STUDY OF APPLICATION AND TESTING OF THE EXPERIMENTAL FUEL ASSEMBLY WITH 36 %, 19.8% ENRICHMENT

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1. Introduction.

On the reactor WWR-SM INP of AS RUz since March, 1987 till March, 1989 the service life tests 3-rd FA (fuel assemblers) of a type IRT-3M (two 6- tube and one 8- tube) 36 %-s' enrichments on U-235 were conducted, which one were developed within the framework of the first stage of the program on a decrease of enrichment of fuel for research reactors of countries of New Independent State. Density of uranium in hearts fuel elements - 2,5 g/c^3. Width of hearts - 0,5 mm. The tests these FA have passed successfully with achievement of burn-out of fuel more than 50 %.
All calculations Moscow, Russia was executed to the employees of institute «Kurchatov».
The transfer of the reactor WWR-SM INP of AS of Republic of Uzbekistan on usage FA of a type IRT-3Ì with fuel (UO2-Al) of 36 %-s' enrichments on U-235 was started in August, 1998 and is finished in February, 1999. Density of uranium in hearts these fuel elements - 2,7 g/c^3.
Calculations till definition of a temperature coefficient of a reactivity was executed Rakhmanov, together with ANL.
We have conducted research works till definition of radionuclides in water of the 1-st contour and gas.
In outcome have changed a mode of rise of reactor power.
In November, 2000 on the reactor the WWR-SM was started service life test 4-th FA of a type IRT-4M with enrichment 19,7 % on U-235.
In March 20, 2002 successfully have finished resource test FA of a type IRT-4M.
From January 14 till March 14 2002 Rakhmanov A. B. And Baytelesov S. A. together the employees ANL made calculations FA of a type IRT-3M from 9 % Mo density 5,4g/c^3, and weight of 375 g on U-235 and Pin-type fuel assemblers c 9 % Mo, made by Institute by him "Bochvar".
Comparing outcomes test IRT-4M, IRT-3M from 9 % Mo and Pin-type we hope to select optimum FA approaching on ours the reactor.

In future we wait manufacturing these and other FA and we hope on successful test it.

For secure maintenance of the reactor the definition radionuclides of a structure of different environments of the reactor is necessary: primary waters, water of storehouse for spent fuel, air in space above an active zone of the reactor. The information on air-tightness of fuel elements (fe) in an active zone of the reactor and in storehouse for spent fuel is very important also. The condition fe of an active zone can be evaluated ground definition of a specific activity of fission products of uranium -235 in heat carrier. The contents of radionuclides in water is determined by a radiometric way. However, the definition and identification of the contents of radionuclides is easy of volatile chemical units such as Iodum, the inert gases etc. are required(demanded) special chemical equipment and costs a lot of by(with) time for fulfilment of the analyses [1].

By us is developed high-performance, fast and idle time(simple) Method of the analysis of primary water and gas of air The reactor by application of modern radiometric
The installations of high resolution with By usage of the personal computer.

2. Path of a fission yield U-235 from fuel composition.

The fission yield from fuel composition in heat carrier can implement several paths:

- At the expense of recoil atoms at division from a surface of fuel,
  Contacting with heat carrier (Rot);
- At the expense of diffusion of fission products on a system of cavities and pores,
  Arising in fuel composition at processes of oxidation and corrosion (Rdf);
- At the expense of diffusion of fuel composition as a result of abrasive operation of heat carrier, oxidation and corrosion of uranium dioxide (Rrz).

Thus, the receipt(entry) in heat carrier of fission products at the expense of the main(basic) three set forth above processes will look like the following:

Rs = Rot + Rrz + Rdf = And ×l + B Ö l + C

Where: Rs - receipt(entry) in heat carrier of fission products;

Rot - fission yield from fuel composition in heat carrier at the expense of recoil atoms at division from a surface of fuel;

Rdf - fission yield from fuel composition in heat carrier at the expense of diffusion of fission products on a system of cavities and pores;

Rrz- a fission yield from fuel composition in heat carrier at the expense of diffusion of fuel composition;

And,, With - constants, which one are determined by an experimental way;

L- a disintegration constant of a concrete radionuclide.

The speed an output(exit) of a radionuclide from fuel composition is direct depends on constant decay(disintegration) of a concrete radionuclide.

The state estimation of an active zone of the reactor, is carried out(conducted) at measurement of activity of reference nuclides of heat carrier, after transformation(conversion) of value volumetric activity of reference nuclides by the way of normalized speeds of receipt(entry) of nuclides in heat carrier:

$$Ri = \frac{AI \times (l + nf + no + nu) \times V}{Ai}$$

Where: Ai - volumetric activity i of a nuclide in heat carrier, Ku/l;
V - Water volume in a contour of circulation, l;
l - Disintegration constant i nuclide, 1/with;
Nf - constant of clearing i nuclide on filter, 1/with;
No - constant of a deposition i of a nuclide on surfaces
Contour of circulation, 1/with;
Nu - constant of outflow(leakage) i of a nuclide from water in
reactor up space, 1/with.
A i - output(exit) i of a nuclide on division

3. Selection(sampling) sample and registration of geometry of measurements.

The sample of water (0,5-5,0 mls) depending on the induced(guided) activity is measured at a definite level (on an altitude) from the semiconducting detector.

For definition of the separate corrections, of efficiency of measurement of the semiconducting detector two drugs from Eu-152 were made. One of them is dried under an infrared(infra-red) lamp, the second target were measured by the way of solution. Both - dry and liquid drugs sequentially were measured on the radiometric installation in, identical,

Geometrical conditions. On value of a specific activity Eu - 152 in solution and dry drug have defined(determined) photoefficiency of the semiconducting detector.

The sanction of a spectrometer for energy g - radiation 1332 kB made 6.5 kB. Accuracy calibration on energy ¸ 4 kB (in 0 - 1500 kB).

4. Measurement of sample and definition of air-tightness FA.

For measurement of activity of sample have used the spectrometric device SU-01P, semiconducting detector DGDK-100, preamplifier and personal computer IBC-PC-386 of «Gold Star«, loaded by the program ÍÏÖ " Aspect, Angamma ".

After one-hour exposure (after strong reduction(decreasing) of oxygen activity, short life of radionuclides (Al-28, N-17 etc.) sample of water is on the semiconducting detector ÄÃÄÊ - 100 (Ge- the lithium detector), the spectrometric devices SU - 01P hooked up on high pressure(voltage, stresses) 2.06 kWs. At the organized spectrometric analysis determined a specific activity in heat carrier of following radionuclides: Kr - 85m, Kr - 87, Kr - 88, Xe - 135, Xe - 138, I - 132, I - 135, Rb - 88, Rb - 89, Sr - 92, Cs - 138, Ba - 139, Ba - 140, I - 131, I - 133, I - 135, Zr - 95, Nb - 95, Mo - 95, Ru - 103, Ce - 141, Ce - 143, Np - 239, Na - 24, Cs - 137.

From these radionuclides took most typical a fission product U-235 for of definition of relative air-tightness FA of an active zone.

In two hours after selection(sampling) sample of primary water we could define(determine) relative air-tightness FA of an active zone of the reactor, evaluating a relative output(exit) U - 235 in heat carrier. All measurements of the induced(guided) activity made in 3 stages(phases); 1 stage(phase) - through 60 min after selection(sampling) sample (that for this time had time(was in time) burn a number(series)

Nuclides with rather short half-life, 2 stages - in day, 3 stages(phases) in 7-10 day.

Knowing specific activities of primary water determined activity of all heat carrier on a nuclide under the formula:

$$N = N' V$$

Where: N - activity of water, Ku;

N ' - specific activity of water of Ku/l:

V - Water volume 1 - contour, l, V = 12460 liters (volume of a central reactor pot, primary piping and heat exchangers).

Knowing activity of a reference nuclide of a fission product U-235 determined equivalent weight U - 235 in heat carrier under the formula:

$$M = Ak\ 8.86\ 10\ T\ Ma\ [3]$$

Where: Ak - activity of a nuclide, Ku;

T - Half-life of a nuclide, sec;

Ma - mass number in grams.

The relevant problem at maintenance of the reactor is the definition and identification of the contents in gas media of light-end products of division U-235 and radioactive by-products of activation of air in reactor up space of an active zone of the reactor. The contents of light-end products of division U-235 in out gases is interdependent to activity of heat carrier of a primary loop and enables to conclude a condition of shells(envelopes) fe while in service of reactor.

For increase of sensitivity of measurements have used before to enrichment of sample of radioactive gas by an adsorption on absorbite at the temperature of of liquid nitrogen. As is known, the rare gases at the temperature of of liquid nitrogen will derivative crystallohydrates and are adsorbed on absorbite.

For definition of density of radioactive by-products of activation of inert gases and fission products U-235 in air above reactor of space of an active zone of the reactor above reactor air from flat space through a layer of absorbite at the temperature of liquid nitrogen. For measurement of activity of sample have used the spectrometric device SU-01P, semiconducting detector DGDK100, preamplifier and personal computer IBC-PC-386 of «Gold Star«, loaded by the program NPS " Aspect, Angamma ".

5. Results of measurements

Outcomes of the control of air-tightness of a shell(envelope) made 28.04.2001ã.

Outcomes of the control of air-tightness of a shell,(envelope,) of made,

With the help of the spectrometric equipment Inspector (Canberra)

The detector CLO515R

Sampling was made 28,04,2001. In 09-o'clock in the morning.

Measurement was made 28,04,2001. In 10-o'clock in the morning.

Нукл ид	5-4 **mCu/l**	6-4 **mCu/l**	3-5 **mCu/l**	2-4 **mCu/l**	4-4 **mCu/l**	5-2 **mCu/l**	5-5 **mCu/l**	4-5 **mCu/l**
Mo99	3e-07	-	3e-07	2.9e-07	-	2.8e-07	2.8e-07	2/9e-07
Tc99	3.4e-11	3.2e-11	3.6e-11	3.6e-11	-	3.4e-11	3.1e-11	3/2e-11
Ba133	4.8e-04	1.6e-05	3.9e-04	4.0e-04	-	3.6e-04		
Xe133	2.9e-04	4.5e-04	1.0e-04			1.0e-04		
Xe1352	2.9e-07	1.4e-08					2.1e-07	2.1e-07
Fe59					1.7e-10			
Pa231					2.9e-05			
Th131					1.4e-05			
I-131							2.2e-05	2.2e-05

Analysis of samples of water

Spectrometer INSPECTOR (CANBERRA)

detector CLO515R

Measurement was made 2-05-2001

Sampling was made 28-04-2

	Mo-99 **mCu/l**	Te=99 **mCu/l**	Xe-135 **mCu/l**	Ba-140 **mCu/l**	Ce-141 **mCu/l**	Ce-144 **mCu/l**			
5-4	2.2e-05	2.2e-14	2.6e-04	1,9e-07	1.1e-07				
5-2	2.0e-05	2.0e-14	2.5e-04	2.1e-07	1.0e-07				
4-4	1.0e-05	2.1e-15	-		1.3e-07				
4-5	1.1e-05	2.6e-15		1.8e-07	1.2e-07	1.2e-05			
4-7	8.7e-04	2.0e-15		1.7e-07					
2-4	8.4e-04	2.1e-15			1.2e-07				
3-5	1.1e-05	3.4e-15		2.9e-07	7.9e-06	1.0e-05			
5-5	2.6e-05	2.8e-14		2.7e-07	9.6e-06				

Analysis of samples of water

Measurement was made 1-05-2001

Sampling was made 28-04-2001

	2-4 Cu/л	**3-5 Cu/л**	**4-4 Cu/л**	**4-5 Cu/л**	**4-7 Cu/л**	**5-2 Cu/л**	**5-4 Cu/л**	**5-5 Cu/л**
Ba-140	2.7e-06	2.4e-06	3.5e-06	5.3e-07	2.6e-06	1.7e-06	1.8e-06	4.6e-06
Ce-141	8.0e-07	1.5e-06	2.1e-06	1.oe-06	8.5e-06		1.1e-06	2.8e-06
I-131	8.0e-06	9.3e-06	7.9e-06	8.5e-06	1.2e-05	8.0e-06	9.2e-06	8.1e-06
Zr-95	1.4e-06	1.2e-06	1.5e-06	1.3e-06	1.6e-06	1.2e-06		1.6e-06
Sm-153	1.2e-05	1.2e-05	1.1e-05	1.1e-05	1.3e-05	1.1e-05		
Np-239	4.9e-06	5.0t-06	5.4e-06	5.8e-06	6.4e-06	7.2e-06	6.4e-06	3.oe-05

Ru-103	7.7e-07	7.4e-06	7.5e-07	7.4e-07	7.0e-07	7.4e-07		8.2e-07
Te-132	7.9e-07	7.0e-07	8.4e-07	8.1e-07	8.6e-07	6.9e-07	7.7e-06	4.0e-08
Kr-85m		6.7e-08	5.9e-08	4.9e-08	5.4e-08	6.3e-07	6.3e-08	7.9e-08
I-130	3.7e-08	5.0e-07	3.7e-08	7.7e-07	1.6e-07	6.2e-07		7.9e-08
I-133	1.8e-06	1.6e-06	1.9e-06	2.5e-06	2.6e-06	1.6e-06		1.5e-06

6. Utilized literature.

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