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# CONTRIBUTIONS FOR THE DECOMMISSIONING OF THE HORIZONTAL FUEL CHANNELS IN THE CANDU 6 NUCLEAR REACTOR.
# PART 2 - PRESENTATION OF THE DECOMMISSIONING DEVICE

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***Abstract:*** *The objective of this paper is to present a possible solution for the designing of a device for the decommissioning of the horizontal fuel channels in the CANDU 6 nuclear reactor. In the final phase of the nuclear reactor dismantling, the most important operation is the decommissioning of fuel channels. Should be taken into account the detailed description of the fuel channel and its components, the installation documents history, adequate radiological criteria for decommissioning guidance, safety and environmental impact assessment, including radiological analysis of the risks that can occur for workers, public and environment, the proposed radiation protection procedures to be used during decommissioning, the description of the proposed program for decommissioning the fuel channel and its components, the description of the quality assurance program and of the monitoring program, the equipments and methods used to verify the compliance with the decommissioning criteria, the planning of performing the final radiological assessment at the end of the fuel channel decommissioning. The device shall be designed according to the radiation protection procedures. The fuel channel decommissioning device is an autonomous device designed for dismantling and extraction of the channel closure plug and shield plug, extraction of the end fitting, cutting and extraction of the pressure tube. The fuel channel decommissioning device consists of following major components: coupling and locking fuel channel module, assembly valve for access to the fuel channel, storage tubes assembly for extracted components, handling elements assembly, cutting and extraction device and housing device. The decommissioning device assembly of the fuel channel components is composed of the device itself and moving platform support for coupling of the selected channel to be dismantled and is achieved according to the particular features of the fuel channel components to be dismantled in the program of nuclear reactor decommissioning according to all the safety aspects and environmental protection during the activities, resulting from the decommissioning plan developed.*
***Keywords:*** *Candu reactor, device, decommissioning, dismantling, radiation protection, fuel channel*

## 1. INTRODUCTION

The CANDU reactor decommissioning activities are dismantling, demolition, controlled removal of equipment, components, conventional or hazardous waste (radioactive, toxic) in compliance with the international basic safety standards on radiation protection.
The decommissioning activities performed are administrative and technical and include the preparation, endorsement and approval of documents, obtaining permits and authorizations, providing financial resources, decontamination, dismantling, demolition, controlled removal of equipment, components, conventional or hazardous waste (radioactive, toxic), demonstrating the fulfillment of the radiological conditional or unconditional release of the facility and the ground included in the decommissioning project.
Many of the decommissioning activities involve the remote devices coordination to prevent the contact or some removed components proximity, of the operators.
The dismantling of the fuel channel components is performed according to the nuclear reactor decommissioning documentation and the detailed schematic documentation of a CANDU nuclear reactors fuel channel.

## 2. THE DECOMISIONING DEVICE PRESENTATION

Many of the decommissioning activities involve the remote devices coordination to prevent the contact or some removed components proximity, of the operators.

## 2.1. General considerations

Considering the fuel channel complexity, and that the designed operation life of a fuel channel is 30 years at 80% capacity and 24 years at maximum capacity, at the design of the channels fuel decommissioning device for shall be taken into account:
- the detailed fuel channel description and its components;
- the installation documents history from the operation period of the dismantled fuel channel;
- adequate radiological criteria for decommissioning guidance;
- safety and environmental impact assessment, including radiological and non-radiological analysis of the risks that can occur for workers, public and environment;
- the proposed program description of the fuel channel decommissioning and its components;
- the description of the quality assurance program;
- the monitoring program, the equipments and methods used to verify the compliance with the decommissioning criteria;
- the planning of performing the final radiological assessment at the end of the fuel channel decommissioning.

Initial conditions for fuel channels decommissioning starting are the following:
- there are no fuel bundles in the fuel channels;
- the cooling system should be power off and the facility dismantled;
- the feeders coupling of each feed pipes through which the cooling agent passes, located on the outside of each end fitting to be disassembled and the connection to be covered with a blind flange with four fastening screws and metallic safety lock against unscrewing;
- the platform shall be in maintenance position for installation of the dismantling device.

Dismantling of the fuel channel components is performed when the initial conditions are carrier out. Channel status before dismantling is exemplified in Figure 1.

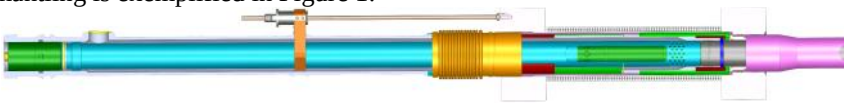

**Figure 1:** Representation of the fuel channel before dismantling

## 2.2. Presentation of the device assembly components

The device assembly for fuel channel components decommissioning is composed of the device itself (1) and moving platform (2) that contains the device support assembly (3) for front alignment at the fuel channel (Fig. 2).

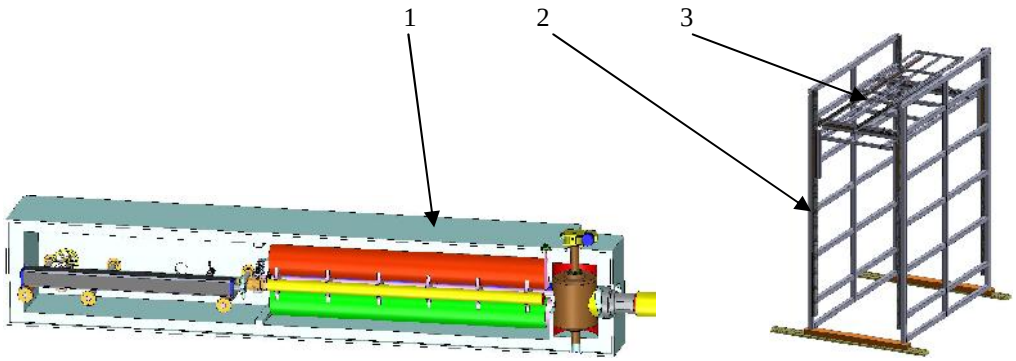


**Figure 2:** Representation of the device assembly components

The moving platform is necessary for moving in vertical and horizontal calandria plan and positioning in front of the fuel channel which shall be decommissioned.

The device support assembly is required for the positioning of the decommissioning device at the fuel channel which shall be dismantled, for coupling of the channel.

## 2.3. Presentation of the decommissioning device components

The decommissioning device for fuel channel components decommissioning is intended for the following operations performed at the fuel channel:
- the storage of the channel closure plug extracted from the end fitting;
- the storage of the channel shield plug extracted from the fitting end;
- the storage of the pressure tube extracted from the fuel channel;
- the storage of the end fitting.

The decommissioning device for fuel channel components decommissioning consists of the coupling and locking fuel channel module (1), the access valve assembly to the fuel channel (2), the storage tubes assembly for extracted components (3), the handling elements assembly (4), the cutting and extraction device (5) and the housing device (6), exemplified in Figure 3.

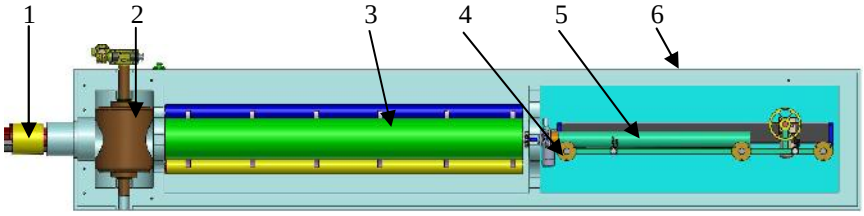


**Figure 3:** Representation of the fuel channel decommissioning device components

The cutting and extraction device consists of the following modules: guiding-fixing module (1), traction modules (2), guiding-fixing module at cutting (3), cutting module (4), guiding-extracting module (5) articulated elements (6) for modules connecting and command cable (7) (see Fig. 4).

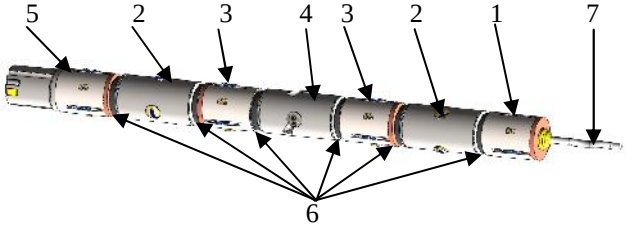


**Figure 4:** Representation of the cutting and extraction device components

## 2.4. Presentation of the coupling and locking module

The coupling and locking module is a stand-alone device, for coupling and fixing the device at the fuel channel for performing the dismantling operations. The operation of the fuel channel coupling device is done manually by the operator. The coupling and locking module consists of the auxiliary closing piece (2), the locking cylinder (3), the safety seal (4) of the locking cylinder and is coupled to the fuel channel (1), exemplified in Figure 5.

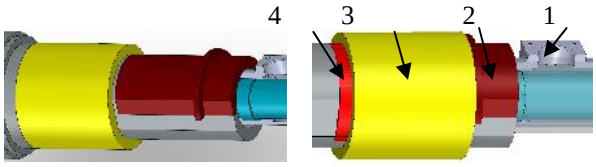


**Figure 5:** Representation of the coupling and locking module to the fuel channel

After fuel channel module coupling, is mounted a protective cylindrical screen, made of two semicircular pieces, closed with screws, covering the end fitting for the radiation protection of the operator, after extraction of the fuel channel end fitting (Fig. 6).

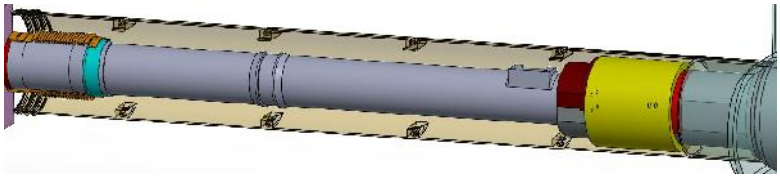

**Figure 6:** Representation of the protective cylindrical screen for end fitting extracting

## 2.5. Presentation of the access valve assembly

The access valve is a structure which, by opening, enable the access of handling elements into the fuel channel to achieve the dismantling operations, and consist of the access valve itself (1) and the valve actuator (2), exemplified in Figure 7.

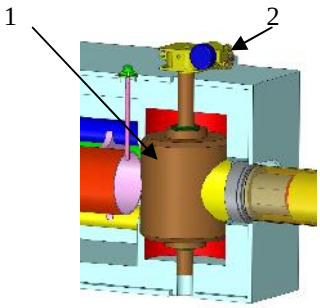


**Figure 7:** Representation of the access valve assembly

## 2.6. Presentation of the storage tubes assembly

The storage tubes assembly is used to store the extracted components of the fuel channel, as a result of the dismantling operations. This assembly consists of the radiation detector (1), the Blue tube (2), the Red tube (3), the Yellow tube (4), the Green tube (5) and the gearmotor drive (6), exemplified in Figure 8.

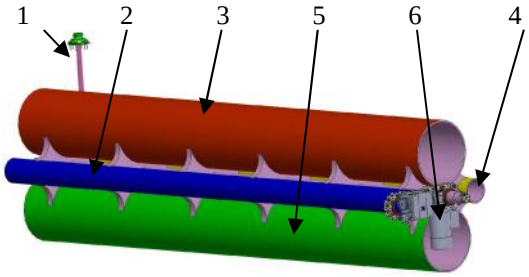


**Figure 8:** Representation of the storage tube assembly components

The storage tubes assembly is mounted on a shaft driven by a gearmotor to turning it in order to place a tube in front of the access valve for access to the fuel channel.
The storage tubes are used as follows:
- the Blue tube for storage of the pressure tube;
- the Red tube for the fitting end storage;
- the Yellow tube for storage of the channel closure plug and the channel shield plug;
- the Green tube for storage of the extended channel closure plug.

## 2.7. Presentation of the handling elements assembly

The handling elements assembly is composed of the sleigh assembly (1), the sleigh travel actuator (2), the stationary tube of the cutting and extraction device (3), connecting cable roller of the cutting and extraction device (4), the extracting actuator of the end fitting (5), exemplified in Figure 19.

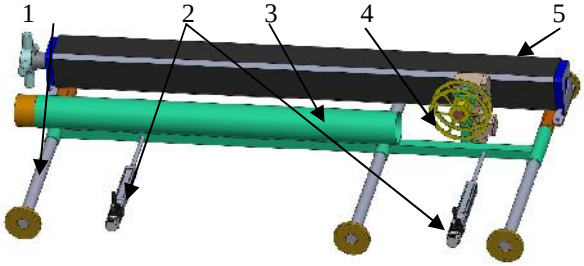


**Figure 19** The handling elements assembly

The handling elements assembly can operate two positions in order to place one element front of the storage tube:
- one position is when the stationary tube it is in working direction for the movement of the cutting and extraction device; cable roller realize the cable progress or tightening of the cutting and extraction device in time of displacement; the operations are the extraction of the channel closure plug, the channel shield plug, cutting and extraction of the pressure tube;
- the second position is when the extracting actuator it is in working direction; the operations are extraction of the end fitting, installation or removal of the extended channel closure plug.

## 3. CONCLUSIONS

The decommissioning of the fuel channels is a complex process that requires piece by piece removal activities of components, transport and storage in dedicated facilities, preparation of records and documents specific decommissioning operations.
The dismantling operation stages of the fuel channel components are repeated for all the 380 channels of the reactor, from the front of calandria side (plane R) as well as the rear side (plane R').
The presented device is a device that extracts the internal components of the horizontal fuel channels, ensuring a radiation protection during the stages of decommissioning.
The design of the device, moving platform and the device support assembly shall be achieved according to the particular features of the fuel channel components to be dismantled in the nuclear reactor decommissioning program, with respect of all security aspects, environmental protection during decommissioning activities and working procedures resulting from decommissioning plan developed.

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