9/31/69
Dr Swallow (See P2 (ii))

NATIONAL INSTITUTE OF OCEANOGRAPHY

CRUISE REPORT: R.R.S. "JOHN MURRAY" CRUISE 8, LEG 2.
11th - 21st OCTOBER 1969.

1. Personnel (All N.I.O.)

R.N. Bonner
H.M.C. Fielding
N.H. Kenyon (15th & 16th October only)
B.S. McCartney (Senior Scientist)
P.J. Smith
A.R. Stubbs

2. Objectives:-

(i) To measure the noise levels of towed hydrophone arrays under different conditions including ship speed; to compare hydrophones of different design design; to measure sensitivities and noise levels of the R.V.U. E.G. & G. Type 264 array and the Cambridge University 'Flexotir' array.

(ii) To record the noise spectrum of the ship under different engine conditions.

(iii) To make extensive tests of recent design modifications to the air-gun and to test its reliability.

(iv) To obtain Grab samples from five areas of small sand waves to the South of the Isle of Wight.

3. Ship Movements

The "John Murray" left Barry at 17.00 hrs. on 12th October. Hydrophones and air-guns were tested during the days and evenings of 12th - 15th October and the ship entered Southampton to collect N.H. Kenyon on the afternoon tide of the 15th. Grab samples were taken at Stations Nos. 1922 and 1923 on the evening of the 15th and at Station Nos. 1924, 1926 and 1927 during the 16th. Mr. Kenyon disembarked in the agents' launch at Cowes Roads at 19.00 hrs. on the 16th. The ship set course for the Hurd Deep and further hydrophone measurements and air-gun tests were made on the 17th and 18th. "John Murray" spent the evening of the 18th in St. Peter Port. On the 19th the Flexotir array was streamed over the Hurd Deep. Hydrophones were towed and air-gun tests were continued on the 20th as the ship made passage towards Barry, which was reached at 07.00 hrs. on the 21st.

Apart from short periods of Force 6 winds on the 13th and a heavy thunderstorm on the evening of the 14th the weather was generally good.

4. Scientific Programmes

(i) Nine N.I.O. hydrophones ranging from one sphere in a 2 ft. tube to 100 spheres in a 200 ft. tube were towed and noise spectra obtained at three ship speeds up to 7 knots, using the Bruel and Kjaer $\frac{1}{3}$ octave spectrometer and level recorder. The data have not yet been fully reduced, but preliminary checks indicate that there is little difference in noise in the important profiling band (20 Hz to 200 Hz) between hydrophones of different internal constructions with similar spacings. There does appear to be a reduction in noise at low frequencies as the element spacing is reduced. Fig. 1 is a typical spectrum obtained for a 100 ft. long array containing 50 hydrophone spheres 1 ft. 10 inches apart. The noise below 300 Hz could be flow-induced or ship-noise or a mixture of the two, whilst in the band 300 Hz to 2,000 Hz the ship noises are well cancelled by the surface reflected ray and ambient sea noise is almost reached. Above 2,000 Hz ship-noises predominate and the peaks in the spectrum at 3,000, 6,000 and 9,000 Hz are due to the strong end-fire directivity peaks of the array with this inter-element spacing. With hydrophones towed 150-200 m astern no significant changes in noise levels were observed in water depths reducing from 80 fms to 40 fms and then 20 fms. A further reduction in depth to 10 fms was not possible at the same time and sea conditions, though records were obtained on another occasion. Recordings on magnetic tape were made of noise levels from pairs of hydrophone spheres at different spacings in the same tube, for time and space cross-correlation analysis and for comparison with similar recordings from "Discovery" on Cruise 27.

Faults on the E.G. and G. Type 264 array were repaired and noise spectra obtained at 3.5 kts, but at higher speeds intermittent faults in the first tube of pre-amplifiers prevented further use. Even at such a slow speed the noise levels were high and it is felt that this is due to the small number (9) of sensitive elements in the 150 ft. length.

The "Flexotir" array consists of two active sections but the aft section was not connected electrically and the break could not be found. The front section worked satisfactorily up to 5.5 kts and then electrical contact with this was lost. On recovering the array the cable was found to be connected through and the front section of the array was connected, so that the fault was either the mating plug or an intermittent fault in cable or array under tension.

Approximate sensitivities of both commercial arrays were obtained by measuring the bottom echo return from an air-gun pulse in the deepest water available (Hurd Deep), though it was not really deep enough and geometrical corrections will be necessary.

(ii) The high frequency noises from the ship apparent on Fig. 1 and especially at 10 kHz are a serious limitation for any work using acoustic instrumentation such as pingers and acoustic command systems. Fig. 2 summarises the spectral measurements made with an omni-directional hydrophone 40 m deep below the stationary ship in 90 fms of water. It can be seen that over the whole spectrum noise levels are higher with the propellor at zero pitch than with the prop de-clutched and both engines running at normal speed but off-load, whilst the Paxman auxiliary diesel engine powers the ship's supplies. A further reduction in noise especially between 150 Hz and 800 Hz occurs when the main engines are shut down, though the small reduction above 1,000 Hz indicate that the Paxman is as noisy as the main engines in this band. These results suggest at first sight a very noisy prop, but the similarity of spectrum slopes is significant and may indicate that the prop and shaft, when clutched-in, couple the engine noises to the water. From spectra of a single hydrophone towed 150 m astern at 7 kts it is remarkable that the "John Murray" is 15-20 dB noisier than "Discovery" in the 10 kHz band, and 30 dB noisier than "sea-state 2" noise. For pinger listening in these circumstances the use of two spheres 3 inches apart in the hydrophone tube is recommended; this combination presents a directional null in sensitivity in the direction of the ship and a 3 dB loss to signals 30° from the vertical in the fore-aft plane, so that the signal-to-noise improvement, when the ship is over the pinger in deep water, or when the pinger is abeam, should improve by 10 to 15 dB.

(iii) Air Guns.

(A) 'Ewing' type Gun.

It was suspected after "Discovery" Cruise 29 that the gun was faulty and would not fire at high pressures. Tests on this cruise showed that this was not so and a complete set of high pressure versus low pressure readings were obtained up to a high pressure gauge reading of 2,700 p.s.i. These gave a value of $5\frac{3}{4}$ for the ratio of high to low pressure, compared with a theoretical value of $7\frac{1}{2}$. The reason for this discrepancy is not readily apparent.

(B) Solenoid triggered Air-Guns.

During "Discovery" Cruises 27 and 28 various aspects of these guns were unsatisfactory and the present cruise was used to test subsequent improvements and redesign.

(a) Solenoids. These were rewound with stronger input leads and were housed in new bodies of type S80 stainless steel. These operated satisfactorily and gave no trouble.

(b) Top liners. A new grooved design replaced the original type with ports and this also proved trouble free.

(c) Leakage, lower flange. To overcome the seating problem a new design based on the 'Ewing-gun' seal was produced and was satisfactory.

(d) Leakage, upper flange. Various designs were tried to produce a reliable method of seating but all attempts failed. A number of reasons have become apparent to assist future re-design.

In spite of the leak from the top flange it was possible on most tests to operate the gun up to the rated pressure of 2,000 p.s.i. on initial firing. The maximum firing pressure possible without leakage then fell with repetitive firing and eventually levelled at about 800-1,000 p.s.i. Stripping and cleaning the gun usually restored the maximum pressure back to 2,000 p.s.i.

(iv) Thirty-three samples, of which fourteen were retained were taken by Shipek grab.

5. <u>Ship Facilities</u>

Generally the working and accommodation facilities were found to be very good. In addition to the information on ship noises above it may be useful to record some more specific comments about the "John Murray".

(i) The speed control from the bridge by stepped changes in propellor pitch is rather inflexible. For example the notch position for nominally 4 knots can produce speeds through the water of 3.6 kts against the wind or 4.4 kts with the wind, whilst the adjacent notches give speeds outside this range. Consequently it is not possible to achieve a constant speed from one course to another or from day to day, though a mean speed can be achieved by continually adjusting the pitch control back and forth, with an eye on the log. The process of changing the pitch is noisy and it seems a pity to have to move it at all when at a fixed notch in good sea conditions the speed is quite steady ($\pm$ 0.1 kt).

(ii) Top speed appears to be 8 kts if the main engines power the other supplies or 9 kts if the Paxman does so. (Not 11.5 kts as advertised.)

(iii) The intercom system was unreliable and when working very distorted, except the aft deck speakers which were acceptable.

(iv) The digital clock and timing outlets were not working.

(v) The ease of accessibility to the after deck from the general and wet labs. was appreciated.

(vi) The earthing bus was useful.

(vii) The air supply from the compressor carried a certain amount of oil which it is thought could have affected the air-gun performance. Also the Ewing-gun tests indicate that the delivery from the compressor does not reach its advertised value for 10 cu.ft./min. rating. (The machine label actually quotes 20 cu. ft. per min!) The air to be compressed is taken in from the compressor compartment via a small filter which tends to become covered in oil. It is suggested that both the quality and quantity of delivered air could be improved if the inlet air were obtained from an external source via a larger filter.

(viii) The air control board on the aft deck could be usefully improved by the addition of (a) a high pressure regulator and (b) exhaust valves on all outputs. At present there is no way of controlling the high pressure or of venting off surplus air when it is required to lower the pressures.

6. Acknowledgments.

It is a great pleasure to record our thanks to Captain Perry, his Officers and Crew for their excellent co-operation and hospitality. The loan of hydrophone arrays from R.V.U. and Cambridge University is gratefully acknowledged.

B.S. McCartney
A.R. Stubbs
N.H. Kenyon

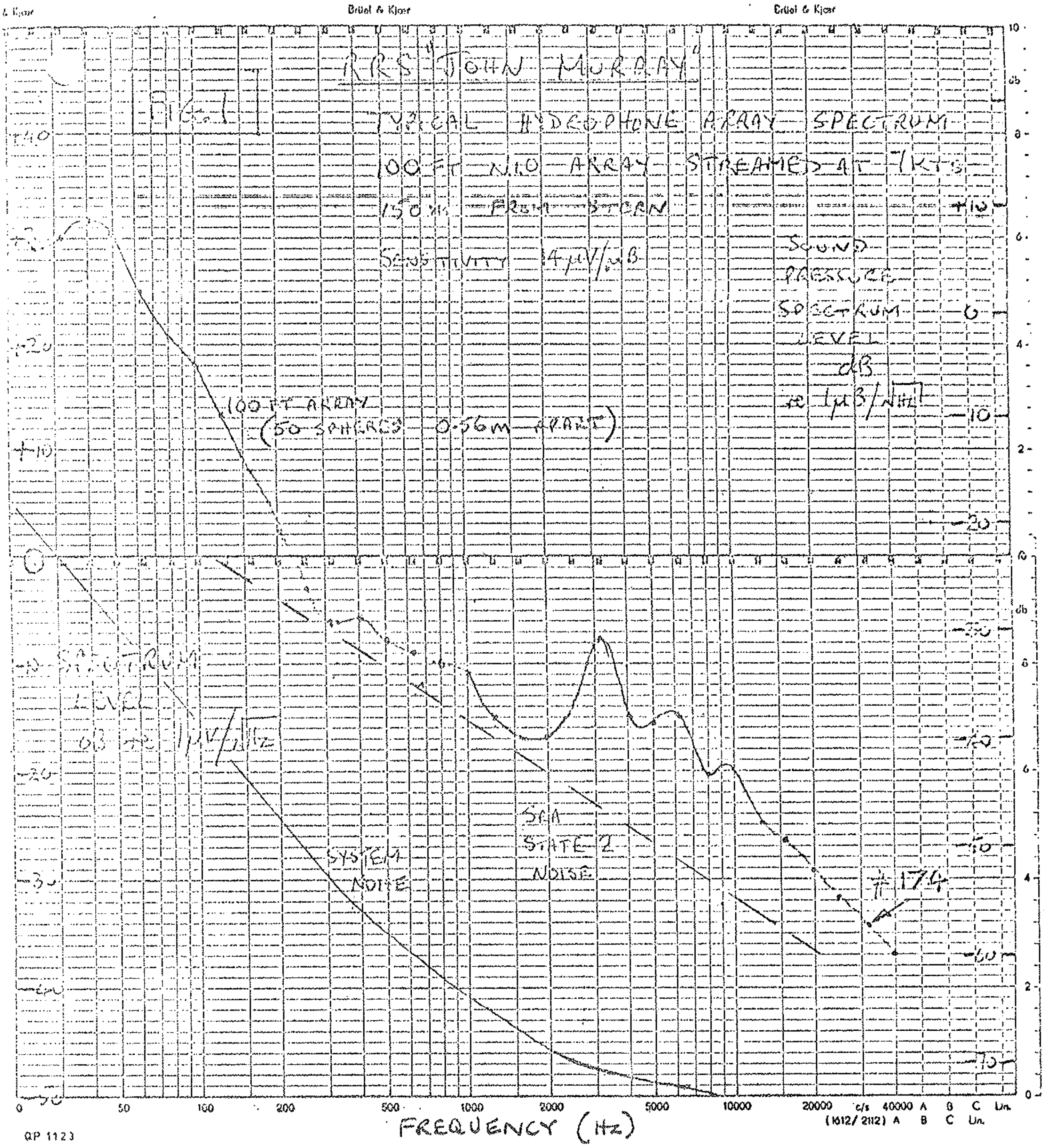
Brüel & Kjær
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FIG. 1
RRS "JOHN MURRAY"
TYPICAL HYDROPHONE ARRAY SPECTRUM
100 FT N10 ARRAY STREAMED AT 7 KTS
150 M FROM STERN
SENSITIVITY 14 μV/μB
SOUND PRESSURE SPECTRUM LEVEL dB re 1μB/√Hz
100 FT ARRAY (50 SPHERES 0.56 m APART)
SPECTRUM LEVEL dB re 1μV/√Hz
SYSTEM NOISE
SEA STATE 2 NOISE
#174
+40
+30
+20
+10
0
-10
-20
-30
-40
-50
+10
0
-10
-20
-30
-40
-50
-60
-70
0
50
100
200
500
1000
2000
5000
10000
20000
c/s
40000
A B C Lin.
(1612/2112) A B C Lin.
FREQUENCY (Hz)
QP 1123