THE DANISH DECCA CHAIN IN GREENLAND
COMPILED BY THE DANISH HYDROGRAPHIC OFFICE

(Lecture delivered during the VIth International Hydrographic Conference, Monaco, April-May 1952, by Kommandör P.C.S. JENSEN, Hydrographer.)

Chronological Introduction :

Among the responsibilities of the Danish Hydrographic Office is the Hydrographic Survey of Greenland waters.

Most of the present charts are compiled from old surveys dating mainly from the latter part of the nineteenth century. These were not based on a continuous triangulation along the coast, and the soundings were made by well-known old-fashioned methods and therefore very sparsely distributed.

According to modern standards these charts are far from satisfactory, and as shipping and fishing have been intensified greatly during the last decades the demand for modern charts has grown accordingly.

In the late 1920's the Danish Geodetic Institute started a modern survey of Greenland based on a continuous first-order triangulation including several base-measurements and astronomical observations along the coast.

For the Hydrographic Survey the "Hejmdal" was built at the Copenhagen Naval dockyard in 1934 and commissioned in 1935.

As the hydographic survey has to follow the triangulation made ashore by the Geodetic Institute, this work started in Disko Bay.

This first modern survey was made by the orthodox methods : three point fixes from coordinated points ashore in the years 1935-38. From Disko Bay the survey was intended to proceed south along the coast, and the need for an aid to fix the position far from the coast and in the prevailing fog arose.

In 1938 experiments were carried out with three mobile radiodirection finding stations placed along the coast. These were far from promising, and the war then put a stop to all further work in Greenland.

When the war was over the Hydrographic Office got information about the British Decca position fixing system that had been developed during the war. In 1946 the Danish government purchased a survey chain from the Decca Navigator Co., Ltd., consisting of three transmitting stations and one monitor station, the prototype of the later Decca portable survey chain : (viz. I. H. R. Vol. XXVIII-I, page 99).

After reconnaissance on the coast and consultation with the Decca Co., the stations were established by the "Hejmdal" in 1947 as follows : — One on Nunarsuaq in the Kronprinsens Eilande group, one on Aningaq near Rifkol and one on Mollers outside Holsteinsborg.

The monitor station was established at Agton about seven miles east of Rifkol. The positions of the stations were determined in relation to the first-order triangulation.

The diesel generators for the stations had not been delivered, as they were of a new type not yet completed. In order to be able to try out the transmitters and make a preliminary lane-counting, some old and rather unreliable German diesel generators had been used instead.

During the winter 1947-48 the Decca-grid was computed at the Danish Hydrographic Office by the method developed by the Nautical Almanac Office of the British Hydrographic Department (viz. I. H. B. vol. XXIV, page 176, and Vol. XXVI, page 41).

The computations were based on a speed of propagation of radio-waves of 2.9940×10^5 km./sec. advised by the Decca Co., and on the positions of the stations computed by the Danish Geodetic Institute.

The survey room of the "Hejmdal" was rebuilt by the Naval dockyard to accommodate the larger personnel required for the Decca survey work, and in order to get better working conditions. Two new recording echo-sounders were installed, Hughes-Kelvin type, MS 21 and MS 19, as the former Atlas echo-sounders had been removed by the Germans. As the special survey receivers had not yet been developed, four Decca Mark IV receivers were installed.

During the summer of 1948 a lane-counting was made to place the transmitted Decca-grid as near as possible to the computed grid.

The survey was started and several experiments and trials were carried out. To test the system at long distances a trip was made to Home Bay, Baffinland, nearly 300 miles from the station.

The new one-cylinder Enfield diesel generators that were now in use were reliable, but not sufficiently strong to stand running weeks on end, and accordingly two-cylinder generators were ordered for the next seasons.

Owing to various reasons no survey took place in 1949. In the meantime the Decca grid was recomputed to a speed of propagation of 2.9968×10^5 km./sec. in accordance with the latest results as to speed of propagation of radio-waves over sea water, and with new positions of the stations caused by an adjustment of the first-order triangulation.

In 1950 the survey was continued, with everything working satisfactorily.

The area between { 68°45' N 54°20' W / 68°00' N 60°40' W } approx. was surveyed. (See plan).

In 1951 the rest of the area covered by the stations was surveyed without mishap. A site for a new station on the west coast of Disco was found { 69°43' N / 53°43' W } the position of which was determined by the Geodetic Institute.

The new chain will for the coming season (1952) consist of this station as northern slave, the one at Kronprinsens Eilande as master station, and the station near Rifkol as southern slave. The monitor station will be moved to Egedesminde in order to have it placed as near the middle of the chain as possible.

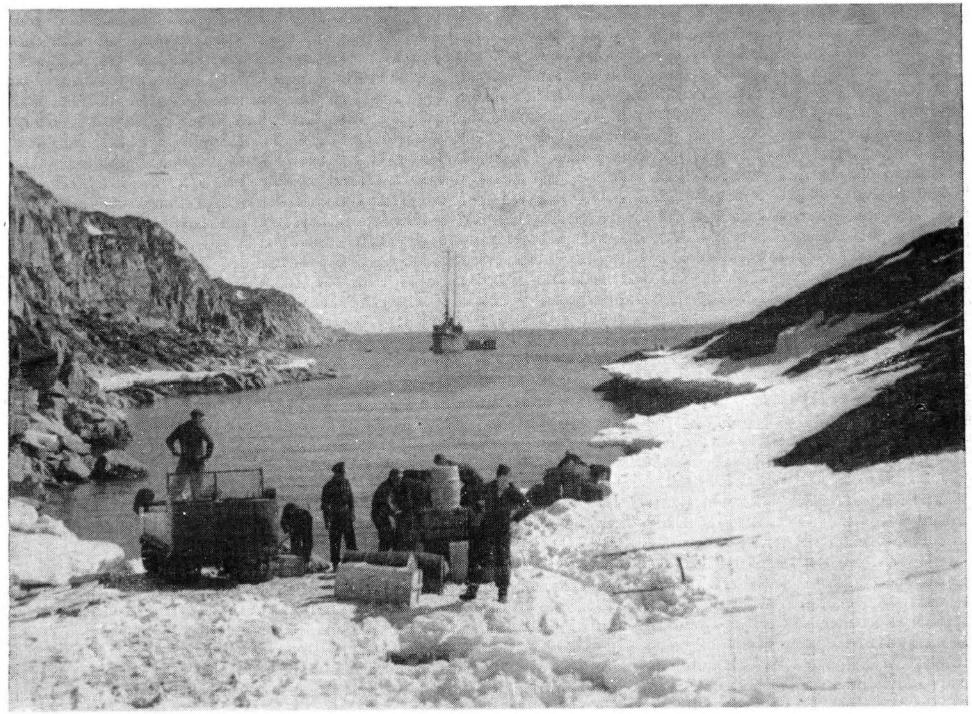


Fig. 1

Decca Survey in Greenland. Northern Slave, Landing of Material

Fig. 2

Decca Survey in Greenland. Surveying room « Hejmdal »

As only three sets of antenna masts are available, and in order to speed up the survey work, a steel cable of approximately 2.000 metres was rigged between a mountain top of about 600 metres, across a valley to the foot of another mountain (see sketch), which made it possible to get a vertical length of antenna of about 180 metres; however, owing to the proximity of the mountainside the antenna will be suspended somewhat further down the cable with a vertical length of 100 metres. Extensive electrical measurements were made to determine whether this system would stand any chance of working with satisfactory results.

It is expected that the area covered by this new chain can be finished during the summer of 1952, and the chain will then be moved south along the coast.

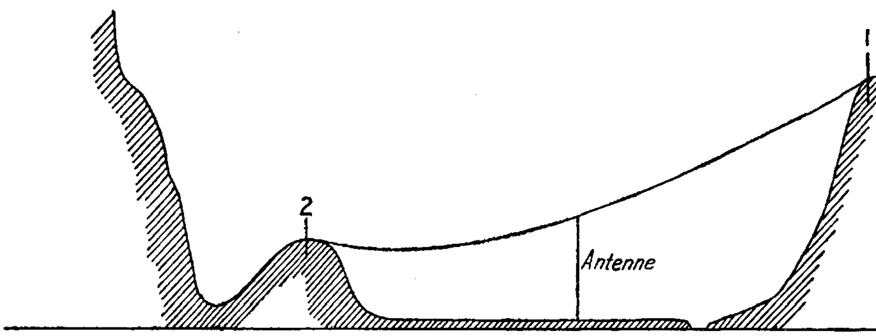


Fig. 3

Decca Survey in Greenland. Sketch of the aerial system of the Northern station N° 2

Special conditions for survey work in Greenland :

The special conditions in Greenland compared to other more civilized places greatly influence hydrographic surveying in these waters.

First of all the working season is very short. The winter ice does not disappear, at least not between the islands, till sometime in May. The snow stays on the land till June or later and comes back again about the middle of September, which means that all building operations, erecting of antenna masts, etc., have to be done during these few months. However, when the stations have been built, the snow makes transport far easier to and from the coast, so that it is possible to equip the stations as soon as the ice permits.

When the ice formed at sea retreats from the Greenland coast it moves westward and is, till nearly the end of summer, to be met in the form of heavy pack ice, somewhere in the middle of the Davis Strait.

Only towards the end of August is there a possibility of getting sounding lines across the Strait to the coast of Baffin Land.

At all times icebergs are to be met in the waters so far surveyed, constituting a severe danger to the surveying ship if this is not equipped with very reliable radar, as heavy fog is prevalent most of the time.

During the months of the actual summer, the night effect is hardly felt and it is possible to work 24 hours a day without trouble; but from the end of August no surveying is possible at night, and at that time of the year the nights grow longer rapidly.

In Greenland the survey exepedition must be completely self-supporting : the country is very sparsely populated and practically no mechanical help can be had.

The transport and landing of material and supplies for the stations on the coast offer special problems.

The material:

For landing material on the coast two LCM's on loan from the U.S. Navy are used. These craft are exceedingly handy for the purpose as they carry a considerable load, but they are not very seaworthy, which is a drawback as they have to move from one place to another along the coast under their own power, and accordingly lose quite a lot of valuable working time waiting for fair weather.

The bottom construction of the craft ought to be stronger as they are often landed in very rocky places exposed to the swell.

For transport ashore a " weasel " also on loan from the U.S.N. has been used with great success and must be considered absolutely essential for the job. As mentioned above it is advantageous if the land is covered by snow as in that case no special routes free of boulders have to be located.

For supply purposes, and to escort the LCM's an inspection cutter is being used. This vessel, built of wood along fishing vessel lines, is very suitable for the purpose, ans as it is fitted with echo-sounding gear, it is used for reconnaissance purposes as well as in the uncharted inshore passages.

The Survey :

The actual survey has so far been done by the " Hejmdal " running sounding lines at right angles to the coast, one mile apart as far as the 200-metre line, and from there spaced from two to four miles according to the depth and the distance from the shore.

Readings of three decometers are noted simultaneously every 5 minutes, and readings of the Fathometer every one minute if no abnormal depths are observed. All the Fathometer graphs are kept for reference when the smooth sheets are drawn at the Hydrographic Office and then stored.

Communications between the bridge and the survey room are maintained by loudspeaker, and the stations ashore are in constant radio-telephone communication with each other and the ship when working. In this way a constant check is kept on the effect of the night effect, etc., and breakdowns can be reported immediately.

This system has worked satisfactorily so far.

Bottom samples are taken evenly spaced in the surveyed area, up to depths of about 200 metres at a speed of ten knots with the American "Scoopfish" (viz. I.H.R. vol. XXV-I, page 61); for larger depths the ship has to be stopped.

Conclusion :

As long as everything works satisfactorily quite a large area can be surveyed every season, but it is essential that every hour be taken into consideration. It might be worth considering making the antenna mast system lighter, and with fewer masts, especially for survey work far from civilization, where every hour saved on building is an hour gained on the actual survey, as it is usually the same personnel that have to do both jobs.

I shall now give a short account of the accuracy with which the chain has worked so far.

Based on a new adjustment of the triangulation the exact positions of the three original stations are :

Northern Slave at Kronprinsens Eilande	68°59'18",45 N 53°21'06",73 W
Master at Rifkol	67°56'42",37 N 53°50'02",11 W
Southern Slave near Holsteinsborg	66°55'29",84 N 53°44'55",75 W

The phase velocity 2.9968×10^5 km./sec.

For the year 1952 a new Northen Slave has been established on the West

Coast of Disko : Enochs Havn 69°44'06",65 N.
54°47'26",58 W.

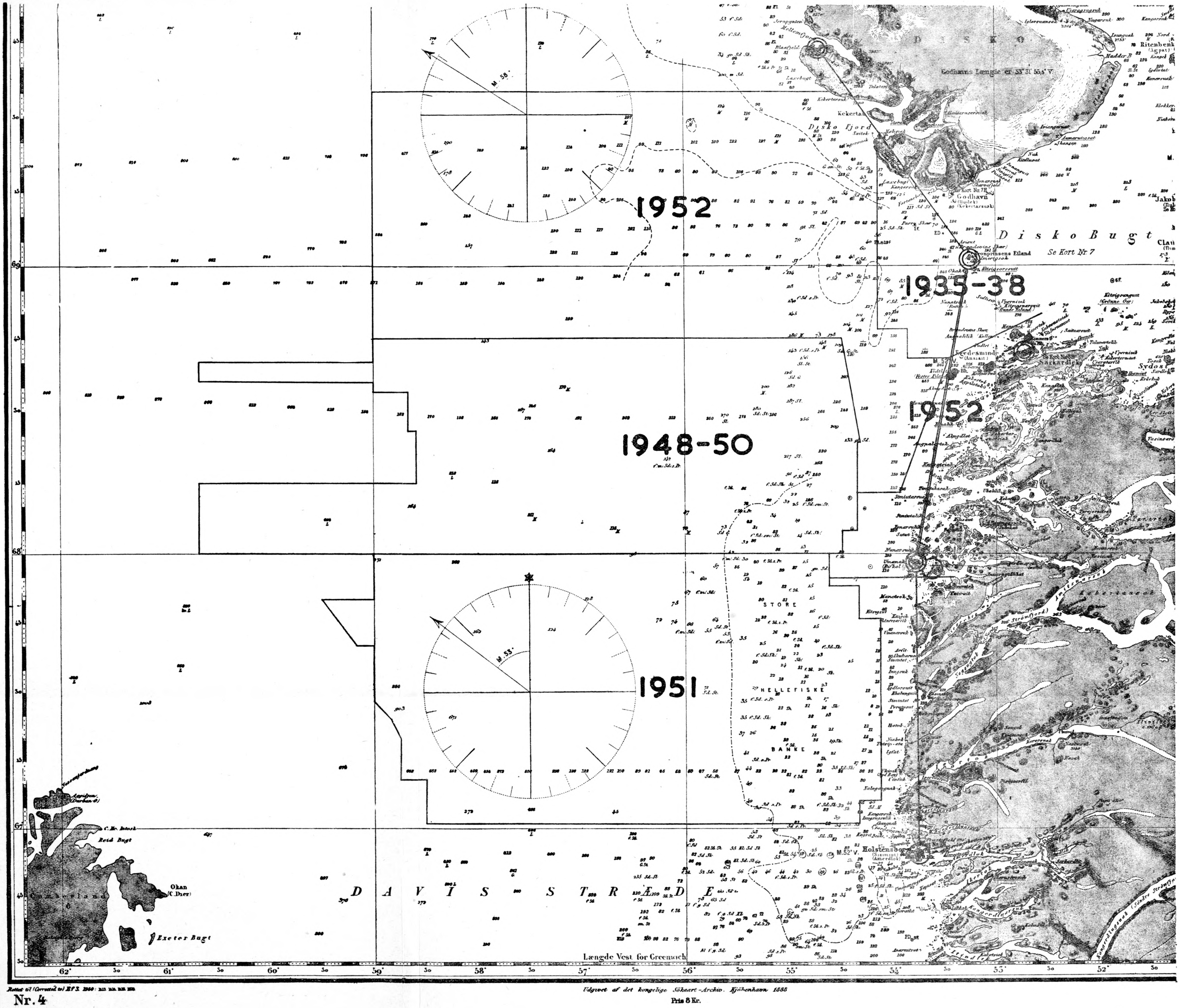
The Master Station has been removed to the site of the former Northern Slave and the former Master becomes the Southern Slave.

The basic frequency of the chain is 14.8148 Kc/sec. The aerial systems are suspended between four masts 33 m. high.

The chain is sited for off-shore surveying of the fishing banks to a distance of about 150 N.M. from the coast and not intended for in-shore work, as the coast is always in the blind sector of one of the baselines.

At the different distances mentioned in the accompanying form the following receiver-errors (Gaussian mean-error, unit 1 : 100 of a lane) were found by comparing the readings of 3-4 decometer-sets on 10 fixes near that distance :

					Bad weather conditions Middle of system W. of master station					Fine weather conditions W. of middle of northern baseline			
	Distance to master station in N.M..	10	15	20	25	50	75	100	125	160	200	250	290
RED SYSTEM	Individual receiver error.....	±1,4	±1,0	±0,7	±1,8	±1,4	±2,6	±2,9	±2,3	±0,9	±2,4	±3,1	±4,9
	Residual receiver errors......	±0,6	±0,7	±0,4	±0,7	±0,9	±1,0	±1,0	±1,1	±0,8	±0,5	±1,3	±0,8
	Lane Width in metres.......	920	830	850	910	1100	1310	1680	2010	2840	3000	3880	4440
GREEN SYSTEM	Individual receiver error......	±1,1	±1,1	±1,5	±1,4	±1,9	±2,9	±2,8	±2,6	±1,5	±2,0	±2.2	±4,0
	Residual receiver errors.....	±0,5	±0,8	±1,3		±0,7	±0,9	±1,2	±1,0	±0,8	±0,8	±0,7	±0,6
	Lane width in metres.......	730	910	930	1000	1330	1740	2080	2470	2840	3710	4290	5060
	Angle of cut...............	76°	71°5	67°5	64°	48°	37°	30°	25°5	20°	16°5	14°	12°



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The errors are Gaussian mean errors. The unit used is one hundredth of a lane.

The observations between 25-125 N.M. were taken under adverse weather conditions (storm and sea) in the middle of the system W. of the master station.

The observations between 160-290 N.M. were taken under fine weather conditions W. of the middle of the northern baseline on a trip to Home Bay (Baffin Land) to try the system on long distances. Only the observations on 250 N.M. were taken at night.

Lane-slipping occurred once on one receiver at night on 250 N.M. and twice on different receivers at night on 280 N.M. The lane-slipping was observed at once and immediately corrected.

The receivers were trimmed or verified on board with an artificial signal-generator from Decca. The individual receiver-error (verification-error) increased with the distance or with decreasing field-strength, while the residual errors were nearly constant.

For surveying work it is a great advantage to have at least three receivers as a control against lane-slipping and to minimize the effect of individual receiver errors.

The stability of the pattern as observed on the monitor station under ordinary conditions by day was about ± 0,01 lane; but at night the stability of the pattern deteriorated to about ± 0,03 — ± 0,05 lane under adverse conditions with propagation anomalies. It was no use sending corrections less than 0,03 lane to the slave stations as the phase-locking of the slaves has in fact about the same accuracy as the monitor-receivers.

It is considered an advantage to have the stations sited on off-lying islands thereby enabling the surveying-ship to cross the extensions of the baselines at different distances; observations for lane-counting from the surveying-ship are considered much more accurate than from an aircraft.

The effect of reflections from large mountains (1000-1200 m. high) was observed close to the coast (1 - 3 N.M.) and on an aircraft flying over the country. Large icebergs (100-120 m. high) were not observed to give any reflections even at very short distances.

The tracking of sounding-lines was spaced with an interval of 1 N.M. and fixes were taken every 5 minutes. The sounding-lines can easily be spaced much closer; how much will largely depend on the scale of the plotting-sheet.