DOSES OF THE STAFF DURING THE SPEND FUEL ASSEMBLIES TRANSPORTATION AND STORAGE IN NUHMOS 56V CONCRETE SYSTEM

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The NUHMOS 56V concrete system provides long-term interim storage (50 years) for spent fuel assemblies, which have been out of the reactor for a sufficient period of time. It consists from horizontal storage modules (see Fig. 1). The fuel assemblies are confined in a helium atmosphere by a canister containment pressure vessel (see Fig. 2). The canister is protected and shielded by a massive reinforced concrete module. Decay heat is removed from the canister and concrete module by a passive natural draft convection ventilation system.

The project of storage does not foresee the radiation monitoring inside of building and around it. But we provided and realize the radiation monitoring program around storage, it includes tree phases:

⇒ determination the zero background around the building before storage put in exploiting;
⇒ monitoring of the radioactive particles in air (additional aspiration plant); dose rate monitoring by portable dosimeters and soil monitoring during the process of the fuel storage;
⇒ constantly after the completion the fuel storage process - monitoring of the radioactive particles in air (additional aspiration plant); dose rate monitoring by portable dosimeters, and soil monitoring. Also designed the dose rate monitoring by the dosimeter RME^3 with the transfer of data by radio channel to central monitor.

The canisterized spent fuel assemblies are transferred from the plant's spent fuel pool to the concrete storage modules in a transfer cask (see Fig. 3). The cask is aligned with the storage module and the canister and inserted into the module by means of a hydraulic ram. The system is a totally passive installation that is designed to provide shielding and safe confinement of spent fuel for a range of postulated accident conditions and natural phenomena.

The primary operations for system are:

1. **Cask preparation :**
   Cask washdown and interior decontaminaton.
2. **The dry shielded canister (DSC) preparation:**
   The internals and externals of the dry shielded canister are washed or wiped down.
3. **Placement DSC in cask:**
   The empty dry shielded canister placed into the transfer cask. Proper alignment is assured by visual inspection.
4. **Fill with water and seal cask/DSC annulus:**
   The transfer cask and dry shielded canister inside the cask are filled with water. This prevents an in-rush of poll water as they are placed in the pool. The dry shielded canister/cask annulus is sealed prior to placement in the pool. This prevents the contamination of the dry shielded canister outer surface by the pool water.
5. **Cask lifting and placement in poll:**
   The water-filed transfer cask, with dry shielded canister inside, is then lifted into the fuel pool and positioned in the cask laydown area.
6. **DSP spent fuel loading:**
   Spent fuel assemblies are placed into the dry shielded canister basket. This operation is identical to the presently used at plant for shipping cask loading.
7. **DSC top shield plug placement:**
   This operation consists of placing the dry shielded canister top shield plug onto the dry shielded canister using the plant's crane.
8. **Lifting cask from poll:**
   The loaded cask is lifted out of the pool and placed (in vertical position) on the decontamination area. This operation is similar to that used for shipping cask handling operation.
9. **Decontamination of the cask.**
   The loaded cask is decontaminated and then transferred to the work cask area.

10. Inner DSC sealing.

Using a pump, the water in the dry shielded canister is lowered below the inside surface of the dry shielded canister top shield plug. The inner top cover is put in place and a seal weld is made between the edge of the cover plate and the dry shielded canister shell. This weld provides the inner seal for the dry shielded canister.

11. DSC drying and backfilling.

The initial blow-down on the dry shielded canister is accomplished by pressurizing the vent port with neutral gas. The water in dry shielded canister is forced out and goes back to the fuel poll. The dry shielded canister then evacuated to remove the residual liquid water and water vapor in the dry shielded canister cavity. When the system pressure has stabilized, dry shielded canister is backfilled with helium and re-evacuated. The second backfill and evacuation ensures that reactive gases remaining are less then 0,25% by volume. After the second evacuation, the dry shielded canister is again backfilled with helium and slightly pressurized. A helium leak test of the inner seal performed. The helium pressure is the reduced, and the drain and fill port penetrations seal welded closed.

12. Outer DSC sealing:

After Helium backfilling, DSC outer top cover plate is installed by placing a second seal weld between the cover plate and the DSC shell Together with the inner seal weld, this weld provides a redundant seal at the upper end of **DSC.** The lower end has redundant seal welds, which are installed and tested during fabrication.

13. Cask/DSC annulus draining and top cover plate placement:

The transfer cask is drained, removing the demineralized water from the cask/DSC annulus. A swipe is then taken over the DSC exterior at the DSC top cover plate and the upper portion of the DSC shell. Clean demineralized water is finished through the cask/DSC annulus to remove of any contamination left on the DSC exterior as required. Then the transfer cask top cover plate is put in place using crane. The cask lid bolted for subsequent handling operations.

14. Transport the loaded cask to HSM:

Upon entering the ISFSI secured area, the transfer cask is positioned and aligned with the particular HSM in which a DSC is to be transferred.

15. Cask/HSM preparation:

At the ISFSI with the transfer cask positioned in front of the HSM, the cask top cover plate is removed. The trailer is backed into close proximity with the HSM and HSM door is removed. The skid positioning system is used for final alignment and docking of the cask with the HSM.

16. Loading DSC into the HSM:

After final alignment of the transfer cask HSM and hydraulic rum the DSC is pushed into the HSM by the hydraulic carriage.

17. Storage.

After the DSC is inside the HSM, the hydraulic carriage is disengaged from DSC and withdrawn through the cask. The trailer is pulled away, the HSM shielded access door installed. The DSC is now in safe storage within the HSM.

In framework of the project were designed dose rates at the operations by unloading and transporting the fuel assemblies, they are shown in table 1.

Using data of table 1, we calculate the doses at the carrying-out of operations by loading and transportation the spent fuel assemblies, they are shown in table 2.

We also want to show you the data, describing the radiation situation during the loading the dry shielded canister (see table 3).

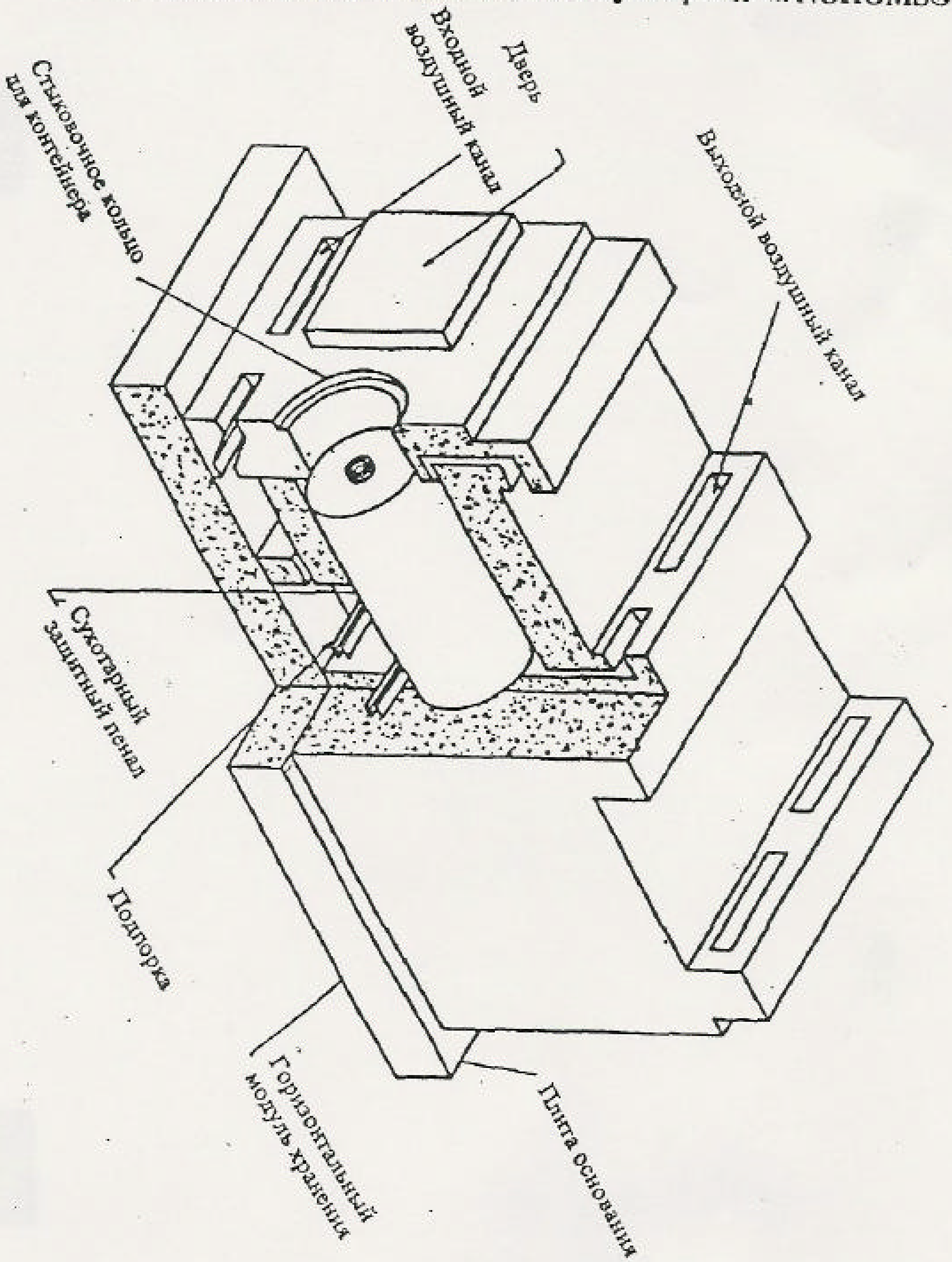
The measuring of doses of the personnel was carry out by electronic and TLD dosimeters.

Comparison the data of the lust two columns of the table 2 shows that the doses, calculated by our specialists, are about 1,5 times less then real doses. The main cause of it is that the designed in the project dose rates, shown in table 1, are found less than real dose rates. The cause of that, was that circumstance, that during the designed calculations were taking into account the doses from the spent fuel assemblies which storage time in spent fuel pool is 3 years, but the real storage time was 10 years. Taking into account the experience obtained by our specialists, we can expect, that in future the similar operations by storing the spent fuel assemblies would bring to more little doses.

In particular, the doses obtained during the operations by: decontamination of the cask and dry shielded canister and placement-replacement of the additional temporary screens are equals 2,51 mSv (11% from total dose) and 7,14 mSv (31% from total dose) accordingly. It is enough much. And we can decrease them with the help of decreasing the time of operations.

Рисунок 1.3-3

Схема горизонтально расположенного модуля хранения NUHOMS®

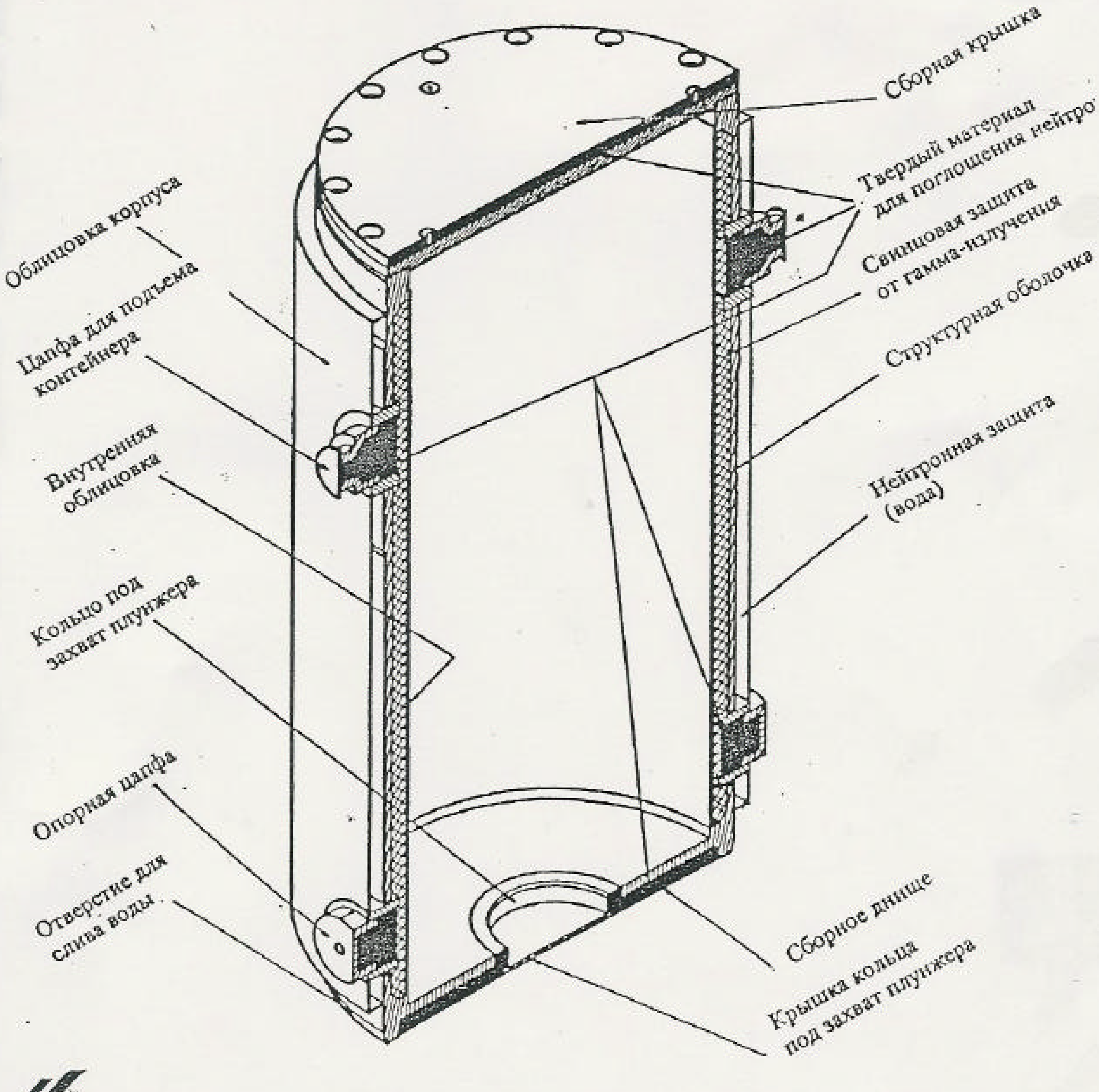


FRAMATOME
NUCLEAR OPERATIONS

Рис. 1.3-5

Перегрузочный

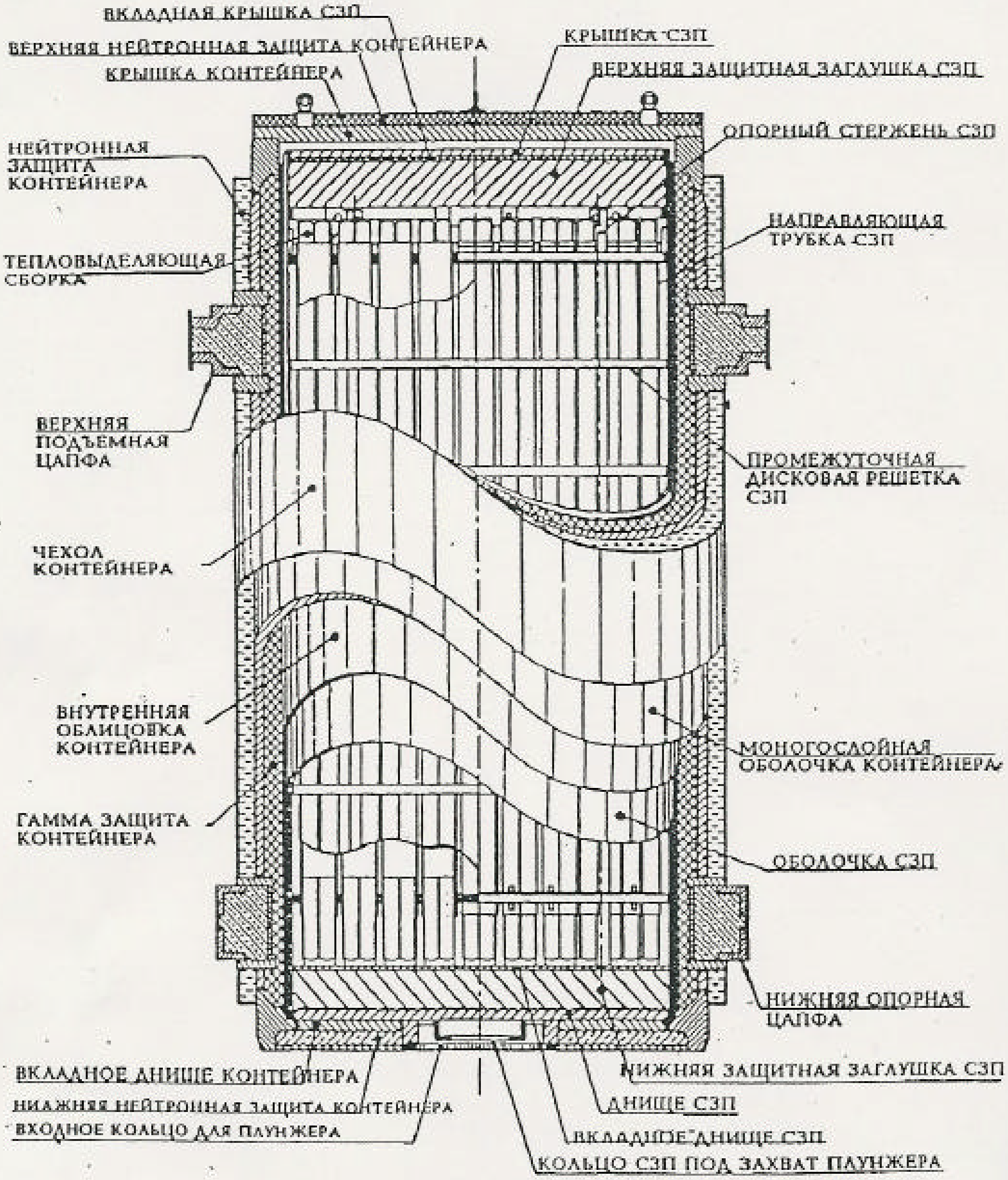
защитный контейнер



FRAMATOME
NUCLEAR OPERATIONS

Рисунок 4.2-7

Общий вид перегрузочного защитного контейнера NUHOMS и СЗП с установленными ОТВС



FRAMATOME
NUCLEAR OPERATIONS

Table 1.
The designed dose rates at the operations by unloading and transporting the fuel assemblies.

Situation	Direct dose rate [μSv/h]			
	Kind of contact	Neutron	gamma	Total
1. Dry shielded canister during the pressurizing: 1.1 a) the canister is fill of boron water b) the water is between the DSC and cask c) with the install upper cover.	Axial contact 1 meter	88 85	1093 837	1181 922
	Radial contact 1 meter	341 159	2240 1100	2581 1259
1.2 The same after moving off the little volume of water a) from cavity of the dry shielded canister b) and from ring clearance between dry shielded canister and cask.	Axial contact 1 meter	320 308	1847 1390	2167 1698
1.3 The same after installs the cover.	Axial contact 1 meter	272 261	826 637	1098 898
1.4 The same after installation the temporary protection Screen	Axial contact 1 meter	30 29	169 129	199 158
	The upper edge	24	135	159
1.5 The same without the boron water spent fuel assemblies	Axial contact 1 meter	510 484	408 306	918 790
	Radial contact 1 meter	520 250	2700 1280	3230 1530
1.6 The same without temporary protection.	Axial contact 1 meter	6219 5947	2026 1519	8245 7466
1.7 The same after installs the cover.	Axial contact 1 meter	4752 4540	616 470	5368 5010
1.8 The same after installing the temporary protection	Axial contact 1 meter	377 356	143 110	520 466
	The outside edge	302	114	416
1.9 The same without the water ring clearance between the dry shielded canister and cask.	Radial contact 1 meter	710 330	2858 1363	3568 1693
1.10 The cover of cask is install.	Axial contact 1 meter	430 402	25 19	455 421
2. Dry shielded canister in horizontal storage module The roof of horizontal storage module	-the contact dose of direct radiation -the dose rate of radiation from the grate (diffused)	1,74 0,35	117,4 1,5	179,1 1,85
The side wall of horizontal storage module	- the contact dose	0,89	53,7	54,6
The closed door of horizontal storage module	-the contact dose - 1 meter	38,2 35,8	10,4 6,4	48,6 42,2
The open door of horizontal storage module	- the contact dose	5622	1119	6741
3. Dry shielded canister during the transportation in the protection cask.	-Radial contact -1 meter	710 330	2858 1363	3568 1693
	- Contact of the upper axial direction - 1 meter	430 402	25 19	455 421
	-contact of the upper axial direction	440	190	630

Table 2
Calculated and real doses at the carrying-out of operations by loading and transportation the spent fuel assemblies

Operation	Number of workers	The time of carrying-out the operation (hours)	The dose rate μSv/h	Cacl. dose mSv	**Real doses mSv**
Loading of dry shielded canister					
Preparation the cask and dry shielded canister	2	4	10,8	**0,05**	**0,04**
Placing the cask and dry shielded canister in pool	3	10	10,8	**0,10**	**0,06**
Loading the spent fuel in dry shielded canister	3	16	72	**1,28**	**0,83**
Placing the upper shield cover of dry shielded canister.	3	1	72	**0,08**	**0,06**
Extraction the dry shielded canister from the pool and placing it in the decontamination area.	5	2	1181	**2,40**	**1,62**
Total for operation				**3,91**	**2,61**
Pressurizing the dry shielded canister.					
Decontamination of the outside surface of the cask	2	1	2581	**2,50**	**1,68**
Discharging the water over the shield cover of dry shielded canister	3	1	1181	**1,20**	**0,74**
Decontamination the upper part of the cask and dry shielded canister	2	1	1181	**1,20**	**0,83**
Removing the compression from the ring clearance between the cask and dry shielded canister, placing the cover and welding devise.	2	2	2167	**4,20**	**2,85**
The automatics welding the cover with the body of dry shielded canister.	2	4	10,8	**0,05**	**0,04**
Placement of the additional temporary screens.	2	0,5	199	**1,00**	**0,61**
Performance of metal control	2	1,5	199	**0,30**	**0,20**
The vacuum drying and pumping the helium in the dry shielded canister	2	16	199	**0,80**	**0,48**
Testing the joints for hermetic.	2	1	199	**0,20**	**0,12**
Welding the covers of ventilation opening and siphon.	2	1,5	199	**0,30**	**0,21**
Removing of the additional temporary screens.	2	0,5	8245	**4,10**	**2,67**
Placement of the cover.	2	0,5	5368	**2,65**	**1,75**
Weld with the welding devise.	2	9	10,8	**0,10**	**0,06**
Placement of the additional temporary screens.	2	0,5	5368	**2,65**	**1,62**
Removing the welding devise from the dry shielded canister.	2	0,5	520	**0,26**	**0,17**
Performance of metal control	2	2	520	**1,00**	**0,60**
Removing of the additional temporary screens. Discharging the water from the ring clearance between the cask and dry shielded canister.	2	0,5	5368	**2,65**	**2,24**
Placement the cover of the cask.	2	1	455	**0,40**	**0,26**
Total for operation				**25,56**	**17,13**

Table 2(continuation)

Loading the cask for transportation					
Preparation the supporting carriage of the cask and the trailer.	2	2	10,8	**0,02**	**0,010**
Placement the cask on the supporting carriage of the trailer.	2	0.5	455	**0,20**	**0,008**
Replacement the bottom and placement the protection cover.	2	1	455	**0,45**	**0,30**
Fixing the cask on the carriage.	2	1	455	**0,45**	**0,28**
Total for operation				**1,12**	**0,60**
Transportation dry shielded canister to the horizontal storage module					
The horizontal storage module preparation	2	2	0,1-0,2	**-----**	**0**
Transportation the cask to storage.	6	1	1693	**1,60**	**1,12**
Removing the cover from the cask.	3	1	455	**0,45**	**0,26**
Attachment the cask with the horizontal storage module	3	2	455	**0,90**	**0,68**
Placement the hydrocylinder and attachment with the cask.	3	1	455	**0,45**	**0,35**
Push out the dry shielded canister from the cask.	3	0.5	455	**0,22**	**0,12**
Placement the hydrocylinder on the trailer and un-docking the cask from the horizontal storage module. Placement the seismic limit.	3	0.1	6741	**0,60**	**0,24**
Placement the door of the horizontal storage module	3	1	179,1	**0,20**	**0,06**
Total for operation				**4,42**	**2,83**
Total				**35,01**	**23,17**

Table 3
Radiation situation during the loading the dry shielded canister

Operation	Dose rate in different points (μSv/sec)							
Loading the dry shielded canister in container com-partment. The water level in container compartment – 6,7 meters.	-	-	-	-	-	-	-	-
Extraction the dry shielded canister from the container compartment and its decontamination. The water level in container compartment – 10,5 meters. Contamination of the dry shielded canister surface is 360-400 β-particles/sm^{2}minute.	0,10	0,06	0,03	0,02	0,02	0,02	0,04	0,05
Installation the first cover	0,08	0,07	0,02	0,02	0,02	0,02	0,04	0,05
Pump out the water from the dry shielded canister	0,16	0.10	0,04	0,06	0,07	0,07	0,04	0,05
The vacuum drying of dry shielded canister	0,15	0,10	0,04	0,06	0,07	0,07	0,04	0,05
Compression the helium in to the dry shielded canister	0,03	0,10	0,05	0,06	0,07	0,06	0,04	0,05
Installation the second cover	0,01	0,06	0,03	0,06	0,05	0,06	0,04	0,05
Notice: the alpha particles and neutrons does not recorded								