Chernobyl Nuclear Power Plant Accident

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Chernobyl Nuclear Power Plant Accident

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Introduction

On April 26, 1986, a sudden surge of power during a reactor systems test destroyed unit #4 of the nuclear power station at Chernobyl, Ukraine, in the former Soviet Union. The accident and the fire that followed released massive amounts of radioactive material into the environment. The Chernobyl disaster is considered the worst nuclear power plant accident in history, both in terms of cost and casualties. The accident prompted safety upgrades on all remaining Soviet-designed RBMK reactors, ten of which continue to be operational as of 2020.

The Chernobyl Power Complex, lying about 80 miles north of Kiev, Ukraine, consisted of four nuclear reactors of the RBMK-1000 design. Units 1 and 2 were constructed between 1970 and 1977, while units 3 and 4 of the same design were completed in 1983. Two more RBMK reactors were under construction on-site at the time of the accident. To the southeast of the plant, an artificial lake of some nine square miles, situated beside the river Pripyat was constructed to provide cooling water for the reactors.

The city of Pripyat is about two miles away from the reactor and had a population of 45,000 before the accident. The old town of Chernobyl, which had a population of 12,500, is about nine miles to the southeast of the complex. Within a 19-mile radius of the power plant, the total population was around 135,000 at the time of the accident. See Figure 1.

Figure 1

The accident destroyed the Chernobyl unit #4 reactor, killing 31 operators and firemen within four months and causing several more deaths later. *Acute radiation syndrome* (ARS) was confirmed in 237 people on-site and involved with the clean-up. Of these, 28 people died as a result of ARS within a few weeks of the accident. Nineteen more workers subsequently died, but their deaths cannot necessarily be attributed to radiation exposure. No one offsite suffered from acute radiation effects, although a significant but uncertain fraction of the thyroid cancers diagnosed since the accident in patients who were children at the time are likely to be due to intake of radioactive iodine fallout. Large areas of Eastern Europe, including Belarus, Ukraine, Russia, and beyond were contaminated in varying degrees.

The accident started during a safety test on an RBMK-type nuclear reactor, which was commonly used throughout the Soviet Union. The test was a simulation of an electrical power outage to develop a safety procedure for maintaining cooling water circulation until the back-up generators could provide power. This operating gap was about one minute and had been identified as a potential safety problem that could cause the nuclear reactor core to overheat.

The operating personnel failed to follow procedure, creating unstable operating conditions that, combined with inherent RBMK reactor design flaws and the intentional disabling of several nuclear reactor safety systems, resulted in an uncontrolled nuclear chain reaction.

A large amount of energy was suddenly released, vaporizing superheated cooling water and rupturing the reactor core in a highly destructive steam explosion. This was immediately followed by an open-air reactor core fire that released considerable airborne radioactive contamination for about nine days that precipitated onto parts of the USSR and Western Europe.

A few weeks after the accident, the crews completely covered the damaged unit in a temporary concrete structure called the "sarcophagus" to limit the further release of radioactive material. Chernobyl's three other reactors were subsequently restarted, but all eventually shut down for good, with the last reactor closing in 1999.

Severity of the accident

The International Atomic Energy Agency developed the *International Nuclear and Radiological Event Scale* (INES) to enable prompt communication of safety-significant information in case of nuclear accidents. The scale has seven layers, as shown in Figure 2. The Chernobyl accident is considered the worst nuclear disaster in history and is one of only two nuclear energy disasters rated at seven—the maximum severity—on the International Nuclear Event Scale, the other being the 2011 Fukushima Daiichi nuclear disaster in Japan.

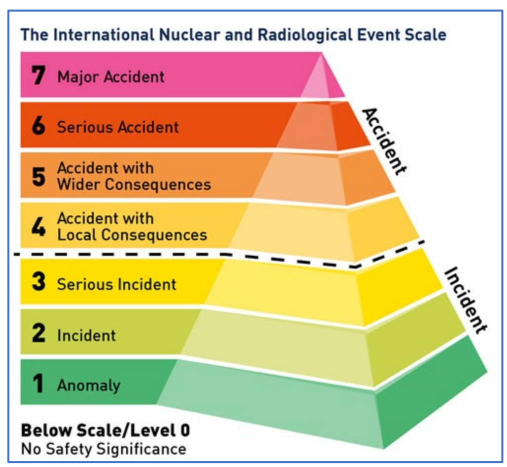
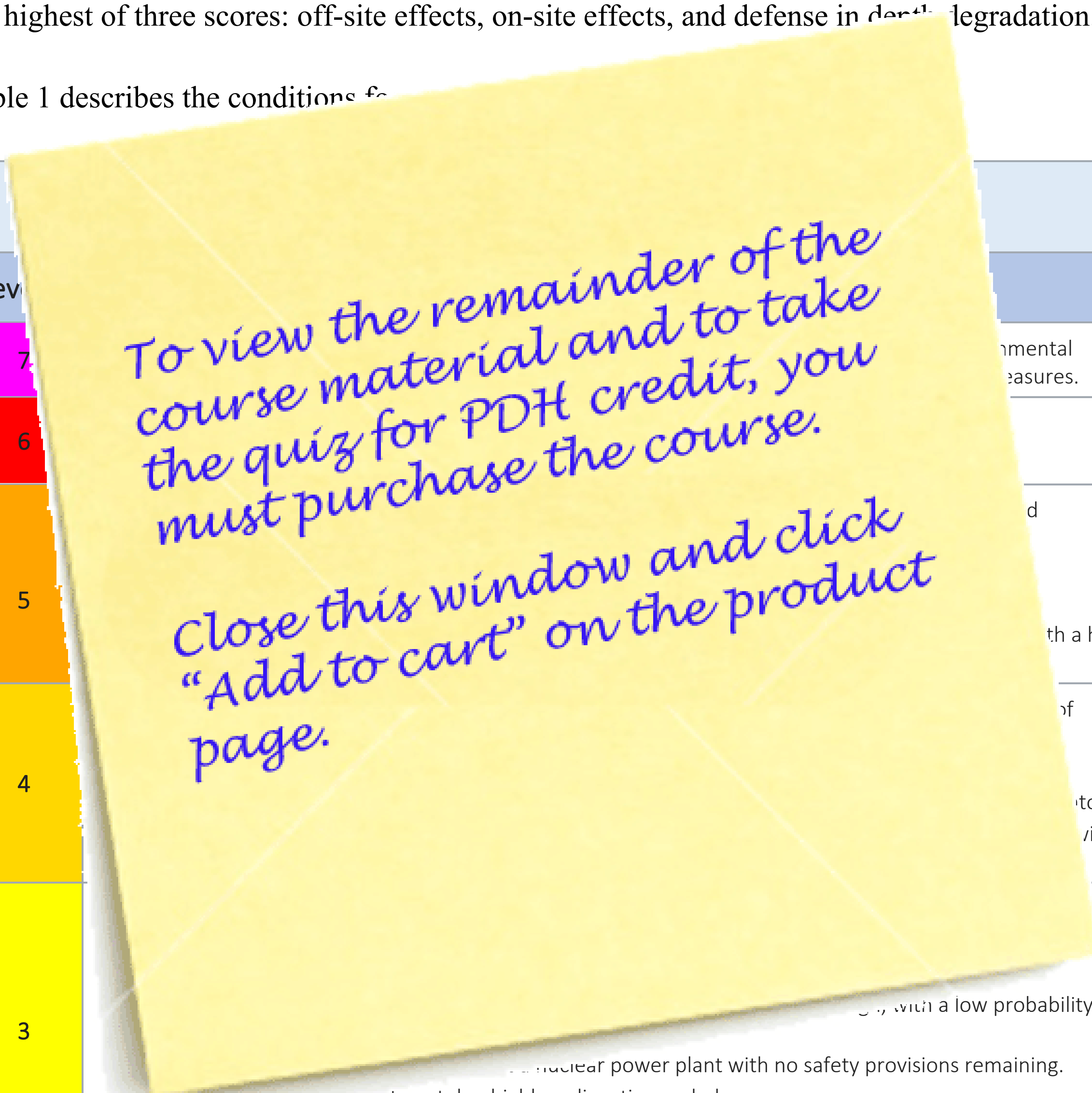


Figure 2

The scale is intended to be logarithmic, and each increasing level represents an accident approximately ten times as severe as the previous level. The scale is subjective; therefore, a severity level is only assigned with significant analysis after the event occurs.

A number of criteria and indicators are listed to assure coherent reporting of nuclear events by different official authorities. There are seven nonzero levels on the INES scale: three incident-levels and four accident-levels. There is also a level 0. The level on the scale is determined by the highest of three scores: off-site effects, on-site effects, and defense in dept[illegible] degradation.

Table 1 describes the conditions f[illegible]



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4		[illegible]f [illegible]tory. [illegible]ith a
3		[illegible] with a low probability of [illegible] nuclear power plant with no safety provisions remaining. Lost or stolen highly radioactive sealed source. Misdelivered highly radioactive sealed source without adequate procedures in place to handle it.