# A remote technique for a preparation of tension test specimens from the irradiated round bars

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In Ukraine the fifteen WWER nuclear power plant units have being operated, two of which are WWER-440 units located at Rivne NPP site. In 2010 a thermal annealing of the RPV weld 4 for the Rivne NPP unit 1 was performed. The thermal annealing was a key condition in the procedure of a license renewal for long term operation of this reactor pressure vessel. A new surveillance program for a material science support of RPV safe operation after the thermal annealing was developed according to the requirements of a national regulatory body.

The round tension specimens have been provided for an estimation of the changes in mechanical properties of RPV metal due to a re-irradiation. However, the round bars have been put in the surveillance capsules instead of standard round tension specimens. So, there was necessity to prepare the tension specimens from the round bars. The paper presents the technical details about an application of the new technique for a preparation of tension specimens from the irradiated round bars.

**Brief description of a remote equipment**

For machining the round specimens from irradiated bars, a new remote lathe with a computer control LEON-01 has been developed (Figure P12). The new equipment is placed in the special zone of a hot cell laboratory designed for handling the irradiated material. The CNC control electronics runs the step motors of the machine. The CNC control unit is the interface between a PC software Mach 3 with a setup under Windows 10 and the lathe mechanics. The software provides the machine with the geometry information for a travel of the cutter considering a small deflection of the bar during a machining process.

Two step motors provide precise travel of the tool in two mutual perpendicular directions. There is a special holder to quickly put the round bar in the collet of the lathe. The three-end cutter is applied as the machining tool. A temperature of the specimen must be less than 100°C during the machining process, so a cooling system has been provided in the lathe design.

The lathe is operated with a power supply of 380 V. The rotation speed of the spindle was selected to be 3000 rpm and the travel speed of the cutter was 30 mm / min to ensure the necessary quality of the specimen surface. A material layer of 0.05 mm thick is removed for each pass of the tool.

**Specimen preparation**

The reference specimens have been prepared to check an effectiveness of the new equipment. An archive metal of WWER-1000 RPV support shell has been used in this study. Firstly, round bars with a length of 26 mm and a diameter of 6 mm were cut from halves of the tested Charpy specimens using an electric discharge machine (figure P13a). After that the tension specimens were machined from the round bars using the lathe with remote control. The measurements have shown that the dimensions of a reduced section meet the DSTU EN 10002-1:2006 standard requirements.

A view of the machined specimen with a diameter of 3 mm and the gage length of five times the nominal diameter is shown in Figure P13b.

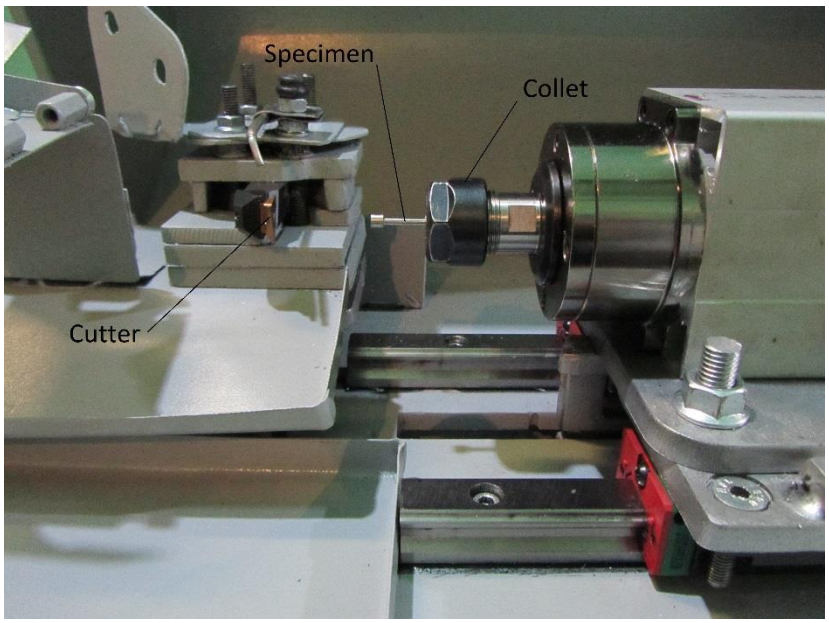


Figure P12: Working area of the lathe with remote control

a)

b)

Figure P13**:** A round bar cut from a half of the tested Charpy specimen (a), a tension specimen machined from the round bar (b)

Finally, the four remotely machined specimens have been tested at room temperature. An analysis of tension test data has shown that a scatter of strength and plasticity parameters which is characterized by standard deviation (3 MPa and 0,5 % respectively) is small enough, therefore, the new equipment allow us manufacturing the round specimens and getting acceptable test results. A location of fracture within the specimen gauge length also indicates the validity of procedure for the specimen preparation.

**Conclusion**

The report provides information on the development of remote technology for manufacturing tensile specimens from irradiated round bars. The operation principle and components of the lathe with remote control are given. A brief description of machining process is presented. The tension test data has shown that new equipment can be successfully applied for manufacturing the tensile specimens.