CONTRIBUTION FOR THE DEVELOPMENT OF A DEVICE FOR THE DECOMMISSIONING OF THE HORIZONTAL FUEL CHANNELS IN THE CANDU 6 NUCLEAR REACTOR. CUTTING AND EXTRACTING DEVICE FUNCTIONING

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This paper presents a constructive solution proposed by the authors in order to achieve of a cutting and extracting device for the decommissioning of the horizontal fuel channels in the CANDU 6 nuclear reactor.

The Cutting and Extraction Device (CED) performs the dismantling, cutting and extraction of the fuel channel components. It's a flexible and modular device, which is designed to work inside the fuel channel and has the following functions: moving with variable speed, temperature monitoring and video surveillance inside the pipe, unblock and extract the channel closure plug (from End Fitting - EF), unblock and extract the channel shield plug (from Lattice Tube - LT), 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.

The Cutting and Extraction Device (CED) consists of following modules: guiding-fixing module, traction modules, cutting module, guiding-extracting module and flexible elements for modules connecting. The guiding-fixing module is equipped with elastic guiding rollers and fixing claws in working position, the traction modules are provided with variable pitch rollers for allowing variable travel speed through the fuel channel. The cutting module is positioned in the middle of the device and it is equipped with three knife rolls for pressure tube cutting, using a system for cutting place video surveillance and pyrometers for monitoring cutting place temperature.

The Cutting and Extraction Device (CED) is fully automated, connected by wires to a Programmable Logic Controller (PLC) and controlled from a Human Machine Interface (HMI).

The design of the Cutting and Extraction Device (CED) shall be achieved according to the particular features of the fuel channel components to be dismantled and to ensure radiation protection of workers.

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

1. INTRODUCTION

In the decommissioning process of a nuclear reactor CANDU-6, due to safety reasons, the protection measures of personal are required against the nuclear radiation, and using special devices with command and control from the outside. The CED should perform all operations needed, as: unblock and extract the plugs, block into the pipes, cut and extract the pressure tube.

2. GENERAL FUNCTIONING PRESENTATION

The decommissioning activities involve the remote devices coordination to prevent the contact of the operators with some removed components proximity.

The operations performed by the Cutting and Extraction Device (CED) of 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 Preliminary Operations
The preliminary operations to be performed before functioning of the Cutting and Extraction Device (CED) are (Figure 1):
- decommissioning device mounting on the moving platform (1);
- moving platform to position of the fuel channel to be dismantled (2);
- positioning assembly dismantled (3);
- decommissioning device coupled to the fuel channel (4) and protective cylindrical screen mounted;

![Figure 1. Representation of the preliminary operations before dismantling](image1)

Dismantling of the fuel channel components by the Cutting and Extraction Device (CED) is performed when the initial operations are carried out. Channel status is exemplified in Figure 2.

![Figure 2. Representation of the fuel channel before dismantling](image2)

2.2 Fuel Channel Closure And Shield Plug Removal
The preliminary operations to the decommissioning device for the fuel channel closure and shield plug removal by the Cutting and Extraction Device (CED) are (Figure 3):
- the handling elements assembly movement that the stationary tube (1) with the Cutting and Extraction Device (CED) to reach the working position;
- the storage tube assembly rotation that the tube for the pressure tube storage (the blue tube (2)) to reach the working position (coaxial with the axis of the fuel channel reactor);
- the access valve assembly (3) opening;

![Figure 3. Representation of the preliminary operations](image3)

After completing the preliminary operations, the Cutting and Extraction Device (CED) is ready to move, to unlock, to extract (1) and storage (2) of the channel closure plug in the yellow tube. The next operation for the Cutting and Extraction Device (CED) is to move, to unlock, to extract and storage of the shield plug in the yellow tube (see Figure 4).

![Figure 4. Representation of the channel closure and shield plug extraction and storage](image4)
2.3 Fuel Channel Pressure Tube Cutting

The first step for the pressure tube cutting is to move the Cutting and Extraction Device (CED) in the middle of the pressure tube (1) and fixing the claws blocking (3) from the guiding-fixing module (2) exemplified in Figure 5.

![Figure 5. Representation of the cutting device positioning and fixing](image)

After device positioning and fixing claws blocking (from the guiding-fixing module), can start the cutting operation with the cutting module (1). In the cutting operation time (2), the operation is monitored by pyrometer (3) for temperature recording in the cutting area and by video camera (4), for cutting operation viewing (see Figure 6).

![Figure 6. Representation of the cutting operation](image)

The second step for the pressure tube cutting is to move the Cutting and Extraction Device (CED) (2) at the end of the pressure tube at the joint with the end fitting (1) and fixing the claws blocking from the guiding-fixing module (Figure 7).

![Figure 7. Representation of the second cutting](image)

2.4 Fuel Channel Presure Tube Extraction

The pressure tube extraction should be done after the both cutting of the pressure tube, in the middle and at the end of the pressure tube at the joint with the end fitting. The extracting operation is to move the Cutting and Extraction Device (CED) (1) at the end of the pressure tube at the joint with the end fitting, so that the guiding-fixing module go into the pressure tube and fix the claws blocking (Figure 8). The half of the pressure tube is withdrawn (2) in the decommissioning device and stored into the blue tube (3) of the storage tube assembly.
After the pressure tube storage the Cutting and Extraction Device (CED) (1) is retracted into the stationary tube from the decommissioning device handling elements assembly (2), exemplified in Figure 9.

3. CONCLUSIONS

The Cutting and Extraction Device (CED) device is a device that performs the cutting and extracting of the internal components from the horizontal fuel channels nuclear reactor and ensure a radiation protection during the stages of decommissioning.

Due to its capabilities and properties, flexibility, remote command and control of the functions, temperature and video monitoring, the Cutting and Extraction Device (CED) should become a very helpful device in the Candu fuel channel decommissioning process.

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