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Japan's Triple Meltdown: Tour of Fukushima Daiichi Nuclear Power Plant

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Fairewinds and GRTV

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Each week Fairewinds receives many questions about the ongoing tragedy unfolding in Japan as a result of the triple meltdown at the Fukushima Daiichi nuclear power plant.

Join us as Fairewinds' Chief Engineer Arnie Gundersen highlights the many problems facing Japan as he takes you on a tour of the Fukushima Daiichi site by combining satellite video, animated graphics and photos to create a comprehensive and easy to follow video tour.

Video Transcript

AG: Hi. I'm Arnie Gundersen from Fairewinds. Fukushima Daiichi has been in the news a lot lately. There's been tank leaks, contaminated ground water, contaminated Pacific Ocean. And now Tokyo Electric is in the process of trying to remove the nuclear fuel from Daiichi Unit 4. All of these present enormous problems. So I thought I'd use a video today to take you on a guided tour of the site. We'll go up to the tank farm and check it out and then move down and look at each of the units individually, because every one of them presents a challenge to Japan. I hope you enjoy the tour.

In the center of this drawing is Fukushima Daiichi 1 and Fukushima Daiichi 2 – and 3; and then 4. On the far side of this picture, on the right, are two more cubes, and that's units 5 and 6. We'll talk about them later. As the numbers indicate, Fukushima Daiichi 1 was the first to be built. And all of the problems that are presently happening on that site as well as all of the problems that happened with the tsunami, were created when they built Fukushima Daiichi 1. And *they* is not Tokyo Electric. *They* is an American company called General Electric, and another American company called EBASCO. They're the ones that determined how close this power plant is to the water.

Now we're going to jump here to another slide of what Daiichi 1 looked like when it was built. And this is only Fukushima Daiichi 1. All of the issues on Daiichi 1 were locked into concrete. What happened on units 2, 3 and 4 as well; specifically the grade. If you look back up the road, you'll see about a hundred-foot drop that engineers built a road down to the water. That was actually all dirt. This entire piece was dirt. And those power plants weren't there. They removed about 100 feet of dirt over top of those power plants. So the decision to put Fukushima Daiichi near the water was made by General Electric and EBASCO. Now of course that had an effect on the tsunami and we won't talk about that today, but now it's a leading cause of the problem with the groundwater. The high area has a lot of groundwater in it and where is it going? Water flows downhill, right into the basement of these power plants. So the decision to cut away the bank that was made in 1965 by General Electric and EBASCO is the fundamental problem on this site because it's causing the basements to

flood. Back in the day, in the 60's, there was a large, steep dropoff to the ocean. That was leveled by engineers.

Okay. On the far side of this picture on the right is the tank farm. It wasn't there in 2011 and it grew dramatically from 2011 to 2012, 2012 to 13. And you can see it's getting pretty darned full. They're going to wind up having to take some of the land in the next farmer's fields over in order to continue to store all this liquid radioactive material. So the tank farm has grown dramatically and it's on the hill. Of course, the problem is because it's on the hill, water flows down. And if there's an earthquake, all of these pipes are held together with plastic piping, not much different than what you've got on a swimming pool. So the plastic pipe will snap and that water will just run right down that roadway directly into the ocean. The tank in question in this farm is leaking directly into the groundwater. But that's just one tank out of a thousand. And while it's serious enough in itself, it's only problem number 1. Problem 1, the tank that's leaking. There are other tanks that are leaking, too, but the worst one was the one that was identified about 3 weeks ago. Problem 2 is that this entire tank farm is not seismically qualified.

All right. Let's go down and take a look at the power plants along the water and we'll get to problems 3, 4, 5. Now remember, these power plants have basements that are essentially below sea level. And the water on the hill that's just coming out of the hill as groundwater had been coming out for 50, 60, 1,000 years. When they built the power plants, they had sump pumps in the basement that pumped that water out so that the basements would stay dry. Well now, of course, the basements are radioactive so they can't pump it out. Well, we've got hot radioactive material in these basements and it's got no place to go except downhill into the Pacific Ocean. The problem #3 is not the leaky tank farm. Problem #3 is the leaky basements on Daiichi 1, 2, 3 and 4.

All right. Let's take a look at Fukushima Daiichi Unit 1. Now it doesn't look like this right now. It's got a cocoon over top of it. And the cocoon is made of Kevlar, almost like the kind of shrink wrap you put on a boat for the winter. This is, of course, a result of the explosion. It was the smallest unit. It was under 500 megawatts. And it exploded first. Mystery #1 here is just how much damage happened before the explosion. There's a lot of indications on Daiichi 1 that radiation was being released before the explosion and before the tsunami. So it appears, at least for Daiichi unit 1 that the earthquake caused some damage. Now in the foreground here is the stack. And Tokyo Electric found cracks in the stack at about 66 meters up. That's likely a seismic node and it's quite likely that that stack buckled from the earthquake. So there's a bunch of indications here that Fukushima Daiichi was in trouble from the earthquake and the tsunami just sealed its fate.

Let's move over to unit 2. Unit 2 looks like it's in the best condition but it actually had probably the most severe containment explosion. Units 1 and 3 and 4 are also exploding. But the explosions appear to be outside the containment. Explosion occurred inside the containment and at the bottom of the reactor below the grade of the reactor there's likely a crack in the containment as a result. Now luckily, the side panel of Unit 2 blew out and hydrogen gas was able to escape as opposed to blowing up the box. But that box is not the containment. That box is something called the reactor building and it's really no stronger than a tin shed you'd buy at Sears. It was designed to hold radioactivity in because fans pumped gases out those tall stacks that you see on the left and right here. Of course, after the accident, the fans failed because they had no electricity, the hydrogen built up and blew the sides off units 1 and 3. Luckily, unit 2 had a blow-out panel pop and the hydrogen gases were able to merge with the atmosphere. Unit 2 is a mess inside but it sure looks okay from

the outside.

Let's go up here to 3. Unit 3, of course, is the reactor that had *the* worse explosion; something called a*detonation shockwave* compared to something called a *deflagration shockwave*. We talk about that on the site. Unit 1 had a deflagration shockwave, which was nowhere near as damaging. Unit 3 is a structural mess. Now it's so badly damaged that they cannot move the nuclear fuel the way they traditionally had planned. The structure just won't handle the extra weight of a heavy crane put inside it. What they're doing right now on this plant is still removing rubble. And by the way, those cranes that you see in the movies are all being moved remotely. The operators are not inside those cranes because the radiation exposures around these buildings are so high. Inside that building, it's essentially a No Man's Land. It's inaccessible because radiation levels are so high.

Well, what the heck happened in there is another mystery. We know a detonation shockwave happened and no nuclear plant in the country can withstand a detonation shockwave. The NRC doesn't want to address that so here in America we've solved the problem of detonation shockwaves because we ignore the problem of detonation shockwaves. But we know this picture is evidence that it can happen. Inside that building is an extraordinary amount of radiation, but also outside that building, fuel pellets were found in the aftermath of the accident. Now those were bulldozed under. But that's an indication of a major problem inside the fuel pool. You know, I've been saying all along that I think unit 3 had something called a prompt moderated criticality in the fuel pool. And that particulars of fuel would be found lying outside unit 3 is an indication that that happened. If the fuel had come from inside the nuclear reactor, it would have had to go through the containment and through a very circuitous path. So to my mind, it's very unlikely that fuel would be found outside the reactor. We do know that very high sources were covered up with bulldozers early on after the accident and are likely still there.

But what will they do with unit 3? It has fuel in the fuel pool. Eventually, it's going to have to be emptied. But the radiation exposures are so high that personnel access is really, really limited. My biggest fear on unit 3 is that another earthquake will happen. It doesn't have to be a Richter 9, like the original one. It can be an 8.5 aftershock. But this building has been so damaged that it could topple and shatter from another significant earthquake. It's being covered up and probably will be completely covered with one of those shrink-wrap covers by the winter. But right now, it's the only building that's exposed to the atmosphere.

Let's go down the road in between the power plants now to Daiichi 4. Now Daiichi 4 wasn't running when the accident happened, but yet it exploded as well. What made Daiichi 4 dangerous was the fact that all of the nuclear fuel wasn't in the containment. All of the nuclear fuel was in the fuel pool. So this was the biggest concern of all the experts after the accident. And it's the reason that the Americans evacuated out to 50 miles. Even though we had explosions in unit 1 and unit 2 and unit 3, that was not the big threat to the population in Japan. It was Daiichi 4. Now the reason for that was that the fuel was hot – physically hot. And if the fuel pool didn't get enough water, it would have drained and then you would have had a meltdown inside the fuel pool. And there's nothing between the fuel pool and the sky to keep that radiation in. At least 1, 2 and 3 had containments that may have been leaking, but they hadn't completely failed. So the main issue was, what if unit 4 runs out of water. Well, you'll recall right after the accident, they brought in pumping trucks to pump water in and even before that, they tried the helicopters, which was a joke. There was no way a helicopter was going to keep this thing full. But in any event, they were able to pump the

water back into that fuel pool. And now they got underneath the fuel pool and stabilized it. This is another indication of a seismic problem on the Daiichi site because after this building exploded Tokyo Electric went in and beefed up the floor under this fuel pool. So clearly they had concerns back in April and May, right after the accident, that this plant had a fuel pool that was in jeopardy of failing. Now this one's all wrapped up in shrink wrap right now and they're planning to begin to move nuclear fuel shortly.

Now nuclear fuel is like cigarettes in a pack of cigarettes. If the pack is new, you can pull a cigarette out pretty easily. But if the pack is distorted and you pull too hard, you'll snap the cigarette. Same thing can happen inside this fuel pool. If you pull too hard on the nuclear fuel, you can snap the nuclear fuel because the rack has been distorted. The roof fell in on the building; of course the rack is distorted. So it wouldn't surprise me that in the course of emptying this fuel pool over the next year, they'll snap a fuel bundle. And you see the stack over there on the right? Well, that's connected now. So they'll pump the gases from inside that envelope up the stack and release them into the air. So it wouldn't surprise me that will get airborne Krypton again – Krypton 85 – as a result of cracked and damaged fuel inside that fuel pool. It happens at nuclear power plants around the country periodically. What normally happens is the fuel pool area is evacuated, all those gases get sucked out and pumped up the stack. So keep your eye on unit 4. I suspect in the future, that'll happen.

Now we have to pray on unit 3 and unit 4 that there's no significant earthquake until those fuel pools are empty. Unit 4 is structurally stronger than unit 3 but still it's in jeopardy because it, too, had the effects of an explosion. There's also a bulge in that blue wall right at the bottom. That blue wall is concrete, and above it was the steel building that we talked about that you could buy at Sears. But that blue wall has a buckle in it and it bows out about an inch or two. That's something called a *first mode Euler strut buckle*and it's an indication of a structural problem caused by the earthquake on Fukushima Daiichi unit 4.

So the buildings along the water – there's a long row of buildings along the water – those are the turbine buildings. And while impressive, there's really not much going on inside them of a nuclear safety standpoint. They do have basements, however, that are flooded with radioactive waste. Out beyond those is rubble along the waterline. And those are where the cooling pumps were that all failed as a result of the tsunami. That's what was supposed to cool the diesels. And like I said before, even if the diesels had not been flooded, they would have failed anyway because they could not have been cooled because all of that rubble along the coast.

But what Tokyo Electric is now planning to do because we've got radioactive basements being constantly flooded with something like 400 tons of water every day, is they're going to build a trench all the way around unit 1, 2, 3 and 4. And they're going to pump it full of very cold liquids through pipes and freeze it. And this is what's called the ice wall. So an ice wall would go on the land side of the buildings that had exploded. And it'll turn the corner and then it will go down the water side of the turbine holes. And hopefully they're going to freeze more than a mile's worth of soil in the process. Now there's no guarantees it'll work. It's never been tried before on such a large scale. And even if the wall works, there's no guarantee that it will seal with bedrock so we still may have leakage in the future with the ice wall. And oh, by the way, it's going to take at least two years before they build that ice wall, which means this thing is going to continue to leak into the Pacific for at least two years.

While we're on the subject of the ice wall, I want to talk about the book I wrote two years

ago. This problem of radioactivity in the basements was foreseeable back then. And the plant manager at Daiichi saw that it was going to be a problem in April during – right after the accident occurred. So it didn't take a genius to figure out that these basements were going to flood. In the book I wrote, I talked about the need to build a Zeolite trench on the high side of these buildings, on the land side of these buildings. And the reason I wanted that was not to keep the radioactive material from getting into the ocean, but to keep the clean water from getting into the power plant. Now you can think of these power plant basements as a bathtub. And if you've got the spigot on and the drain closed, what Tokyo Electric is trying to do is build the walls higher as this bathtub begins to fill. Well, my approach isn't to build the walls higher; my approach is to turn the spigot off. The trick here was not to try to prevent the water from getting into the ocean. The trick was to keep the clean water out. That's why the Zeolite trench, if it had been built two years ago, would have allowed engineers to go up on the hill and pump clean water right out into the ocean. It would not have been contaminated because the Zeolite trench would have prevented that from flowing out. Now it's too late. The groundwater is contaminated. And if you were to suck groundwater up now, you're not sucking clean water up. You're sucking contaminated water up. And we'll see if it works.

The last thing I want to talk about on the site today, remember we started this by saying that the design decisions on Fukushima Daiichi 1, 2, 3 and 4 were made by American engineers at GE and EBASCO. If we go to the other side of the site, there's Fukushima Daiichi 5 and Fukushima Daiichi 6. They're not in the same location, are they? They're further away from the water and they're physically higher. So Tokyo Electric recognized that the General Electric decisions on Daiichi 1, 2, 3 and 4 were wrong and when they built more reactors on the site after the first 4 that were essentially carbon copies of each other, Daiichi 5 and Daiichi 6 were built far enough away from the ocean and high enough – they were another 10 feet higher – that when the tsunami hit, it didn't do anywhere near as much damage. The Abe administration has just suggested that they're going to shut 5 and 6 down anyway; that in fact we are detecting radiation in the basements of 5 and 6, but as far as meltdowns go or hydrogen explosions go, they survived that pretty darn well. Because engineers learned that the decisions on 1, 2, 3 and 4 were wrong and they built these further back and higher from the ocean.

I'm Arnie Gundersen from Fairewinds. Thanks for tuning in and I hope you enjoyed the tour. I'll keep you informed.

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