 5 KVA 0.8 p.f. generator which has given satisfaction with but minor repairs. The total weight of supply of 1360 pounds has caused some complaint but its greater reliability is much to be preferred to the weight advantage of the 602-T6 supply, with its attendant unreliability.

Again at this site the stores have been no problem since the personnel, consciously or otherwise, put into effect some of the recommendations outlined in Dr. Magee's report on the "CONDITION OF SERVICE MATERIAL UNDER TROPICAL CONDITIONS IN NEW GUINEA". That is, thorough cleaning and ventilation of spares together with occasional testing, keeps them in good condition. The rainfall here is 130 inches per year but humidity has not adversely affected the equipment, due probably to the fact that it is on the air all day. Spare transformers are baked out in wet weather before installation.

IFF with vertical $\lambda/2$ transmitting and vertical $\lambda/4$ receiving antennas backed by screen. Model BL.4 U.S.Navy. Display on LW/AW "A" scope downwards.

Land-line phone is normally used to report to Fighter Sector with W/T as a standby. A single operator at the AW tube (A scope) rotates the turntable by hand to scan the sector, (usually less than 360°) maximizes on targets, and gives the R, θ, information to the plotter-teller in another tent who plots the data and then relays it to the Fighter Sector. The average time for a plot to reach F.S. is from 60 - 120 seconds.

Later on other LW/AW sets were examined in the Ramu Valley and at Finschhafen, which again appeared to give reliable service under the most difficult site and climatic conditions. The American Army has been even more enthusiastic about the LW/AW than the Australians themselves since its performance is as good as the very heavy 270 set and much better than the 602-T6. The U.S.S.C. has placed orders for LW/AW, and for LW/AW antennas which are now used on 602 sets,

and are impatient for delivery. In point of fact, the general consensus of opinion is that the LW/AW set is the best piece of equipment in the S.W.P.A. theatre with the fewest maintenance headaches.

SCR-516 Nadzab (Markham Valley) - This is a modified SCR-268 set. The modification consists of adding a couple more dipoles to the height-finding antenna and calling the set an early-warning-cum-height-finding equipment instead of a fire-control set. (See descriptions of both 268 and 516 in N.R.C. files). Operationally it is much worse as a 516 than as a 268 and at that the 268 proper is not very good. Some difficulty was encountered in convincing them that they could not do any kind of height-finding below 10° - 12° (which is the most important region for early warning height finding, though not for fire control). In addition, the H-F antenna had some very obvious minor lobes which interfered with the main beam split even when the main beam was well clear of the ground, thus explaining some weird results that have been obtained at specific angles between 12° and 20°.

Three A scopes are used. One is range only, one is azimuth with CD-type split, one elevation with CD-type split. In practice they no longer attempt to use the set as a height-finder, except on very high aircraft, but merely as an air warning station feeding in plots to the Fighter Sector as any other E.W. set. This station is intended chiefly to watch up the valley.

The receivers and the c.r. scopes have given a lot of trouble in transformer and condenser breakdown. They find that spare transformers must be warmed on low voltage before installation. There was some deterioration of stores due to the moisture here, but no fungi were in evidence. IFF Mk. II-G in use.

602-T6's at Lae, Finschhafen and Saidor and Surrounding Area - A total of nine 602-T6's were inspected in the above areas, four of them within thirty miles of Finschhafen and three near Saidor. Servicing problems were discussed also with the maintenance men at headquarters battalion. In the maintenance of these sets the following points were noted, which are here recorded in haphazard sequence.

The H.T. transformer can is too small; breakdown occurs between the coils and the can. The sealing compound is not good. Ten failures in eleven H.T. transformers have occurred in the past month.

Spark gap motor is reasonably satisfactory. In every case they had removed points from the gap, which normally comes with four points, to leave one, or at most two points. This was to cut down pronounced jitter troubles rather than to increase range. (This sounds more like something wrong with the Kipp relay and sweep circuits than with the gaps). The blower and blower motor have been discarded on most of the units since the motor wore out quickly, and the air from the ventilating fan is directed over the CV-92's.

The transmitter and modulator components have been reshuffled in the chassis to shorten and to isolate H.T. leads. This is not a standard modification but has been done in many of the equipments.

The receiver power transformer invariably breaks down after a few days operation, usually internally. However, poor cabling is a contributing factor since an arc sometimes starts behind the retaining plate of the connector.

Normal maintenance period is one hour out of twenty-four. A 100% replacement of all units is desirable during this period so that a given 602 equipment has one day on and one day off being overhauled, but supply and circumstances do not permit this in the more forward areas. A dry brush and a cloth are used to clean every unit daily. Carbon tetrachloride is used on tubes and insulators. Moisture in this part of New Guinea may make the equipment inoperative during the hour maintenance period unless care is taken to heat up the units slowly, or preferably, to keep the work tent heated, (this latter procedure is very uncomfortable!) It is not possible to add electric heaters to the field installations since the power supply is already fully loaded.

Chief breakdown in receiver, apart from the transformer, is the 0.02 condensers. Some general comments on the receiver are: sensitivity poor; signal-to-noise bad; overall gain insufficient for good A scope display; scope itself has a poor baseline appearance which prevents weak echoes being detected as baseline breaks. The I.F. loading resistors have been removed in most of these field sets which improves some of the above characteristics at the expense of introducing instability.

PPI's were used in one or two installations in the Trobriand Islands before the equipments were moved to New Guinea. They were never satisfactory as used with the 602 and their main use was as azimuth indicators. Much of the prejudice against PPI is due probably to the fact that the ASV Mk. II receiver is not at all designed for

PPI work so that the operators are correct in stating that the PPI ranges are less than A scope ranges, though with proper design the ranges should be equal. Another point influencing the discard of the PPI tube is that the 602 Yagis have been thrown out in most of the stations (only one Yagi was seen in use) and the Australian LW/AW antenna, wigwam, and turning gear substituted. Suitable gearing is not available for coupling the PPI sweep coil system to this antenna. As a by-product, however, the PPI power supply is invariably used on the receiver, since it holds up much better than the receiver supply, though there is a tendency for the PPI transformer to arc across the leads inside the case.

The main power cable to the generator sometimes fails with internal shorts. The double generator itself holds up quite well though the Briggs and Stratton engine is too light for continuous load. The carburetor butterfly wears out quickly and governor goes haywire slowly and causes bad hunting. It was suggested that the Australian 10 h.p. Ford engine would be good. The 583rd A.W. Battalion under Major Lambert has used Jeep motors quite successfully to drive the 602 generator. One of the Briggs and Stratton motors has done 2500 hours without an overhaul but this is exceptional. The three-way pulley has been redesigned since most of the Briggs and Stratton motors have had their speed lowered to 2200 r.p.m. to obtain longer engine life.

One tropic-proofed 602-T6 is now in the area and has been operating at Station 621 for a few days. This was not long enough to determine how effective the tropic-proofing may be, because it had not rained the past week.

No serious trouble was encountered with carbon pile regulators provided the discs are cleaned with CCl_4 once a week. It was suggested that it was highly essential to have better voltage control of the modulator H.T. in order to warm the sets up gradually.

All the spares and replacement units are cooked in the field by means of makeshift tin can ovens and blow-torches. At the maintenance posts more elegant ovens are improvised for this purpose.

Test equipment is very scarce. They find that the Ferris Signal Generator and the Dumont Scope are quite satisfactory. However, the voltohm-meters supplied have one and all gone haywire on the multipliers. Particular attention should be paid to supplying test equipment capable of operating on the generator supply frequency and preferably on 60 cycle as well.

The serial numbers of R.E.L. 602-T6's in use at the 583rd AW Battalion were 67 - 71, 73 - 78, 80 - 81, 207 - 210. These fifteen sets were used to keep six radar stations on the air. Originally, the earlier serial numbers were put into training use in U.S.A. December 1942, and went into operation in the Trobriands in June 1943, and later shifted to New Guinea. Many of these have been dunked in the ocean, dragged through mud and rivers and dropped from cliffs.

Every care is taken to ensure good drainage from the operating and equipment tents, together with adequate ventilation. Grass huts are sometimes built to replace the tents and are much cooler. Both the 602 and the LW/AW wigwams can get very hot -- some of the ambient temperatures run up to 120° - 130°F so that operator efficiency drops sharply after twenty minutes. In one or two cases double-walled tents were used, with lowered temperatures.

The 602's move into position on D-day plus three or four hours consequently while under fire and in raw jungle, the first set-ups are not in the best sites. Actually, at Saidor where the mud was three feet deep, the radar units moved in on D-day minus a couple of hours! Something slipped in the schedule and the air warning platoon arrived at the beach ahead of the main landing forces. Fortunately opposition at the beach itself was negligible at the time, though plenty was encountered a few hours later. (There were still a few dead Japs a short distance from the radar sites when I arrived at Saidor a few days later.)

The only 602 seen using the Yagi antenna was sited five feet above sea level in a coconut grove. The sea level siting enabled them to get a measure of height-finding but the station was actually used only for range and azimuth. Planes have been reported by this station up to 124 miles inland and destroyers at 25 miles. These "results" might be due in part to the fact that the siting officer had selected a better air warning site about 500 feet elevation farther inland but the platoon commander was not at all anxious to move his station. It frequently happens, and with justification, that the site must be chosen not only for its radar value but also with regard to pitching a livable camp for fifty men, with a water supply.

Mk. II-G, IFF was used on most of the 602's, though one at Saidor was installing a Philco Mk. III type RC-192A, with the whole works in a box about 12" x 12" x 8". This

was working well the next day while I was there. During January the order was issued to swing over from Mk. II to Mk. III in the S.W.P.A. but it will be several months before all the ground stations have Mk. III IFF.

Some major changes suggested in the 602-T6 set are as follows: (see also memo February 2nd to General Akin)

1. Substitute LW/AW or equivalent type for Yagi antenna.

2. Use power turning on the new antenna. (LW/AW antenna is hand-turned.)

3. Increase capacity and durability of power supply even at expense of weight.

4. Discard present receiver in toto. Suggest installing the receiver from the 588 CHL/GCI set which is a much better job in every way and is now in production at R.E.L. A pre-amplifier would be very useful.

5. Unless the receiver is designed to favour PPI the PPI portion may well be omitted because it is not used.

6. The present unit boxes should be made stronger and waterproofed to be sufficiently strong in themselves. Present practice is to discard the heavy outer boxes because they are unnecessarily heavy for air transport and they get broken up in water transport.

Numerous suggestions for minor changes will be apparent from preceding notes. Major Lambert of Fifth Fighter Echelon, stated that he would send in a report to N.R.C. in a few weeks outlining his findings on the 602 and including his recommendations.

I have taken care to emphasize that the U.S. Signal Corps asked for the 602, along the lines of the original rush job model shop units, and that they were intended for temporary or beachhead operation and not for twenty-four hours a day duty for a year. In fact, with a bit of tact (I hope) here and there most of the complainers were soothed down and admitted that they were trying to get far more out of the set than the specifications called for. I lost no opportunity to impress them that, though the set was not a good radar for this theatre, it was not R.E.L.'s fault but the responsibility of the U.S.S.C.

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S.O. Equipment on P.T. Boats - The P.T. launches patrolling the Huon Peninsula - New Britain area are well equipped with standard 10 cm. S.O. sets. The spinner is housed in a small dome mounted on a ten-foot pedestal, just aft of the cockpit, which folds down when not in use. Transmitter and receiver at the base of the pedestal are in a small box with waveguide running to the antenna. The PPI display is in the cabin just forward of the cockpit so that direct verbal or telephonic instructions can be furnished to the pilot.

It is used chiefly for coastline navigation. Normally one boat out of the usual patrol of three is using its radar at a time. They had not tried blind torpedoing with it but had used it on several occasions to locate Jap ships and barges, then sinking them with the aid of a searchlight when necessary.

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Two types of 602-T8 Westinghouse 500 megacycle sets were unloaded at Dobadura while I was there but they have not yet been unpacked.

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270 Set at Scarlett Beach - This station was hauled up a 500 foot hill and put into operation in two days, which is something of a record for this type of equipment. Water-cooled 530's are used. The maximum ranges are of the order of 150 miles. This is only ten percent greater than that of the LW/AW station operating at the same site, whereas the power and weight ratio of the 270 over the LW/AW is rather more than three to one. Spares are very short and hard to get; a universal complaint. Due to the rugged and conservative construction of the 270 few maintenance difficulties have been encountered.

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AI Mk. IV sets in four P-70 planes (formerly A-20's) were inspected briefly at Finschhafen. The antennas and display systems do not appear to have been changed from those seen at R.A.E. Farnborough, England, in 1940. These planes had just arrived at Finschhafen with a couple of nights' operation only, so that no operational data was available. There is no GCI station in the area and the vectoring is done very roughly from the Fighter Sector by R/T.

Mk. II ASV in New Guinea Area - Hudson aircraft had started to be fitted at the beginning of 1942.

During 1942, Catalina aircraft were using ASV consistently on operation.

The serviceability of Hudson installation was very poor partly due to faults in equipment, and partly due to the installation and A/C generators. Towards the end of the Hudson's life the ASV was giving slightly better results due to modifications carried out in the equipment.

Beaufort a/c have always given good results with ASV. The installation in the Beaufort gives very little trouble if proper inspections are carried out. The ASV equipment now in use has had many modifications carried out on it which have increased its serviceability to a high standard as long as routine inspections are maintained.

There are now only a few consistent faults. Calibration inaccurate. Voltage regulator type 8H tends to hunt after about 150 hours operation. This fault can be easily eliminated by smearing the dash pot piston with anti-freeze oil at every 80-hourly inspection.

Blower motors have a habit of stopping.

Type AV11 filament transformer still tends to short internally.

All the valves give good serviceability except the AVII's which have the highest percentage of failures.

The following aircraft carry Mk. II ASV:-

	Homing	Searching
Beauforts	S.R.A.S.V. &	L.R.A.S.V.
Hudsons	"	"
Catalinas	S.R. & L.R. A.S.V.	"
Walrus	S.R.A.S.V.	
Ansons	L.R.A.S.V.	
Venturas	S.R. & L.R. A.S.V.	L.R. A.S.V.

The Beaufort gives a serviceability of over 90% when good maintenance is carried out.

Average maximum ranges with Beaufort aircraft are as follows (approx.):

	L.R.A.S.V.	S.R.A.S.V.
Medium sized ships	25 miles	16 miles
Convoys	35 miles	22 miles
Beacons	Full scale	Full scale

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GL Mk. II and SLC at Dregor Harbour and Langemak (Huon Peninsula)- Two GL Mk. II's and six British SLC's are operated here by the 2/1 Australian Composite A.A. Regiment. These two GL's have been in the field for twenty-one months. One of them was originally used as a trainer in Australia and many of the training faults put into the sets by the instructors were still in it when it reached New Guinea. The two sets are separated several miles. The sites in each case are fairly good, reasonably flat for 100 yards radius, and at 4000 yards a range of hills cuts off the line of sight at about 12° so that permanent echoes are not troublesome. It has not been possible to run calibration flights and the only check on the accuracy is that the heights from the two sets agree to within ± 200 feet. Also, they have shot down three Japs at night in the past month which is very good since the blighter comes over now only about once a week in sporadic raids.

Incidentally, the last time that the Jap came over while I was there he dropped ten "Angels" at one mile intervals and this put the GL's off for a bit until they realized the targets were drifting too slowly to be aircraft. None of these particular specimens were captured, but on a previous occasion a weird metallic structure supported by a parachute was reported to have been recovered by some infantry men and torn up for souvenirs.

These GL stations are running literally without any spares! It is not feasible to keep them warm continuously yet they must go on the air with one minute's warning. So far they have stood up to the strain of being turned on quickly after several hours idleness in 90% humidity. (Will GL III-C do this?)

They are very keen to get hold of some GL III-C sets in the S.W.P.A. theatre. The closest that one has got is Darwin where it was put into operation towards

the end of this January. They were enthusiastic here, and also at Melbourne, about getting Canadian Army technical men over to operate and instruct in GL III-C. This has already been covered in my previous cables and the action is in hand.

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Radar Counter Measures - R.C.M. in New Guinea is not yet in a very advanced state. The chief project on foot is listening to Jap radio and radar stations with search receivers and assimulating the information obtained for the benefit of Intelligence. No counter-jamming on Jap stations has been employed yet. Since the Jap is not as obliging as we are in operating radar sets in certain fixed bands the first difficulty is to locate his frequencies. Once a Jap radar has been located and observed for several days they usually turn the location over to Bomber Command who then proceed to eliminate the station, unless there is some prospect of capturing it by an Allied landing. The available information to date indicates that the Jap has not progressed much further in his radar technique since the installation captured at Guadalcanal. There is not the slightest evidence that he knows about centi-metre techniques and consequently no magnetrons have been flown over Jap territory. Two Ferret aircraft have recently arrived in New Guinea, equipped with all kinds of panoramic and aural search receivers. "Angel" mentioned above, is one of the concerns of the R.C.M. group. "Window" has also been used but in insufficient quantities to be effective.

On one occasion while at Finschhafen, a chain of six radar stations was reporting to Fighter Sector the track of an Allied night fighter approaching the air strip. All six operators apparently failed to notice, or at least to report, that there were two planes in the flight. The second was a single Jap raider coming in on the tail of the night fighter and since the entire base was fully illuminated he was able to do some damage with his bombs. The Jap has performed this trick a couple of times and as a result the night fighter pilots have developed a reluctance to turn on their AI or their IFF because they claim that the Jap is d.f.'ing on their radar and so following them in. The R.C.M. group have weighed the meagre evidence in these cases and have concluded that this premise is probably unfounded and that the Jap merely established visual contact.

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Fighter Sectors - The Fighter Sectors at Port Moresby, Nadzab, Finschhafen and Saidor were inspected under working conditions. Each of these is a small scale Stanmore, having a large table map of the area with the appropriate grid. Markers with breast-sets stationed around the table are in land-line or F.M. radio contact with the chain of six to ten radar stations of various types feeding into the sector.

The Controller sits at a raised desk and analyses the board. Representatives of Fighter and Bomber Commands are on hand for identification and liaison. American and Australian A.A. and searchlight controllers are also present to pass on defensive instructions. If an unidentified or hostile track approaches within ten miles of the camp the Controller pulls the red alert siren and plunges the district into darkness. (Even the most forward areas are fully illuminated at night unless a red alert is sounded). The Controller then gives instructions to the A.A. and searchlight men, and directs the defence of the area. This man is usually a young first or second lieutenant without too much experience but he invariably turns in a very fine job, under great pressure.

The Fighter Sectors are housed in above-ground huts about 40' x 30' and having open sides for adequate ventilation. They are built in a newly invaded area within one or two days after D-day as a rule.

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In general, throughout New Guinea, the ground radar equipment appeared to be of obsolete design and with the exception of the LW/AW, not well suited for operation in New Guinea terrain and climate, both of which are the world's worst, I think. In spite of this most of the stations were turning in a performance, both in operation and maintenance, that would put to shame the performance of many a North American radar crew operating under much more favourable conditions. The P.E.'s everywhere are simply appalling (have a look at a contour map of New Guinea) and yet the operators learn to track aircraft through them with uncanny skill. Much of this success is due, not to any inherent quality of the equipment, but to the untiring diligence of the maintenance men and of the operators who put everything they have into the job. The repair man simply has to devise ways and means of keeping the sets on the air and soon gets to know every component intimately.

The airborne equipment in the area appears to be less subject to trouble than the ground radar. In addition, new aircraft coming in are sometimes fitted with more modern sets though there is still a deplorable lack of suitable equipment.

The U.S. Navy, on the other hand, has excellent radar equipment, probably because all the ships are properly fitted in the States regardless of where they may be going. The Australian Navy is fairly well fitted, though manufacturing bottlenecks tend to slow up this programme.

2. REPORT ON RADAR IN CEYLON AND INDIA:

Two GL Mk. II installations were inspected in Ceylon in the vicinity of Colombo. No operational difficulties have been encountered, the sites are good and many calibration flights have been made. Humidity and moisture causes the same troubles that exist in New Guinea (see table of temperature and humidity for Colombo at end of this section, Appendix A), but not to the same degree. Condensers, small and large, are the chief cause of failure. All rubber covered power cables must be left above ground and preferably raised slightly, otherwise white ants will eat through the rubber and fabric sheath right to the copper in a few days' time. Even above ground the rats appear to be very fond of rubber and frequently cause damage. There has been no evidence of fungus. An interesting feature is that the GL receiver cabins are air-conditioned; these are American products made by Carrier, Frigidaire, General Electric, etc. The capacity of the one inspected was not known by the officer in charge but the driving motor was rated at 1 h.p. The temperature in the cabin on a normal sunny day runs from 115°F to 120°F without the air-conditioner and is about 75°F to 80°F with it. The outside shade temperature being in the neighbourhood of 80°F to 85°F. No evidence of condensation on the equipment or interior was noticed, though the inside temperature must have been hovering near the dew-point.

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IFF Mk. II, II-G and II-N is presently in use in Ceylon. Mk. III has not yet been installed in Ceylon or for that matter in the S.E.A.C., with the exception of the Bengal-Arakan front where installation of Mk. III IFF has begun. It is expected that aircraft and new ships will be fitted with Mk. III transponders by about April 1st, and if so, a change-over order will be given to switch from Mk. II to Mk. III at that time.

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The R.A.F. is operating twenty-six ground radar stations throughout Ceylon and it is considered that the early warning coverage is very good. The radar AW stations are of types TRU and MRU operating on 4 to 7 metres, using 105-foot, 120-foot and in some cases where the country is very flat, 184-foot wooden towers. The working ranges of these types vary from 80 to 100 miles with some height-finding. The azimuthal accuracy is not too good.

Several COL stations (CHL) are sited round the coast on sites ranging from 150 feet to 500 feet above sea level. These furnish fairly good low flying coverage (none too low) up to 130 odd miles. Some GCI stations also tie in to the AW chain when required for air warning, though usually they are allowed to perform their normal function of fighter control.

The GCI station at Ridgeway, Ceylon, was operating from trailers. The antenna was mounted on a short pedestal staked to the ground and was a single bay affair, that is, the lower 7 1/2 and 12 1/2 foot antennas only of the usual GCI type. All the equipment, receiver, transmitter, Lister diesels, plotting boards, etc. was housed in three large trailers. This station vectored the fighter in a successful attack on the only Japanese raider, a four-engined flying boat, to approach Colombo in the past month. The Beaufort fighters are equipped with Mk. IV AI at present, though some of the Mk. VIII AI (S-band) has been shipped from England and is expected in the theatre shortly.

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An interesting complaint was that the iron dust cores of the I.F. coupling transformers rusted rapidly; the consequent swelling would detune the transformers and in bad cases the screw cores would jam so that they could not be re-tuned. The condensers were giving the usual troubles in the R.A.F. equipment but the maintenance crews had developed a technique of boiling the condensers for several hours in beeswax and then allowing to cool off with a beeswax coating. This permitted the condensers to run at their full ratings for several thousand hours as compared to zero to a few hundred hours for untreated condensers. Beeswax is infinitely preferable to the hydroscopic paraffin waxes. Transformers were being re-wound in the Base Shops after breakdown, first boiled in beeswax and then sealed in pitch. The bakelite terminal strips on many transformers deteriorate rapidly and take up moisture.

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Two CD Mk. V (S-band) sets were inspected at Colombo. One of these used a single 6-foot dish pan with single waveguide feed and standard 277 radio. The other used a pair of 6-foot dish pans with dipole feed and a transmitter of much lower power -- about 10 KW. Their chief troubles come from salt spray corroding all the metal work and are minimized by applying typical Naval techniques such as constant cleaning and bi-weekly painting of exposed parts. Wax-free shellac dissolved in ethyl alcohol, is used to coat insulated wires. It is usually possible to warm up the equipment slowly for an hour or so before applying H.T. so that moisture difficulties are reduced.

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The first British LW set to arrive in Ceylon had just been put into operation. This does not differ greatly from the 602-T6. Four Yagis are employed and apparently the PPI operation compares favourably with the A scope presentation so that the PPI is the main tube in operation use. It is a little early to say how the operational characteristics and maintenance of these sets in the tropics will compare with the 602-T6.

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There are no 602-T6 sets in Ceylon, and in fact, no American radar on the island at all. The Americans are just beginning to move in, however, and their radar may follow, though the island appears to be adequately covered at present. There are four 602-T6's in Assam and Northern Burma, their serial numbers are 151 to 154. They were put into operation about August 1943 and have been operated spasmodically since. None of the sets has run more than 300 hours and no attempt has been made to keep them on the air on 24-hour duty as in New Guinea, consequently complaints on the maintenance of these sets were not as severe as those encountered in the S.W.P.A. As far as could be ascertained no modifications have been made to the 602-T6's in India such as have been carried out in New Guinea.

The difficulties of jungle warfare in Northern Burma are immense. Weeks and months are required to get the radar equipment to the desired locations and the operational difficulties are identical to those in New Guinea inasmuch as the terrain is very mountainous and permanent echoes universal. Two American 270 sets are

in this area but do not appear to be any better operationally than the 602. Several British GCI and CHI sets have been installed along the coast from Calcutta to Arakan and are giving good service in spite of adverse terrain. Long wave AW sets, such as TRU and MRU are also in use but are less effective than the 200 megacycle equipment.

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At New Delhi the opportunity was provided for numerous interviews and conversations with the staff of the Radar Command of South East Asia Command. In the main it was evident that, as far as tropical conditions were concerned, the equipment on the Burma Front has to operate under conditions almost identical to those experienced in New Guinea. The types of radar equipment in this area are the same as those in New Guinea, with the addition of several fixed TRU stations and a higher percentage of CHL/GCI. Since the scale of fighting here appears to be somewhat smaller than in the S.W.P.A. the number of radar equipment in the Assam-Arakan area is rather fewer. The humidity and fungus troubles are countered by a stepped-up maintenance programme suited to tropical climates similar to that evolved through hard experience in New Guinea.

Topographically the country is somewhat tougher than New Guinea both for radar operation and for transport and supply. In fact the time and difficulty involved in reaching a representative number of stations in Burma appeared to outweigh the value of any additional first-hand information on actual tropical conditions so that in the light of the above remarks no visit was paid to this front.

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The Radar Command is experimenting with COL sets (CHL Overseas) mounted on Chevrolet or Ford trucks. They have tried a British LW set in a Jeep with very good results using a small broadside array, 2 x 2 elements, without PPI. The LW set has also been mounted in an amphibious Jeep but this is not considered operationally successful because of the difficulty in maintaining freeboard and trim. However, it is now working well in a larger amphibious vehicle, the DUKW. The GCI has also been placed on board a LST and has given good results, with some modification to the height-finding technique.

Several Rebecca-Eureka trials have been carried out in the jungle with quite fair success though no trials have been run under operational attack conditions as yet. H_2S has been used with fair results though the data is not complete. The typical Asiatic city of several hundred thousand inhabitants gives a very poor H_2S response as compared to a European city of small size. Two Lancasters have been fitted with H_2S so far. A chain of navigational aids is in use throughout India consisting of high frequency d.f. stations, medium frequency d.f. stations, VHF homing stations, ASV and AI beacons. Light mobile G-H is intended for use in the Arakan valley. Mk. VIII AI has been tested in the area.

Mk. II IFF is currently in use in the S.E.A.C. and the switchover to Mk. III IFF is scheduled for April 1st if sufficient equipment can be installed in time.

The chief Base Repair and Service Unit is located at Bombay. Here are made all modifications necessary to adapt new incoming equipment to Indian conditions and serious repairs to field equipment are also returned to Bombay.

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The radio manufacturing facilities in India appear to be rather meagre naturally, though the peace time commercial firms are turning out standard components such as batteries, condensers, transformers and so on for Service use. It is probable that these facilities will be tapped only for certain standard items and that no attempt will be made in the near future to set up production of radar or communication equipment in India. The Indian Government research organizations are interested in the radar field and it is possible that they will be able to make some contribution to the art. The liaison between the S.E.A.C. and the Indian Command is good though not perfect, but may become more difficult when the S.E.A.C. moves to Ceylon sometime in April.

APPENDIX A

COLOMBO

Months	Rainfall Standard Averages	Temperature Averages		Relative Humidity Standard Averages	
		Max.	Min.	Day Conditions	Night Conditions
	ins	°F	°F	%	%
January	4.03	86.4	71.9	70	91
February	2.20	87.1	72.2	68	92
March	4.87	87.9	74.0	68	93
April	8.88	87.9	75.9	71	92
May	14.98	86.7	77.5	76	89
June	8.98	85.3	77.3	78	87
July	5.96	84.7	77.0	78	87
August	2.64	84.7	76.8	76	87
September	7.01	85.3	76.6	75	89
October	13.25	84.9	74.9	76	92
November	12.34	85.0	73.5	76	93
December	5.64	85.5	72.4	72	92
Year	90.78	86.0	75.0	74	90

TRINCOMALEE

January	8.70	80.5	75.2	78	86
February	2.04	82.6	76.0	70	82
March	2.36	85.4	76.6	70	87
April	1.99	89.0	77.7	68	88
May	3.45	91.6	78.8	64	83
June	1.08	91.9	79.0	60	80
July	1.87	92.4	78.1	59	79
August	3.51	91.9	77.2	60	80
September	3.52	91.7	76.9	62	82
October	9.14	87.8	75.7	70	88
November	14.26	83.5	74.9	79	90
December	12.01	81.0	74.8	79	88
Year	64.83	-	-	68	84

3. REPORT ON RESEARCH AND MANUFACTURING ORGANIZATIONS IN AUSTRALIA:

The complete wiring diagram for all branches of scientific research in Australia is given in a small pamphlet entitled "SCIENCE ON SERVICE", now on file at the National Research Council, so that only the salient features of the radar organization need be mentioned here.

Radiophysics Laboratories, Sydney - There is no need to go into any detail about this organization because their projects are already well known to N.R.C. members and their reports and monthly progress bulletins are received regularly. Only the new and interesting highlights will be mentioned here briefly.

At present their active projects include AWH (Air Warning with Height Finding). Their experiments on this project in the past have demonstrated its feasibility using an array sixteen dipoles high. The signal strength from the whole array is compared with the signal strength from the central half of the array. Since the polar diagrams in free space of these two arrays are greatly different it is possible to obtain fairly accurate height finding between 5° and 35^{c} independent of the height of the site and independent of the interference pattern. As designed for the R.A.A.F. the antenna will probably consist of a square array eight dipoles high and wide in order to obtain azimuthal resolution.

They have already a CmH patterned closely after the British model and are obtaining fairly good results.

They have designed a J33 ASV set for aircraft which is similar to the American ASD-1. If delivery of a long outstanding order on ASD equipment is made in time it is probable that this set will not go into production.

In the early warning field they have done considerable developmental work towards setting up a system on the L band (25-30 cms.). The Valve Laboratory at the University of Melbourne has been working on the magnetron and local oscillators for this band with fair success. They contend, with very good reason, that long range early warning can best be done on a wavelength in this neighbourhood. This wavelength was also given serious consideration in Canada but rejected because of the difficulty in obtaining components for production sets.

R.P.L. has constructed several CD sets on the S-band for the Army which are installed around the coast.

At the request of the R.A.A.F., R.P.L. are making several tropic-proofed Rebecca-Eureka equipments and expected to test them in New Guinea shortly. It is probable that all the R.A.A.F. requirements can be met by Australian production.

The research and engineering standard in Radiophysics is quite high and fully comparable with similar institutions in the United States and Great Britain. However, the same cannot be said for the manufacturing effort.

Tropic Proofing - Tropic-proofing of electrical equipment is the responsibility of the National Standard Laboratory whose programme of course includes all supplies and equipments. Their publication "ELECTRO-TECHNICAL SPECIFICATION 2", on file at the N.R.C., is representative of the work being done. Because of their proximity to jungle conditions, the Australians are in a good position to make rapid advances in the art of tropic proofing. At present the National Standards Laboratory is handicapped by a lack of personnel and it is recommended that the Canadian Tropic Proofing Committee should give serious consideration to sending one or more competent men to Australia to assist in this programme and to acquire experience which would be beneficial to Canada on their return, especially in view of the possibility that Canadian forces might well be in this theatre of war in the future. It is suggested that a physicist or a chemist, or both, with some industrial experience would be the best men to send. A mycologist would be useful but not as important.

Manufacturers - The largest firm engaged in production of radar equipment is Amalgamated Wireless Association which employs about four hundred persons on radar. They have made eighty sets of 272 Mk. I equipments (very similar to British 271 S-band equipment) for both the Army and Navy. A 272 Mk. II set has passed the development stage and is starting into production. A.W.A. is also making the A-79 which is a 150 cm. equipment used with the LW/AW set.

Amalgamated Wireless Valve Company, employing forty persons, is responsible for the manufacture of centimetre magnetrons and local oscillators. They have produced about 1000 CD-35's and are making a CV-83. The

production of NT-98's is about 20 per week with a total of 150 to date, and of CD-56's 20 per week with a total of 100 to date. They are making British yellow and red spot crystals at a rate of 50 per week. (Note: The valve department of A.W.V. suffered very severe damage by fire late in February).

New South Wales Railways Annex is doing most of the mechanical work for Australian radar equipment. They build the aerials, turntables, wigwam frames, etc. for the LW/AW; the 1 1/2 metre small ship arrays; double cheese slice for the Australian 272 set as used by the Navy. The 103 coast defence fire control displacement corrector and predictor designed by the National Standards Laboratory is being built here. Its size is about 6' x 10' x 8' high. It takes any two co-ordinates together with rates of change from any of six observation posts and cranks out the predicted ship position. The first model is very near completion.

The N.S.W.R. Annex appears to be quite efficient at taking rough sketches of mechanical structures and turning out a production prototype in a short time. Unfortunately their capacity is quite inadequate to the demand.

The H.M.V. Gramaphone Company has about 250 employees making air warning equipment and test gear.

4. R.A.A.F. OPERATIONAL REQUIREMENTS:

The R.A.A.F. outlined their operational requirements for air warning and GCI in the S.W.P.A. Summarized these are as follows:-

1. A light weight GCI station with the following performance

(a) Air warning from 5 to 50 miles.

(b) Height finding with an accuracy of ± 1500 feet between 10,000 feet and 35,000 feet at 10 miles and 45 miles.

Pending the provision of more efficient equipment the R.A.A.F. will use some LW/GCI Mk. I equipments.

A discussion at Brisbane on 5th February revealed the impossibility of departing from the reduced 1944 LW/GCI operational requirement. Current operations,

particularly at ARAWE, have shown the necessity for a light weight GCI station that can be operated on the target area to provide the completest possible GCI cover up to 35,000 feet over the whole of the area swept out by a radius of 45 miles measured from the GCI station. R.A.A.F. Command realise the impossibility of completing the zone represented by a cylinder of 10 miles radius about the station, and have therefore asked only for cover in the zone lying between 10 and 45 miles from the station.

Whereas ± 1500 feet in height finding accuracy will be acceptable for LW/GCI Mk. I and II, it is desirable that the R.P.L. should regard 500 feet as the ultimate aim for GCI height finding accuracy.

It now seems likely that LW/AWH will be able to provide height finding above 6,000 feet (in addition to early warning) over ranges lying between 30 and 100 miles; furthermore, the low flying cover stations (LFC) should be able to provide a useful degree of warning below that height (vide the following paragraph). R.A.A.F. Command are, therefore, prepared to cancel the full operational requirement for the LW/GCI, but must rely on the R.P.L.'s forecast for LW/AWH performance as set out in Fig. 3 of the R.P.L. Report T1/101/1 and upon the provision of adequate low flying cover below 6000 feet.

In respect of performance of low flying cover stations, R.A.A.F. Command would like the maximum possible performance by these stations in a zone from 10 to 70 miles at heights between sea level and 6000 feet. It is appreciated that detection at sea level will not be possible from low sites at ranges of 70 miles.

In brief the operational requirements are as follows:

(i) A LW/GCI station giving full GCI facilities from 10 to 45 miles at all heights from 10,000 feet to 35,000 feet. Height accuracy to be ± 1500 feet.

(ii) LW/AWH stations giving height finding accuracy of ± 2500 feet over ranges from 30 to 100 miles. The air warning performance should remain as far as possible that of the current LW/AW Mk. IA.

(iii) Low flying cover stations (LFC) giving air warning from 10 to 70 miles at all heights from sea level to 6000 feet with the exception of the zone lying below the optical horizon.

These requirements were put up to R.P.L. who have undertaken to meet requirement (i) above by improvements on the design of the LW/GCI; (ii) by AWH development described in the preceding section; (iii) can be covered to a fair extent by LW/AW stations but some thought will be given to decimetre and centimetre early warning.

5. SUGGESTIONS FOR FUTURE AIR WARNING EQUIPMENT FOR S.W.P.A. AND S.E.A.C.:

After lengthy discussions with members of the staff of the Chief Signal Officer, S.W.P.A., together with information obtained from meetings between the R.A.A.F. and Radiophysics, Sydney, the following suggestions for ground radar equipment were drawn up. To some extent these ideas duplicate the R.A.A.F. requirements as outlined in Section 4 but they are clarified by contact with the American Services and personal observations.

(i) "Package" Set

Total weight to not exceed 250-300 lbs. including generator and should be broken down into units of not larger than 50 lbs. with container. Desirable range as great as possible, naturally; 30-35 miles acceptable. Beam should be narrow in both horizontal and vertical planes because of the requirements that it must operate in valleys and highly mountainous terrain. PPI if possible. Tropicalised.

This is a rather stiff specification and may not be easy to meet. The use of X-band equipment appears to be the most promising attack and some thought is being devoted to this at the N.R.C. utilising a MTB set. The Package Set would be extremely useful because there are many operations in which no vehicle can penetrate to the desired location and air transport is not feasible.

(ii) Light Weight Fighter Control Set

Of existing equipments, the SCR-615 (S-band) in its mobile version appears to offer a fair and immediate solution. There are none in New Guinea as yet. The SCR-615 is still a very heavy set and an equipment mounted on trucks or trailers is not universally usable in jungle and island fighting. An alternative suggestion, though more in the line of medium range warning, would be the N.R.C. MZPI (S-band) which is mounted on a 6 x 6 truck. The requirements for the GCI set are as outlined by the R.A.A.F. (see Section 4) and it is probable that the R.P.L. 200 megacycle LW/GCI will give excellent performance together with transportability. Tropic proofing required.

(iii) Long Range Air Warning

The range on a medium bomber must be at least 100-120 miles and preferably greater. Height coverage on a 40,000-foot aircraft is required to as short a minimum range as feasible, although inside 30 miles the tracking on high aircraft can be taken over by short range equipment. Height finding of some nature must be provided, the more accurate the better, though a low-medium-high type would be acceptable. It is recognized that a high powered long range set cannot be built as a package set but the equipment must be air transportable and individual units should not weigh more than 250-300 lbs. Ease and rapidity of assembly is essential as are simplicity and reliability of operation. Tropic proofing required.

The proposed Australian 200 megacycle LW/AWH should meet many of these requirements. On the other hand, the use of S-band equipment offers some additional features. The Jap has been considerate enough so far to come in at fairly high altitudes but this is no guarantee that he will not adapt the practice of wave-hopping in the future, and microwave equipment is required to counter this, as shown by experience in England. The N.R.C. has been making MEW equipments for the R.C.A.F. which have ranges

equivalent to the American MEW but which are much simpler, that is, they have fewer displays and electronic luxuries. With the addition of a height finding technique and a complete re-design of the mechanical structure together with a further circuit simplification, it is felt that a satisfactory long range set can be built suited to S.W.P.A. and S.E.A.C. conditions. Work on the design of such a set will start shortly.

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The Staff of the Chief Signal Officer S.W.P.A. was of the opinion that a few equipments of rugged and reliable design in the field as soon as possible would be greatly to be preferred to waiting for production line sets in larger numbers. The proposed operational technique is to use such sets, say, of the order of 20 or 30 in number, asadvance stations, moving them forward as operations progress. The base positions can then be replaced by older equipments already in production.

D. W. R. McKinley.

Ottawa, Canada,

April, 1944.