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# CONSIDERATIONS REGARDING THE HORIZONTAL FUEL CHANNELS NUCLEAR REACTOR. PART 2 - DISMANTLING MAIN STEPS OF THE FUEL CHANNEL

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***Abstract:***, *Based on the knowledge referring to presentation and assembly the fuel channel components into calandria of CANDU nuclear reactor, the objective of this paper is to achieve a possible method for the horizontal fuel channels decommissioning from calandria vessel. The decommissioning of nuclear reactor consists in a planning phase and the implementation of all procedures in operation, methods and technologies for decommissioning, including decontamination, dismantling, waste management, robotics and remote operation. The decommissioning of fuel channels, one of the most important operation in the nuclear reactor dismantling, represents the final phase which is performed in the nuclear power facility decommissioning and refers to the technical operations taken to extract the components from inside of the nuclear reactor channel. The dismantling operation stages of the fuel channel components should be repeated for each of all 380 channels of the reactor, starting from the front of calandria side and continuing with the rear side. The decommissioning requires activities with help of a decommissioning device, such as, locking/unlocking the channel closure and the shield plug, pressure tube cutting, extracting of each component from the channel, as well as radioactive waste management. The radiological safety analyses should be made by certified experts, for protection assessment to radiation exposure of workers in time of fuel channel dismantling.*
***Keywords:*** *Candu reactor, calandria tube, fuel channel, pressure tube, fuel bundle, end fitting, annulus spacer*

## 1. GENERAL CONSIDERATIONS

The decommissioning of fuel channels represents one of the last operation which is performed in the nuclear power decommissioning, as the most important operation in the nuclear reactor dismantling. The dismantling of the fuel channel components is performed according to the detailed schematic documentation of a the CANDU nuclear reactors fuel channel.
The nuclear decommissioning includes two phases: a planning phase and an implementation phase of all procedures and operations. These will include also, a description of the proposed radiation protection procedures to be used during decommissioning.
The dismantling of the fuel channel components is performed according to the detailed schematic documentation of a the CANDU nuclear reactors fuel channel.
The operations of the fuel channel dismantling in the CANDU nuclear reactor calandria, shall satisfy the general decommissioning requirements which are described in the documents specified by AECL.

## 2. DISMANTLING MAIN STEPS OF THE FUEL CHANNEL COMPONENTS

The dismantling of the fuel channel components is a complex process and requires activities such as locking/unlocking the channel closure plug and the shield plug, pressure tube cutting, extracting of the components from inside of the nuclear reactor channel, as well as radioactive waste management.
The decommissioning operations of a 380 fuel channels of the nuclear reactor shall be repeated for all the channels, from the front of calandria side (plane R), as well as the rear side (plane R ').

## 2.1. Initial condition of the fuel channel components dismantling

The dismantling of the fuel channel components is performed when the initial conditions are performed. The initial conditions for decommissioning starting are the following:

- 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 support platform shall be in maintenance position for installation of the dismantling device.

The fuel channel components which has to be dismantled are illustrated in Figure 1.

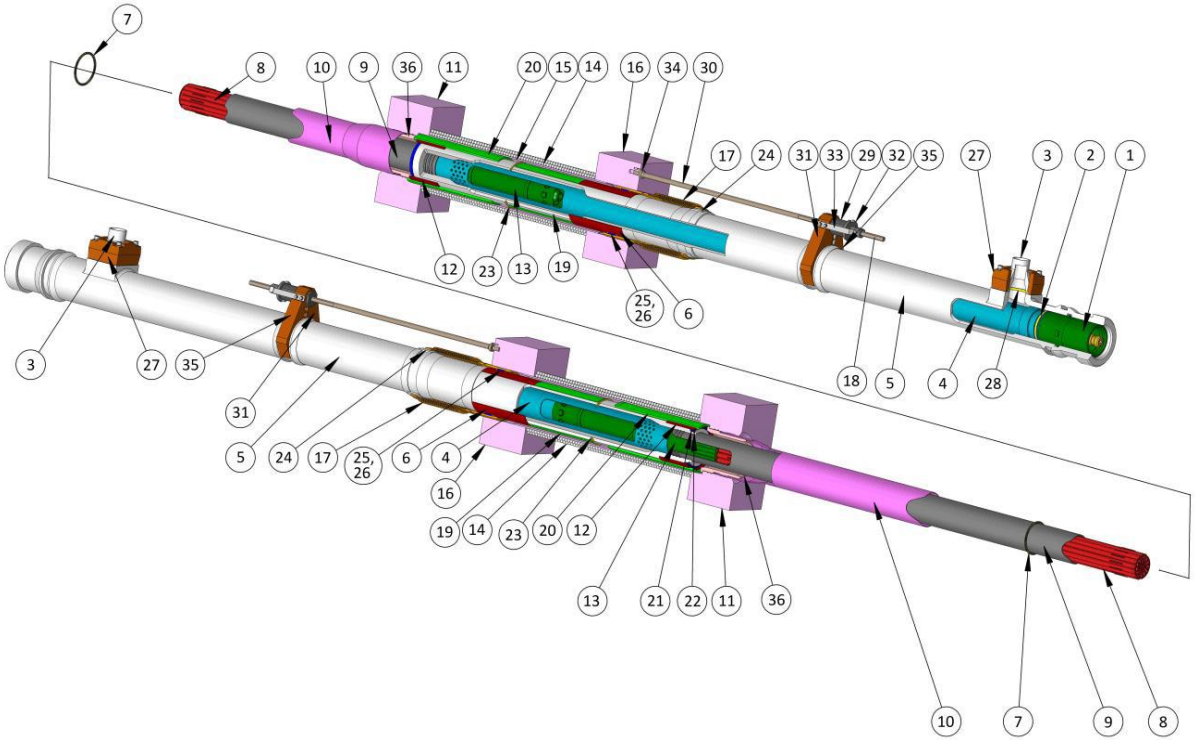


**Figure 1:** Representation of a CANDU fuel channel component parts

1. Channel closure; 2. Closure seal insert; 3. Feeder coupling; 4. Liner tube; 5. End fitting body; 6. Outboard bearings; 7. Annulus spacer; 8. Fuel bundle; 9. Pressure tube; 10. Calandria tube; 11. Calandria tubesheet; 12. Inboard bearings; 13. Shield plug; 14. Endshield shielding balls; 15. Endshield lattice tube; 16. Fuelling tubesheet; 17. Channel annulus bellows; 18. Positioning assembly; 19. End fitting shielding sleeve; 20. Lattice tube shielding sleeve; 21. End fitting inner ring seal; 22. Elastic safety lock for end fitting inner ring seal; 23. Elastic safety lock for end fitting shielding sleeve; 24. Support ring for annulus bellows; 25. Annulus bellows outer ring seal; 26. Elastic safety lock for Annulus bellows outer ring seal; 27. Feeder coupling attachment; 28. Feeder gasket; 29. Rod positioning threaded part; 30. Rod positioning; 31. Right fastening piece for rod positioning; 32. Counter nut locking; 33. Safety lock for counter nut; 34. Lock pin for rod positioning; 35. Left fastening piece for rod positioning; 36. Crimping ring for calandria tube;

## 2.2. Positioning Assembly dismantling

The first operation before start the fuel channels decommissioning shall to be the dismantling of the positioning assembly of all 380 fuel channels.

The dismantling operation procedure of the fuel channel positioning assembly is manually performed, illustrated before and after removal in Figure 2.

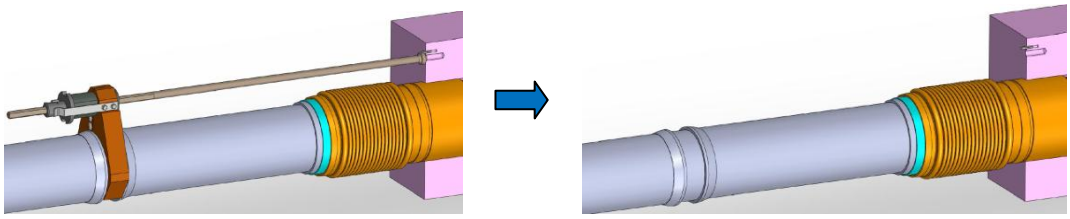

**Figure 2:** Representation of the positioning assembly before and after dismantling

- dismantling operation stages of the positioning assembly shall be repeated for all the channels, from the front of calandria side (plane R), as well as the rear side (plane R ').

## 2.3. Coupling to the fuel channel

Before the end fitting dismantling operation shall to be mounted a coupling module and a protective cylindrical screen which covering the end fitting for the radiation protection of the operator, as is illustrated in Figure 3.

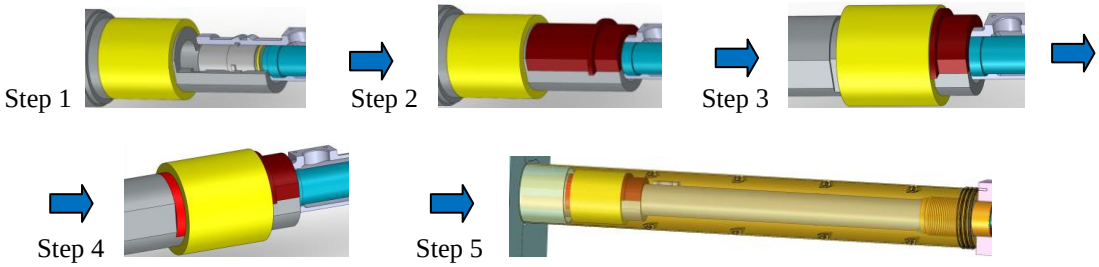


**Figure 3:** Representation of the device coupling steps and the protective cylindrical screen mounting

## 2.4. Extraction of the channel closure plug from End Fitting

First operation procedure for end fitting components dismantling is unlocking and extraction of the channel closure plug (1) (see Figure 4).

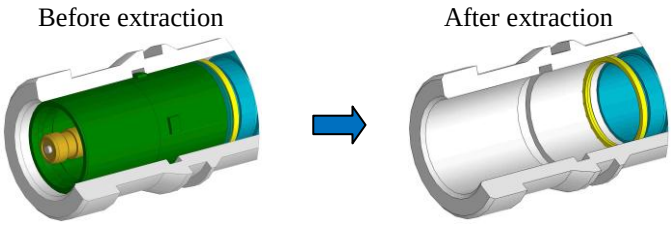


**Figure 4:** Representation of the channel closure removal

## 2.5. Extraction of the shield plug from End Fitting

Unlocking and extraction of the shield plug (13) (see Figure 5) is the second operation to open the fuel channel.

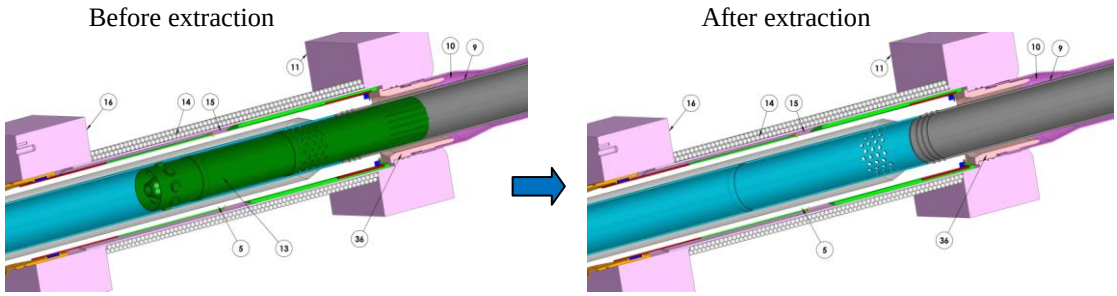


**Figure 5:** Representation of the shield plug removal

## 2.4. Pressure Tube cutting

The cutting procedure facilitates the pressure tube removal and of the fitting end for each fuel channel on each side of the calandria. The first operation procedure of pressure tube cutting is to cut at middle of the tube (see Figure 6).

**Figure 6:** Representation of cutting with rollers in the middle and to end of pressure tube

The second operation procedure of pressure tube cutting is to cut at the end from of end fitting (see Figure 7).

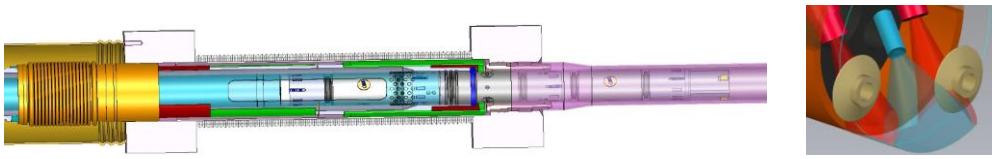

**Figure 7:** Representation of cutting with rollers in the middle and to end of pressure tube

The cutting operations are monitored by video camera and pyrometers for recording the temperature in the cutting rollers area.

### 2.5. Extraction of the End Fitting

The operation for end fitting dismantling is performed by extraction working head. After extraction of the end fitting from the fuel channel, the final state of the channel is represented in Figure 8.

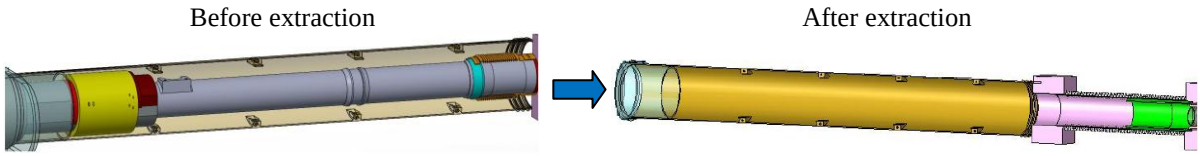


**Figure 8:** Representation of the channel state before and after end fitting extraction

After extraction operation of the end fitting from the fuel channel, shall be inserted the extended channel closure plug into the channel and now it is possible to remove the protective cylindrical screen (see Figure 9).

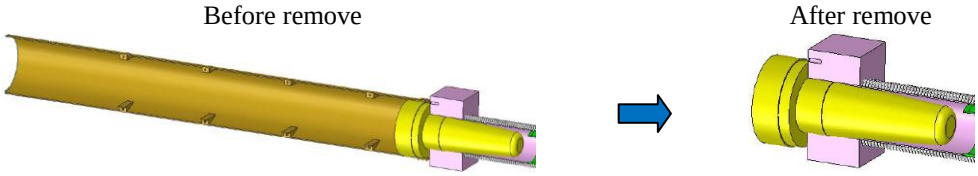


**Figure 9:** Representation of the channel state after mounting of the extended channel closure plug

## 2.6. Extraction of the Pressure Tube

This operation describes the procedure for the pressure tube (9) removing from fuel channel, performed by the working head (see Figure 10). The operation is monitored by video camera mounted on top of working head.

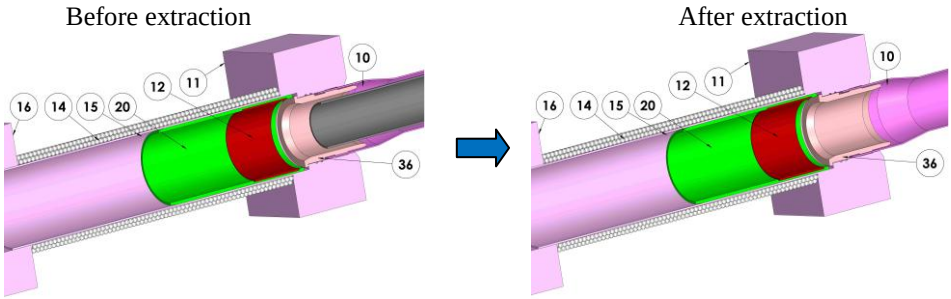


**Figure 10:** Representation of the channel before and after extraction of the pressure tube

After components extraction from the fuel channel, shall be inserted the extended channel closure plug into the channel and the final state of the channel is represented in Figure 11.

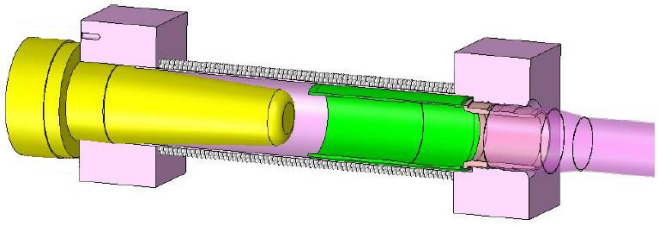

**Figure 11:** Representation of the fuel channel final state

The dismantling of fuel channels components, piece by piece, shall be performed for all 380's fuel channels of the nuclear reactor. After each operation, the resulting information shall be recorded in the specific registration and verification documents of each component and each operation.
All dismantling operations shall be performed by a remote controlled decommissioning device.

## 3. CONCLUSIONS

The decommissioning of fuel channels represents one of the last operation which is performed in the nuclear power decommissioning and refer to the administrative and technical actions taken to eliminate the facility from the nuclear field regulations.
The dismantling of the fuel channel components is performed according to the detailed schematic documentation of a the CANDU nuclear reactors fuel channel.
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 radiological safety analyses should be made by certified experts for protection assessment to radiation exposure of workers in time of fuel channel dismantling.
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 final aim of decommissioning is to recover the geographic site to its original condition.

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