The testing procedure and the results of tests performed on a 19-element fragment of a VVÉR-1000 fuel assembly in the channel of a MIR reactor under conditions of the second and third stage of a maximum anticipated accident are presented. The state arising in the reactor core with an uncompensated leak arising in the first cooling loop when a pipeline with the maximum diameter bursts (large leak) is studied in the experiment. In each case study, superheated steam cools the top part of the fuel elements. The main goal of the tests is to obtain data on the distortion of fuel-element cladding under tensile stresses.

The behavior of fuel elements and fuel assemblies under conditions of anticipated accidents must be studied in order to substantiate the safety of operating reactors and new reactor designs. One of the most serious, with respect to consequences, accidents is a loss-of-coolant accident which can be caused by the rupture of a pipeline in the first cooling loop. The seriousness is due to the possible partial or complete drying of the core, overheating and rupturing of fuel-element cladding, and radionuclides escaping into and, possibly, out of the reactor building.

It is of special interest to investigate the behavior of VVÉR fuel elements with high burnup accompanying the rupture of a pipeline with the maximum diameter (800 mm). Such an accident is classified as the maximum anticipated accident for a power generating facility.

Individual phenomena are studied by means of experiments performed in protected chambers (burned up fuel elements) and on laboratory stands: oxidation of the cladding and fuel in steam, escape of radionuclides from the fuel, thermal stability of fuel elements, deformation of gas-filled cladding during heating, and so forth. The results of the investigations show that the state of the reactor core during and after an accident is largely determined by the initial state of the fuel elements, the operating conditions, and the effect of fuel elements in a fuel assembly on one another. The fuel burnup, the lineal power density of fuel elements at the moment a leak appears, and the coolant parameters as well as the maximum temperature of the fuel elements and its rate of change, the duration of heating, and the conditions under which the core is refilled all play an important role.

Since a computational model cannot describe all the processes that can occur in the core during an accident, it is necessary to perform model integral reactor experiments where multielement assemblies of fuel elements are used as the test objects, as a result of which the action of all of the factors listed above and the covering of the flow section of a fuel assembly are taken into account. When a reactor experiment is performed, the complex intercoupled processes characteristic for the maximum anticipated accident must be reproduced:

- the initial energy release and its variation in time in the fuel elements (nominal level, transient process, and residual energy release);
• the heat exchange between the fuel elements and the coolant in a different aggregate state (water, superheated steam, steam–water mixture);

• the thermomechanical state of the fuel elements;

• the cladding–fuel and cladding–coolant interaction;

• the effect of neighboring elements and spacing lattices on the state of a bundle of elements, and so forth.

Such experiments are, essentially, integral because all the parameters and thermohydraulic processes listed above are reproduced to the maximum extent possible in them.

The experiment must also yield data for verifying the computer program used for computational validation of VVÉR fuel.

According to the results of predictive thermohydraulic calculations of the development of an accident with rupturing of the maximum-diameter pipeline in the first loop of VVÉR-1000, the transient process in the core of the reactor is complex [1] and difficult to realize in an experiment performed in the channel of a research nuclear reactor. It is especially difficult to simulate the first fast stage, where the rates of change of the temperature of the fuel elements and the pressure in the