BBC NEWS

SCIENCE & ENVIRONMENT

14 March 2011 Last updated at 11:58 ET

Exposed rods spark meltdown fear

By Richard Black
Environment correspondent, BBC News

The fuel rod exposure at Fukushima Daiichi number 2 reactor is potentially the most serious event so far at the plant.

A local government official confirmed the fuel rods were at one point largely, if not totally exposed; but we do not know for how long.

Without coolant around the rods, temperatures can rise to levels hot enough to melt metallic components over a prolonged period.

This opens the possibility of a serious meltdown - where molten, highly radioactive material from the reactor core falls through the floor of the containment vessel and into the ground underneath.

However, engineers appear to have restored some water flow into the reactor vessel and if they are successful, temperatures will begin to fall again rapidly.

What the incident illustrates is the ad-hoc nature of the operation being mounted at Fukushima.

An official with the Tokyo Electric Power Company (Tepco), which runs the site, said seawater was being pumped in both by fire engines and via the system installed to extinguish fires in the power station's turbine hall.

He told BBC News that the use of this methodology had never been foreseen - it had been invented by the team on the ground at Fukushima.

Even the mere use of seawater in this way is an extraordinary step to take.

According to the main Japanese news agency Kyodo, the rods were exposed when the flow of seawater into reactor number 2 stopped simply because a fire pump ran out of fuel.

With the entire region of Honshu island reportedly low on fuel and other vital supplies, a key question is whether plans are in place to keep the power station supplied with diesel.

Core issue

With reactor 2, what is not yet known is how long the rods were exposed to the air, and what temperatures were reached.

In the absence of cooling, temperatures in the core could rise up to 2,000C (3,600F), said Paddy Regan, professor of nuclear physics at the UK's University of Surrey - hot enough to melt the zirconium cladding that surrounds the fuel rods.

In addition, the zirconium reacts at these temperatures with water molecules to form hydrogen.

This makes the cladding more brittle and likely to fall away from the rods.

The fuel itself - being in the form of ceramic pellets - should not directly melt, although the hotter it gets the more likely it is that steam can leach out radioactive substances from the pellets.

A nightmare scenario for any nuclear plant is a total meltdown - where the molten core collapses in the bottom of the steel containment vessel and heats it so much that it falls through.

This possibility was highlighted by the 1979 incident at Three Mile Island in the US - and dramatised in the contemporary movie The China Syndrome.

The steel containment vessel, though, is designed to withstand temperatures substantially higher than 2,000C - so is meltdown a realistic possibility?

"It is possible," Professor Regan told BBC News.

"It didn't happen at Three Mile Island, though.

"If it did happen, it would still be localised; it wouldn't be a good scenario, but much better it does that than explodes."

The key issue for technicians in the plant now is to get enough water into the reactor to bring the temperature down again.

Further releases of mildly radioactive steam from the containment vessel are likely, because the hot core will vaporise much of the water that is injected.

Releasing the steam is also the main way to take heat out of the vessel.

Tepco is reportedly considering making holes in the roof of the reactor 2 building so hydrogen released with the steam will not collect and lead to a third explosion.

Multiple failures

The chain of failures illustrates the capacity of events such as this massive earthquake and tsunami to overwhelm systems that are designed to be "redundant" - to have more than one means of doing the same thing.

The earthquake caused Fukushima Daiichi and other power stations to shut down - taking away the electricity driving the reactors' cooling systems.

Back-up was supposed to come from diesel generators.

They cut in - but then cut out again after about an hour, probably due to being overwhelmed by water from the tsunami, although Tepco has not confirmed this.

The diesels themselves were backed up further by batteries, but these were designed to function only for eight hours.

When they ran out, nothing else was available.

Reports say that five fire pumps were then deployed to provide water, but that the explosions in buildings 1 and 3 knocked four of them out of action.

Meanwhile, devastation from the tsunami as well as the fear of aftershocks means simply driving new pumps or fuel to the site is much more difficult than it would be under normal circumstances.

All this is already providing material for anti-nuclear groups to argue that no nuclear facility can be designed to be completely safe.

This is manifestly correct; but the same is true for any industrial operation.

Supporters of nuclear power will point to the fact that so far casualties number just a few, that engineers have so far - however desperately - been able to confine the problem, and that far fewer people die each year from nuclear accidents than in coal-mining.

More Science & Environment stories


Tools 'demand new American story'
[/news/science-environment-12851772]
Archaeologists unearth thousands of stone tools in North America they say predate technology assumed to have been carried by the first settlers.
Africa rhinos face poaching crisis
[/news/science-environment-12859295]
Botanic gardens 'invasives' role
[/news/science-environment-12849021]