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Exclusive Arnie Gundersen Interview: The Dangers of Fukushima Are Worse and Longer-lived Than We Think - Friday, June 3, 2011, 3:54 pm, by Adam For More Information: (http://www.fairewinds.com/home)

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June 3, 2011

Transcript for Exclusive Arnie Gundersen Interview: The Dangers of Fukushima Are Worse and Longer-lived Than We Think - Below is the transcript for Exclusive Arnie Gundersen Interview:

"The Dangers of Fukushima Are Worse and Longer-lived Than We Think"

Chris Martenson: Welcome to another ChrisMartenson.com podcast. I am your host, Chris Martenson and today I have the privilege of speaking with Arnie Gundersen of Fairewinds Associates.

In my eyes, a kind of living legend in the field of nuclear engineering. He has over thirty-nine years of nuclear industry experience and oversight and is a frequent expert witness on nuclear safety matters to the US Federal Government and private industry.

Since the initial days of the disaster at Fukushima, Arnie and his staff at Fairewinds have produced hands down, the most thorough, measured, accurate analysis of the unfolding developments there. A feat made all the more challenging by the frequent lack of information from TEPCO and the Japanese government and media.

Now today, Arnie and I will talk about the latest state of the situation at Fukushima, which remains wholly unresolved and it's quite troubling – we should keep our eyes on it. In addition, we are going to discuss what the important factors are for you to know, as well as what pragmatic preparations those of us who live in or near nuclear installations or countries that have them should really be doing. So Arnie, welcome to the show, it's a pleasure to have you.

Arnie Gundersen: Thank you very much and I note that a lot of your readers have come to our site and I appreciate it.

Chris Martenson: We have some great readers and they are interested in knowing the truth, as best they can find it and we have a way of being at our site, which is that we really like to keep our facts very separated from our opinions. Something that I really admire that you do, as well.

Arnie Gundersen: Well thanks.

Chris Martenson: Let's just briefly review – if we could just synopsize – I know you can do this better than anybody. What happened at Fukushima – what happened and I really would like to take the opportunity to talk about this kind of specifically, like where we are with each one of the reactors. So first of all, this disaster – how did it happen? Was it just bad engineering, was it really bad luck with the tsunami? How did this even initiate – something we were told again and again – something that couldn't happen seems to have happened?

Arnie Gundersen: Well the little bit of physics here is that even when a reactor shuts down; it continues to churn out heat. Now, only five percent of the original amount of heat, but when you are cranking out millions of horsepower of heat, five percent is still a lot. So you have to keep a nuclear reactor cool after it shuts down. Now, what happened at Fukushima was it went into what is called a "station blackout," and people plan for that. That means there is no power to anything except for batteries. And batteries can't turn the massive motors that are required to cool the nuclear reactor. So the plan is in a station blackout is that somehow or another you get power back in four or five hours. That didn't happen at Fukushima because the tidal wave, the tsunami, was so great that it overwhelmed their diesels and it overwhelmed something called "service water 2" But in any event, they couldn't get any power to the big pumps.

Now, was it foreseeable? They were prepared for a seven-meter tsunami, about twenty-two feet. The tsunami that hit was something in excess of ten and quite likely fifteen meters, so somewhere between thirty-five and forty-five feet. They were warned that the tsunami that they were designed against was too low. They were warned for at least ten years and I am sure that there were people back before that. So would they have been prepared for one this big? I don't know, but certainly, they were unprepared for even a tsunami of lesser magnitude.

Chris Martenson: So the tsunami came along and just swamped the systems and I heard that there were some other design elements there too, such as potentially the generators were in an unsafe spot or that some of their electrical substations all happened to be in the basement, so they kind of got taken out all at once. Now, here's what I heard – the initial reports when they came out said, "Oh, nothing to fear, we all went into SCRAM," which is some kind of emergency shutdown and they said everything is SCRAMed and I knew that we were in trouble in less than twenty-four hours, they talked about how they were pumping seawater in. Which I assume, by the time you are pumping seawater you have a pretty clear indication from the outside that there is something really quite wrong with this story, is that true?

Arnie Gundersen: Yes. Seawater and as anybody who has ever had a boat on the ocean would know, saltwater and stainless steel do not get along very well. Saltwater and stainless steel at five hundred degrees don't get along very well at all. You are right, they had some single points of vulnerability – the hole in the armor and the diesels were one of them. But even if the diesels were up high, they would have been in trouble because of those service water pumps I talked about. And they got wiped out and those pumps are the pumps that cool the diesels. So even if the diesels were runnable, cooling water that runs through the diesels would have been taken out by the tsunami anyway. So it's kind of a false argument to blame the diesels.

Chris Martenson: Okay, so take us through. Reactor number one, it was revealed I think about a week ago now that they finally came to the revelation that I think some of us had come to independently, that there had been something more than a partial meltdown, maybe even a complete meltdown. What is your assessment of reactor one and where is it right now?

Arnie Gundersen: When you see hydrogen explosions, that means that the outside of the fuel has exceeded 2,200 degrees and the inside is well over 3,500 degrees. The fuel gets brittle, it burns, and then it plops to the bottom of the nuclear reactor in a molten blob like lava. It was pretty clear to a lot of people, including apparently to the NRC, but they weren't telling people back in March, that that had occurred in reactor one.

There was essentially a blob of lava on the bottom of the nuclear reactor. So I have to separate this – a nuclear reactor - and that is inside of a containment. So there is still one more barrier here. But the problem is that the reactor had boiled dry and they were using fire pumps connected to the ocean to pump saltwater into the reactor.

Now, if this thing were individual tubes, the water could get around the uranium and completely cool it. But when it's a blob at the bottom of the reactor, it can only get to the top surface and that would cause it to begin to meltdown. Now, on these boiling water reactors, there are about seventy holes in the bottom of the reactor where the control rods come in and I suspect that those holes were essentially the weak link that caused this molten mass. Now it's 5,000 degrees at the center, even though the outside may be touching water, the inside of this molten mass is 5,000 degrees. It melts through and lies on the bottom of the containment.

That's where we are today. We have no reactor essentially, just a big pressure cooker. The molten uranium is on the bottom of the containment. It spreads out at that point, because the floor is flat. And I don't think it's going to melt its way through the concrete floor.

It may gradually over time; but the damage is already done because the containment has cracks in it and it's pretty clear that it is leaking. So you put water in the top. And the plan had never been to put water in the top and let it run out the bottom. That is not the preferred way of cooling a nuclear reactor in an accident. But you are putting water in the top and it's running out the bottom and it's going out through cracks in the containment, after touching directly uranium and plutonium and cesium and strontium and is carrying all those radioactive isotopes out as liquids and gases into the environment.

Chris Martenson: So this melting that happened, is this just a function of the decay heat at this point in time? We're not speculating that there has been any sort of re-criticality or any other what we might call a nuclear reaction – this is just decay heat from the isotopes that are in there from prior nuclear activity – those are just decaying and giving off that heat. That's sufficient to get to 5,000 degrees?

Arnie Gundersen: Yes, once the uranium melts into a blob at these low enrichments, four and five percent, it can't make a new criticality. If criticality is occurring on the site - and there might be, because there is still iodine 131, which is a good indication - it is not coming from the Unit 1 core and it's not coming from the Unit 2 core, because those are both blobs at the bottom of the containment.

Chris Martenson: All right, so we have these blobs, they've somehow escaped the primary reactor pressure vessel, which is that big steel thing and now they are on the relatively flat floor of the containment – they concrete piece – and you say Unit 2 is roughly the same story as Unit 1 – where's Unit 3 in this story?

Arnie Gundersen: Unit 3 may not have melted through and that means that some of the fuel certainly is lying on the bottom, but it may not have melted through and some of the fuel may still look like fuel, although it is certainly brittle. And it's possible that when the fuel is in that configuration that you can get a re-criticality. It's also possible in any of the fuel pools, one, two, three, and four pools, that you could get a criticality, as well.

So there's been frequent enough high iodine indications to lead me to believe that either one of the four fuel pools or the Unit 3 reactor is in fact, every once in a while starting itself up and then it gets to a point where it gets so hot that it shuts itself down and it kind of cycles. It kind of breathes, if you will.

Chris Martenson: Right, so when it's doing that breathing, it's certainly generating a lot of heat through the fission process and then of course, it's generating more isotopes to decay and contribute to the decay heat at that point. What's your assessment if there is that sort of breathing going on, is sort of like a little pocket within one of the geometries that exists that would still allow fission to be supported or could you imagine this being a fairly significant amount or how much do you think might be happening?

Arnie Gundersen: I think it's a relatively significant amount – maybe a tenth of the nuclear reactor core starts back up and shuts back down and starts back up and shuts back down. And that's an extra heat load; you are not prepared to get rid of one tenth of a nuclear reactor's heat by pumping water in the top

Now, Unit 3 has another problem and the NRC mentioned it yesterday for the first time and it gets back to that saltwater and the effect on iron. They are afraid that the reactor bottom will break, literally just break right out and dump everything. Because it's now hot and it's got salt on it and it's got the ideal conditions for corrosion.

So the big fear on Unit 3 is that it will break at the bottom and whatever else remains in it, which could be the entire core, could fall out suddenly. And if that happens, you can get something called a "steam explosion," and this may be a one in a hundred chance. I don't want your listeners to think it's going to happen tomorrow, but if the core breaks you will get a steam explosion, but we're not sure the core is going to break. And that is a violent hydrogen explosion like the one we've already witnessed.

Chris Martenson: Reactor 3 caught me when it blew, because what I saw there with my eyes was a fairly focused upwards very high-energy event, which completely looked different from what I saw when Unit 1 blew. Are you talking about – is that or I know you have postulated in the past that you think that might have been -- what's the name for it a "prompt" criticality?

Arnie Gundersen: I called it a "prompt criticality," that created a detonation and engineers differentiate – either way it's going to be a big explosion. But the violence of Unit 3's explosion and I did some calculations to show that the speed at which the flame traveled in order to through particles as far as this one threw particles – the speed of that shockwave had to be in excess of a thousand miles per hour. That's a detonation, where the shockwave itself can cause incredible damage and that can happen if we were to have one of these steam explosions at the bottom of the reactor in Unit 3 falls out – you could have another one of those all over again.

Chris Martenson: Obviously, not a good thing if that happens. What can they do at this stage though, if that is a concern that they have – this sounds very tricky to me, because if it turns out that there is excess heat being generated because we are having this breathing re-criticality event going on, but for whatever reason let's just say that the core of reactor three is pretty hot. What can they really do beyond just keep trying to dump water in there and keep their fingers crossed?

Arnie Gundersen: Well, that's two out of the three things they have to do. The other one is they can flood, if they can flood it from the outside – in other words, put water outside the pressure cooker, as well as inside the pressure cooker. They may be able to remove more heat that way and prevent the gross failure of the pressure vessel. But really, it's just hoping that you can put enough water in.

And the other piece of that is and it relates to Unit 4 too, is a seismic event. If you put too much water in these reactors they get heavy, and they are not designed to sway when there is heavy – tens of tons of extra water in them. So they are really not designed to sway. So let's say there is a severe aftershock, Unit 3 and Unit 4 are in real jeopardy. And if you remember the Sumatra earthquake, that was a nine plus about three or four years ago. The biggest aftershock occurred three months afterwards and that was an eight six, so aftershocks even though we are two months into this, if the Sumatra event is any indication, aftershocks are still possible.

Chris Martenson: Right and so you mentioned Unit 4 then, also being at risk for this. I thought that unit four, the core was out and that they have some water back in the pool. What is the concern with unit four at this point?

Arnie Gundersen: You are absolutely right and there is no reactor running there. Everything has been taken out and it was put in the spent fuel pool. But that means there is no containment either, so the entire spent fuel pool is visible literally. When they have those helicopter fly-overs, you can look down into this blown out shell of a building and see the fuel in the spent fuel pool. It's still relatively hot, because it only shut down in November. So there is still a lot of decay hear in that pool.

Brookhaven National Labs did a study in 1997 and it said that if a fuel pool went dry and caught on fire, it could cause a hundred and eighty-seven thousand fatalities. So it's a big concern and probably the biggest concern. I now the Chairman of the NRC said that the reason he told Americans to get out from fifty miles out was that he was afraid that Unit 4 would catch fire, that exposed fuel pool would volatilize plutonium, uranium, cesium, and strontium. And if the Brookhaven Study is to be believed could kill more than a hundred thousand people, as a result.

Chris Martenson: And this is from the effects of radiation or long-term cancer exposures? Something we will get into in a minute.

Arnie Gundersen: Hot particles from long-term cancer exposure.

Chris Martenson: So we have these four units and each of them has sort of had their own crisis and each of them has released contamination into the environment – first how much contamination really got released here? Second, we see that a bunch of it is headed into the ocean, although we're still questioning I think how much and where it all is – so my question is around how much contamination is around these buildings at this point in time and what are the challenges and what happens when – not if – but when typhoon season comes up? Say, we had sort of a large bunch or kind of a storm, would that create issues? I am just trying to play out how much has been released, how much might be released, and what it actually implies at this point in time.

Arnie Gundersen: Well, this event is – **I have said it's worse than Chernobyl and I'll stand by that.** There was an enormous amount of radiation given out in the first two to three weeks of the event. And add the wind and blowing in-land. This could be – it could very well have brought the nation of Japan to its knees, I mean there is so much contamination that luckily wound up in the Pacific Ocean as compared to across the nation of Japan. It could have cut Japan in half. But now the winds have turned, so they are heading to the south toward Tokyo and now my concern and my advice to friends that if there is a severe aftershock and the Unit 4 building collapses, leave. **We are well beyond where any science has ever gone at that point and nuclear fuel lying on the ground and getting hot is not a condition that anyone has ever analyzed.**

So the plants, you will see them steaming and as summer goes on, you will see them steaming less, because the air is warmer, but it's not because they are not steaming, you just don't see it. Because this event occurred in March and it was cool there, so you will see the steam a lot easier. **Those plants are still omitting a lot of radiation.** Nowhere near as much as on the first two weeks, but a lot of **radiation: cesium, strontium, and mainly cesium and strontium** – those are going to head south, whether or not there is a tropical hurricane. **The wind is going to push it south this time and so the issue is not the total radiation you might measure with a Geiger counter in your hand, but hot particles.**

Chris Martenson: Well, there was already and I was taken aback when I read the reports that in some predictors right around Tokyo. They had found what I consider to be pretty hot readings, 3,000 or 4,000 becquerels in the soil -- a 170,000 becquerels in some kind of a fly ash or they found some in sludge, as well. But I think the higher reading was from some sort of ash, which means it came through an incinerator or some sort of burning process. I felt those were pretty shocking levels, because I hadn't really been informed that the winds had shifted south long enough and enough contamination had made it that far in order to get readings like that. So I felt fairly confused, as if I didn't have a good understanding of how much might have gotten there or how it got there or when it got there. And that they had found those readings in March and of course, they didn't release the data until sometime toward the end of April – did you follow that part and what do you make of readings like that?

Arnie Gundersen: Yes I followed it and I am as confused as you are. Individuals have sent Fairewinds some car air filters from Tokyo and they turn out to be one of the ideal ways of measuring ways of radiation, because they trap a lot of these hot particles.

And had one person with seven filters and they ran a body shop or something and five of the filters were fine. And two were incredibly radioactive.

So what that tells me is that the plume was not regular and you'll have places where there was not much deposition and you'll have places where there was a lot of deposition.

That same thing happened up to the north, but within Tokyo it seems like wherever the official results were being reported didn't really represent the worst conditions of the plume. And I saw that on Three Mile Island – we shouldn't be surprised that a plume meanders and a plume may miss a major radiation detector by a quarter of a mile and not be detected. It doesn't mean it's not there, it means we just didn't detect it.

Chris Martenson: Sure, this is fluid dynamics. When you put a drop of dye in a glass of water and watch it swirl around, obviously more ends up in some places than others, so that's part of it. And anybody who has looked at the aftermath of Chernobyl all across Belarus and Ukraine and what not -- it's obviously not a big circle. It's a very, very convoluted map of depositions, so that's part of it. I guess I was surprised because I hadn't heard of any warning signs that that amount could have been deposited that far south yet, but there was. That was pretty interesting to me.

Arnie Gundersen: What happened there was the plume went out to sea, but then curved south and then west. It actually came in like a hook. So that when you were measuring what was happening at Fukushima it appeared that the plume was heading out to sea, but then offshore the winds took it south and then west into Tokyo. It contained the particles that they are picking up in air filters and they are strontium and cesium and americium, which is an indication of fuel failures.

Chris Martenson: Right. That was the same plume that I remember was in South Korea and they actually shut some schools down because it was raining at the time and they had a lot of radiation coming down. So we know that there was a big south and then west 'hooking' in order for it to get there, so maybe that was part of that one process. But it speaks to something, which is that these plumes that are coming up and out of contaminated plumes with radioactive particles in them are pretty hot. As you might expect. I remember the reactor that was scaring me the most for a while was number two, which looked sedate – it had this little hole in the side, but it was just constantly emitting steam, constantly for a whole period of time and I knew what was in that steam – it was going to be pretty hot, I thought.

Arnie Gundersen: Unit 2 has gotten to the point where it can't get any worse, because it is now laying at the bottom of the containment and the containment has a hole in it. That doesn't mean that it's not really bad still: it just can't get any worse.

The concern now is this enormous amount of water that is being used to cool these reactors, so tens of tons an hour. And the original plan was to recirculate the nuclear reactor water through the nuclear reactor. And on the other side have a heat exchanger that took the heat away. So you wouldn't generate any water. In fact, we've got hundreds of thousands of tons of radioactive water. It's not mildly radioactive and here's the problem:

<u>If you were to mineralize this or filter this, the filters and the mineralizers would become so radioactive that the filters might melt, because they are made of a plastic material, and the other part of it is that the personnel couldn't get near the filters to change them. So it's a very difficult problem, what do you do with all of this contaminated water, the large volume and the high radioactivity make getting rid of that water very difficult.</u>

Chris Martenson: I would like to talk about the other challenges they face, too. I don't what they are going to do with all that water and I don't think they do either. They are pumping it into a big storage tank right now and I just read that maybe that is leaking or at least some water went out of it. So one guess is that it is leaking. Talk to us about the other challenges that the engineers and clean up crews are going to be facing. What is the work environment like there right now?

Arnie Gundersen: We are not out of the woods by any stretch of the imagination. The people outside are wearing completely enclosed clothing, taped to their faces and they have respirators on. The respirators are designed with a charcoal filter – but they are breathing through their lungs and they are taking from the outside through those respirators. It's hot, it's sticky, and you are constantly looking at this radiation gauge. But it is something that while uncomfortable, probably isn't lethal.

The people that are going in are a different problem. They are going in, in essentially a bubble suit and they have their own self-contained air like a fireman in a fire – a Scott AirPacks is sort of what they are called. So they are going in with their own self-contained air into a place that has no lights. Into a place that has water everywhere and a place that is dark with rubble.

And on top of that it's highly radioactive and they are probably carrying thirty or forty pounds worth of gear to do whatever it is they were sent in there for. The stay time in that environment would be tough if there were no radiation. It's a hot, sticky, pretty miserable place to work for an hour or so. But the radioactivity levels are so high that these guys are being chased out on the order of fifteen minutes. And they are receiving an exposure, which is roughly equivalent to the worst an American worker would get over five years. These guys are picking it up in ten minutes.

Chris Martenson: So let's assume that they do actually have the – I think they have bumped it up to two hundred fifty millisievert as an annual dose limit now. So once a worker gets to that threshold, then what?

Arnie Gundersen: Hopefully, they are no longer allowed to receive any more radiation - period. Not just for a year or for a month, but they really shouldn't receive any more than that. Here's a general rule of thumb: 250 rem will kill you. So that means that if ten people get twenty-five rem, one of them will develop a cancer. And if a hundred people get 2.5 rem, one of them will get a cancer. So it doesn't mean lesser doses assure you of not getting a cancer. So what these people are doing is they are increasing the likelihood the they will get a cancer – 250 millisievert is 25 rem by the way - but they are increasing the likelihood that they will get a cancer by 10 percent.

Chris Martenson: And so, gosh, some of the readings that I saw in there are pretty scary hot readings, some are definitely all the way up in the one sievert zone for some of the areas and some are hotter in all of that. So we've got these damaged buildings – they are sending people in. My concern has been that there are only so many people who are trained to work in those facilities and so they know them and they know them well, the systems, the parts, and how to even navigate the hallways. Once they have gone through and used up their allotment of radiation exposure – they are done, right? And I guess they train the next people to go in.

One thing that concerns me is that I know that when Chernobyl went – Russia just threw hundreds of thousands of people at it in small little bits to clean that up. Here we are seeing a very different response, it is much more measured and it is relatively small teams by my eye. I look at satellite photos and I don't see hundreds of thousands of people converging on that – I see a pretty focused response. How long is it going to take with a focused response like that to get this job done, do you think?

Arnie Gundersen: The Russians needed thousands of people because large fragments of the fuel had fallen on the surrounding farmland, so literally people would pick up a fragment in a wheelbarrow and run toward where the reactor was – throw that fragment into the reactor pit and they were done.

They had received their lifetime exposure. In this case, while the radiation is not contained, it's not coming out of solid particles that can get picked up, it's coming out of this liquid. Woods Hole has already said that the ocean has ten times more radiation from Fukushima than the Black Sea did from Chernobyl.

So the Chernobyl reaction was a large staff of people and because it sort of blew up and the Fukushima reaction, while it did blow up, a lot of it is going down and we're just beginning to deal with it. They are importing workers from the US already and I suspect they will again.

I was in the business as a Vice President, I would hire people to work in very high radiation zones. Now, we would train them for two to three weeks in a mockup and then they would have three minutes in a high radiation zone to do what we trained them for and that would be their yearly exposure. We would give them a check and say thank you very much, see you next year. And that's what will happen here at Fukushima.

Chris Martenson: So talk about -- realistically – I mean this is going to be months, years, whatever, it's going to take a long time. What do they do at this point, are they going to entomb these things, are they required to just keep dumping water on these things until they finally cool down, capturing water all the way through? Or is there some way that they can maybe just throw up their hands and just pour a bunch of concrete on it and call it a day?

Arnie Gundersen: I think eventually they may get to the point of throwing up their hands and pouring the concrete on. They can't do that yet, because the cores are still too hot. So we are going to see the dance we're in for another year or so, until the cores cool down. At that point, there's not anywhere near as much decay heat and you probably could consider filling them with concrete and just letting sit there, like we have it at Chernobyl, as a giant mausoleum.

That would work for units 1, 2, and 3. Unit 4 is still a problem, because again all the fuel is at the top and you can't put the concrete at the top because you will collapse the building and it's so radioactive, you can't lift the nuclear fuel out. I used to do this as a living and Unit 4 has me stumped.

Chris Martenson: So what do they do, do you think?

Arnie Gundersen: I think they will be forced to build a building around the building and then, because you need heavy lifting cranes – cranes that lift a hundred and fifty tons, which are massive cranes, to put the put the nuclear fuel into canisters, which then can get removed.

That is sort of what happened at TMI, but all of the fuel at TMI was still at the bottom of the vessel. But it was a three-year process to get the molten fuel out of Three Mile Island – four years actually.

So the problem here is that all of the cranes that do that have been destroyed, at least on units 1, 3, and 4. And you can't do it in the air. It has to be done under water. So my guess is that they will have to build a building around the building to provide enough shielding and water, so that they can then go in and put this fuel into a heavy lift canister.

Chris Martenson: Okay, all right, I hadn't considered that. That's a great insight.

So let me summarize here – we have these four reactors, three of them have melted through – one of them is – Unit 4 – is probably one of the more dangerous ones in the sense that it is going to be years to build a building around it. It's going to be years until really the situation is contained. And in unit four though, we are still concerned that in the year or two or however it takes to build a building and really stabilize that, another aftershock could come along. Or in the case of Unit 3, if another aftershock comes along and the pressure vessel is full of water there's a chance here that we could see other event. That this situation is not yet fully stabilized in the sense that there are still surprises to be found. It's surprising where the water shows up. There might still be some surprises left in how the building behaves or systems hold up or fail. What else would you add to that summary?

Arnie Gundersen: The groundwater. I am very concerned – I am hearing nothing about ground water monitoring. We know the ocean – we know there have been leaks into the ocean. I am not convinced that there are not cracks in the structures that are allowing this highly radioactive water to get into the groundwater.

And I have been talking to people in Japan and my recommendation there is that they should build a moat all the way around the reactor, down to bedrock, which is sixty feet or twenty meters, and about four and a half feet wide, which is a meter and a half wide. And fill it with a material called Zeolite. It's a very good absorber of radioactive material and it would prevent the outward migration of any of this radiation. That's not happening and I don't understand why.

So now we look at the building and we look at stopping the heat and the radiation that is going upward, but this is an enormous amount of radioactive material in the soil right now. And one of the prefectures nearby had radioactive sewage sludge.

Someone who watches our site is an executive at a sewage business and he said it's not uncommon after an earthquake for groundwater to infiltrate a sewage system and that frightened me a lot, because if the groundwater is already contaminated out in these prefectures it could be a serious problem that is receiving no attention right now.

Chris Martenson: So generally speaking, do you have a sense of how fast groundwater migrates? Is this something that will be three miles away from the plant in ten years or in ten weeks. How big of a problem is this immediately?

Arnie Gundersen: I don't think it's an immediate problem, but I do think unless mitigated pretty quickly, it can become an immediate problem. It moves slowly, but if it's already out of the barn, it's going to be harder the further out you have to build this trench, of course the bigger the trench has to be, so my goal is to trap it near the source, than to let the horse get too near the barn.

Chris Martenson: Okay, well thank you for that. What I would like to do now is I would like to move on to a part for our enrolled members and I would really like to talk about what the actual impacts of this are on people.

Arnie Gundersen: "I have said it's worse than Chernobyl and I'll stand by that. There was an enormous amount of radiation given out in the first two to three weeks of the event. And add the wind blowing in-land. It could very well have brought the nation of Japan to its knees. I mean, there is so much contamination that luckily wound up in the Pacific Ocean as compared to across the nation of Japan - it could have cut Japan in half. But now the winds have turned, so they are heading to the south toward Tokyo and now my concern and my advice to friends that if there is a severe aftershock and the Unit 4 building collapses, leave. We are well beyond where any science has ever gone at that point and nuclear fuel lying on the ground and getting hot is not a condition that anyone has ever analyzed."

Chris Martenson: So cautions Arnie Gundersen, widely-regarded to be the best nuclear analyst covering Japan's Fukushima disaster. The situation on the ground at the crippled reactors remains precarious and at a minimum it will be years before it can be hoped to be truly contained. In the near term, the reactors remain particularly vulnerable to sizable aftershocks, which still have decent probability of occuring. On top of this is a growing threat of 'hot particle' contamination risk to more populated areas as weather patterns shift with the typhoon season and groundwater seepage.

In Part 1 of this interview, Chris and Arnie recap the damage wrought to Fukushima's reactors by the tsunami, the steps TEPCO is taking to address it, and the biggest operational risks that remain at this time. In Part 2, they dive into the health risks still posed by the situation there and what individuals should do (including those on the US west coast) if it worsens.

Part II Transcript Starts Below:

Chris Martenson: Let's just briefly review – if we could just synopsize – I know you can do this better than anybody. What happened at Fukushima – what happened and I really would like to take the opportunity to talk about this kind of specifically, like where we are with each one of the reactors. So first of all, this disaster – how did it happen? Was it just bad engineering, was it really bad luck with the tsunami? How did this even initiate – something we were told again and again – something that couldn't happen seems to have happened?

Arnie Gundersen: Well the little bit of physics here is that even when a reactor shuts down; it continues to churn out heat. Now, only five percent of the original amount of heat, but when you are cranking out millions of horsepower of heat, five percent is still a lot.

So you have to keep a nuclear reactor cool after it shuts down. Now, what happened at Fukushima was it went into what is called a "station blackout," and people plan for that. That means there is no power to anything except for batteries. And batteries can't turn the massive motors that are required to cool the nuclear reactor.

So the plan is in a station blackout is that somehow or another you get power back in four or five hours. That didn't happen at Fukushima because the tidal wave, the tsunami, was so great that it overwhelmed their diesels and it overwhelmed something called "service water 2" But in any event, they couldn't get any power to the big pumps.

Now, was it foreseeable? They were prepared for a seven-meter tsunami, about twenty-two feet. The tsunami that hit was something in excess of ten and quite likely fifteen meters, so somewhere between thirty-five and forty-five feet. They were warned that the tsunami that they were designed against was too low. They were warned for at least ten years and I am sure that there were people back before that. So would they have been prepared for one this big? I don't know, but certainly, they were unprepared for even a tsunami of lesser magnitude.

Chris Martenson: So the tsunami came along and just swamped the systems and I heard that there were some other design elements there too, such as potentially the generators were in an unsafe spot or that some of their electrical substations all happened to be in the basement, so they kind of got taken out all at once.

Now, here's what I heard – the initial reports when they came out said, "Oh, nothing to fear, we all went into SCRAM," which is some kind of emergency shutdown and they said everything is SCRAMed and I knew that we were in trouble in less than twenty-four hours, they talked about how they were pumping seawater in. Which I assume, by the time you are pumping seawater you have a pretty clear indication from the outside that there is something really quite wrong with this story, is that true?

Arnie Gundersen: Yes. Seawater and as anybody who has ever had a boat on the ocean would know, saltwater and stainless steel do not get along very well. Saltwater and stainless steel at five hundred degrees don't get along very well at all. You are right, they had some single points of vulnerability – the hole in the armor and the diesels were one of them.

But even if the diesels were up high, they would have been in trouble because of those service water pumps I talked about. And they got wiped out and those pumps are the pumps that cool the diesels. So even if the diesels were runnable, cooling water that runs through the diesels would have been taken out by the tsunami anyway. So it's kind of a false argument to blame the diesels.

Chris Martenson: Okay, so take us through. Reactor number one, it was revealed I think about a week ago now that they finally came to the revelation that I think some of us had come to independently, that there had been something more than a partial meltdown, maybe even a complete meltdown. What is your assessment of reactor one and where is it right now?

Arnie Gundersen: When you see hydrogen explosions, that means that the outside of the fuel has exceeded 2,200 degrees and the inside is well over 3,500 degrees. The fuel gets brittle, it burns, and then it plops to the bottom of the nuclear reactor in a molten blob like lava. It was pretty clear to a lot of people, including apparently to the NRC, but they weren't telling people back in March, that that had occurred in reactor one.

There was essentially a blob of lava on the bottom of the nuclear reactor. So I have to separate this – a nuclear reactor - and that is inside of a containment. So there is still one more barrier here. But the problem is that the reactor had boiled dry and they were using fire pumps connected to the ocean to pump saltwater into the reactor. Now, if this thing were individual tubes, the water could get around the uranium and completely cool it. But when it's a blob at the bottom of the reactor, it can only get to the top surface and that would cause it to begin to meltdown. Now, on these boiling water reactors, there are about seventy holes in the bottom of the reactor where the control rods come in and I suspect that those holes were essentially the weak link that caused this molten mass. Now it's 5,000 degrees at the center, even though the outside may be touching water, the inside of this molten mass is 5,000 degrees. It melts through and lies on the bottom of the containment.

That's where we are today. We have no reactor essentially, just a big pressure cooker. The molten uranium is on the bottom of the containment. It spreads out at that point, because the floor is flat. And I don't think it's going to melt its way through the concrete floor. It may gradually over time; but the damage is already done because the containment has cracks in it and it's pretty clear that it is leaking. So you put water in the top. And the plan had never been to put water in the top and let it run out the bottom. That is not the preferred way of cooling a nuclear reactor in an accident. But you are putting water in the top and it's running out the bottom and it's going out through cracks in the containment, after touching directly uranium and plutonium and cesium and strontium and is carrying all those radioactive isotopes out as liquids and gases into the environment.

Chris Martenson: So this melting that happened, is this just a function of the decay heat at this point in time? We're not speculating that there has been any sort of re-criticality or any other what we might call a nuclear reaction – this is just decay heat from the isotopes that are in there from prior nuclear activity – those are just decaying and giving off that heat. That's sufficient to get to 5,000 degrees?

Arnie Gundersen: Yes, once the uranium melts into a blob at these low enrichments, four and five percent, it can't make a new criticality. If criticality is occurring on the site - and there might be, because there is still iodine 131, which is a good indication - it is not coming from the Unit 1 core and it's not coming from the Unit 2 core, because those are both blobs at the bottom of the containment.

Chris Martenson: All right, so we have these blobs, they've somehow escaped the primary reactor pressure vessel, which is that big steel thing and now they are on the relatively flat floor of the containment – they concrete piece – and you say Unit 2 is roughly the same story as Unit 1 – where's Unit 3 in this story?

Arnie Gundersen: Unit 3 may not have melted through and that means that some of the fuel certainly is lying on the bottom, but it may not have melted through and some of the fuel may still look like fuel, although it is certainly brittle. And it's possible that when the fuel is in that configuration that you can get a re-criticality. It's also possible in any of the fuel pools, one, two, three, and four pools, that you could get a criticality, as well. So there's been frequent enough high iodine indications to lead me to believe that either one of the four fuel pools or the Unit 3 reactor is in fact, every once in a while starting itself up and then it gets to a point where it gets so hot that it shuts itself down and it kind of cycles. It kind of breathes, if you will.

<u>End of Interview Part I</u>

Arnie Gundersen is an energy advisor with 39 years of nuclear power engineering experience. A former nuclear industry senior vice president, he earned his Bachelor's and Master's Degrees in nuclear engineering, holds a nuclear safety patent, and was a licensed reactor operator. During his nuclear industry career, Arnie managed and coordinated projects at 70-nuclear power plants around the country. He currently speaks on television, radio, and at public meetings on the need for a new paradigm in energy production. An independent nuclear engineering and safety expert, Arnie provides testimony on nuclear operations, reliability, safety, and radiation issues to the NRC, Congressional and State Legislatures, and Government Agencies and Officials throughout the US, Canada, and internationally.

Arnie Gundersen Interview (Part II):

http://www.chrismartenson.com/page/transcript-exclusive-arnie-gundersen-interview-dangers-fukushima-are-worse-and-longer-lived-we-

Protecting Yourself If The Situation Worsens

Friday, June 3, 2011

Executive Summary

•Identifying the health dangers from radiation & contamination

•Steps those living in Japan and the US West Coast should be taking today

•Precautions to take with food

•The implications of radioactive seawater

•Urgent steps to take in a worst-case scenario if reactor 4 collapses

The Dangers of Fukushima Are Worse and Longer-lived Than We Think

May 3, 2011 – Part II

Part II: Arnie Gundersen Interview: Protecting Yourself If The Situation Worsens

Chris Martenson: So yes, I am interested in personally, now much more than I used to be, I think in really thinking these issues through. So the first thing is here is where I'd like to start because here is where a huge source of confusion lies - and the media hasn't helped this one a lot. It's the difference between radiation dangers and contamination dangers from radioactive particles. Can you talk to us about that?

Arnie Gundersen: There are three kinds of radioactive material: there are gamma rays: initially when the nuclear reactors blew they emitted large clouds of xenon and krypton gases. Those are noble gases. They don't react with your skin or anything but they emit gamma rays.

So the readings you saw with people walking around with the Geiger counters were from essentially being in a cloud of gamma rays hitting them from the outside. And that's significant but it is also dispersed over your entire body.

To my mind, the bigger problem, are the two ways that radioactive material decays and those are called beta particles and alpha particles. They don't travel as far but they have an enormous amount more energy than a gamma ray. So if they lie on your skin, you are just fine. You can wash it off and life goes on.

The problem is if they get inside they can selectively go to an organ and bombard a very small piece of tissue with a lot of exposure and potentially cause a cancer and that is what we call a hot particle. All of these particles are radioactive. But when you talk about contamination it means almost always that one of these particles gets attached to an organ and begins to bombard that organ.

Chris Martenson: So with radiation there is three types, there is the alpha particles, which is a particle, we have beta, which is a particle and then we've got gamma rays.

So I guess when we are saying radiation it is like somebody says oh, let's talk about cars. There is Lamborghinis, there is VW Beetles, there is Mustangs there is all these different things so we have to first we have to know a little bit about that and radiation exposure levels, as I understand them, are set at sort of a whole body level that says you can have so many REMs.

Which you can get a REM of alpha particles hitting you, a REM of beta, a REM of gamma. It is just sort of a standardized way of saying you are going to get this whole body exposure, we are just going to hit you. Like when you go to get an X-ray or something, another type of radiation, an X-ray. So that is one part.

But the contaminated particles that happen to be emitting radioactivity are the issue because they can localize just make it simple, we inhale a 10 micron particle and it happens to be radioactive. It goes into our villi in our lungs and it sticks there potentially. And it is now going to in a very, very, very small, very close way, intimate way, be bombarding that tissue around that particle for however long it happens to be radioactive or until it gets excreted somehow.

So the idea here then is that radiation tells us sort of something, but very few people actually die from radiation as I understand it. It is a very rare event because you need a whole lot of it on a whole body level to really take somebody down.

But contamination is a whole different matter that the lethal dose from contamination can actually be really small measured on a radiation scale. I am thinking now of this guy, Lenchenko, who was actually poisoned. He was a Russian dissident and he was poisoned in London in 2006 with a very, very small amount of polonium 210, it is an alpha emitter. He got that in his food somehow and then because of where polonium goes it ended up killing him, I think very rapidly, in nine or 10 days, considering. So the thing that I really want to invite people to consider is the real key around contamination is to not get it in your body. That's part one.

How would people, how do you do that? If you were so let's imagine, Arnie, there you are, you are living in Tokyo now or closer, how would you be behaving over there right now?

Arnie Gundersen: **Yes, and actually we should extend this to the West Coast, because the same particles there too.**

To answer your question about Tokyo; what I'm advising people in Tokyo who are there now, is take your shoes off at the door, wet dust. Don't dry dust. We are actually finding that contamination inside houses is higher now than contamination outside because it has been trucked in over the last two months and it hasn't left.

And if you dry dust you throw all of that radioactive material up into the air. I am also advising friends there to buy these little HEPA filters, high efficiency particulate filters that look like a little round device that sits on the floor, and change the filters frequently.

Also advising people to remove the filters in their air conditioners and the air conditioner in their car, and replace them. Because they pick up particles over the last couple of months and it is a good time to replace them as well. Also telling people don't do any demolition work. The last thing you want to do right now is tear a wing off your house because you will stir up that dust, not knowing exactly what's in it, you run a risk of contamination.

The other things I am telling friends in Tokyo is keep your eye on Unit Four. If there is an earthquake and Unit Four topples don't believe the authorities you are well beyond where science has ever imagined and it is time to get on a flight and get out of there.

Chris Martenson: Don't ask any questions. Just move. What about food? I mean, this is a big issue and I would think this would be potentially an issue for people on the West Coast of the US even. Is the idea that there are certain isotopes up there and particles that can somehow get through the food chain, maybe through milk because cows graze a whole lot of grass and turn it into a very little bit of milk helping to concentrate whatever was on that grass or leafy vegetables that have a real affinity for certain of these isotopes, potentially cesium, certainly iodine if that is still around, which it shouldn't be, but apparently it still is. How do you approach food? Because that is one quick way to ingest things.

Arnie Gundersen: Well, the cow milk predominantly would have iodine and we are out now at 80 days and most of the iodine should have disappeared because it has an eight day half life and the rule of thumb is 10 half-lives.

But we are still seeing iodine which is kind of strange and it gets back to that issue of criticality re-criticality that we talked about earlier. So I'm still telling friends until the middle of June stay away from milk and dairy products. Clearly washing the vegetables is critical.

In Japan we are saying avoid fish caught in the Pacific, unless you know they are caught a long way away from Fukushima. I am saying 100 miles of Fukushima, don't even consider it. I think that will actually get worse with time.

Greenpeace has some numbers that came out indicating that it is worse with time. So we are telling the Sea of Japan is a different story. You can probably feel safe eating fish from the Sea of Japan. But if you believe it came from the Pacific, avoid it.

Arnie Gundersen: There is two isotopes there; the predominant one is cesium, which is a muscle seeker so of course fish meat is muscle and cesium is likely to build up in your body if you take it from fish. The other one, strontium, which would be in the fish bone.

So unless you have some kind of a delicacy that uses the fish bone, the fish is unlikely to expose you to strontium. So eventually though we are going to see top of the food chain animals like tuna and salmon and things like that that have this process bio accumulates.

The bigger fish gradually get higher and higher concentrations. And I am concerned that the FDA is not monitoring fish entering the United States because sooner or later a tuna is going to set off a radiation alarm at some part and people are going to think it's a dirty bomb or something like that.

So that's not here yet because the tuna haven't migrated across the Pacific. But I am thinking by 2013 we might see contamination of the water and of the top of the food chain fishes on the West Coast.

Chris Martenson: I keep hearing the Pacific is a really big ocean, that old saw has been touted out a lot. And I think what they are missing here, in those stories of course, is what you mentioned is the bio accumulation which is that these are – many of these isotopes mimic really important elements and so our bodies preferentially take them up and so do microorganisms and they all get eaten by something larger than them and so on as we go.

And over the course of that, we should all be familiar with this. Because this is how mercury tends to bio accumulate. This is how a lot of toxins bio accumulate. So we are talking about the concentration of radioactive particles. You mentioned that you had some assessment that more radioactivity has landed in the Pacific than did in the Black Sea from Chernobyl. Do you have a sense of how much you think has gone in?

Arnie Gundersen: Well, actually it's Woods Hole, and they are certainly a reputable scientific organization. They are saying 10 times more. And yes, the Pacific is big. But we are still talking about what's there now and I think it's important for everyone to understand that we are not out of the woods, when Chernobyl was over we are still 10 times when Chernobyl is over and we still have no end in site from releases from Fukushima and it is already 10 times that.

I am concerned, we have already seen small fish on the order of four or five inch fish as far away as 50 miles containing cesium levels of 10 to 50 times higher than allowable. And of course those fish are going to get eaten by bigger fish up the food chain. So it's a concern.

Arnie Gundersen: Seaweed seems to absorb iodine, but it also absorbs cesium which is something that I just learned. I was worried I was telling people don't worry about seaweed after 90 days because the iodine is all gone. But I'm not sure about that at this point. Because as I understand it now it can also absorb the cesium, so I am a little unsure on that science.

Chris Martenson: Well, fortunately the EPA has a rigorous testing program in place, right?

Arnie Gundersen: Trust me, I'm from the government.

Chris Martenson: Yes, unfortunately on that. So this is part of the environmental legacy of Fukushima. And oh, by the way, I should mention in my research I came across the idea that shellfish particularly crabs and other crustaceans will accumulate cesium pretty heavily in their shells so we might want to add shellfish to the cesium story there as well.

I think if I lived there, personally, I would just be avoiding all seafood Pacific. As you mentioned I think that is sage advice at this point. Until and unless we had a really believable and aggressive monitoring program I would be personally leery myself. Can you talk to us, what really then are the health risks that are faced by those that live in or near the reactor at this point, on the reactor complex?

Arnie Gundersen: Well, there is a large plume of radioactivity that moved to the north and to the west. Out as far as 50 miles. I don't know how you are going to clean it up economically. The cesium deposition higher than the forbidden zones of Chernobyl, out 50 miles just in that northwesterly direction. So again, thank God, the wind was blowing mainly out to see. I think it's going to boil down to does Japan want to spend the money. I can't imagine people ever getting back in to the 20 kilometer zone, especially in the northwestern quadrant. It just is going to cost way too much to decontaminate that land. Farming is going to be a problem now as well because again, cows and cattle will absorb cesium for years to come. We are seeing that in Germany after Chernobyl we are still seeing, 30 years ago, wild boars in Germany that eat mushrooms are still contaminated with cesium. So this is not a problem that goes away in a generation, it hangs around for quite a while.

I think there is two cost issues here. I think the cost – and it really does boil down to money at some point. The cost to decontaminate the site is probably going to be on the order of $30 to $50 billion. Normally a decommissioning is around a billion to decommission a plant that is really clean. But each of these plants has got a molten glob of fuel at the bottom which is territory that no one has ever assessed. And that is just the site. So I am thinking that a $30 to $50 billion hit for the nation of Japan because I don't think Tepco can afford it, as well as contamination further inland could easily be $100 billion more.

Now, I put that out on my website and I had people say oh no, it is never going to be that high. Of course it will be a long time before we get there. And some of those costs might get mixed up with tsunami costs as well. It wouldn't surprise me in excess of $100 billion to decontaminate that area within 20 to 30 kilometers of Fukushima would be a realistic number.

Chris Martenson: And when we say decontaminate, so I guess you scrub surfaces, but once you have got stuff down to the soil level don't you do what they did at Chernobyl? What can you do besides carve the top number of inches off and cart it away and pile it up somewhere, is there more that can be done?

Arnie Gundersen: <u>No. No, there's not. Basically it becomes a disposal somewhere. So it has to go to somebody's backyard.</u> And cesium is quite water soluble so it does move down through the soil over time. There is some work with zeolite that seems to indicate you can lay down some zeolite and it will pull the cesium back out. You are talking about hundreds of square miles here. So this is a little more than a science project.

Chris Martenson: I am still a little bit shocked that you were able to receive air filters through the mail, I presume in some way, that came in with some contamination on them and this is something I have been focused on for a while, is trying to assess what the real economic impacts are going to be outside of the borders of Japan.

A very important manufacturing, industrial center, critical in certain supply chains. Maybe we will find ways to mitigate that over time. But for now they have a bunch of critical functions. And just worrying about what might happen to their import/export balance if it turns out that there is more evidence of these strange contamination moments popping up; hey, it's in the sludge. Oops, it's in air filters. They don't really, it could end up anywhere.

Do you have any insight into what sort of supply chain disruptions you might expect at this point or how they might manage this process of importing/exporting given everything needs to be checked for contamination and how would you go about that? What are we facing here?

Arnie Gundersen: <u>Well I was a little bit surprised that Hillary Clinton made sort of a pact with the Japanese to try to encourage buying Japanese food and vegetables.</u> Clearly the food and vegetable chain we already talked about. I think the large industrial products like automobiles and transistors and computers and things like that are going to be just fine. The boxes they are made in I might be a little bit concerned about that they are shipped in. But I would expect that the shippers would be on top of that because the last thing somebody wants is a crate load of televisions coming up contaminated because the boxes are contaminated. So I think the big guys are going to be alert to that Mitsubishis and the Sonys and the Hitachis and they are going to watch that a lot. **The intermediate people in the market, the small manufacturers who some clay pots coming out of Japan and things like that I am hoping there will be some kind of government monitoring on that because without that I don't have any confidence of what kind of product I am buying.**

Chris Martenson: Alright, to wrap this up, I am just interested in for all of our listeners who may live in Japan or live in the West Coast or wherever they may be; if there is an aftershock and if Building four sort of topples over what would your advice be, I heard your advice to the people in Japan, get on a plane if possible or get far away or know which way the wind is moving and go in the other direction. What would you do if you were in the United States and you saw that that had happened?

Arnie Gundersen: Well, I am in touch with some scientists now who have been monitoring the air on the West Coast and in Seattle for instance, in April, the average person in Seattle breathed in 10 hot particles a day.

Chris Martenson: What? I did not know that.

Arnie Gundersen: Well, the report takes some time to make its way into the literature. The average human being breathes about 10 meters a day of air, cubic meters of air. And the air out in the Seattle area are detecting, when they pull 10 cubic meters through them, this is in April now, so we are in the end of May so it is a better situation now. **That air filter will have 10 hot particles on it.** And that was before the Unit Four issue.

Clearly we all can't run south of the equator to our second homes in Rio or something like that. But it will stay north of the equator for anyone who has a Leer jet and can get out. But I guess what I am advising at that point is keep your windows closed. I would definitely wear some sort of a filter if I was outside. I certainly wouldn't run and exercise until I was sure the plume had dissipated. This isn't now. This is, as you were saying, this is worst case.

If Unit Four were to topple, I would close my windows, turn the air conditioner on, replace the filters frequently, damp mop, put a HEPA filter in the house and try to avoid as much of the hot particles as possible. You are not going to walk out with a Geiger counter and be in a plume that is going to tell you the meter. The issue will be on the West Coast, hot particles. And the solution there is HEPA filters and avoiding them.

There is also potentially some medical issues Maggie and I have been working with a couple of doctors to look at ways to mitigate to help your body cleanse particles if you know you have been exposed to them. But that is a little bit premature to go into much more detail on that.

Chris Martenson: Right. So but this is all worst case and we are just going to keep our eyes on it. I think the important message here is that the situation is not yet over. It is something we are going to have to keep our eyes on, which is tricky, the media tends to not have a very long attention span when it comes to these things. In your estimation it is still an evolving situation over there. There could still be some curveballs. It is possible there might be a steam explosion at three, might be a toppling event at Building Four these are some of the key risks we are going to keep a look out for. Is there anything else to this story you want to add?

Arnie Gundersen: No. It is going to be a long slog.

Chris Martenson: Yea, well thank you so much, Arnie. It has been a fabulous conversation and again where should people go if they want to follow you and find out more?

Arnie Gundersen: For More Information: http://www.fairewinds.com/home

Maggie and I are doing it for free. It has been a volunteer work. We do have a donate button to keep our computer whiz computing but it is a not for profit venture.

Your faithful information scout,
Chris Martenson

"End of Interview"