The first unit of the Kura nuclear power plant, which has been placed on line, consists of two turbogenerators installed at an elevation of +12 m. A foundation slab of monolithic reinforced concrete is set at an elevation of -6.5 m. Thus, the overall height of the foundation of each turbogenerator, which is built of monolithic and sectional-monolithic reinforced concrete, is 18.5 m. The 57.2 x 10.25 x 3-m foundation slab is supported on reinforced-concrete piles 6 m long with a 0.3x0.3-m planform, which are arranged in a 1.5 x 1.25-m grid. The overall distance between extreme points of the foundations of the Nos. 1 and 2 turbogenerators is 145 m. There are joints that allow for settlement between the foundations. The design pressure on the soil along the lower surface of the foundation with allowance for the weight of the technological equipment is 0.13 MPa.

The bed of the foundation slab is composed of gray and grayish-yellow silty sands with clayey and iron-sand segments up to 5 m thick. Underlying this is a 9-m stratum of fine yellow and gray sands with clayey-soil and sandy loam interlayers, which rests on bedrock of marlaceous dark-green and greenish-gray clays 4 m thick, and then chalk jointed to varying degrees.

The compression modulus of the sands making up the mass below the foundation bed of the turbogenerator ranges from 18 to 28 MPa, while that of the marlaceous clay is 27 MPa.

The expected settlement of the foundation supporting the turbogenerator, disregarding the effect of hydrogeologic conditions, is 5.8 cm, and the expected depth of the active zone is 20 m. The foundation settlement was computed in accordance with the method of an equivalent soil layer [1].

Ground water, the level of which could be found 1-2 m below the zero elevation of the machine gallery during the period when the reservoir was filled to the design elevation, is present over the entire area of the industrial site.

The similar geologic structure of the rock mass forming the foundation bed can cause nonuniform settlements of the turbogenerator foundations, which may lead to generator deformations of a different kind, the latter having a negative effect on the technological processes.

To determine the character of foundation deformation, the authors performed a number of cycles of high-precision instrument observations on benchmarks using an NA-1 level and three-meter precision rods.

Prior to the start of the first cycle of observations, benchmarks lmg and 4mg were affixed to one of the metal columns of the machine gallery at elevations +1 and +12 m; a rigid geometric link was established along the vertical between the benchmarks using a calibrated steel measuring tape. The excess between these benchmarks was later assumed to be a constant value. The absolute elevation was transmitted from the deep ground benchmark to benchmark lmg (elevation +1 m) prior to each measuring cycle. We then computed the absolute elevation of benchmark 4mg on which the fundamental closed leveling circuit for the turbogenerator benchmarks at +12 m, which consisted of 8-10 marks, was based. Open second-order leveling circuits were then run between benchmarks of the basic circuit. The elevation of individual marks were determined by suspended motions with a single support. Actual residuals in movements obtained within the range of 0.1 to 1.9 mm. The root-mean-square leveling error for one station was ±0.3 mm; this corresponds to the requirements established for first-class leveling circuits.

The first cycle of observations on the Nos. 1 and 2 turbogenerators was conducted on May 24, 1976 during the final stage of construction. A total of 18 cycles of observations were performed over a five-year period;
Fig. 1. Diagram showing arrangement of settlement benchmarks and leveling circuits around Nos. 1 and 2 turbogenerators (five-year settlements of benchmarks are given under their numbers). Solid lines denote basic circuit; broken lines indicate second-order circuit; 1-18) leveling marks on turbogenerator foundations; 4mg denotes mark in machine gallery.

Fig. 2. Settlements (S) of marks on turbogenerators No. 1 (1) and No. 2 (2).

of these, two observations were made in 1980.

The layout of benchmarks on the Nos. 1 and 2 turbogenerators is presented in Fig. 1. Benchmark settlements since May 1976 are given under their numbers. For benchmarks 2 (TG1) and 8 (TG2), which have experienced the greatest settlements, we plotted curves (Fig. 2) from which it is apparent that beginning in March 1978, the settlements of these marks fluctuated relative a certain magnitude. No further increase in settlement occurred; this would indicate their stabilization.

The settlement curves for the No. 1 turbogenerator along the lines of benchmarks 1-9 and 10-18, which characterize the deformation in the longitudinal and transverse directions for the entire observation period, are presented in Fig. 3a. The maximum difference of $-3.7 \text{ mm}$ in settlements is observed between marks 6 and 13; this corresponds to a transverse foundation incline of $4 \cdot 10^{-4}$ in this direction. In the longitudinal direction, the settlements are also nonuniform; the median section has a smaller settlement than the end sections of the foundation. The overall longitudinal incline is $2 \cdot 10^{-4}$ between benchmarks 13 and 17, and $0.8 \cdot 10^{-4}$ between marks 2 and 6.

As for the No. 1 turbogenerator, the settlements of the foundation under the No. 2 generator along the line established by benchmarks 1-9 exceed those of benchmarks 10-18 (Fig. 3b). This can be explained by the dissimilar rates of construction of the TG1 and TG2 and by the proximity of the construction area of the second power unit to the No. 2 turbogenerator.

It is apparent from Fig. 3b that the TG2 foundation is deformed in the longitudinal and transverse directions due to nonuniformity of settlements. Since 1976, the greatest settlements have been noted in the segment (benchmarks 6 and 13), from which the inclines are directed toward the foundation ends. Thus, the incline is $0.76 \cdot 10^{-4}$ between benchmarks 13 and 18, and $1.7 \cdot 10^{-4}$ between benchmarks 13 and 10. In the transverse direction, the maximum incline is observed between benchmarks 11 and 8 $- 4.4 \cdot 10^{-4}$ - and the minimum between benchmarks 18 and $1 - 4.4 \cdot 10^{-4}$. 