PARTICULARITIES REGARDING THE OPERATING PROCESS OF THE CUTTING AND EXTRACTION DEVICE IN THE CANDU HORIZONTAL FUEL CHANNELS PRESSURE TUBE DECOMMISSIONING
PART II: CUTTING AND EXTRACTING PRESSURE TUBE PROCESS

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Abstract: *This paper presents some details of operation process for a Cutting and Extraction Device (CED) in order to achieve the decommissioning of the horizontal fuel channels pressure tube in the CANDU 6 nuclear reactor. The most important characteristic of the Cutting and Extraction Device (CED) is his capability of totally operator's protection against the nuclear radiation during pressure tube decommissioning. The cutting and extracting pressure tube processes present few particularities due to special adopted technical solutions: a special module with three cutting rollers (system driven by an actuator), a guiding-extracting and connecting module (three fixing claws which are piloted by an actuator and block the device in the connecting position with extracting plugs). The Cutting and Extraction Device (CED) is a train of modules equipped with special systems to be fully automated, connected with a Programmable Logic Controller (PLC) and controlled by an operator panel type Human Machine Interface (HMI). All processes are monitored by video cameras. In case of error, the process is automatically stopped, the operator receiving an error message and the last sequence could be reinitialized or aborted due to safety reasons.*

Keywords: Candu reactor, fuel channel, decommissioning, dismantling, cutting, extraction

1. INTRODUCTION

Due to safety reasons, the protection measures of personal are required against the nuclear radiation in the decommissioning process of a nuclear reactor CANDU-6. Using special devices with command and control from the outside could be a feasible solution.

2. GENERALITIES OF CUTTING AND EXTRACTING PROCESS

The cutting and extraction device (CED) for the decommissioning of the horizontal fuel channels in the CANDU 6 nuclear reactor which is presented hereunder, it's a complex assembly with several main functions and fully automated, connected by wires to a Programmable Logic Controller (PLC) and controlled from a Human Machine Interface (HMI).

One of them represents cutting and extracting fuel channel pressure tube.

The all operations performed by the Cutting and Extraction Device (CED) into fuel channel are as follows: unblock and extract the channel closure plug, unblock and extract the channel shield plug, block and cut the middle of the pressure tube, block and cut the end of the pressure tube, block and extract the half of pressure tube.

2.1 DEVICE ASSEMBLY COMPONENTS PRESENTATION

The Cutting and Extraction Device (CED) consists of following modules (see Figure 1):

1 - module for guiding and fixing;
2 - modules for traction;
3 - module for cutting;
4 - module for connecting and guiding-extracting;
5 - flexible elements for connecting of the modules;
6 - traction ring
7 - command cable.

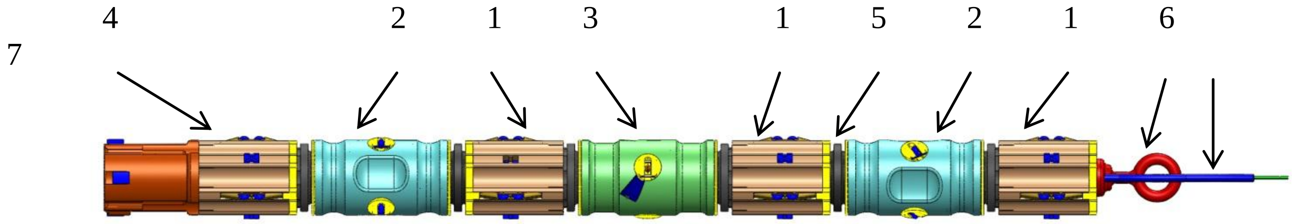


Figure 1. Cutting and Extraction Device (CED)

2.2. MODULE FOR CUTTING

This is the most important module of CED (see Figure 2). The cutting process is a classical one: cutting with sharp rollers. The pressure tube (PT) of CANDU 6 nuclear reactor has 3 mm thickness, but this module has three cutting rollers for cut up to 5 mm steel thickness.

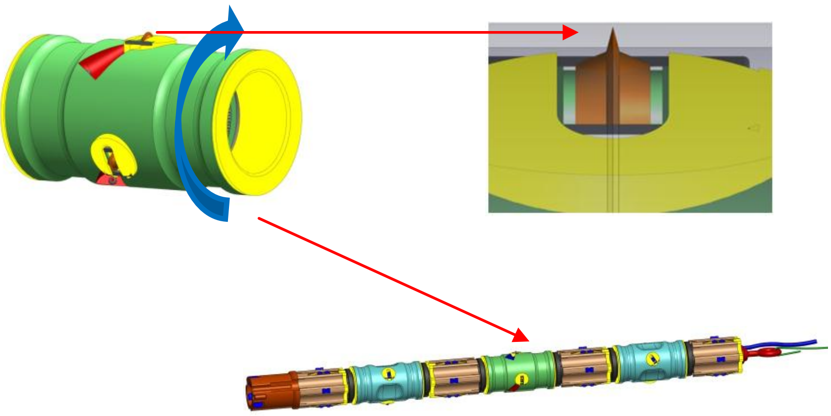


Figure 2. Module for cutting

The particularity of process is that cutting is done from inside to outside. These cutting rollers are pushed on the cutting surface by a system driven by an actuator (see Figure 3).

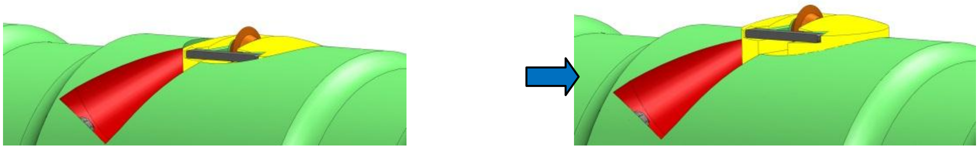
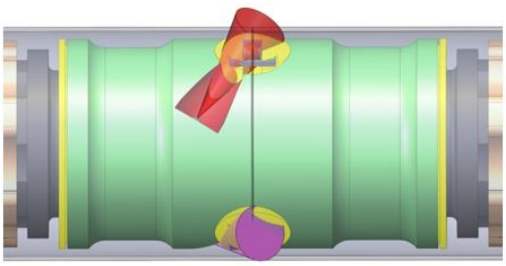
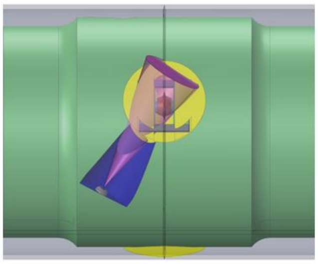
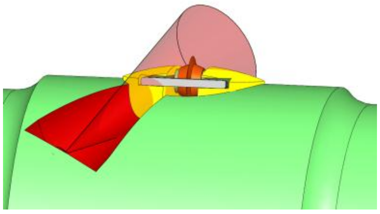


Figure 3. Radial displacement of cutting rollers

Two of the rollers have in their proximity the pyrometer for temperature monitoring (the red cone, see Fig.4). The third cutting roller has a camera for video surveillance of the cutting process (the magenta cone, see Fig. 5).







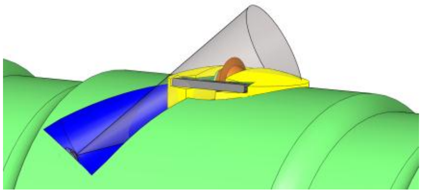


Fig. 4 - Temperature and pyrometer (cone red) monitoring

Figure 5. Video surveillance, camera cone (magenta)

2.3. EXTRACTING OF THE PRESSURE TUBE

First step of the pressure tube cutting is to position the Cutting and Extraction Device (CED) in the middle of the pressure tube and fix the blocking claws from the guiding-fixing module (see (2) from Figure 1) exemplified in Figure 6.

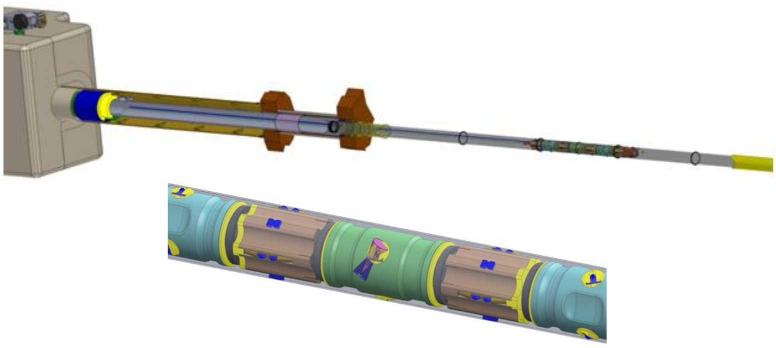


Figure 6. Positioning the CED for cutting in the middle of pressure tube

Now, it can start the cutting operation with the cutting module. During the cutting process, the operation is monitored by pyrometer for temperature and by video camera recording in the cutting area, for cutting operation viewing (see Figure 7).

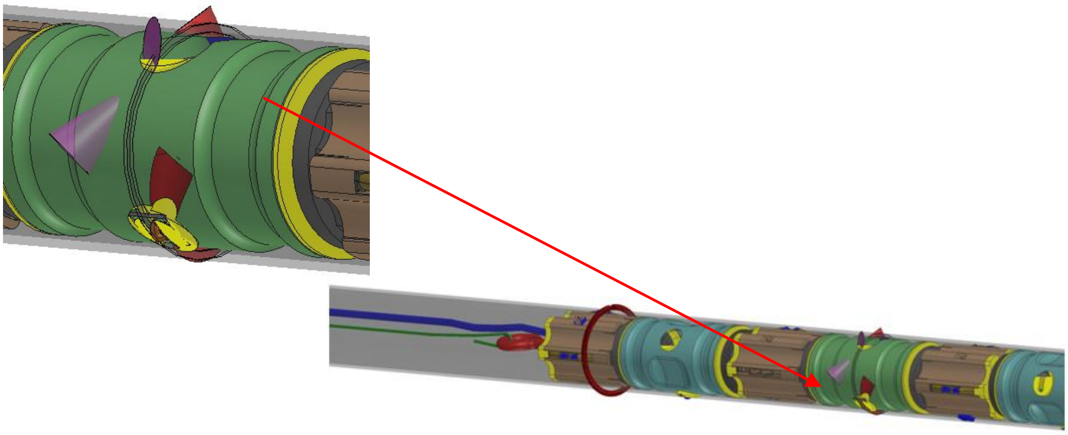


Figure 7. Process of the pressure tube cutting in the middle

Due to shape cutting rollers, pressure tube (PT) will be cut (see Fig.8). The PLC is processing in real time all parameters (pressure, temperature, cutting thickness) and cutting process is very well checked and monitored.

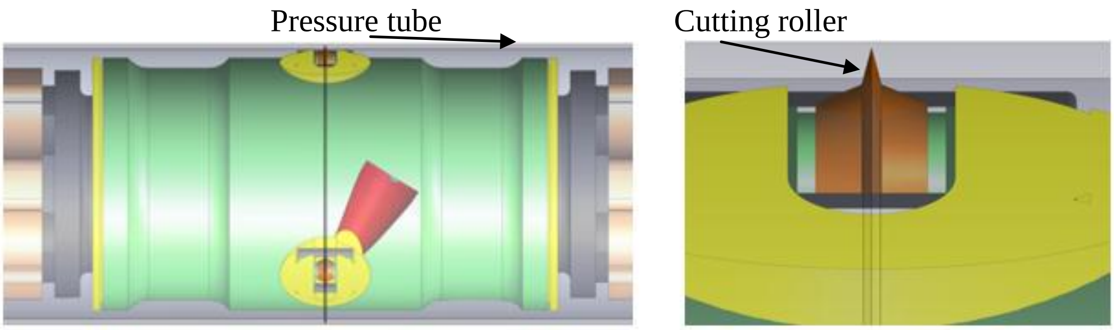


Figure 8. Process of the pressure tube cutting

The second step for the pressure tube cutting is to move the Cutting and Extraction Device (CED) at the end of the pressure tube at the joint with the end fitting and fixing the claws blocking from the guiding-fixing module (see Figure 9).

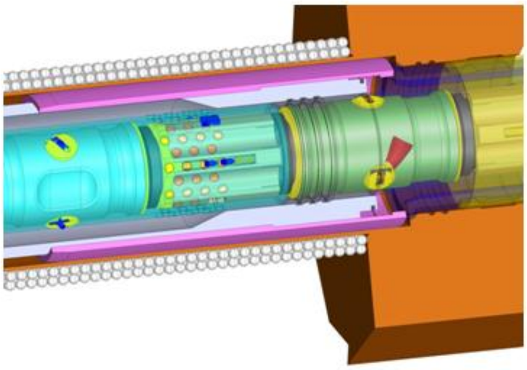


Figure 9. Process of the pressure tube cutting at the end

The pressure tube extraction could begin after the both cutting of the pressure tube are finished. The extracting operation starts to move the Cutting and Extraction Device (CED) at the end of the pressure tube; so that the guiding-fixing module goes into the pressure tube and fix the blocking claws (see Figure 10).

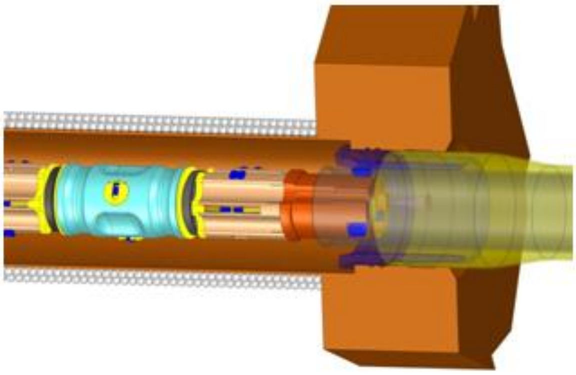


Figure 10. CED positioning at the end of pressure tube and claws expanding

The half of the pressure tube is withdrawn into the stationary tube from the decommissioning device using the traction cable (green cable, from Figure 11) driven by a gear motor system. The other half of pressure tube remains into the Calandria tube until the decommissioning process will be done from the other direction of reactor.

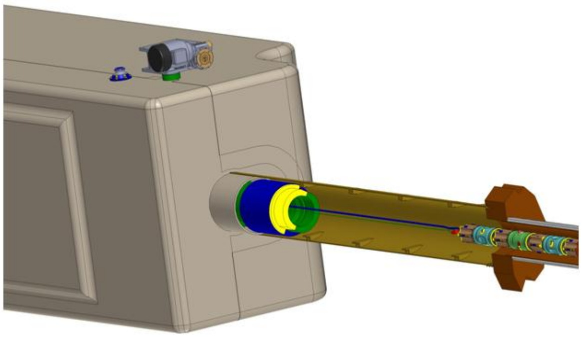


Figure 11. Half pressure tube extracting

3. CONCLUSIONS

The mechanical design provides a safe system according with the safety and environmental impact assessment, considering radiological and non-radiological analysis of the risks that can occur for workers, public and environment. It also is interesting the detailed fuel channel description and its components.

The Cutting and Extraction Device (CED) of the fuel channel decommissioning device should become a very helpful device in the decommissioning process, due to its capabilities and properties:

- flexibility, secure command and control;
- this device which extract the internal components of the horizontal fuel channels, ensures radiation protection during the stages of decommissioning due to its complex design.

Due to performant monitoring system, this device could be used to improve the next generation of these systems, analyzing all steps and the aspects from DFMEA analysis of device.

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