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INFORMATION REPORT INFORMATION REPORT

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INFORMATION REPORT INFORMATION REPORT

INSTALLATIONS

Atomic Power Station

1. There was in operation a uranium nuclear reactor which furnished electric power to an electric network. This reactor was under the auspices of the Academy of Sciences of the USSR. It was an experimental reactor. The electricity generated was still very expensive, but this was apparently the first successful attempt at a nuclear reactor to generate a significant amount of electrical energy.

2. The reactor was located to the south of Moscow in Obninskoye, a railroad stop on the Kishinëv—Moscow (sic) line, 110 kilometers from Moscow. The delegates went there by automobile, most of the way on the big highway from Moscow to the Crimea, and then 120 (sic) kilometers on a side road to Obninskoye. The reactor was near the Pravda River, from which water was taken and again discharged. 50X1-HUM

3. The experimental reactor was under the supreme leadership of Prof. Blokhintsev, member of the Academy. Of course, the immediate control on everyday matters was in the hands of the plant engineer. Prof. Blokhintsev, a theoretical physicist, was probably in charge of the nuclear physics aspect.

4. The reactor proper was a uranium reactor moderated by graphite and was of the cylindrical type. There were 130 rods containing uranium, while the reactor contained 17 tons of graphite. Because of the complex structure of the rods, as indicated below, it would hardly be correct to speak of "uranium rods." In the rods, besides uranium and graphite, there were stainless steel and ordinary water. The uranium was also strongly enriched; it contained five percent U-235. Thus the total amount of uranium in the reactor was 500 kilograms, containing 25 kilograms of U-235. The rods held the uranium inside, which was cooled by water streaming through rapidly. The rods were coated with graphite and fitted into the cylindrical graphite moderator block. The rods were really pipes 6.5 meters long. The uranium was in the lowest two meters, or perhaps one and one-half meters, of the pipes. The expert who guided the delegates around the power station said that he did not know how the pipes looked inside; the rods (or pipes) were received from elsewhere ready for use. The uranium was coated with stainless steel, and outside that again coated with graphite.

5. The reactor was built into the ground and was screened from outside by a biological screen of one meter of water, directly connected to the reactor, followed by three meters of concrete.

6. The control rods were of boron carbide. They were 18 in number and were set vertically. Each control rod could absorb 10^{-5}, expressed in Keff. = 1 (sic). The shutoff rods (two, source thought) were also of boron carbide and could each absorb ten percent of the reactivity. There were a couple of canals or channels for taking measurements, but there were very few of them, for the real purpose of this reactor was the production of energy. 50X1-HUM

7. The cooling water of the primary water system came in from above, streamed downward, and again upward. Figure 1 gives a possible construction:

Figure 1

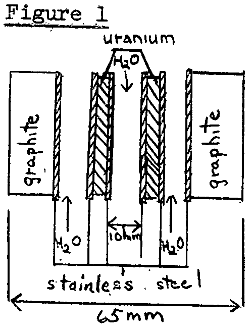
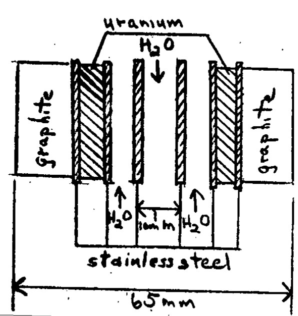


Figure 2

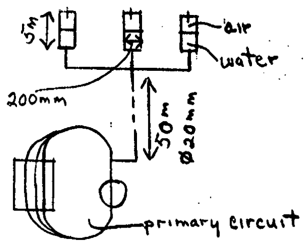


8. [redacted] 50X1-HUM the width of the water channel was 15 millimeters. The innermost water channel, for the downward streaming water, was 10 millimeters wide. The uranium, in any case, was in a ring or cylinder acting as a water channel, and on both sides it was equipped with stainless steel. Whether it was cooled on both sides or only on one side was not wholly clear. [redacted] 50X1-HUM

9. <u>The primary water system</u>. The cooling water which streamed through the reactor tubes or pipes was under a pressure of 100 atmospheres. [redacted] 50X1-HUM the boiling point of water was then 390°. This, however, is incorrect, since the boiling point is 312°C or about 590°F. 50X1-HUM In any case, in the primary circuit the water remained below the boiling point at 100 atmospheres. The cooling water entered the reactor tubes at a temperature of 190°C, and left at a temperature of 260° to 270°C.

10. The pressure was built up by means of air balloons, with everything in stainless steel, as indicated in figure 3.

<u>Figure 3</u>



To prevent dissolving and the inward diffusion of light, there was a diaphragm with a very small surface in the space between the "air cushions" and the water surface of the air balloons. [redacted] 50X1-HUM [redacted] this was intended to be a kind of floater, which could go back and forth on the surface of the water and which allowed little direct contact between water and air. 50X1-HUM The air balloons were kept even farther away from the rapidly circulating primary water system by means of a long narrow pipe. The air cushions of the air balloons were in direct contact with 2.5 cubic meters of air at 100 atmospheres. There seemed to be two of these pressure-giving systems, one at work and one in reserve.

11. There was a great deal in reserve. The primary water was driven around by two centrifugal pumps of stainless steel, while there were two others in reserve. The water in the primary system took eight seconds to make the circuit.

12. <u>The secondary water system</u>. The heat of the primary system was developed in steam generators, in which a secondary water system generated steam of 250°C and 12.5 atmospheres. The boiling point at 12.5 atmospheres is about 190°C; thus, really superheated steam was produced. In the secondary system, which was made up of ordinary steel and was not radioactive, there were 300 tons of water. Working at full steam, 42 tons of steam an hour were developed. The steam was conveyed to steam turbines in a nearby building, etc. After condensation, the water was again sent back into the secondary system.

13. When working, each reactor tube or pipe was separately supplied with water from the primary water system, and two cubic meters of water per hour streamed through each reactor pipe. It is essential that the primary water going out of each pipe have the same temperature. Each pipe, there, was controlled independently. The tolerances lay between 1.6 and 2.4 cubic meters per hour. If one of the flow tolerances on even one of the pipes was under-working or overworking, the boron carbide pipes went to work, and the reactor was automatically shut off. These shutoff rods could each take up ten percent of the reactivity. [redacted] 50X1-HUM

14. At full speed, the flux was 5×10^{13} neutrons per square centimeter per second. Thirty thousand kilowatts of heat were generated. There was 18 percent output

in the conversion into electric energy. After deduction of the consumption of energy of the operation itself, a net of 5,000 kilowatts of electric power was available.

15. There was a second generator in the generator room which worked on gas, so that they could stop the reactor from working at any time without cutting off the supply of electricity to the network. Eventually every nuclear reactor power station is to have at least two reactors. [redacted] 50X1-HUM [redacted] the reactor was working at 55 percent of its capacity. The temperature of the uranium remained below 500°C. In the graphite of the moderator, the temperature can go up to 700°C. 50X1-HUM

16. After 100 days (full steam?) the uranium pipes have to be removed. Then the reactor is shut off, and they wait two days until the worst radioactivity has disappeared. Then they can lift the pipes out with large cranes, and can store them in a room which was underground and was shielded from above by 250 millimeters of steel, under which there were eight meters of water.

[redacted] 50X1-HUM

17. Controls. Each room was checked constantly for radioactivity, which was done centrally by ionization chambers. The maximum level permitted was 1.8 microroentgens per second. The change of air was such that each room or compartment had completely fresh air 20 to 25 times per hour. The waste was carried off by a smokestack 100 meters high.

18. The speed of the primary water. The surface of the section of the pipe going down the center of each reactor tube was about 0.75 square centimeter. Since two cubic meters of water per hour were driven through, the linear speed of the water was about eight meters per second. This would be true for stainless steel; for aluminum the maximum safe speed would be seven meters per second.

19. The thickness of the uranium layer. In each pipe there were about 200 cubic centimeters of uranium. If the height of the uranium layer was two meters, this would mean one cubic centimeter of uranium per running centimeter of tube. In the reconstruction in figure 1 above, there would be a thickness of about 2.8 millimeters, and in figure 2 about 2.5 millimeters of uranium.

20. If there was a coherent layer of uranium, then the uranium must have been rolled into a small strip about 2.8 or 2.5 millimeters thick, which had then been wrapped in a spiral form around a stainless steel cylinder. Lengthwise there was no need for any great amount of cohesion between the uranium and the stainless steel. It would be effective, if the leading contact between the uranium and both the surrounding steel cylinders was good. Then there could have been uranium pellets between the steel cylinders, and there might even have been a similar profile rolling of a somewhat wider system of two concentric steel cylinders filled with uranium pellets of a good thickness. Then they could even use UO_2 or other uranium compounds.

21. In this design, bursting or rupturing in a vertical direction along the length of the pipe would not be so serious. Perhaps this was the way in which they obtained such a high number of megawatt/days. At full speed, they got 30,000 kilowatts of heat. The reactor held one-half ton of uranium. If the pipes or tubes went for 100 days at full speed, the output was 6,000 megawatt/days per ton of uranium. [redacted] this is very high. 50X1-HUM

22. The thickness of the graphite coating. Suppose the thickness of the stainless steel cylinders was 0.8 millimeter each. This could be true, for at 100 atmospheres and 270°C a thickness of 0.6 millimeter would be necessary, based

on two-thirds of the fluid limit. Then, according to both figure 1 and figure 2 above, the graphite coating of the pipes would be about 24 millimeters thick. When the pipes are changed, this graphite, which suffers the most through radiation, must be changed at the same time.

22. Uranium costs. Five hundred kilograms of non-enriched uranium would cost nearly $31,000. There were, however, 25 kilograms of U-235 in the reactor. Putting the price at $20.00 per gram, the cost of U-235 would come to about $500,000. Replaced every hundred days this would amount to a yearly cost of approximately $1,750,000. It may be assumed that there is a supply of uranium of this price. [redacted] 50X1-HUM [redacted] there was a full lot in the reactor, a used set of rods in the ground, and a reserve lot along the wall. The maintenance of a full supply depended only on the speed of operation in the factory producing the uranium rods. 50X1-HUM

23. Degree of enrichment. The strength of enrichment with five percent U-235 was necessary because of the mass of stainless steel and ordinary water.

24. [redacted] 50X1-HUM It was clear, however, that after 100 days of the power station reaction at top speed, they must have used a quantity of nuclear fuel amounting to about three kilograms of U-235. 50X1-HUM

Synchro-cyclotron near Moscow

25. The synchro-cyclotron of the Academy of Sciences of the USSR has been in operation since 1949. It was situated on the Volga at the place where the Moscow canal entered the river (125 kilometers northeast of Moscow). [redacted] 50X1-HUM A very large artificial lake was created, which served to feed the Moscow canal, where the large power station worked. There was insufficient water power closer to Moscow.

26. [redacted] 50X1-HUM The institute was one of many belonging to the Academy of Sciences, and had as its aim the study of physics of particles of very high energy (protons, deuterons, neutrons, positive and negative mesons). The dispersal of neutrons by neutrons was studied by Gillipov, the dispersal of neutrons and pi-mesons by Kasadayev [redacted] 50X1-HUM

27. The diameter of the machine was six meters. The magnets of 7,000 tons were not made of cobalt steel but of "steel III". The magnet nuclei were cooled with air, which in its turn was cooled by water. The current in the magnetic poles was 5,000 amperes, the capacity 1,000 kilowatts. The field was 17,000 gauss (at the edges 15,000). The distance between the termini was 60 centimeters in the center and 40 centimeters at the edge. There were 50 to 70 impulses per second.

28. They used ordinary ion sources with low pressure, such as W-filament, graphite bars, etc. They got 10^{10} protons per square centimeter per second at the source. With protons they obtained 680 Mev (current of 0.3 to 0.4 microampere). With neutrons they obtained 500 Mev, and with negative mesons between 140 and 400 Mev. When the machine was in operation, no one was around; the screen to the measuring rooms consisted of a wall of reinforced concrete six meters thick.

29. [redacted] 50X1-HUM The length of life of the mesons was 10^{-15} second; they then gave gamma radiation. Be was bombarded for negative mesons, and Cu for positive mesons. [redacted] 50X1-HUM

30. There was a great deal of room for mounting experimental apparatus, and many experiments could be carried on at the same time. Two simultaneous measurements could be made at the same time. In particular, besides Wilson cameras, they worked there with bell formations in liquids, which were suddenly released to a pressure below the boiling point (Glaser vessel). [redacted] 50X1-HUM Various examples of this type of improved indicator instruments were being tried. They had a 12-channel gamma-spectrometer.

Heavy Water Reactor near Moscow

31. About 25 to 30 kilometers to the west (sic) of Moscow, there was a physics institute of the Academy of Sciences, in which there was a heavy water moderated reactor.[4]

32. The reactor contained four and one-half cubic meters of D_2O. This D_2O was twice distilled; there was no extra water purification. Above the D_2O was helium which was regularly purified through a Pd catalyzer and a condenser of D_2 and O_2. There was, thanks to very pure D_2O and He, little anatomizing, and the recombination of D_2O, therefore, amounted to only a few milliliters per hour.

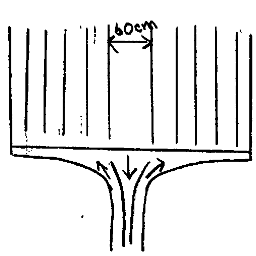
33. The graphite reflector was kept under vacuum. Thus, they had a good leak detector, since they had no barometric effect.

34. The capacity of the circulation pumps was 21 cubic meters per hour. The loss in D_2O with the pump was ten milliliters per day, which was not serious--they had enough D_2O. The heat exchanger was of stainless steel. The D_2O streamed into the inner pipes, where it was cooled from 70°C to 50°C. The Cd-control plates could take up four percent of the reactivity. [redacted] The switch-off plates were removed; the switching off was then done by lowering the D_2O level. 50X1-HUM

35. There were 2.1 tons of natural uranium in the reactor, in the form of solid bars 22 millimeters in diameter coated with 0.8 millimeters of anodic oxydized aluminum. There was a total of 250 bars 1.60 meters long in a square lattice with nine centimeters between bars. The diameter of the tank was 1.75 meters, the thickness of the wall of the tank was three millimeters of aluminum.

36. In the center of the reactor there were no bars, but rather a cylinder with a diameter of 60 centimeters. There they had space for experimentation with two thermo-columns. The thermic neutron flux in the center was 2.5×10^{12} neutrons per square centimeter per second; the energy level was 400 to 600 kilowatts. There were no canals (channels) through the tank; four canals went up to the tank and four up to the reflector. The reflector consisted of one-meter-thick graphite.

37. The reactor has been working since 1949, and the uranium bars have been replaced twice. The top cover was revolving and was registered on a model, where the bar numbers were recorded. The D_2O was brought in from below and was also pumped back as indicated in the following sketch:



38. The Soviets at this institute were carrying on the following experiments, among others:

   a. "Cross section" of o- and p-deuterium
   b. "Neutron chopper"
   c. Spectrometer for gamma-quanta.

Cyclotron of 14 Mev in Moscow

39. There was a cyclotron of 14 Mev in Moscow. This instrument had a diameter of 1.20 meters and a magnetic field of 13,000 gauss. The vacuum was 3×10^{-6} mm Hg., the "separating time" four microseconds, the "inlet" 80 kilovolts. [redacted] there was another synchrotron outside Moscow, and one in Leningrad as well. 50X1-HUM

Institute of Physical Chemistry of the Academy of Sciences [redacted] 50X1-HUM

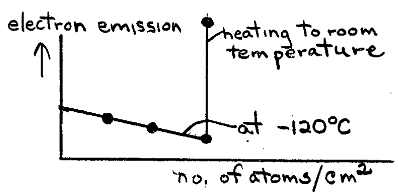
40. In Dubinin's section, they were studying the adsorption of mixtures of gasses on silica gel and carbon. In the multimolecular field, in the presence of one component sometimes more of another component can be adsorbed. This is not the case in the unimolecular field.

41. The adsorption of heat was measured calorimetrically. With a Pt-resistance thermometer they could measure to 2×10^{-5} degrees Centigrade. In a quartz torsion balance they could weigh one gram with an accuracy of 10^{-8} gram. Also on 100 square centimeters of gold film, a complete isotherm could be taken.

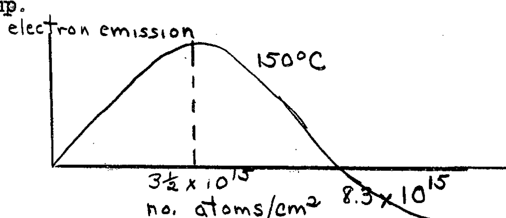
42. For measurements at a lower temperature, they had a cryostat with a constancy of 5×10^{-3} degrees Centigrade. Heat insulation was accomplished by polystyrene foam rings, heat circulation by a bakelite isolation piece between copper rods in a cooler (sic) and to cool the frame (sic). By wrapping in Pt while heating it for use, the cold current was compensated.

43. The Soviet electron microscope UEM 100 (100 kv) gave a resolving power of 30 Å. There was very fine absorption, and it was also stereoscopic.

44. Frumkin was making oxide plating in a vacuum, and was measuring electron emission and then electrochemical properties in the same plating. When at room temperature, O_2 was adsorbed on Fe to a thickness of one monolayer (1.51×10^{15} atm./cm actual surface); then the layer was more active than normal. If adsorbed at -120°C, the electronic emission in that condition was lower than normal; if it was warmed to room temperature, the layer was more active.



45. With more O_2 at room temperature, more deactivation occurred. At a higher temperature, still more O_2 was needed for deactivation. Electron emission at 150°C gave a maximum at 3.5×10^{15} atom. O/cm^2. They measured with an accuracy to 10^{-8} Amp.



46. An iron plate of 0.1 mm was between two containers. In one container there was acid, and in the other an alkaline solution. In a polarized alkaline solution almost no H appeared on the plate. In the acid solution much H showed up on the plate, and thus the H_2 formed on the alkaline side! If much H was permitted to go to the acid side, then there was a decrease of the span (sic) on the alkaline side. The same result was obtained by letting H enter from gas (discharge in H_2 + Ne; Ne-pressure 7 mm, thus higher than PH_2O).

47. Roginskiy's impression was that the surfaces of technical catalyzers are "biographically" heterogeneous. In his laboratory it was possible to see the atom going back and forth in the "field emission" of tungsten globules in H_2.

48. Deryagin was measuring the working force between plates at a distance. At distances important in colloid chemistry, the law $1/r^3$ (London, etc.) no longer holds true, but rather smaller forces. The theory of Casimir and Polder gave this already, but this was very well explained by the Russian Lifshits. At Deryagin's laboratory, they were also measuring the pressure resistance of films of surface active matter.

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