BEYOND NUCLEAR BACKGROUNDER

Arnie Gundersen: Busting the Myths, and Learning Real Lessons from TMI

February 25, 2014

Arnie Gundersen, Chief Engineer at Fairewinds Associates, Inc., will deliver a keynote presentation, “35 Years and 5 Meltdowns Later: The REAL Lessons from TMI” at a conference entitled “The Three Mile Island Nuclear Crisis in Perspective: Analyses, Stories, Policies,” (or “TMI@35,” for short) to be held March 27-28, 2014 at Penn State Harrisburg [https://www.eventbrite.com/e/conference-tmi35-the-three-mile-island-nuclear-crisis-in-perspective-tickets-9802807461].

Arnie serves as the environmental coalition, including Beyond Nuclear’s, expert witness in the fight against the proposed new Fermi 3 atomic reactor in Monroe, MI, as well as resisting the risky, San Onofre-like steam generator replacements at the age-degraded, problem-plagued Davis-Besse reactor near Toledo, OH.

For the 30-year commemoration of the TMI meltdown in 2009, Three Mile Island Alert (TMIA) also invited Arnie to keynote. The video of Arnie’s presentation, “Three Myths of the Three Mile Island Accident,” is posted at Fairewinds’ website: http://fairewinds.org/media/fairewinds-videos/three-myths-of-the-three-mile-island-accident.

He began by admitting that until 1992, he was “of the opinion that this [TMI meltdown] was a non-event.” In fact, he said on a t.v. interview that “the *Titanic* hit the iceberg and the iceberg sank.” But Arnie was hired as an expert witness by survivors of the meltdown in 1994, and after digging into it, his “opinions have essentially gone 180 degrees. It is a significant event that we need to learn from…”.

To the question “**Should an evacuation have been ordered?,”** Arnie responded with an emphatic “yes!” Arnie documented how, by the nuclear utilities’ (General Public Utilities and Metropolitan Edison, GPU and Met Ed) own internal policies – and a real time calculation showing dose rates as high as 10 Rem/hour (R/hr) in nearby Goldsboro, as well as measurements of elevated doses already suffered by TMI workers -- an evacuation of surrounding populations should have been ordered by 7 AM on the first morning after the disaster had begun.

By 10 AM, temperatures in the reactor core of 2,100 degrees F, and in the hot leg normally carrying hot water out of the core of 700 F, showed that there was not enough – or perhaps even not any – cooling water reaching the core, and the irradiated nuclear fuel was undergoing a zirconium-water reaction, generating explosive hydrogen gas. Also, massive reactor cooling pumps were drawing very low amperages, “an indication

that they [were] not pumping water," and "neutron monitors outside of the nuclear reactor were reading very high levels of neutrons… an indication that the core had lost its water and was uncovered." Radiation monitors in the containment dome were measuring thousands of R/hr, lethal levels within just minutes of exposure. A reactor coolant sample measured 200 R/hr, lethal in two hours of exposure. These were clear indications of fuel failure. GPU/Met Ed's Health Physics Dept. asked the plant management to evacuate the auxiliary building, yet the State of PA was not informed how out of control the situation had become.

Arnie also quoted statements from TMI station manager, Gary Miller, made a year or two after the disaster, clearly revealing how dire Miller knew the situation was that first morning: "They [in-core temperatures] were hot enough that they scared you"; "Pretty early we were scared. Radiation was all over the place. Everything was off scale"; "We don't know where the hell the plant was going"; "We were not in our minds convinced that the core was totally covered." Arnie surmised these were all clear indications "that it is time to let the civilians know to head for the hills. But it did not happen."

Arnie then asserted that the "Last time where I think anybody of conscience would have ordered an evacuation, [was] before 2 o'clock in the afternoon."

As documented by Arnie, at 12:20 PM, the NRC asked TMI, "What is the temperature in the core?" The reactor owner/operator responded, "We don't know. The computer is printing question marks…That means that the computer is messed up." But this was deceptive, for question marks meant that the core temperature was at least 700 F, another indication of a meltdown in progress. In addition, two temperature indications were not in question marks. They were 599 F, whereas they would normally have been expected to measure only about 500 F. The nuclear utility did not inform NRC about this.

Just before 2 PM, a hydrogen explosion occurred. As Arnie described it, "there was a big change in pressure and a loud noise that shook the building. To me that is an explosion."

The NRC was not informed about the explosion until two days later. Affidavits by four reactor operators later confirmed that station manager Miller was in the control room at the time, and was well aware of the explosion, for the control room shook. Arnie concluded, "After that it was unconscionable that an evacuation was not ordered on the first day. I would say 7:30, but even if you give them the benefit of the doubt at 2, an evacuation should have been ordered on the first day."

"**Did the containment leak?** Arnie again answered in the affirmative.

Arnie stated "[W]hat I believe happened, based on sub-compartment pressure, is that a leak occurred in a portion of the containment wall, perhaps not all through the containment, but a portion of that containment wall got a crack and started to leak."

He mentioned his fellow expert witness at the TMI trial, Dr. Reytblatt, structural engineering professor at the University at Bridgeport, who testified "A plausible release

of up to 8–10% of the volatiles may have occurred due to the unavailability of the containment system at the time of the accident."

Arnie analyzed TMI Unit 2 data provided by John Daniel, the industry expert he squared off against in the legal proceeding. Although "most of the radiation detectors had already gone off scale" at TMI before the hydrogen explosion, Arnie found "three that were on scale that suddenly then went off scale immediately after the explosion. The first one recorded a 5-fold increase…The second one recorded a 10-fold increase and then went off scale. This [third] one I think is the most interesting. This one doubled and it was protected by four inches of lead. Well, four inches of lead will eliminate everything except the most powerful gamma rays. So in addition to a doubling of incredibly powerful gamma rays, what this also shows is that there had to be low level gammas and a lot of alphas and a lot of beta that were also released that this instrument never picked up." Arnie confirmed that these three radiation monitors "were very near the containment. In the annular gap around the containment and in areas right next to it and in the auxiliary building."

Arnie concluded that TMI Unit 2's containment failed after the hydrogen detonation.

The final myth Arnie busted was the carefully crafted, widely distributed misinformation that little hazardous radioactivity escaped from TMI during the first days of the disaster (never mind the significant intentional releases into the air and Susquehanna River, carried out in the months and years after the 50% reactor core meltdown).

Arnie stated that "A thorough analysis of the TMI accident indicates that releases were 100 to 1,000 times higher than the NRC estimated."

To begin with, "there is no measurement of how much radiation was released. Every monitor was broken, it had failed high, it had burned out like turning a camera toward the sun…burned out on the releases."

Assumptions had to be made based on off-site exposures. Arnie pointed out that "all of them were non-conservative. They were all low ball assumptions."

Arnie agrees with NRC senior staff member John Collins, who had warned: "My problem . . . the concern I have about aerial monitoring was that for the first three days we were pretty much into a very static air condition. There was very little dispersion. When you were flying your helicopter and taking your aerial measurements, you were actually reading erroneous readings… I really doubt some of the measurements that were made."

As Arnie explained, "erroneous readings" were compounded by the helicopter itself having mixed clean air with contaminated air. In addition, the helicopter was in the wrong place at the wrong time to get accurate measurements, Arnie reported.

NRC's Collins added: "…not only should we have good monitors but also people who understand how to use them. That was a problem since day one. They get data and no one sits down and evaluates the data to try and understand what it means."

Arnie also expressed doubts about measurements on the radioactivity plume taken by a chaser car. Designating it the most important point of all, Arnie said "in a plume variation, from the center of the plume, 6 degrees off, if you miss the plume by 600 feet [in just one mile's distance], you would be measuring 1,000 or 10,000 times less radiation than was on the center line. So when you hear of a person being exposed (the metallic taste, hair loss issues) and perhaps the neighbor wasn't, the reason was that the dispersion of the plume was very narrow."

Arnie went on: "You could easily have a factor of 10,000 according to a Dr. Vergeiner, who was the meteorologist on the job, when you look just 600 feet off at a mile, it would be about 1,200 feet off at 2 miles. But, again the further out you go, you just have to move a couple hundred feet off the center of the plume to have a dramatic difference in the amount of radiation."

In 2009, the NRC estimated that about 10 million Curies of radiation were released, as stated on the agency website. A Curie is 37 billion atomic disintegrations per second. An atomic disintegration per second is also referred to as a Becquerel (Bq). 10 million Curies equates to 370,000,000,000,000,000 disintegrations per second -- or 370 quadrillion Bq.

As Arnie said, "These are disintegrations per second and in static air, that radiation stays behind and just keeps disintegrating at that rate every second until it can get blown out."

Still air in the Susquehanna River Valley persisted for days on end after the meltdown began. This likely meant concentrated radiation dose exposures to those unfortunate enough to be living, working, or traveling through the area on those fateful first few days.

Although the NRC's website reports 10 million Curies released at TMI, one of the agency's own top staff members, Lake Barrett, calculated a figure of 36 million Curies. Barrett's analysis was published as NUREG-0637, Appendix C.

Arnie explained the overly optimistic assumptions Barrett made:

"Barrett used time average plume dispersion as opposed to hour-to-hour plume dispersion, and that has a tendency of flattening the curve, so it reduces the exposures. Barrett assumed that the center of the plume hit the detector. And I have already shown that if you were off by 600 feet, you have got a factor of 10,000 difference. Barrett then

averaged 7 days or 8 days or 10 days of data and wound up with a number lower than any of the other numbers in his calculations. It is kind of interesting…Barrett says on the first day of the accident, 14 million Curies were released. Well the NRC's website, of which he was a member, says there is 10 total. If you add up all of Barrett's numbers, he comes up with 36 million Curies. So this is the NRC's estimate, but the website shows 10. And on top of that, the NRC's estimate is, the time averaging of the dispersion can cause a 10-fold error. Being on the center line of the plume versus being off the plume by just a little bit can cause a thousand, some of the data says a 10,000 fold error. And averaging the data changes it by about a factor of 3. The net effect is that the NRC's 10 million could be wrong a thousand fold. The NRC's could be low, based on those assumptions by a thousand fold."

Barrett went on to work at the U.S. Department of Energy's Office of Civilian Radioactive Waste Management – as Acting Director, often in charge of the now-cancelled Yucca Mountain, Nevada high-level radioactive waste dump project. He now works as a consultant for Tokyo Electric Power Company (TEPCO). TEPCO has cited Barrett's blessing on its high-risk Fukushima Daiichi Unit 4 irradiated nuclear fuel storage pool removal operations. Barrett has also been quoted in the press as urging TEPCO to simply release the well over 116 million gallons, and growing, of highly radioactive water stored at the wrecked reactors into the Pacific Ocean, a proposal that the Japanese fishing industry has thus far blocked.

During the TMI trial, Arnie went up against the industry's expert, John Daniel. Daniel "magically" calculated 10 million curies of radioactivity released. But when Arnie went back through Daniel's assumptions and used them correctly, he came up with 150 million curies released. The presiding judge let Daniel re-do his expert report, resulting in the industry's current figure of 17 million Curies released.

As Arnie summed up: "[T]his puts the NRC in an interesting position, because the guardian of public health and safety has the lowest estimate on the totem pole for what was released from the accident. Even the industry is almost twice as high. Their [NRC's] own experts are three times as high and in fact, if you look at the data, and all of the non-conservative assumptions, it can easily be on the order of a thousand times higher than the NRC's estimate, which puts you at around a billion Curies."

Arnie then connected the dots between Dr. Reytblatt, who testified that about 10 percent of the radioactivity inside the containment leaked, and Dr. Akers, an industry expert, who had said there were 10 billion Curies inside the containment.

As Arnie surmised, "10 percent of that is around a billion. So Aker's number, this is an industry guy, this is not me, says 10 billion, a tenth of it got out by Reytblatt, puts you at around a billion Curies, not the 10 million the NRC is advertising on their website."

Arnie also mentioned allegations contained in Dr. Helen Caldicott's 2006 book *Nuclear Power Is Not the Answer*. Caldicott, Beyond Nuclear's Founding President, cited several

recently released Hershey Chocolate Co. documents showing that Iodine-131 was measured in cow's milk 150 miles away from Middletown.

Arnie commented:

"Well, 10 million curies at the NRC website does not get you to being able to detect iodine 150 miles out...We all know, and it was publicized, that Hershey froze milk. And that was a good prudent business decision. But Hershey had data apparently by Dr. Caldicott, Hershey had data that would have been helpful to civilians in the area, to let them know that, in fact, the plume was out at 150 miles. That is pretty significant because this time of year, grass does not grow very fast, so the cows were on silage, which meant that they were probably getting the iodine as an inhalation dose, as opposed to eating it out of the grass."

Arnie went on to explain how NRC and industry now exploit the fanciful figures for radioactivity releases at TMI.

"If you believe that only 10 million Curies got out, the NRC has made that sort of gospel, it is something called the alternate source term. It has allowed power plants to reduce the amount of radiation which they claim to release, which then turns around and then they can increase the power. So, a lot of plants have gone through power upgrades as a result of Three Mile Island because the NRC is allowing them to say, well, a lot less radiation got out than we thought. So, they have lowered the source term which has allowed them to crank up the power so they can get back to where they were. But in fact, if you do not believe the NRC's 10 million Curies, then the alternate source term and all these power increases is, in fact, wrong."

Between 1977 and 2013, NRC has rubber-stamped 149 power uprates, totaling nearly 21,000 Megawatts-thermal, at age-degraded U.S. atomic reactors. John LaForge at Nukewatch Wisconsin has confirmed with NRC that the agency has denied just one power uprate that was sought by industry.

Arnie also warned:

"[L]ess robust containments are planned for the next generation reactors on the basis of how well TMI survived it. But I think the data does not show that TMI survived it. And finally, there is a lot of consideration of collapsing evacuation zones, or even eliminating evacuation zones, based on the success of TMI and I really question that."

Arnie's overall conclusion is that I think that the 10 million Curie figure published on NRC's website is wrong by between a factor of a hundred and a factor of a thousand. So, between a hundred-fold and a thousand-fold larger amount of radioactivity was released at TMI than officially acknowledged by NRC.