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What happened at Fukushima? Updated December 6, 2011

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It is one of the mysteries of Japan's ongoing nuclear crisis: How much damage did the March 11 earthquake do to the Fukushima Daiichi reactors before the tsunami hit? The stakes are high: If the quake structurally compromised the plant and the safety of its nuclear fuel, then every other similar reactor in Japan will have to be reviewed and possibly shut down. With virtually all of Japan's 54 reactors either offline (35) or scheduled for shutdown by next April, the issue of structural safety looms over the decision to restart every one in the months and years after.

The key question for operator Tokyo Electric Power Co (TEPCO) and its regulators to answer is this: How much damage was inflicted on the Daiichi plant before the first tsunami reached the plant roughly 40 minutes after the earthquake? TEPCO and the Japanese government are hardly reliable adjudicators in this controversy. "There has been no meltdown," top government spokesman Edano Yukio famously repeated in the days after March 11. "It was an unforeseeable disaster," Tepco's then President Shimizu Masataka improbably said later. As we now know, meltdown was already occurring even as Edano spoke. And far from being unforeseeable, the disaster had been repeatedly forewarned.

The earthquake and tsunami did extensive damage to large areas of Tohoku. Photo by Ikuru Kuwajima Galleries | Ikuru Kuwajima

Throughout the months of lies and misinformation, one story has stuck: "The earthquake knocked out the plant's electric power, halting cooling to its six reactors. The tsunami – a unique, one-off event - then washed out the plant's back-up generators, shutting down all cooling and starting the chain of events that would cause the world's first triple meltdown. That line has now become gospel at TEPCO. "We had no idea that a tsunami was coming," said Murata Yasuki, head of public relations for the now ruined facility. "It came completely out of the blue" *(nemimi ni mizu datta*). Safety checks have since focused heavily on future damage from tsunamis.

But what if recirculation pipes and cooling pipes burst, snapped, leaked, and broke completely after the earthquake -- before the tidal wave reached the facilities and before the electricity went out? This would surprise few people familiar with the nearly 40-year-old reactor one, the grandfather of the nuclear reactors still operating in Japan.

Problems with the fractured, deteriorating, poorly repaired pipes and the cooling system had been pointed out for years. In 2002, whistleblower allegations that TEPCO had deliberately falsified safety records came to light and the company was forced to shut down all of its reactors and inspect them, including the Fukushima Daiichi Power Plant. Sugaoka Kei, a General Electric on-site inspector first notified Japan's nuclear watchdog, Nuclear Industrial Safety Agency (NISA) in June of 2000. The government of Japan took two years to address the problem, then colluded in covering it up -- and gave the name of the whistleblower to TEPCO.

In September 2002, TEPCO admitted covering up data about cracks in critical circulation pipes in addition to previously revealed falsifications. In their analysis of the cover-up, The Citizen's Nuclear Information Center writes:

> "The records that were covered up had to do with cracks in parts of the reactor known as recirculation pipes. These pipes are there to siphon off heat from the reactor. If these pipes were to fracture, it would result in a serious accident in which coolant leaks out. From the perspective of safety, these are highly important pieces of equipment. Cracks were found in the Fukushima Daiichi Power Plant, reactor one, reactor two, reactor three, reactor four, reactor five."

The cracks in the pipes were not due to earthquake damage; they came from the simple wear and tear of long-term usage. On March 2nd, 2011 nine days before the meltdown, the Nuclear Industrial Safety Agency (NISA) warned TEPCO of its failure to inspect critical pieces of plant equipment, including the recirculation pumps. TEPCO was ordered to make the inspections, perform repairs if needed and report to NISA on June 2nd. It does not appear that the report has been filed as of this time.

The problems were not only with the piping. Gas tanks at the site also exploded after the earthquake. The outside of the reactor building suffered structural damage. There was no one really qualified to assess the radioactive leakage because, as NISA admits, after the accident all the on-site inspectors fled. And the quake and tsunami broke most of the monitoring equipment so there was little information available on radiation afterwards.

The authors have spoken to several workers at the plant. Each recites the same story: Serious damage to piping and at least one of the reactors before the tsunami hit. All have requested anonymity because they are still working at or connected with the stricken plant. Worker A, a 27-year-old maintenance engineer who was at the Fukushima complex on March 11, recalls hissing, leaking pipes.

> "I personally saw pipes that had come apart and I assume that there were many more that had been broken throughout the plant. There's no doubt that the earthquake did a lot of damage inside the plant. There were definitely leaking pipes, but we don't know which pipes – that has to be investigated. I also saw that part of the wall of the turbine building for reactor one had come away. That crack might have affected the reactor."

The walls of the reactor are quite fragile, he notes.

> "If the walls are too rigid, they can crack under the slightest pressure from inside so they have to be breakable because if the pressure is kept inside and there is a buildup of pressure, it can damage the equipment inside the walls. So it needs to be allowed to escape. It's designed to give during a crisis, if not it could be worse – that might be shocking to others, but to us it's common sense."

WORKER B, a technician in his late thirties **w**ho was also on site at the time of the earthquake recalls what happened.

> "It felt like the earthquake hit in two waves, the first impact was so intense you could see the building shaping, the pipes buckling, and within minutes, I saw pipes bursting. Some fell off the wall. Others snapped. I'm pretty sure that some of the oxygen tanks stored on site had exploded but I didn't see for myself. Someone yelled that we all needed to evacuate. I was severely alarmed because as I was leaving I was told, and I could see, that several pipes had cracked open, including what I believe were cold water supply pipes. That would mean that coolant couldn't get to the reactor core. If you can't get sufficient coolant to the core, it melts down. You don't have to be a nuclear scientist to figure that out."

As he was heading to his car, he could see that the walls of the reactor one building itself had already started to collapse. "There were holes in them. In the first few minutes, no one was thinking about a tsunami. We were thinking about survival."

Worker C was coming into work late when the earthquake hit. "I was in a building nearby when the earthquake shook. After the second shockwave hit, I heard a loud explosion. I looked out the window and I could see white smoke coming from reactor one. I thought to myself, 'this is the end.'"

When the worker got to the office five to fifteen minutes later the supervisor immediately ordered everyone to evacuate, explaining, "there's been an explosion of some gas tanks in reactor one, probably the oxygen tanks. In addition to this there has been some structural damage, pipes have burst, meltdown is possible. Please take shelter immediately." (It should be noted that several explosions occurred at Daiichi even *after* the March 11th earthquake, one of which TEPCO stated, "was probably due to a gas tank left behind in the debris".)

As the employees prepared to leave, the tsunami warning came. Many of them fled to the top floor of a building near the site and waited to be rescued.

The suspicion that the quake caused severe damage to the reactors is strengthened by reports that radiation leaked from the plant minutes later. Bloomberg has reported that a radiation alarm went off at the plant before the tsunami hit on March 11. The news agency says that one of the few monitoring posts left working, on the perimeter of the plant "about 1.5 kilometers (1 mile) from the No. 1 reactor went off at 3:29 p.m., minutes before the station was overwhelmed by the tsunami."

Workers at the Fukushima Daiichi nuclear power plant check water levels at the No 1 reactor. Photograph: Tepco/EPA

The reason for official reluctance to admit that the earthquake did direct structural damage to reactor one is obvious. Onda Katsunobu, author of *TEPCO: The Dark Empire* (東京電力・帝国野暗黒), who sounded the alarm about the firm in his book (2007) explains it this way:

> "If TEPCO and the government of Japan admit an earthquake can do direct damage to the reactor, this raises suspicions about the safety of every reactor they run. They are using a number of antiquated reactors that have the same systemic problems, the same wear and tear on the piping."

Kikuchi Yoichi, a former GE engineer who helped build the Fukushima nuclear power plant says unequivocally that, "the earthquake caused the meltdown not the tsunami." In his recent book : 原発をつくった私が、原発に反対する理由: (Why I'm Against the Nuclear Plants I Helped Build), he explains that poorly maintained water pipes and circulation system failure were the cause of the triple meltdown. Kikuchi in his book writes (p. 51), "At Fukushima Daiichi Nuclear Power Plant, at first the plan was to use the water coffin (水棺) approach. In other words, to fill the containment vessels with water and cool down the pressure vessel and ensure a safe and stable state. However, once (TEPCO) understood that the containment vessels (格納容器) had been damaged, they gave up this plan. Because water was probably leaking all over the place from the pipes, from the start this was an unreasonable scenario."

Tanaka Mitsuhiko, a former nuclear power plant designer and science writer asserts that at least the Number One reactor melted down as a result of the earthquake damage. He describes it as a loss of coolant accident (LOCA). "The data that TEPCO has made public shows a huge loss of coolant within the first few hours of the earthquake. It can't be accounted for by the loss of electrical power. There was already so much damage to the cooling system that a meltdown was inevitable long before the tsunami arrived."

He says the released data shows that at 14:52 on March 11th, before the tsunami had arrived, the emergency circulation equipment of both the A and B systems automatically started up. "This only happens when there is a loss of coolant." Between 15:04 and 15:11 the water sprayer inside the containment vessel was turned on. Tanaka says that it is an emergency measure only done when other cooling systems have failed.

By the time the

Onda Katsunobu's book *Tokyo Denryoku: Teikoku No Ankoku*, , detailed the history of accidents and cover-ups at TEPCO in great detail. Issued in 2007, it was mostly ignored and sold only 4,000 copies. It was reissued this year. In many ways, it was a remarkably prescient book.

tsunami arrived and knocked out all the electrical systems, circa 15:37, the plant was already on its way to melting down.

Tanaka believes that a fault in the Mark I reactor, the same type as the number one reactor, was another contributing factor to the meltdown. On November 5, 1987, NISA began an evaluation of the Mark 1 reactors to consider how much stress they could take before a LOCA would occur. The results of that evaluation have not been made public.

There are currently ten remaining Mark type reactors in Japan, according to Tanaka's research. He believes that each one is the equivalent of a ticking time bomb.

Sugaoka Kei, who conducted on-sight inspections at the Fukushima plant, was the man who first blew the whistle on TEPCO's data tampering with critical machinery. He says that he wasn't surprised that a meltdown took place after the earthquake. He sent the Japanese government a letter dated June 28th, 2000 warning them of the problems there. It took the Japanese government almost two years to act on that warning.

Sugaoka asserts in his letter that TEPCO left in place and continued to operate a severely damaged steam dryer in the plant even ten years after he pointed out the problem. The steam dryer had never been properly installed and was 180 degrees out of place. Sugaoka states, "It wasn't a surprise that a nuclear accident happened there. I always thought it was just a matter of time. This is one of those times in my life when I'm not happy I was right."

Worker A says there were "probably pieces of equipment on site that had never been checked."

"Let's say you have a refrigerator – the manufacturer recommends it be checked every ten years. But it's surrounded

> by many other kinds of equipment in the plant, all with different requirements for checking. So if the refrigerator check is missed, it will be another 10 years before it is done. Sometimes checks might not happen for decades. In a strong earthquake, that equipment could fail. That's TEPCO's responsibility. They're supposed to make the schedule."

Onda Katsunobu notes, "I've spent decades researching TEPCO and its nuclear power plants and what I've found, and what government reports confirm, is that the nuclear reactors are only as strong as their weakest links, and those links are the pipes."

During his research, Onda spoke with several engineers who worked at the TEPCO plants. One told him that often piping would not match up the way it should according to the blueprints. In that case, the only solution was to use heavy machinery to pull the pipes close enough together to weld them shut. Inspection of piping was often cursory and the backs of the pipes, which were hard to reach, were often ignored. Since the inspections themselves were generally cursory and done by visual checks, it was easy to ignore them. Repair jobs were rushed; no one wanted to be exposed to nuclear radiation longer than necessary.

Onda adds, "When I first visited the Fukushima Power Plant it was a web of pipes. Pipes on the wall, on the ceiling, on the ground. You'd have to walk over them, duck under them—sometimes you'd bump your head on them. It was like a maze of pipes inside."

It's not very difficult to explain what happened at reactor one and perhaps the other reactors as well, Onda believes.

> "The pipes, which regulate the heat of the reactor and carry coolant are the veins and arteries of a nuclear power plant; the core is the heart. If the pipes burst, vital components don't reach the heart and thus you have a heart attack, in nuclear terms: meltdown. In simpler terms, you can't cool a reactor core if the pipes carrying the coolant and regulating the heat rupture—it doesn't get to the core."

The Great Tohoku earthquake forced many to evacuate their homes and live in shelters. Photos by Ikuru Kuwajima Galleries | Ikuru Kuwajima

Hasuike Touru, a TEPCO employee from 1977 until 2009 and former general safety manager of the Fukushima plant**,** also notes: "The emergency plans for a nuclear disaster at the Fukushima plant had no mention of using sea-water to cool the core. To pump seawater into the core is to destroy the reactor. The only reason you'd do that is that no other water or coolant was available."

Before dawn on the 12th, the water levels at the reactor began to plummet and the radiation began rising. Meltdown was taking place. The TEPCO Press release on March 12th just after 4 a.m. states: "The pressure within the containment vessel is high but stable." There was one note buried in the release that many people missed. "The emergency water circulation system was cooling the steam within the core; it has ceased to function."

According to the daily *Chunichi Shinbun* and other sources, a few hours after the earthquake, extremely high levels of radiation were recorded within the reactor one building. The level of contamination was so high that a single day exposed to it would be fatal. The water levels of the reactor were already sinking. 6 hours and 20 minutes after the earthquake on March 11th at 9:08 the radiation level was 0.8 mSv every ten seconds. In other words, if you spent 20 minutes exposed to those radiation levels you would exceed the five-year limit for a nuclear reactor worker in Japan.

At 9:51 pm, under the CEO orders, the inside of the reactor building was declared a no-entry zone. Around 11 pm, radiation levels for the inside of the turbine building, which was next door to the reactor reached levels of 0.5 to 1.2 mSv per hour.

The meltdown was already underway.

Oddly enough, while TEPCO later insisted that the cause of the meltdown was the tsunami knocking out emergency power systems, at the 7:47 pm TEPCO press conference the same day, the spokesman, in response to questions from the press about the cooling systems, stated that the emergency water circulation equipment and reactor core isolation time cooling systems would work even without electricity. The emergency water circulation system (IC) did in fact start working before the power loss and continue working after the power was lost as well.

Sometime between 4 and 6 am, on May 12th, Yoshida Masao, the plant manager decided it was time to pump seawater into the reactor core and notified TEPCO. Seawater was not pumped in until hours after a hydrogen explosion occurred, roughly 8:00 pm that day. By then, it was probably already too late.

On May 15, TEPCO went some way toward admitting at least some of these claims in a report called "Reactor Core Status of Fukushima Daiichi Nuclear Power Station Unit One." The report said there was pre-tsunami damage to key facilities including pipes. "This means that assurances from the industry in Japan and overseas that the reactors were robust is now blown apart," said Shaun Burnie, an independent nuclear waste consultant. "It raises fundamental questions on all reactors in high seismic risk areas."

As Burnie points out, TEPCO also admitted massive fuel melt --16 hours after loss of coolant, and 7-8 hours before the explosion in unit 1. "Since they must have known all this -- their decision to flood with massive water volumes would guarantee massive additional contamination - including leaks to the ocean."

No one knows exactly how much damage was done to the plant by the quake, or if this damage alone would account for the meltdown. However, eyewitness testimony and TEPCO'S own data indicates that the damage was significant. All of this despite the fact that shaking experienced at the plant during the quake was within it's approved design specifications. Says Hasuike:

"What really happened at the Fukushima Daiichi Nuclear Power Plant to cause a meltdown? TEPCO (Tokyo Electric Power Company) and the government of Japan have provided many explanations. They don't make sense. The one thing they haven't provided is the truth. It's time that they did."

Update: On December 6, 2011, Sato Akira reported in the Asahi Shimbun that "Panel doubts TEPCO claim tsunami caused nuke accident." Hatamura Yotaro, chair of a government panel investigating the accident is among those panel members who conclude that the accident was caused by the earthquake, a finding with important consequences for all other nuclear plants in Japan and elsewhere.

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Freelance photographer Ikuru Kuwajima started photography while studying journalism at the University of Missouri, Columbia. He is currently based in Kazakstan. His work has appeared in Courrier Japon and National Geographic Romania and Japan. *His many awards include the Picture of the Year International. His web site is here Galleries | Ikuru Kuwajima.*

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