MELTDOWN

Japan is working desperately to prevent a nuclear catastrophe at its over-heating Fukushima reactors. The failure of cooling and safety systems has led officials to flood two reactors with seawater in a bid to cool them down and prevent total meltdowns. An explosion has already damaged the outer building of one reactor.

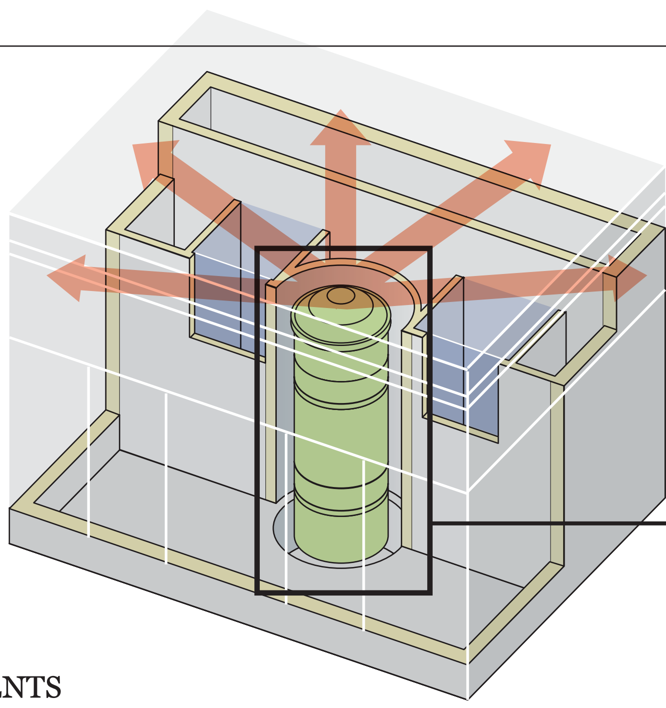
The damaged roof of reactor No. 1 at the Fukushima Daiichi nuclear plant after an explosion that blew off the upper part of the structure.

PHOTO BY OKYO ELECTRIC POWER COMPANY

THE EXPLOSION

The Fukushima Daiichi reactor no. 1 is housed in a building with a steel structure underneath. An explosion at No. 1 reactor on Saturday tore through the roof and walls of the outer housing leaving the steel structure exposed. The explosion was caused when hydrogen was generated and leaked into a space between the building and the container. It mixed with oxygen and exploded.

The fuel rods inside the reactor continue to heat the water and engineers are now using sea water as an emergency coolant.



THE CHAIN OF EVENTS

FRIDAY

▮ **Evening:** Japan's Nuclear and Industrial Safety Agency announce a heightened state of alert at Fukushima Daiichi nuclear power plant. No release of radiation detected. Three reactors at the plant were operating at the time.

▮ **21:49:** Japanese authorities order the evacuation of residents within a three-kilometre radius of the Daiichi plant, and tell people within a 10-kilometre radius to remain indoors.

▮ **21:55:** The government says radiation has leaked from one of the plant's reactors, but is not dangerously high.

▮ **Friday night:** A nuclear emergency situation is declared. At the nearby Daini nuclear power plant, officials declare a heightened alert condition. No radiation leak detected. Batteries arrive to restore some power to cooling systems. Pressure increasing in No. 1 reactor.

SATURDAY

▮ **09:00 - 10:00:** Venting begins at No. 1 reactor to lower pressure. Evacuation radius at Daiichi increased to 10 km. Evacuation of residents within three kilometres begins at Daini.

▮ **17:47:** Cabinet Secretary Yukio Edano confirms an explosion and radiation leak at Daiichi. Hydrogen was generated and leaked into a space between the building and the container. It mixed with oxygen and exploded. Explosion destroys an outer building but leaves the reactor and containment structure intact.

▮ **20:43:** Tokyo Electric Power Company (TEPCO) plans to fill the leaking reactor with sea water to cool it and reduce pressure in the unit, Mr. Edano says. He says it will take about five to 10 hours to fill the reactor core with sea water and around 10 days to complete the process.

▮ **Saturday evening:** Evacuation zones increased – 20 km at Daiichi and 10 km at Daini. Authorities prepare to distribute iodine to local residents to offset any radiation.

SUNDAY

▮ **00:49:** The nuclear accident is rated at four under the International Nuclear and Radiological Event Scale. Three Mile Island accident in 1979 was rated five and the 1986 Chernobyl disaster was a seven, top of the scale.

▮ **Morning:** In a 20-km radius around the Daiichi complex, about 170,000 people evacuated. In a 10-km radius around the Daini complex, about 30,000 people evacuated.

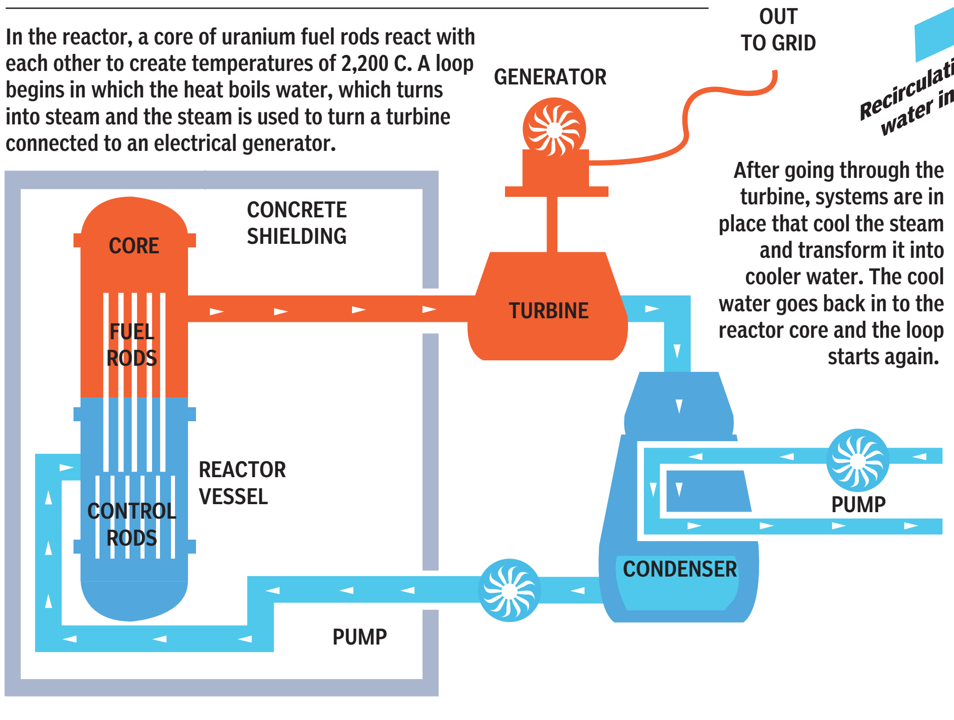
▮ **15:23:** Mr. Edano says there is a risk of an explosion at another Daiichi reactor.

▮ **23:37:** TEPCO says it is preparing to put sea water into the No. 2 reactor at Daiichi. The company is already injecting sea water into the No. 1 and No. 3 reactors to cool them down and reduce pressure inside reactor container vessels.

▮ **Sunday afternoon:** Mr. Edano said there might have been a partial meltdown of the fuel rods at the No. 1 reactor. There was a possibility of it happening at the No. 3 reactor.

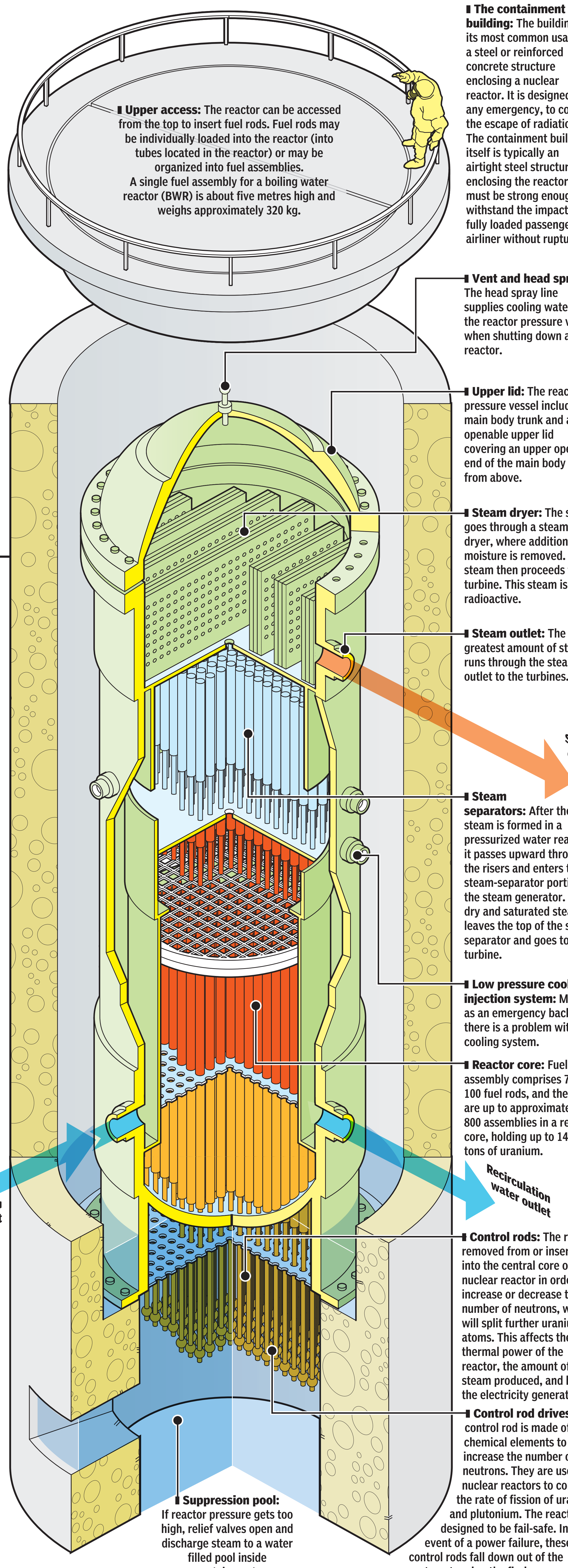
THE BOIL WATER REACTOR CYCLE IN ACTION

In the reactor, a core of uranium fuel rods react with each other to create temperatures of 2,200 C. A loop begins in which the heat boils water, which turns into steam and the steam is used to turn a turbine connected to an electrical generator.



INSIDE A BOILING WATER REACTOR

Water, heated by the splitting of uranium atoms, turns to steam and drives turbine-generators to make electricity. The steam condenses back to water and is pumped back into the reactor to continue the cycle.



▮ **The containment building:** The building, in its most common usage, is a steel or reinforced concrete structure enclosing a nuclear reactor. It is designed, in any emergency, to contain the escape of radiation. The containment building itself is typically an airtight steel structure enclosing the reactor. It must be strong enough to withstand the impact of a fully loaded passenger airliner without rupture.

▮ **Vent and head spray:** The head spray line supplies cooling water into the reactor pressure vessel when shutting down a reactor.

▮ **Upper lid:** The reactor pressure vessel includes a main body trunk and an openable upper lid covering an upper open end of the main body trunk from above.

▮ **Steam dryer:** The steam goes through a steam dryer, where additional moisture is removed. The steam then proceeds to the turbine. This steam is radioactive.

▮ **Steam outlet:** The greatest amount of steam runs through the steam outlet to the turbines.

▮ **Steam separators:** After the wet steam is formed in a pressurized water reactor, it passes upward through the risers and enters the steam-separator portion of the steam generator. The dry and saturated steam leaves the top of the steam separator and goes to the turbine.

▮ **Low pressure coolant injection system:** Meant as an emergency backup if there is a problem with the cooling system.

▮ **Reactor core:** Fuel assembly comprises 74 to 100 fuel rods, and there are up to approximately 800 assemblies in a reactor core, holding up to 140 tons of uranium.

▮ **Control rods:** The rod is removed from or inserted into the central core of a nuclear reactor in order to increase or decrease the number of neutrons, which will split further uranium atoms. This affects the thermal power of the reactor, the amount of steam produced, and hence the electricity generated.

▮ **Control rod drives:** A control rod is made of chemical elements to increase the number of neutrons. They are used in nuclear reactors to control the rate of fission of uranium and plutonium. The reactor is designed to be fail-safe. In the event of a power failure, these control rods fall down out of the reactor, stopping the fission process.

SOURCE: UNITED STATES NUCLEAR REGULATORY COMMISSION AND NEWS REPORTS - CHARLES LEWIS AND RICHARD JOHNSON / NATIONAL POST