



FEDERAL AGENCY FOR ATOMIC ENERGY  
**FEDERAL STATE UNITARY ENTERPRISE  
"MAYAK PRODUCTION ASSOCIATION"**

**FSUE "MAYAK" PA ACTIVITIES  
IN THE FRAMEWORK OF RITEG DISPOSAL PROGRAM.**

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(April 23-25, 2008. Moscow. IAEA CEG Workshop on RITEGs.)*

*The paper describes principal production activities of FSUE "Mayak" PA in terms of RITEG handling. Factors imposing restrictions on capabilities of spent RIT receiving for long-term storage are listed, operating conditions of the "Mayak" PA infrastructure elements are described. The "Mayak" PA proposal concerning the establishment of the complex for RITEG disassembly and disposal is provided.*

**1. The "Mayak" Production Association principal activities  
in terms of RITEG handling.**

**1.1 RIT-90 production at the "Mayak" PA.**

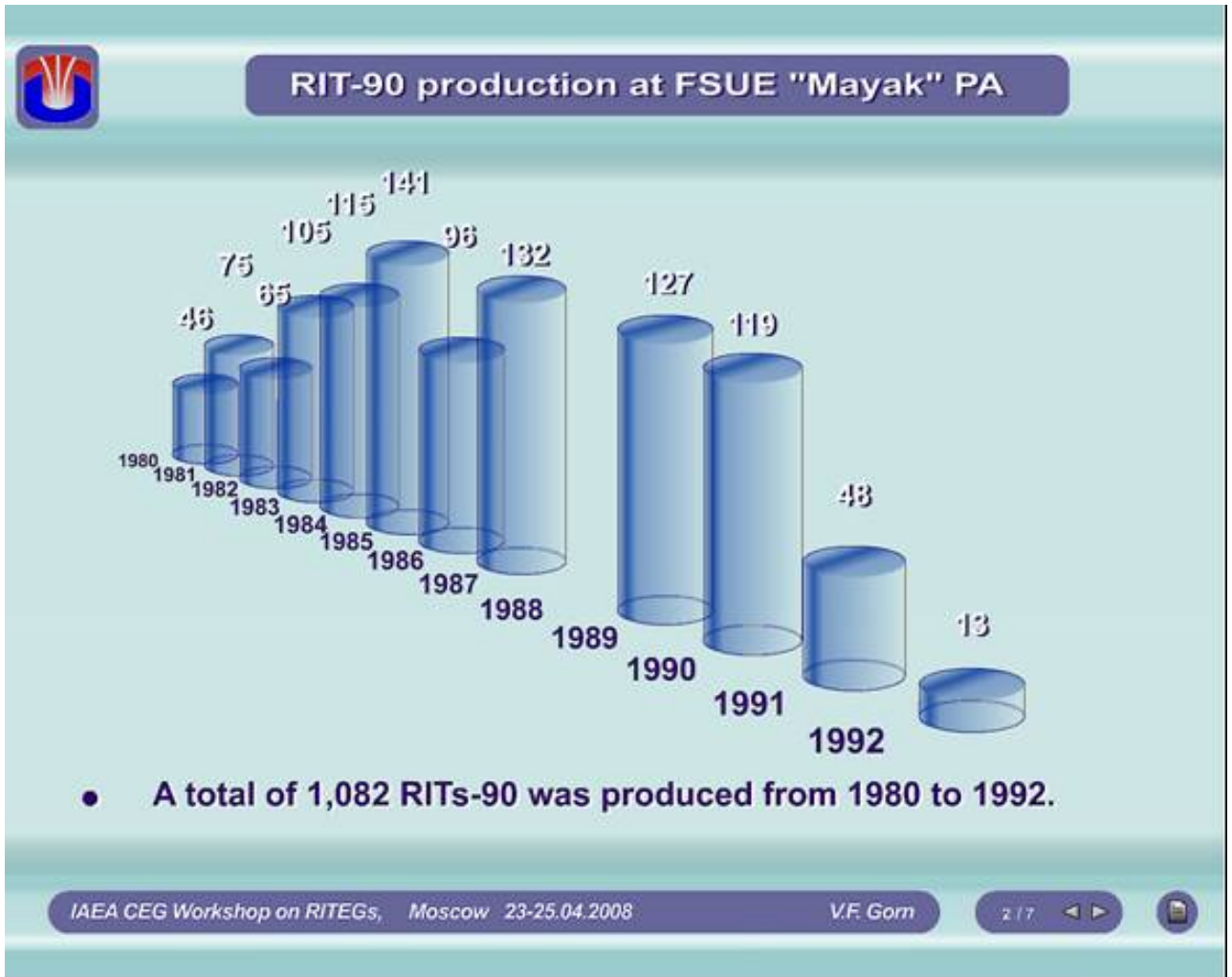
Since the late 1970-s, pilot production of radionuclide heat sources on the basis of strontium-90 (RIT-90) has been established at the "Mayak" PA. These heat sources served as the main element of radioisotope thermo-electric generators (RITEGs).

Structurally, RIT consists of radionuclide fuel pellet (RFP), casing, seal disk, internal and external lids.

At first the radionuclide fuel pellet was made using strontium titanate composition, later – strontium-borosilicate glass. Stainless steel of type 12H18N10T was used as structural materials for RITs, whereas corrosion-resistant alloy of type HN65MV - for RITu-90 (from 1983 to 1990).

The main differentiating parameter for various types of RIT is the nominal value of heat flow depending on the fuel pellet size.

A total of 1,082 RITs-90 was produced from 1980 to 1992.



(Slide 2: "RIT-90 manufacturing at FSUE "Mayak" PA over years": 1980 – 46 items, 1981 – 75 items, 1982 – 65 items, 1983 – 105 items, 1984 – 115 items, 1985 – 141 items, 1986 – 96 items, 1987 – 132 items, 1989 – 127 items, 1990 – 119 items, 1991 – 48 items, 1992 – 13 items.)

## 1.2 Disposal of spent RITs at FSUE "Mayak" PA

When the designed service life of 11 years for RIT and 11.5 years for RITu expired, in the early 1990-s, there emerged a need for establishment of transportation and technological scheme for RITEG disposal. The main prerequisite for implementation of the given scheme was solution of the task related to safe disposal of spent radioactive heat sources (spent RIT).

In the framework of this task, a concept of spent RIT long-term storage at the specialized storage facility of the Complex for high-level waste vitrification (HLW Vitrification Complex) was accepted. This approach allowed timely start of full-scale program related to RITEG decommissioning with meeting the current safety requirements without considerable capital expenditures.

Transportation-technological scheme (TTS) of spent RIT long-term storage is operable at FSUE "Mayak" PA since 1994. Spent RIT handling activities are performed in accordance with the three Rostechnadzor licenses:

- radioactive substance handling at their transportation;
- operation of the complex containing radioactive substances;
- operation of the complex with nuclear substances.

The main portion of products delivered for long-term storage to the specialized storage facility of the HLW Vitrification Complex of the RT-1 plant, is products containing strontium -90 radionuclide (RIT-90, RITu-90, TRIB-90)

Until recently, the main operations related to spent RIT handling at FSUE "Mayak" PA have been as follows:

- reception and placement of spent RITs at the warehouse of the RI plant in transport containers (UKT), being the property of FSUE "VNIITFA",
- spent RIT transfer from transport containers UKT to process casks of KIZ type in the shielded chamber of the RI plant for interfacility transportation, performance of spent RIT accounting procedure;
- transfer of KIZ casks to the RT-1 plant with motor transport;
- transfer of spent RIT from KIZ cask to KAU transfer cask in the shielded chamber;
- transfer of spent RIT in KAU cask to the chamber of vitrified HLW canister batching (KKP);
- transfer of spent RIT from KAU to the flask with vitreous mass (or empty flask) placed in KKP;
- canister filling with three flasks with vitrified mass and spent RIT, transportation with the help of shielded handling machine and canister placement into the vitrified HLW storage facility.

At the present time, with the objective of increasing the TTS capacity, spent RIT transfer is performed directly from transport containers UKT to KAU casks in the shielded chamber of the RT-1 plant, except for the procedure of spent RIT transfer to process casks of KIZ type at the RI plant. The TTS improvement allowed decreasing the number of procedures related to spent RIT handling, resulting in increasing the scheme capacity and its safe performance.



## Main procedures related to spent RIT handling

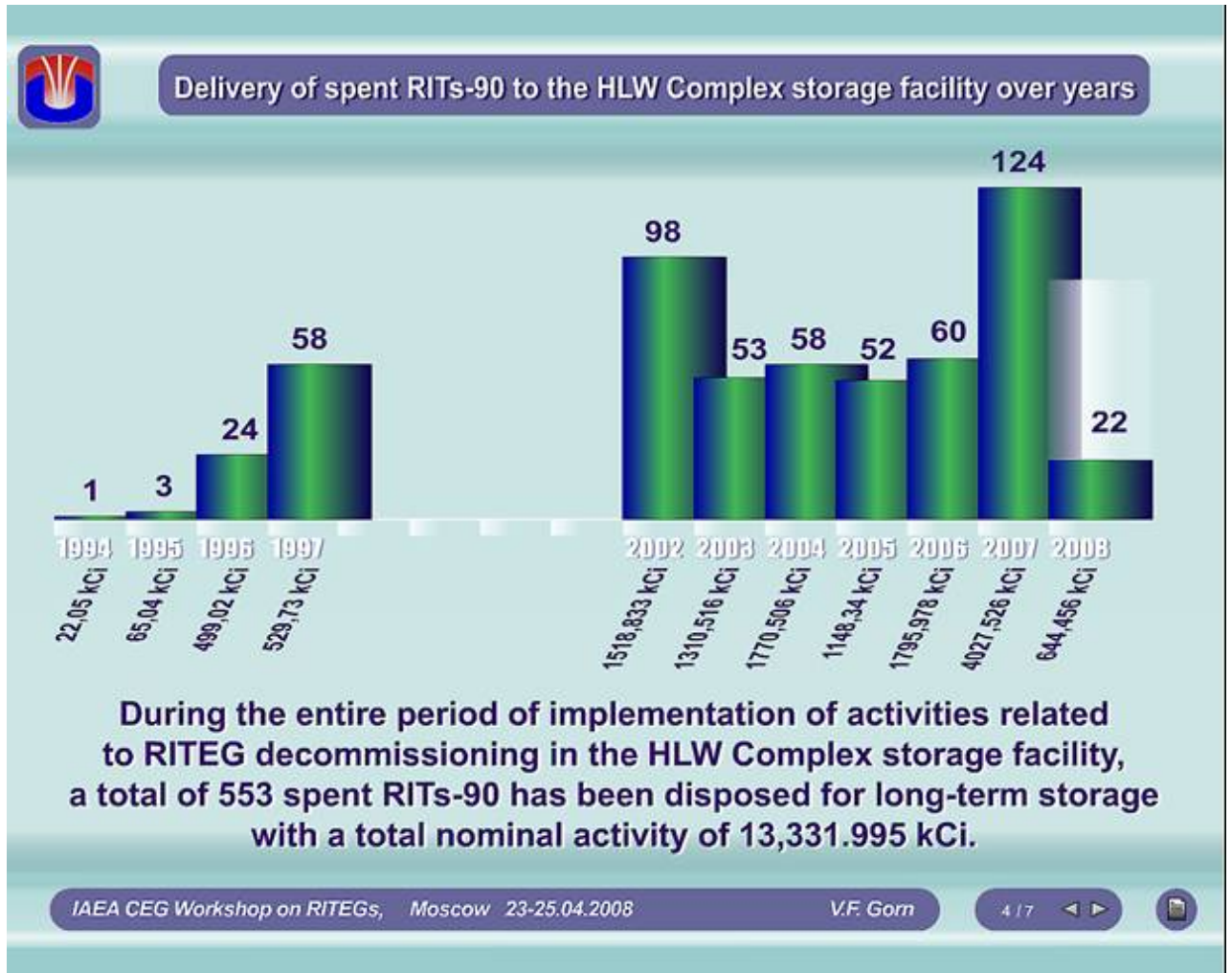
- Reception and placement of spent RITs at the RI plant warehouse in transport containers (UKT), being the property of FSUE "VNIITFA";
  - spent RIT transfer from transport containers UKT to process casks of KIZ type in the shielded chamber of the RI plant for interfacility transportation, performance of spent RIT accounting procedure;
  - transfer of KIZ casks to the RT-1 plant with motor transport;
- Transfer of spent RIT from KIZ cask to KAU transfer cask in the shielded chamber;;
- Transfer of spent RIT in KAU cask to the chamber of vitrified HLW canister batching (KKP);
- Transfer of spent RIT from KAU to the flask with vitreous mass (or empty flask) placed in KKP;
- Canister filling with three flasks with vitrified mass and spent RIT, transportation with the help of shielded handling machine and canister placement into the vitrified HLW storage facility.



(Slide 3: Transportation-technological scheme of spent RIT disposal at FSUE "Mayak" PA)

Recently, at RITEG disassembly at FSUE "VNIITFA", there have occurred seal failures of RITu-90 capsule with release of strontium-90 isotope and RIT blockage in the biological shielding of several RITEG types. In this connection, in January 2008, our enterprise has coordinate the scheme of receiving and long-term storage of disposal blocks containing along with RIT-90 some structural components and biological shielding of RITEG of several types: REU-3, IEU-1, IEU-2, Gorn, Gong. For adaptation to the current process scheme of spent RIT handling at FSUE "Mayak" PA, the disposal block is made in the form of a flask used for vitrified HLW storage.

During the entire period of implementation of activities related to RITEG decommissioning in the HLW Complex storage facility, a total of 553 spent RITs-90 has been disposed for long-term storage with a total nominal activity of 13,331.995 kCi.



(Slide 4: "Spent-RIT-90 delivery to the storage facility of the HLW Complex over years: 1994 – 22.05 kCi (1item); 1995 – 65.04 kCi (3 items); 1996 – 499.02 (24 items); 1997 – 529.73 kCi (58 items); 2002 – 1,518.833 kCi (98 items); 2003 – 1,310.516 kCi (53 items); 2004 – 1,770.506 kCi (58 items); 2005 – 1,148.34 (52 items); 2006 – 1,795.978 kCi (60 items); 2007 – 4,027.526 kCi (124 items); 2008 – 644.456 kCi (22 items))

### 1.3 Spent RIT handling infrastructure at the Mayak PA

The main infrastructure element that provides appropriate operation of the spent RIT handling scheme at the Mayak PA is the High Level Waste Vitrification Complex. The Complex includes a facility, where LRW are prepared for vitrification, electric direct heating furnaces EP-500 and vitrified waste storage. The LRW Vitrification Complex was commissioned at the RT-1 plant in 1987.

In recent years, an amount of spent RITs delivered to the Mayak PA for long-term storage has been sharply increased. However, there are factors that impose certain constraints on the amount of spent RITs received for long-term storage.

There are limitations, which are specified in the regulatory documents, and which relate to the maximum thermal load of HLW storage cells: it is 1300 W for a flask with vitrified waste, whereas, it is 1600 W for a canister with three casks. Therefore, it is possible to place spent RITs only in flasks, which are filled with vitreous mass with a certain volumetric activity, so that the total heat generation of spent RITs and vitreous mass does not exceed the values specified in the regulatory documents.

One of the important conditions that provides a possibility of spent RIT receiving for long-term storage is current operation of electric HLW vitrification furnaces. This is essential to achieve the most efficient use of cells in the specialized storage. In 1998-2001, when the electric furnace EP-500/3 was decommissioned, and before the EP-500/4 was commissioned, disposal of spent RITs for long-term storage was not performed.

Another important factor, which determines a possibility of spent RITs' receiving for long-term storage, is the availability of empty cells in the storage. Currently, 70% of the existing vitrified HLW storage is filled. 600 cells are empty and can store 1800 tons of vitrified mass. At the capacity of the operating electric furnace EP-500/4 of 2.2 tons of vitrified mass per day, the storage will be completely filled in 2.3 years. The Mayak PA took the initiative to introduce modifications in the storage design directed towards increasing the load of the storage cells in order to extend its operation for three more years. Therefore, commission of a new storage is necessary to continue the program of RITEG decommissioning after 2012. Design of the new storage is being developed in the framework of construction of the electric furnaces EP-500/5, 6.

Long-term storage of spent RITs in the HLW Vitrification Complex assumes that, in future, an issue of their final disposal in geological formations is to be solved.

A crucial term, which determines the duration of long-term storage, is the designed operation period of the HLW storage facility that is 30 years (up to 2017). When the time is up, structural constructions of the storage facility must be examined in terms of potential extension of its operation period.

## **2. Establishment of the complex for disassembly and disposal of RITEGs at the Mayak PA.**

In 2006, Mayak PA experts proposed a plan of actions, which allowed for the performance of RITEG handling at the enterprise. The proposal was to build a storage facility for temporary storage of RITEGs, and to reconstruct the existing shielded chamber KKP-2 in order to perform RITEG disassembling.

The proposal was based on the following prerequisites.

Organization of temporary storage and disassembly of RITEGs at the Mayak PA will ensure radiation safety of the population, the personnel and the environment, as well as provide safe storage and non-proliferation of radioactive substances in the course of RITEG handling.

The complete cycle of activities related to disposal of RITEGs in the Urals will minimize both a number of transport operations with RITEGs and the total duration of these operations.

### **2.1 Establishment of the complex for RITEG disassembly and disposal.**

In order to perform the complete cycle of RITEG handling, the following activities are to be carried out at the Mayak PA (the enterprise capacity is 120 RITEGs per year):

### ***2.1.1 Construction of a site for unloading specialized railway cars and of access ways for motor transport.***

Unloading of RITEGs from specialized railway cars will be performed with the help of an auto crane with the lifting capacity of 10 tons. It will be performed onto the unloading platform with hard coating. Specialized car feed is carried out through the use of existing railway track.

### ***2.1.2 Development and construction of the storage facility for temporary storage of RITEGs and their batching.***

The storage facility must be located close to the RITEG unloading site. Transport containers with RITEGs will be transferred using an automated lift truck.

Dimensions of the storage facility as well as its capacity in terms of RITEGs will be specified at the design stage with the consideration of peculiarities of transportation, types of RITEGs and capacity of the disassembly chamber.

The storage facility should be equipped with a system of radiation monitoring, which is a complex of engineering tools, including portable ones, designed to reduce the risk for personnel overexposure, i.e. doses above admissible levels.

The radiation monitoring system provides:

- Monitoring of radiation source term in the storage facility and on the unloading site during work performance.
- Individual dosimetry monitoring of the personnel.

An alarm system and a personnel access control system should be installed in the storage facility.

### ***2.1.3 Establishment of the RITEG Disassembly Area.***

Establishment of the area for RITEG disassembling consists of two primary tasks:

#### **2.1.3.1 Reconstruction of the Existing Shielded Chamber KKP-2 in Building 120/12 of the HLW Vitrification Complex:**

- Dismantling of the existing in-chamber equipment;
- Reconstruction of the ventilation system,
- Development, fabrication and assembly of non-standard equipment for RITEG disassembling;
- Equipping the chamber with a sliding sluice heavy door;
- Development and manufacturing of the equipment for mechanical cleaning and decontamination of the “hot” chamber;
- Acquisition and installation of four manipulators of MEM-55 type;
- Installation of additional lighting.

#### **2.1.3.2 Establishment of an Enclosure for RITEG Preliminary Disassembling:**

- Construction of the enclosure with a system of ventilation (i.e., a room

- for personnel temporary staying);
- Development and fabrication of a cartrack with electric drive and a system of remote control for transferring RITEGs from the preliminary disassembly enclosure to the shielded chamber;
- Development and production of equipment for preliminary disassembly of RITEGs of different types.

#### ***2.1.4 Development and Fabrication of a Heavy Transport Container for RIT Transfer.***

The currently used heavy transport container does not have sufficient biological shielding. As a result, RIT transportation causes excessive radiation exposure to the personnel.

It is worth mentioning that, first, the proposal to design the Complex did not assume developing either methods or technologies for receiving and treatment of damaged RITEGs.

**Activities Directed Towards Establishment of the Complex for RITEG Disassembly and Disposal at the Mayak PA**

- 1. Establishment of the site for unloading specialized railway cars and of access ways for motor transport;**
- 2. Development and construction of the storage facility for temporary storage of RITEGs and their batching;**
- 3. Establishment of the RITEG disassembly area:**
  - Reconstruction of the existing shielded chamber KPP-2 in building 120/12 of the HLW Vitrification Complex;**
  - Establishment of an enclosure for RITEG preliminary disassembly**
- 4. Development and fabrication of a heavy transport container for RIT transfer.**

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(Slide 5: Activities Directed Towards Establishment of the Complex for RITEG Disassembly and Disposal at the Mayak PA)

## **2.2 Scoping calculation of the costs of establishment of the Complex for disassembly and disposal of the RITEG at the "Mayak" PA .**

### *2.2.1 Cost of design work and expert examination.*

In the framework of tentative agreement with CEA FRANCE, experts of our enterprise have developed technical and financial proposal for designing the Complex for disassembly and disposal of RITEGs. According to the proposal, the cost of these activities is estimated at 292,875 euro.

The design developer is FSUE "UGPII "VNIPIET" with participation of FSUE "VNIITFA"

The design is supposed to be developed over one stage "Detailed design". Period of development: 14 months.

### *2.2.2 Cost of establishment of the Complex for disassembly and disposal of RITEGs.*

According to the preliminary estimate made by FSUE "UGPII "VNIPIET", the cost of establishment of the complex for disassembly and disposal of RITEGs makes **115 mln. roubles** (3.2 mln. euro) according to the prices as of Quarter I, 2008. Cost estimation was carried out by analogy (with the RT-1 plant building), i.e. based on the cost of one cubic meter of a new technological building with equipment.

The expected period of implementation of the Complex establishment project - 24 months.



(Slide 6: Terms and cost of the project implementation for establishment of the Complex for disassembly and disposal of RITEGs at FSUE "Mayak" PA)

### 3. Conclusion

Currently, duration of the program related to RITEG decommissioning is determined by the efficiency of the current transportation-technical scheme and amounts of funding from donor-countries.

With consideration of recent growth of RITEG disposal rates, the problem of efficiency of investments in construction of infrastructure for RITEG handling at our enterprise is directly dependent on its commissioning terms. In addition, our enterprise has plans concerning the use of shielded chamber KKP-2 for solution of R&D tasks.

Therefore, we consider that the problem of funding of the activities related to establishment of the Complex for RITEG disassembly and disposal at the "Mayak" PA should be solved in the first half of 2008.