A method for optimizing VVER-1200/1300 control in a daily load schedule is examined. It is aimed at lowering the amplitude of the power release fluctuations in the core and decreasing the amount of liquid radwastes. It is proposed that ‘lightened’ groups of control rods (analog of ‘grey’ groups in PWR) and soft temperature regulation – action on the reactivity by changing the coolant temperature in the reactor – as well as optimization of the power-change schedule be used to control the reactor. It is shown by computational modeling that the method proposed makes it possible to control the reactor in a daily load schedule in a prescribed range, avoiding in the process the accumulation of liquid wastes. The implementation of the proposed method of control is discussed.

For soft temperature regulation and definite limits on the rate of increase of power, the daily load schedule 100–50–100% VVER-1200/1300 can be maintained for an entire run without liquid radwastes being accumulated [1]. The present article examines the optimization of a method for controlling a reactor aimed at decreasing the amplitude of the local fluctuations of the power release in the core.

In a daily maneuver of the power, the axial offset of the power release briefly exceeds the limits of the recommended region of the offset–power diagram [2]. This is allowed for a single daily maneuver but for repeated maneuvers it is desirable to maintain the offset within the recommended region, which will decrease the intensity of the local power oscillations, increase the margin to the maximum admissible values and on the whole make reactor operation more reliable.

It is proposed that in controlling the reactor ‘lightened’ groups of control rods, i.e., groups with lower effectiveness, be used to decrease the amplitude of the change in the offset. It should be noted that in foreign NPPs with PWR ‘grey’ groups in which some of the absorbing boron or cadmium rods are replaced with steel rods are used for this. For VVER, there is no fundamental need to use such ‘grey’ groups with steel rods. It is sufficient to decrease the number of control rods in them, as shown in [3].

Cartograms of the regular and lightened groups of VVER-1200 control rods are shown in Fig. 1. The regular group labeled as No. 12 is divided into the lightened groups A and B, each of which contains three control rods; the No. 11 group is divided into the lightened groups C and D with three and four control rods, respectively. The No. 10 regular group coincides with group E. The lightened groups are lowered into the core in the sequence A, B, C, D, and E and extracted in the reverse sequence.

As in [2], computational modeling of VVER-1200 in a daily load schedule was done at the end of a stationary run, boron regulation is not used and control is accomplished using groups of control rods in the range ±2°C as well as the effect whereby the power increases with xenon burnup but with lightened groups. The transfer of motion from group to group occurs at a level equal to 30% of the core height during downward motion and at 50% during upward motion.
Fig. 1. Arrangement of the regular groups of control rods in the VVER-1200 core with the insertion sequence into the core 12, 11, and 10 (a) and lightened groups A, B, C, and D (b).

Fig. 2. Main parameters of reactor control in a daily load schedule: 1, 2, 3, 4) position of the groups A, B, C, and D; 5) axial offset (AO); 6) equilibrium axial offset (AO*) (W – power; $T_{in}$ – coolant temperature at the reactor inlet; $H_i$ – position of the groups of control rods; C – concentration of boric acid in the coolant).