H.M.S. EMERALD.

(Editor's Note :-

An excellent example of the type of Radar Report which is welcomed in A.S.E. is shown below. Lack of space prevents publication in full.

The summary of running hours is a most interesting feature of this report and might well be followed by other ships.)

The following report is submitted in accordance with C.A.F.O.2509/41.

PERFORMANCE.

Type 273QR.

During exercises held in the past six months it has been possible to compile a table of picking up ranges of ships of different sizes. The picking up ranges varied from night to night and day to day, and it is not possible to determine whether this is due to instability of the tuning of the set or to changes in the atmosphere, or to a combination of both. The picking up range by day was always higher than the picking up range by night, and a broadside target was always picked up at a greater range than one head on.

Ship.	Picking up range.
Ramillies	48,000 - 50,000 yards.
Suffolk	42,000 - 47,000 yards.
Newcastle	38,000 - 45,000 yards.
Danae	35,000 - 42,000 yards.
Destroyers ('Q' and 'R' classes)	27,000 - 37,000 yards.

The bearing accuracy is never greater than ± 2° and when the echo saturates is probably less and more difficult to obtain as the side lobes are much in evidence. When watching more than one echo, the side lobes complicate the operating of the set and greatly reduce the rate of reporting. Cloud echoes, wave echoes, ghost echoes and even bird echoes have been experienced. Except for the latter they are fairly easy to distinguish from real echoes, for by turning up the gain to maximum, a thin line is usually seen running through the base of the echo, thereby indicating it to be unreal. Also wave echoes, cloud echoes and ghost echoes are not as a rule clearly defined.

Type 273QR has been found most useful in Fighter-Direction exercises for detecting aircraft flying at 2,000 feet and below. Its picking up range varies from 30 miles to 15 miles, the optimum height is believed to be about 1,000 feet.

The panel L17 has been found to be a most accurate ranging instrument. It has never been necessary to set any correction between it and the matching dial.

Type 281.

This set gives a reliable performance. The bearing accuracy is about ± 1° - 1½° using beam splitting, and about ± 2° - 3° using searching. Height finding at sea is usually more accurate than ± 1500 feet. Height finding in harbour has been found to be very inaccurate (± 2,500 feet), but as yet there is not sufficient evidence to forward a report on this.

The height finding procedure is based on the echo to gain ratio method. Both the polar diagrams for searching and beam switching are used to exploit to the full the different position of the maximum and the minimum and the different echo ratios obtained from each and to benefit by the extra range obtained on searching. To facilitate this a pedal has been fitted in parallel with the tumbler switch, controlling the beam switch, so that the operator can alternately beam switch and

search easily and quickly.

To measure the echo ratio a cursor made of perspex is mounted in a holder which runs on a track and can be placed in any position in front of the tube. Two cursors are used, one with 2 mm. and the other with 1½ mm. spaced lines, to meet the variation of gain required. The gain is set up to one division on the cursor, and the ratio then read off.

Control unit 20 D. has been very satisfactory.

Type 243.

Very little experience has been had of this set. I.F.F. has been obtained off an aircraft at 114 miles. The estimated height of the aircraft was between 20,000 and 25,000 feet. Operating from Kilindini harbour, results were obtained on H.M.S. "EMERALD's" own aircraft (fitted with Mark III) of 2/3 saturation response at 60 miles at a height of 5,500 feet. It should be noted that results obtained in harbour are not quite so good as those obtained at sea.

The vertical polar diagram of the Type 243 is lower than that of the Type 281 and often H.M.S. "EMERALD's" own aircraft's I.F.F. is clearly visible on the Type 243 scan when its echo has faded on the Type 281 scan. The horizontal polar diagram is very broad and therefore the bearing accuracy on I.F.F. responses only is about ± 5°.

Type 253.

Little experience has been had of this set, but during exercises aircraft reported the response very clear at a range of 34 miles, the estimated height of the aircraft was 1,500 feet. No means has yet been found to prevent it being fired by Type 243. No Type 253 handbook is held on board, but it is intended if possible, to try to build a valve transformer locked to the Type 243 to produce a 12 volt 10 micro-second square-topped positive pulse at the right time to suppress the 253 and thereby prevent it from being fired by Type 243.

Type 262.

As a gunnery set, this appears to give a normal performance. No opportunity has yet occurred to try blind Radar fire with it.

It has been used to sweep through the stern at night, as H.M.S. "EMERALD's" Type 273 QR will only sweep from Red 120 to Green 120 through right ahead, and it is far more subject to ghost echoes than the Type 273 QR. As many as fourteen ghost echoes have been seen ranging from 2,000 - 23,000 yards. These echoes were quite well defined and quite good bearings could be obtained of them using the remote tube: there was no cloud in the vicinity at the time.

Type 282.

These have behaved normally and, during throw-off shoots on H.M.S. "EMERALD" have been successfully used to range on shell splashes.

Outfit F.V.1.

Watch is always set on this set on proceeding to sea, but no results have so far been obtained. It still picks up Types 281, 282 and 285 in many places and, when the Types 281, 282 or 285 are switched on, is practically impossible to operate for this reason.

Type 251 M.

There has been little opportunity for testing this set, but one aircraft gave the set a maximum range, at about 1,500 feet, of 27 miles. This occurred before it was possible to borrow test set Type 28 and it is hoped that results may now be better.

RECURRING FAULTS.

The aerial flexible feeders have broken four times in six months and their life appears to be further reduced by the use of the fast pedal of unit Type 20 D.

During a Fighter Direction exercise, H.M.S. "EMERALD's" ranges suddenly went about 20 to 15 miles higher than everybody else at about sixty miles, coming into agreement at about 15 to 20 miles. This error was not apparent on the calibrator and was due to the Dubilier resistors in the anode load circuit of the warning time base valve altering their value.

It is considered that a calibrator producing five mile calibration pips would be most useful and prevent this error recurring. Should this occur at sea, with no available ranging aircraft, it would go undetected. This fault has occurred twice and now Erie resistors have been substituted and the fault has not so far re-appeared.

Types 282 and 285.

Electrolytic condenser C16 reference diagram 21 of C.B.4221(1)A keep going down, causing resistors R1 and R2 to burn out. It is thought that the running temperature is too high as the electrolyte is generally found to be running out through the base of the condenser when this fault occurs, as it has done since August, 1943.

The Dubilier resistances R4 and R2 in the anode load of V5 have also altered their values twice.

A slight jitter of the trace was the indication that C16 was collapsing and complete failure to calibrate was the indication of the resistances R1 and R2 altering their value.

Type 273 QR.

The setting up procedure outlined in Commander-in-Chief, Home Fleet's memoranda of 26th June, 1943, number H.F. 1559A/5 is always used and is most valuable and has given the best results.

Transmitter.

Frequency pulling is very marked owing to the close proximity of range-finders, W/T aerials and superstructure and it is only possible to set about one in three magnetrons up on peak power.

The power output of individual magnetrons seems to vary to quite a large extent and it is felt that it would be very advantageous to have an absolute, as opposed to a relative, means of measuring the power, in order to determine the minimum power at which the set would work efficiently. Otherwise the unit has been found to be very reliable.

Type 273 QR Receiver.

The receiver is always tuned with the G82A in the wave-meter position, but it is strongly felt that results would be far better if the G82A generated a more stable frequency. The G82A frequently wanders in both wave-meter and oscillator positions, often giving very misleading results and making both tuning and an accurate check of the sensitivity and tuning of the receiver very difficult.

AE. Gyro stabilizing equipment has been found very satisfactory.

This set has proved immensely valuable, but when detached with no other ship to tune upon, it is impossible to guarantee results owing to the inadequacy of the test equipment which although in itself is invaluable, is not reliable enough.

Type 243.

Mutual interference between the calibrator and Type 243 caused distortion of the Type 243 scan. This was cured by putting a tumbler switch between terminals 29b of units Q and C.

Responser.

The wax condensers 401 SMP 72 S 200 u.u.f., C31, C38, C43, C47, C55, (reference handbook H438, diagram 14) melted and were replaced by condensers pattern 1431. This change has not affected the efficiency of the set. It is considered that Pattern 401 SMP 72 S condensers are unsuitable for use in the tropics owing to the low melting point of the dielectric.

It is considered that to maintain Radar efficiency at its highest standard, signal generators producing a calibrated signal which will indicate the state of the receivers (particularly 273 QR) are essential, as, when detached with nothing to tune up on or if Radar silence has to be enforced, it is almost impossible to switch on and have the receivers and transmitters of the various sets exactly in tune.

SUMMARY OF RUNNING HOURS AND BREAKDOWNS.

Set.	Running hours.		Breakdowns.		Total.	
	Apl - July	Aug - Jan	Apl - July	Aug - Jan	Break-downs	Running hours
281	330	1,130	16	22	38	1,460
273	365	1,185	15	23	38	1,550
285	150	517	8	17	25	667
232 T	105	145	11	8	19	250
232 S	105	145				250
243	-	-	-	3	3	-
F.V.1.	450	1,355	-	6	6	1,805
L.17	365	755	3	-	3	1,120

REPORT ON RADAR TYPE 277 FROM H.M.S. CAMPANIA

From the Commanding Officer H.M.S. "CAMPANIA".

METHOD OF OPERATION.

The following is, on the whole, rather straightforward.

AIRCRAFT WARNING.

The principal watchkeeper, the P.P.I. operator, wears a head and breast set telephone by which he passes reports to the Air Direction Room plotter.

The P.P.I. is normally operated on the 75,000 yards scale as it is unlikely that aircraft will be detected beyond this range. It is recommended that the Calibration rings be kept on whilst operating and the range read direct from them so that any calibrating errors or movement of the centre spot are cancelled.

The most suitable speed of aerial rotation for warning purposes is three to four r.p.m.

(Editor's Note : The calibration rings may tend to distract the operator's attention from careful search and it is left to individual ships to form their own opinions. We think that in general it is preferable to keep the calibration switch off.)

The second operator keeps watch on the L26 "A" scan using the 150,000 yards scale. Any echoes over 75,000 yards are communicated to the P.P.I. operator who then obtains a bearing etc. The interrogator is controlled by this operator, and he is responsible for classification of any doubtful echoes.

HEIGHT-FINDING.

It is considered impossible to give a height on aircraft which are detected with the aerials horizontal; it can be said that the aircraft is below 5,000 feet. Thus, all occasions of accurate height-finding are on aircraft detected by the W.A. set.

When Type 277 is required to find the height of an aircraft, the L26 operator moves to the H.P.I. and mans a head and breast telephone to the height-filter position. The P.P.I. operator is conned on to the bearing of the aircraft and, as he sweeps back and forth across the bearing, the H.P.I. operator elevates the aerial in 2^{o} steps until he has passed the elevation necessary for the estimated height and range etc. until the echo is detected.

Directly the echo is obtained, the H.P.I. operator leaves his control in position and the P.P.I. operator stops the aerial on the centre bearing and calls "ON". The aerial is kept stationary until the H.P.I. operator has obtained a height when he in turn calls "ON" and leaves the aerial at the correct elevation. Each in turn continues to take cuts and pass reports over their respective phones.

(Editor's Note : In order to over-come the difficulty referred to above, a modified form of P.P.I. known as an Azicator is being developed. This consists of a P.P.I. displaying Type 281 with a mechanical bearing cursor which is coupled to the Type 277 bearing control. The Azicator is placed so that it can be viewed by the Type 277 bearing operator who can thus make the Type 277 aerials follow in Azimuth a moving target while searching in elevation.)

In order that the height-finding may be as efficient as possible, the P.P.I. operator must be given all information as to the whereabouts of the aircraft and its movements, and the H.P.I. operator must be given the estimated height of the aircraft.

A rate of two height reports a minute is the most accurate and is totally adequate for fighter direction, though more frequent reports may be essential for gunnery purposes.

When used for surface echo reporting, the tactical plot dictates the scale to be used by the P.P.I. operator, taking into consideration the ships geographical position and the disposition of shipping. Reports are made by phone direct to the tactical plotter.

RESULTS.

With the transmitter H.T. between 12·5 Kv. and 13 Kv. a wattmeter power of 300 Kw to 480 Kw and a standing-wave ratio of 0·5 and 0·6, the following tabulated results have been obtained over the last six months.

Aerial height; 68 feet above sea level.

	GUARANTEED RANGE	AVERAGE RANGE	'BEST SEEN' RANGE	REMARKS
aircraft at 50 feet.	16 miles	20 miles	26 miles	SWORDFISH aircraft on patrol.
aircraft at 500 feet.	19 miles	23 miles	29 miles	SWORDFISH aircraft.
aircraft at 1500 feet.	27 miles	32½ miles	55 miles	SWORDFISH aircraft on patrol.
aircraft at 5000 feet.	28½ miles	35 miles	46 miles	Either one or two aircraft. FULMARS or WILDCATS.
aircraft at 10000 feet.	24 miles	27 miles	73 miles	Single aircraft. (Best seen range height was estimated from Type 281)
aircraft above 10000 feet.	23 miles	-	-	Very limited experience.
Single Frigate.	15 miles	19 miles	Two Frigates 56 miles	-
Convoy of about 35 ships.	17 miles	20 miles	28 miles	-
submarine fully surfaced.	6 miles	7½ miles	9½ miles	Very few opportunities to check these readings.
Buoy.	1½ miles	2½ miles	4½ miles	These ranges are taken for the average size of buoy.
Land up to 3000 feet high.	40 miles	50 miles	75 miles	-

Aircraft are frequently tracked across the plot at ranges over 50 miles which have not been detected by Type 281 and a height therefore not obtained.

When in warmer weather such as the vicinity of GIBRALTAR in Summer, the average range of detection increases by 20%.

Areas of bad weather often cause a marked drop in detection range.

Accuracy of height findings is at least +/- 1,000 feet, and an accuracy of +/- 500 feet may be expected at closer ranges. Limited height finding may be carried out on the L26 panel with interpolation of the height curves of the H.P.I. at ranges over 25 miles.

Improved ranges of maximum detection, possibly due to anomalous propagation, are experienced in warm weather with high relative humidity.

NAVIGATION BY TYPE 277.

To obtain an accurate fix with Land Echoes, the following notes are of interest :-

(a) The land detected can only be used for an accurate fix if :-

(i) There are small islands easily distinguishable.

(ii) There are lighthouses or other peaky prominences above the surrounding terrain.

or (iii) There are sharply defined headlands.

Any other land echoes will only give an approximate fix.

(b) The accuracy naturally depends on the range of detection.

(c) Three different points of the nature given in (a) should be chosen and the range and bearing of all three taken as nearly simultaneously as possible.

(d) The three methods of obtaining a fix are as follows :-

Plotting (i) the intersection of the range circles.
(ii) the position of each range and bearing.
(iii) the intersection of the bearings.

Method (i) gives by far the most accurate fix. Methods (ii) and (iii) are used when the actual point selected in (c) is not definitely known.

(e) The following table gives an indication of the accuracy which may be expected :-

ACCURACY.

Range of echo	Method (i)	Method (ii)	Method (iii)
Under 8 miles	½ mile	1-2 miles	2-3 miles
Between 8 and 35 miles.	1-2 miles	2-5 miles	3-7 miles
Over 35 miles	2-4 miles	-	-

(f) When the Type 277 is used for keeping station in convoy or for manoeuvring close inshore, a very clear picture is obtained on the P.P.I. if the 15,000 yard scan is used with the Anti-wave-clutter unit set to give zero grass at full gain for 13,000 yards and thence gradual increase to full grass at 20,000 yards. This eliminates side echoes without cutting down the detection range appreciably.

CLOUD ECHOES ETC.

Cloud is normally identified as such by virtue of the fact that it covers a large area on the P.P.I. and has a "fuzzy" appearance on the L.26. Confusion may occur owing to small isolated patches of cloud which are detected as small echoes similar in appearance to surface echoes, the "fuzziness" of which are not immediately apparent on the L.26 panel. It is often possible however to classify the echo as cloud by comparing its movement with the wind speed and direction, weather conditions, and by close examination of the L.26 when the signal/noise ratio increases to more than 3/1.

Cloud echoes have one valuable asset, they provide an excellent means of tuning the receiver when out of range of land echoes.

Cloud has been observed to the limit of the 150,000 yard scan.

Side echoes of ships or land occur up to ranges of approximately 15,000 yards and 25,000 yards respectively in normal conditions. They are usually about 5° either side of the centre bearing, though they frequently extend up to 20° either side. The effect of side echoes can be minimised or even eliminated by control of the Anti-wave-clutter unit.

Wave echoes occasionally break through the anti-wave-clutter unit but cause no trouble.

The close proximity of the mast or funnel or other objects renders detection on and around the bearing of the obstruction practically nil. At best, echoes will be poor, maximum detection cut by 50% to 60% and bearings will be unreliable.

SETTING UP THE TYPE 277

TUNING THE RECEIVER

When tuning the Gas-gap (CV.83 or CV.985) it is important that the pick-up loop is properly tuned. Even if the gas-gap section of the wave-guide is inverted it will often be found impossible to obtain any appreciable tuning effect with the lower gas-gap. The gas-gaps sometimes deteriorate in a very short time; the only means of detecting this is by the falling off of maximum detection range.

To preserve the life of the Monitor tube, it should be switched off whenever possible.

The Pye-plugs and sockets, as always, are the first suspects in the event of a breakdown.

The centering of the spot on the P.P.I. should be frequently checked. In this ship the Degaussing coils cause the spot to shift as much as $\frac{1}{4}$ inch when the course is altered.

For all fault-finding the Handbook, H546, has proved totally adequate.

cut in the centre of the top of the P.P.I. case has in all cases greatly reduced the heat of the unit.

FAULTS.

On the whole faults are few, the only source of worry being that of checking the output power and reception and keeping both at optimum efficiency.

The following faults have however occurred during the period 1st March 1944 to 21st July 1944:-

Air diaphram of the vertical stabilizer sticking.
Freed by small alteration of the tension.

Azimuth stabilizing burnt out. (Twice)
Motor rewound and replaced. All local wires replaced.

Aerial brake worked loose.
Holding screws secured and tightened.

Mica cover of the wave-guide burnt through.
Frequently replaced.

Radiation meter slipring wires broken.
Replaced.

Gyro Vertical replaced after 550 hours running. Showed no sign of deterioration.

Transformer Patt. A.P. W3975 burnt out due to earth on the 300 v.
Replaced.

Decoupling condensers in the I.F. amplifier M.70 shorting (Twice)
Resistors and condensers replaced.

Waveguide dryer heaters burnt out. (Twice)
New unit installed.

Failure of the modulator CV.12 (Twice)

Failure of the magnetron. (Three times)

Variac brushes failing to make proper contact.
Difficult to service, brushes replaced.

Gas-gaps deteriorating to approximately 25% efficiency.
Difficult to spot at sea.

Monitor tube and its HT valve often faulty.
Monitor now used very sparingly, to preserve its life.

Failure of a CV35 which had different tuning points for echoes at varying ranges.

Normal replacements of CV1091's etc.

Failure of filament Transformer for H.P.I. CRT. Giving only 60% required voltage and consequent loss of brilliance.

Inumerable faults at the beginning of the commission due to bad installation of inter-unit wiring.