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THE MALAYAN TRIALS OF THE WS A510

(Tests on laboratory Models in April 1952)

By

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1. GENERAL

The purpose of these trials was to assess the A510 in an area where not only tropical conditions existed but also where a military action was actually taking place. The aim was further to show the equipment to members of the British Army and receive criticism based on their first hand knowledge of requirements in that area. Further, apart from the A510 itself, it was expected that the general knowledge gained would be of great advantage in the design of future equipments.

The party consisted of Lt.Col.D.Small (Department of Supply), Major R.P.Woollard (Directorate of Signals), and Major R.Coutts (Directorate of Infantry), together with K.G.Dean and L.K.Curran as civilian observers representing A.W.A.

It was much appreciated by the A.W.A. members that although we were two civilians of a military party, in military surroundings, we were at all times treated as two members of an Australian party of five, whose purpose was to test and demonstrate the equipment which we had brought with us. From our point of view, our greatest disappointment was the restrictions placed on our movements in Malaya. Australian Military headquarters had specifically stated that the civilian members were to be permitted to go only into safe areas. As bandit activity exists over the whole of Malaya this was interpreted by G.H.Q., Singapore, to mean that we were free to move only on Singapore Island itself and in the camp area of the Farelf Training Centre, (F.T.C.), 25 miles north of Singapore, in the country around which most of the tests were carried out. This did not permit us to see or make any technical assessment of primary jungle from the point of view of aerial erection or propagation conditions, although we had assumed that this would be one of our important tasks.

On the other hand, much was learned from people we met at the F.T.C. The F.T.C. is a centre where not only are troops trained for the jungle action in Malaya but where the staff has an intimate and detailed knowledge of the conditions existing in Malaya. A general background of ideas on requirements and limitations of communications equipment was obtained, not only from officers, but also from N.C.O.'s and signallers. Although most of the information was obtained from direct technical discussion, the very contact with people of experience in the jungle often provided, indirectly, just as important information. For example, the story of a training patrol left in the jungle for two days without rations expected from an air drop, because the signaller had rendered his wireless useless by leaving it switched on and allowing the batteries to run down, was a rather forcible reminder that all equipment needs to be as foolproof as possible.

At the F.T.C. we were permitted to see demonstrations of tactical and signals methods used in the jungle. Having stressed the need for maximum efficiency of aerials when used with small sets, it was of great interest to find that it was the practice in Malaya to do everything possible to get the most out of the aerials used, even to the extent of spending an hour (after a day's treck through the jungle fully loaded with gear) in clearing the scrub around the aerial site.

The tests were usually carried out with one A510 at the F.T.C., set up as base-station, and one or two A510 sets mobile in the surrounding jungle or rubber areas. Tests were carried out using both sky-wave and ground-wave conditions with both long wire and whip aerials, and comparisons were made with the WS68 which is the set currently used in Malaya. Although the 68 set is probably equal or better than the A510 in power and radiation efficiency, it proved at most times to be inferior in operation to the A510, because of the 68'set's lack of stability, the difficulty in netting it with other sets, and because of the time it took to get it tuned and "on the air."

The A510 also has a marked advantage over the 68 set in weight and shape (form factor). The comparative weights of the A510 and the 68 are respectively 16 and 34 pounds. Demonstrations and tests were carried out with the A510 carried on a soldier who was also loaded with his other gear (ammunitions, weapons, rations, etc.). When the A510 is mounted on the chest in two basic pouches (the normal mounting position), the complete load enabled the man to stand erect in a comfortable position (see photograph 4). The 68 set is strapped with the rest of the soldier's equipment on a standard metal carrier (left hand of soldier in photograph 4), which is mounted on the back. With this method of mounting and the additional weight of the 68 set, (the total weight then is 70 lbs.), the soldier must lean forward to maintain balance and it is difficult to walk without swaying. In order to satisfy some who preferred all the equipment to be mounted on the back, it was demonstrated that the A510 could also be fitted very neatly onto the standard carrier (photographs 3 & 5).

Demonstrations were also given of a soldier fully loaded with gear, plus the A510 mounted on the chest, to show that he could go to ground and use his weapons whilst the A510 was in an operating position, including the whip aerial and loading coil being in place (photograph 2). Photographs of the equipments mounted on the soldier are appended to this report.

A one-day visit was paid to Kuala Lumpur where the sets were shown to the Headquarters staff and signals representatives from the operational brigades in the area. Unfortunately, a short demonstration was largely a failure, due to excessive electrical noise at the base station.

Whilst at Kuala Lumpur, an Army report was obtained on aerials and propagation; this was based on operational rather than technical results. It is most interesting because, in spite of difficulties of erecting good aerials in the jungle, the operational recommendations agree by and large with those made by us on purely technical grounds.

The D.S.I.R. ionosphere research station in Singapore was visited twice. It was of interest to find that a Thomas noise recorder had been installed some months previously. Readings are not interpreted in Singapore but are sent back to England for analysis. At the time of the first visit no results of the analysis were yet available, but since then the first results have been received and are now in the D.S.I.R. official (unpublished) reports on noise which can be seen in Australia. Also, the ionospheric records which we were permitted to examine indicated clearly the unusual ionospheric conditions of that area, which has an important bearing on the choice of operating frequencies; these are rather lower than would usually be expected. Only a limited number of records had previously been found in the literature.

The R.E.M.E. (Royal Electrical and Mechanical Engineers) workshops at Singapore are well equipped for radio servicing and are air-conditioned. Discussions with the people there, on servicing problems and faults in military equipments, proved to be most profitable. It was of particular interest to note that failure of sealing in the 88 set, which has similar cases to those which will be used on the A510, represented only about 2% of all faults. The greatest number of faults was due to valves.

2. TESTS

The majority of tests carried out were listening tests and subjective ratings (strength 1 to 5) were given to the signals received at each end of the radio circuit. These, it is considere give only an assessment relative to the prevailing conditions of general background noise, both atmospheric and electrical. This is especially so as the receiver of the A510 has sufficient gain almost always to give adequate acoustical levels of output, particularly when long aerials are used. It is considered that these figures give an overall assessment of the communications circuit. It was shown that the assessments by members of the Australian party agreed with those of signallers; further, that when strengths 4 to 5 were recorded, more than 80% of words, sent in random relationship, could be copied correctly.

Rather than being an assessment of maximum ranges achievable over a limited number of conditions, the tests were carried out to demonstrate that communications could be achieved speedily and under a wide range of conditions. Comparisons with the 68 set indicated not that this set was inferior in radiated power, but that the A510 was superior in simplicity of operation and stability.

The fixed A510 base-station at the F.T.C. usually had better aerials, particularly for ground-wave working, than the mobile station. For example, generally when a whip was used for the out-station a long wire was used at base; however, a whip was at times also tested at the base station. Also, the area around the base station was either cleared or comparatively lightly covered for at least a quarter of a mile in all directions. The frequency used for ground wave working was generally 3.45 Mc. but, again, all other frequencies were examined. For sky wave working the frequency basically used was 6.45 Mc. as this was estimated as being the nearest to optimum of the frequencies available, but for this mode of propagation the other frequencies were also examined.

Under conditions of the base station as described, ground wave communications in both directions were achieved, with a whip aerial at out station and wire at base, for distances up to 5 miles or more when the intervening terrain consisted of rolling hills covered by rubber plantations. When the mobile station was mounted on a vehicle (thereby providing a better counterpoise for the set), two-way communication for distances of 6 to 8 miles was possible. When long wire aerials were used at both ends, communications over distances of nearly 10 miles were achieved. With a whip aerial at both base and out station distances greater than 3 miles were possible with this intervening terrain. The above distances are quoted for intelligible communication (above strength 3 on the subjective rating) and for a suitable low frequency 3.5 Mc. Less ranges or strengths were found for higher frequencies.

When the intervening terrain was covered by 3 miles of jungle and 5 miles of rubber, ground wave communication of low intelligibility, but sufficient to transmit the record of strength received back to base, was achieved.

For distances between 5 and 10 miles it is often possible to use, with equal effectiveness, either the sky-wave or the ground wave and when end-fed aerials are used, it is difficult, at times, to tell which is the mode of propagation. It was possible to get some indication that the ground wave was being received by replacing one aerial by a whip, which ideally will receive no sky wave. Further, a serious increase in fading when dipoles (for the sky wave) were replaced by inclined long-wire aerials indicated the presence of a strong ground wave as well as sky wave in the second case.

When the intervening terrain, except for the camp area, was covered entirely by primary and secondary jungle, a range of about 3 miles was achieved when a long-wire existed at base and a whip at the out station. For whip to whip working within the jungle a range of a little over 2 miles was achieved, but it is considered that this figure (2 miles) is rather optimistic and a safer conception of the range for the worst jungle would be a mile or less. (Note - it is difficult for us to discuss this point as we saw only partly the type of country involved).

It is particularly to be noted that the ranges obtained for whip to whip working in jungle were achieved only at the highest frequencies (6.5 and 9.5 Mc.). No exact numerical explanation can yet be given of this fact for a distance of 2 miles as sufficient knowledge does not exist of jungle attenuation nor has the actual radiated power of the A510 yet been accurately determined, but it should be noted that the original propagation estimations for the A510 for soil conductivities of 10^{-13} (good soil) and 10^{-14} (poor soil), indicated that for distances less than 1 mile <u>higher</u> fields would be expected for the <u>higher</u> frequencies. <u>Further</u>, it has been found experimentally that the aerial losses are often greater at the lower frequencies than originally assumed in the theoretical estimations and aerial coil losses are likewise greater. Three factors determine the relative ranges for different frequencies, viz, efficiency of whip aerial which increases with increase in frequency, the efficiency of the aerial loading coil which increases also with increase in frequency, and ground-wave propagation efficiency which is less at higher frequencies. Atmospheric noise during quieter part of the day should not be a limiting factor. For average terrain the third factor compensates for the other two. In one assumes for the jungle an equivalent conductivity of 10^{-15} E.M.U. the field strengths for all frequencies should be about the same at 2 miles <u>neglecting</u> the additional tuning coil losses at lower frequencies, <u>and also</u> neglecting aerial losses in addition to those originally assumed.

Radio/telephone sky-wave communication was maintained without trouble. The maximum distance achieved was about 26 miles but this distance is unimportant, as for sky-wave working there is no propagation difference for surface distances up to 50 miles and little for even greater distances, the height of the ionosphere being 200 miles or more. The basic frequency used was 6½ Mc., and when other frequencies were tried it was automatic that a return was made to this frequency, so that in spite of any failure on a less advantageous channel, contact was always maintained. The choice of this frequency for basic use appeared substantially correct but good results were obtained also with 5.2 and 4.2 Mc. and some contact, at inferior intelligibility, was made with a frequency of 3.5 Mc. and also at 9.9 Mc.

The fact that 9.9 Mc. was found to be inferior to lower frequencies is important, as without knowledge of ionospheric anomolies existing in the area, this is the frequency which would be chosen. It proved less useful because firstly, the effective height of the ionosphere is greater than at lower frequencies, and secondly, because of interfering stations and also higher atmospheric noise during the middle of the day.

For sky-wave communication during the day in Malaya, it can be said that satisfactory R/T results were obtainable for the period of the trials provided correct frequencies were used and, generally speaking, provided a dipole was used at one terminal at least, and preferably at both terminals. Although good results were, at times, obtained when inclined end-fed aerial were used at both ends of the circuit, this was not always the case

A summary of the listening tests is included in the appendix.

3. MEASUREMENTS

Only a limited number of measurements of field strength were taken as the equipment used was too inflexible. As weight precluded taking an ordinary F.I. set to Malaya, an A510 was adapted for the purpose. This consisted of a receiver with output meter; for calibration the transmitter was placed at a known distance from the receiver (greater than 100 yards). A most interesting feature of the measurements taken was the low fields actually recorded, some of these being less than 1μV/m. These fields are well below the capabilities of the Marconi F.I. Set. With fields of this order, intelligible signals were received even on a whip aerial, especially if an earth mat were used. This latter fact indicates to what extent the success of the set in Malaya has been due to the sensitivity of the receiver.

These measurements are recorded in the Appendix together with the subjective tests. A point of particular note is the increase of strength when an earth mat is used and when higher power batteries are used.

Measurements on noise were mainly carried out using a 6.5 Mc. dipole at the base station. The received noise was measured by using the adapted A510 receiver (with meter) and the substitution of a signal generator for the aerial determined the level of the input voltage. The dipole was used for convenience as it was already erected and there was no means for calibrating a vertical aerial. Further, there was no means for tuning an aerial on the adapted receiver and a cut dipole provided an aerial which virtually did not require tuning.

4. AERIALS

The importance of efficient aerials is well appreciated in Malaya where the most simply erected inclined aerial is not recommended for the equipment there. All aerials used there are supported at two points and are mainly the inverted -L type. Such types could well be used with the A510, with the limitation that the A510 would not tune an aerial having a half-wave horizontal section and a vertical section less than a quarter-wave, which is the most promising type at present used in Malaya.

The dipole is, however, the best simple aerial of all and the A510 has been specifically designed to have maximum efficiency when feeding it.

In Australia, the dipole was never tried properly with the A510, it being regarded only as an aerial to be used when others failed. A previously cut dipole proved very effective in Malaya and easy to erect, and due to its use, it is considered that the sky-wave tests were far more effective. When dipoles were used, even at only one end of the circuit, better results were achieved than with end-fed aerials, provided the dipoles were sufficiently high. It is to be noted, especially when tests were specifically carried out, that a low dipole (5 - 7 ft say) always gave an inferior rating strength to a higher dipole (25 ft.) and usually inferior also to well erected end fed aerials. It should also be noted, however, that good communications did take place at times whilst the outstation was still erecting the aerial and on one occasion when the aerial was actually on the ground but an increase in receiver output level was always noticed as the aerial was raised.

6. <u>THE EQUIPMENT</u>

It is considered that the success of the trials in Malaya can be attributed to three aspects of the equipment, viz, (a) the high sensitivity of the receiver, (b) the simplicity of the transmitter tuning <u>even</u> with the present function switch which is difficult to use and is being replaced, (c) the general reliability of all parts of the equipment and its inherent stability. It is considered that had the equipment been sent to Malaya at a less developed stage, or after a more hurried development with consequent less attention to detail, the tests may well have been disappointing.

Three complete wireless stations A510 and one modified to serve as an F.I. set, were taken to Malaya. The sets were those used in the field trials at Balcombe, Victoria, in February. It will be recalled that as a result of the Balcombe trials many modifications were requested, the most important of these being the replacement of the function switch and a greater meter reading for tuning when using the rod aerial.

The equipments taken to Malaya were modified to give greater output indications but no other modifications were carried out, except that the preferred type loading coil was used on each. A new arrangement for the transmitter panel in which the function switch had been replaced by a much more convenient system had been designed before the party left for Malaya. A "dummy" front panel incorporating the ideas of the proposed new arrangement was taken to Malaya and shown at all the demonstrations of the equipment. The criticisms made by the user at Balcombe were repeated by their equivalent types in Malaya, although perhaps with not the same emphasis, as the signal personnel were prepared to accept some difficulties in their earnest approach to establishing communication.

Of the three equipments, two contained receiver units which did not incorporate AVC, the third set containing a receiver with AVC. This latter set was the only one, therefore, which met the user requirements technically. The transmitter sections and interwiring was identical in each station.

At Balcombe the four equipments had worked throughout the trials without a fault occurring. In Malaya two equipments failed during the trial period, these being the receiver unit with AVC and the receiver unit modified to serve as an F.I. set. The failure in both cases was due to the effect of humidity on the i.f. transformers causing primary to secondary leakage due to inadequate sealing of the case to front panel and the omission of the sealing screws on the i.f. assemblies. This fault was not regarded with any seriousness as the present cases were not claimed capable of providing real hermetic seals, but it is significant to note that the receivers in which the I.F. transformers were sealed, gave no trouble. There were no other electrical faults and mechanical ones were only comparatively minor.

The receiver units were repaired at the very well equipped workshop of R.E.M.E. This workshop was very efficiently organised and included a large air-conditioned section containing screen rooms and an oven in which dry air was circulated. The repair on the two receiver units did not remain effective and these two units deteriorated again.

The operation of the sets in the jungle brought to light two unexpected difficulties and some modifications have been called for as a result. In the jungle perspiration from the operator is sufficient to shower the panels of the sets as though it were raining. This shower of moisture covers the window of the main tuning meter and impairs visibility to a very large extent. Heavy rain, which is a regular feature of the tropic areas, also has this effect. The first modification, therefore, is concerned with improving the viewing of the tuning scale. This information was passed back to the A510 team at A.W.A. whilst the party was still in Malaya and the modifications to design were well under way when the party returned.

The impaired visibility made the tuning of the whip loading coil much more difficult than it should have been. The Army representatives asked that an investigation be made as to whether the tuning was too coarse and to carry out any modification thought desirable. This information was likewise passed back to A.W.A. whilst the party was still in Malaya. However, it is probable that with an improved viewing arrangement the present tuning of the loading coil will be satisfactory.

The heavy perspiration and rain shower on the panel also showed that the aerial terminal did not provide adequate insulation. This information was also passed back to the A510 team whilst the party was still in Malaya and a new terminal should prove quite satisfactory, both electrically and mechanically. The terminals on the equipments had proved inadequate in the mechanical sense, both at Balcombe and Malaya.

The second important requirement brought to light was the necessity for some form of crash limiter. The severe local thunderstorm which occurred each afternoon in which a large burst of static occurred with intervals of 1 sec. to 1/5 sec, impaired intelligibility by overloading the ear. The provision of a crash limiter was one definite requirement not previously suggested. Since the return of the party an investigation has shown that there will be some difficulty in incorporating the limiter.

Slight modifications in the layout of controls were suggested by various people and these have been acted upon where possible. In general the sets were accepted and used in their present form with ease by all types of signals people. It was obvious, however, that the Balcombe request that the function switch be simplified was quite justified.

With regard to accessories, it was noted that the 8-wire earth system, for use with long aerials, was cumbersome for jungle working. This had already been noted during the aerial investigations early in the development of the A510, and alternatives having the same efficiency were examined, and for one reason or another found wanting from an electrical point of view. The only answer seems to be to reduce the number of wires and accept the additional loss. Deterioration of the "shorting links" on the one-length end-fed aerials occurred but this did not cause undue concern, as they had been prepared quickly in order to answer the criticism of the Balcombe trials that three separate aerial sections to be used in combination (as then supplied) are liable to be lost. The success of the dipole in Malaya calls again for an adjustable dipole as originally specified. The only way of achieving this effectively seems to be some form of roll-up spool. If such can be developed it could overcome also a major fault of the one-length long-wire aerial, i.e. that when a short aerial is required much of the height is often lost in the non-active sections.

It had been suggested before the Malayan trip that the set should be sealed in such a manner that it would not be possible to repair it in the field without special tools. It was noted that this is in fact being done with the WS88, in which a new case screw which breaks off when tightened sufficiently is being used. Also the dessicator cannot be replaced unless the unit is withdrawn from the case.

The WS.A510 compares favourably with the WS68 at present being used in Malaya. The technical figures for the sake of comparison are shown below:-

	WS68	WS A510
Frequency coverage	3 - 5.2 Mc.	2 - 10 Mc.
Power output	1 Watt in 75Ω	0.75W in 75Ω
Receiver sensitivity	4.0µV	1 - 3µV
Weight	34 lbs.	16 lbs.

CONCLUSIONS

The A510 proved itself to be a reliable and flexible piece of communications equipment under the conditions which it was required to operate in Malaya; it proved itself to be superior, in overall effectiveness, to the currently used heavier 68 set. Except for deterioration due to moisture in two of the sets, no new major faults were found. (This fault did not cause undue concern as it had not yet been possible with the hand-made cases to provide perfect hermetic sealing).

Faults, such as those of panel layout, etc. discovered in previous tests, continued to be evident. Some smaller faults were evident, (these are now being remedied), and methods of improvement suggested themselves and these are now being acted upon where possible.

From our point of view the novel arrangement of including civilians in the Army party was a success and much was learned by us of Army requirements and problems; it is thought that only benefit can result from continuing this arrangement and permitting A.W.A. people to be present at future trials.

We wish again to express our appreciation to the Army members of the party who, at all times, treated us as one of them.

A P P E N D I X

BRIEF SUMMARY OF TESTS

TEST NO.1.

Test was carried out using Mobile A510 Set in jungle communicating to fixed A510 Station at F.T.C..

Able (Fixed Station) used an end fed inclined aerial on H condition.

Able 1 (Mobile Set) used a whip aerial.

The Frequency used was 3,450 Kc..

Test commenced with Able 1 in secondary jungle, 2 miles from base. Able 1 (who was with foot ambush demonstration) then moved ½ mile into jungle on foot, first through primary jungle, then into secondary jungle. A condensation of results obtained is below.

Time	Strength		Comments
	Able to Able 1	Able 1 to Able	
1430	5	5	Commenced walking.
1457	5	5	In primary jungle.
1520	5	5 (At times 3)	In secondary jungle. Some intelligibility lost due to movement of Able 1.
1535	5	5	Able 1 stationary in middle of jungle at administration area.
1547	5	-	Communication lost due to electrical noise at base.
1602	5	5	Noise gone, Able still near administration area.
1625	5	5	Walking back towards transport.

TEST NO.2 - 9/4/'52.

Test carried out with Able (A510 at F.T.C.) on long wire aerial and Able 1 (A510 Mobile). In conjunction with Able 1 was Able 2, a 68 Set.

Frequency 4,240 Kc.

Time	Location	Strength	Remarks
1500	1 Ula Tiram (1.75 mls.)	Able to Able 1 - 4 Able to Able 2 - 2 Able 1 to Able - 4 Able 2 to Able - 5	Able 1 on whip 7'6" Able 2 on whip 11 ft. Static and electrical noise present.
1530	2 (3.2 mls. South)	Able to Able 1 - 5 Able to Able 2 - - Able 1 to Able - 3 Able 2 to Able - 2	Noise (electrical) present as well as X's. Able 1 on 7'6 whip Able 2 on 11 ft. whip. Tests carried out using signallers as operators indicate that our assessment of strength is substantially correct.
1615	"	Able to Able 1 - 5 Able 1 to Able-1to3 Able 2 - not heard	Electrical noise continues Able 1 on whip.
1630	"	Able to Able 1 - 5 Able 1 to Able - 5	Long wire aerial for Able 1.
1645	3 (5 miles South)	Able to Able 1-4to5 Able1 toAble 1-4to5 Able 2 (on whip not heard)	Wire aerial for Able 1 C.W. interference and static.

TEST NO.3 - 11/4/'52.

Comparisons were made for different frequencies at Positions 1 and 2 and measurements of field strength were taken. on 3.45 Mc.

Considerable amount of time was lost in taking measurement owing to the difficulty of operation of this equipment by one man the receiver and calibrating oscillator being 100 yards apart.

Able - (A510 Base Station), Able 1 - (A510 Mobile Set).
Baker - (Fixed 68 Set), Baker 1 - (Mobile Set).

Time Hrs.	Position	Frequency	Strength	Remarks
1000	1 ($1\frac{3}{4}$ mls.)	2000 Kc.	Able to Able 1 - 5 Able 1 to Able - 5	Slight Xs. Able 1 on whip.
		3450 Kc.	Able to Able 1 - 5 Able 1 to Able - 5	Slight Xs. Able 1 on whip.
		6485 Kc.	Able to Able 1 - 4 Able 1 to Able - 1	More Xs than on other channel. Able 1 on whip.
		9860 Kc.	Able to Able 1 - 3 Able 1 to Able - 3	Morse interference blots out 9860 Kc. channel. Able 1 on whip.
		3900 Kc.	Baker to Baker 1-5 Baker 1 to Baker-5	Baker 1 on whip. Baker on end fed wire.
		3450 Kc.		Measurements taken on Able 1 and Baker 1.
1120	2 (3.2 mls.)	2000 Kc.	Able to Able 1 - 3 Able 1 to Able - 3	Loud crashes of Xs Able 1 on whip.
		3450 Kc.	Able to Able 1 - 5 Able 1 to Able-3to5	Able 1 on whip. Loud crashes of Xs
		3450 Kc.	Able to Able 1 - 5) Able 1 to Able - 5)	Wire aerial Able 1
		" "	Able to Able 1 - 5) Able 1 to Able - 5)	Whip aerial at Able
		3450 Kc.		Measurements taken of Able 1 on wire and whip aerial under various conditions.

TEST NO.4 - 12/4/'52.

Ground wave tests continued. Some conditions of test 3 repeated for measurement purposes and then Able 1 moved further on to point 3 and moved into rubber plantation. Able has long wire aerial and Able 1 has whip unless otherwise specified.

Time Hrs.	Position	Frequency	Strength	Remarks
0850	2 (3.2 mls.)	3450 Kc.	Able to Able 1 - 4 Able 1 to Able - 4	Noise generally low but loud Xs. once every 4 secs.
		9860 Kc.	Able 1 to Able-Nil	Interfering signal
0940	3 (5 mls.)	3450 Kc.	Able to Able 1 - 4 Able 1 to Able - 4	
0950		"	Meter	Measurement carried out.
1001	"	"	Able to Able 1 - 4 Able 1 to Able - 4	Able 1 moved from roadside right into plantation and now covered completely by canopy of leaves
	"	"	Able to Able 1 - 2 Able 1 to Able - 3	Able with whip as well as Able 1.
1012	"	2004 Kc.	Nil	Change to 2004 Kc.
	"	3450 Kc.	Able to Able 1 - 4 Able 1 to Able-3-4	Whip on Able 1 Wire on Able as before.
	"	6450 Kc.	Able to Able 1 - 3 Able 1 to Able - 3	" "

TEST NO.5 - 12/4/'52.

A sky wave R.T. test between Tanglin Mess and the F.T.C. was carried out. Distance approximately 35 miles. Able 1 at Tanglin. Able at F.T.C.

Time	Frequency	Strength	Remarks
1715	6485 Kc.	Able to Able 1 - 2 to 5 Able 1 to Able - 2 to 5	Fades cause drop in strength. Able using dipole. Able 1 using end fed.
1735	3450 Kc.	Nil	Heavy noise.
1750	6485 Kc.	Able to Able 1 - 2 to 5 Able 1 to Able - 1 to 4	Fades. End fed aerial at Able 1. Dipole at Able.
1800	9865 Kc.	Able to Able 1 - 1 to 2 Able 1 to Able - 1 to 2	Heavy morse interferences blots out signals. End fed aerials both ends
1850	6485 Kc.	Able to Able 1 - 2 to 4 Able 1 to Able - 2 to 3	Morse interference at Able.

TEST NO.6 - 13/4/'52.

Sky-wave tests between Tanglin and the F.T.C. were continued (Distance 35 miles). Fading existed most of the time and the range of strengths is given in order to indicate approximately the effect of these fades. Unless otherwise specified Able (at F.T.C.) used the higher voltage B-battery and Able 1 (at Tanglin) the standard batteries. The whole day's tests were carried out with only the A510 circuits as means of communication.

Time Hrs.	Frequency	Strength	Remarks
1000	6485 Kc.	Able to Able 1 - 3 to 5	Test commenced in heavy rain at Tanglin. Able on dipole, Able 1 on end fed wire aerial.
1020	3450 Kc.	Nil	
1040	6485 Kc.	Able to Able 1 - 3 to 5 Able 1 to Able - 4 to 5	Dipole at Able End fed aerial at Able 1.
	"	Able to Able 1 - 2 to 3 Able 1 to Able - 2	End fed aerials both ends.
1112	5180 Kc.	Able to Able 1 - 2 to 3 Able 1 to Able - 2	" "
1150	9865 Kc.	Able to Able 1 - 1 Able 1 to Able - 1	End fed aerials both ends. Heavy Q.R.M. and Q.R.N. becoming pronounced at Able 1.
1230	6485 Kc.	Able to Able 1 - 4 to 5 Able 1 to Able - 4 to 5	Able using dipole Able 1 using end-fed aerial.
1400	6485 Kc.	Able to Able 1 - 3 to 5 Able 1 to Able - 2 to 5	" "
1530	3450 Kc.	Able to Able 1 - 3 to 5 Able 1 to Able ?	Both stations using end fed aerials. Contact lost on this channel.
1545	6485 Kc.	Able to Able 1 - 4 to 5 Able 1 to Able - 1 to 3	Q.R.M.present & Q.R.N. increasing. Able on dipole. Able 1 on long wire.
1600	"	Able to Able 1 - 3 to 5 Able 1 to Able - 3 to 5	High voltage B-Battery now on Able 1.
1620	9865 Kc.	Able to Able 1 - Nil Able 1 to Able - 1	Able heard Able 1 only once on R.T., but heard Able 1. O.K. on C.W.
1645	6485 Kc.	Able to Able 1 - 5 Able 1 to Able - 5	Some fades.
		Able 1 to Able - 5	Able 1 whispering.

TEST NO.7 - 14/4/'52

In this test wire aerials were used at each end, unless otherwise stated. Able was at the F.T.C.. Able 1 at point 4, approximately 9 miles south of the F.T.C., mainly through rubber.

Time Hrs.	Frequency Kc/s.	Strength	Remarks
1010	3450	Able to Able 1 - 5 Able 1 to Able - 3	Able 1 using L condition of aerial. Able using H condition. Conditions quiet.
1026	"	Able to Able 1 - 2 Able 1 to Able - 2	Able 1 on whip. Able on wire.
1027	"	Able to Able 1 - 4 to5 Able 1 to Able - 4 to5	Wire aerials as previously.
1030	6485	Able to Able 1 - 5 Able 1 to Able - 3*	Dipole at Able, wire at Able 1 *C.W. interference at Able.
1050	2004	Nil	Unsatisfactory, long wire aerial at Able 1.
1100	3450	Able to Able 1 - 5 Able 1 to Able - 5	Able 1 and Able aerials as before on this channel.
1115	9365	Nil	Xs higher on this channel.
1130	3450	Able to Able 1 - 4to 5 Able 1 to Able - 5	

TEST NO.8 - 14/4/'52

Able still at F.T.C.; Able 1 at position 5 approximately 8 miles north of the F.T.C..

Time Hrs.	Frequency Kc/s	Strength	Remarks
1510	6485	Able to Able 1 - 3 to 5 Able 1 to Able - 5	Able on dipole (25 ft.) Able 1 on 8-10 ft. high end-fed aerial in rubber plantation.
1520	"	Able to Able 1 - 2 Able 1 to Able - 2	Able changed to low dipole (5 ft. high).
1525	"	Able to Able 1 - 5 Able 1 to Able - 3 to 5	Able reverts to previous aerial condition.
1530	"	Able to Able 1 - 3 to 5 Able 1 to Able - 1 to 5	Able 1 and Able both on end-fed aerials. Fading at both ends.
1535	"	Able to Able 1 - 5 Able 1 to Able - 5	End-fed aerial Able 1. Dipole on Able.
1600	3450	Able to Able 1 - 2 to 3 Able 1 to Able - 1 to 2	End-fed aerials both ends. Static higher on this channel.
1610	6485	Able to Able 1 - 5 Able 1 to Able - 3 to 5	Dipole Able. End-fed aerial Able 1.
	"	Able to Able 1 - 2	Low dipole Able.
1615	"	Able to Able 1 - 5 Able 1 to Able - 3 to 5	Dipole Able (25 ft.) and Dipole Able 1 (20 ft.)

Tests were carried out by one A510 (Able 1) moving off with Training Exercise which was using 68 Sets. Able was at the F.T.C.. Test commenced on 6485 Kc. with Able 1 at Point 6 approximately $8\frac{1}{2}$ miles North East.

Time Hrs.	Frequency	Strength	Remarks
1015	6485 Kc.	Able to Able 1 - 4 to 5 Able 1 to Able - 4 to 5	Able on normal dipole Able 1 on low dipole. Noise and interference low.
1030	4240 Kc.	Able to Able 1 - 2 Able 1 to Able - 3 to 4	Able 1 having interference from local 68 Set.
1040	6485 Kc.	Able to Able 1 - 4 to 5 Able 1 to Able - 2 to 4	Aerial conditions as previously on this channel.
	"	Able to Able 1 - 2 Able 1 to Able - 2	Able replaces higher dipole by 6 ft. dipole.

Tests were now concluded at this position and Able replaced dipole with end fed aerial (H condition) and Able 1 used whip. Able 1 then communicated from vehicle moving towards F.T.C. At first signal of Able was blotted out by ignition noise but Able 1 was received by Able at strength 1 to 2.

	6485 Kc.	Able to Able 1 - 1 to 2 Able 1 to Able - 2	3 to 4 miles.
	"	Able to Able 1 - 5 Able 1 to Able - 4	2 miles.
		Able to Able 1 - 5 Able 1 to Able - 5	1 mile.

Able 1 then called into F.T.C. and frequency was changed to 3450 Kc. and Able 1 then moved south towards Johore Bahru. At a distance of about 5 miles Able's strength was 5 at Able 1 and the strength of Able 1 at Able was varying, depending on position, from 2 to 5. It was not until about 8 miles from camp that Able 1 at Able dropped to strength varying from 1 to 3 and Able at Able 1 to strength 3 to 4 depending on exact position. Able 1 reported later that he heard Able calling until about 10 miles.

The next contact was made by sky-wave on 6485 Kc. with Able 1 at position 7 near Johore Bahru water tower.

Time	Frequency	Strength	Remarks
1230	6485 Kc.	Able to Able 1 - 5 Able 1 to Able - 3 to 5	Able on high dipole Able 1 on 10 ft. dipole Noise quiet.
1233	6485	Able to Able 1 - 5 Able 1 to Able - 3	Able 1 dipole on ground.
		Able 1 to Able - 5	Able 1 raises dipole again. Change from strength 3 to 5 is noted.
1420	"	Able to Able 1 - 3 to 5 Able 1 to Able - 3 to 5	Able 1 aerial 8 ft. high. In Johore Bahru (Position8) Noise and interference higher at Able. Fading

TEST NO.9 (Contd)

Message was then sent to Able 1 in the form "Boy, Joy, Toy, Coy, Rat, Tat, Sat etc." and was read at least 80% correctly.

Next contact was made by Able 1 from Hee Soon on Singapore Island, Position 9.

Time Hrs.	Frequency	Strength	Remarks
1630	6485 Kc.	Able to Able 1 - 5 Able 1 to Able - 3 to 4	Fading both ends. Able 1 aerial 15 ft. high dipole. Able - same high dipole. Fades drop Able 1 signal to 1 at times. Static now heavy. Able 1 reads message of unconnected words from Able, at least 80% correctly.
1705	4280 Kc.	Able to Able 1 - 3 to 4 Able 1 to Able - 3 to 5	Q.R.K. and Xs high. Both Able and Able 1 on dipole.
1715	6485 Kc.	Able to Able 1 - 5 Able 1 to Able - 3 to 5	Fading both ends.

TEST NO.10 - 20/4/'52

3 Set Net.

Two sets in jungle (Able 1 and Able 2) separated from one another.

Third Set at F.T.C. (Able).

Able 1 and Able 2 used whip aerials. Able used inclined wire.

In carrying out the test Able 1 and Able 2 were mobile. It took some time before each was in a position close enough for satisfactory intercommunication, but communication between each and Able was at most times satisfactory. Only a very brief summary is given and much of earlier stages of test is not given.

(1) Frequency - 3450 Kc.

Able 1 - 400 yards in primary jungle from road.

Able 2 - 200 yards off road on track leading to foot ambush area in secondary jungle.

Able - F.T.C.

Distances:- Able to Able 1 - 3 miles
Able to Able 2 - 1¾ miles
Able 1 to Able 2 - 2¼ miles

Strengths

Able 1 to Able	Able 2 to Able	Able 1 to Able 2	Able 2 to Able 1	Able to Able 1	Able to Able 2
3	4	2 - 3	3 - 4	5	5

(2) Frequency - 3450 Kc.

Able 1 moves 500 yards further into jungle and down into deep gulley with 200 ft. sides.

Strengths

Able 1 to Able	Able 2 to Able	Able 1 to Able 2	Able 2 to Able 1	Able to Able 1	Able to Able 2
2 - 3	4	-	2	5	5

(3) Frequency - 2004 Kc.

Position as (2) above.

Able 1 to Able	Able 2 to Able	Able 1 to Able 2	Able 2 to Able 1	Able to Able 1	Able to Able 2
2	5	Nil	Nil	4	5

Able 1 then comes out of gulley

TEST NO.10 - (Cont'd)

(4) Change to Frequency - 6485 Kc.

(Able 1 is now out of gulley)

Able using T Aerial.

Able 1 to Able	Able 2 to Able	Able 1 to Able 2	Able 2 to Able 1	Able to Able 1	Able to Able 2
2 - 3	2 - 3	4	4	3 - 5	5

MEASUREMENTS OF FIELD STRENGTH

It is to be noted that the fields measured are very low indeed; far lower in many cases than can normally be measured by usual F.I. meters. The fields less than 1 mV/m must therefore be treated with some reserve. It should be noted, however, that the adapted A510 used for the measurement has been re-calibrated since the return from Malaya and there is every confidence that the results indicated below are of the right order. More measurements were not taken as it was found that the measuring method was rather cumbersome to use in view of the limited time available.

Date	Test (See above)	Position	Condition (All C.W.)	Field Strength µV/m
12/4/52	3	1	(a) A510 on Ground normal whip 7 ft.	4.9 µV/m
			(b) 68 Set with its whip 11 ft.	4.9 µV/m NOTE: Relative measurements previously taken on 68 Set indicated higher fields than the A510 as would be expected with longer whip. Small differences in position cause large changes in field where the sets are in trees
	3	2	(a) A510 long wire aerial & counter poise.	4.4 µV/m
			(b) Whip aerial A510 on ground.	0.56 µV/m
			(c) As b but with counterpoise.	0.65 µV/m
			(d) As (b) but high battery 135V in parallel with 90V (this was in error).	0.9 µV/m
			(e) As c with higher battery (in parallel).	1.27 µV/m
12/4/52	4	3	(a) A510 on ground. Whip aerial counterpoise 135V battery (correctly in place now).	3.53 µV/m
			(b) As a. No counterpoise.	1.9 µV/m
			(c) 90V Battery. No counterpoise.	0.49 µV/m

MEASUREMENT OF THUNDERSTORM - 11/4/'52

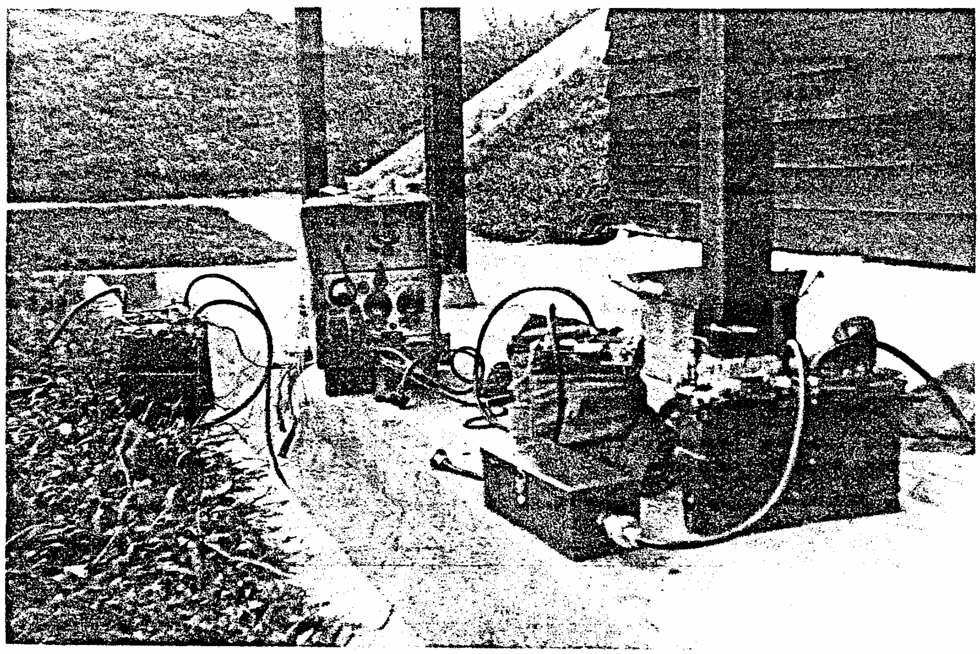
A heavy thunderstorm hit the F.T.C. and induction in long wire aerial was at times sufficient to cause shocks. After the worst of the storm had passed, a measurement was taken of the noise. Crashes varied widely in amplitude but occurred at the rate of 70 in 90 secs. A large number of individual crashes were recorded and the median value noted.

The median F.I. turned out to be about 5 μV/meter but many individual crashes were at least twice this and some probably more than 10 times this value. As the storm was passing quickly it was not possible to measure both median and peak values.

MEASUREMENT OF NOISE RECEIVED ON A 6½ Mc.DIPOLE

These were obtained by substituting a signal generator (since calibrated) for the aerial and adjusting level until meter reading on the adapted A510 (used for F.I. measurements) gave the same readings as the noise. The values obtained varied from day to day and, of course, according to time of day. As the aerial was the one also used for other tests it was not always possible to take measurements at the same time each day. To obtain such measurements a recorder is really necessary. The average values obtained are approximately as follows :-

Time Hrs.	F.I. (Median) in db relative to 1μV/m	Frequency of Noise Crashes.
0700	+ 3	2 per second.
0800	- 7	1 per second.
1000	- 12	1 in 5 seconds.
1200	- 17	Varying from no crashes to 1 in 3 secs. Noise 10 db lower when no crashes existed.
1400	- 10	1 in 2 secs.
1600	- 6	Continuous noise and burst at 2 per second.
1800	- 3	Continuous bursts at least 4 per second.
2000	+ 1	" "
2400	+ 5	" "



The WS68 set in background surrounded by a number of A510s (pairs of boxes) together with various test appendages.

PHOTOGRAPH 1

Soldier on ground

A 510 on his chest

Whip, on ball joint, turned upwards

PHOTOGRAPH 2

A 510 fitted on Standard Metal Carrier (as used in Malaya) with other gear. Arranged as demonstration - not normal position of A 510.

PHOTOGRAPH 3

See also Photograph 5

Soldier on left with WS68 set together with pack on standard metal carrier.

Soldier on right with A510 on chest and pack on back.

Note: Soldier on left is young British National Serviceman.

On right a Gurkha soldier.

PHOTOGRAPH 4

The two A510 cases mounted on top of standard metal carrier in current use in Malaya - demonstration of versatility of A510, not normal way of carrying.

PHOTOGRAPH 5

DEAN & CURRAN compare notes at Farelf Training Centre, Malaya.

Note: although in a "safe" area, side arms were worn at all times.

Photograph added 1978

Lt. Col. Don Small and Ken Dean in grounds of Tanglin Barracks, Singapore.

Photograph added 1978

<u>DEAN:</u> (with pack of WS78 plus other gear on metal carrier, 70 lbs total).

"Why don't you get a REAL Soldier if you want to take a photograph".

<u>REAL SOLDIERS:</u> "We want you to know how heavy it is".

Photograph added 1978