

**TWO-RANGE DECCA INSTALLED  
ON THE HYDROGRAPHIC VESSEL « KAPUSKASING »  
(CANADA) - 1956 SEASON**

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Ottawa, October 1956.

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Extracts from a report covering the 1956 season and forming a sequel to the information covering the 1955 season contained in the article *Application of Two-Range Decca to Hydrographic Survey in Canada* by the same author, which appeared in the May 1956 edition of the *International Hydrographic Review*.

**SET-UP, INVESTIGATION OF PATTERN AND COMPLETION  
OF THE SOUTHERN PORTION OF THE PROJECT**

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SUMMARY

On Tuesday 15th May, the C.G.S. *Kapuskasig* sailed from Halifax for Pictou, via North Sydney. The slave station equipment was loaded at Pictou and by p.m. Monday, 21st May, the vessel had berthed in Summerside, Prince Edward Island, in readiness to commence operations.

The Red Slave, located 20 miles from Summerside, on the north shore of the island, was constructed and in operation within three days. The survey stations were reoccupied and the position of the Electrical Centre recovered without difficulty.

On Saturday, 27th May, the vessel sailed for Magdalen Islands via Tracadie. Good weather favoured the operations at the Magdalens and the equipment was landed by boat at Millerand in a very short time. The Purple Slave was in operation within three days. Again triangulation stations and Electrical Centre were reoccupied without difficulty.

On Friday, 1st June, calibration was commenced at the Purple Slave and calibration of the Red Slave was accomplished on Monday, 4th June. The following day was spent tying-in the permanent navigation buoys, lane-counting and computing. A tide-gauge was set up at Escuminac in preparation for the sounding runs. Meanwhile, our Tidal and Current Survey Section had established gauges for us at Mal Bay, Quebec, and at Etang du Nord in the Magdalens.

On Wednesday, 6th June, the first run of soundings (126 miles) was successfully completed and on subsequent days the runs were so arranged that all

navigation buoys in the area were tied by runs from at least two points of origin and checked by sextant fix.

On Wednesday, 13th June, favourable weather provided us with an opportunity to run a third set of calibration observations at Shippigan. Hydrographic monuments Lee and Lit were reoccupied and a station San established in a suitable position. Ship-Station observations were then carefully taken and the vessel resumed normal operations the following day. The results and an analysis of these calculations will follow.

Again we have been troubled with electrical storms. On two consecutive days, the 14th and 15th June, we were forced to abandon operations due to exceptional noise level conditions. At this time we were operating at ranges of about 100 miles from each Slave station. Again on Friday, 22nd June, due to heavy thunder-storms, we were compelled to abandon sounding for the day. However, with more settled weather conditions, operations proceeded satisfactorily and by the end of June more than 1700 miles of accurately plotted lines of soundings were obtained.

The plotting methods adopted last year were continued, the same tabular values holding good.

Every endeavour was made to check the electronic pattern in areas where an overland path was unavoidable. The errors, if any, must be extremely small and quite beyond our plotting ability.

Tests were also run while using the ship's W/T equipment. We must report that the decometers lost torque completely and that lane count is definitely interrupted. W/T communication is therefore restricted to the hours of darkness when the Decca Pattern is off the air.

A Marine Track-Plotter, type 350, was supplied to us by the Decca Navigator (Canada) Ltd, and this has proved to be of considerable value. A more detailed report follows.

The southern portion of the Project was completed on 31st July 1956.

Total number of miles of sounding:	1955.....	7,286
	1956.....	4,072

Grand Total.....	11,358
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5 Shoals were investigated.

The Electronic Pattern was cancelled and dismantling of the Red Slave commenced on 1st August.

A report of progress on the northern portion of the project will follow.

To date the following radiated and comparison frequencies were used:

Radiated frequencies :	Master :	84.280 Kc/s
	Red :	112.373 Kc/s
	Purple :	70.230 Kc/s

Comparison frequencies :	Red :	337.120 Kc/s
	Purple :	421.400 Kc/s

Speed of propagation used :	229,650,000 metres p/sec.
Red lane-width :	444.426 metres
Purple lane-width :	355.541 metres
Maximum working range :	120 miles
Projection scale :	1:144,000.

## SET-UP

*Red Slave*

Situated on Prince Edward Island, north shore, in the vicinity of Cape Tryon, within 300 metres of the shore-line. Latitude:  $46^{\circ}32'22''.970$  North, and Longitude:  $63^{\circ}33'28''.055$  West. Some slight modifications were introduced at this Slave. The mains were earthed, the diesels moved slightly further away from the co-axial, the earth-mat extended and a stout 3-wire fence constructed around the perimeter of the anchorages.

The earth wires extending beyond the fence were buried to a depth of at least four inches. This Slave was in operation within three days.

*Purple Slave*

On the southwestern shore of Amherst Island in the Magdalens Group, in Latitude:  $47^{\circ}13'21''.611$  North, and Longitude:  $62^{\circ}00'50''.066$  West.

The transmitting antenna of this Slave was extended by 20 feet in order to achieve greater ranges. Again this year the mast height is 120 feet, the top-dressing acting as rigging for the extra length. All equipment in this case was installed as before.

A stout 3-wire fence was erected and earth wires buried. This Slave was also in operation within three days.

## PLOTTING

The same projection, the same pattern, the same tabular values, and the same methods were employed during the completion of the southern portion of the project.

## COMPUTATION OF LOCKING CONSTANTS

The methods adopted last season were used. Ten observations, using transits set up at our triangulation stations ashore, were taken and averaged. The decometer readings of the Red and Purple Slaves were recorded at the same instant.

At each Slave the vessel steamed round the theoretical periphery of the slave induction field and careful sextant angle fixes were compared with instantaneous decometer readings. These sextant fixes were plotted on a projection at scale 1:36,000 specially laid down for Slave area lane identification. No variation in Locking Constants of any measurable value could be observed, and it must be assumed that, if land/sea boundary errors exist in our area, then these must be extremely small.

*Results:*

Red	:	Locking constant	:	.473 Lane.
Purple	:	—	—	.526 Lane.

## ANALYSIS OF RESULTS

With complete and carefully taken sets of observations at the Magdalen Islands, Prince Edward Island, and Shippigan, it is safe to assume that these represent electronic pattern conditions throughout the area containing an overall seawater path.

In the first instance, computation of Locking Constants for each of the two Slaves, at each end of the baseline, shows a difference of six one-hundredths for the Red and eight one-hundredths for the Purple Slaves. The lower value in each case was obtained at the 76 mile distance. This represents an error in pattern of

approximately 26 metres, but by feeding the average value of Locking Constant into the shipborne receivers, the maximum discrepancy felt should be limited to half of this amount, i.e. 13 metres only.

At Shippigan, where triangulation stations were set up and positioned, the third set of values was procured. Accurate spheroidal distances Ship to Red and Ship to Purple were computed by Inverse Solution for comparison with decometer readings. Locking Constants computed here show a further small drop proportional to the increase in distance from each Slave.

These results, carefully analysed, show an overall discrepancy in the pattern of 28 metres. If we assume the Locking Constants computed close to the Slave concerned to be correct then the error is approximately 1 in 14,000. These values, calculated at only 15 lanes' distance from each Slave, should be unaffected by small changes in propagation velocity, as the distance involved is relatively short. If these Locking Constants decrease with distance this indicates that the adopted speed of propagation is too high. In our case it is too high by approximately 50,000 metres per second.

Conversely, using a speed of propagation of 299,600,000 metres per second instead of the original 299,650,000 metres per second, the Locking Constants calculated at all three observation stations for each Slave are brought almost into coincidence. The spread in this case is limited to 16 one-thousandths on Red and to 16 one-thousandths on Purple, or 5.6 metres on Red and 7.1 metres on Purple.

All of these observations were carried out with extreme care, and the decometers were referenced immediately prior to the agreed time. With last year's experience behind us we felt confident of a completely stable pattern with overall discrepancy values of less than 13 metres.

Headquarters were informed of this and it was recommended that tabular values, based on a propagation speed of 299,600,000 metres per second, be computed in readiness for the commencement of the northern portion of the project.

Where possible, further investigation of pattern was procured by compared sextant angle fixes. No variation was observed.

#### INTERFERENCE

Several times during the season operations were interrupted by exceptionally high noise level generated by local thunderstorms. It would seem that only an increase of radiated power could overcome such conditions but it is felt that this would not be economical.

Several tests have been run to determine whether or not the ship's W/T system still caused interference. Ship telegraphy communications are confined to the 425 and 500 Kc bands by law. The equipment was operated on each of these frequencies and the decometers lost torque completely. Lane count is obviously lost under these circumstances. For this reason W/T communications have again been confined to the hours of darkness when the Decca Pattern is off the air.

The reason for this interference is somewhat obscure. It is possible that W/T on 425 and 500 Kc/s is powerful enough at source to shock-excite the Master transmitting antenna which is tuned to a frequency close to that of the Slaves. It may be possible that the interference generated from this source is forcing the Decca off the air.

## LANE IDENTIFICATION

Decca readings have been established for all permanent navigation buoys in the area and these proved to be extremely useful. In other areas lane identification is achieved by sextant angle fix.

## MARINE TRACK-PLOTTER, TYPE 350

This instrument provides us with a graphical record of decometer readings. A choice of five scales from 1/4" to 4" per lane is provided and fixes can be indicated by momentarily depressing one of four switches. It is possible to have the Red pattern activate the paper and the Purple pattern the stylus pen or vice versa.

It is considered that this instrument is definitely an asset. By using different colours of ink in the stylus pen, one roll of paper can be made to last for one week. The record provided is of little value for plotting purposes but loss of lock, indicated by pen deviation from the intended track, is readily observed. For comparison purposes, day to day, or outward to inward track, it is most useful.

For instance, although the record is presented in rectilinear grid form, a vessel steaming past a buoy and proceeding to seaward for sixty miles, appears on the paper to steer a zig-zag track. However, immediately she turns back on a parallel track, say one mile south, her return journey is plotted parallel to the outgoing journey. When she steams past the buoy in the evening the two tracks will meet exactly at the point of origin proving beyond doubt that there has been no lane slip.

## COMPLETION OF THE SOUTHERN PORTION OF THE PROJECT

Before the end of operations on this part of the project the Locking Constants were again accurately measured.

No appreciable change had taken place and the values are as follows:

Red	:	Locking Constant	.457 Lane.
Purple	:	Locking Constant	.530 Lane.

FREQUENCY CHANGE — SLAVE LOCATION CHANGE  
RE-CALIBRATION AND COMMENCEMENT  
OF THE NORTHERN PORTION

## FREQUENCY CHANGE

This change of frequency was necessary in order to avoid interference from a powerful land-based chain over the city of New York.

The change of crystals was done while the Red Slave was removed from Prince Edward Island and reconstructed in the Shippigan area.

*The radiated frequencies are now:*

Master	:	84.326 Kc/s.
Red	:	112.435 Kc/s.
Purple	:	70.272 Kc/s.

*The comparison frequencies are now:*

Red	:	337.304 Kc/s.
Purple	:	421.630 Kc/s.

On recommendations, based on the results obtained during the first half of this season, the speed of propagation used to compute tabular values was reduced to 299,600,000 metres per second.

The Red lane-width is now	:	444.110 metres.
The Purple lane-width is now	:	355.288 metres.
Length of base-line	:	112 miles approx.
Maximum range	:	145 miles.
Projection scale	:	1:144,000.

#### FREQUENCY CHECK

A single beam oscilloscope was locked to the 60 c/s mains supply with its time base running at 15 c/s. This gave exactly 4 cycles of trace when a 60 c/s signal was fed to the « Y » plates. This signal was removed and the beat frequency between the old and the new crystals (obtained from the anode of V10) was applied, via a 1  $\mu$ f condenser to the « Y » plates.

The timing control of the upper unit was adjusted until exactly 3 cycles of trace were visible on the screen. This gave a frequency difference of 45 c/s. The timing control was further adjusted in a direction which decreased its capacity, until the trace was running off at 1 cycle. This gave the required frequency difference of 46 cycles. The frequency of the nominally 60 c/s mains supply was checked by counting the revolutions per minute of a synchronous motor unit. Its actual frequency was found to be within 0.4 c/s of 60 c/s.

This comparison of frequencies was made repeatedly over a period of about one and a half hours and consistent results to within one division on the tuning control were obtained. This is considered to be satisfactory.

#### RECONSTRUCTION OF THE RED SLAVE

This site, on Shippigan Island, had been chosen after previous reconnaissance. The soil here was extremely soft and mixed with sand. It was decided that normal mast anchorages would not be suitable. Deadmen were used. Four baulks of timber 8" x 8" and 5 feet in length were buried to a depth of five feet. From each of these, a wire-strop with fish-plate attachment reached to ground surface. These anchorages proved to be fully adequate.

The geographical position of this site was obtained by triangulation. Big Shippigan Lighthouse, a secondary unoccupied geodetic station and Shippigan R.C. Church provided the base and azimuth. The receiving angle at our station was more than 36 degrees. In addition a traverse was run from Big Shippigan Lighthouse to the slave station as a check.

Reconstruction was commenced on Monday, 6th August, and the station was in operation by the 9th August.

#### RECALIBRATION

Before calibration observations were commenced the vessel proceeded to Magdalens to re-rig the top-dressing of the Purple transmitting mast.

Again observations were carefully taken and two values for Locking Constants computed. These checked to 10 one-thousandths on the Purple pattern, and to 14 one-thousandths on the Red pattern, or approximately 6 metres.

## RESULTS

Red : Locking Constant : .499 Lane  
 Purple : Locking Constant : .548 Lane

## PATTERN CHECKS

Good checks were available in the Gaspé area and sextant angle fixes were compared with Decca positions on numerous occasions. These were at all times wholly satisfactory, no measurable difference being observed at any time.

## PLOTTING

At this stage it was considered expedient to try out a new plotting system. This involves the use of zones rather than round tens of lanes. In the first instance the number of circles required to be described around each slave is reduced to one third, and the need for accumulative tabular values no longer exists.

Assuming zones of 24 lanes to be described around the Red Slave and zones of 30 lanes around the Purple Slave, positioning is available using a circular plotting diagram.

The radius of the outer circle of the diagram is equal to a Decca zone at scale. The width of this zone, of course, is the same for both Slaves. For further sub-divisions in lanes, the diagram is divided into Red and Purple semi-circles. Within each, the circles are drawn at intervals of half a lane, with lanes numbered as they appear on the decometers. In a small sector, perpendicular to the sub-dividing diameters, a fine scale is provided.

When plotting a point the diagram is turned so that the dividing diameter points in the direction of the base-line with the Red semi-circle towards the Red Slave, and the Purple semi-circle towards the Purple Slave. The diagram is placed so that the required Red and Purple readings are achieved simultaneously. The point is transferred to the chart by pricking through the centre of the diagram.

## LANE IDENTIFICATION

In this northern portion of our season's operations fewer navigation buoys were available for lane identification. Our own buoys, dans and drums, proved to be quite satisfactory.

To avoid the possibility of drift, 1,000 lb. concrete sinkers were made on board, to which these buoys were moored. The sinkers were never recovered. The vessel merely picked up the buoys and cut the mooring when tight.

## RESULTS

Total number of sounding miles in 1955/56	
Project .....	15,904 miles
Number of sounding miles 1955.....	7,286 —
Number of sounding miles 1956.....	8,618 —
Total miles on South Sheet.....	11,358 —
Total miles on North Sheet.....	4,546 —

## CHECK CALIBRATIONS

Before dismantling of slaves was begun the system was re-calibrated and the computations show a closure overall of 25 metres.

## CONDITION OF EQUIPMENT : RECOMMENDATIONS

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### SLAVES

1. The sectional steel shacks have been declared unsuitable and it is essential that these be replaced by sectional wooden shacks.
2. New receiving gantries are required for each Slave station.
3. Radio-telephone gantries are required for each Slave station.
4. A complete set of mast rigging is required for each Slave.
5. A complete top-dressing is required for each Slave.
6. The top-dressing copper collars on each mast should be renewed.
7. The following additional equipment is also required :
  - 4 rolls barbed wire for fencing ;
  - 50 bull-dog grips 1/4" ;
  - 24 D shackles 1/2" ;
  - 100 new phosphor-bronze earth radial wires.

### MASTER

1. Top-dressing downhauls to be renewed by ship's crew.
2. 4 Diesel generators to be overhauled ;
3. Main-transmitting antenna : The insulators on the lower set of guys should be lowered by about four feet to increase capacitance and to keep earthed guy wires away from the mast.

### RECOMMENDATIONS

1. The 20-foot extensions on the Purple mast should be avoided in future operations and, if necessary, the ranges limited to accept this reduction. The masts are specially designed for the 100' height and extensions are really quite dangerous.
2. In view of the poor propagation characteristics of the Purple frequency this station should be located in the position from which the lesser range is required.
3. Log-book sheets are now required in the following combinations :
 

Red/Purple	Purple/Green	Red/Green
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4. Standing orders governing the usage of Two-Range Decca might be conveniently issued now.

### NOTE

The following is submitted for your information in order that you may assess the value of the work done by a Slave Station Technician. The question of assistant technicians for Slave stations should be considered.

#### *Slave Station Technicians*

In addition to the ability to set up a Slave station : assemble and service equipment ; and service diesel generators, etc.

#### *When operational*

The station must be attended at all times, the main duties of the technician being :



1. Keep careful watch on aerial-tuning, anticipating changing weather conditions, and adjusting when necessary.

2. Referencing of Racks: This is usually done at least once every hour. These are Phase Control Racks and at each station there are two — one operational, and one on standby. Each has three lights : Red for operational, Green in lock, Orange out of lock.

The Standby Phase Control Unit is the only means of monitoring Two-Range Decca and this is very important.

Standard signals can be fed into this standby unit for comparison purposes by means of a reference oscillator. Close adjustments made on this rack by an experienced operator provide readings by which the accuracy of the operational rack can be adjudged. Drift in the operational rack can be noticed and, if necessary, corrected by means of a goniometer on each rack.

Large drifts in pattern on the standby unit indicate the necessity for an immediate re-reference for check — then, if necessary, the racks may be changed by pushing one button—the Master station being informed at once by radio telephone in case of lane-slip. The rack changed from operational to standby can then be referenced to monitor the other.

To carry out these duties efficiently a good knowledge of the principles involved in the system is most necessary, and a good period of training is required.

## ACCURACY INVESTIGATION ST. PAUL ISLAND

Practical investigation of pattern was carried out on the 23rd and 26th October. Sextant fixes were carefully checked against Decca positions on both sides of the Island and discrepancies of 75 to 100 metres were observed.

Decca readings have been carried from two separate buoys, tied to the topography by calibration, and carefully counted on the Track-Plotter. There is no possibility of a lane-slip.

The vessel was stopped on either side of the island and average sextant fix positions compared with Decca positions transferred by proportional dividers from scale 1:144,000 to 1:24,000. Here, discrepancies were limited to 50 metres.

In order to avoid pattern errors due to plotting and transferring, the Decca readings at several fixes have been converted by computation to geographical co-ordinates for comparison with sextant fixes. The maximum discrepancy is now 50 metres.

These computations involve slave station positions and Decca readings converted to spheroidal distances only, so that the possibility of errors accumulating from projectional distortion, atmospheric distortion, comparison of physical pattern to field sheet, geometrical angle of cut, etc., are excluded from the final comparison of Visual Fix with Decca Fix.

This would indicate that the accuracy of the Two-Range Decca is satisfactory and that the discrepancies displayed by the overlay on field sheet 1878A - Sc St. Paul Island for the 21st August are due to an accumulation of errors.

In general, the main sources of error are contained within the comparison of distortions between the field sheet and the plastic overlay and the geometrical angle of cut in the area of St. Paul Island.

The soundings around the island were all done on one day, the 21st August. A new physical pattern covering this area has been prepared and this day's work re-plotted. These are now compared with the original pattern and, where necessary, adjusted.

A careful transfer of these lines has been applied by overlay to St. Paul Island field sheet and the comparison is now satisfactory.

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