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Abstract

Prototype nuclear power plant A-1 located at Jaslovské Bohunice, was a HWGCR with channel type reactor KS 150 (refuelling during operation) and capacity of 143 MWe. Single unit has been constructed with reactor hall building containing reactor vessel, heavy water system and equipments for spent fuel handling. Another compartment of main building contents coolant system piping, six steam generators and six turbocompressors, the turbine hall was equipped by three turbines. Unit also shares liquid radwaste treatment and storage buildings and ventilation systems including chimney. It started operation in 1972 and was shutdown in 1977 after primary coolant system integrity accident. In 1979 a final decision was made to decommission this plant.

The absence of waste treatment technologies and repository and not sufficient storage capacity affected the planning and realization of decommissioning for NPP A-1. The decommissioning policy for the first stage is for lack of regulations based on "case by case" strategy. For these reasons and for not existence of Decommissioning Fond until 1995 the preferred decommissioning option is based on differed decommissioning with safe enclosure of confinement.

Transfer of undamaged spent fuel cooled in organic coolant to Russia was finished in 1990. It was necessary to develop new technology for the damaged fuel preparation for transport.

The barriers check - up and dismantling of secondary circuit and cooling towers was performed during 1989/90.

The complex plan for the first phase of A-1 decommissioning - the status with treated operational radwaste, removed contamination and restored treated waste and spent fuel (in case of interruption of transfer to Russia) was developed in 1993 - 1994. Under this project bituminization of all liquid operational radwaste (concentrates) was performed during 1995/96, vitrification of inorganic spent fuel coolant started at 1996, decontamination of spent fuel pool coolant occurs (under AEA Technology support) in 1997 as well as preparation for bituminization of organic spent fuel coolant. The new equipment for spent fuel handling including new storage (semi dry) for spent fuel was projected and should be built up in 1997.

The decontamination and dismantling of auxiliary equipments (radwaste tanks, evaporation plant and original solid storage) should start after the commissioning of conditioning centre and bituminization plant with new evaporation plant in 1998 and finish at 2000. The decontamination and dismantling of original spent fuel storage should finish at 2007/8. Supporting activities to these works started at 1994/95.

Introduction

Prototype nuclear power plant A-1 located at Jaslovské Bohunice, was a HWGCR with channel type reactor KS 150 (refuelling during operation) and capacity of 143 MWe. Single unit has been constructed with reactor hall building containing reactor vessel, heavy water system and equipments for spent fuel handling. Another compartment of main building contents coolant system piping, six steam generators and six turbocompressors, the turbine hall was equipped by three turbines (Fig. 1). Unit also shares liquid radwaste treatment and storage buildings and ventilation systems including chimney. It started operation in 1972 and was shutdown in 1977 after primary coolant system integrity accident. In 1979 a final decision was made to decommission this plant.

Accident Description [1]

The first accident (failure of the closing mechanism of technological channel) happened on January 5, 1976. Fresh fuel assembly (together with the technological plug) ejected to the reactor hall. Coolant (carbon dioxide) flowed out of the reactor short time until the refuelling machine was reconnected with open technological channel and stopped coolant leakage. NPP A1 recommenced the operation after channel repair and inspection in September 1976.

During refuelling, the insufficiently transmissive fuel assembly was charged into the reactor core February 22, 1977. Local overheating of fuel, technological channel and heavy water circuit tube caused to the loss of barriers integrity between heavy water moderator and fuel with cooling gas. The cladding and steam generator tube corrosion under water saturated by carbon dioxide occurred and resulted to the contamination of primary and secondary circuit.

Decommissioning Strategy

The absence of waste treatment technologies and repository and not sufficient storage capacity affected the planning and realization of decommissioning for NPP A-1. The decommissioning policy for the first stage was for lack of regulations based on "case by case" strategy. For these reasons and for not existence of Decommissioning Fond until 1995 the preferred decommissioning option is based on differed decommissioning with safe enclosure of confinement. The updated conceptual plan for A1 decommissioning including will be issued at the end of this year.

The complex plan [2] for the first phase of A-1 decommissioning called "safety status"- the status with removed spent fuel, treated operational radwaste, removed contamination and restored treated waste and spent fuel (in case of interruption of transfer to Russia) was developed in 1993 - 1995. The complex plan for the first phase of A-1 decommissioning contents also the conceptual plan for handling with spent fuel in case of transport to Russia interruption till the year 2038 and decontamination and dismantling of contaminated hot chamber till 2027.

The NRA SR policy on decommissioning will be codified in the Act on Peaceful Uses of Nuclear Energy (Atomic Energy Act) what is currently under preparation. In the relevant part of this Act the decommissioning is defined as safe removal of nuclear facilities from service and reduction of residual radioactivity to a level that permits release of property for another nuclear facility or unrestricted site release and termination of licence.

First Phase of A-1 Decommissioning

After the decision to decommission A1, the main activity focused to the spent fuel transfer to Russia. The transfer of all spent fuel what was possible to manipulate (440 fuel assemblies) was finished in 1990.

The barriers check - up and dismantling of secondary circuit and cooling towers was performed during 1989/90.

Paralelly, the technologies for radwaste treatment and conditioning were developed. Bituminization of all liquid operational radwaste (concentrates) was performed during 1995/96, vitrification of inorganic spent fuel coolant started at 1996, decontamination of spent fuel pond coolant started (under AEA Technology support) in 1996 as well as preparation for bituminization of organic spent fuel coolant.

The decontamination and dismantling of auxiliary equipments (radwaste tanks, the part of the evaporation plant and original solid storage) should start after the commissioning of conditioning centre and bituminization plant with new evaporation plant in 1998 and finish at 2000. The decontamination and dismantling of original spent fuel storage should finish at 2007/8. Supporting activities to these works started at 1994/95.

The Radioactive Inventory

The remaining spent fuel represents the main part of radioactive inventory at NPPA1. Because the fuel cladding was damaged, several events during spent fuel handling caused to the contamination of pond cooling water, reactor hall etc. by spent fuel coolant. Radwaste from spent fuel cooling represents therefore very significant part of inventory (Fig. 2). The increasing of total radwaste activity as a consequence of accidents was not so significant in comparison with the increasing of radwaste volume because of low contaminated secondary circuit (Fig. 3).

The remaining spent fuel

Although during the accident in 1976 some assemblies were overheated [3] and during the accident in 1977 some of them were partially influenced because of cladding corrosion due to its contact with heavy water saturated by carbon dioxide, the most of fuel assemblies after their cooling in Dowtherm (biphenyl and biphenyloxid mixture) was transferred to the Russia.

The source of problem of very bad cladding status of all remaining fuel (132 assemblies) is their corrosion during the original way of spent fuel cooling in water solution

- 1. reactor KS 150
- 2. steam generator (6 units)
- 3. turbocompressor (6 units)
- 4,5) turbine set (3 units)
- 6) main condenser
- 7) cooling towers
- 8) circulation pumps
- 9) steam cooler
- 10, 11) condenser with cooler
- 12-14) condensate pumps, heating
- 15) vacuum degasificator
- 16,17) circulation pumps
- 18-20) feedwater pumps and tank

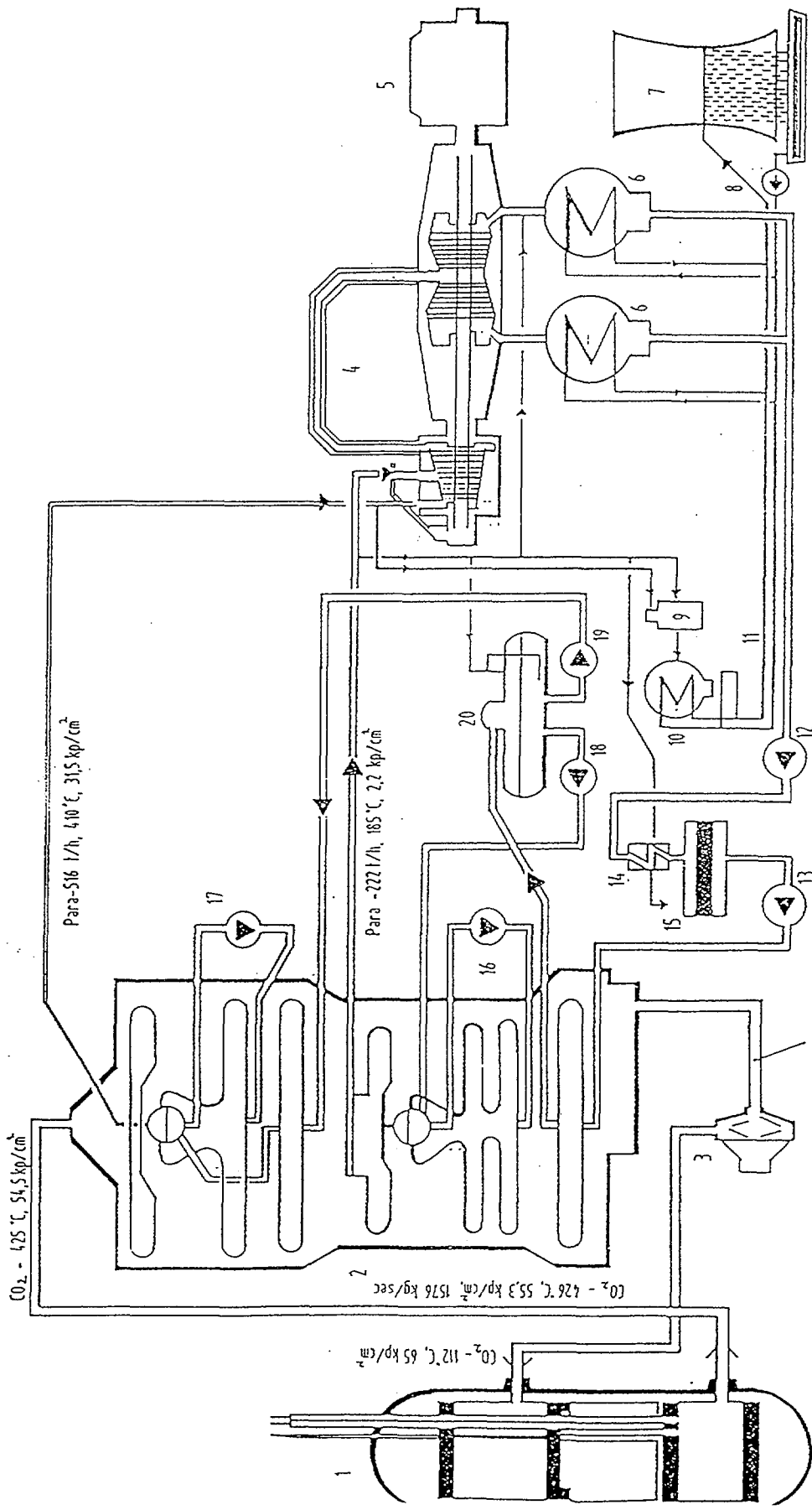


FIG. 1. NPP A1 primary and secondary circuits.

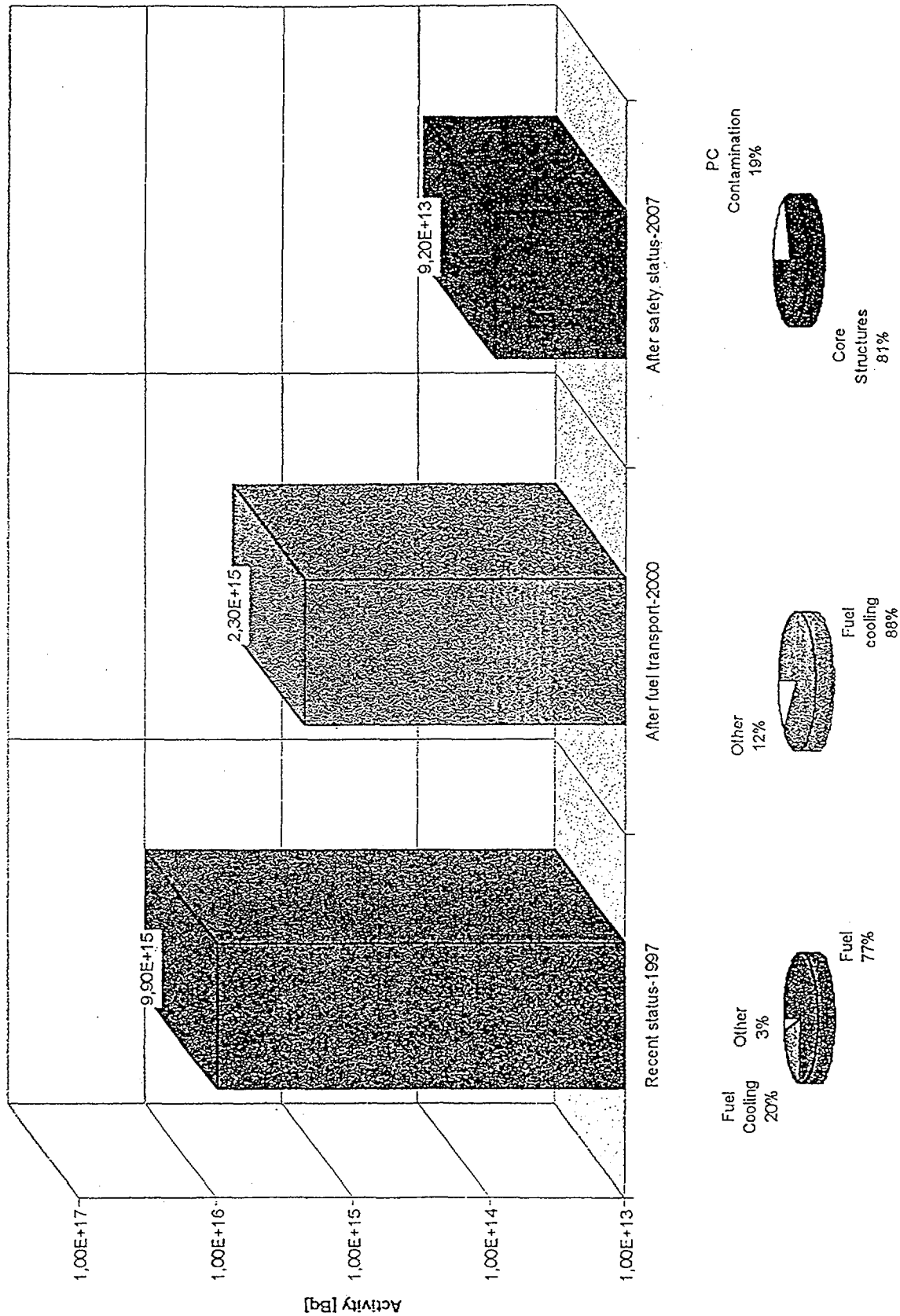


FIG.2. Radioactive inventory during decommissioning phases [5].

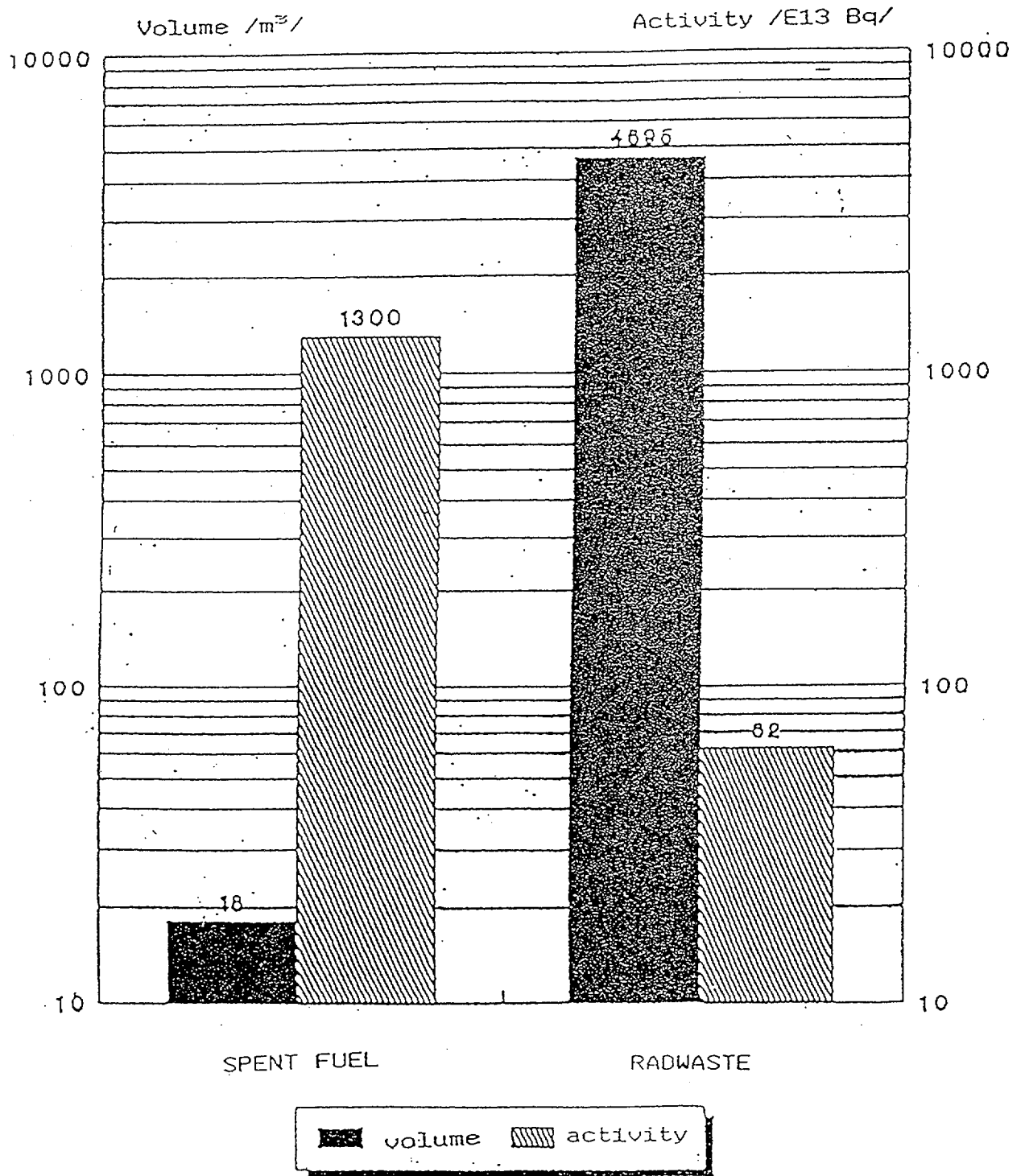


FIG. 3. Diagram of raw volumes and activities arising from the NPP A-1 operation and decommissioning [1].

of potassium bichromate (chrompik) saturated in starting cooling period with carbon dioxide (short term storage). Especially in the case of fuel with cladding damaged during operation in reactor due to higher temperatures and burn-up [4] the cladding is so significantly damaged, that is not possible to manipulate with fuel and to take it off from the cooling containers.

In 1974/5 the coolant was changed, and all fuel assemblies stored/ cooled in Dowtherm were transferred to Russia.

The new technology for spent fuel preparation for transfer represents the drainage of original inorganic coolant with high content of cladding corrosion and fission products from cooling container with fuel assembly and repack fuel assembly and shorted original container to the new hermetic container. The development of this technology started at 1988 and the equipment was in the stage of active tests in 1991.

The accident leading to contamination of reactor hall during these tests occurred, so only 4 fuel assemblies were prepared for transport and were later transferred to Russia. The decontamination of reactor hall was provided in 1993 - 1996 under technical support of AEA Technology, the transfer of fuel was interrupted.

Paralelly to the reactor hall decontamination the improved equipment for damaged spent fuel handling and preparation for transfer based on gravitational drainage was developed with safety features including fire protection (argon atmosphere). The facility is now under active test, the first transport performed last month.

The new storage (semi dry) for spent fuel was projected and should be built up at the end of 1997. The remaining spent fuel will be replaced from the wet pond with expired time of operation to this storage during the first half of the next year.

Radwaste from the spent fuel cooling

The main portion of such type activity represents chrompik in canisters with spent fuel, what will be drained during fuel preparation to transport to special tank and later vitrified.

Approximately 10 % of the chrompik activity represents water of spend fuel pond. Decontamination of this coolant (2-3 orders activity decreasing) is based on Caesium removal on sorption columns. The cleaning of water will be finished after removal of fuel, chrompik and dowtherm, water will be evaporated and bitumenized.

The chrompik from canisters (the fuel was transfer to Russia in late eighties, activity is significantly lower) will be replaced to the new tanks and later vitrified or cemented.

Dowtherm will be bitumenized and/or incinerated, bitumenization with concentrates from WWER 440s will start this year.

REFERENCES

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- 3) Czechoslovak- Soviet Report, NPPA1 Operation during 1.10.1974 - 30.9.1976, Jaslovské Bohunice 1976
- 4) HREX, Conference on the result of experiment with A1 fuel assemblies, Piešťany June 1-2, 1976
- 5) NPP A1 Safety Report, DECOM Slovakia, 1997