Unanswered questions as radiation levels rise at Fukushima nuclear plant

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Workers were once again evacuated from the Fukushima nuclear power plant as radiation rose to extraordinarily high levels on Sunday. Levels of 1,000 millisieverts per hour were measured in surface water within the Fukushima Unit 2 reactor building.

This means that a human being entering building 2 would be exposed to four times the annual limit of radiation within an hour. The Japanese government has raised the limit to 250 millisieverts per year for the workers who are attempting to bring the Fukushima nuclear emergency under control. The normal background level of exposure for a person not working in the nuclear industry might be 3 millisieverts per year.

How such large amounts of radiation leaked into the environment is not clear. Neither the Japanese government, the official regulatory agency NISA, nor the Tokyo Electric Power Co. (Tepco) can give a satisfactory explanation of what is happening at the plant.

What is clear is that the desperate efforts to contain the situation have again been brought to a halt. The evacuation follows the halting of work at the Unit 3 reactor two days before when high levels of radioactivity were found in water in the turbine building adjoining the reactor.

Three workers who were laying cables in the turbine building were exposed to this water and had to be rushed to hospital. Two of the workers, who were not wearing protective boots, are said to have received radiation burns. The men were transferred Friday from Fukushima hospital to the National Institute of Radiological Sciences in Chiba where they are being kept under observation.

Tepco has since apologized for the incident and admitted that it did not warn the workers of the levels of radiation to which they could be exposed.

"If we had given (the employees) the heads up thoroughly, we would have been able to avoid their exposure to the radiation at this time. We regret our lack of communication", a company statement said.

The company's statement strongly indicates that the workers are not being kept fully informed about the changing safety situation or being equipped appropriately to deal with the conditions they may face on the site.

Even now there is no objective statement from the company about the level of radiation to which the men were exposed. Officials at the National Institute of Radiological Sciences said they were exposed to between two and six sieverts (two thousand to six thousand milliseiverts) of radiation when their feet came into contact with radioactive water, but they gave no time period for this exposure. The length of time matter matters because it influences the extent to which the radiation was absorbed into the body.

Levels on the surface of the water were later measured at 400 millisieverts per hour, according to the UK-based *Guardian*, while the level in the air in the building was 200 millisieverts per hour. The figures given by the National Institute of Radiological Sciences would be consistent with the workers being ankle-deep in the water for at least three hours, which correlates with the description of the incident given by the pro-industry *World Nuclear News*.

The implication is that Tepco kept these workers operating in radioactive water for at least three hours without adequate protective clothing and without rotating in a new team to limit the exposure of any individual worker.

A similar picture of the dangers to which workers have been exposed emerges from interviews that the UK-based *Sunday Telegraph* has managed to conduct with some of those who were sent to Fukushima. The leader of a team of firefighters described spending 26 hours on site with no more protective gear than respirators and normal fire service uniforms. All their clothes were confiscated afterwards because they were contaminated.

Electricians working on restoring the cables told the *Telegraph* that only senior people had full protective gear. The workers were simply issued disposable industrial overalls of the type that a spray-painter might wear. They have badges that are supposed to warn them if the total dose of radiation they are exposed to reaches dangerous levels, but these offer no protection against the hazard of wading through contaminated water. This is what their colleagues were doing when they received burns.

The risks to which these workers are being exposed would be unacceptable under any circumstances, but even more so when the rising levels of radiation indicate that situation is escalating with no sign that Tepco is capable of getting it under control. The radiation levels in building 2 pointing to mounting problems.

There are signs that high levels of radiation are reaching well beyond the plant. NISA said on Sunday that levels of radiation were 1,850 times normal when measured in the sea at a distance 330 meters away from the plant, close to the discharge canal for reactors 1, 2, 3 and 4. On Saturday the levels were 1,250 times above normal, compared to only 104 times the previous day.

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Tepco officials have downplayed the risk, pointing to the short half-life of iodine-131, only eight days. This means that it takes only that long for iodine-131 to lose half its radioactivity. But the fact that the level of contamination in the sea is rising means there is a serious and increasing flow of radioactive material from somewhere in the plant.

A spokesman for Tepco said, "High levels of caesium and other substances are being detected, which usually should not be found in reactor water. There is a high possibility that fuel rods are being damaged".

NISA officials confirmed this view arguing that it was most likely that the water was leaking from a reactor core rather than the storage pool containing spent fuel rods. They pointed to traces of caesium-137 in the water, suggesting damage in the reactor fuel rods.

This explanation raises more questions than it answers. According to pressure readings in the reactor vessels given by NISA, the containers have not been damaged. If a reactor container was cracked or compromised in some way the pressure should drop.

Officials have suggested that the water might be leaking from broken pipes or valves through which coolant and steam from the core pressure container pass. But high levels of radiation have now been detected in four buildings. David Lochbaum, director of the Union of Concerned Scientists' Nuclear Safety Project, raised doubts about the official explanation.

"We haven't seen any clear signs whether it [the water] came from the reactor core or from the damaged fuel in the spent fuel pool…. There are also pipes that connect the reactor vessel in the primary containment to the turbine building that were normally isolated in situations like this, but might have been a pathway for the radiation to get from the containment to the turbine building. We're just not sure from the data so far".

Some experts regard the high readings as proof that the water is coming from the reactor core. Olivier Isnard, of the French Institute for Radiological Protection and Nuclear Safety, said that high reading in themselves were "proof that the reactor core partially melted".

Lochbaum, a nuclear engineer who has worked at US nuclear plants for 17 years, is more cautious He said there were "inconsistent signs" and "contradictory data" about the source of the very high levels of radioactivity. "There's quite a bit of damage in quite a few areas", he said. "There's not a lot of instrumentation available. There's not a lot of access available for workers to go through the facility and more accurately assess conditions in lieu of the instrumentation that's spotty at best".

The US 7th Fleet is now bringing in barges loaded with fresh water to cool the reactors. The move suggests that damage to the cooling system is suspected. The seawater that was pumped in with fire hoses and dropped from helicopters may have caused corrosion to pipes and valves.

The lack of clear data was highlighted when Tepco withdrew an announcement that the level of radiation in the pools of water gathering in Building 2 was 10 million times that normally found in a functioning nuclear reactor.

"The number is not credible", Tepco spokesman Takashi Kurita said and added "We are very sorry".

Tepco blamed a worker for taking one reading and then running away in terror at the reading, but the company would not, or could not, offer an alternative more accurate reading. The incident must cast doubt on all the company's claims.

So contradictory and opaque have reports been that even the Japanese government, which is normally supportive of the company, was forced to criticise Tepco for its lack of transparency in providing information.

"We strongly urge Tepco to provide information to the government more promptly", said Chief Cabinet Secretary Yukio Edano.

What is becoming increasingly clear amid the confusion is that Tepco has long been indifferent to safety.

Yukinobu Okamura, director of Japan's Active Fault and Earthquake Research Centre, warned NISA in 2009 that Tepco should be prepared for a larger tsunami. He pointed out that the Fukushima's sea defences were based on models of the tsunami in 1938, but that there had been a much larger tidal wave in the year 869.

Historical documents record that the tsunami of 869 was large enough to wash away a castle. Surveys of the sediments that the tidal wave left behind confirmed these contemporaneous reports of its size. Okamura told the *Financial Times* that representatives of the company had dismissed his concerns. Other seismologists have confirmed that there is a consistent underestimation of the risks to power stations from seismic activity.

Tepco's refusal to upgrade the sea defences of the Fukushima plant point to a consistently reckless attitude to safety. President Masataka Shimizu of Tepco is now facing calls for his resignation, but only because the crisis at Fukushima has wiped $26 billion off the company's share value, not because his company has put countless lives at risk.

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