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The Highest Risk: Problems of Radiation at Reactor Unit 4, Fukushima Daiichi

Shaun Burnie, Matsumura Akio and Murata Mitsuhei

The Risks to Japan From Fukushima

Shaun Burnie

The efforts of two Japanese citizens, Matsuura Akio and Murata Mitsuhei, to raise awareness of the risk of a further major accident at Fukushima are to be commended. More than 13 months after the accident began – the threats from the Fukushima Daiichi site are multi-dimensional and on-going, but the under reporting of these risks as a result of nuclear crisis fatigue tied with the 24 hour news cycle can lead to a complacency on the current and future reality at the site.

The specific issue highlighted by Matsumura and Murata is the risk and consequences of the failure of the spent fuel pool at the destroyed reactor unit 4 at Fukushima Daiichi. As they report the spent fuel inventory at this pool is the largest of all 4 reactors that were destroyed by the earthquake and tsunami in March 2011.

While one can take issue with some of the language used – fate of the whole world being one – it is important to understand the scale of the threat, and why there are no easy and quick solutions. The risks from spent fuel have been known almost since the beginning of nuclear power – the radiation levels are so high that without shielding, direct exposure to spent fuel rods is fatal. Despite this knowledge the world proceeded to deploy nuclear power reactors – led by the United States – that has created a total global inventory of over one quarter of million tons. Most of this is stored in water filled pools. In addition to creating a massive plutonium stock – 2500 tons (contained in spent fuel) and compared with the micro-grams that were valued above gold in 1944 by the engineers running the Manhattan project – the spent fuel crisis has spread worldwide to every nation operating nuclear reactors.

The Fukushima Daiichi accident focused attention on the issue as never before. Japan, a nation committed to reprocessing spent fuel at the Rokkasho-mura plant, had failed to solve the problem – like other nations the reprocessing route in Japan has failed economically and technically. TEPCO, at the CEO level in the late 1990s, was less convinced of the reprocessing route to spent fuel management than other utilities. Its support for the interim storage facility at Mutsu in Aomori underscored that it was not fully committed to the reprocessing option.

The Spent Fuel Problem

One consequence of this was that the Fukushima Daiichi site contained more spent fuel than most sites. But this problem is not unique to Japan – the United States currently has over 65,000 tons of spent fuel – three quarters of which is stored in poorly maintained and vulnerable pools.

Matsumura and Murata have performed a vital public service. Their analysis and call for urgent action has been informed by such leading experts as Robert Alvarez, who for decades warned of the risks from spent fuel pool storage. Bob is a colleague of mine at Friends of the Earth in the United States and his grasp of shocking details that the nuclear industry and their governments would prefer to ignore is critically important for more people to understand.

The evidence of risk has been known for decades. The much-cited Brookhaven study is worth studying in detail. Japan's Nuclear and Safety Agency (NISA), TEPCO and their counterparts in the U.S. and internationally have been well aware of the hazards of spent fuel. But have done nothing to reduce these significantly.

Now we face a crisis for which there is no simple, risk free solution. Removing the spent fuel rods at Fukushima Daiichi is a priority, but it will not be achieved (or even attempted) before 2013 or later. Securing the structure of the pool at Unit 4 was identified early on in the crisis, with support columns installed. But the survivability of these columns, if struck by a major seismic event, must be doubted. A decision to build a new structure around the plant with heavy lift cranes is only the start of a long process that risks failure at numerous corners. All through this period and before the spent fuel is unloaded and put in secure casks the possibility will persist of loss of cooling water leading to an exothermic reaction that would lead to the release of a vast inventory of radioactive cesium and other radionuclides. The 50 mile evacuation zone recommended for U.S. citizens in the months after the Fukushima accident began would not be sufficient to protect Japan, including Metropolitan Tokyo, from potential devastation as a society. That was the information conveyed to Prime Minister Kan more than one year ago – and it remains the nightmare today.

Responding to the Problems of Radiation at Fuel Pool at Unit 4

In the event of further severe damage to the spent fuel pool in Unit 4 what are TEPCO's options?

Water spraying and the use of materials such as boron and sand would appear the most relevant. The risk is that, with water spraying on Fukushima Daiichi unit 4 following a loss of the cooling water and even collapse of the building, this could make the situation worse – if the spent fuel rods have gone beyond 900 degrees then the water will provide further oxidation helping to release more radionuclides into the atmosphere. The zircalloy fuel cladding around the thousands of fuel rods at Fukushima Daiichi ignites at 900 degrees and above – fuel melting as seen in the cores of units 1, 2 and 3 occurs at 2800 degrees.

Other important factors include the possibility that the pool collapses and the spent fuel rods are scattered on the ground with the result that the complexity of dealing with the problem is magnified. Emergency worker access to these rods may be impossible as they will be emitting lethal levels of gamma radiation. Remote access through the use of robots may not be feasible given the radiation levels. The rods will continue to release radiation until they are secured under water – but without access to the rods and

the use of a crane this would not be possible – so a prolonged nuclear release over days and weeks would be potentially catastrophic for Japan.

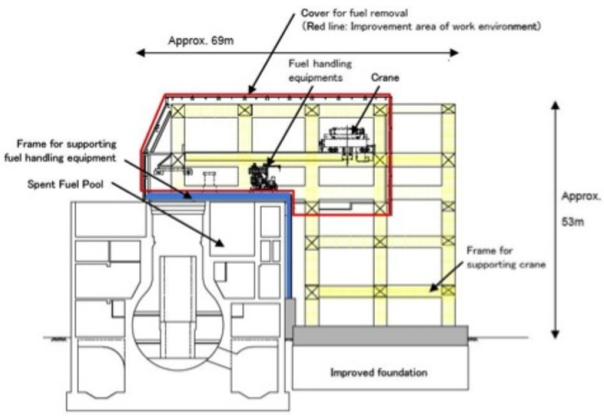

Fig.2 Schematic Diagram of the Cover for Fuel Removal

It is worth noting that the crisis could have been even much worse. Plans by TEPCO to load hundreds of tons of Mixed Oxide fuel containing tons of plutonium were thwarted a decade ago by local citizens and then Governor Sato Eisaku of Fukushima. If TEPCO had been successful the spent fuel pools of reactors at the site, as well as the molten reactor cores would have presented an even greater challenge in terms of cooling, the threat of widespread and large scale plutonium dispersal, and their devastating human health impacts. Informed citizen action, unrecognised at the time, deserves widespread credit from Japanese society.

Spent Fuel at Southern California's San Onofre Nuclear Plant and the Threat of Radiation

Along with Alvarez, I have the honour to be working with Arnie Gundersen on a crisis at the San Onofre nuclear plant in southern California. The spent fuel threat at that site is if anything an even greater radiological risk given the 8.4 million people that live within 50 miles of the site.

The simple lesson from Fukushima is that the threat from nuclear power, and in particular spent fuel, is real, should never have been ignored by governments for the past half century, and should be a decisive factor in ending the nuclear age. If Matsumura and Murata's warnings could play a role in making such a future more achievable, this would be a signal achievement.

Shaun Burnie *is a nuclear consultant to Friends of the Earth U.S. and Greenpeace Germany. For over two decades he has been a campaigner and coordinator and now consultant to Greenpeace. He has visited and worked in Japan over 20 years – including in support of citizens seeking to prevent TEPCO plans for MOX fuel loading at Fukushima in 1999-2001. He is Scottish, currently visiting the United States.*

The Fate of Japan and the Whole World Depends on the No. 4 Reactor at Fukushima

Matsumura Akio

Cesium-137 at the Fukushima Daiichi site is 85 times greater than at Chernobyl.

Reactor # 4 at Fukushima Daiichi

Japan's former Ambassador to Switzerland, Mr. Murata Mitsuhei, was invited to speak at the Public Hearing of the Budgetary Committee of the House of Councilors on March 22, 2012, on the Fukushima nuclear power plants accident. Before the Committee, Ambassador Murata strongly stated that if the crippled building of reactor unit 4 - with 1,532 fuel rods in the spent fuel pool 100 feet (30 meters) above the ground - collapses, not only will it cause a shutdown of all six reactors but will also affect the common spent fuel pool containing 6,375 fuel rods, located some 50 meters from reactor 4. In both cases, the radioactive rods are not protected by a containment vessel; dangerously, they are open to the air. This would certainly cause a global catastrophe like we have never before experienced. He stressed that the responsibility of Japan to the rest of the world is immeasurable. Such a catastrophe would affect us all for centuries. Ambassador Murata informed us that the total number of spent fuel rods at the Fukushima Daiichi site, excluding the rods in the pressure vessel, is 11,421 (396+615+566+1,535+994+940+6375).

I asked top spent-fuel pools expert Mr. Robert Alvarez, former Senior Policy Adviser to the Secretary and Deputy Assistant Secretary for National Security and the Environment at the U.S. Department of Energy, for an explanation of the potential impact of the 11,421 rods.

I received an astounding response from Mr. Alvarez [updated 4/5/12]:

> In recent times, more information about the spent fuel situation at the Fukushima-Dai-Ichi site has become known. It is my understanding that of the 1,532 spent fuel assemblies in reactor No. 4, 304 assemblies are fresh and unirradiated. This then leaves 1,231 irradiated spent fuel rods in pool No. 4, which contain roughly 37 million curies (~1.4E+18 Becquerel) of long-lived radioactivity. The No. 4 pool is about 100 feet above ground, is structurally damaged and is exposed to the open elements. If an earthquake or other event were to cause this pool to drain this could result in a catastrophic radiological fire involving nearly 10 times the amount of Cs-137 released by the Chernobyl accident.

The infrastructure to safely remove this material was destroyed as it was at the other three reactors. Spent reactor fuel cannot be simply lifted into the air by a crane as if it were routine cargo. In order to prevent severe radiation exposures, fires and possible explosions, it must be transferred at all times in water and heavily shielded structures into dry casks. As this has never been done before, the removal of the spent fuel from the pools at the damaged Fukushima-Daiichi reactors will require a major and time-consuming re-construction effort and will be charting in unknown waters. Despite the enormous destruction caused at the Dai-Ichi site, dry casks holding a smaller amount of spent fuel appear to be unscathed.

Based on U.S. Energy Department data, I assume a total of 11,138 spent fuel assemblies are being stored at the Daiichi site, nearly all of which is in pools. They contain roughly 336 million curies (~1.2 E+19 Bq) of long-lived radioactivity. About 134 million curies is Cesium-137 - roughly 85 times the amount of Cs-137 released at the Chernobyl accident as estimated by the U.S. National

Council on Radiation Protection (NCRP). The total spent reactor fuel inventory at the Fukushima-Daiichi site contains nearly half of the total amount of Cs-137 estimated by the NCRP to have been released by all atmospheric nuclear weapons testing, Chernobyl, and world-wide reprocessing plants (~270 million curies or ~9.9 E+18 Becquerel).

It is important for the public to understand that reactors that have been operating for decades, such as those at the Fukushima-Dai-Ichi site have generated some of the largest concentrations of radioactivity on the planet.

Many of our readers might find it difficult to appreciate the actual meaning of the figure, yet we can grasp what 85 times more Cesium-137 than Chernobyl would mean. It would destroy the world environment and our civilization. This is not rocket science, nor does it connect to the pugilistic debate over nuclear power plants. This is an issue of human survival.

There was a Nuclear Security Summit Conference in Seoul on March 26 and 27, and Ambassador Murata and I made a concerted effort to find someone to inform the participants from 54 nations of the potential global catastrophe of reactor unit 4. We asked several participants to share the idea of an Independent Assessment team comprised of a broad group of international experts to deal with this urgent issue.

I would like to introduce Ambassador Murata's letter to UN Secretary General Ban Ki-moon to convey this urgent message, and also his letter to Japan's Prime Minister Yoshihiko Noda, for Japanese readers. He emphasized in the statement that we should bring human wisdom to tackle this unprecedented challenge.

It seems to us that the Nuclear Security Summit was focused on the North Korea nuclear issue and on the issue of common security from a terrorist attack. Our appeal on the need for independent assessment at Reactor 4 was regarded as less urgent. We predicted this outcome in light of the nature of the Summit. I suppose most participants fully understood the potential disaster which will affect their countries. Nevertheless, they decided not to raise the delicate issue, perhaps in order not to ruffle their diplomatic relationship with Japan.

I was moved by Ambassador Murata's courage in pressing this issue in Japan. I know how difficult it is for a former career diplomat to do this, especially in my country. Current and former government officials might be similarly restricted in the scope of their actions, as Ambassador Murata is, but it is their responsibility to take a stand for the benefit of our descendants for centuries to come - to pass on a world safer than our ancestors passed on to us.

If Japanese government leaders do not recognize the risk their nation faces, how could the rest of us be persuaded of the looming disaster? And if the rest of us do not acknowledge the catastrophe we collectively face, who will be the one to act?

Tokyo

March 25, 2012

Dear Secretary-General,

Honorable Ban Ki-moon,

I wish to express my heartfelt gratitude for your considerate letter dated 2 March, 2012. Your moral support for a United Nations Ethics Summit will remain a constant source of encouragement for my activities.

Please allow me to pay a tribute to your great contribution to strengthen nuclear safety and security. The current Nuclear Summit in Seoul is no doubt greatly benefiting from the high-level meeting you convened last September.

I was asked to make a statement at the public hearing of the Budgetary Committee of the House of Councilors on March 23. I raised the crucial problem. of N0.4 reactor of Fukushima containing1535 fuel rods. It could be fatally damaged by continuing aftershocks. Moreover, 50 meters away from it exists a common cooling pool for 6 reactors containing 6375 fuel rods!

It is no exaggeration to say that the fate of Japan and the whole world depends on NO.4 reactor. This is confirmed by most reliable experts like Dr. Arnie Gundersen.

Please allow me to inform you of an initiative being taken by a former UN official who is endeavoring to have the Nuclear Security Summit take up the crucial problem of N0.4 reactor of Fukushima. He is pursuing the establishment of an independent assessment team. I think his efforts are very significant, because it is indispensable to draw the attention of world leaders to this vital issue.

I am cooperating with him, writing to some of my Korean acquaintances that this issue deserves the personal attention of President Lee Myung-bak. I have written today to Prime Minister Noda Yoshihiko. I asked him to consider taking the initiative of mobilizing human wisdom on the widest scope to cope with the Fukushima reactor No.4 problem, fully taking into account the above-mentioned "independent assessment team."

The world has been made so fragile and vulnerable. The role of the United Nations is increasingly vital. I wish you the best of luck in your noble mission. Please accept, Secretary-General Ban Ki-moon, the assurances of my highest consideration.

Murata Mitsuhei

Executive Director, the Japan Society for Global System and Ethics

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Matsumura Akira, 'Finding the Missing Link,' published this at *Reader Support News* on April 12, 2012 - link.

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