

## **The Chernobyl Nuclear Power Plant disaster**

**Date of the disaster:** April 25<sup>th</sup> 1986

### **Background information**

The Chernobyl power plant was a symbol of the industrial and technological power of the Soviet Union; providing electricity to two million people in Kiev. There were huge benefits in nuclear power production; 1kg of Uranium produced the same energy as 3million kg of coal.

Chernobyl had four reactors running at the same time. Reactor four was the newest of the reactors, being a mere three years old.

### **Who was involved?**

On the date of the disaster Boris Stoliarchuk was the water pump operator. Boris was young, loved his job and was proud to be operating the equipment in the plant.

Yuri Korneev operated the turbines that generated the electricity. This was his dream job since graduation.

Leonid Toptunov was responsible for the operation of the reactor. He was 27 years old.

### **How the plant should work**

Uranium rods are used to produce heat in the core. The amount of energy produced by the Uranium is controlled using control rods that can be raised/lowered to increase/decrease energy production. Heat in the core can be increased by raising the controls rods and decreased by lowering the control rods. Water passes around the core to cool the reactor and produces steam that drives the turbines that produce electricity. If there is not enough steam the turbines can stop which doesn't provide the electricity to power the water pumps. This can increase the heat in the core very quickly because the water is not acting as a coolant. Therefore there needs to be enough steam produced (from the water being heated around the core) to turn the turbines (to generate the electricity for use and the water pumps) but enough water to keep the reactor cool.

### **Incident overview**

The operators (Toptunov, Stoliarchuk and Korneev) arrived thirty minutes early for their shift to examine the equipment and readings from the previous shift. They were surprised to hear that their supervisors had told them to complete a safety drill. The scheduled drill was planned to see if the plant could run until a back-up generator was deployed in an emergency if the turbines were not producing electricity and the water pumps weren't cooling the core.

At 12:00am the night shift began, five minutes later they began to prepare for the test. Toptunov began to reduce the power in the core and everything went to plan for the first twenty minutes. At 12:28am the power levels dropped suddenly and Toptunov increased the power in the core which fixed the problem. At 01:00am Toptunov thought the reactor was stable so preparations continued for the safety drill.

Stoliarchuk then turned on two auxillary water pumps (which divert water from other areas of the plant in the case of an emergency) but the water was pumped around the reactor too quickly. This meant that not enough steam was produced to drive the turbines. Toptunov thought he could help the situation by increasing the power in the reactor and this worked. The operators at this point thought that they had the situation under control. Korneev got a call that the preparations for the test were complete and everything appeared normal.

At 01:23am the operator turned down the turbines signifying the beginning of the test. Toptunov saw the temperature of the core increase as the pressure in the reactor neared critical level. The operators realised that they were no longer in control of the reactor and Toptunov pressed the emergency shutdown button. However, there was no shut down and the heat continued to rise to 100x the normal level. The extreme heat began to destroy the core.

At 01:24am there was an explosion that blew the roof off the reactor and 8 tonnes of highly radioactive fuel was released in to the night sky. Four minutes later the first fire fighters arrived without protection, unaware that they were receiving lethal doses of radiation. At 05:00am the flames were extinguished but 31 of the 69 fire fighters had lost their lives. The plant was still leaking radiation but the government reacted with silence, trying to hide the disaster. It took 36 hours for the people of the small neighbouring town of Pripyat (where most of Chernobyl workers and their families lived) to receive news of an explosion at the nuclear power plant. They were evacuated as a result of the radiation.

Countries around the world began to notice an increase in radiation levels. A US satellite had picked up images of the explosion and in Sweden nuclear power plant workers were able to track the radiation source back to the Soviet Union. The radiation spread as far as the USA and Japan and the government could no longer deny the disaster.

### **Contributory factors in the Chernobyl disaster**

The design of reactor 4 meant that it was vulnerable to getting very hot very quickly. The senior officials were aware of this design flaw.

The safety test had been scheduled to be completed in the day when more senior engineers were on duty. However, this would have meant shutting down the reactor disrupting the Kiev power supply. Therefore the test was postponed until the night because this was when electricity demand was at its lowest but by this time the senior engineers had gone home. The engineers on duty were fully qualified but did not have much experience.

### **More detailed explanation of the sequence of events on the night of the disaster**

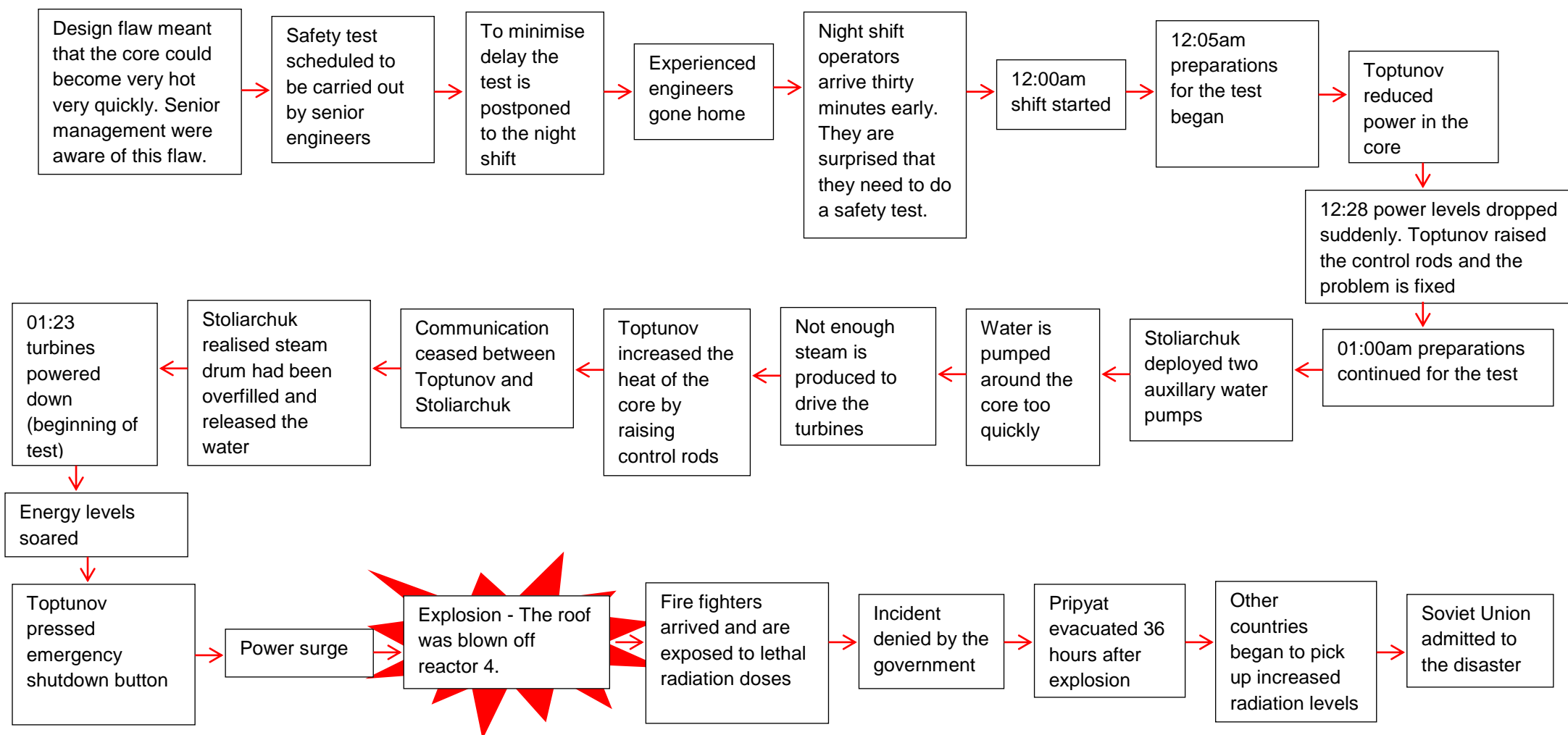
1. Toptunov powered down the core (there were 211 control rods in reactor 4)
2. The power level dropped too low too fast so Toptunov increased power by raising/reducing the number of control rods. This solved the problem.
3. Stoliarchuk altered the water flow around the pump by deploying the auxillary pumps. However, he did this too quickly and not enough steam was produced.
4. Stoliarchuk pumped water in to a steam drum where water and steam levels can be monitored, but too much water was allowed in to the steam drum, and still too little steam was being produced.

5. Toptunov responded by reducing the number of control rods. The minimum number of control rods you can have in the core is 26 but Toptunov removed all but six to increase the heat in the core.
6. At this point the test continued even though there were only six control rods in the core. Only the water surrounding the core could halt the heating.
7. Communication ceased between the two operators (Stoliarchuk and Toptunov)
8. Stoliarchuk realised there was too much water in the steam drum and cut the water supply not taking in to consideration the small number of control rods in the core.
9. The reactor became seriously overheated
10. Turbine operator got the go ahead to start the test
11. Energy levels soared
12. Toptunov attempted to shut the reactor down but this caused a power surge and an explosion ensued.

### **Information sources**

The information in this document was sourced from the National Geographic 'Seconds from Disaster' television series.

## What happened?



## What NTS contributed to the accident?

STAGE		SUB-SKILL	WHO DISPLAYED THE NTS	NOTES
OBSERVE	1.1	Attention to detail	All	Stoliarchuk pumped water around the core too quickly. Totunov raised too many control rods too quickly.
	1.2	Overall awareness	All	Both operators thought that the reactor was stable.
	1.3	Maintain concentration		
	2.1	Systematic & thorough approach		
	2.2	Checking	All	Communication ceased so Stoliarchuk and Toptunov were not checking what one another were doing.
	3.1	Listening		
UNDERSTAND (KNOWLEDGE)	1.2	Overall awareness	All	Both operators thought that the reactor was stable.
	1.4	Retain information		
	1.5	Anticipation of risk	Toptunov	Toptunov failed to anticipate the risk of raising all bar six control rods.
	4.1	Effective decisions	All	Toptunov made an ineffective decision when he raised all bar six control rods and when he pressed the emergency shutdown button. Stoliarchuk made an ineffective decision to reduce the water level in the steam drum but originally made an effective decision to use it.
	4.2	Timely decisions	All	Toptunov made an untimely decision to press the emergency shutdown button. Stoliarchuk made an untimely decision to reduce the water level in the steam drum.
	4.3	Diagnosing & solving problems	All	Stoliarchuk did fill the steam drum. Toptunov raised too many control rods.
DECIDE	4.1	Effective decisions	All	Toptunov made an ineffective decision when he raised all bar six control rods and when he pressed the emergency shutdown button. Stoliarchuk made an ineffective decision to reduce the water level in the steam drum but originally made an effective decision to use it.
	4.2	Timely decisions	All	Toptunov made an untimely decision to press the emergency shutdown button. Stoliarchuk made an untimely decision to reduce the water level in the steam drum.

	4.3	Diagnosing and solving problems	All	Stoliarchuk did fill the steam drum. Toptunov raised too many control rods.
	2.3	Positive attitude to rules & procedures	Toptunov	Raised too many control rods (more than the minimum specified).
	3.4	Sharing information	All	The communication between Stoliarchuk and Toptunov ceased.
	5.1	Considering others' needs		
	5.2	Supporting others		
ACT	4.1	Effective decisions	All	Toptunov made an ineffective decision when he raised all bar six control rods and when he pressed the emergency shutdown button.  Stoliarchuk made an ineffective decision to reduce the water level in the steam drum but originally made an effective decision to use it.
	4.2	Timely decisions	All	Toptunov made an untimely decision to press the emergency shutdown button.  Stoliarchuk made an untimely decision to reduce the water level in the steam drum.
	4.3	Diagnosing & solving problems	All	Stoliarchuk did fill the steam drum. Toptunov raised too many control rods.
	2.1	Systematic & thorough approach		
	2.2	Checking	All	Communication ceased so the operators were not checking what each other were doing.
	3	Communication (all)		3.4 - The operators failed to share information.
	5.2	Supporting others		
	5.3	Treating others with respect		
	5.4	Dealing with conflict / aggressive behaviour		

ALL STAGES	6	Workload management		6.2 – completing the test was perhaps prioritised too much.
	7	Self-management		7.1 - Stoliarchuk was a well motivated employee 7.4 - The operators were prepared and organised for duty – arriving 30 minutes before their shift.



## Description of the Chernobyl Nuclear Power Plant disaster

### Boris Stoliarchuk

Situational awareness					Conscientiousness			Communication				Decision making & action			Cooperation and working with others				Workload management			Self-management			
1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.3	5.4	6.1	6.2	6.3	7.1	7.2	7.3	7.4

### Leonid Toptunov

Situational awareness					Conscientiousness			Communication				Decision making & action			Cooperation and working with others				Workload management			Self-management			
1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.3	5.4	6.1	6.2	6.3	7.1	7.2	7.3	7.4