Commentary
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COMMENT ON SUZUKI PRESENTATION ON THE FUKUSHIMA ACCIDENT

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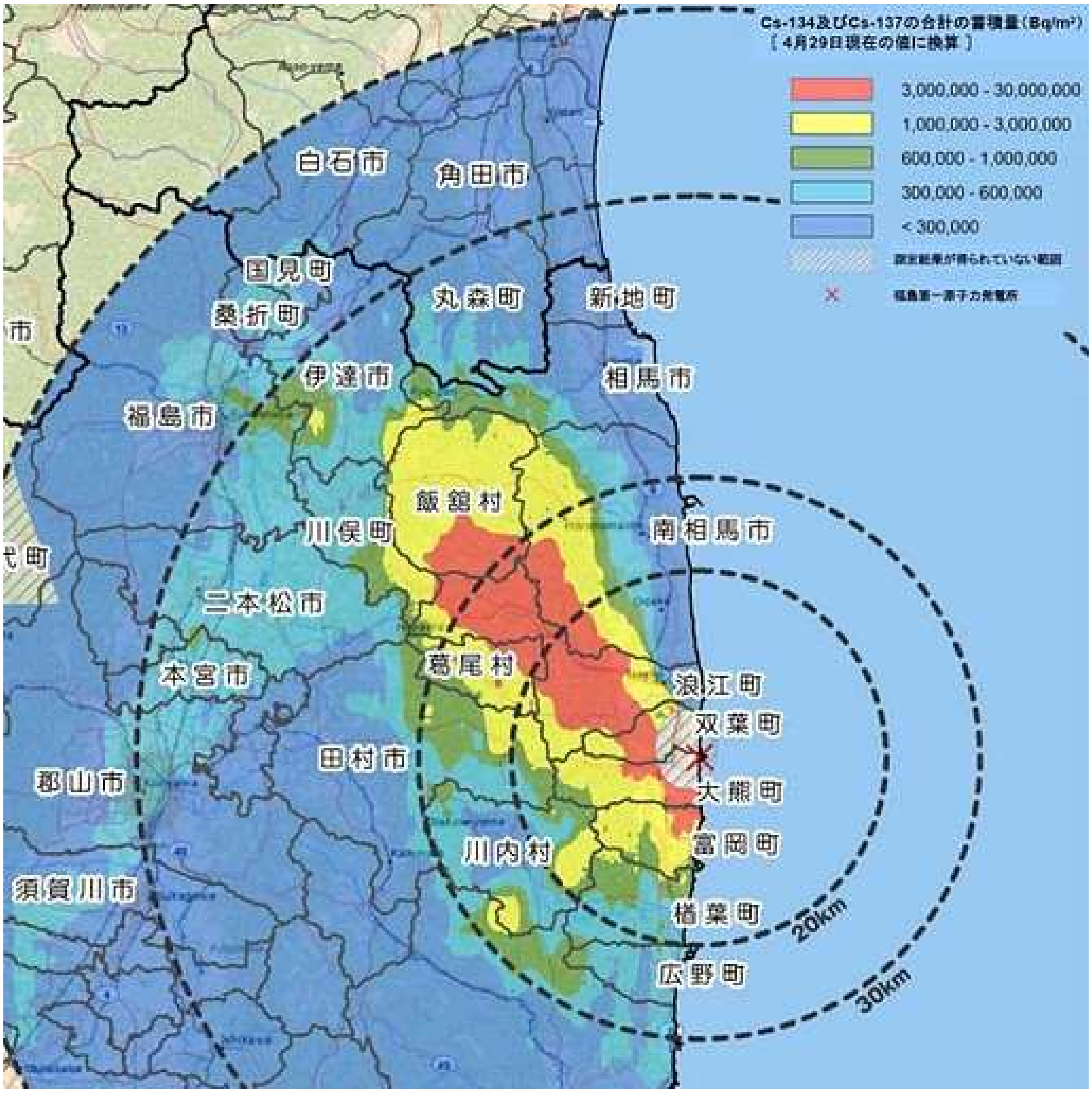
We’ve gotten an exceptionally informative and candid report on what is known about the accident. Judging by my own experience at Three Mile Island, it will be several years before we fully understand it, and I think there will still be some surprises.

Tatsu also presented a long list of useful lessons learned and recommendations for improvement of nuclear power plants. We have to hope they will be adopted. But even if they are, and it is not assured that they will be, that is still not enough. The implications of the accident go beyond this list.

I think we have to rethink the commitment to this technology, at least in its current form—the so-called Light Water Reactor, which is the main type of reactor used throughout the world. Let me to try to explain why I think this.

I would like to concentrate my remarks on one single point—on the radiological contamination of the surrounding area, and the consequent need to evacuate large numbers of people. While this aspect of the accident has not received a great deal of attention, I think it will prove to be the most important one for the future of nuclear power.



The figure above shows the extent of the contamination beyond the reactor site, extending for tens of kilometers to the northwest. The red zone, which extends past the 30 kilometer circle, is the area within which the Japanese authorities estimate that an inhabitant would get between 40 and 400 times the normally permissible radiation dose over the next year. The yellow zone is the area in which the inhabitant's annual dose would be between about 15 and 40 times the permissible amount. (The international standard for an individual radiation dose from all man-imposed radiation is 100 millirem per year in common US units, which is equivalent to 1 milli-Sievert per year in international units.)

As the Japanese evacuation criterion is 2000 millirem per year, the evacuation zone is slightly within the boundary of the yellow zone. In other words, the Japanese evacuated an area if they estimated that a person staying there would get 20 times the normally permissible amount of radiation over the next year. It includes nearly 100,000 persons.

The Japanese apparently carried out the evacuation promptly and efficiently, preventing any large radiological impact. That is the positive side to the evacuation. John Ritch,, Director General of the World Nuclear Association, told the June 2011 IAEA Ministerial Conference on Nuclear Safety that the evacuation demonstrated the "essential safety of nuclear power." The other side of it is that the evacuees will have to wait until next year to find out when they can come back; and because the contamination is long lasting some of them probably never will be able to return. Many thousands, perhaps tens of thousands, will become permanent nuclear refugees.

The reason the radiation will be long lasting is that the main contaminant at this point is cesium 137, which has a half-life of 30 years. That means it takes that long for the radioactivity to drop by half. For example in an area where the current level is 20 times the permissible dose (which as you can see it is extending out past 50 kilometers from the plant), it would still be 10 times the permissible dose after 30 years, and 5 times after 60 years, and so on. In the red zone the doses would still be more than 20 times the permissible limit after 30 years. (The early contamination by Iodine 131—that concentrates in the thyroid—has by now decayed as its half-life is only 8 days, and while important initially is not so any longer.)

The slow decay of radioactive Cesium released in the 1986 accident still keeps the area around Chernobyl off limits. Despite what you may have heard, there are important similarities in the two cases. Fukushima radioactive releases were about 1/6 of those at Chernobyl, and most of the radioactive material blew eastward over the Pacific, but there was still a lot of contamination on land. It could have been much worse had the winds blown differently. The maps of radioactive Cesium deposition in the areas around

Fukushima and Chernobyl are I would say recognizably similar in extent and level of contamination.

As the Fukushima heavy contamination zone—over 20 times the permissible dose—is about 20 kilometers wide and about 40 kilometers long, we are talking about hundreds of square kilometers that may be off limits for decades, and perhaps longer. In other words, tens of thousands of persons are in danger of becoming permanent nuclear refugees.

If people do go back eventually to some locations they will have to wear dosimeters and step carefully. As this sinks in, the impact is going to be considerable.

The earlier Chernobyl accident forced an even greater relocation of populations, but the Western nuclear programs didn’t think they had much to learn from the experience. The thought was that “it couldn’t happen here” because Western reactors were far superior to the “primitive” Soviet ones.

This time, however, the Fukushima plants that failed were of Western/US design, and their operating practices—even with their faults—are more or less representative of nuclear operations in developed countries around the world. (In fact, when I was on the NRC we looked to Japan as a model for good operation of nuclear plants.)

Yes, they were confronted by highly unusual natural events. However, there is no getting away from the main lesson of Fukushima:

Big radiation releases are possible in LWRs—releases so big that they could put large tracts of land off-limits for an indefinite period and force the permanent relocation of large numbers of people.

It seems to me one shouldn't have to worry about this. It is hard to be comfortable with this technology in its current form.

What then do we do about it? The nuclear answer, reflected in some of the recommendations on the slides, is mainly to be more careful to reduce the probability of an accident.

But even with reduced likelihood of accidents the basic characteristic of these machines remain. It is what drives the need for numerous safety systems and the need for near-military level of discipline in reactor operations. And ultimately this drives the cost of the reactors.

The basic characteristic is this: Even after shutdown it typically takes little more than an hour of coolant failure before the residual radioactivity heats the 100 tons of uranium fuel to the melting point. And that melted fuel can release a fearful amount of radioactivity.

If you want the reactors to be able to contain the melted fuel in the event of an accident, you run into serious difficulties.

None of the LWRs was designed to cope with a severe accident, that is, one that involves melting of fuel such as occurred at Fukushima. At least none of the 104 US operating plants are, and so far as I know this applies as well to the others. All the US plants were licensed on the assumption that such an accident was *"not credible."* This approach dates back to a deliberate decision by the US Atomic Energy Commission around 1968.

The result is that about half the US reactors were built with rather weak containments. A fundamental question is whether some of the oldest and most vulnerable plants should continue to operate, at least not without major modifications. Situation differs in various countries.

New reactors are probably safer, but their basic characteristics are the same as those of currently operating LWRs. I believe that we shouldn't build more of these plants until we have dealt adequately with the ones we have. A government's willingness to take this course is to my mind an indication of its seriousness about nuclear safety.

We also need to go back to basics. The reason for interest in nuclear plants, at this point: given their high cost, is to reduce greenhouse gas emissions in electricity generation. To make a serious dent on the global warming problem on a worldwide basis would probably take more a thousand plants, perhaps more. I don’t think it’s wise to replicate current light water reactor technology on that scale. There are other reasons for resisting the wide scale deployment of LWRs, but they are beyond the scope of today’s discussion.