THE SURINAM TRAVERSE

by Lieutenant Commander W. G. van GENT, R.Nl.N.

EDITORIAL NOTE. — *At the beginning of 1966 extensive hydrographic and oceanographic surveys of the continental plateau and the coastal waters of Surinam were undertaken under the auspices of the Hydrographic Office of the Royal Netherlands Navy. These surveys were the subject of one of the lectures given at the 9th International Hydrographic Conference and published in the January 1968 number of the* International Hydrographic Review.

The present article, reprinted from Hydrographic Newsletter, *Vol. 2, No. 1, June 1968, with the permission of the Netherlands Hydrographic Office, gives additional information on the geodetic operations necessary to the setting up of a Decca Chain.*

The Netherlands Hydrographic Office is at present preparing a special publication covering the various aspects of this survey.

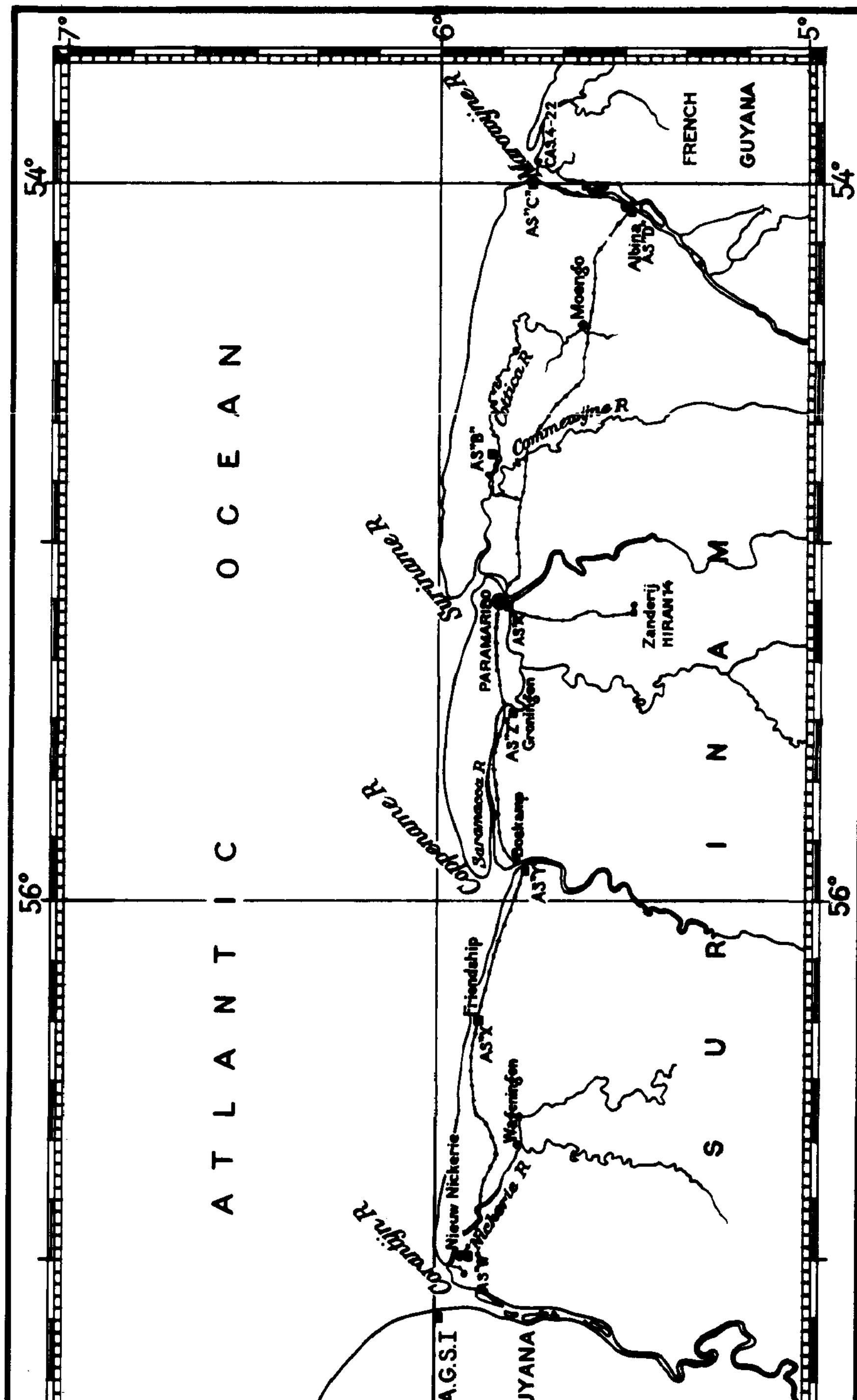
INTRODUCTION

The establishment of Decca survey stations for position fixing in the sea area of Surinam required the knowledge of the exact position of these stations — exact to an order which did not exist in this country when the project started.

The geodetic framework of national charting consisted of a number of astronomical stations tied together by aerotriangulation. These astronomical stations, however, are affected by plumbline deflections of unknown magnitude, and errors of about 300 metres may be expected.

In order to obtain the correct positions of the Decca survey transmitters, or at least the exact length of and the angle between the baselines, a traverse had to be measured along the whole north coast of Surinam by means of tellurometer and theodolite. A similar project had been carried out by the Canadian Air Service Ltd. only a short time earlier, but there were reasons that it should be repeated :

1. The results were not yet forthcoming;
2. It was uncertain that the C.A.S. traverse would equal the accuracy required for the Decca project;



ATLANTIC OCEAN
SURINAM
FRENCH GUYANA
GUYANA
I.A.G.S.I
PARAMARIBO
Zanderij
HIRAN 14
Moengo
Albina
Groningen
Boskamp
Friendship
Wageningen
Nieuw Nickerie
Surinam R
Coppename R
Saramacca R
Commewijne R
Cottica R
Nickerie R
Corantijn R
Marowijne R
AS "B"
AS "C"
AS "D"
AS "X"
AS "Y"
AS "Z"
CA 3.4-22
7°
6°
5°
54°
56°

Fig. 1

3. When planning the execution of the measurements it was assumed that they would take much less time than they actually did.

Now the results of the C.A.S. traverse have been published they turn out to be very valuable, as they can be used as a check and an amplification of the present traverse and vice versa.

The coastal area consists of low swampland, some parts cultivated and others overgrown with jungle or savannah vegetation. In the easterly region some hills are found, but generally the altitude variations are small. The path of the traverse was planned to run along the main road (east-west connection) from Nickerie to Albina.

In carrying out the measurements of the traverse, great help was rendered by the cooperation of several Surinam government services which were cointerested in the results of this traverse. In this respect the assistance of the Central Bureau for Aerial Mapping (Centraal Bureau voor Luchtkaartering) should be mentioned, which helped in planning and setting up of the traverse, which accepted responsibility for the erection of permanent markers, and which during the period in which the tellurometer was unserviceable made an Electrotape set available. From the beginning and throughout the whole period in which measurements were being carried out an excellent assistance was rendered by the triangulation service of the Surinam Department of Development. This assistance, in the form of material and personnel, has been essential for the speeding-up of the measurements.

ORGANIZATION AND EXECUTION OF THE MEASUREMENTS

Working with the tellurometer it is favourable to choose the sites as far apart as is practicable (up to 20 kilometres), but the required accuracy for the angular measurements did not permit this, as one must be able to see the pointing marks even under unfavourable circumstances of lighting and undulation.

Anyway the distances had to be of almost equal length. As a compromise, the distance between the measuring positions was made about 1 500 metres but, due to local conditions, deviations from this standard have occurred.

To provide intervisibility of the measuring positions it has been necessary to carry out a lot of woodcutting, but in order to minimize this the use of measuring towers was introduced. These towers consist of an inner part to carry the instrument and an outer part to carry personnel and extra material. The altitude of the instrument above ground level is 5 metres.

A reconnoitring group explored the sites where measurements had to be carried out, and attended to the problems of intervisibility by means of cutting down trees and brushwood. To eliminate the effects of reflections due to the bush, a path of at least 10 metres wide had to be cleared. This party consisted of about 20 local workers.

A second party, consisting of about 10 local workers equipped with a 3-ton truck, attended to the job of erecting and transporting the measuring towers.

Initially, three towers were available, but it soon became apparent that this was insufficient, so two more were constructed. In several cases the measurements could be carried out from normal tripods.

The third party performed the actual measurements. Initially both distance and angular measurements were carried out by the same people, but later the increase of the experienced personnel made it possible to split the tasks, one group working with the tellurometer and the other with the theodolite. This splitting-up of the party greatly increased progress.

At the request of the Central Bureau for Aerial Mapping the measuring positions were marked permanently, although this was of no particular interest to the Royal Netherlands Navy. So a final party attended to the construction of these concrete pillars. Shortly after their construction several of these concrete markers were damaged and consequently had to be repaired and remeasured.

The project started in January 1966 in New Nickerie, near the western border of Surinam, where one of the astronomical stations — viz. A.S. "W" — is situated. This was made the starting point of the traverse. Distance measurements were carried out by officers of H.Nl.M.S. *Snellius* by means of tellurometer type M/RA 1. All distances were measured twice, interchanging the instruments between measurements.

Each measurement consisted of two coarse readings and about 15 fine readings. The difference between the two measurements was not allowed to exceed 10 centimetres. If larger differences occurred, the measurements were repeated.

The angles were measured by means of a Theodolite Wild T2, four double series (Besselian reiteration method). Also the vertical angles, for determining the eventual slope corrections, were measured in every position.

In order to find the direction of the initial line, an azimuth by means of hour angles of stars was determined. After approximately 15 angular measurements, astronomical bearings were taken on either sun or stars to control the azimuth. In order to find corrections for fixed geodetic points — such as astronomical stations, HIRAN and IAGS points — in the neighbourhood of the traverse, these points were connected to it by side branches.

As the track of the traverse did not directly connect the positions of the Decca survey transmitters there were also some side branches to connect the stations to the traverse. The road running through the coastal area (east-west connection) has considerably facilitated the transportation of the equipment. Because of the many bends encountered it could not always provide a smooth measuring line; in many cases, however, the measuring sites could be chosen alongside the road. To cross the rivers intersecting the road, use had to be made of ferries that did not run a day-and-night service. For practical reasons it was decided that the measuring

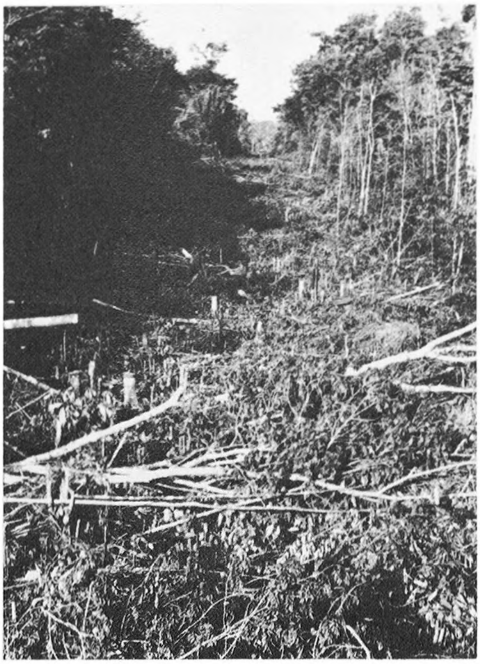


FIG. 2. — A path of about 10 metres wide had to be cleared.

FIG. 3. — The measuring party disposed of a landrover and trailer.

FIG. 4. — Measuring tower with theodolite.

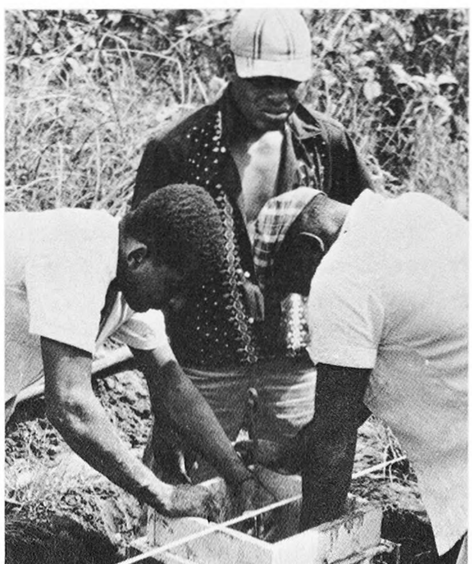


FIG. 5. — Construction of a concrete marker.

and assisting parties should live on that side of a river where work was carried out. Living accommodation was found at Nickerie on board H.Nl.M.S. *Snellius*, at Wageningen in Hotel "De Wereld", at Friendship in the government's guesthouse, at Boskamp in the ferry boatman's house, at Groningen in the holiday resort of the Overseas Gas and Electricity Company Ltd. (O.G.E.M.), in Paramaribo on board H.Nl.M.S. *Snellius* or at the Army Camp, in Marienburg at the sugar factory's guesthouse, in Moengo at the government's guesthouse and in Albina at the Army Camp.

This resulted in a minimum of transporting time for personnel and material. In all these places facilities for recharging batteries could be arranged.

In October 1966 H.Nl.M.S. *Snellius* was relieved by H.Nl.M.S. *Luymes*. At the same time the measuring party was provided with a new type of tellurometer, MRA 101. This instrument is more practical as it is no longer necessary to interchange the instruments between measurements.

It is not believed that the new instrument gives a higher accuracy. With the new tellurometer 2 coarse readings and 15 fine readings were taken — as with the old instrument. Unfortunately, after about three months working a fault developed, and it was no longer possible to keep the difference between the first and the second measurement within 10 centimetres. The trouble could not be diagnosed on site, and consequently the work was interrupted. After looking into the matter it was concluded that the instrument could not be repaired in Surinam. Fortunately, at that time C.B.A.M. had at its disposal an Electrotape set which was offered as an alternative means — this instrument being gratefully accepted. With the Electrotape 2 coarse readings and 10 fine readings were taken, and the results proved to be within the limits of accuracy set for this traverse.

Generally the weather did not have any marked effect on progress, but in the rainy season some delays were encountered because astronomical sights could not be easily taken. Also it was considered that the rain could possibly be detrimental to the electronic equipment.

The measurements were finally completed in May 1967 at the mouth of the Marowijne River bordering French Guyana, at which point the traverse could be linked up with the traverse being completed by the Canadian Air Service Ltd.

CALCULATIONS

While the field work was being carried out, the results received were being calculated initially on board H.Nl.M.S. *Snellius* and later H.Nl.M.S. *Luymes*. In principle the calculations are of a simple type, but in practice they turned out to be too time-consuming to keep up with field-work, as they had to be done in between other essential activities of the ship's staff, while carrying out normal hydrographic survey work. Consequently, when errors were discovered in the material received from the field the necessary remeasurement also was very time-consuming, as it required the retransportation of material and personnel in their respective positions over large distances, and so impeded the progress of field-work.

In a triangulation carried out by H.Nl.M.S. *Luymes* in 1964 I.A.G.S. 1 (see figure 1) was connected with A.S. "W". The coordinate of I.A.G.S. 1 computed from A.S. "W" differed from those officially stated. It was assumed that the official coordinates of I.A.G.S. 1 were correct, so that a correction had to be applied to the coordinates of A.S. "W", and the corrected coordinates (called A.S. "W"/66) were used for the calculations of the traverse. All the calculations were carried out in the plane of the Transverse Mercator projection International spheroid with the central meridian of 55°41′ W. The choice of this unusual central meridian is motivated by the demand for easy conversions of T.M. coordinates into stereographic ones and vice versa, because the central point for the stereographic projection of Surinam is 4°07′00″ N — 55°41′00″ W.

The Decca lattice for the sea survey is drawn in T.M. projection with the central meridian 55°41′ W also. Since the actual sea chart will be drawn in normal Mercator projection, a transformation will have to be carried out from Transverse to normal Mercator projection. As the sea area with the adjacent coastal area extends only from about 5°30′ N to about 8°30′ N it is justified to use in the formula for the scale factor just one value for term XVIII, in this case 0.012380.

This assumption facilitated calculations quite a lot. The general plan of calculations will be given in the following.

After conversion of the geographic coordinates of A.S. "W"/66 into T.M. coordinates, and after having determined the azimuth from A.S. "W" to the first angular point of the traverse from the stars observation (corrected for grid convergence), a coarse calculation of the following traverse points could be carried out.

Angles in full seconds, sine and cosine at 5 decimal places, distances in centimetres but uncorrected for scale factor, Eastings and Northings in metres. In this manner a coarse position of the point where the next astronomical bearing was taken could be found (in Easting and Northing).

These T.M. coordinates were converted into geographical ones and used in the calculations of the azimuth. The difference between the astronomical direction and the direction deduced from the traverse was divided over the intermediate angles with taking into account the respective standard deviations of these angles. With the corrected angles the definite grid azimuths were found. Scale factors (and occasionally slope corrections) were applied to the measured distances — scale factors to six decimal places were determined with the argument Easting from the coarse intermediate positions — and consequently the semi-definite positions of the traverse points could be calculated from grid azimuth (in full seconds) and grid distance (in centimetres), using sine and cosine to 8 decimal places. This gave Easting and Northing in centimetres. All computations have been carried out by two independent calculators. As the astronomical stations in the neighbourhood of the traverse were tied to it by side branches the positions of these stations could be calculated as parts of the traverse. The equation problems caused by the contradiction in the coordinates of the astronomical stations deduced from the traverse and those from the original stars observations are to be solved at the Hydrographic Office in The Hague.

With the definite positions of the Decca stations, finally, the definite Decca lattice needed for the sea survey can be computed electronically.

Some remarks should be made on corrections possibly to be applied to angles and distances.

1. An angular reduction for the difference between geodetic line and straight line in Transverse Mercator projection is not necessary because the amount is too small (smaller than 0.05″) throughout the traverse.

2. A correction to the mean measured distance for elevation is to be applied only when the difference in altitude between two adjacent positions exceeds 15 metres.

3. A correction to the mean measured distance for altitude above Mean Level should be applied for single distances only if this altitude exceeds 50 metres (otherwise smaller than 1 centimetre).

4. The zero correction of the tellurometers and the Electrotape has always been applied.

5. The tellurometer has been verified at regular time intervals on the calibration baseline in New Nickerie (length about 550 metres), on the calibration baseline in Paramaribo (length about 950 metres) and by re-measuring one of the distances in the traverse which was favourably situated.

From these checks it was concluded that no further corrections had to be applied to measured distances.

ACKNOWLEDGEMENTS

To all authorities — civil, military and governmental — which assisted in carrying out measurements many thanks should be rendered. Most of them have been mentioned previously.

There has been smooth and enthusiastic cooperation, and any appeal for further assistance found positive and prompt reaction. The satisfaction of having coopërated in a project which offers the possibility for further development of Surinam may be an adequate reward to all those who contributed to the execution of these traverse measurements.

APPENDIX

Outline of the field parties

1. Woodcutting party	5 men in semi-permanent service 15 men — local workers (different from district to district)
Transport	small bus or truck
Material	axes, choppers, ladders, binoculars
2. Tower party	10 men
Transport	3-ton truck
Material	5 measuring towers, ropes, choppers, spades, plumbline
3. Angle measuring party	1 geodetic surveyor 1 driver 1 secretary 2 assistants
Transport	private car
Material	Theodolite T2, 2 pointing marks (enlarged Wild type), plumblines, tripods, binoculars, measuring forms
4. Distance measuring party ..	1 or 2 officers R.N.N. 1 technical official (geodetic) 2 drivers 2 secretaries 4 assistants
Transport	landrover + trailer, private car
Material	2 tellurometers, 2 batteries 12 volts, tripods, barometer, psychrometers, binoculars, plumblines, umbrellas, measuring forms, chronometer, radio, Theodolite T2, Theodolite T0
5. Marker erection party	4 or 5 men from party 2, using the same truck when available
Material	spades, measuring tapes, concrete ingredients, shuttering, copper marking plates.

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