Dangers of the Spent Fuel Pool of Unit 4 at Fukushima Dai-ichi

FYI – Here are copies of two letters addressed to Akio Matsumura, a Japanese activist with high-level political concerns. Akio has been particularly concerned about the spent fuel pool in reactor Unit 4 at Fukushima-Dai-ichi.

See his blog on this subject: *"The Fourth Reactor and the Destiny of Japan"* *http://tinyurl.com/6dlxek5* ***and my*** *response* ***to his blog*** *http://tinyurl.com/65pago9* .

The following two letters were written in an attempt to answer further questions posed by Mr. Matsumura.

January 13 2012

Dear Akio:

Regarding the spent fuel pool in Reactor Unit 4 of the Fukushima Dai-ichi Nuclear Power Station:

(1) If the spent fuel pool were to topple or collapse or even shift away from the horizontal, as a result of an earthquake or other major event, we will be in a situation that has never been studied or analyzed by nuclear scientists anywhere in the world.

(2) Loss of coolant from the pool will result in intense gamma radiation fields that may prevent access by atomic workers for hundreds of metres in all directions, preventing prompt or timely remediation efforts from taking place.

(3) Overheating of uncooled spent fuel in the pool will drive temperatures upwards and will eventually result in renewed releases of radioactive fission products into the atmosphere due to the complete lack of any containment structure surrounding the pool.

(4) At about 900-1000 degrees C, intense chemical reactions between the zirconium cladding of the fuel and steam will add to the heat load, driving temperatures up even faster and exacerbating the radioactive releases.

(5) At these temperatures an intensely hot zirconium fire may well start, releasing tiny aerosol particles of spent fuel (called "nuclear fleas") that may be carried hundreds of kilometers by the winds, and that will constitute potent sources of radiation exposure and radioactive contamination for centuries to come.

(6) Under adverse conditions, a fuel meltdown within the pool is still possible after several days of heating, occurring at temperatures of about 2800 degrees C; such a meltdown would be uncontained due to the lack of a containment structure for the spent fuel pool.

(7) Crowding of the spent fuel due to gravitational or other forces can restart the fission process within the pool, greatly increasing the danger level to workers, the

public, and the environment, shortening the time for a fuel meltdown, and contributing a new generation of short-lived heat-generating fission products to be dispersed into the environment.

Gordon Edwards.

NOTE: Point number 7 above does not apply to CANDU spent fuel pools. Since CANDU fuel is unenriched it cannot undergo nuclear fission when immersed in ordinary water; it would require expensive "heavy water" in order to restart the fission chain reaction, and this is simply not available in CANDU spent fuel pools.

January 13 2012

Dear Akio:

You asked me why there has been so little warning from the "nuclear establishment" (TEPCO and the regulatory agency) about the potential for catastrophic accidents involving the spent fuel pool in reactor number 4.

In the field of nuclear safety, the focus of attention has always been on analyzing and preventing catastrophic accidents involving the core of the reactor.

In comparison, little attention has been paid over the years to catastrophic accident scenarios involving the spent fuel pool.

Since the very first US Reactor Safety Study, the "Brookhaven Report" in 1957, to the major 12-volume US NRC Reactor Safety Study (the Rasmussen Report) of 1974, and continuing right down to the present day, virtually all of the attention has been directed to extreme conditions that might develop in the core of the reactor -- unterminated power excursions, loss of coolant accidents, breach of the reactor vessel, core meltdowns, and so on.

Most nuclear engineers and nuclear regulators have developed a "blind spot" about the catastrophe potential associated with the spent fuel bay because of years of neglect. Such considerations have never played a significant role in their training as nuclear engineers or in their many subsequent years of experience in the field of nuclear safety analysis.

As a result we have backup pumps, backup electrical supply systems, and backup cooling systems for the core of the reactor, but NO backup pumps or electrical supply or cooling system for the spent fuel bay. We have extravagant containment systems for the core of the reactor, but no comparable containment systems for the spent fuel pool.

This absence of backup systems for the spent fuel pool is testimony to the lack of effort and lack of forethought that has been devoted to the spent fuel bay. Nevertheless, the radioactive inventory in the spent fuel pool is often much greater than that in the core of the reactor, and a prolonged loss of coolant -- or even loss of circulation of coolant -- will lead to overheating of the fuel and extensive fuel damage. This will result in significant releases of radioactive fission products into the atmosphere due to the inadequate or even non-existent containment provided for the spent fuel pool.

Moreover, a loss of coolant in the spent fuel pool -- whether by leakage, spillage, or boiling off of the cooling water -- will lead to intense gamma radiation that would prevent human access for hundreds of metres in all directions around the spent fuel pool, making it very difficult to take corrective actions.

Under adverse circumstances there can even be a fuel meltdown in the spent fuel pool, if the temperature climbs to about 2800 degrees C, which would vastly increase radioactive releases and spread those releases over a much wider area.

The overheating of the spent fuel in the pool can be exacerbated by the intense exothermic reaction between the zirconium cladding and the steam produced from the overheated water, and can even result (at around 1000 degrees C) in a very intense zirconium fire which can result in tiny particles of intensely radioactive spent fuel being liberated into the atmosphere.

Depending on the diameter of these "hot particles" (sometimes referred to as "nuclear fleas") they can be transported greater or lesser distances by the wind, possibly affecting populations hundreds of kilometers from the spent fuel pool. Once dispersed into the environment, these hot particles will constitute a source of radiation exposure and environmental contamination for centuries to come.

In addition to the possibility of zirconium fires (which have for a long time been almost completely overlooked by nuclear engineers and regulators) there is another, even more dangerous possibility. An alteration in the geometry of the spent fuel in the pool, by which the separation between the spent fuel rods is slightly but significantly reduced, can lead to re-initiation of the chain reaction in the pool. ***[True for "light water reactors" : not so for CANDU reactors.]***

Such "accidental criticality" will not only drive the temperature up rapidly, but will replenish the supply of short-lived heat-producing fission products, accelerating damage to the fuel, magnifying the heat loading, increasing the probability of a fuel pool meltdown, & vastly increasing the atmospheric releases of radioactivity.

It has been a standard practice in the nuclear industry to avoid consideration of all of these possibilities, based on the assumption that there will be "lots of time" to react to any emergency involving the spent fuel pool, as it will normally take days for the spent fuel to reach the melting point and it will be a "simple matter" to refill the pools with water if necessary.

This ignores the fact that major structural damage may make it impossible to approach the spent fuel pool due to the lethal levels of gamma radiation emanating from the spent fuel once the protective shielding of the water is gone.

Gordon Edwards.