

## ***Final Written Comments on Darlington “New Build” Project:***

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May 17, 2011*

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### **The Radioactive Nub of the Problem**

Every nuclear reactor is a machine that not only produces electricity, but also mass-produces staggering quantities of highly radioactive and/or highly radiotoxic materials that did not exist in nature in measurable amounts prior to the discovery of nuclear fission in 1938.

The fission products (like iodine-131 and cesium-137), together with the activation products (like tritium and carbon-14) and the transuranic elements (like plutonium), created inside every operating nuclear reactor, constitute a unique threat to the environment of living things. Under conditions where these materials are released in significant quantities, they have the capacity to poison large land areas and large bodies of water, rendering them unsuitable for human use for very long periods of time.

This being so, there should be no more siting of new nuclear reactors on the shores of the Great Lakes or in the neighbourhood of large population centres. To advocate or authorize the building of new nuclear reactors at the Darlington site in 2011, knowing what has happened at Chernobyl and at Fukushima, is not only unwise but could be seen as a crime against future generations. It is certainly contrary to the precautionary principle.

The review panel cannot in good conscience exempt Ontario Power Generation from the responsibility of characterizing the worst possible accident scenario at the proposed new Darlington reactors – partial or complete core meltdowns coupled with partial or complete loss of containment.

To paraphrase the California Energy Resources and Conservation Development Commission, the belief that nuclear power reactors are acceptably safe is based not so much on scientific evidence as on engineering euphoria. (The Commission made a similar statement with regard to the “safe disposal” of irradiated nuclear fuel.)

## **Nuclear Power is Inherently Dangerous**

Around the world, nuclear regulatory agencies are allied with the nuclear industry to work together in a common effort to make nuclear energy an economically viable and “acceptably” safe energy choice. Although they may try to deny it, the fact of the matter is that there is zero tolerance in these organizations for any anti-nuclear attitudes among staff, while pro-nuclear attitudes are considered normal, healthy, and even desirable. Thus there is a strong inherent bias in both the industry and in the regulatory bodies that nuclear energy is fundamentally desirable and safe.

As the President’s Commission on Three Mile Island concluded, however, the number one cause of the TMI accident was the false belief – prevalent among workers and managers alike – that nuclear energy is inherently safe. According to the Presidential Commission, headed by John Kemeny, there will surely be future meltdowns caused by a combination of human error and equipment failure unless this attitude is fundamentally changed.

Workers and managers must see nuclear power as an inherently dangerous technology. But this flies in the face of the industry PR message – aimed at the general population and their elected representatives – that nuclear energy is safe. This is the exact message emblazoned on the cover of the latest Annual Report from the Canadian Nuclear Safety Commission (CNSC) where one reads:

***“FACT: Nuclear in Canada is safe.”***

Such a message from any nuclear regulatory agency anywhere in the world would indicate that that agency is “Unfit to Regulate” – a term used by the British Columbia Medical Association in Chapter 22 of its publication, “Health Dangers of Uranium Mining” [<http://ccnr.org/bcma.html>].

A regulatory agency that does not even draw a distinction between a “fact” and an “opinion” is not worthy of public trust. Such an agency has chosen to act as a public relations arm of the industry rather than as an agency that seeks to enlighten the public about the very real dangers associated with nuclear power – dangers which make the existence of a federal regulatory agency necessary in the first place.

## **Meltdowns are Inevitable if Cooling is Inadequate**

It is a fact that any nuclear power reactor currently operating will undergo a core meltdown if deprived of adequate cooling for a long enough period of time. The reason for this is that the radioactivity created by the fission process during normal operation generates about seven percent of full-power heat. For a 1000 (electric) megawatt reactor, the heat output is about 3000 (heat) megawatts. Thus, immediately after shutdown, the radioactivity in the core of the reactor continues to generate about 200 megawatts of heat – more than enough to melt the core of the reactor at a temperature of about 2800 degrees Celsius.

The essential point is that this radioactivity cannot be shut off. Thus the “decay heat” produced by the enormous inventory of radioactive poisons in the core of the reactor is literally unstoppable. As more heat is added, the temperature rises higher and higher, and the only way core-damaging temperatures can be prevented is by removing the heat just as rapidly as it is being produced. With a complete loss of on-site and off-site electrical power, thus becomes impossible. Such a circumstance, while unlikely, can be brought about by a variety of abnormal conditions, ranging from natural disaster, to acts of warfare, to deliberate sabotage, to devastating fires in the electrical systems of the reactor, to simple mechanical failures with or without human error.

Even before fuel melting begins, the cladding will begin melting at about 1200 degrees Celsius, as zirconium metal (Zr) combines with steam ( $H_2O$ ) in a strongly exothermic (heat-generating) reaction to produce zirconium oxide ( $ZrO_2$ ) and large quantities of hydrogen gas that can result in powerful explosions.

This is all very basic science, yet none of it is communicated to the public or to their elected representatives by the regulatory agency or by the proponent in language that can be easily understood by the lay person.

To withhold this information is an act of intellectual dishonesty that is unconscionable. The panel should not accept this as permissible behaviour on the part of the proponent or the regulator.

## **Misuse of Mathematics Leads to Self-Deception**

Nuclear proponents and regulators often rely on a technique called “probabilistic safety analysis” in order to persuade themselves and others that certain accidents -- the very accidents that would make nuclear power completely unacceptable – do not need to be considered because they are so unlikely to occur.

While probabilistic safety analysis is a useful technique for comparing competing mechanical or electronic designs, or for assisting engineers to appreciate sequences of events (mechanical failures) that could have major undesirable consequences, it is entirely unscientific and a misuse of mathematics to use this technique to assert that certain types of reactor accidents are so unlikely to occur that their consequences need not be considered.

Anyone who studies probability theory knows that an event that cannot be imagined ahead of time cannot be given any probability at all. Thus the probability of such an event is, to the analyst, “ZERO”.

Probability theory begins by creating a real or imaginary list of all possible outcomes that can be foreseen. This is called the Sample Space. Then the analyst assigns probabilities to each outcome by estimating its expected frequency of occurrence, based on a number of mathematical assumptions that are sometimes (but not always) rooted in experience.

No one denies that this is a useful exercise. However, in actual fact, the probability of almost all nuclear accidents that have so far occurred is in fact ZERO, because none of them were foreseen as possible outcomes by any of the people who carried out the safety analysis initially.

Did anyone foresee the possibility of Fukushima Dai-ichi units 1, 2, and 3, suffering core damage simultaneously? Did anyone foresee the chain of events that led to the fires in the spent fuel bay of unit 4? I think not. Even if such outcomes had been analyzed in advance, the real probability of that particular outcome is dominated by the probability of the earthquake and tsunami that precipitated the outcome, and that probability is incalculable by any reliable scientific method available to us.

## **Simple Prudence Dictates....**

Arrogance is inappropriate, even criminal, in the face of such incipient dangers. Science and engineering are powerful and useful tools, but they are no substitute for common sense. Just as many people around the world are asking themselves, “Why would the Japanese site nuclear reactors so close to an earthquake zone?”, our grandchildren may well be asking themselves, “Why would our forebears site nuclear reactors so close to the most precious body of freshwater in North America, and perhaps in the entire world?”

Simple prudence, coupled with a sense of responsible humility, should tell us that it is folly to continue to site nuclear reactors which are CAPABLE of undergoing such terrible meltdown scenarios, on the Great Lakes or near large population centres. In fact an enormous portion of the entire North American population lives within the “striking distance” of a potential nuclear catastrophe on either side of the border.

## **A Royal Commission of Inquiry**

We urge the panel to recommend that the government of Canada launch a pan-Canadian Royal Commission of Inquiry into the Future of Nuclear Power in Canada. We urge the panel also to recommend that all licensing of new nuclear reactor facilities be suspended until the Commission has completed its work. We further urge the panel to recommend that no new nuclear reactors be sited on the shores of the Great Lakes unless it can be proven beyond any doubt that a catastrophic release of radioactive fission products is physically impossible.

It is time to stop hiding the truth about the dangers of nuclear power from the Canadian population and from their elected representatives. A Royal Commission of Inquiry will allow the facts to be made public – facts about both the benefits and the hazards of this technology. On the basis of a clear understanding of those facts, Canadian citizens and their elected representatives will be enabled for the first time since the dawn of the nuclear age to make an informed choice about the future of this heavily-subsidized energy option.