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Issues of Water and Light in the Turbine Buildings at Fukushima Daiichi¹

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Workers at the Fukushima Daiichi plant have been trying to reestablish electricity connections to pumps so as to restart the cooling system for the reactors at the plant. According to news reports, two of the major obstacles have been

- a high radiation environment (on the order of 1,000 millisieverts per hour) due to contaminated water on the floor of the turbine buildings, and
- a lack of light in the turbine buildings, which has forced the electricians to work in the dark.

The combination of these two factors has made it exceedingly difficult to accomplish the objective and has so far frustrated it. Pumping water out of the reactor buildings has not been possible since there are no empty tanks on site of sufficient capacity to hold the water, which is too contaminated to be pumped into the ocean. Recent reports indicate that the water is also leaking out of the building on to the site, further contaminating the working environment and complicating efforts to bring the problem of cooling the reactors and spent fuel pools under control.

It is extremely difficult to suggest possible courses of action from afar; yet sometimes, the ability to bring the experience of other localities and technological challenges to bear on a problem may be helpful. In this spirit, we put forward a suggestion in the hope that it might be considered by those on sight who are struggling with the very difficult and complex effort to bring seven major sources of radioactivity under control (three reactors and four spent fuel pools). The suggestions presented here may or may not be suitable courses of action. However, they may be worthy of consideration after which the authorities may decide whether they merit implementation or suggest alternative approaches. It should be understood explicitly, that we are not recommending that the steps outlined below be implemented, since we are not in a position to evaluate the various possible safety and feasibility issues associated with them. The responsibility for making and implementing decisions belongs fully and solely to the Japanese government's safety authorities and the Tokyo Electric Power Company.

A. Light

¹ This paper reviewed by Dr. Ferenc Dalnoki-Veress and Dr. Patricia Lewis. I am grateful for their helpful comments. As the author, I alone take responsibility for its final contents and any deficiencies that remain.

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Punching holes into the roof of the turbine buildings (with due consideration to the hydrogen that may be in them) could provide an initial amount of light, which would enable much more work to be done in the 15 minutes to which workers are limited under the current radiation conditions (according to news reports). At that point, explosion-proof lights using small external generators could also be introduced into the buildings through the holes in the roof to further facilitate work. Any increased radioactivity in the atmosphere outside the turbine building is likely to be very minor compared to the radioactivity on site already, and puncturing the roof will reduce radiation doses greatly once the leakage onto the site is stopped and the water in the building evacuated. Any increased radiation will also likely be temporary since this method will facilitate the removal of water in the building provided the pumping is maintained while the source of the leak is being repaired (if possible).

B. Pumping out water

It is suggested that an empty oil tanker of sufficient size to accommodate the accumulated water and that anticipated to leak into the turbine buildings in the coming period be brought as close to the site as possible. (Alternatively, two tankers may provide a more flexible arrangement, since one could carry water away for unloading into tanks elsewhere in Japan.) The radioactive water can be pumped into the tanker, which can serve as a floating tank. Fresh water to cool the reactors and spent fuel pools is already being brought to site by U.S. barges. This would be the reverse of the process. Of course, it is recognized that the vessel would probably have to be written off, but in the scheme of damages that have already occurred and that may occur if the regular cooling system is not made functional soon, it would seem that this may not be a major consideration.

Since the water is extremely radioactive, pumping out water and putting it in a ship's hold (like putting it in a tank on land) will involve some hazards that the authorities should evaluate and take the necessary precautions. For instance, there could be residual radioactive noble gases in the water; it is established that there are volatile radionuclides, notably iodine-131. Other iodine isotopes may also be present. Appropriate arrangements to protect workers pumping the water and those managing the filling of the holds on board, such as venting of the holds, should be made.

Finally, given that the water contains a significant concentration of long-lived cesium-137, we stress that it should not be discharged into the ocean, into any other body of water, or onto land; neither should it be injected into the ground. It should be held in large tanks away from the site that are appropriately seismically qualified and checked regularly. The water should be held until all the short-lived radionuclides are decayed away so that the rest can be captured, for instance by ion exchange in resins, as is done with reactor primary water.

C. Conclusion

It appears urgent to devise ways of lighting the turbine building at least by daylight and preferably also by electric explosion-proof lamps. The suggestions above are for consideration and evaluation by the Japanese governmental authorities and by TEPCO. They are not recommendations for action, but could provide ideas that might be useful in an extremely difficult and dangerous situation; they may also be rejected if found unsafe or unsuitable for any reason. The responsibility for evaluation and implementation rests, of course, entirely with the Japanese governmental authorities and with TEPCO who may accept, reject, or modify them as appropriate. Our only desire is to be helpful at a very difficult time for the Japanese people and for the workers and managers who are trying their best to manage the unprecedented nuclear crisis at the Fukushima Daiichi plant.