

## SHORAN TRIANGULATION IN CANADA.

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"The Geodetic Survey of Canada", by J. L. RANNIE).

The accelerated economic growth of Northern Canada has necessitated the establishment of accurate mapping control by some swifter method than ordinary triangulation. The Shoran method appears to be the most suitable alternative.

Early in 1948, distance measurements obtained by Shoran methods were compared with values resulting from primary triangulation in Eastern Canada. A personnel training programme of Air Force crews, redesigning of equipment and the inclusion of additional refinements were undertaken in order to increase the accuracy of Shoran technique.

Later in the same year, the reconnaissance and station preparation of the first Canadian Shoran net were carried out in mid-western Canada. Preliminary operations consisted of the selection and preparation of ground stations, determination of approximate latitudes, longitudes and azimuths by astronomical means, and the determination of approximate elevations by barometric means.

In general each station was established on the highest hill in its immediate neighborhood for unobstructed radio propagation purposes. The hill also had to be near a lake on which large aircraft could land, so that difficulties in transporting the heavy and bulky Shoran ground equipment from plane to station could be reduced to a minimum. The site of the station was permanently marked by a concrete monument, and a 100-foot square was cleared of trees and shrubs to enable the station to be identified on aerial photographs. Vistas were cut through any heavy timber on top of the hill in the direction of the other stations to clear a path for radio signals.

The astronomic positions were used to compute approximate lengths and azimuths of the lines making up the Shoran net. This information is necessary so that the planes engaged in measuring operations can fly directly to the mid-points of the lines and make line-crossing flights at the proper azimuths. The azimuths are moreover required for orienting the antennae at the ground stations.

Elevations of all Shoran ground stations must be known for the reduction of the measured lines to horizontal distances and to sea-level distances. To determine the approximate elevations, readings of three aneroid barometers at each station were taken over a ten-day or two-week period. Four readings a day were taken simultaneously with routine barometer readings at meteorological stations located in the same area. The Shoran station readings were transmitted to the Meteorological Service, which compared them with its own readings to give the best value of the height of Shoran stations above sea-level. The aneroid barometers were standardized before and after the field season, but in future portable mercury barometers will be used and the aneroids standardized more frequently. Exploratory elevations, the only type available over most of Northern Canada, are not sufficiently accurate for Shoran.

The mid-western Shoran network, which was laid out in 1948, extends into an area where horizontal coverage is urgently required. At the same time it provides a rather large-scale testing-ground for the electronic method of distance measurement. The net begins at two first-order triangulation stations about 185 miles apart in south-eastern Manitoba. From there it extends 650 miles in a northerly direction, 300 miles westerly, and 250 miles southerly, to close on two other first-order stations about 250 miles apart, in Saskatchewan and Alberta.

The net as laid down in 1948 consists of 21 stations. The minimum number of lines required to fix these points is 37, but measurement of 67 lines is planned. The minimum length of these lines is 80 miles, the maximum 310 miles and the average 202 miles. Two Laplace stations have been set up to control accumulative errors of azimuth which are reputed to reach fairly large numerical values in Shoran triangulation. Checks in position, length and azimuth will be available from the known lines at the two ends of the net.

In May 1949 the Shoran electronic measurement of the triangle sides was begun by the line-crossing method. Later in the season, reconnaissance for the extension of the net towards the north-west was begun. To date, a very satisfactory agreement has been obtained with regard to the different line-crossing measurements of any one line. Systematic errors, however, may not have been completely eliminated. Adjustment of the net by a differential method is planned, which would add new conditions in successive adjustments. By following this procedure, it is hoped that a useful assessment of the attainable precision will be obtained, as well as the establishment of a criterion for the number of lines and line-crossings required for future nets.

Shoran triangulation in Canada is a co-operative enterprise carried out by the Royal Canadian Air Force, the National Research Council, the Meteorological Service and the Geodetic Survey of Canada. The Air Force supplies and operates aircraft and electronic equipment, and provides personnel, the Research Council develops and improves the electronic and other equipment, and the Geodetic Survey does the preparatory work outlined above, as well as the analysis and reduction of observations. It also prescribes standards for obtaining the accuracy required.

