Service-life extension and obtaining higher fuel burnup of VVÉR and RBMK reactors while maintaining high reliability remain high-priority problems. Adopting structural and technological measures to improve the components of the core requires a comprehensive check of the desirability and effectiveness of such measures. Alloys based on É110, É125, and É635 zirconium are the main structural material for fuel assemblies in light-water reactors. These alloys are used to manufacture fuel-element cladding, guiding channels, the central tube, jackets, angle brackets, and spacing lattices. The anisotropy of zirconium alloys produces a texturing when these objects are manufactured.

Several important effects can be identified in the change of the geometric parameters of the structural components, since the radiation growth and radiation-thermal creep depend strongly on the texture [1]. A large variance is sometimes observed in the change of the diameter and length of fuel elements, even for elements in the same fuel assembly. Analysis of the experimental data on the dependence of this effect on diverse parameters (technological, structural, and operational) occasionally does not give a satisfactory explanation. In these cases, it is important to investigate the texture of standard objects after irradiation. However, textural investigations of the cladding of irradiated fuel elements have still not been done. The difference observed in the change of the length of the guiding channels and the central tube of a VVÉR-1000 fuel assembly can certainly be explained by the ratio of the axial loads and the degree of texturing. However, without performing texture investigations these effects cannot be satisfactorily explained, and the unconforming length changes of the components of fuel assemblies are a source of internal stresses in the structure and can limit the reliability and service life of an object.

The theory of texture investigation using x-ray diffraction analysis is well developed [2, 3]. Automatic diffractometers for constructing a complete direct polar figure are available. But these investigations impose special requirements on the samples, specifically, when remote-controlled devices are used to study the irradiated objects.

However, there is a different variant of the textural studies of thin-wall tubes, which can be easily implemented using general-purpose diffractometers and the remote-controlled DARD system. Here, it is necessary to check the reproducibility of the results and to determine whether or not the diffraction lines in the diffraction pattern are strong enough to investigate inverse polar figures.

An inverse polar figure is a standard gnomostereographic projection of a crystal lattice with an indication of the probability that the corresponding normals of the planes coincide with some external directions, for example, the axis of the fuel-element cladding. Its experimental determination reduces to measuring the integral intensity of the largest possible number of reflections with the standard construction of x-ray diffraction patterns using Bragg–Brentano focusing. Then, the polar density $P_{hkl}$ – the fraction of crystallites for which the normals to the $(hkl)$ plane coincide with the normal to the surface of the sample – is calculated as

$$P_{hkl} = \frac{I_{hkl}^{\text{sam}} / I_{hkl}^{\text{std}}}{\sum_n A_{hkl} / (I_{hkl}^{\text{sam}} / I_{hkl}^{\text{std}})}.$$
where \( I_{hkl}^{\text{sam}} \) and \( I_{hkl}^{\text{st}} \) are the relative intensity of the corresponding interferences for the sample and the standard; \( A_{hkl} \) are the Morris normalization numbers

\[
\sum A_{hkl} P_{hkl} = 1,
\]

which determine the fraction of crystallites in a texture-free sample that give a reflection from the \((hkl)\) plane. Their values depend on the type of crystal lattice and the anode of the x-ray tube; \( n \) is the number of reflections analyzed.

Aside from the constructions in the gnomostereographic projection of the distribution of the polar planes \( P_{hkl} \), the texture parameter \( f \) is also calculated. This parameter is the effective fraction of the basal planes in the chosen direction (along the axis of the tube or in the radial and tangential directions):

\[
f = \frac{n \sum \left( \frac{I_{hkl}^{\text{sam}}}{I_{hkl}^{\text{st}}} \right) A_{hkl} \cos^2 \varphi}{\sum n A_{hkl} \left( \frac{I_{hkl}^{\text{sam}}}{I_{hkl}^{\text{st}}} \right) .}
\]

where \( \varphi \) is the angle between the (001) and \((hkl)\) planes.