PARTICULARITIES REGARDING THE OPERATING PROCESS OF THE CUTTING AND EXTRACTION DEVICE IN THE CANDU HORIZONTAL FUEL CHANNELS PRESSURE TUBE DECOMMISSIONING
PART I: MOVEMENT AND FIXING DEVICE INSIDE THE PRESSURE TUBE

Ing. Drd. Constantin POPESCU,
Polytechnic University of Bucharest, email: puiu_2001uss@yahoo.com
Dr. fiz. Gabi ROȘCA FÂRTAT,
Polytechnic University of Bucharest, email: rosca_gabi@yahoo.com
Ing. Principal **Nicolae PANĂ**,
Polytechnic University of Bucharest, email: npaniki@gmail.com
Fiz. Drd. Tudor BURLAN-ROTAR,
Polytechnic University of Bucharest, email: tudor.burlan@yahoo.com
Prof. Univ. Emerit Dr. Ing. Constantin D. STĂNESCU,
Polytechnic University of Bucharest, email: prof_cstanescu@yahoo.com
Ing. Drd. Doina ENE (TĂRABUȚĂ),
"I.N. Socolescu" Technical Architecture College, Bucharest, email: doinaene@ymail.com

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 movement and fixing processes present few particularities due to special adopted technical solutions: train guiding-fixing modules equipped with elastic guiding rollers and fixing claws, traction modules with elastic rollers and variable pitch, also with propriety to adapt the system according to various dimensions of the tube. 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 OPERATING 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 movement and fixing inside the tube (to which I will refer in this paper).

But, the all 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) Some has the following characteristics and capabilities:

- CED Length = 1320 mm
- CED Outer diameter = 98 mm
- Pressure tube inner diameter: minimum = 100 mm
  maximum = 110 mm
- Pressure tube cutting thickness: up to 5 mm
- Displacement velocity in pressure tube: 0.. 0.2 m/s

2.1 DEVICE 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, 7 - traction ring and command cable.

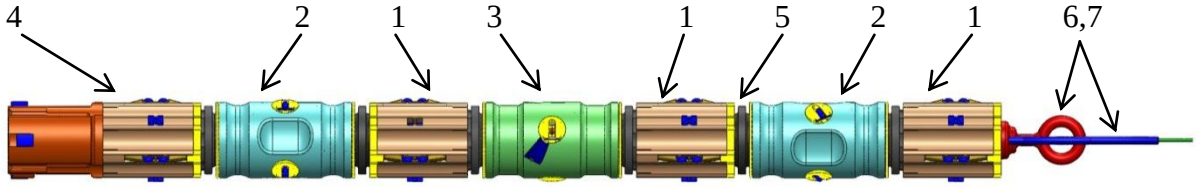

Fig. 1. Cutting and Extraction Device (CED)

2.2. CED MOVEMENT INSIDE OF THE TUBE

In the CED structure, before and after the traction module, there are guiding-fixing modules, whit the goal to assure the linear displacement (see Figure 2). The traction module assures the movement of device inside the tube - forth and back - by his three traction rollers and is driven by an electrical engine.

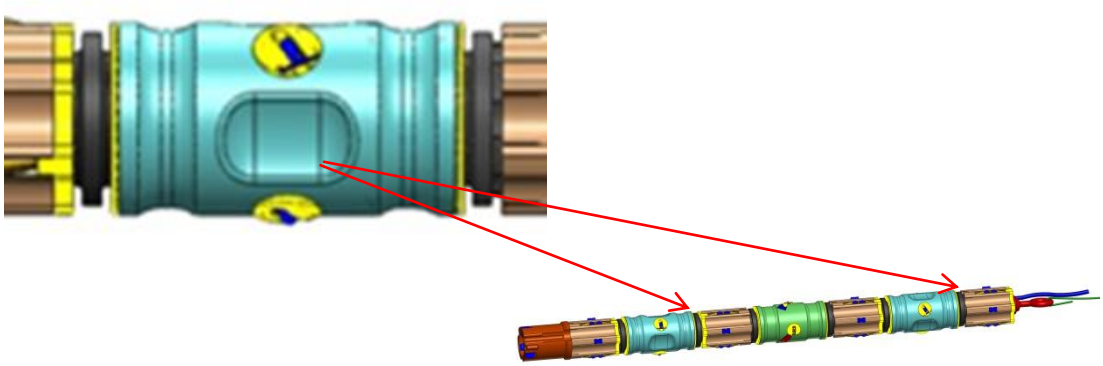

Fig. 2. Traction module between two guiding-fixing modules

The traction roller is an elastic system, with variable pitch. Its elasticity allows that the CED could work in different diameter pipes (see Figure 3) and could be checked the value on pressure to have optimum grip: rollers on internal surface of tube.

a. b.

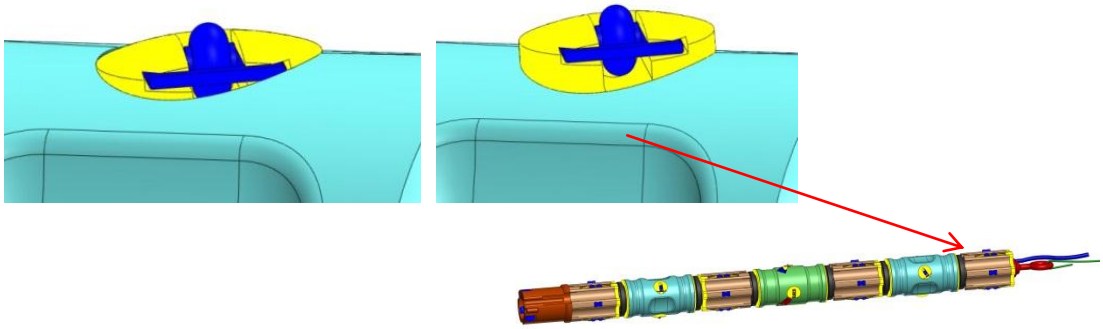

Fig.3. Traction module with three traction rollers:
a. traction roller in total withdrawn position for minimum diameter (100 mm)
b. traction roller in total extended position for maximum diameter (110 mm)

The displacement is done by the principle “screw drives - nut”. The traction module spins at a constant speed, but the linear speed variation coming from angle variation on traction rollers (see Figure 4). If need it, the operator could adjust the angle and adapt it to optimum value during running program by HMI panel type.

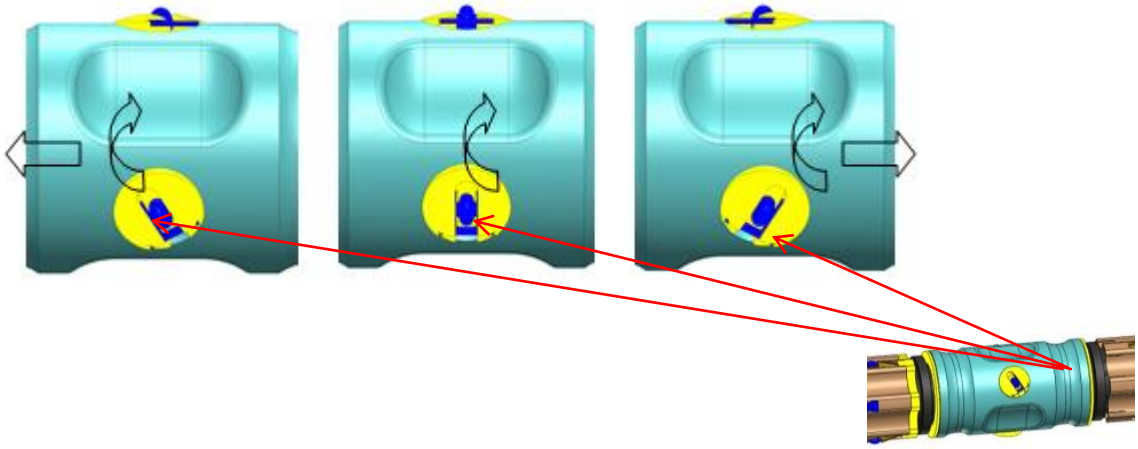

Fig. 4. Traction roller movement position

In the tubes junction area CED movement is ensured by the traction module that is entirely in the bigger pipe (see Figure 5). This sequence is active only until the passive module is also totally in the bigger pipe.

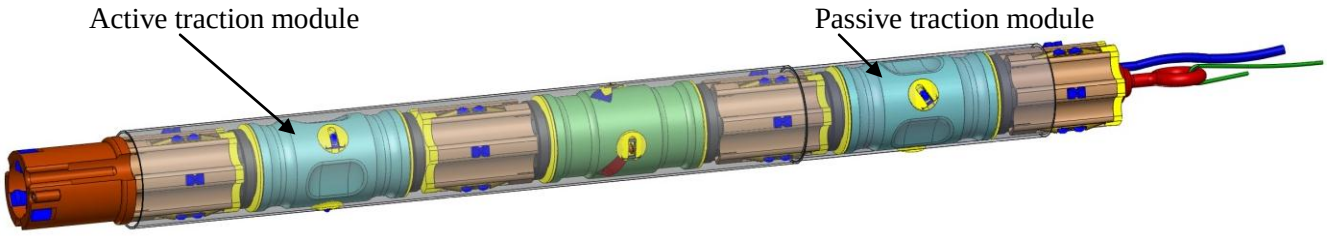

Fig. 5. General view of the CED passing from the thin tube at another one thicker

2.3. FIXING CED INSIDE THE PRESSURE TUBE

The fixing of device inside the tube is assured by guiding-fixing module. The guiding-fixing module (see Figure 6) is equipped with elastic guiding rollers in order to achieve the linear displacement (see Figure 7) and fixing claws in working position. The fixing claws are piloted by an actuator and block device in the desired position, monitored by the PLC.

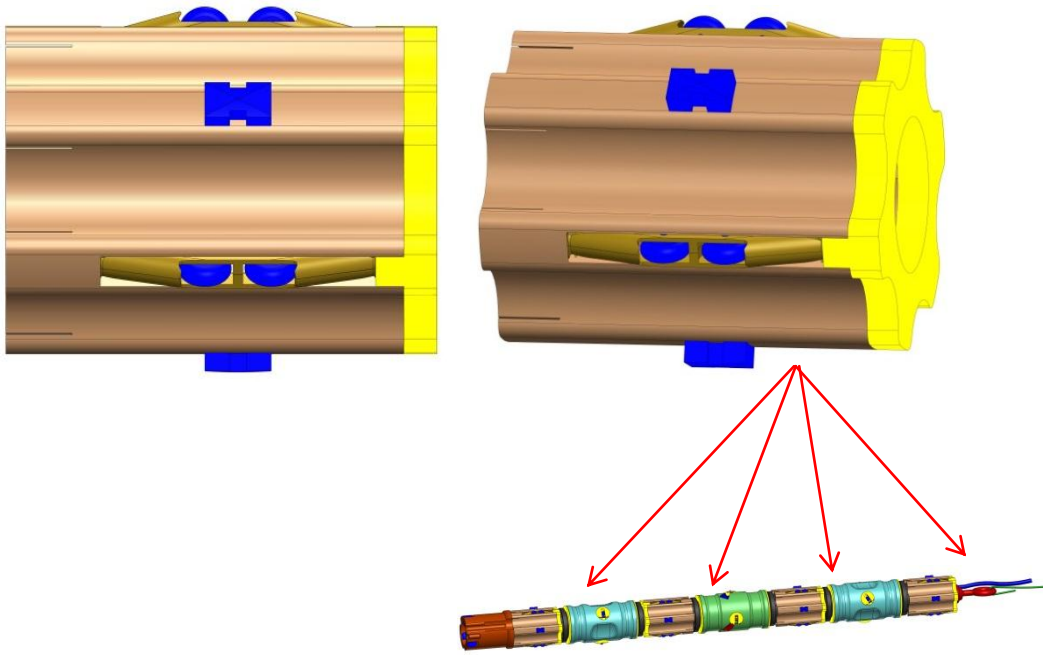

Fig. 6. Module for guiding and fixing

Along the CED structure there are four as such modules, one of them coupled with connecting module (front of device, see Figure 1 - module 4). The goals are: fixing entire device inside the pipe, providing safety for cutting process, even if is a junction of two pipes with different diameters. 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 (see Fig. 7). Rollers are manufactured by silicone.

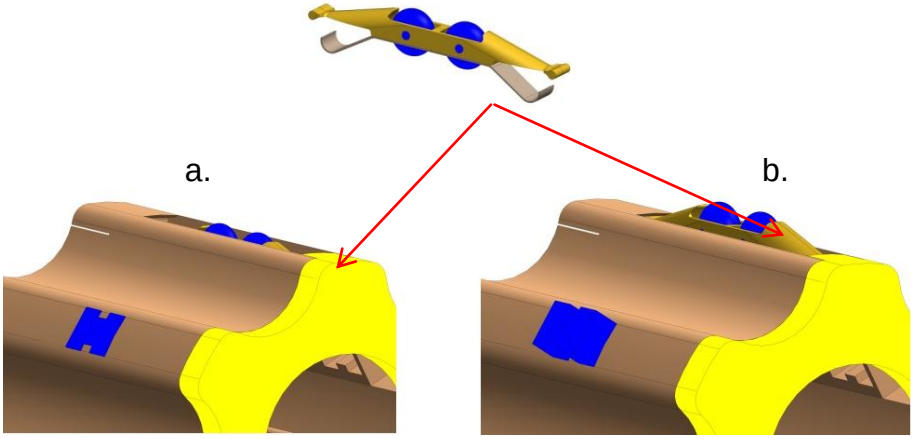

Fig. 7. Guiding-extracting and connecting module
a. CED with fixing claws for minimum inner diameter; b. CED with fixing claws for maximum inner diameter

3. CONCLUSIONS

The mechanical design of the Cutting and Extraction Device 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.

4. REFERENCES

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