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March 11, 2011-Brief Chronology of Events + Description – Day 1 Japan Nuclear Disaster'
Transcript of the Rachel Maddow Show

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Guests: Edwin Lyman, Nathan Layne, Joe Cirincione

RACHEL MADDOW, HOST

MADDOW: Nuclear power is a very, very expensive way of boiling water. Instead of a nuclear fission, a nuclear chain reaction causing a nuclear explosion, nuclear power plants control the chain reaction, channel the massive energy of what would be a mushroom cloud instead into heat, a massive amount of heat. And we use that heat to boil water.

That's what a nuclear power plant does. They boil water. The water makes steam, the steam spins turbines, and the spinning turbines make electricity.

It is a logical process, but it has two problems.

First: even when used as directed, making power this way produces nuclear waste—radioactive dangerous waste that can in some cases be turned into the raw material for nuclear weapons.

But second: Beyond the nuclear waste problem, nuclear power production is kind of a high-wire act. When the whole idea behind what you're doing depends on this plant controlling a nuclear chain reaction, you really can't afford anything that might interrupt your control. In most reactors, if there's any sort of local disturbance, say an earthquake, the nuclear chain reaction process is immediately shut down, control rods drop into the hot, hot nuclear core to stop the fission process.

But even when it's not still in effect turned on, that nuclear core is still so hot that a lot of things still have to go right in order to keep something really bad from happening.

Have you ever noticed that a lot of nuclear power plants are on the shore, they're right on top of a water source? If you tend to think of nuclear power plants in terms of the possibility of radioactive leaks or emissions, it can be unnerving to see those nuclear towers right on your local river, your local coastline. But the reason they're on the water is because they use a huge amount of water to cool down that unimaginably hot nuclear core.

Even when the process of nuclear fission is stopped, the nuclear core is so hot it needs a constant, heavy supply of cool water to be cycled around the nuclear core in order to dissipate its heat, pumping huge amounts of water through the cooling system to dissipate that nuclear heat. Ironically enough, that actually takes power, electric power, even if the plant is turned off.

So, if an earthquake or some other disaster is severe enough to cut off electrical power to a nuclear power plant, if it is severe enough to disrupt the backup systems, too, if the power is off and water isn't flowing through those tanks to dissipate that heat from that nuclear core, then that core will, over time, turn all the water into the cooling system into steam, it will start to evaporate. And if the power is off so long that the watery evaporates so much, that the water levels fall so low, that the nuclear core itself gets exposed to the air, its un-dissipated heat will cause what is called as nuclear melt down. I'm not using that as a metaphor, I mean that literally.

A meltdown of the nuclear core—it overheats, it melts, it melts through and ultimately destroys the reactor. And then we pray whatever containment facilities built around the reactor are sufficient to actually contain the disaster.

Today, at 2:46 p.m. local time in Japan, the Tokyo Electric Power Company reported that the three reactors at a nuclear plant called Daiichi were shut down due to the massive earthquake in that country.

Here's an important to note—at 2:46, at that first announcement, they said they had lost electrical power that they get from off-site. But they said they've been able to switch to their backup, to on-site diesel generators.

Remember, the earthquake that hit Japan was offshore. The tsunami caused by the earthquake didn't hit shore until about an hour after the big quake.

So, at 2:46, after the quake, but before the tsunami, the reactor is shut down, right? And they lost power. But their on-site generators were working to keep the thing cool.

But then 55 minutes later, at 3:41 local time, a second announcement came from that plant. Now, the backup generators were out, too. We don't know if they were knocked out by the tsunami—the timing seems right—but the backup power source failed.

So, then the Daiichi plant was down to just the failsafe for the failsafe, which is battery powered generators. And those only last as long as the batteries hold out, if they can't be recharged.

The stakes here are high. If they cannot keep power onto keep water circulating through the cooling system around the nuclear core, the nuclear core will evaporate the water that is surrounding it, the core will ultimately be exposed, and it will melt down—and that is very bad.

Authorities initially evacuated a two mile radius around the Daiichi plant. They then extended that evacuation area to six miles.

As they vented the steam being produced by the water that is in the cooling system, the Japanese nuclear safety agency said radiation levels had risen to 1,000 times normal in the control room of that plant. Officials reportedly described radiation levels eight times normal at the gates of the facility.

Japan has declared an atomic power emergency. The International Atomic Energy Agency—and this is the good news part you've been waiting for—the International Atomic Energy Agency says mobile electricity supplies have arrived at the reactor site.

Japan has more than 50 nuclear power plants. At least 10 reactors are off line because of the quake.

In addition to the Daiichi plant, they are also this evening—they also this evening declared another emergency at another plant called Daini as well. This is where the Daiichi plant is and this is where the Daini plant is. You can see nearby. We've also marked Tokyo on this map so you can see where that is, as well as the epicenter of the earthquake so you can see how this all fits together.

Joining us now is Edwin Lyman. He's senior scientist at the Union of Concerned Scientists. He's an expert on nuclear power. Dr. Lyman, thanks very much for your time today.

DR. EDWIN LYMAN, UNION OF CONCERNED SCIENTISTS: It's great to be here.

MADDOW: Between the two of us, there's only one PhD in physics and it is yours. If you could just—if you could start by letting us know if anything that I just explained—if I misstated anything or if there's anything critical that I left out.

LYMAN: Actually, it was technically flawless. And I think you should get an honorary doctor at in nuclear engineering.

MADDOW: Well, that's—this is starting off very, very well. I like the sound of this.

Is there anything about how the situation has progressed over the last—even over n the last few hours that makes you feel any better or more reassured about the chances of preventing a big disaster here?

LYMAN: Unfortunately, I'm getting less reassured with every update. The news that the incident was affecting not just three reactors at Daiichi but also a number of reactors at Daini indicated that the authorities were not being up front a long time ago in their dealings with the public, and just makes the situation seem as if it's escalating out of control. So, I'm really worried about what else we are not being told at this point.

MADDOW: When the authorities put up statements about pressure in some of these reactors rising—we saw one report today, for example, that pressure in one of the Daiichi reactors was more than twice its designed capacity. What does that mean? What are they talking about with pressure? How dangerous is that? How do you alleviate that pressure?

LYMAN: Well, the danger is that, of course, as the reactor gets hotter and the containment atmosphere gets hotter, the pressure will increase. And in order to avoid a potentially catastrophic rupture, the hope is that you release some of the pressure by venting some radioactive gas now and avoid a larger catastrophe later. So, it is really a devil's bargain. But, of course, the radiation exposure resulting from moderate venting is going to be a lot less than if this accident actually progresses to a worst case where we have a full-scale core melt, and then a catastrophic rupture of containment.

MADDOW: To be clear about that venting, that essentially is a controlled, deliberate release of some amount of radiation. And, obviously, that's a better scenario than an uncontrolled release of a lot of radiation. But is there reason to be concerned even about what has been vented, even though it's been done on purpose?

LYMAN: Well, any amount of radiation is a hazard. It's an established fact that there's no safe level of radiation. So, of course, any artificial radiation introduced into the environment is a concern.

But I think—you know, I understand the logic behind doing controlled venting at this point and I think we all just need to hope that it's going to work because if there's a catastrophic rupture of the containment and large-scale core melt, we could be facing something like Chernobyl as opposed to something like Three Mile Island. At Three Mile Island, as bad as it was, they were able to avert a full-scale containment failure, and there was a release of radiation but comparatively small. But, of course, you know, you're dealing with comparatives here. It's—you know, you have two unpalatable choices and you have to decide.

MADDOW: I don't mean to ask you to explain the obvious. But just looking at these images from Japan today, confronting the certainty of hundreds of deaths, the likelihood of more than a thousand, if not thousands of deaths, confronting the certainty of billions and billions of dollars' worth of damage, if there is a—if there is a nuclear meltdown and as you say, we could be looking at something as serious as Chernobyl, does that make this a global disaster in addition to being a Japanese disaster?

LYMAN: Yes, I think in a number of ways, it does. First of all, Chernobyl did inject a lot of radioactivity into the atmosphere and that did go around the Northern Hemisphere. There were certain aspects of that release that we probably wouldn't see here. It was a much hotter plume and it went much higher, but I think we can expect there will be some detectible radioactivity if there were an event of that size in Japan.

But, also, the other ramifications are clearly economic and also they have to do with their ability to mitigate climate change. Our organization, UCS, is not opposed to nuclear power, per se. We do worry about climate change and we understand nuclear power is one option.

But we shouldn't take that option off the table by running nuclear power plants in unsafe way, because, obviously, catastrophe like this could really eliminate the possibility of that option. So, our—we believe that nuclear plants really have to make an extra effort to be as safe and secure as possible. And, unfortunately, that doesn't seem to be the attitude of the nuclear industry, even in the United States or abroad.

MADDOW: Let me ask you one last question about that attitude and that seriousness about safety. If there is a meltdown, God forbid, at either of these affected nuclear plants that have now been declared emergency sites by the Japanese government, we will be counting on the containment units around the reactors themselves to confine the damage.

Just so we understand it—can you just explain for a lay audience what a containment unit is like, if one has ever been tested in a real life disaster before, and if we should assume that they might be compromised by the earthquake and tsunami themselves?

LYMAN: Well, the containment structures are generally reinforced concrete buildings that have a leak tight liner. And the idea behind the containment is really if you have a—what's called a design basis accident where you have a partial melting of the core, but don't have any catastrophic explosion, that that containment will function to limit radiation releases. Unfortunately, after most reactors operating today were designed and built, they discovered that—well, there are certain types of events that could challenge the containment and they're not impossible.

So, most of the containment buildings at reactors today are vulnerable to certain severe events that could threaten their capacity to contain radiation, and unfortunately, the Mark 1 boiling reactor, which is what we have at Fukushima, has vulnerabilities that people have known about for a long time, that if there were a core melt that escaped from the reactor vessel, it might also breach the containment.

And so—so I think there's a wide range of containment buildings out there, but I am concerned about the Mark 1s in particular and their ability to contain radiation in this event.

MADDOW: Dr. Lyman, senior scientist at the Union of Concerned Scientists—you have helped me understand this better and you have not set my mind at ease at all. But thank you for helping us explain it. Thanks a lot.

LYMAN: Thank you.

MADDOW: You look at the devastation caused in Japan, and it makes you realize just how huge an 8.9 earthquake is. Consider that there may be no other country in the world that is better prepared for earthquakes than Japan is. What happened to Japan is horrific and it is still unfolding. And the reasons why it wasn't an even bigger disaster than it was are really important, and in some cases surprising.

A live report from Japan about what has happened, what is happening now, and some of the reasons the catastrophe is not even worse. Plus, a further nuclear safety update later in the show. Please stay with us.

(VIDEO CLIP PLAYS)

MADDOW: What the fight largest earthquake ever reported does to the most earthquake prepared nation in the world. We have a live report from Japan coming up next.
Stay with us.

(BEGIN VIDEO CLIP)

UNIDENTIFIED REPORTER: Disrupting a meeting of Japan's parliament. Politicians clearly shocked as the floor beneath them vibrates and the chandelier above their heads swings ominously.
It was a scene experienced in offices and homes across Japan.

(END VIDEO CLIP)

MADDOW: We do not yet know how many people died in Japan in the last 24 hours as a result of the world's fifth largest earthquake since we as humans started recording the size of earthquakes. It could be hundreds of people dead, but it could conceivably be thousands—not to mention billions of dollars in damage.

This is what it was like to be at work, at home, shopping, parking the car, doing the things everybody does every day while it happened. Only today in northeast Japan, those things were terrifying.

If you have ever experienced an earthquake, you know how scary the shaking sensation of that can be. But what you can see from this footage we've had out of Japan today is what hit northeastern Japan was so big, it was almost qualitatively different—almost qualitatively different anything we have seen.

And even with the astounding damage just Japan sustained today, we are also confronted with the strange fact that it really could have been worse. I mean that in one specific way. Japan is one of the most earthquake-ready nations on Earth. In addition to multiple systems to warn the population and evacuate them from potential tsunamis, they also have one of the world's strictest building codes.

When earthquakes hit and tall buildings swayed like this, that was not a mistake. That's what the billions of dollars in earthquake technology intended—deep foundations and shock absorbers make the buildings sway. When buildings sway, they are less likely to fall.

Office buildings, schools and homes were almost always outfitted with earthquake emergency kits with things like food, water, medical supply, even hard hats and gloves.

Since the 1980s, Japan has invested in concrete sea walls, some as high as 40 feet that wrap around the nation's lengthy coastline to blunt the force of high waves. Some towns closest to water have warning systems by which local authorities can contact people directly in their homes. There are flood gates that close automatically and ports built up on raised platforms.

Every Japanese kid goes through a monthly earthquake drill. Some fire departments even take groups of school kids into earthquake simulator machines.

For adults, there are community evacuation drills to teach people about specially designed evacuation routes. None of this is enough, of course, when confronted with a quake and tsunami this big. But even if it is not enough, it is something, and it probably means that many fewer lives were lost today than might have been true had the same quake and same tsunami hit any other nation.

Joining us now is Nathan Layne. He is "Reuters" Tokyo bureau chief.
He's lived in Japan for more than a decade.

Mr. Layne, thank you very much for joining us this evening. We are happy to have you.

NATHAN LAYNE, REUTERS: Thank you very much.

MADDOW: What can you tell us about rescue efforts and the aftermath in Japan now?

LAYNE: Right. Well, obviously, the quake hit about 3:00 local time here yesterday, and then the devastation carried through the night. And basically the government, self defense forces, have put all of their efforts into trying to find survivors, trying to get help to people that are under debris or have been washed away, trying to find them.

MADDOW: I know that—or at least I imagine you lived through other earthquakes in Japan if you've been there over a decade. How soon was it clear that this was not just another earthquake, that this was actually a national disaster of really significant magnitude?

LAYNE: It was immediately clear to me. I was actually a few minutes outside the office, and I've been through many earthquakes, and you get—you become immune to them. You're used to them. But this one was qualitatively different.

Outside our building, we—"Reuters" is in a 40-story building. You could say it visibly swaying from side to side. People rushed out into the streets. It was obvious that this one was a big one.

MADDOW: Do you think Japan's earthquake preparedness and tsunami preparedness made a difference in the survivability of this disaster?

LAYNE: Oh, there's no doubt. Obviously, Japan has invested billions of dollars into break waters, flood gates—you know, because Japan has lived with tsunamis for hundreds of years and learned to live with them, and learned to be very aware that they could come at any moment.

Obviously, it was not enough. You see some of the areas, certain cities (INAUDIBLE) about one under a third of water, airport underwater. Obviously, it was not enough.

But, certainly, the amount of money and the effort put into preparations limited the damage here. Of course, we still don't know what the toll of this quake is. I mean, we won't know for several days.

MADDOW: Beyond immediate rescue efforts, what can you tell us about health and safety concerns for the general population now and moving into the weekend—things like power and clean water and communications?

LAYNE: Right. Well, communications is still a bit patchy, but phone communication is getting back. The Internet is for the most part there. Obviously, the devastated areas are in a more difficult—a more difficult spot.

Obviously, the rescue efforts are concentrating on getting food and water to the people that need them. Power was out for millions of people, and that's, you know, slowly getting back. But, obviously, that's a focus of the rescue efforts.

MADDOW: Do the authorities—do local government and the national government appear to have a disaster plan that accounts for disaster of this magnitude? Do they seem to be reacting in a fashion that is orderly, inspires confidence, and that seems capable of dealing with the massive challenges that Japan now faces?

LAYNE: Obviously, the challenge of this rescue is huge, and to what extent the government and the authorities have responded well to this—well, I think we won't really know until the final damage is known. But, certainly, in the initial hours, the response by the government did seem to be quite orderly. There was quick dissemination of information to the media about what was going on.

And even with this nuclear power plant issue, the government has at least—we don't know what we're dealing with right now quite yet, but the government has at least gotten in front of the issue and is—appears to be trying to inform the public about the risks and the dangers.

MADDOW: I know that it may be hard to compare magnitude of concern given the disaster of this size and of this complexity—but in terms of that nuclear disaster, is there significant concern in Japan on top of everything else everybody is dealing with that that might be a whole new level of complication and risk for the people of Japan?

LAYNE: No doubt. There's a lot of concern right now about, you know, really what might happen.

We have experts saying that, you know, it's not going to be Chernobyl. That it could be contained. And even if there is a radioactive leak, you know, that it might not be really all that devastating.

But who knows? And that's the scary part.

I think immediately there are more people in Japan that are dealing with the damage of the quake, and that's sort of the most important thing in front of them, that's—the tsunami, the impact of the earthquake itself as opposed to what might happen at the nuclear plant. But certainly, this is—this is front page news, and the media is all over this story, and for obvious reasons. The risk is huge.

MADDOW: Nathan Layne, "Reuters" Tokyo bureau chief, who I'm sure is exhausted at this point, having both lived through it and still covering it all these hours later—thanks for joining us and good luck with your continued coverage.

LAYNE: Thank you.

MADDOW: The tsunami that was generated by the earthquake in Japan reached Hawaii and the continental United States this morning. People there had lots of advanced warning that it was coming, and that is something that cannot be taken for granted. That's next.

(BEGIN VIDEO CLIP)

UNIDENTIFIED MALE: Aloha from Honolulu where we are under a tsunami watch.
UNIDENTIFIED FEMALE: We are one block out of the evacuation zone.
UNIDENTIFIED MALE: Expect my mother to be calling soon.
(SIREN)
UNIDENTIFIED FEMALE: This is so eerie.
UNIDENTIFIED MALE: It is eerie.
(END VIDEO CLIP)

MADDOW: That's what it was like on the big island of Hawaii early this morning where a tsunami warning was issued following the devastating earthquake off the coast of Japan.

Ultimately and thankfully, there was little damage when the waves hit Hawaii at about 3:00 a.m. local time. Officials then downgraded that warning to an advisory.

Tsunami warnings were also issued in California, in Oregon, and in Washington state.

In northern California town of Crescent City, right up by the Oregon border, a man who was reportedly swept up by a wave in the Pacific Ocean, near the Klamath River, that man is now presumed dead after officials failed to locate his body.

He and two friends had reportedly gone to the shoreline to photograph the incoming tsunami waves. They were as high as 6 ½ feet. They did significant damage to the harbor and coastline in Crescent City.

More than six years after the Indian Ocean tsunami killed 230,000 people, tsunami warning systems around the world have taken on the highest levels of importance in terms of disaster preparedness and coordination. Tsunamis may be rare but they are massive.

The tsunami warning system in the Pacific is based in Hawaii. It includes 26 different member states. The goal is simple: to take data about the hundreds of earthquakes that strike every day and determine the likelihood that that seismic action could trigger a tsunami.

Here in the United States, the National Oceanic and Atmospheric Administration, NOAA, operates a system that's called DART, D-A-R-T. DART stands for Deep Ocean Assessment and Reporting of tsunamis. DART is a network of 39 stations out at sea, anchored to the bottom of the sea floor. Up on the ocean surface is a buoy that gathers information about temperature and pressure and sends it back to be analyzed four times an hour. Using anchors and buoys information, the system determines essentially the height of the water, and if the buoys detect some unusual event, they ramp up the frequency with which they send back their information to home base—they ramp it up to four times a minute.

As important and life-saving as this tsunami early warning systems are, they are also facing severe budget cuts. The spending plan approved by the Republican-controlled House last month would cut the budgets of the organizations that run the Pacific Tsunami Warning Center in Hawaii by almost 30 percent.

We'll be right back.

MADDOW: Nearly a third of all Japan's energy comes from the nuclear power. There are 55 different nuclear plants across the country, all of which have multiple reactors.

Two of the nuclear plants in Japan are in a state of emergency tonight after a massive 8.9 earthquake and subsequent tsunami not only knocked out power to the cooling systems that prevent the nuclear core and those reactors from melting down, but they also then knocked out backup systems as well. They've been working on battery-powered, double-back generators. They've been trying to restore full power ever since.

At the Fukushima Daiichi nuclear plant where two reactors are in trouble, radiation levels inside the control room are reportedly 1,000 times normal levels. Radiation levels at the gates of that facility are reported to be eight times the normal. Authorities told an estimated 45,000 people in a six-mile radius around that plant that they needed to evacuate. This is in one of the hardest-hit areas of Japan.

They had vented some of the vapor from the reactor in order to relieve the pressure. That does release radiation into the atmosphere, but they're hoping the cure is better than the disease.

To the south of that facility, at the Daini plant, three reactors are in a declared emergency situation there. Authorities there have now told an estimated 3,000 people within a two-mile radius of that plant to evacuate while they consider whether to release some of the radioactive vapor from those reactors as well.

So, far, the Japanese government says it can contain the nuclear meltdown threat.

But President Obama made it clear today that the United States is standing by to help.

(BEGIN VIDEO CLIP)

BARACK OBAMA, PRESIDENT OF THE UNITED STATES: I've asked Steve Chu, our energy secretary, to be in close contact with their personnel to provide any assistance that's necessary, but also to make sure that if, in fact, there are breaches in the safety system on these nuclear plants, that they're dealt with right away.

(END VIDEO CLIP)

MADDOW: Joining us now is **Joe Cirincione**, president of the Ploughshares Fund, a global security foundation. And full disclosure, my friend.

Joe, I wanted to talk with you about this all day today, at least as soon as I realized how serious it is. Thanks for your time, man.

JOE CIRINCIONE, PLOUGHSHARES FUND: My pleasure, Rachel.

MADDOW: How—you are not a guy who gets easily worried, I know. How worried are you about the situation in Japan? How confident are you that the nuclear energy world knows how to resolve some like this?

CIRINCIONE: I am very worried and I'm getting increasingly worried. And part of that worry is we're not getting very good information out of Tokyo Electric Power Company. It's not really clear what's happening. They maybe have retained control over the cooling systems of these two reactors. But what happened all day is that they have assured us that the situation is under control, and then they released another statement that indicates it's not in control at all.

We have never seen something like this. We have never seen multiple reactors at risk. We have at least two reactors that they say at the Daiichi site that are having coolant problems. There's another three reactors that you say at the Daini site that are also at risk. Nothing like this has ever happened in the nuclear power industry. We are in unchartered territory.

MADDOW: In terms of worst-case scenario—I don't know much about nuclear disaster, but I think I know that Chernobyl did not have a containment facility around their reactors. That blew up. And these Japanese reactors do.

Is that reason to think of this as a qualitatively different thing? Should we stop invoking Chernobyl because it's too different than even the worst-case scenario here?

CIRINCIONE: Most experts are not thinking there's that great risk of explosion at these sites, but it could happen if the containment vessel gets too much pressure built up. As you noted on the show, they now have two times the design pressure building up inside these containment vessels. So, it's not out of the question. It's just considered unlikely at this point.

And as Ed Lyman said before in the show, that was a very hot explosion, a very high plume of radioactive material. So, probably nothing of that magnitude. It's more like a Three Mile Island scenario, in these boiling water reactors where the core melts and will drop through the containment vessel.

And then you want to make sure that the concrete which is feet thick can contain that molten core. If that fails, then that is really the worst-case scenario that the entire containment structure collapses. And then we're talking about massive releases of highly radioactive material.

MADDOW: And the highly radioactive material that would be released in a case like that would be released in a gaseous form? I mean, in a form of a radioactive cloud that could then move?

CIRINCIONE: Absolutely. Once this hot material starts hitting the atmosphere, starts hitting other structures, you're getting fires, you're getting smoke, you're particulates, and then, of course, you have ground contamination. We've never actually seen something like this happened. They stopped Three Mile Island before it got to that stage.

We have to all hope that the Tokyo officials know what they're doing, that they're able to contain this, that the generators are being rushed in there, can get online. We're going to know in the next few hours whether this situation will be under control. We should know by tomorrow morning just how bad it is, if we can get the nuclear power industry to actually give us up-to-date information.

MADDOW: In terms of these next few hours, and as you say, we're not going to know how this is going to resolve. And the best case, for now, for the next few hours—is the evacuation, so far, the six-mile radius they've drawn, thousands of people moved under very difficult circumstances, is that—does that seem appropriate to you in terms of protecting the population there?

CIRINCIONE: That is—that is a minimum evacuation scenario that you would want. It depends. You know, if you're just having release of radioactive steam, that's not supposed to happen, that you don't like that, no amount of radioactivity is safe, but then that radiation—that evacuation scenario makes sense.

If you're going to talk about massive releases of more radioactive steam, then we really would be talking about hundreds of square kilometers you would like to evacuate. Fortunately, these are close to the sea. The winds are blowing west to west. So, it will blow most of the radioactivity out to sea. And, of course, in a catastrophe, it will blow all that radioactive material over to the West Coast of the United States.

MADDOW: Are there international resources that could be brought to bear on this that would make a difference? Or is Japan as good as anyone at dealing with this technology?

CIRINCIONE: Japan is very good. These reactors are generally considered in Japan in the state of the art. These are particularly old designs, but they have relatively high construction standards for their reactors. IAEA can be brought in to help on this. And in the case of airlift, which is what the president was talking about today, the United States could help lift things like generators, backup power supplies to these.

This really should be an all hands on deck exercise. As bad as the natural disaster was today and still is today in Japan, this could be a technological catastrophe here. For my money, this is the most important part of this tsunami crisis to be focusing on right now.

MADDOW: It is also the thing that could turn this tragedy and disaster in Japan into international tragedy. Joe Cirincione, president of the Ploughshares Fund—you are smart and lucid about these things at a time when we really need that. Thanks, Joe.

CIRINCIONE: Thank you, Rachel.

MADDOW: Most of our tension has been on Japan where it remains, frankly. There is however one other story—a story about the U.S. and terrorism that we as a show decided tonight—decided that it bears telling, even on this night with everything else that's going on in Japan. We will be back with that in just a moment…"

"…MADDOW: At this hour, it is late morning in Japan well into what is now the day after the biggest earthquake ever recorded in that country. In the bright light of day, there is revealing the full extent of damage from the 8.9 magnitude earthquake -- 8.9.

To put that in perspective, the U.S. Geological Survey says a magnitude 9 earthquake is equivalent to the force of 25,000 nuclear bombs. You know, that massive earthquake that devastated Christchurch, New Zealand, last month—scientists say this one, the one in Japan, was nearly 8,000 times stronger than the one that hit New Zealand.

There's also the tsunami that the earthquake triggered which sent a 30-foot wall of water—not just water but water and mud washing across low-lying coastal areas of Japan. Entire towns were swept away.

Rescue efforts are now in top gear. Kyoto news agency reporting in one of the worst hit residential areas people buried under rubble can now be heard calling for help.

And now, even given how immense this disaster is, I almost can't believe I'm saying it, but the potential for even greater disaster is still unfolding. Workers at two of Japan's nuclear power plants are struggling to prevent nuclear meltdowns in five different reactors in which the cooling systems have failed or are operating on their failsafe, failsafe systems—two power plants, five reactors.

This is the Fukushima Daiichi plant in northeastern Japan where it was originally believed that only one reactor had been affected. But the Tokyo Electric Power Company later confirmed that cooling ability had also been lost in three reactors at the nearby Daini plant—seen on this map -

as well as at a second reactor at Daiichi. So, altogether, five reactors are in a state of emergency in Japan in danger of melting down.

It is the first time ever that the Japanese government has declared a state of emergency for a nuclear power plant, let alone two of them at once, each involving multiple reactor failures.

The prime minister of Japan was seen departing Tokyo on his way to visit the nuclear plant just hours ago. There's lots more that still unknown at this hour. Authorities say the roads are too badly damaged to allow them to yet reach one area along the coast where it's believed that up to 300 people were killed at the shore line.

Hundreds of people are missing. The number of people reported injured has already reached nearly 1,000, and the search for the dead and the trapped and the missing is frankly just beginning.
That does it for us tonight. We'll see you on Monday. Good night.

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Transcript of the Rachel Maddow Show

RACHEL MADDOW, HOST: Good evening, Lawrence. Thanks for that.

And thanks to you at home for joining us this hour.

The nuclear fuel rods in a reactor like the ones that are in trouble in Japan are about 12 feet long. They are about 12 feet long. This is 12 feet long. And they are skinny.

Calling them rods actually isn't exactly right because they're not solid, they are hollow.

This one is made of cardboard so that I can hold it. But you can't see. Can you see it's hollow there?

It's essentially a big straw. That's what they call these fuel rods. And these straws themselves, the real ones, are made of metal, a metal called zirconium.

And inside the big metal straw, inside the zirconium is uranium, the working part of the reactor, the part that makes it nuclear. When the reactor is working, the uranium pellets inside the fuel rods are creating fission. They are creating a nuclear reactor in order to generate heat.

The whole point of nuclear power is that you create an environment in which fission happens. A nuclear chain reaction happens, but it's controlled so it does not produce an explosion. It just generates heat in a controllable way instead. Use that heat to essentially just boil water. Actually, you literally use it to boil water.

The boiling water makes steam, steam spins a turbine, and that makes electricity. That's the whole basic idea behind these 40-year-old reactors in Japan that are in so much trouble right now.

When the reactor is on, in effect, the uranium pellets inside those big 12-foot long fuel rods are involved in a nuclear chain reaction generating heat. When they shut off the reactor either in the normal course of events or because of something like an earthquake, they stop that nuclear reaction.

Now, in order to stop the nuclear reaction, to do that, they move a bunch of control rods in among the fuel rods. The control rods stop the nuclear reaction from happening in an orderly way.

I don't know if you ever had the chance to develop a photo in a real dark room before everything went digital. You know how you put the photo, or may have seen it in a movie, right, somebody working with an actual—with actual film and actual developing chemicals in an actual dark room. You put the photo in the developer until the image comes in the way you want it, and then once it's the way you want it, you put it in a different chemical bath to stop the developing.

That's sort of like the control rods. They stop the nuclear chain reaction. But the fuel rods, those pellets of uranium inside those big metal straws, even when the reactor is turned off, they are still wicked hot. And so, even though the reactor is off and it is not being used to boil water to make steam, to spin turbines to make electricity any more, the fuel rods still have to stay underwater because if they are not underwater, they just get to hot to keep it together, to maintain their integrity. They start to melt.

The first thing that happens is that the metal on those long metal tubes oxidizes and essentially just rusts really, really fast. And as you know from what happens in normal life when something rusts, it breaks down, right? It bubbles. It cracks. It splits.

Damage to those fuel rods is a partial nuclear meltdown. One of the things that is released into the air as the water level drops and the fuel rods get exposed to the air and those big metal straws and the fuel rod starts to oxidize, one of the gases produced is hydrogen, and hydrogen can be explosive.

Authorities believe that hydrogen explosion is what caused this to happen at one of the Fukushima reactors on Friday night, East Coast Time, it was daytime Saturday Japan time.

Then on Monday morning, Japan time, a second reactor at the same facility suffered what they say was the same type of hydrogen explosion.

When we were told this weekend after the first explosion at the Daiichi nuclear plant that authorities had detected radioactive iodine and cesium in the atmosphere? Now, what did that mean? Why were they detecting radioactive elements in the atmosphere after that explosion?

Well, those detections were indication that the fuel rods had been damaged. And that let some of the radioactive elements in that nuclear fuel get released. And that is not good.

As I say, a partial nuclear meltdown. It doesn't sound good. It is not good.

But it is not the same as a total nuclear meltdown which they are still working to stave off. The explosions that happened at two reactors at the Daiichi nuclear plant in Fukushima on Saturday and on Monday Japan time, these are explosions and they happened at nuclear power plants. But these were not nuclear explosions. They were explosions that were caused by the inability to keep those fuel rods underwater and cool.

The radioactivity released so far has been a sign that the fuel rods were damaged. The steam that's being vented, that's being led out into the atmosphere to avoid the pressure building up too high around the reactor, that is mildly radioactively contaminated steam, contaminated by the fuel rods being at least damaged, at least

partially compromised. They have kept up efforts to submerge the rods in seawater, even after they knew they were damaged, because they are trying to prevent any further damage.

As I said, what they think they have got is a partial meltdown. And that is bad. But what they are trying to avoid is an uncontrolled total meltdown in which those fuel rods wouldn't just be damaged, they would breakdown totally. If that happens, the uranium inside those fuel rods slumps down into the bottom of the reactor, into what is essentially a big blob of radioactive lava, burning I think at several thousand degrees Fahrenheit.

If that happens, if total nuclear meltdown happens in a reactor, that pile of hot, radioactive lava, that pile of hot radioactive goo, will burn through most everything around it, and we will be hoping that this last line of defense containment structures are actually capable of containing that melted fuel, keeping it from the outside world and from the Earth, because if they are not, that would entail a much larger release of radioactivity, and that is not helpful for children or other living things.

Tonight, just a couple hours ago, we got word that a third explosion had been heard on site at the Fukushima plant. They have three reactors there that they have been worried about at Daiichi. Two of them had hydrogen explosions on Saturday and early today, Japan time. Now, it appears the third reactor they were worried about had suffered an explosion as well.

The first two reactor explosions authorities say did not result in unconstrained large radioactive release. Containment vessels had survived the blast. The main containment vessel around the reactor itself had survived the blast, even as other walls had been blown down.

Well, tonight, reports from Japan indicate that the third blast may be more serious than the first two. It may have resulted in a breach of the internal containment vessel for the first time, may have. We do not have confirmation on that, it may have.

Again, an explosion is not the same as a meltdown. An explosion at a nuclear reactor is not the same as a nuclear explosion. What happens happened is that the inability to keep enough water circulating over these giant fuel rods, enough water to keep them cool, that has resulted in damaged nuclear fuel rods and that caused three explosions so far. And that has provided us with the only conceivable thing that could make the whole world look at devastation this horrible and think we are as yet worried about something else, we are as yet worried about what might happen next, after this.

Joining us now is David Lochbaum. He is a nuclear engineer and he is the director of the Nuclear Safety Project of the Union of Concerned Scientists.

Mr. Lochbaum, thanks very much for being here. I really appreciate your time.

DAVE LOCHBAUM, UNION OF CONCERNED SCIENTISTS: Good afternoon. Good evening, Rachel.

MADDOW: Let me know first, I guess, if I got anything wrong there, if I got anything important wrong there or I left anything important out. I am obviously a layman, trying to understand this for myself as well as make it understandable for our viewers.

LOCHBAUM: It was a solid and accurate description of where we are today.

MADDOW: OK. Within the last couple hours, as I mentioned, a third explosion was reported at Fukushima's number two reactor. Number one had explosion this weekend, number three did about 24 hours ago. And now number two has happened as well.

Can we tell yet if this is a more consequential blast than the others or is this likely to be of the same consequence?

LOCHBAUM: The initial reports coming out of the facility are that this is the most severe explosion yet. The clearest sign of that seems to be that the pressure inside the containment structure on unit two is decaying off, would suggest that some of the air space or some of the volume inside containment is leaking out someplace—perhaps through a breach, perhaps through a crack, perhaps through a valve that's been left open. But if the containment were intact, the pressure inside would be maintaining constant and not decaying as it is or reports show that the pressure is dropping.

MADDOW: In terms of that word "containment," it's a word we use commonly not as jargon, it's meant in this case to mean a couple different types of structure, right? I mean, containment can be the outside building that surrounds the reactor as a whole. That was what we saw the explosion do so much damage to in the first two explosions. But containment also refers to the smaller containment around the core itself, around the reactor itself?

LOCHBAUM: That's correct. These type of plants use defense and depth, there's actually two containment structures. There's the outer containment structure that was damaged by the explosions. That structure had completely surrounded the other containment structure, kind of Russian dolls containment within containment. The inner containment is called primary containment, it's five—four to five feet thick of concrete, reinforced concrete, with an inner steel liner of about two inches thick of steel to provide integrity against the release of radioactivity.

MADDOW: And it's that primary containment vessel that you are worried may have been compromised by this most recent blast?

LOCHBAUM: The initial reports—hopefully turn out not to be true. But initial reports are that part of the containment called the pressure suppression pool or the torus, which is a big, round, metal donut-looking thing has been compromised. We don't know whether it was by the third blast the facility experienced or some other mechanism. Pressure is reported to be dropping from inside containment. That would suggest that gas is leaking out somewhere.

MADDOW: Forgive me if I get this question wrong or if I say this in an ignorant way. But as I have understood it, even after there have been blasts at these other facilities and that was—that reflected some damage to the fuel rods, there has not been any sort of full meltdown of those facilities, and so, even after those blasts, they've kept up the effort to cool those facilities down to prevent any further damage to those fuel rods, any further meltdown.

With the type of damage that you are worried about that you're saying this lack of pressure might indicate, does that mean that they will not be able to continue to cool this down? That they will not be able to essentially continue to work on this, to try to make it more safe?

LOCHBAUM: That's a good point, because if the containment is breached the way it's been suggested, not only can radioactivity escape through the pathway, but the seawater—the water that's being used to cool the reactor—could also leak out that same crack or the same breach. If the leak rate—if the water is leaking out faster than they can put it back in, then they're going to have trouble cooling that reactor core, and things may get worse before they get better.

If on the other hand, they are able to put water in faster than it leaks out to whatever pathway, they should be able to continue cooling the reactor down to a cold shut down condition.

MADDOW: One last question for you. Authorities evacuated some workers from Daiichi now. They say there are about 50 people left on site.

If it turns out to have been a very—if there turns out to have been a large radioactive leak with this most recent explosion, if it becomes too dangerous for people to work there, it's just too radioactive—is there a risk that

they'll have to stop whatever they're doing to prevent further melt downs? I mean, because these three reactors are right next to each other.

LOCHBAUM: That does pose a challenge. That came up in Chernobyl accident. Chernobyl unit four exploded, caused a lot of radiation to go all over the other areas. There were other—three other operating reactors that were in the same proximity like Japan. Workers there were able to deal with the other three reactors.

That widespread radiation at Chernobyl is worse than what we've seen or suggested so far in Japan. So, it seems like the workers would be able to handle the other two units, and even the stricken unit at Japan like they did in Chernobyl.

MADDOW: David Lochbaum, nuclear engineer, the director of the Nuclear Safety Project at the Union of Concerned Scientists—thank you for helping us understand this, sir. This is a dramatic and bad night in this news. But I appreciate your time.

LOCHBAUM: Thank you very much.

MADDOW: Thanks.

LOCHBAUM: There is a reason that in the English language and particularly in American English, we use the word meltdown so much as a metaphor. That's because it always sounds like hyperbole. It always sounds like you are overstating it no matter what context you use it in.

But when we mean the word meltdown literally, it is worth being precise about it. It is not a good idea to let your imagination just run with this stuff. The facts are both understandable and on nights like tonight, worth understanding.

MADDOW: At the Tepco news conference on the third explosion at the Japanese reactor tonight, reporters were visibly angry with the company's explanation of what happened with that explosion.

To our understanding of an already stressful situation in Japan, we can also add Japan's history frankly of scandals and cover-ups related to nuclear power and safety. In 1995 in Japan when a reactor caught fire, the government run agency in charge of that reactor tried to cover up how bad the fire was by releasing a doctored video of the accident.

In 2002, at Tepco, the company that owns the plants that are currently in crisis, the president of Tepco and four other senior executives were forced to quit when it was revealed that Tepco had been falsifying safety records at its nuclear plants for years, dating back to the 1980s.

Another Japanese nuclear power plant operator was force to shut down a reactor in 2007 after it acknowledged they had covered up 15 minutes of near-disaster in 1999, when an accident involving three fuel rods caused an out-of-control nuclear chain reaction.

The Monday, quote, "investigation (ph)" was this, quote, "It happened at around 2:00 or 3:00 a.m., so people probably thought no one would notice."

This crisis is, of course, now unfolding in much different circumstances. But some of the reporters' anger at that Tepco presser tonight reflects the suspicion and frustration that we are still dependent for much of the most crucial information in events like this on sources that have a vested interest in keeping us all calm and deflecting suspicion and anger away from themselves. It is probably unavoidable and it is frustrating as all heck.

MADDOW: It is now around 10:20 a.m. in Japan, the beginning of day five in what has been one of the worst natural disasters in modern history. This is typically still the search and rescue phase of a disaster like this. And at this hour, the rescue mission does continue in Japan.

But at this point, day five of this disaster, it appears to be more of a recovery mission rather than one of further dramatic rescues. Japanese troops, firemen, and police have been mobilized to work in this rescue effort. And, of course, rescue crews from other countries, including the United States, are now on the ground in Japan assisting in this effort.

But the sad reality of this disaster is that there do not appear to be many survivors to find. The vast majority of victims appear to have been killed by the earthquake and tsunami, rather than injured by it. Further complicating the rescue effort are the enormous aftershocks that continue to come, one after the other.

And search and rescue in the town of Soma had to be called off today after a magnitude 6.2 aftershock struck the area. The Japanese coast had been hit by more than 150 aftershocks since the initial earthquake struck on Friday.

The immediate needs on the ground right now are really the basics of human existence—food, water, shelter. And while Japanese troops hand out things like blankets and bottles of water, local officials report that only about 10 percent of supplies needed had made it through to the affected areas so far. Those who managed to survive the initial disaster on Friday are not only in desperate need of the basics, but, of course, there is another concern brewing right now.

Scenes like this are becoming increasingly frequent through the Japanese countryside. Hazmat teams testing survivors for radiation exposure.

About 180,000 survivors have been evacuated from the area surrounding the country‘s damaged nuclear reactors, and possibly of radiation sickness is now among concerns. Effect of radiation exposure in humans is something that you can be precise about. There are a wide range of outcomes that prolonged or in some cases even brief exposure to radiation can lead to.

But the worst end are examples like the Chernobyl nuclear reactor accident in 1986, 28 firefighters and plant workers who were exposed to large amounts of radiation in the immediate aftermath of that accident ultimately died of acute radiation sickness moist—mostly within three weeks of being exposed.

And that‘s sort of the key to understanding this. Radiation sickness is extremely rare, of course, but the greater your exposure to radiation both in terms of proximity and time—the more severe and the more immediate the symptoms are.

So far in Japan, we have preliminary reports of several nuclear plant workers who have been treated for possible radiation exposure or sickness. Today, we got news that radiation exposure was detected in 17 members of the U.S. Navy who are conducting a relief mission in Japan. According to the Navy, the crew was exposed to the equivalent of one month‘s worth of natural background radiation.

How serious is that? Well, serious enough that the Navy is telling us about it. But the treatment for it, the way they were decontaminated was simply through using soap and water.

This disaster in Japan is, of course, still on-going. But one of the ways the Japanese government is trying to avoid nuclear meltdown at those reactors is by periodically releasing steam into the atmosphere of those reactors, steam that is radioactively contaminated.

Right now, officials say that these radioactive releases do not pose a major health risk, but if they continue doing this, does it have a cumulative effect?

Japanese officials estimate right now that about 190 people have been exposed at some level to some radiation from the plant within the last four days. Should we expect that number to go up and what are the potential long term effects here?

Joining us now is David Brenner. He's the director of the Center of Radiological Research at Columbia University Medical Center.

And, Mr. Brenner, thanks very much for being here. Appreciate it.

DAVID BRENNER, CTR. FOR RADIOLOGICAL RESEARCH: Nice to be here.

MADDOW: Did I get anything wrong there?

BRENNER: I think you had it exactly right.

MADDOW: I keep saying these really bad news things leading into people who know better and I keep hoping I'm going to get it wrong.

The two radioactive isotopes we've been hearing the most about in terms of what's been detected, what is worrying to Japanese authorities, iodine-131 and cesium-137. Are those—can you tell us about what to worry about with those particular elements? And are there others that you're concerned that people might being—people might be being exposed to?

BRENNER: The population are being exposed to a whole panoply of different radio isotopes—those are the two most common ones that you mentioned, iodine and cesium. But there is strontium, which is a bone seeker. So, that goes to the bone. Xenon, there are literally dozens of other ones.

But cesium is probably the one that we should be most concerned about at the moment.

MADDOW: Why is that?

BRENNER: Because—just because of its chemical nature and it exposes the whole body. Iodine really only exposes the thyroid gland. Strontium is a bone seeker, so they only expose—exposes the bone.

Cesium exposes the whole body. So there is more concern about cesium.

MADDOW: In terms of what you know so far about this radioactive steam release and the evacuation area and the number of people exposed so far—do you expect that this is going to be an event that has—affects a very geographically large number of people in terms of medically important radioactive exposure? Or is this something that's likely to be confined to people in the very immediate area around the reactors?

BRENNER: Well, let's talk about two different populations. There is actually the population inside the nuclear reactor, the folks who are actually working as you were describing before, to try and pour water into the core and try and keep the cores cool.

Now, I think there's a significant possibility that some of them are going to be significantly exposed to radiation, to high doses, and it's certainly possible to lethal doses of radiation. We can contrast that with the general population outside the nuclear plant, and as you say, they've actually been evacuated for a few miles away.

So, now, we got a very large population exposed at least as far as we know now to pretty low doses of radiation. We'll know better in the next couple days whether that dose of radiation becomes higher.

But all in all, it is still going to be a low dose of radiation, the general population are not going to be exposed to high levels of the sort that the nuclear workers are. So, there are going to be different consequences for the two different populations.

MADDOW: In terms of the broader population, and thinking about what might be a manageable amount of radioactive exposure—I realize it is a fluid situation. We don't yet know how much radiation is going to be released into the atmosphere. But one of the things that has been discussed is the distribution of iodine tablets to try protect people from thyroid cancer.

Why is that important? And how important is that?

BRENNER: Well, **in my view**, it's not important at all. It's not actually the appropriate way to deal with the issue of iodine-131. The way iodine gets—radioactive iodine gets into the body is a crowd of iodine falls to the ground. Cows eat grass which has got that radioactive iodine in it. The milk that they produce has radioactive iodine in it, and we drink the milk.

So, the simple way to avoid the iodine problem is simply not to drink the milk and that works. It doesn't work with all the other radio isotopes. For the special case of iodine, simply don't drink the milk.

MADDOW: So, that's—that's not like you're using cows and milk production as an example of one way in which all different ways you can be contaminated. That's the specific route?

BRENNER: It's the specific route of iodine. Yes.

MADDOW: OK.

BRENNER: So, iodine pills, they're not going to do harm, but they're not really going to do any good either. The real way is to stop people drinking the milk.

MADDOW: We talked a little about the prospect of radiation sickness. And again, this is something that we are mostly thinking about for the people who are working inside Fukushima's nuclear plant at this point, trying to stop that.

In terms of the symptoms and prognosis that they are likely to be undergoing, what will authorities be watching for, and what can they do for people who have been significantly exposed? This isn't anything that's going to affect anybody outside Japan and probably nobody outside those plants—I worry about those people and I think about them because we all sort of depending on them getting their jobs done.

BRENNER: Absolutely. I think we can already say that these heroes who are going into some very dangerous situations. , the first thing that one can look for is vomiting. That's one of the very first symptoms of high radiation exposure.

But really, there's a whole panoply of symptoms from just feeling a little bit ill to being seriously ill in the first few hours. Very likely nobody is going to die within the first few days. It takes several weeks typically for people to die of radiation exposure—and again, only for super high radiation doses. And there is a lot that can be done for people who have high radiation exposures—really you die from infection, the blood forming organs, the bone marrow gets damaged, the lining of the gut, the gastrointestinal system gets damaged and you get infection.

So, good nursing is key. Good nursing, antibiotics, and you can really bring back an awful lot of people that would otherwise die with just fairly simple procedures.

MADDOW: Simple, good quality medical care.

BRENNER: Good quality health care.

MADDOW: And to the extent that people might be suffering from those things, it's going to be a small and defined population that does offer them some hope, even the people in the worst case scenarios.

BRENNER: Yes, unless people get a super high lethal dose, most of these people will survive, even though they gotten very, very high radiation exposures.

MADDOW: And to be clear, if this is freaking you out at home because we're talking about this—you should know that U.S. officials say that they do not expect that any of the releases of radiation thus far are going to pose any threat to any part of the United States, and that what's been released so far is blowing out to sea and is becoming dilute.

So, that is the best news for us here as we continue to watch this unfold in Japan.

David Brenner, director for the Center of Radiological Research at Columbia University—thanks for coming in and helping.

BRENNER: My pleasure.

MADDOW: A pleasure. Appreciate it.

We will get a report live from Japan, coming up next.

(BEGIN VIDEO CLIP)

LEE COWAN, NBC NEWS (voice-over): They call it the town that disappeared. All we could find was a shattered footprint at the end of a washed out road…"

"…Do we have—Robert Bazell actually is joining us now from Tokyo, who's just done a report on "Nightly News" tonight about this third blast at the Fukushima reactor in northern Japan.

Bob, what can you tell us about what you learned tonight.

ROBERT BAZELL, NBC NEWS CHIEF SCIENCE CORRESPONDENT: Well, Rachel, it's ominous news. The company that owns the power plant said that one of the reactors, reactor number two, where there was explosion yesterday, it's early morning now in Japan, at a press conference this morning, they said that that explosion was not like the other two, which was outside buildings. It was actually in the dome that is supposed to contain the radiation, and that radiation has now leaked out into the environment. As a result of that, they evacuated the plant, except for the most core staff that they could keep there.

Now, I have to point out that the amount of radiation so far they say has been measured is nothing like it was at Chernobyl that caused dozens of deaths in a few weeks and then thousands over time. It's a high level of radiation, a dangerous level of radiation, but this changes the situation enormously. We no longer have a possible bad outcome, we have a bad outcome.

And in terms of rating this, this nuclear disaster going on and nowhere near ended here in Japan is worse than Three Mile Island in the sense that very little radiation escaped for Three Mile Island. It's not as bad as Chernobyl, but it's now the second worst nuclear disaster ever known, and it's not going to be shut down any time soon—Rachel.

MADDOW: Bob, to be clear, what we have on site at these facilities, we've all learned so much about them on reporting this in the past few days, is the internal containment vessel which is right around the reactor, there is also a secondary containment vessel which is in effect the building that surrounds the entire reactor complex.

For us to have had a significant radiation leak into the environment—does that mean officials are saying both of the containment units have been breached, both the outer building and smaller containment vessel around the dome?

BAZELL: That's a good question, not clear at all, and not clear the smallest has been breached yet. But what's happening is that because the core nuclear material in there, which had been an on-going nuclear reaction, was shut down, but it's still extremely hot and they've been trying to cool it off with seawater. And when they pour that seawater in there, sometimes enormous amount of steam builds up. So, it could have just been a blast of steam and hydrogen outside—out of that metal reactor into the other one, and the hydrogen tends to explode, and that could have been what caused the breach.

So, there is no indication yet that that critical metal one has been breached. But they are talking about the nuclear material inside melting, and it's so hot that it could potentially melt the metal. That's potentially. We don't know what's happened.

Every physicist is pointing out that we are now in uncharted territories. We are in a situation that's never happened with a nuclear reactor, except for Three Mile Island, which was contained, with less release of radiation that we've already had here.

So, we need to get more details. The press conference was not—difficult—you know, it was not easy follow because it was in Japanese and they were skirting a lot of issues. And I think, honestly, they don't really understand themselves what's happening, which, of course, makes these situations even more frightening than they already are, Rachel.

MADDOW: Bob, as you say, the reactor core continues to be very, very hot, which is why they have been adding seawater to it. With the type of explosion they had and the type of damage they think they have had—can they continue their efforts to keep those fuel rods submerged in seawater? Can they keep doing in effect mitigation work to try to prevent further damage to the fuel rods, further meltdown? Or does this mean their ability to even keep that seawater in there is also impaired?

BAZELL: The answer to that is I don't think anybody knows that right now. What happened with this reactor number two that's gotten into big problems is that the water circulation that normally works to keep it going had been continuing with some kind of power generation in that one reactor. And they thought that was working. But apparently, it failed.

They announced two things yesterday. They announced that the water circulation had failed, and then later on, they announced that there was an explosion. And the explosion seems to have been inside the reactor.

So, this reactor was behaving differently. They thought they had it under control with the water. The water wasn't working. The fuel rods became exposed, so they had to try to pump in seawater. And when they started trying to pump in seawater was when things went very badly awry.

And so, whether they can still pump in seawater or what happens next, they haven't said, and I think they probably just don't know right now and are trying to figure that out.

MADDOW: Are you expecting, Bob, that we will get any sort of quantitative measure of how big that radiation release has been, either from international officials or from Japanese officials?

BAZELL: They gave a quantitative figure today, and it's about—around the reactor. It's about as much radiation as a human being is typically exposed to in a year. You know, we get radiation from natural sources, you get radiation from when you fly in airplanes, when you get an X-ray.

So, we're not talking about the kind of radiation that makes people drop dead, or even increases cancer risk substantially. But if in one hour you're getting as much as you get in a year, clearly, that's a lot of radiation in that immediate area. The radiation levels will go down as it gets dispersed.

There is another thing that's happening here today, which is there's a storm coming in, a weather pattern, and it shifted the winds on the ground that has been blowing radiation out to sea, it switched them to the west, which is going inland over this area that's already suffered so severely from the earthquake and tsunami. So, as if the poor people didn't have enough to contend with, now they have serious amounts of radiation coming their way, even though as it disperses—if it remains at that level, it's not a serious matter, when it gets a few miles away from the plant.

So, what they've done, they've evacuated the area around it already, as we know. They have given out iodine pills, which is preventive measure for thyroid cancer. And there's not a lot more that can be done right now.

And if it doesn't get to go higher levels of radiation, it's not a problem. But if again—I'm repeating, everybody says this is unknown territory. There's never been a reactor that's behaved like this before. And as a result, no one knows where it's going next.

MADDOW: NBC's chief science correspondent, Robert Bazell in Tokyo for us—thank you so much for helping us understand this. Bob, we really appreciate it.

We will be right back with congressman and physicist, Rush Holt, right after this.

MADDOW: We are still learning just how massive Friday's earthquake actually was. It was originally rated by Japanese government scientists as an 8.8 magnitude earthquake. But on Sunday, Japanese's meteorological agency issued a correction. It turns out it was actually a 9.0. magnitude quake, making it the fourth largest earthquake in the world since the year 1900.

Friday's earthquake off the coast of Japan was so powerful, we now know it actually moved Japan's coastline. It changed the balance of the planet. Because of the earthquake, according to scientists, Japan is wider than it was before, and the earthquake is believed to have shortened the day, the entire day of the whole Earth by a couple millionths of a second. It tilted the earth's axis slightly.

As we discussed on Friday's show, Japan is one of the most disaster-prepared countries in the world. This is a country that celebrates, nationally observes disaster prevention day every year. They have elaborate earthquake and tsunami early warning systems, comprehensive public and private evacuation plans and super strict building codes.

But it was not enough. Friday's earthquake and the tsunami that followed it were devastating to Japan. Thousands of homes were destroyed in the earthquake, washed away by the tsunami. Hundreds of roads are damaged. There have been explosions now at three different reactors at a nuclear power plant in northern Japan.

As "The New York Times" reported this weekend, at least 40 percent of Japan's 22,000 mile coast line is lined with concrete sea walls or other structures meant to protect against high waves, typhoons, and tsunamis. But they weren't enough. The tsunami washed right over the sea walls meant to protect a pair of nuclear power plants near the coast, including the one where subsequently those explosions have happened.

A leading expert on designing nuclear power plants to withstand earthquakes told “The New York Times” that the sea walls of the Japanese plants probably could not handle tsunami waves of the height that struck them and the plant‘s diesel generators were situated on low ground on the assumption that those sea walls were high enough to protect against any likely tsunami.

As we plan for the worst-case scenario, are we under estimating what the worst-case scenario is? It‘s important that we know how likely a really, really big earthquake is, not just for insurance or actuarial purposes but so we can plan our own infrastructure, so we can work on our own disaster preparedness.

As we work on disaster preparedness, we need to know what kinds of disasters we should be prepared for.

Here at home, one of California‘s nuclear power plants, the one at Diablo Canyon, is in the middle of a fight with local residents. The plant wants to extend its operating license. But local opponents who note the recent discovery of a fault line about a mile offshore from the plant, they would like to see some new seismic studies first. The plant is designed to withstand up to a 7.5 magnitude earthquake.

Again, after the upgrade the one in Japan this weekend is now considered to have been a 9.0.

Joining us now is Congressman Rush Holt, Democrat of New Jersey, and a physicist who has worked on nuclear issues.

Congressman Holt, thank you very much for being with us tonight.

REP. RUSH HOLT (D), NEW JERSEY: Good to be with you, Rachel. And thanks for the reports from Bob and Lee. This is a good program. Thanks.

MADDOW: Thanks. Thank you very much. It‘s nice of you to say that.

Let me get your reaction particularly to what Bob was talking about, which is the news that this **third explosion** at this reactor in Japan may be more serious than the previous two, that there may have been a significant new release of radioactivity. An American public listening to you tonight, thinking of you as both a congressman and physicist, what‘s your advice about how we should understand the severity of this news?

HOLT: Well, it is troubling. And as you said, this is one of the worst, maybe the second worst nuclear accident in the history of nuclear power. You know, it is—it was supposed to be rare. These are well-designed plants.

The Japanese plants are operated, I think, at least as well as plants in the United States. The designs are similar to what we find in the United States. They have a lot of experience and, yet, these rare events seem to be occurring, you know, every decade or two—the ones that are supposed to occur only every many thousands of years.

You know, we‘ve had some reminders in the last weeks that our oil supply is perilous, whether talking about Gulf Coast explosions or Libyan uprisings. And now, we have another reminder that our hopes for nuclear power are perilous as well. And it just underscores that we need a good energy plan. We don‘t know how we‘re going to get out of our energy predicament.

MADDOW: In terms of comparing this to previous disasters, what happened at Chernobyl is complicated but for me just—as a lay audience reading about it as far as I understand it, it seems like a poorly designed experiment that went bad. At Three Mile Island, it was also human error that really ended up being a significant part of the cause there.

That does not seem to be the case in Japan. As you point out, these are well-built facilities that are as well-run as anywhere else in the world. I worry that our comfort with nuclear power is based not on a lack of

organization or a lack of being—or a lack of our ability to believe that we could be bad at our jobs, by a lack of imagination about how bad things are that the Earth could throw at us.

Are we basing our faith in this energy process on fundamentally unsound assumptions about how stable the world is in terms of our climate and earthquakes?

HOLT: I think we might call it human error that they put the backup diesel generators on low ground.

MADDOW: Yes.

HOLT: So—I mean, the point is, none of these things are free or easy or cheap. I mean, we're -- 10,000 Americans are dying prematurely each year because of our use of coal. **You know, this is—there is no free energy and the nuclear power has problems with safety, mostly under control, with disposal of the used fuel, mostly under control.**

But I must say the big issue—the looming issue that I think determines how aggressively we should move forward with nuclear power is the connection with weapons, weapons proliferation. Far more people would be killed with—and far more damage to civil society would be done with nuclear weapons than with any nuclear power plant accident.

And I know the industry says, oh, no, we're not in the weapons business. We're just in the power business. There is no connection.

I say, if there's no connection, why is everybody so worried about Iran? Of course, there's a connection. And that has to be figured in to the future of nuclear power.

MADDOW: Even when things don't go wrong, when used as directed.

HOLT: Even when things don't go wrong—that's right.

MADDOW: Congressman Rush Holt, Democrat of New Jersey, and an actual physicist—it's a real pleasure for us to have you here tonight with us, sir. Thank you.

HOLT: Good to be with you.

MADDOW: Recapping the breaking news from this hour, officials in Tokyo have announced that there has been a third explosion at the Daiichi nuclear power plant in northern Japan.

The first and second explosions at that nuclear power plant were described by officials as explosions of hydrogen, hydrogen that had built up near the reactors as workers used seawater to try to cool down damaged fuel rods. In both instances, although damage was done to external radiation containment buildings, the reactors themselves they said were not damaged by the blasts.

In the case of the third explosion, this new one, they are not giving the same assurances about the integrity of the containment vessels. They say there has been a radiation release although not one that is catastrophic.

Please stay with MSNBC. We will keep you posted as we learned more details in this containing, developing story. "THE ED SHOW" starts right now. Good night.

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