CONSIDERATIONS FOR THE DEVELOPMENT OF A DEVICE FOR THE DECOMMISSIONING OF THE HORIZONTAL FUEL CHANNELS IN THE CANDU 6 NUCLEAR REACTOR.
PART 8 - PRESENTATION OF THE CUTTING AND EXTRACTING DEVICE

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ABSTRACT: This paper presents a constructive solution proposed by the authors in order to achieve a cutting and extracting device for the decommissioning of the horizontal fuel channels in the CANDU 6 nuclear reactor.
One of the most important parts of the decommissioning device is the Cutting and Extraction Device (CED) which performs the dismantling, cutting and extraction of the fuel channel components. This flexible and modular device is designed to work inside the fuel channel.
The main operations performed by the Cutting and Extraction Device (CED) are dismantling and extraction of the channel closure plug and shield plug, cutting and extraction of the pressure tube.
The Cutting and Extraction Device (CED) consists of following modules: guiding-fixing module, traction modules, cutting module, guiding-extracting module and articulated 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 travel speed change through the fuel channel. The cutting module is positioned in the middle of the device and it is equipped with three roll knives for pressure tube cutting, having a system for cutting place video surveillance and pyrometers for cutting place monitoring temperature.
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.
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.

Key words: 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 decommissioning devices with command and control from the outside.
2. **GENERAL PRESENTATION OF THE DEVICE**

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

The device presented hereunder, is a constructive solution proposed by the authors in order to achieve of a cutting and extracting device (CED) for the decommissioning of the horizontal fuel channels in the CANDU 6 nuclear reactor.

### 2.1 General considerations

The operations performed by the Cutting and Extraction Device (CED) of fuel channel (Figure 1) 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.

![Fig. 1. Schematic representation of the fuel channel before dismantling](image)

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

Some characteristics and capabilities of the Cutting and Extraction Device (CED) device:
- Length = 1320 mm
- Outer diameter = 98 mm
- Pipe inner diameter: minimum = 100 mm maximum = 110 mm
- Pipe cutting thickness: up to 5 mm
- Displacement velocity in pipe: 0.. 0.2 m/s

### 2.2 Device assembly components presentation

The Cutting and Extraction Device (CED) consists of following modules (see Figure 2):
1. guiding-fixing module
2. traction modules
3. guiding-fixing modules at cutting
4. cutting module
5. guiding-extracting and connecting module
6. flexible elements for modules connecting
7. command cable
2.3. Guiding-extracting module

The guiding-fixing module is equipped with elastic guiding rollers and fixing claws in working position (Figure 3).

This module is a self-adapted device to the differences of diameters along the pipe, derived from thermal cycles, in reactor time life or other mechanical deformation (Figure 4). The fixing claws are piloted by an actuator and block device in the desired position.

The Cutting and Extraction Device (CED) has four such modules. This is helpful for: fixing entire device inside the pipe, providing safety for cutting process, even if is a junction of two pipes with different diameter (see Figure 5).
2.4 Traction module

This module has three traction rollers. Before and after this module, in the CED structure, there is a guiding-fixing module, which allows the linear displacement (see Figure 6).

Each traction roller is an elastic system, with variable pitch.

The traction module spins at a constant speed, linear speed variation coming from angle variation on traction rollers (see Figure 7). The displacement is done by the principle “screw drives - nut”.

In the junction area CED movement is ensured by the traction module that is entirely in pipe (see Figure 8).
2.5 Cutting module

This is the most important module in the CED structure. It has three cutting rollers able to cut up to 5 mm steel thickness. The pressure tube (PT) of CANDU 6 nuclear reactor, has 3 mm thickness.

These cutting rollers are pushed on the cutting surface by a system driven by an actuator (see Figure 9).

Two of the rollers have in their proximity one pyrometer for temperature monitoring during the cutting process (the red cone, see Figure 10).

The third cutting roller has a camera for video surveillance of the cutting process (the magenta cone, see Figure 11).
2.6 Guiding-extracting and connecting module

This module is composed by two parts: the guiding-fixing module and connecting module, the rigidly coupled together (see Figure 12).

![Fig. 12. Guiding-extracting and connecting module](image)

In the front of the connecting module there is a camera for video surveillance of the connecting process (see Figure 13).

![Fig. 13. Frontal video camera](image)

The connecting module has three fixing claws which are piloted by an actuator and block the device in the connecting position with extracting plugs. The CED is prepared to extract the channel closure plug (see Figure 14) or the channel shield plug (see Figure 15).

![Fig. 14. Extracting channel closure plug](image)

![Fig. 15. Extracting shield plug](image)

2.7 Flexible elements for connecting modules

The CED is a flexible device which should work inside the pipes. For to be able to pass through the pipes, between modules there are flexible elements (see Figure 16) to allow the displacement along the pipes, even if there are deformations from the thermal cycles or from the mechanical tolerances.
During the time life of the nuclear reactor, due to high temperature, can occur plastic deformations of the pressure tube (PT) or lattice tube (LT).

We should take in consideration that the decommissioning process is possible after 20-25 years at the activity stop of the nuclear reactor.

2.8 COMMAND CABLE

The Cutting and Extraction Device (CED) is fully automated, connected by wires (see Figure 17) to a Programmable Logic Controller (PLC) and controlled from a Human Machine Interface (HMI).

3. CONCLUSIONS

The design of the channels fuel decommissioning device should takes into account:
- the detailed fuel channel description and its components;
- safety and environmental impact assessment, including radiological and non-radiological analysis of the risks that can occur for workers, public and environment.

The Cutting and Extraction Device (CED) of the Candu fuel channel should become a very helpful device in the decommissioning process, due to its capabilities and properties:
- flexibility, command and control, safety;
- excellent monitoring program, methods and equipment used to verify the compliance with the decommissioning criteria;
- this is a device that extracts the internal components of the horizontal fuel channels, ensuring radiation protection during the stages of decommissioning.

4. REFERENCES


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