Nuclear power accidents

The following is part seven of an eight part written debate regarding nuclear power generation
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The Debaters

Dr. Daniel Meneley retired from Atomic Energy of Canada in 2001, and now holds the honorific title of Engineer Emeritus. He currently serves as Chair of the External Advisory Panel on the Generation IV reactor program of Natural Resources Canada, in addition to other advisory committees and consultancies.
Dan worked in nuclear power engineering for over 50 years, as a researcher, plant designer, senior manager, University educator, and as AECL's Chief Engineer. He was directly involved in the building and operational support of 17 CANDU units, nationally and internationally. He served as safety advisor to IAEA, in several advisory positions.

In the 1990's **Elena Schacherl** was on the Steering Committee of Pokebusters, a group opposed to building nuclear reactors in Saskatchewan including the SLOWPOKE 3 heating system.

Currently Elena is Chair of Citizens Advocating the Use of Sustainable Energy (CAUSE) in Calgary and also Southern Vice-President of the Coalition for a Nuclear Free Alberta. She has been involved in researching the nuclear industry for some 8 years and is co-author of the April 2009 report: "Nuclear Power in Alberta: An Alternative Perspective". Elena has some 20 years of management experience in the not-for profit sector. For more information see: www.nuclearfreealberta.ca.

Elena Schacherl opening statement

Accidents by nature happen because they are unanticipated. The nuclear accident at the NRX research reactor at Chalk River in 1952 occurred when an operator opened some valves by mistake and worsened when the supervisor instructed him to push the wrong button, raising rather than lowering the control rods. This was followed by a hydrogen-gas explosion that destroyed the reactor core. We are not able to foresee all human error, particularly in a complex system such as a nuclear reactor.

What is the risk of a nuclear accident in a CANDU reactor? In 1978 the Ontario Royal Commission on Electric Power Planning accepted the assessment of Dr. Gordon Edwards and Ralph Torrie that the risk of a core meltdown in a CANDU is 1 in 10,000 per reactor per year. If we increase the number of reactors in Canada from 22 to 32, then the probability of a catastrophic nuclear accident happening in one of these nuclear reactors during the 60 year projected lifetime of the ACR-1000, would be slightly more than one in six, or slightly riskier than playing Russian Roulette. And the more nuclear reactors we build, the higher the risk.

With a proposal for first-of-a-kind, untried nuclear reactors, unsolved CANDU design problems, ongoing concerns about large safety margins for a Loss of Coolant Accident, and a Canadian nuclear regulator that lacks independence, the probability of a nuclear accident is all that much more likely. Before any new nuclear reactors are built, Bruce Power should be required to provide an independent, level three probabilistic safety assessment (PSA) for the specific technology proposed. This full scope safety assessment is critical in estimating the likelihood of a severe accident involving core damage and a large release of radiation and the extent of damage to our health, environment and economy.

Dan Meneley opening statement

People make mistakes. At a very basic level, all accidents in the world are caused by mistakes made by one or more humans. The same is true of nuclear power accidents, as has been recognized and considered from the beginning of this enterprise more than 60 years ago. We study and correct our mistakes.

Nuclear power accidents quickly come to public attention via press releases, and by other means if the accident is serious – such as the one at Chernobyl in 1986 and at Three Mile Island in 1979. Independent technical experts examine even minor abnormal events. Their job is to audit the safety performance of each operating nuclear power plant. Lessons are learned and recorded, then passed on to other operating nuclear plants as well as to the designers of new nuclear plants.

Nuclear reactors release large amounts of heat energy from small amounts of uranium fuel at a controlled rate. Systems are designed to regulate the balance between the heat release rate and the rate of electrical energy delivery to the public. Independent systems slow down or stop the heat release if things go wrong. This second class of systems, called safety systems, "watch over" plant operation and take action if necessary to ensure its safety.

Nuclear-electric power plants represent a mature technology. Though we expect accidents to happen in the future as the number of power plants increases, we confidently expect that the health consequences of any such accidents will remain under control.

Historically, the operation of nuclear power plants marks them as some of the lowest risk components of our modern industrial society. This stellar performance is sustained by expert operating staff and supported by senior managers. Their safety record is the primary performance measure. Public oversight is welcomed.

Elena Schacherl first rebuttal

Mr. Meneley and I agree that nuclear accidents are caused by human error. In existing CANDUS the "positive void coefficient" is a design mistake that causes the power to ramp up instead of down when the coolant is lost as happened in the Chernobyl accident. AECL tried but failed to correct a similar flaw in the mothballed Maple Reactors. AECL claims they can solve this problem in the ACR-1000, but can they?

The ACR-1000 is an incomplete design. Mr. Meneley recognizes more "unidentified failure modes" can be expected in a new technology starting up, and "actual failures should (but don't automatically) provide the lessons necessary to avoid recurrence"((1) footnote). Do we want to be guinea pigs used to test a first-of-a-kind reactor?

Canada's 22 CANDUS came online between 1973 and 1993. In 1997, 7 out of 19 Ontario reactors were shut down due to poor management and related safety concerns. Following numerous loss of coolant and regulation accidents that could easily have been much more serious, additional reactors were taken offline to replace faulty pressure tubes. As of 2007 the operating experience of the CANDU was the equivalent of 22 reactors operating for 25 years, far from the 60 year "stellar" safety record claimed.

CANDU "safety systems" have not met design targets, and a steam explosion penetrating the containment during an accident remains possible. If nuclear power is of the "lowest risk", then why aren't private insurers willing to provide coverage to homeowners?

Dan Meneley first rebuttal

Ms. Schacherl and I are close to agreement on one point. But my understanding is that all accidents, anywhere, are caused by human error – machines are too stupid to make mistakes. The positive void coefficient in CANDU is not a mistake at all – very few inherent characteristics of any technology are as well understood or defended against (2).

The ACR mnemonic stands for "Advanced CANDU Reactor". It is a CANDU that has been slightly modified to improve both its operating characteristics and its safety characteristics. This is the normal, orderly evolution that takes place in any successful technology – engineers learn, then refine. Think of the latest jetliner versus the old Douglas DC3. This is the result of careful, evolutionary change.

Ms. Schacherl's so-called "numerous accidents" in CANDU could, of course, been more serious – but they were not. It also has been reported that the sky might fall. Defense in Depth and careful, watchful, operation resulted in both the "no consequences" of CANDU accidents and the precautionary shutdown of several units – caused, as you say, by poor management. These human errors originated at the upper levels of Ontario Hydro and the Ontario government, not at the power plants.

CANDU safety systems have performed very well in the past. They are steadily improving under the watchful eye of the CNSC, Canada's safety regulator. Private insurers do provide coverage against accident consequences. The Canadian government provides "backup" insurance.

Elena Schacherl second rebuttal

Mr. Meneley defends the positive void coefficient, but the international nuclear community has shown concern. Canada's response: "the ACR -1000 is being designed with a negative coolant void coefficient, which effectively eliminates the large LOCA (safety) margin issue." (3) Whether AECL can meet this design goal is doubtful.

Rather than a "lightly modified" CANDU, nuclear industry partner SNC LAVALIN explains, "The ACR-1000 is a new design and a substantial departure from the prior CANDU technology". As a "first-of-a-kind" (FOAK) plant….initial operating problems that are typical of FOAK plants should be anticipated." (4)

CANDU safety systems have often performed poorly. Dr. Edwards and Ralph Torrie have demonstrated the Emergency Core Cooling at Pickering has been unavailable about 10 times more often than the 1 in 1000 legally required. As for CNSC, the Fraser Institute recognizes "the conflict-of-interest inherent in the federal government being both the owner of AECL and its safety regulator" (5).

All property insurance policies in Canada have a nuclear exclusion clause; only nuclear operators are insured. The legislated cap and government "backup " are just more taxpayer subsidization. Does Mr. Meneley support government consultant Magellan Engineering's recommendation to carry out a probabilistic analysis of severe accidents so the real costs to the community can be assessed?

Russian Roulette anyone?

Dan Meneley second rebuttal

Contrary to Ms. Schacherl's rebuttal statement there is no need for me to defend the positive void coefficient. In CANDU, it defends itself. Work described in the reference (6) , Section 14 (i) c, "Issues Identified by Safety Assessment — Demonstration of Adequate Safety Margins for Large LOCAs" is now almost complete. I am happy to report that the international community is no longer concerned now that they fully understand the CANDU reactor's safety defenses.

The ACR-1000 design was successfully designed to exhibit a small coolant void coefficient. This modification is an example of AECL's continuing efforts to improve their best internationally accepted design, the CANDU 6. While respecting others' opinions, I maintain that the ACR design is far more complete than a typical "first-of-a-kind" or FOAK. Yes it has been slightly modified – this was the whole point of the design exercise.

Regarding safety systems reliability, Ms. Schacherl confuses legal requirements with the process of CNSC regulation. The CNSC tribunal acts on licensing issues based on the best available evidence gathered from recommendations of expert technical staff and informed by their own broad knowledge of safety performance. In this way their actions are identical to other (more than 20) federal regulatory agencies. These agencies exist as an integral part of the Government of Canada. It must be so.

Probabilistic analysis of all potential accidents in CANDU already has been carried out for many years. These analyses have been very useful within the context of risk-informed regulation. This evolutionary process will continue.

Footnotes:

1) "Nuclear Safety and Reliability, Dan Meneley, October 2003.

2) "LARGE LOCA MARGINS IN CANDU REACTORS", Ajit Muzumdar and Dan Meneley, Proc. CNS Conf., Calgary, June 2009

3) Canadian National Report for the Convention on Nuclear Safety, Sept. 2007, p. 70.

4) "Nuclear Energy Options Evaluation Report", SNC LAVALIN, May 2008, p29 and 66.

5) "CANDU or no CANDU, The Future of Nuclear Power in Ontario, Fraser Forum, March 2008, p. 26.

6) Canadian National Report for the Convention on Nuclear Safety, Sept. 2007, p. 68 et seq.