

# The Chernobyl Accident

April, 26, 1986 (Saturday)

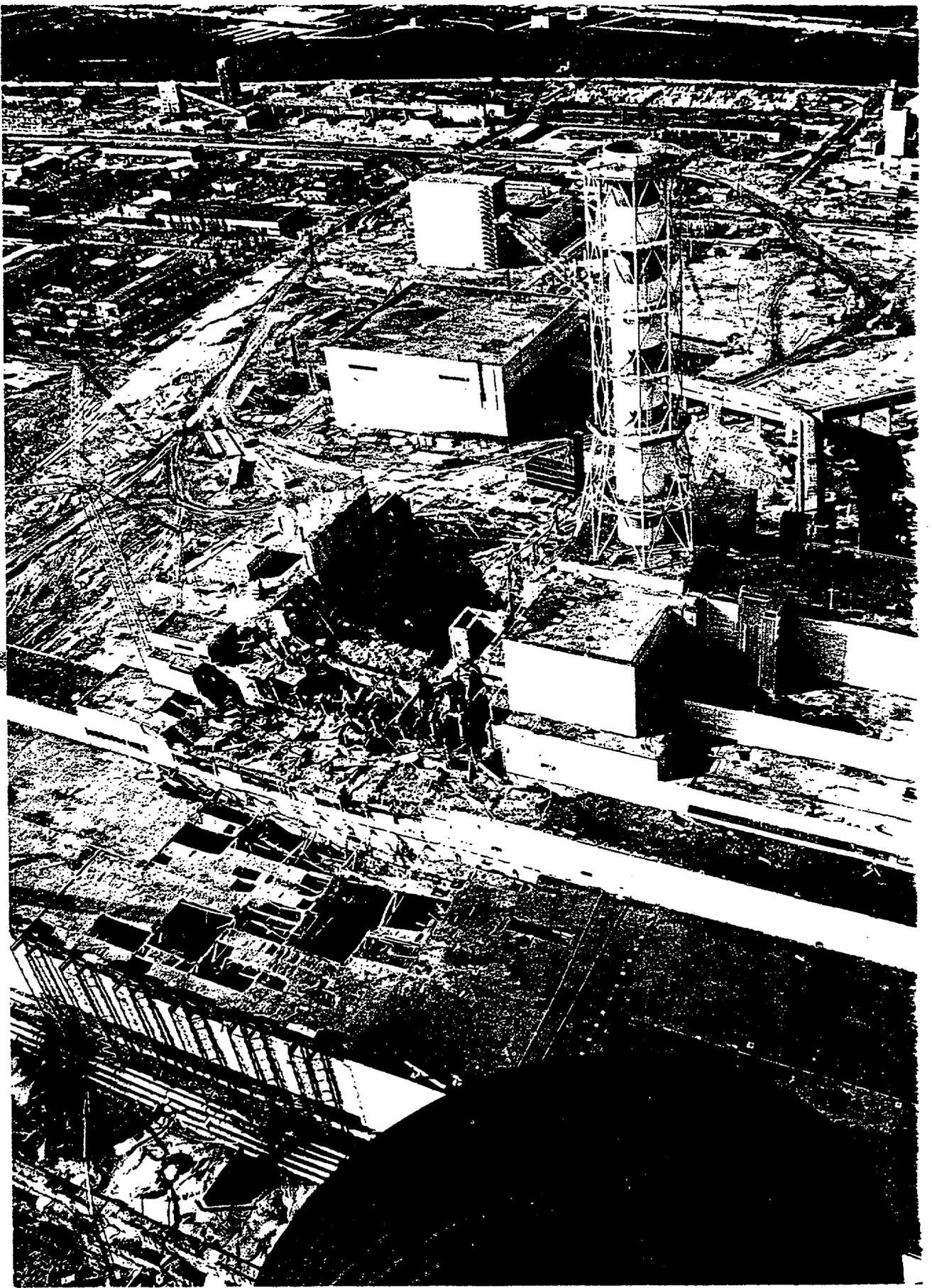
At 1.23.40 a.m. the head of the unit crew gave the order to extraordinary shutdown of the unit. But as a result of the above-mentioned number of reasons in parallel with the flaw of the control rods contributed significantly to the reactivity, the reactor power increased hundred times without any control.

It caused the abrupt increase of the temperature up to  $6000^{\circ}\text{C}$  and pressure up to 500atm, segregation of the fuel and heat explosion, which damaged the reactor and part of the plant building involving the escape of radioactive substances to the atmosphere. Thus, according to the reports of different witness who were outside of the forth unit, since about 1.24 a.m. two explosions rang out, the burning pieces and sparks flow up upon the unit. Half of them fell down on the shelter of the turbine hall and caused the fire.

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## THE CHERNOBYL ACCIDENT

Nuclear Society International  
Moscow, 1993



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(accompanying text to the slides)

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of the unit finally caused the accident. As a result of a series of violating the operating conditions by the staff of the fourth unit (only the number of the most dangerous mistakes reached six) the reactor was put into its most unstable state and its emergency protecting system intended for extraordinary terminating of the reaction had failed. As for the authors of the project, they hadn't considered the special measures for prevention of the accident having such number of deliberate violations, because such situation was accepted as unlikely. The available flaws of emergency protecting system should be mentioned also.

So, how did the events run during carrying out the test (slide N6)? According to the program the test should be carried out at the power level 700-100 MW (heat), because the continuous work at the lower level is forbidden because of arising instability in reactor's work.

In the 25th of April at 1.00 a.m. (slide N6, position N1) the staff began to decrease the power from the rating (3200MW) and at 1.05 p.m. (slide N6, position N2) its ratio reached 1600 mW. After that the turbo-generator N7 was turned off. At 2.00 p.m. according to the program of the test the emergency cooling system was turned off. Soon the controller from the "Kievenergo" sent a ban for further decreasing of the power because of the demands for electric energy, which was canceled nine hours after (slide N6, position N3).

As power decreased again at 0.28 a.m. on the 26th of April it was demanded to change over the regulating regime of the reactor. But, as a result of the operator's mistake, the power's level drastically decreased to 30MW (slide N6, position N4). In such situation the accumulation of xenon<sup>135</sup> with strong absorption of neutrons in the core takes place. This results in the so-called poisoning of the reactor ending the decrease of reactivity (the ability to the chain reaction). According to the instructions, in this situation the reactor should be shut down and it meant cessation of the test. The staff didn't go to it and decided to increase the power.

At 1.00 a.m. it had been gained to keep the power at the level of 200MW instead of necessary 700-1000MW (slide N6, position N5). As a result of removing the control rods for compensation of the poisoning the so-called efficient margin of reactivity providing the ability of the safe shutdown of the reactor became much lower than acceptable. In other words, the reactor became badly controlled, and its acceleration ability (increasing the power out of control) became

much more than the ability of the control reactor. In spite of all contra-indications the test.

According to the instructions at 1. alternates main circulation pumps were working ones (slide N6, position N6) unstable. under these conditions the staff in order to keep the reactor operating over they gained to keep stable process to start the test. At 1.23.04 a.m. the stop N8 were closed, and the steam supply (slide N6, position N7). In spite of the the emergency systems with turning off repeating the test with turning off the required.

As four pumps linked to the generator N8 began to retard revolution reduced and the boiling/enhanced. In the positive steam reactivity coefficient reactivity), the reactor power began to a.m. (slide N6, position N8).

At 1.23.40 a.m. the head of the extraordinary shutdown of the unit. mentioned number of reasons in para rods contributed significantly to the increased hundred times without any cause. It caused the abrupt increase of the pressure up to 500atm, segregation which damaged the reactor and part of escape of radioactive substances to the reports of different witness who were about 1.24 a.m. two explosions rang sparks/flew up upon the unit. Half of the turbine hall and caused the fire.

#### THE MEASURES TO MITIGATE THE CONSEQUENCES

The first major problem after the result of explosion in the reactor (s

the accident. As a result of a series of errors by the staff of the fourth unit (only the gross mistakes reached six) the reactor was started and its emergency protecting system terminating of the reaction had failed. As a result, they hadn't considered the special nature of the accident having such number of errors. Such a situation was accepted as unlikely. The emergency protecting system should be

started during carrying out the test (slide 6, position 1) the test should be carried out at the start (heat), because the continuous work at the start because of arising instability in reactor's

At 1.00 a.m. (slide N6, position N1) the staff started from the rating (3200MW) and at 1.05 (2) its ratio reached 1600 mW. After that the reactor was turned off. At 2.00 p.m. according to the emergency cooling system was turned off. Soon "Energo" sent a ban for further decreasing the demands for electric energy, which was (slide N6, position N3).

At 0.28 a.m. on the 26th of April it was the regulating regime of the reactor. But, as a result of a mistake, the power's level drastically (slide N6, position N4). In such situation the reactor with strong absorption of neutrons in the units in the so-called poisoning of the reactor activity (the ability to the chain reaction). In this situation the reactor should be stopped. The staff didn't go to it and were

unable to gain to keep the power at the level of about 700-1000MW (slide N6, position N5). The control rods for compensation of the sufficient margin of reactivity providing the safety of the reactor became much lower than that, the reactor became badly controlled, and increasing the power out of control) became

much more than the ability of the control rod system to muffle the reactor. In spite of all contra-indications, the staff decided to carry out the test.

According to the instructions at 1.03 a.m. and 1.07 a.m. the two alternate main circulation pumps were turned on in addition to six working ones (slide N6, position N6). After that the reactor run unstable. Under these conditions the staff disabled the safety systems in order to keep the reactor operating. After a number of changes they gained to keep stable processes in the reactor and decided to start the test. At 1.23.04 a.m. the stop valves of the turbo-generator N8 were closed, and the steam supply of the turbine was stopped (slide N6, position N7). In spite of the instructions, the staff blocked the emergency systems with turning off both turbines in the hope of repeating the test with turning off the turbo-generator as might be required.

As four pumps linked to the feeding bus-bar of the turbo-generator N8 began to retard revolutions, a flow of water in the reactor reduced and the boiling enhanced. In so far as the RBMK reactor has the positive steam reactivity coefficient (the more steam, the higher reactivity), the reactor power began to increase slowly since 1.23.30 a.m. (slide N6, position N8).

At 1.23.40 a.m. the head of the unit crew gave the order to extraordinary shutdown of the unit. But as a result of the above-mentioned number of reasons in parallel with the flaw of the control rods contributed significantly to the reactivity, the reactor power increased hundred times without any control (slide N6, position N9). It caused the abrupt increase of the temperature up to 6000°C and pressure up to 500atm, segregation of the fuel and heat explosion, which damaged the reactor and part of the plant building involving the escape of radioactive substances to the atmosphere. Thus, according to the reports of different witnesses who were outside of the fourth unit, since about 1.24 a.m. two explosions rang out, the burning pieces and sparks flew up upon the unit. Half of them fell down on the shelter of the turbine hall and caused the fire.

#### THE MEASURES TO MITIGATE THE ACCIDENT'S CONSEQUENCES

The first major problem after the accident was fire control. As a result of explosion in the reactor (slide N7) and emission of the