A Fukushima Diary

Peter Bernard Ladkin

13 July 2011

In memory of Harold Warren Lewis, 1 October 1923 - 26 May 2011

Dedication

I started corresponding with Hal Lewis in the late 1990's, after he asked whether I would review his newest book, on reasoning with probabilities and chance. Hal was a spectacularly clear writer. He was also an avid pilot, and over the years we discussed much about physics, good and bad science (for example, concerning the accidents to TWA Flight 800 and Swiss Flight 111 and high-intensity electromagnetic radiation, on which I performed some scholarly research and aided the TSB Canada), and airplane accidents in general. Hal worked in Santa Barbara, so besides a mutual interest in airplanes as well as risk, we were both naturalised Californians; we got our higher degrees from UC Berkeley.

Hal was the main author of the so-called Lewis Report in the 1970's to the NRC, which is regarded by most as giving a far more accurate assessment of risks involved in civil nuclear power than its predecessor, the WASH-1400 ("Rasmussen") report, as explained below in my entry from 34.03.2011.

I'd missed his correspondence since last October, and when the Fukushima accident occurred he was one of the first people to whom I wrote, inviting him to join our discussion group. I heard nothing. After an inquiry to UC Santa Barbara, he wrote me briefly about the illness with which he had been diagnosed in October, and which had led to his withdrawal. Definitely not a man to make a fuss. Two months later he was gone. In his penultimate note he had sent me a beautiful picture of his wife, a World War II aviatrix, in full flying gear standing on the wing of an airplane.

I wanted to dedicate the 11th Bieleschweig Workshop to his absence, but I must dedicate it instead to his memory. I never met him. I miss his correspondence. Life is not fair. Death is even less so.

This Document

is a compilation of comments which I sent to the mailing list which we set up in the wake of the Fukushima accident. It suffers from the rambling, repetitive nature of such writing, but I still think it gives some insight to what was known, when, how information was socially controlled, and thereby how we may do differently, perhaps better, in the future – for there will be a future which includes severe accidents with which we must learn how to cope, although I dearly wish it were not so.

Clarifying comments, and uniform style changes (for example, to proper names) added in editing are included in square parentheses: "[.....]". Additional remarks at time of editing are included similarly, but in italic script with a date. Quotations from others (other contributors, newspapers, other articles) are include in italic script, longer ones indented.

I leave an overview for a separate document.

The Diaries

13.03.2011

[Charles Perrow] wrote a note for the New Scientist. I found he had had a similar reaction to myself about putting secondary safety power supply in a basement where it could be flooded if you get your tsunami estimates wrong, and your spent-fuel ponds up near the ceiling where they can leak if, say, the structural integrity of your building is ever compromised. But I hadn't realised the severity of the event of loss of spent-fuel covering liquid because, well, I haven't been paying attention. [Perrow] said it. And the [New York Times] NYT has got to it today, I note. .....

I read on a BBC Twitter newsfeed yesterday (this has got me reading Twitter, who would have thought?) that Alan Fells, emeritus Prof at Newcastle and a nuclear-energy expert, told the BBC that the population in Japan was more in danger from electricity blackouts than from radiation release. I thought "what can he possibly be thinking?". .....

I think there is a non-zero chance that the fallout (figuratively as well as literally) from the Fukushima accident could be more consequential than the damage from the tsunami. Here's a worst-case scenario just concerning spent-fuel fire, courtesy of the NYT, from Brookhaven in 1997: http://www.osti.gov/bridge/product.biblio.jsp?osti_id=6135335 Let us remember, though, caveats about [exclusively] worst-case [thinking] ..... The example I use in my course is that if I fall off my reclining bicycle, I am most likely to suffer a scratched finger (as I put my hand on the ground when the thing rolls over) and indeed that is what I expect. Whereas worst-case is that I get squashed by the truck who has been following too close and didn't notice me wobble as I hit the pothole.

Here is my current take.....

Given the obviously [inadequate Hazard Analysis] HazAn performed for the Fukushima installation, I very much doubt if anyone thought through what they would do if secondary safety failed.

So they [TEPCO,NISA, government et al.] are improvising. And they are obviously not succeeding (everything which people said would come to pass is coming to pass; the state [of the plant] has never been stable). As Feynman pointed out to the Challenger inquiry, physics always wins.

So I think at this point that it is more likely than not that there will be full meltdown of one of the reactors. [2011.07.19 *It is now known that at this point there had been three meltdowns.*] Then, inevitably, of all of them because any personnel left on site will have martyred themselves with the first one [2011.07.19 *Wrong. The meltdowns were contained. Exactly how and why is still open. My bet is still: luck. But a manager, who refused orders to follow his intuition, saved the situation, without doubt*]. Equally, no one will be able to keep the spent-fuel ponds filled and we will be looking at multiple fires exhausting into the atmosphere. [2011.07.19 *Based on the supposition that the Reactor Pressure Vessels, RPVs, could not be kept cool. The operator has so far managed the primary prophylaxis, to keep the RPVs cool.*]

What are they going to do about that? Whatever is done, it can't involve people. Does the US military have a bunch of robotic transport helicopters it could call on to dump lots of wet concrete on the former ponds? Isn't that going to break the building structure and make the situation worse? Concrete will stop spent-fule fires venting to the atmosphere, but is it anything more than a temporary solution?

If that is not done, if this stuff vents, over days or weeks, what are the chances that the wind will remain constantly westerly? Or that it will at some point change to northerly so Tokyo [receives a wind-borne radiation plume]?

15.03.2011

When you have that much super-hot highly active material from the cores descending into the earth, it is going to affect the groundwater. I don't know what the aquifer is like there, but the effect of that could be that large swathes of Japan will never again be able to use groundwater for anything. Is there any possible way to stop that happening? Also, groundwater doesn't just sit there. Imagine [as containment] canalising all springs at source and conducted them underground until well out at sea. Building desalination plants will obviously be possible [to supply water that no longer can come from the aquifer], but that is not going to work easily if your seawater is contaminated by river water - you are going to need to build pipelines to draw your intake from well away from any of that.

It **could be** that the results are worse than what we have just seen in the way of physical damage and loss of life from the tsunami. [2011.07.19 T*his possibility is still open. But it probably depends on how you count and what you consider important.*]

It is only a sequence of possibilities, but at this point I don't know what those likelihoods are and I don't see anything preventing it canonically except good luck [2011.07.19 *So right! Good luck has played a major role.*]. Which of this stuff is right, and which is wrong?

15.03.2011

On 3/15/11 12:29 PM, Bernd Sieker asked:

> *Is it certain that the spent fuel pools at reactor 4 have been on fire?*

Richard Black of BBC News says " *the fire in reactor 4 building - believed to have started when a pool storing old fuel rods dried up.*" at http://www.bbc.co.uk/news/world-12740843

The NYT (Nabuchi, Sanger, Bradsher) says "*But late Tuesday, Japan's nuclear watchdog said a pool storing spent fuel rods at that fourth reactor had overheated and reached boiling point and had become unapproachable by workers at the plant. The fire earlier Tuesday morning was sparked by a hydrogen explosion generated by rising temperatures at the fuel pool, which released radioactivity directly into the atmosphere.*" in http://www.nytimes.com/2011/03/16/world/asia/16nuclear.html

I take it that's what [Bernd] ha[s] read also. So [the answer to his question is] no, from those sources it isn't certain. On the other hand, is such gas at the temperature of boiling water sufficiently hot to self-ignite?

> *Is there any information about the thermal power of the spent elements in those pools?*

I haven't seen any.

> ..... *Do they actually produce enough heat to cause them to melt*

> *and/or catch fire without active (circulation) cooling?*
>
> *Is it permissible to store nuclear fuel capable of melting from its own thermal power outside a containment?*
>
> *Another thing struck me. How could the operators ..... assume that a few holes in the reactor 2 building would provide enough ventilation to prevent the formation of explosive oxyhydrogen gas?*

I think they were improvising. I guess they were mostly concerned about overpressure and decided that was all they could try to handle and anything else just had to run its course. Maybe they figured that a partial building destruction wouldn't be **that** bad, and indeed they were able to put a good spin on the explosion Saturday. Just from the way it looked, I would say that the one Monday was a lot more damaging. But this is just me speculating.

.....

15.03.2011

Paul Marks of the New Scientist just asked me if I knew about other nuclear plants built near fault lines. Well, of course I do, [being a naturalised] Californian - Diablo Canyon!

What a history! I found the timeline at http://www.energy-net.org/01NUKE/DIABLO1.HTM (first page of two).

It is a mess of California 60's hippy/70's new age/80's new cynicism politics and a few engineering issues (at first opponents were mostly worried about abalone). The Hosgri fault was discovered in February 1969, and apparently there is a closer one called the Shoreline Fault, discovered in 2008: http://www.newtimesslo.com/news/4987/nrc-workshop-turns-into-diablo-canyon-debate/

The engineering issues seemed to be mainly, in no particular order, (a) construction faults and failures, (b) operational failures, (c) earthquake resilience. Item (c) is a design issue, but there appear to be no higher-level "why on earth did they do it that way?" as at Fukushima.

.... it also struck me that the issues with Diablo Canyon are all but impenetrable. There is no defining document (which is what Paul [Marks] asked me about), partly because the history is a series of court processes and regulatory commission decisions spreading over nearly thirty years.

It then occurred to me that the history shows a good reason why it is important to have ***a*** safety case, even if it has to be updated every few months for thirty years.

If there had been one document detailing how and why the plant was safe to operate, along with the long list of amendments, then one would indeed know, at any point in time, what is the current rational basis for operation of this possibly dangerous engineering artefact and what the hazards are.

What is the betting that there wasn't such a document associated with Fukushima?

Going back to Martyn's perennial, and perennial well-taken, point about public safety cases. Suppose there had been one, and it had been public. Then surely, over the last twenty years or so, somebody somewhere in the world -maybe somebody in our HazAn lab class in which we were using it for teaching- would have said at some point "wait a minute, they only designed for a Force

8.0 quake and ensuing tsunami? But what happens when you get the hundred-year earthquake and the tsunami breaches the sea wall? They lose the primary and secondary safety systems!"

15.03.2011

On 3/15/11 3:15 PM, Martyn Thomas wrote:

> *How do the tectonic plates in Japan interact with those in California?*

There is a subduction zone off the coast of Hondu Island between the Okhotsk Plate and the Pacific Plate, which is where I believe the current quake originated (further south there is a subduction zone with the Phillipine Sea Plate and the Pacific Plate). The San Andreas Fault is a strike-slip fault between the Pacific Plate and the North American Plate on the east side.

> *Is the risk now higher in [California] following the Japanese quake?*

I wouldn't have thought a subduction quake on the west would affect the east at all, because there is a ridge in between which is spreading outwards; I can't see any causal effect across such a ridge on such a large plate.

But who knows? Like everything associated with this calamity, except for Mark-1-Eyeball Hazan I ain't expert.

15.03.2011

On 3/15/11 5:31 PM, Don Hudson wrote:

> *One just doesn't "pour seawater into 'the bucket' " so to speak. The containment vessel would be under enormous pressure, would it not? - how is it possible to pump seawater into the vessel?*

I understand that first the primary containment vessel is vented. This is what has been causing the higher radiation up until this morning's explosion - some fissive matter comes out with the gas. Then vents are closed and more water is pumped in. I think it is being pumped in by means of fire engines which have been brought in for the task. I understand from BBC tweets that the US Armed Forces turned up with a couple of engines to help, and were turned away.

I am not sure any more what exactly the various gaseous mixtures are, and where they come from.

15.03.2011

Just a factoid - the BBC is tweeting at 1958 GMT tonight that the head of seismic hazard at the BGS, Roger Musson, said this tsunami is a 1000-yr event, specifically that there are similarities to a 9th-century event in Sendai. More details, of course, don't fit in a tweet.

16.03.2011

Reactor 4 has repeated problems with fires in the cooling pond. Since the roof of the building is still there, any control of those fires will depend on staff continuing to pump water in as required; you can't fly a helo over and drop water in. So if the staff have to leave, as they did earlier for a while, then the cooling pond in Reactor 4 is going to burn.

Steam-like white "smoke" is rising from Reactor 3. If that really is steam, there are two possibilities for origin. One is that the cooling pond is burning, the other is from the torus, which would mean that the primary containment for Reactor 3 has been breached. Since there was no accompanying explosion, a breach of primary containment could well be because of meltdown [2011.07.19 *Indeed!*]. One the other hand, apparently there is no sustained rise in environmental radiation comparable with what one might expect from either of these two possible events. [Or we are receiving misleading information].

As I wrote earlier, I think that if the staff have to leave on an extended basis, then there will be four core meltdowns [2011.07.19 *This can not have been right, even then. Only Reactors 1-3 were operating. The fuel from Reactors 4,5,6 was stored in the SFPs. So, OK, three meltdowns. Which in fact there had been*] and cooling-pond fires venting to the atmosphere. Others must know this. So those people know that if the crew leave, all possibility for controlling the situation is lost. I therefore wouldn't discount the possibility that [information] about radiation levels [is being controlled] in order to justify [politically] keeping crew on site.

Jan [Sanders] pointed out to me yesterday morning that there actually are six reactors at Fukushima Daiichi. What is happening with five and six? If there is no primary or secondary power for cooling pumps, how are they being cooled? No one has written anything about that, that I have read.

I am guessing that by Friday, if not by this afternoon (GMT), this will be a class 7 accident. [2011.07.19 *It already was, as judged retrospectively by NISA.*]

16.03.2011

I looked at the aerial picture, taken from the east, on the front of the NYT (in my version I look at the [International Herald Tribune] IHT) this morning and couldn't remember how and when the secondary containment building on Reactor 4 (on the left) had been so damaged [2011.07.19 *This is because it hadn't been announced*].

I constructed a timeline from memory and notes, and still couldn't see. I sent it to Bernd [Sieker] and called him up. He pointed out that there is a Wikipedia timeline at http://en.wikipedia.org/wiki/Timeline_of_the_Fukushima_nuclear_accidents

This is a beautiful piece of work, especially the status tables, but I am not completely sure how accurate it is. [2011.07.18 I*t came from a nuclear-industry group; and some of it is misleading, but some of it is accurate. However, it is difficult to tell misleading information from accurate information, and thus it turns out not to have been much help.*]

The table for March 16 12.30 shows the secondary containment building for Reactor 4 as "*severely damaged*", which it certainly appears to be from the NYT photo. The previous table, for 0800 March 16 (these must be local times, so GMT+9) shows "*partially damaged*", as we knew it was from the explosion at [Reactor Building] 3 on Monday as well as the two fires in the cooling pond yesterday.

But what happened there in the local morning of March 16, between 2300GMT March 15 and 0330 GMT March 16? I haven't found anything in the NYT or in the BBC. How could it get so damaged without an explosion of some sort? [2011.07.19 *Answer: there had indeed been an explosion, as noted belatedly by the operators.*] Notice, also, that the cladding is missing entirely on the side 90°

away from where the other reactors are located.

BTW, here are my observations on the photo and my general timeline:

Secondary containment (the building) for Reactor 4 appears to be almost completely unclad, with only the skeleton remaining.

Secondary containment for Reactor 3 [that is, Reactor Building 3, RB3], which is issuing white clouds of what we are told is likely steam, appears to be almost as compromised as Reactor [Building] 4.

[RB2] appears to be mostly intact, but we know Reactor 2 is suspected to have undergone a primary-containment [PCV] breach, maybe in the torus. One square piece of cladding is missing on (what I take to be) the east wall [of RB2], out of which some white vapor is issuing.

The upper part of [RB1] also consists just of the skeleton, and looks much as it did in other photos after Saturday's explosion.

Timeline as follows, as I recall.

Saturday: Oxyhydrogen explosion, captured on video, at Reactor 1. Leaves [RB1] in much the state in which it now appears in the photograph, with upper-level cladding absent but lower-level cladding still intact.

Monday: Explosion, also thought to be oxyhydrogen but (as far as I know) not confirmed, at Reactor 3, removing the cladding of large parts of [RB3]. Indeed, in the photograph it appears to be almost as free of cladding as [RB] 4. That suggests that the explosion was more destructive than that at Reactor 1.

Tuesday: Explosion at [RB] 2, which we have been told was accompanied by an increase in environmental radiation levels along with venting of some gases, which led people to conclude that primary containment, likely in the torus because of the later reduction in environment radiation, had been breached. But secondary containment appeared to remain largely intact, as indeed it now appears on the photograph. .... in the photograph there is some white vapor rising out of a square hole, which is presumably the hole said to have been created by the explosion. If the story is right, then that white vapor is steam leaking out of the breached primary containment vessel and would contain significant radioactive material.

Also Tuesday: two fires, said to be in the cooling pond of Reactor 4 [the spent-fuel pool of Reactor 4, SFP4]. [SFP4] also apparently contains the core elements of Reactor 4. Reactor 4 has not been operating; neither have Reactors 5 and 6.

Wednesday: Another event at Reactor 3. Large quantities of white vapor, said to be steam, are rising, along with an increase in environmental radiation. The photograph shows the rising vapor clearly. This is said to signify a primary-containment breach at Number 3.

From the events on Saturday and Monday, it was presumed likely that there had been partial core-melting in Reactors 1 and 3, because the oxyhydrogen explosions came from gases released during release of overpressure, and the overpressure is believed to have been caused by rising temperatures.

We do not know what in this timeline has caused the Reactor 4 secondary containment [RB4] to blow out.

16.03.2011

Interesting.

The NYT this evening has a lead article under a brand new and somewhat startling title "*Peril and Confusion at Nuclear Plant*".

However, the article contains no new information over what they published this morning under a much milder title, except for reporting US Energy Secretary Steven Chu saying a couple of things. Chu thinks there has been a partial meltdown (which is what the Japanese have been saying since last Saturday); that he is hearing conflicting reports about what is going on ..., and that he doesn't want to speculate ..... The US has sent experts to Japan (known and reported for days), along with (and here comes the news!) "*equipment that can measure radiation levels from the air*" (I take it he doesn't mean manned aircraft, but Predators or some other UAV).

Summary: the new news is in the last half sentence. The title of the piece, however, is completely different from this morning. Conclusion: the NYT now believes it is officially allowed to conclude that (a) there is a high risk and (b) people at Fukushima, and their bosses, really don't know what to do. http://www.nytimes.com/2011/03/17/world/asia/17nuclear.html

[Its previous title: "Possible Rupture at 2nd Reactor Hinders Work in Japan"]

16.03.2011

The BBC has tweeted at 2046GMT that "*Japan's foreign ministry has asked foreign diplomats and government officials to remain calm and "accurately convey information provided by Japanese authorities concerning the plant", according to NHK television.*"

[2011.07.19 *In other words, don't say what you know or suspect, say only what "the authorities" say you may tell people. One is apparently not clear on the Western concept of news reporting.*]

This is presumably in response to

(1) the head of the US NRC, Gregory Jasko, saying he thinks the fuel cooling pond at Reactor 4 [SFP4] has run dry, and that because of that radiation levels are "*extremely high*";

(2) a tweet by the BBC at 1742GMT: "*Switzerland has also advised that its citizens leave north-east Japan and Tokyo. "At the moment, the development in the damaged nuclear facility is unpredictable and aftershocks are possible," said Swiss president Micheline Calmy-Rey.*"

(3) a tweet at 1701: "*Julian Ellmann, spokesman for the [French] embassy in Tokyo, says the advice for French citizens in the capital is "to go the south of Japan, to Kyoto, for example, and for those who want to, come back to France".*", as well as the decision by the French nuclear safety authority yesterday to classify the Fukushima accident as level 6, whereas the Japanese are still sticking with level 4. (Tweet has disappeared from the BBC, but try this reuters link: http://www.reuters.com/article/2011/03/15/japan-quake-nuclear-france-idUSLDE72E2M920110315)

(4) A tweet at 16:45: "*A spokeswoman for EU Energy Commissioner Guenther Oettinger has clarified his earlier remarks that "further catastrophic events" were expected. "He just wanted to share his concern and that he was really touched by all the images of people and the victims," said Marlene Holzner. "In this sense, he said that according to we have seen in the media, it seems that in the nuclear power plants at the moment we do not have technical control."* " Oettinger had said earlier that Japan was facing "*an apocalypse*" (repeated in a BBC tweet at 1649)

(5) A BBC tweet at 1535GMT: "*French Environment Minister Nathalie Kosciusko-Morizet has said "the worse case scenario is possible, and even probable, around the Fukushima plant," Reuters reports.*"

..... (BBC tweet at 1431): "*The UK Government's Chief Scientific Officer, Prof John Beddington, has sought to allay fears of radiation exposure. He told a press conference at the UK embassy in Tokyo: "What I would really re-emphasise is that this is very problematic for the area and the immediate vicinity and one has to have concerns for the people working there. Beyond that 20 or 30 kilometres, it's really not an issue for health," he says. The full and very interesting transcript is available on the embassy's website.*"

The key phrase, for those not familiar with British modes of writing, lie in the phrase "*very interesting*". I infer that the BBC thinks Beddington['s comment is contentious]. .....

17.03.2011

Nothing drastic appears to have changed the situation in the last twelve hours or so. That is in some sense better than the previous few days. On the other hand, the US assessment remains dire.

Secretary Jaszko is absolutely firm on his statement that there is no water in the cooling pond at Number 4 [SFP4]. He repeated that statement Wednesday evening (I presume US EDT), according to the NYT at http://www.nytimes.com/2011/03/17/world/asia/17nuclear.html
He says that this condition has been confirmed both by US NRC people in Tokyo and by TEPCO and others.

This is then said to have been "*rebutted*" by TEPCO, but it is hard to interpret what they said as any kind of definitive statement. The regulatory authority has said that they don't in fact know what the state of the cooling pond in Number 4 [SFP4] is.

From the article:

On Wednesday night, Mr. Jaczko reiterated his earlier statement and added that commission representatives in Tokyo had confirmed that the pool at No. 4 was empty. He said Tokyo Electric and other officials in Japan had confirmed that, and also stressed that high radiation fields were going to make it very difficult to continue having people work at the plant.

....[material about what happens if workers have to leave, namely meltdown]

While radiation levels at the plant have varied tremendously, Mr. Jaczko said that the peak levels

reported there "would be lethal within a fairly short period of time." He added that another spent fuel pool, at Reactor No. 3, might also be losing water and could soon be in the same condition.

Some possible good news is that TEPCO are (they say) close to completing a power line to the plant, which might be able to power up the cooling pumps again.

The question there would be how they intend to complete that work if [SFP] 4 really starts to fizzle. Anybody working out there could well die within an hour of exposure.

Concerning the state of the rods in [SFP] 4, the article says

According to Tokyo Electric's data, the spent fuel pool at the No. 4 reactor contains 548 fuel assemblies that were in use at the reactor until last November, when they were move to the storage pool on the site. That means that the fuel rods were only recently taken out of active use and that their potential to burn and release radioactivity is higher than spent fuel in storage for a longer period.

The article also says that there is concern about a similar situation in the [SFP] at Reactor 3. I take it that pond only contains spent fuel, but it's MOX, containing plutonium, which, as Bernd [Sieker] has pointed out, has much more dire consequences for human health if it's spread around.

A more worrying note has been given by TEPCO in Japan speaking of a chance of re-criticality in the stored fuel rods from the core at Reactor 4, as reported by the BBC in http://www.bbc.co.uk/news/science-environment-12762608 . It has repeated it in the sidebar of http://www.bbc.co.uk/news/world-asia-pacific-12768645 I have no idea whether it could be an issue or not.

The BBC has pictures of Chinooks releasing water onto the area around Reactors 3 and 4. As far as I can tell, that is just symbolic. This isn't a forest fire, with a wide burning area that you need to blanket. This is two storage ponds with a surface area each of 40 ft x 40 ft each (see http://www.cnbc.com/id/42083048 - I just spent a frustrating quarter hour finding these figures again) and one is covered with the remains of a roof (that is why TEPCO and the regulatory people cannot tell from satellite photos whether the storage pond at Reactor 4 [SFP4] is dry or still contains water). You don't need blanket coverage, you need spot deposition. The aircraft has to hover over the spot and release its water load precisely on this 40ft x 40ft area. And the harm to helicopter crew doing that, when the ponds are uncovered, is likely to be significant.

http://www.nytimes.com/interactive/2011/03/16/science/plume-graphic.html?ref=science%5Cr is a film showing the possible spread of a radiation plume starting at Fukushima, which the Times says has been prepared by the CTBT observation organisation. Linked from a BBC liveticker message at 0726 (I have been calling these tweets and probably shouldn't, because only some are on Twitter). There appears to be a new tweeter from Tepco, called @TepcoDisaster, who is saying at just after 0900GMT that ground-based watering (of whatever type) is about to start.

At 0558, an item of spin control. Edano suggests the discrepancy between Japanese reports and the US NRC assessment is due to a "*slight delay*" in the Japanese passing information to other countries. Ah, but information goes the other way, also. The US has aerial and satellite sensors that are providing the best overhead images, so it is quite possible for their informed analysis to be more accurate than that of the Japanese authorities.

At 0401, TEPCO is reported to have said that the "*ceiling*" of Reactor 4 has been "*reduced to the frame*" [meaning of RB4] At 0355, there was a note that the pressure in Reactor 3 (I take it they mean in the primary containment vessel [from here on, PCV]) is rising. At 0352 that the temperature of the storage pond at Reactor 5 [SFP5] was rising. I take it both mean that plant instruments are showing this readings.

17.03.2011

..... I had been imagining that primary containment [PCV] and pressure vessel [RPV] refer to the same structure in the Mark 1 BWR. They don't. .....

I think, in advance of checking, that the following is right [retrospectively]. There have been two suspected breaches of primary containment [PCV], at Nos 2 and 3, but so far no suspicion of breach of [the RPVs]. .....

17.03.2011

An eye-opening article (for me) from the NYT on the spent-fuel situation.
http://www.nytimes.com/2011/03/18/world/asia/18spent.html

The spent-fuel pools [SFPs] hold eleven times as much radioactive material as the reactor cores (I am not sure how the "eleven times" is meant) because apparently the Japanese store all on-site. Germans and Americans do not.

17.03.2011

http://www.slideshare.net/iaea/technical-briefing-of-nuclear-safety-aspects-of-the-situation-in-japan

18.03.2011

The BBC says smoke is coming from the plant and it is not clear what is causing it. They do not say from where the smoke is coming. The IHT at
http://www.nytimes.com/2011/03/19/world/asia/19japan.html says it's from Reactor 2 this time. Apparently some steam has been generated by spraying activity (which the sprayers regard as a sign of success) but I don't think the BBC comment was about that.

The BBC report "*officials*" as saying that they hope to connect power lines to two of the six reactors "*by Friday evening*". There is no report I have seen that that has happened (they are GMT+9, which means it is after 5 0'clock in the evening there as I write).

They report Kyodo News Agency as saying that power may then be restored to Reactor 2 by Friday night, and to Reactors 3 and 4 "*possibly by Sunday*". There is of course no guarantee that any of the pumping kit will work when/if it is reconnected to power. Given how damaged everything is, inside and out, one can well be sceptical while remaining hopeful.

This is the second day on which there has been no radical overtly-acute event. This is not necessarily cause for celebration but it allows one to remain hopeful. I note with relief that my guess on meltdown by Friday has landed on the side with the butter upwards [2011.07.19 *Wrong. Full meltdown had occurred, but the feared effects been mitigated.*]

However, the IHT/NYT (op. cit.) says that US officials are sceptical whether the methods being used, ground-based spraying from vehicles, are very helpful. They are said in the article to judge

"*little or no progress*". Apparently temperatures at the spent-fuel pools, where they still are showing measurements, are not decreasing, and for some critical areas there are no measurements. The US has been flying recce using "Aerial Measuring Equipment". Radiation levels at and around the plant are high; beyond the 19-mile boundary acceptably low. However, the US is maintaining its 50-mile boundary recommendation. Here is a rather more candid comment using vocabulary which I imagine Japanese government spokesmen might find "*unhelpful*":

> *"What you are seeing are desperate efforts — just throwing everything at it in hopes something will work," said one American official with long nuclear experience who would not speak for attribution. "Right now this is more prayer than plan."*

That seems an accurate assessment to me. The BBC liveticker at 0519 says that current spraying operations will discharge 50 tonnes of water. I recall Bernd [Sieker] writing earlier that one spent-fuel pool takes 2000 tonnes, and that at the measured temperature they will be losing 10-15 tonnes per hour. Is that right? Since there are two pools of immediate concern, that 50 tonnes might replace what is lost in two and a half hours of elapsed time if one takes the lower evaporation figure. I wonder if that is more or less time than it takes them to deliver the 50 tonnes? But it sure sounds like a lot without context, "50 tonnes"!

The US military is not saying what its radiation measurements were, but Japan's nuclear regulators have said

> *Measurements taken about a kilometre from the plant were 279.4 microsieverts per hour, against 292.2 microsieverts per hour on Thursday evening.*

on the BBC liveticker at 0149.

As to the politics:

> *After a day in which American and Japanese officials gave radically different assessments of the danger from the nuclear plant, the two governments tried on Thursday to join forces.*
>
> *Experts met in Tokyo to compare notes. The United States, with Japanese permission, began to put the intelligence-collection aircraft over the site, in hopes of gaining a view for Washington as well as its allies in Tokyo that did not rely on the announcements of officials from the Tokyo Electric Power Company, which operates Fukushima Daiichi.*
>
> *American officials say they suspect that the company has consistently underestimated the risk and moved too slowly to contain the damage.*

..... One may well wonder why it has taken a week for the Japanese government to agree that the "*information*" and assessments it has been fed, or not fed, by TEPCO, which has caused it international embarrassment on a number of occasions, is not a good basis on which to make decisions about the health and welfare of its citizens. Those citizens might also well wonder why they elected a government which takes a week to determine that it is being [misled] on a major public health emergency.

It seems from a series of liveticker notes that Amato, the IAEA head, has asked Kan, the PM, to be more forthcoming with information about the accident. Kan is reported to have agreed to do so. .....I cannot understand how the rituals of information (non-)sharing ..... by TEPCO, an

organisation with no experience with severe nuclear accidents and with apparently ..... limited capacity to anticipate physical developments, can take precedence over any action to avert what could still become a major-major disaster (as contrasted with a major disaster, which of course it has been for days).

I was pleasantly surprised, for once, by of all things the Daily Mail. I was thinking about the heros at the plant, people many of which may well die prematurely through radiation exposure, maybe quite soon, and who are there voluntarily. Then I read on the BBC liveticker about a Daily Mail article. Apparently they are called the "*Fukushima Fifty*" - there are about two hundred of them, and the Mail has pictures of spouses and anecdotes: a picture of a lady whose husband sent her an email "*Continue to live well. I cannot be home for some time.*" I thought of Titus Oates: "*I am just going outside and may be some time*". No names, though, not even of the lady or her husband
http://www.dailymail.co.uk/news/article-1367125/Japan-tsunami-Fukushima-Fifty-suicide-mission-battle-nuclear-meltdown.html
The anecdote also made it into the New York Post:
http://www.nypost.com/p/news/international/families_of_fukushmima_grow_increasingly_sjTCaOP0iO15Q7pDseUpPM
There is also a BBC article from yesterday evening on the theme at
http://www.bbc.co.uk/news/world-asia-pacific-12779510

Maybe one can infer that Japanese heros prefer to remain anonymous. Here [in Western Europe], we would think it more appropriate to hold a short ceremony at which their names are read out.

18.03.2011

On 3/18/11 10:07 AM, Jan Sanders wrote:

> *The spent-fuel pools hold eleven times as much radioactive material as the reactor cores (I am not sure how the "eleven times" is meant) because apparently the Japanese store all on-site. Germans and Americans do not.*

I noticed that the [Union of Concerned Scientists] UCS blog at http:allthingsnuclear.org had an assessment of what fuel is where this morning.

> *... until the Yucca Mountain Issue is resolved.*

Don't hold your breath. Yucca Mountain has been going on for four decades now.

> *Obama stopped operations at Yucca Mountain in 2009. The reason: Yucca Mountain is located in seismic active area.*

Here is a [cynical] summary of four decades of "debate" over Yucca Mountain. This is all you need to know, now that we have Google to show you exactly where Yucca Mountain is.

First decade or so:

Fact: Yucca Mountain is located in a seismically active area. Tweedledum: No, it ain't. Nothing's moved around there since anybody here remembers.

Later on [after the first decade]:

Fact: Yucca Mountain is located in a seismically active area. Actually, the most of the entire US west of the Rockies is a seismically active area. Tweedledum: Doesn't matter. Tweedledee: Does too matter. SierraClub/FotE: Besides, it's beautiful around there. Who wants all this industrial crap intruding. Tweedledum: Me. I live east of the Rockies.

18.03.2011

The BBC liveticker says at 1950 GMT that TEPCO reported

> *Tepco has connected the external transmission line with the receiving point of the plant and confirmed that electricity can be supplied.*

so let's hope that they can get some piece of kit to start doing its thing again. I suspect it'll take a fair amount of work before they can actually get the supply to a piece of crucial kit which still functions. All in a serious RadHaz environment.

19.03.2011

BBC liveticker, all times GMT. Fukushima is GMT+9 My comments in [...]

0037 Somebody at the power company said they were "*hoping to connect*" a power cable to R2 "*later today*"

0044 Tokyo Fire Department has apparently taken over the spraying task. Someone said there were going to deposit "*90 tonnes*" on R3

0201 TFD said that spraying was to start at noon (that is, one hour later)

0216 Govt reported to say that a cooling pump is operative at the spent-fuel pool (sfp) of R5
0227 "Thought" to be a diesel pump

0303 Power cable apparently still not attached. still hoping for later today.

0349 Holes have been bored in the roofs of R5 and R6 "*to prevent a potential gas explosion*". [?Huh? Explosions are caused in this case by ignition of oxyhydrogen mixture. Are they hoping to dilute the concentration of hydrogen by letting it leak out? It does say that someone thinks there might well be accumulated hydrogen]

0403 Temperature fallen in R5 [spent fuel pool, SFP].

0409 Yomiuri Shimbun says that the Japanese Govt turned down an early offer of US help on cooling the reactors soon after the earthquake. The Japanese Govt apparently denies this.

0531 The Port and Airport Research Institute (PARI) says that near Sanriku the tsunami waves reached 20m. They attribute this to the topography of the coastline. Wreckage was found on top of a three-storey building. [2011.07.19 *Indeed an entire, intact, passenger boat. Now a famous picture.*]

0651 Power cable has been "*successfully*" attached to the "*outside*" of the "*plant*". [No indication of what this means. I guess we can conclude that there is a continuous power cable at least reaching

the gates of the facility]

0721 Edano says heightened radioactivity has been found in milk and spinach from the vicinity of the plant.

0748 Spraying has resumed [somewhat later than was earlier said, it seems]

0902 Report that a power cable has actually been attached to a reactor. No news which one.

The IHT/NYT article on the current state of Fukushima is no longer the major headline, for the first time in a week. It seems, because the US is apparently about to start military action against Libya.

The article has some new material, but more than half of it is from yesterday.

A named senior official at the "*nuclear safety agency*" [NSA, an advisory body to the regulator NISA] has said that the reclassification of the accident to level 5 is retroactive to Tuesday, and based on the current assessment that more than 3% of the fuel has melted.

The US company iRobot has apparently sent four mobile robots at the request of the Japanese military. Two are capable of measuring radiation; two larger ones capable of hauling fire hoses.

There are some interesting observations in http://www.nytimes.com/2011/03/19/science/earth/19rating.html about the IAEA accident severity ratings. First, they are not trivial. There is, apparently, a 218pp "*user manual*" [2011.07.19 *The INES User Handbook. More below*]. Second, the authority to rate is exclusively that of the on-site authority. When France says "it's a six" this can mean no more than "we think the Japanese should be rating it as six". I had been thinking it was more open to discussion. Third, it is a logarithmic scale. People have been saying "TMI was a five and this is worse!". Well, sure, but the question was how much worse before it jumps category - this is a discrete, not a continuous scale. And the answer is: at least ten times worse. Hard to say this is already ten times worse than TMI, no matter where you are [2011.07.19 *But, as now know, it most certainly was*].

Bernd [Sieker], Jan [Sanders] and I took a look at the scale on Thursday (the one-page explanatory graphic version, not the 218pp manual), and we couldn't really say from the brief info given that it was higher than level 4.

I now think the Japanese regulator is doing a serious and accurate job of rating, as best they can with imperfect knowledge. I don't see there is anything to criticise [2011.07.19 *I do now. They had all the information already to classify the accident as Level 7. See below*]. The new level is retroactive, because they have had a few days to shift imperfect evidence to figure out how much core they think is likely to have melted.

This stuff about the power cable has been used, I think, to focusing hope on some tangible action and object. That is, it has a sociological purpose as well as a technical one. The original plan was to connect it Thursday - and it's now two days later. That means there are huge difficulties. I see a lot of spin in the talk about how the effort is progressing. And just about zero information.

They obviously had to try to reconnect cooling mechanisms, because things overall have been getting hotter and hotter daily. You can't just keep driving in fire trucks for months. People have to operate them and they won't be able to do that for very long without exceeding radiation exposure

limits, and there just aren't that many firemen capable of operating the equipment to continue that for months.

The only way to restart cooling was either with shipping outside electric power or by shipping in lots of diesel or gas-turbine generators, and installing them, and keeping them fed with fuel. Given the very hostile environment that second option seems far less possible, to impossible. So I see the power-cable reconnect attempt as the only possible thing that could have been attempted. Since that is so, one could have expected continual optimistic spin no matter whether the effort was going well or badly, because there is no other option. And indeed it seems that continual optimistic spin is exactly what we have got.

R5 and R6 were always going to be the easy ones: they are further away from the leaks of radioactive material, and the buildings are intact. But even so, it's taken days just to get a generator in and working [2011.07.19 *In fact, it appears to have taken far longer even than that, inferring from Bernd Sieker's monitoring graphs*].

Notice there is no news at all on whether the parameters are getting "better", except for R5 SFP, which was never the main worry. That suggests the important parameters are either not getting better or are not being measured.

All that operations appear to me to be doing at the moment is winning some thinking, planning and negotiating time. That in itself is valuable, because there has been some screwy behavior [2011.07.19 *Indeed some we didn't know about yet, such as attempts to order seawater cooling stopped, which thankfully were ignored by the plant manager*], and one needs to transform that, which takes time.

I suspect the Govt has insisted to TEPCO that they have to talk to US NRC - and also to listen! I suspect the US Govt told the Japanese Govt at the latest on Thursday in very strong terms that they were in possession of resources and information that the Japanese Govt did not have and that they insisted they be used. I am thinking that Jaczko's appearance before Congress was a manoeuvre in that political game.

Still, the big question remains simple. Can things -lots of things- be cooled down? And the answer still is, I think, that no one knows, with the one exception of R5 SFP.

On to broader matters.

There seems to be some suggestion in the newspapers that "no one could have anticipated a quake and tsunami **that** strong and **that** high!". Apparently behind it lies the thought that it's OK to have a catastrophe at a nuclear power plant if the environment does something you didn't quite expect.

Well, it's not. [Charles Perrow]'s observation to the New Scientist on Tuesday cuts directly through that line of thinking.

To recap comments from Tuesday in different words: What were people doing putting their backup power in a position vulnerable to a common-cause failure [CCF]? The answer, I think, is that people couldn't and didn't handle CCFs 40 years ago when the safety analysis was done. That is, at best, a historical observation, which we can maybe call the "Challenger cop-out", after Diane Vaughan's observations of normalised deviance. It doesn't mean that no one could have thought of what might happen, then or later. It means that they didn't, probably because no one any longer paid much

attention to the original safety case and noticed a lack. Which makes a strong case for maintaining up-to-date operational safety cases, as I pointed out on Tuesday. "Maintaining" here means checking that the reasoning conforms to contemporary standards as well as that the case considers the contemporary state of the kit.

19.03.2011

On 3/19/11 12:29 PM, Bernd Sieker wrote:

> *Reactor 4 has been rated Level 4 since today, but was rated Level 3 yesterday.....*
>
> *.... "3": "Near accident at a nuclear power plant with no safety provisions remaining."*
>
> *Looking at this it sounds strange that reactor 4 would only be a "3" until yesterday.*

Recall that the Japanese also have radically different criteria from Europe on what constitutes a light injury, severe injury, and death in a road accident.

A "death" is counted if it occurs within 30 days in Denmark, Finland, GB, NZ, Spain, Sweden, The Netherlands. Within 6 days in France. Within 24 hours in Japan.

A "serious injury" occurs in The Netherlands if the person is admitted to hospital. In Spain if you are hospitalised over 24 hours for sustained injuries. Sweden lists a few "fracture, contusion, sever rupture... concussion... internal injury ... or other kind of injury that results in hospital care"; Britain lists them. Japan: requiring treatment for more than 30 days.

I attach the page of definitions [from the OECD report on vulnerable road users].

What I read from this is that qualitative Japanese judgements of accidents, injuries are likely to be well on the lighter side of European judgements of similar situations.

People have been worried about the SFP at R4. The operator thinks there has been water in it continually, and they have disputed that with the US who thinks it has run dry or maybe still is dry. If there is still water in, then it is a "near accident" if they don't think anything has happened yet (we may suppose that radiation has escaped but maybe they say "no evidence"), and it should also be clear that no safety provisions remain.

If this is true, and they generally classify more mildly for cultural reasons, what might worry us is why the level has just been raised!

Recall also that there is [still] no explanation for the sudden reclassification of the building damage from "partial" to "severe" on Wednesday.

19.03.2011

The NYT running article on reactor status says of R4 that there was a hydrogen explosion (I guess oxyhydrogen explosion) on March 15 at 0600 which damaged the building. I am not sure what times are; there is no indication on the WWW site, and correlation is hard, because times are the times of status comments, not of events.

The Wikipedia timeline includes comments on a number of explosions at Reactor 4, as well as the fires. But it still shows the building going from partially damaged to severely damaged on March 16 morning, without any accompanying commentary.

I am wondering now if that is simply representing a reassessment from new imagery? [2011.07.19 *No, there had been an explosion but it had been unreported.*]

20.03.2011

A propos the discussion Bernd [Sieker], Werner U and I are having about how one assesses, I think it is fundamentally right that assessments and everything else coming out of the Japanese authorities (for this purpose I shall consider there are relevantly three of them: The Govt, NISI, TEPCO) are derived from "what do we know for sure" rather than "what are the likelihoods of which possible futures" way of reasoning.

I am participating in a working group of mainly sociologists at the ZiF at Bielefeld at the moment, on "Communicating Disaster". We had a discussion last Tuesday night on the earthquake/tsunami and on Fukushima, which are of course causally related but phenomenologically different disasters.

I made a point at that meeting and in a subsequent e-mail about assessment from certain knowledge versus assessment from enumerating possible futures, like this. It is a bit "decision theoretical", but then I think that ... appropriate. I think the assessment is not just about politics, it is about justifiable ways of reasoning about uncertain situations. The presumed method of the Japanese authorities, "say only what we certainly know and use deductive reasoning" has much to commend it in many circumstances, for example courts of law. However, if you are trying to anticipate and plan, the Bayesian "possible futures with likelihoods" seems to me to be more appropriate.

> *I was suggesting ways of approaching incomplete information last night. Say the state of the world with which you are concerned (supposing you have some way of drawing a boundary around the aspect that interests you: call everything within this boundary D) is Y (so Y refers just to aspects of D), and what you know about it is X, and assume (Y | = X), that is, that your knowledge is veridical. Then there are (at least) two ways of presenting information X to third parties. One is by reciting X, along with all the cautions that X is all you know, and resolutely refusing to conjecture about anything not in X. Another is by considering all you know that causally and socially and so-on follows from X, and constructing the set of possible futures of X in D, say F1, F2, F3, F4. Then, instead of saying "X, and that's all I know", you say "given what I know, one of F1, F2, F2, F4 will happen".*
> .....
> *Let me consider the "possible futures" strategy from a formal point of view.*
>
> *One can also consider very general likelihoods. You can assign the uniform distribution to all futures (if you have N futures, each future formally gets probability 1/N) and then, for a given possibility (say meltdown of one reactor core) you can count the number of futures, say M, in which this happens, and then M/N might be some kind of guide to its likelihood. Since this is based on formal assumption and not on Y, this guide may or may not be very good. But those interested in decision procedures might recognise its interest. For example, it is a very tempting strategy with extreme values: if someone sketches 20 possible futures, and in 19 of them A happens, most of us are tempted to say "it looks to me very likely that A will happen". But of course the probability of those*

nineteen taken together might be well less than half, and the probability of the twentieth much greater than a half; one does not in fact know. Bayesian reasoning would require one to have low confidence in the outcome of such a decision procedure, but then one would have low confidence in any outcome based on this evidence, and if you have to take a decision, you still have to take it and high confidence is an unobtainable luxury.

Enumerating the possible outcomes is a technique with which I have had some success over the years. It also guides you towards trying to obtain key information which will help decide amongst the possible futures. It puzzles me why more people do not use it, since it seems to work well. But one must have a certain "core" information stance for it to be fruitful: X must contain a certain level of information (we are working one retrodictive case at the moment in which the information X we have is too sparse, and it is exceedingly frustrating).

20.03.2011

The BBC live ticker appears to be no longer active. I feel .... frustrated, because there is, suddenly, very little info. I have given in and joined Twitter, imagining it might help [2011.07.19 *But haven't been at all active. I don't have the hang of Twitter yet*].

The NYT is reporting that TEPCO said Sunday afternoon that pressure had stabilised in R3 and venting would not be needed; and that NISA said Sunday afternoon that overheating would require venting. Der Spiegel is reporting the same.

Without the live ticker, one has no insight into what actually might be going on that is leading to these contradictory statements.

The NYT also reports that on Sunday 11 firetrucks sprayed water into R4. Spiegel says that until Sunday morning early water was spraying continuously into R3 for 13 hours. After that, they say, R4 was sprayed for about an hour by 10 Japanese-SDF trucks (I am translating "Streitkräfte" to mean not the Tokyo Fire Department!) and 1 US military truck.

The BBC reports the statement by NISA (not that by TEPCO) about R3; that spraying operations have continued; and that power cables have been "attached" to R1 and R2, with no indication of any attempts at "power on". Their report dates from 8:46 GMT, so that would be quarter to six on Sunday evening in Fukushima. I conclude the hopes from Day X to have the power on by Day (X+1) have been disappointed yet again.

It is now Day 3 of spraying using trucks. Can we conclude that this maintains the situation in a stable state? I don't think so, if there is overpressure in R3. There is also no info on R4, at which the US NRC thinks the sfp is leaky.

23.03.2011

On another mailing list, the York Safety Critical list, which publically archives its contributions and to which Martyn and I are long-standing contributors, there has been some discussion that a very similar and similarly aged installation, Onagawa, was closer to the epicenter (that does not necessarily mean more vulnerable to the tsunami, but I doubt it was less vulnerable). Onagawa suffered almost no damage. It was built about 15m above sea level.

.... All this stuff about technical vulnerabilities simply ignores the issue that people were not taking severity of rare events as seriously when they built Fukushima as they were when they built Onagawa.

There is a very short thread from late January on "Probabilistic Risk Assessment of Nuclear Reactor Components", which cited Japanese writing on PRAs of nuclear power, some six weeks before the quake.

Best might be to order the list at http://www.cs.york.ac.uk/hise/safety-critical-archive/2011/ by thread and look for the thread title. The one above occurs near the beginning.

The other thread is "Some Details about Japan Nuclear Reactors" which is nearer the end. It starts at http://www.cs.york.ac.uk/hise/safety-critical-archive/2011/0184.html and you can use the "next in thread" link repeatedly to cycle through the discussion.

The key observation is http://www.cs.york.ac.uk/hise/safety-critical-archive/2011/0220.html

23.03.2011

The New Scientist (Paul Marks) asked me Monday for

> *a pithy view from an engineer such as yourself on what makes it so hard to make a failsafe system in the nuclear space.*
>
> *Briefly, what is the key problem?*

I've been on a funding-proposal retreat for a couple of days. I promised him a reply Monday evening but just couldn't get [fewer] than five [key problems]. I discussed it at breakfast with Bernd [Sieker] and Jens-Peter Lindemann, who [was] a computer scientist but is now a biologist.... Here is what I responded. The key phrase "the nature of the waste" is Bernd's. The observation about handling large amounts of chemical-toxic waste through high-temperature burning is Jens-Peter's. He points out that large amounts of surface material is removed from toxic sites in the Ruhr, still probably Germany's most industrially-despoiled area (it started a few hundred years ago!), put into trucks which are loaded onto trains which drive into the Netherlands where they have such burners.

> *I could only come up with a list of five things last night and couldn't prioritise them. So we discussed this over breakfast just now (we are on a retreat to formulate a funding proposal, so two safety engineers and a bioengineer). ....here is one sentence for you (in the next paragraph) with a couple of elaborations (in succeeding paragraphs).*
>
> *The key problem is the nature of the waste, both in normal operation and in case of accident. It is highly toxic, it cannot be transformed to reduce or eliminate the toxicity, it is active, and this all persists.*
>
> *For example, toxic chemical waste, from accidents or normal operation, can be burned at very high temperatures. It gobbles up time, effort and finally money but is a well-understood, even standard, method of cleanup even for large amounts.*
>
> *In comparison with other power plants, nuclear power plants have the capability to produce toxic waste on the scale of the worst chemical accidents or even higher,*

> *whereas filling the atmosphere with coal dust or oil droplets and byproducts is bad but not by any means so toxic.*
>
> *You can't put the waste from regular operation, spent fuel, somewhere on a big tip. It is active and you have to be very careful about spatial separation.*
>
> *All this requires perfection in engineering, in design, construction and operations, and humans are not (yet) good at perfection with highly complex systems requiring significant human organisation.*

23.03.2011

On 3/21/11 Jan Sanders wrote:

> *For those interested in some of the economics surrounding Fukushima:*
> *Gary Becker's and Richard Posner's joint blog has a 2 bits on Fukushima.*

Posner missed the point. He suggests damage could be averted by strengthening the containment vessels. He apparently missed the fact that the major problem was the loss of cooling, both in the reactor and in the spent fuel pools, due to the primary and secondary power sources being put out of action.

24.03.2011

There are some significant reports on reactor safety in the U.S. which are widely referenced amongst the safety community and, rather than do what I should be doing this morning, I got curious about whether I could find them.

First is the Rasmussen Report ([Norman] Rasmussen chaired the Committee), otherwise known as WASH-1400 or, less commonly, as NUREG-75/014, published in 1975. Turns out you can find it on the NRC reading room at http://www.nrc.gov/reading-rm/doc-collections/ It came in for extensive criticism, mostly from people who really knew the science involved (Rasmussen is not a physicist. .....). Here is a review from Frank von Hippel in the Bulletin of the Atomic Scientists in February 1977:
http://books.google.de/books?id=YQsAAAAAMBAJ&pg=PA42&lpg=PA42&dq=%22Rasmussen+Report%22+NRC&source=bl&ots=V7UeLzvNkx&sig=lxgk6NXUVHnFYAjof-0jhDzjcCg&hl=de&ei=BuyKTeHyC4yXOq3P7U8&sa=X&oi=book_result&ct=result&resnum=3&ved=0CC4Q6AEwAg#v=onepage&q=%22Rasmussen%20Report%22%20NRC&f=false

Partly in response to the criticism of the Rasmussen Report, the physicist Hal Lewis (that is, Harold W. Lewis) was commissioned to perform a review. Their report, "Risk Assessment Review Group Rport to the U.S. Nuclear Regulatory Commission", was published in 1978 and is usually known by the snappier title of "The Lewis Report", as in
http://www.physics.ohio-state.edu/~wilkins/energy/Companion/E20.4.pdf.xpdf
Its number is NUREG/CR-0400 (NUREG/CR documents are "contractor reports") and is apparently not to be found on the NRC document server under NUREG/CRs; I don't know why. ..... BTW, John Wilkins, now at Ohio State and whose document is referenced above, has also visited UCSB for extended times. Ben Monreal, whose slideshow on radioactive byproducts of fission reactors and their dangers has already been referenced [in the mailing list. See http://online.itp.ucsb.edu/online/plecture/bmonreal11/], is also with UCSB Physics. I also found a review of the Lewis Report in The Bulletin for February 1979 by Richard Sclove at

http://books.google.de/books?id=GgsAAAAAMBAJ&pg=PA46&lpg=PA46&dq=%22Lewis+Report%22+NRC&source=bl&ots=254TXzP74I&sig=AQBx5n5NqNhc2fM96Xilhzbo5_4&hl=de&ei=e-yKTenCBY3pOYSN6ZUO&sa=X&oi=book_result&ct=result&resnum=2&ved=0CCQQ6AEwAQ#v=onepage&q=%22Lewis%20Report%22%20NRC&f=false

Apart from that, there is NUREG-1150, from 1987 (v1), 1989 (v2), and 1991 (v3, current); the current version offered on the NRC Document site is Version 3. "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants". This is available in its entirety on the NRC document server. http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1150/

There is also NUREG-1420, but again when I look for this my search just disappears into the cloud.

I have looked at the NRC ADAMS document server, with its "Web-Based ADAMS" (also known apparently as WBA [like our accident-analysis method, Why-Because Analysis. We were there first!]) but my patience ran thin; besides it seems one needs an account.

There is a comment on probabilistic safety assessment by Luis Ledermann in the IAEA Bulletin for Autumn 1985 on the IAEA WWW site at
http://www.iaea.org/Publications/Magazines/Bulletin/Bull273/27302045154.pdf
I think it is relevant because probabilistic risk analyses (PRAs) are de rigeur nowadays for many things, but are still controversial because for many important issues of risk you must simply invent the probabilities - it is not at all clear what basis the numbers may have in reality. And the assumption of probabilistic independence of events, which is necessary for many PRA-type calculations, is mostly invalid (this is one of the major weaknesses of Fault Tree Analysis, a standard but faulty method for assessing risks of critical systems now for over half a century).

Going back to John Wilkins, whose comment on the Lewis Report is referenced above, that comment appears to be part of a book, Companion to Energy [see http://www.physics.ohio-state.edu/~wilkins/energy/Companion/], which seems to have interesting material.....

24.03.2011

There is an interesting article in the NYT today about matters that have not yet been discussed here.
http://www.nytimes.com/2011/03/24/world/asia/24nuclear.html .....

One is the worry about salt accumulated in the reactors. Seawater was pumped in, and one engineer, who was head of GE's reactor safety research at the time Fukushima was built, suggests there is 57K pounds in R1 and 99K pounds in R2 and R3. He wonders how much is still in solution, and how much has encrusted the fuel rods: "*Crusts insulate the rods from the water and allow them to heat up. If the crusts are thick enough, they can block water from circulating between the fuel rods. As the rods heat up, their zirconium cladding can rupture, which releases gaseous radioactive iodine inside and may even cause the uranium to melt and release much more radioactive material.*"

The other is the difficulties restarting cooling pumps.

> *The emergency cooling system pump and motor for a boiling-water reactor are roughly the size and height of a compact hatchback car standing on its back bumper. The powerful system has the capacity to propel thousands of gallons of water a minute throughout a reactor pressure vessel and storage pool. But that very power can also be the system's Achilles' heel.*

> *The pump and piping are designed to be kept full of water. But they tend to leak and develop alternating pockets of air and water, Mr. Friedlander said.*
>
> *If the pump is turned on without venting the air and draining the water, the water from the pump would hit the alternating pockets with enough force to blow holes in the piping. Venting the air and draining the water requires a technician to reach a dozen valves, sometimes using a ladder. The water is removed through a hose to the nearest drain, usually in the floor, that leads to machinery designed to remove radiation from the water.*
>
> *The process takes a full 12 hours in a reactor that is operating normally, Mr. Friedlander said. But even then, the water in the pipes tends to be radioactively contaminated because the valves that separate it from the reactor are not entirely tight.*
>
> *Backlash from the reactor is likely to be an even bigger problem when the water inside the reactor is much more radioactive than usual and is under extremely high pressure.*

Can anything be said about the general situation? I think so. Officials [in Japan] seem always to be expressing optimism. Yes, well, a week ago they were laying power cables on Tuesday and expected to have them connected Wednesday and electricity restored shortly thereafter. A week later they appear to have some lights on in R3 and have restarted some kit in R1. So any progress is very tricky.

Second, it has been suggested that the situation is stable (since the last explosion last week). One should not forget that they have a lot of decades-old engineered metal structure that is used to operating in more or less steady state, that has been continually pressure-cycled and heat-cycled for nearly two weeks now and at some point something is going to fracture because that is what happens when you do that.

24.03.2011

On 3/24/11 11:07 AM, Werner U wrote:

> *to do such a Hazard Analysis, would you expect them to have created / used event probability tables to do the statistics?*

No, that is the risk analysis, which is what follows a HazAn. A HazAn just (attempts to) list all the hazards (precursors of accidents). The estimation of how risky a particular hazard is is performed in the risk analysis. That's when the real arguments start.

You can of course do hazard mitigation before performing the risk analysis, although if a HazMit measure costs significant resources, a decision on it usually must wait until the risk analysis. (I would imagine raising the site 15m would have been relatively cheap.)

24.03.2011

[Translation of some German news stories] for the non-German speakers -

On 3/24/11 1:41 PM (GMT+1), Werner U wrote:

13 Uhr Nachrichten: man spricht von Strahlenwerte die zeitweise die schlimmsten Werte von 1986 übersteigen. R3 raucht, R2 hat "viel zu hohe Strahlenwerte"

News at 1200 GMT: radiation levels that are worse at times than those from 1986. Smoke from R3. R2 hat "radiation levels that are much too high"

+ Neues Nachbeben der Stärke 6.1 in Krisengebiet

Aftershock level 6.1 in the crisis area.

+ 3 Arbeiter schwer verstrahlt (170-fache Überschreitung der jährlich akzeptablen maximale Verstrahlung von 1 milli Sv); hatten Hautkontakt mit verstrahltem Kühlwasser

3 workers suffered radiation exposure (170 times the acceptable maximum annual value of 1 milli-Sv). Their skin came in contact with radiating cooling water

+ Japanische Regierung "pessimistisch" -- Lage sei kritisch aber trotzdem stabil (Kommentar: das ist wohl der pessimistischste Kommentar, den man von dieser Quelle jemals hören wird). Man versucht die Bevölkerung mit Comix auf richtiges Verhalten nach einem Super-GAU auszubilden.

The Japanese Govt is "pessimistic". The situation is critical but also stable [Commentary: that is probably as pessimistic a report as one is likely to hear from this source]. The population is being shown cartoons to prepare them for a more serious accident.

+ R5 wurde problematisch: elektrische Versorgung komplett ausgefallen; R2 Strahlung steigt massive

R5 has problems. The electricity supply is completely shutdown.
The radiation from R2 is increasing "massively".

+ nur R6 stabil unter Kontrolle

Only R6 is under control

+ wiederholt weisser und dunkler Rauch über R1, R2, R3 -- wiederholt wurden alle Arbeiter abgezogen (man wechselt doch sowieso ständig das Personal, dachte ich)

again there is white and dark smoke from R1, R2, R3 and again all workers have been evacuated from the areas.

24.03.2011

On 3/24/11 2:17 PM, Lee Clarke wrote:

.... In that book [Worst Cases, University of Chicago Press, 2005] I try to develop a logic for talking sensibly about extreme events and propose the idea of "possibilistic

> *thinking" as a complement to probabilistic thinking.*

.....possibilistic thinking..... sounds a little like HazAn, which enumerates (tries to enumerate) the possible - all of them - precursors of accidents, and in some versions assigns severities to the hazards. It's the risk analysis which then tries to assign probabilities, and that is generally seen to be the more problematical part. (At Fukushima, it is the HazAn that seems to have been faulty. One could not claim that a thousand-year event, such as this was, has zero probability. It seems to me to have a probability of roughly 1/1000 per year. The last such event is apparently within recorded history.)

24.03.2011

The Washington Post has found a tsunami expert who addressed the issue of a tsunami explicitly during a safety review of Fukushima Daiichi in 2009 and, quite obviously from the account, considered he was rebuffed. From what he recounts, by particularly poor argument.

http://www.washingtonpost.com/world/japanese-nuclear-plants-evaluators-cast-aside-threat-of-tsunami/2011/03/22/AB7Rf2KB_story.html

24.03.2011

On 3/24/11 5:59 PM, Lee Clarke wrote:

> *It's akin to hazan, and other technical ways of thinking through possibilities. But it's more general. This review represents me pretty well: http://worstcases.com/reviews/romano_chronicle.pdf*

Romano says that thinking in this way led [Clarke] to predict some of the social outcomes of Katrina which were missed by others.

I argued a few days ago that, in conditions of great uncertainty, thinking in terms of possible futures constrained by the knowledge you do have (as I was) yields more information that simply recounting what you know for sure about the present (as TEPCO, and mostly NISA, were).

Does that fit within the possibilist paradigm, do you think? If it does, it might help explain why some instances of possibilist-type analysis are efficacious.

Airplane structural engineers engage in possibilist thinking. One of my [colleagues is a very accomplished aerodynamicist]. I have had many discussions with him about the famous "10^(-9) criterion" for catastrophic single-point-of-failure. .....He says that is just guidelines. The real way they work is: think of everything, and then rule it out. It's only the stuff you can't completely rule out that gets subject to the risk analysis.

24.03.2011

Quoting CTBTO measurements, the New Scientist is saying that release of Iodine-131 from Fukushima has reached 73% of the Chernobyl level, and that of Caesium-137 60%. Most of it is blowing out to sea. Iodine and Caesium are the most serious with respect to biological

consequences.
http://www.newscientist.com/article/dn20285-fukushima-radioactive-fallout-nears-chernobyl-levels.html

First, possibilist thinking, in so far as I [understand] it...., would have led one to think of what might happen if the sea wall does not function as designed.

... in this case, I think, so would probabilistic thinking (risk analysis): a thousand-year event happens ..... Criteria for "should not happen" range from 10^(-5) to 10^(-9) for probability per time unit. Taking the low end (10^(-5)), you need to argue that your secondary power plant has a 99 in 100 chance of continuing to work after the 1000-year event. Which no one considering the particular 1000-year event could possibly have secured (notice that no one has argued that, after the tsunami, there was still a 99% chance of the secondary power generation working, because no one has explained why it didn't, why it hit the unlikely 1%).

Second, ... the 1000-year quake+tsunami is not the only event, or set of related events, that could take out primary and secondary power through flooding or by other means. ..... how about an air strike on the power sources (there have been a few wars there in the last hundred years, let alone a thousand, and recent rumblings from China and North Korea. And what about terrorists chartering large bizjets)? I believe reactor containment considers this (from my UK experience). Was the primary+secondary power as well protected as the reactor containment? Because - as the world now sees graphically - it needs to be. .... this is not hindsight, but routine analysis.

25.03.2011

On 3/25/11 5:13 AM, Steve Tockey wrote:

> *All that said, I would be interested to hear more about Lee Clarke's "possibilistic" analysis. .....*

Link below (courtesy of Lee). For me, how to think about risky but advantageous engineering projects ..... is a big unsolved problem. I am glad that some of the discussion concerns it.

(Indeed, I am at least as interested in how people reason as I am in the conclusions they come to. This occasionally comes to the fore in, for example, the controversies over the use of CBA, but much less than it could.)

Here is an interesting observation, again from the New Scientist:
http://www.newscientist.com/article/mg20928053.600-fossil-fuels-are-far-deadlier-than-nuclear-power.html

.... the punch-line is not in the title. To rephrase, the most deadly form of power generation from the point of view of provable deaths versus volts is hydroelectric power. Because of one event, in 1974 in China in which dams burst and 230,000 people (were estimated to have) died. However, in Switzerland, which is almost 100% hydroelectric power (they have some nuclear plants, one close by the capital city Bern, which I used to ride around on my bike in 1992), I suspect the number of deaths is miniscule. In China, the number of coal miners reportedly dying each year is 2,000-3,000. In 25 years, the number of people who have died from thyroid cancer from eating contaminated food from the Chernobyl accident is (I read somewhere) 6,000, with more expected. And that was 100% preventable through a more appropriate politics, namely warning people not to eat that food.

Furthermore, Bernd [Sieker] tells me that coal-fired plants have their radiation issues also, that workers are exposed to more radiation per year in normal operations than they are in nuclear power plants.

In summary .... the numbers are so specific and complicated that it is hard to effect comparisons.

Possibilistic reasoning I understand so far broadly on the basis of a short review of his book whose link [Clarke] sent me yesterday: http://worstcases.com/reviews/romano_chronicle.pdf Romano suggests that [Clarke] anticipated the social consequences of Katrina in ways that others did not, through possibilistic analysis.

I wrote a note here [above] ..... about the difference, in cases of great uncertainty, between saying what you know (not much) and enumerating possible outcomes. .... I proposed that the distinction led one to different conclusions about how serious the incident is.

I have a query out to [Clarke] if these are similar ways of thinking. I would categorise them as anticipating the possible consequences. In principle, this is also done by standard techniques such as event tree analysis (qualitative, without the numbers. ETA is also part of Cause-Consequence Analysis, a result of which consists of an FTA with an ETA attached - a CCA will have lots of these things). The trick is to limit the number of salient consequences one has to consider and ETA, indeed CCA, really doesn't have mature methods for doing that. Let us call a principled move to limit the number of consequences to consider a "filtering method".

One filtering method is to reject consideration of consequences which could have been mitigated by an appropriate HazAn combined with attitude towards fellow people. Call this Method 1. This filtering method would not consider the 1974 Chinese floods amongst the consequences of implementing hydroelectric power, neither would it consider Chernobyl. And - I have been arguing and so has [Perrow] - it may well have ruled out Fukushima Daiichi since we have doubts about the HazAn. One may obviously not use Method 1 unless one is sure that appropriate HazAn and principles are available and will be applied. But it does allow comparison of some sort of "ideal" situation. It does consider the waste disposal issue (in normal operations and under accident conditions) of nuclear power, and the problems of atmospheric dispersants from coal-fired plants, maybe even the mining. It could give you a handle on the irreducible parts of the problem area.

Filtering Method 2 might consider the consequences of rare events. This is possibilist thinking, as I understand it, and it is a little like a focused form of HazOp. Like the considerations raised by Yukinobu Okamura in the Washington Post article I cited yesterday: yes, one has protected against event X, but what happens if the protection doesn't work (if the tsunami is more powerful/higher than what you have planned for)? What happens then?

Filtering Method 3 might be considered the "usual scenario" thinking. Yes, we do HazAns but we screw them up. Yes, we think about 1,000-year tsunamis, but we laugh at the possibility because we are going to retire and go on our world cruise before anything like that happens. Yes, we design things carefully at Diablo Canyon but the contractor comes in with backwards blueprints and connects everything the wrong way. Yes, we've got the right concrete specification and contracts in place but we can't trust contractors to prepare it properly (I hear hints that this is a problem the Chinese might well have with their new railroad tracks shortly). Method 3 might seem like a catch-all, but in fact there is a lot of business experience with how to control for it. That is what all the military procurement procedures are about. So there has to be useful data somewhere on, say, how often concrete gets misprepared and typically in which applications.

I put the business of the .....Fukushima HazAn to Peter Neumann, who suggested it was the old business that you can't prepare for everything. When there is an emergency in a building, what is the safe state for the elevators? Should the elevators go up, or go down? Go up (to where the fire is) or go down (to the flooded basement)? I think that is a different issue. Thinking about possible outcomes may well lead one to the conclusion that there is no one unique safe state for the elevators. It follows that preferable automatic behavior for the elevators should not assume there is a unique safe state. Maybe they all need to stop at the nearest floor and people should use the stairs from there.

Concerning Steve [Tockey]'s comment, one should not forget that neither Fukushima Daini nor Onagawa was affected critically. There are things done "right" there that were not done right at Daiichi. So the reasoning "you can't think of everything" doesn't apply: such an event was mitigated at the other plants and not at Daiichi.

25.03.2011

This from NYT: http://www.nytimes.com/2011/03/26/world/asia/26japan.html

NISA suspects a crack in the pressure vessel of R3 [RPV3], because of the relatively high radioactivity of the water that injured the three plant workers.

People between 12 and 19 miles from the plant, who until now have been advised to stay indoors, are now being "quietly encouraged" to leave. Estimates say there are 10,000 still there, many "virtual prisoners" because outsiders are not delivering to the zone and there is no gasoline to leave.

The Washington Post reports that the IAEA has measured concentrations of iodine-131 and caesium-137 isotopes in seawater at several points some 18.6 miles from the plant. The iodine concentrations are much higher than regulation, and those of caesium below. http://www.washingtonpost.com/world/anxiety-grows-over-japans-food-and-water-supply/2011/03/24/AB9JDZOB_story.html

This from http://www.washingtonpost.com/business/economy/a-quarter-of-us-nuclear-plants-not-reporting-equipment-defects-report-finds/2011/03/24/ABHYa2RB_story.html A new NRC Report from the Inspector General says that a quarter of defects that in US nuclear plants should be reported are not being reported. The IG apparently attributes this largely to confusion over the meaning of the reporting rule.

The Rule is 10 CFR 21. Dave Lochbaum at All Things Nuclear (see below) has a piece about this on 24.03

At the entry for 25.03 at http://www.iaea.org/newscenter/news/tsunamiupdate01.html the IAEA says that the injured workers at R3 ignored the warnings of their dosimeters, believing them to be false. NISA apparently ordered TEPCO to "*review the radiation control system immediately*" to avoid such occurrences in future.

According to the IAEA, lighting at R1 control room has been "*recovered*" and people are now working on restoration of the cooling system. Pressure in the PV is high but stable(ised).

At R2, they are still working to restore control room lighting, instrumentation and cooling systems.

At R3, some 120 tonnes of seawater was injected into the spent fuel pool via the cooling and purification line. That was all done on 24.03 during the day, which is also when the workers were injured.

At R4, the SFP was sprayed with around 150 tonnes of water by the Putzmeister in just under an hour, between 05:36GMT and 06:30GMT on 24.03.

At R5 and R6, repair of the temporary pump for Residual Heat Removal (RHR) was completed at 07:14GMT on 24.03, and cooling started again 21 minutes later.

At the Common Spent Fuel pool, power was restored at 06:37 GMT on 24.03 and cooling started again 28 minutes later. Work is now to recover the lighting and instrumentation systems. Temperature was around 73°C AT 0940GMT ON 24.03

AT 10:30GMT 24.03 seawater was being injected into the PVs of R1, R2 and R3.

Dave Lochbaum at All Things Nuclear http://allthingsnuclear.org/ , the UCS WWW site, is advocating the shift to dry cask storage of spent fuel. He says Jaczko is in favor and has been for some time.

In a separate note on 24.03, Lochbaum also gives details of the NRC IG's report on underreporting according to 10 CFR 21.

NISA gives the conditions of each reactor at 0610 (time zone not given) on 25.03 at http://www.nisa.meti.go.jp/english/files/en20110325-2-2.pdf

http://www.nisa.meti.go.jp/english/files/en20110325-2-1.pdf reports that there is continual white smoke from R1, R2 and R4 on 25.03. Nothing reported from R3. Cooling has been started again at R5 and R6.

25.03.2011

On 3/25/11 11:01 PM, Lee Clarke wrote:

> *[PBL wrote] The real way they work is: think of everything, and then rule it out. It's only the stuff you can't completely rule out that gets subject to the risk analysis.*
>
> *Right, but things get ruled out because they're thought to be so outrageous as to be silly to consider*

It's very hard for me to identify the tropes at this level. My [aerodynmicist] colleague is in the forefront of the engineering, but (I would claim) is very effectively shielded from other behavior of the company.

[Example of HazAn and negotiations]
The tropes showing how people think always need to be annotated with the tropes of how they negotiate. And this is deliberately obscured to engineers.

26.03.2011

NISA is saying in its 52nd report (March 25, 19.30, I take it local time) at http://www.nisa.meti.go.jp/english/files/en20110325-5-1.pdf that the three workers exposed to radiation had "no serious problems in the condition of the whole body, were fully conscious and ambulatory". They report a dose rate "on the surface of the water" as 400mSv/h, and the radiation intensity as 3.9 x 106 Bcql/cc. There is a detailed measurement of the radioactive contents of the water at http://www.nisa.meti.go.jp/english/files/en20110325-6.pdf They report isotopes of chlorine, arsenic, yttrium, iodine, caesium and lanthanum. I don't know whether breach of containment can be the only cause of that, but it is the one which springs to mind, because of the half-life of some of these isotopes. There is a hypothesis about corrosion byproducts cobalt and molybdenum (Friedlander, in the NYT, below). I don't know where the info about cobalt and molybdenum comes from.

There is a point about terminology and systems which I don't quite grok. There is piping which comes to and from the PV, containing the turbine + cooling pump circuits. That has to be open, as part of the design, so I would naturally consider it to be part of the PV, since the pressure must be similar in all of it except where it passes through the turbine, which in normal operation would cause significant pressure differences. And then the pump would raise it again. But the engineers talking about it don't appear to be considering it all part of one system. They seem to be talking about a breach of the piping as a separate kind of event from breach of the PV.

There was a picture of a navy vessel towing a barge full of freshwater in the sea in one of the newspapers (but see the WP below).

NISA reports in Bulletin 52 that freshwater injection into some PVs has started (R1 at 15:37, R2 at 18:02 both on March 25). Two fire departments sprayed water into R3 for two and a half hours. Water spray for R4 started with the Putzmeister [extendable concrete pump] at a rate of 50 tonnes per hour at 19.05. Finally, the power supply for R6 Residual Heat Removal Seawater System (RHRS) was "switched" from "temporary" to "permanent" - twice indeed, at 15:38 and 15.42. I presume they switched it back from "permanent" to "temporary" somewhere in between those two times, just from the logic of switching.

The NYT has a different take on the amount of radiation the workers were exposed to, at http://www.nytimes.com/2011/03/27/world/asia/27japan.html "*The National Institute of Radiological Sciences said that the radioactivity of the water that the three injured workers had stepped into was 10,000 times the level normally seen in coolant water at the plant. It said that the amount of radiation the workers were thought to have been exposed to in the water was two to six sieverts.*" They say TEPCO says that water with an equally high level of radiation has been found in the R1 building. Level of radiation is measured in Bcql; Sv/hr is biological dose rate. However, if the relative concentration of the isotopes in the water is the same, one would expect similar dose rates for similar levels of radiation. The papers seem to mix up these two concepts at will. [It would be more helpful if they kept them straight.] The NYT talked to David Brenner, head of the Center for Radiological Research at Columbia U[niversity], who noted that at a whole-body dose of 4 Sv, half the recipients will die. It is not clear at this point whether the exposure was purely local; he said at those levels locally it would cause severe burns. I guess one can conclude from reports that the dosimeters read 170 milliSv that the dose was not whole-body: it didn't reach the dosimeters. I have no idea how to reconcile the NYT report with the NISA report, unless the workers were standing in the water for 2.5 to 16 hours, which from other reports does not seem likely.

The workers were in the turbine building adjacent to the secondary containment building.

The times interviews Michael Friedlander again. He says that presence of cobalt and molybdenum in the water samples suggest that corrosion might be a cause; these materials come not from anything going on in the core but are byproducts of "routine" corrosion in the reactor and associated piping.

"*On Saturday, [NISA] said that a test of seawater taken Friday from a monitoring station at the plant showed the level of iodine 131 at 50 becquerels per cubic centimeter — 1,250 times the legal limit. That was up from 147 times the normal level on Wednesday, the agency said*".

According to the Washington Post,
http://www.washingtonpost.com/world/japan-urges-more-evacuations-as-prime-minister-kan-addresses-nation/2011/03/25/AFKm2IVB_story.html
there are two USN fresh water barges on the way but they are expected to arrive in "*about three days*". The monitoring station for the seawater that registered high levels is said to be about 260 yards (read meters) offshore, where water is normally discharged. Adrian Heymer of the Nuclear Energy Institute in Washington said that about 900,000 gallons have been poured into R3 SFP. No indication of how he estimates that - quite obviously, not all the water sprayed will have reached the SFP.

Here is an odd quote:

> *Looking at the data, we believe the number three vessel still has the capacity to contain radioactive material," Hidehiko Nishiyama, deputy director-general of the Japan Nuclear and Industrial Safety Agency, said at a news conference. "But we have to investigate . . . the possibility the number three reactor has sustained damage.*

It is not clear to me what he means by "the capacity to contain". He may mean that PV and associated systems of R3 is not breached as far as they know. That would seem to be inconsistent with the evidence in the water on the floor of the turbine building. If he means that they think that R3 has radioactive material inside it, well, we know that - it was a working reactor until the quake. Heymer said that the radioactive water in the turbine building could have come from runoff from the water dumped on the outside of the building, or a breach in the steam piping to the turbine, or a containment breach. Given the stuff in the water, I doubt it can have come from runoff without a breach of some kind. Some unnamed person said that iodine-131 had been found in water outside the R1 and R2 buildings, indicating a primary containment breach of some kind there as well, because iodine-131 decays fast enough that it would be unlikely to be coming from the SFPs.

The IAEA has nothing much to add to any of this in its March 26th updates.

26.03.2011

On 3/26/11 10:35 AM, Bernd Sieker wrote:

> *[PBL] The times interviews Michael Friedlander again. He says that presence of cobalt and molybdenum in the water samples suggest that corrosion might be a cause; these materials come not from anything going on in the core but are byproducts of "routine" corrosion in the reactor and associated piping.*

> *So these corrosion products are not necessarily radioactive, but they are merely indicators for the source of the contaminated water?*

The phrase is "*radioactive cobalt and molybdenum*", which leaves it open whether the molybdenum is radioactive. I wasn't precise on the location - these are water samples from the turbine hall of R3 of which he is speaking.

26.03.2011

On 3/26/11 2:53 PM, John Knight wrote:

> *This from NYT:*
> *http://www.nytimes.com/2011/03/26/world/asia/26japan.html*
>
> .....
> *Several of us are sure that the following appeared in that article:*
>
> *"Hidehiko Nishiyama, deputy director-general of the Japan Nuclear and Industrial Safety Agency, mentioned damage to the reactor vessel on Friday as a possible explanation of how water in the adjacent containment building had become so alarmingly radioactive. A senior nuclear executive who insisted on anonymity but has broad contacts in Japan said that there was a long vertical crack running down the side of the reactor vessel itself. The crack runs down below the water level in the reactor and has been leaking fluids and gases, he said.*
>
> *"The severity of the radiation burns to the injured workers are consistent with contamination by water that had been in contact with damaged fuel rods, the executive said.*
>
> *"'There is a definite, definite crack in the vessel — it's up and down and it's large,' he said. 'The problem with cracks is they do not get smaller.'"*
>
> *This text is no longer in the article. The NYT has not published a retraction as far as I can tell.*
>
> *Did you see this quoted text?*

Yes, I did. It has disappeared. The NYT does update articles on its WWW site, without issuing commentary about what it has taken out or put in.....

The question is what is meant by a "*long vertical crack running down the reactor vessel*". If you consider "reactor vessel" to mean the reactor pressure vessel, which is reasonable, the question is how anyone could know. If it means the primary containment vessel (PCV) then it should be apparent to everybody and TEPCO and NISA would be deliberately withholding information, and I doubt in that case they would be using contractors around the building.....

Bernd [Sieker] and I discussed it yesterday. The short answer is that we don't think there is any usable information in the statement and its elision.

There is a reactor pressure vessel (RPV or PV), with accompanying connections to the turbine and

cooling pumps, because they are all in the pressure circuit. The primary containment vessel (PCV) surrounding the pressure vessel must allow the piping for turbines and cooling in and out somewhere. PCV and contains the torus (or "suppression pool") which is supposed to cope with overpressure in the RPV. In order to see a crack on the RPV, you or some camera of yours would have to be inside PCV, with lighting. You are most certainly not there. And if there is a camera in there, that can see a crack, then someone **knows** the PV is compromised and there would be no "we think" about it ..... So the statement is puzzling unless the anonymous source is trying to suggest we are all being blatantly lied to.

Do I think the RPV is compromised on R3?

Well, I look at the pressure figures. The pressure in the PCV of R1 is .270MPa, and the two measurements of pressure inside the PV of R1 are .477MPa and .461MPa, so somewhat under twice that of the PCV. Whereas if you look at R2, PV reads .087MPa, .085MPa, below ambient atmospheric pressure, and PCV reads .115MPa about atmospheric pressure, so it is showing somewhat higher pressure than PV. And for R3, PV shows .139MPa (the second sensor appears to be inoperative - Bernd has been watching it go out for some days) and PCV shows .1066MPa, roughly standard atmospheric pressure at 0MSL 15°C (which is actually .1013 MPa, usually expressed as 1013 hPa).

Bernd [Sieker] has been tracking these on his graphs. PCV pressure is what he calls "drywell pressure", I think. He only has suppression pool pressure for R1, and it seems to be obvious that the "C" sensor on R3 RPV is broken. The graphs have been tracking each other for days.

So in R1, pressure vessel is at about twice primary containment, which is itself a little under 3 times atmospheric, and in the other two it's 30% higher in R3 and actually lower in R2. Is that alone a reason to think that PVs are compromised? I don't know. The reactors are shut down but of course it is still mighty hot in the PV and one imagines that steam pressure must build up enough to make pressure higher than PCV, unless the pressure-vessel-system (including piping) is compromised. And it could be compromised either through some of the system piping leaking, maybe outside PCV, or through a leak, say of the PV, inside the PCV. But both PCVs are roughly atmospheric. If you ask me, without being expert in these things I would think it is likely that R2 RPV and R3 RPV are compromised, just because of the low pressure, until someone gives me an alternative explanation. .....

27.03.2011

[Steve Tockey and I were discussing accidents, and what is foreseeable and what not]

On 3/27/11 12:52 AM, Steve Tockey wrote:

> *Plus, how many times are [road] accidents caused by "the other guy"?*

Almost all non-single-vehicle accidents are initiated primarily by one of the vehicles, so there is always "the other guy" for one of the participants, and a non-trivial proportion of single-vehicle accidents as well. I am not sure of the point you are making.

> *.... I can't think of a better word, but airplane (and nuclear power plant) accidents are far more "spectacular" in scale than car accidents.*

The word is "severity". That is the amount of damage, in terms of people killed or injured, and

property destroyed (measured in monetary units).

> *.....Auto accidents are relatively small-scale events and happen so frequently that we're relatively numb to them, IMHO.*

That depends where in the world you live.

Our local paper publishes articles on almost every severe auto accident and shows a lot of photos of very damaged cars. There are a fair number of young people on Friday and Saturday nights. There is a certain amount of selection bias - not all accidents are shown and reported in the same way - but many people here read the local newspaper and so this gets into local consciousness where it is likely to have the most effect. The fatality count has dropped significantly in the decade and a half I have been here. We had seven in the area last year, unfortunately two of them cyclists (in fatal cycle accidents here, they are almost always collisions with cars or trucks, and they are almost always initiated by the car/truck driver not respecting some traffic rule. Nevertheless, the local police have a couple of seasons a year where they go after ticketing cyclists in force in the name of "road safety". In fact, the safest places are where one has the wildest cyclists. Professional drivers in London are now very much aware of, and careful of, cyclists because so many are unpredictable. This is up from almost zero visibility before 2005).

So, here in Bielefeld, most newspaper readers are very aware of car accidents. Whereas airplane accidents or other high-severity accidents happen somewhere else remote.

> "[PBL] *Driving accidents are overwhelmingly component failure accidents, not system accidents." Really? How are you defining "component"?*

Individual vehicles are components of the road transport system. Failures are mostly local to the participants under environmental conditions. If I am travelling behind someone who has a collision, it doesn't mean I get somehow involved in the collision as well, except as a first responder. Every so often a bridge does collapse, as in Minnesota, but that is not a large part of road transport accidents.

> "*We could easily replace nuclear power with 1) efficiency and conservation alone, 2) wind and solar (though intermittent, there is more wind at night and sun in the day, and the gaps -- to achieve base load -- filled in with gas fired turbines and existing hydro, and more geothermal). Putting a price on the externalities of pollution would drive us to renewables; out problem is electricity is far to cheap (because it is heavily subsidized and the externalities not priced). 3) Carbon Capture and Storage, wherein the coal plume is stripped of CO2 and stored underground, could reduce CO2 emissions by 20%. So there are many alternatives to nucs." I guess I have to politely disagree with this statement too.*

It is backed up in [Perrow's] book. The numbers are compelling. Sweden gets 40% of its energy from renewables, the US 7%. So you can improve things by a factor of five in the US just by doing things that other people do. And the US has far more geographical scope for, say, solar plants than Sweden.

> *If it really were so easy, then why hasn't it happened yet?*

Let me answer with the thesis of [Perrow's] book. The power of large organisations with specific interests that are not those of society as a whole.

> *It's in the best interest of an electrical utility to be as efficient as possible, so ....*

Another thesis from the book (and not just from *this* book): market forces are not efficacious to achieve society's best interests. Just think of the recent financial "meltdown" and how little has changed to prevent it happening again. It is beyond "moral hazard" as the economists say: it is structural moral hazard in an industry which is politically more powerful than the government.

> *..... Japan or Korea where there really aren't any viable alternative means of power generation (which is the main reason why Japan& Korea are so heavily invested in nuclear generation in the first place).*

There are [such alternative means] But there weren't forty years ago, when Fukushima was built.

> "*Not very interesting; there are a lot of birds, and ways to warn them, and most environmentalists would take bird deaths over human deaths." I don't think the environmentalists are buying the "there are a lot of birds" argument.*

The environmentalists here have a political party, the Greens, which is a major force in German politics now (it is one of four major-ish parties). Yes, it is a dilemma taken very seriously, more seriously than [Perrow]'s wording suggests. People have been working on ways to stop killing birds with wind turbines, and have been partially successful. .....

> *.....The usual environmentalist stance is "no death caused by human technology is acceptable". Not people deaths, certainly. But not wildlife deaths either.*

That may be what some continue to say. But international standards on functional safety are now almost all risk-based, so people who take the line above are [arguing in contrast with] the standards now as well, and the standards “win”.....

> *...If you're going to agree to take advantage of some technology then you're going to also have to accept the inevitable consequences of whatever technology that is.*

The point is that the consequences [of nuclear-power accidents] are global whereas the politics are local. Externalities are not correctly priced. There is some chance, with appropriate politics, that they might eventually be correctly priced within a land ..... But I see very little chance that [for example] flooding in Australia would ever be taken as a legitimate reason why Ohio electricity prices should rise.

> "*Regulation could reduce arsenic and other nasty pollutions from the effluence of coal plants. It can't reduce the nasties of nuclear plant accidents." Agreed that regulation could reduce arsenic etc from coal plants, but to think that it would come at no cost is a bit naïve.*

I don't take that to be the point. I take the point to be similar to that which I wrote in response to the New Scientist's request. It is the nature of the waste, which is unique. You cannot transform it by any process known to mankind. It is not just a matter of cost.

> *... I don't know if you ever heard the "too cheap to meter" arguments for nuclear power.*

Everyone over the age of about fifty-five has heard those.....

> *My point here is that the mere fact that the Dai-ichi plants haven't already been obliterated is partly a testament to the designs of those plants in the first place.*

The Daiichi plants were originally to have been decommissioned by now. They were granted an extension for ten years, I understand because of the dearth of replacements.

Expect to find a lot of corners cut both in the ostensible conditions for continued operation, and in how the actual continued operations are construed as fulfilling those conditions.

The journalists are going to have a field day with it [2011.07.18 *and they have*]. I can anticipate that it is going to change the structure of power generation and regulation in Japan significantly. [2011.07.18 *and it appears to be on the way to doing so already*]

This process will be aided by people reacting to the ..... way the authorities in this rich nation have responded to the plight of the people whose lives have been wrecked by the tsunami. There seems to be.....so far a lack of [measured] response. For ..... example, why haven't people stuck in the danger zone around Fukushima already been evacuated by the Self-Defence Forces and other organisations? They have no gasoline so they can't get out by themselves. And they have no place to go. Does that have to be so? Speaking as a complete outsider whose knowledge comes just from friends and newspapers, people in Japan seem to be imbued generally with ... fellow feeling for their countrymen ..... And there is not the structural-legal reason that the US Feds had with Katrina, that they'd like to help but hadn't been asked.

> *.... Look around the Dai-ichi facility, look what other human-made structures are still standing. Not many, right? Had those structures been designed and built to the standards that the Dai-ichi facility had to comply with then a lot more of them would have survived.*

And none of them, not one, had to deal with the problem of the regular use of highly-toxic non-transformable substances. It's different. [To repeat the point] You can clean up anything else.

I don't buy the comparison with any other human endeavor. Use of large quantities of fissile material in any enterprise, be it weapons or energy is just **different**. If humans can deal with it, fine. With nuclear plants, in half a century we have neither solved the problem of how to deal with extreme [unsafe] events nor the problem of waste disposal. With commercial jet airplanes, you can crash and fix, and that has what has happened in the last fifty years. You can't do that with nuclear power. It has to be perfect from the start, and remain that way. And you still have to figure out what to do with the waste.

> *..... But (the opportunity for) unethical behavior isn't a valid argument against nuclear power anyway*

It is if you can show that it happens in almost any organisation with a particular form, [2011.07.18 *as considered most recently by Charles Perrow*]. Here is the condensed argument. Nuclear power plant has to be perfect from the start. If that perfection may be undermined by specific behavior which is almost guaranteed in some form or another, then you can't morally deploy the technology until you can control perfectly for that behavior, and can show that you can do so. I mean, that is standard (meaning: in the standards) for other characteristics of systems; why not for deliberately contraproductive behavior?

27.03.2011

.....

> *[PBL]Concerning Steve's comment, one should not forget that neither Fukushima Daini nor Onagawa was affected critically. There are things done "right" there that were not done right at Daiichi.....*

Was it really because things were done right?

Yes. They put Onagawa on a 15m platform. The tsunami was estimated to be equally high in both places.

> *And that's kinda my point all along: the design engineers in ANY design situation have to use some assessment of **perceived** risk exposure in hopes of getting as close as possible to **real** risk exposure and then design accordingly.*

Yes, but they [performed a flawed] HazAn at Daiichi, and they didn't [do so] in quite this way elsewhere (we may presume it is [flawed] in some other way You can't mitigate a [flaw] by explaining how it is supposed to be done when you do it right.

> *If the design engineers had the ability to see into the future and know that Dai-ichi would be hit by as big a tsunami as they got, then clearly they would have designed for it.But, just as clearly, they didn't then (as nobody has now) have the ability to see that clearly into the future.*

No.... They were told, indeed queried in a formal review on it, by a tsunami expert a couple of years ago. He got a dismissive response. [as] documented ...here already.....

> *As for "So the reasoning "you can't thing of everything" doesn't apply", I disagree. What I was talking about above is what some people call the "known unknowns". Just the same, there are the "unknown unknowns" that won't be revealed until after they happen.*

There are techniques that cope with **all** the possible situations. Namely Ontological Hazard Analysis (OHA). People won't use it because, well, it's a lot of work and uses techniques of logic with which most safety engineers don't care to become familiar.

My response: they should anyway.

It's the same complaint and response to the issue of how to tell if your program actually does what you have said it should do. That has been going on for forty years now, and is still going on, despite that the answer has been categorically given in best practice for some years. The human point is that most people don't seem to want to learn what they weren't obliged to learn as students. It'll change when we can change that attitude. Or when we can get [technical] verification [techniques] into the curriculum everywhere

> *.. There will always be "unknown unknowns". Nobody is clairvoyant.*

Maybe, but there is no argument from this to saying that you cannot do an all-emcompassing HazAn. And indeed there cannot be, because counterexamples already exist.

> "*In France, a utility that wishes to build a nuclear power plant has to choose from one of three government pre-approved designs whereas a utility in the US can **and will** design their plant from scratch".*

That is a fascinating point. Thanks for telling us about it.

27.03.2011

The NYT has blown it open on March 27 with
http://www.nytimes.com/2011/03/27/world/asia/27nuke.html

The word "tsunami" did not appear in government guidelines until 2006.

> *Japanese government and utility officials have .... said that engineers could never have anticipated the magnitude 9.0 earthquake — by far the largest in Japanese history — that .... generated the huge tsunami. Even so, seismologists and tsunami experts say that according to readily available data, an earthquake with a magnitude as low as 7.5 .... could have created a tsunami large enough to top the bluff at Fukushima.*
>
> *After an advisory group issued nonbinding recommendations in 2002, Tokyo Electric Power Company, the plant owner and Japan's biggest utility, raised its maximum projected tsunami at Fukushima Daiichi to between 17.7 and 18.7 feet — considerably higher than the 13-foot-high bluff. Yet the company appeared to respond only by raising the level of an electric pump near the coast by 8 inches, presumably to protect it from high water, regulators said.*
>
> *"We can only work on precedent, and there was no precedent," said Tsuneo Futami, a former Tokyo Electric nuclear engineer who was the director of Fukushima Daiichi in the late 1990s. "When I headed the plant, the thought of a tsunami never crossed my mind."*

He never thought of a tsunami. How about performing a HazAn? Then maybe there is somebody in the room, say [Yokinobu] Okamura [at the meeting at NISA in 2009], who does..... Reminder of the URL: http://www.washingtonpost.com/world/japanese-nuclear-plants-evaluators-cast-aside-threat-of-tsunami/2011/03/22/AB7Rf2KB_story.html Is that the way continuous hazard assessment is [typically] performed .....? When they perform an FMEA, they just look at the system and not at the environment?

> *TEPCO and NISA were well aware that they were not always sufficiently prepared: .... For decades .....Japanese officialdom and even parts of its engineering establishment clung to older scientific precepts for protecting nuclear plants, relying heavily on records of earthquakes and tsunamis, and failing to make use of advances in seismology and risk assessment since the 1970s.*
>
> *For some experts, the underestimate of the tsunami threat at Fukushima is frustratingly reminiscent of the earthquake — this time with no tsunami — in July 2007 that struck Kashiwazaki, a Tokyo Electric nuclear plant on Japan's western coast.. The ground at Kashiwazaki shook as much as two and a half times the maximum intensity envisioned in the plant's design, prompting upgrades at the plant.*
>
> *"They had years to prepare at that point, after Kashiwazaki, and I am seeing the same thing at Fukushima," said Peter Yanev, an expert in seismic risk assessment based in California, who has studied Fukushima for the United States Nuclear Regulatory Commission and the Energy Department.*

TEPCO and NISA knew in 2007 that their hazard criteria needed review. Presumably this was the reason for the meeting that Okamura attended at which his question was trivially rebuffed.

When Japanese engineers began designing their first nuclear power plants more than four decades ago, they turned to the past for clues on how to protect their investment in the energy of the future. Official archives, some centuries old, contained information on how tsunamis had flooded coastal villages, allowing engineers to surmise their height.

So seawalls were erected higher than the highest tsunamis on record. At Fukushima Daiichi, Japan's fourth oldest nuclear plant, officials at Tokyo Electric used a contemporary tsunami — a 10.5-foot-high wave caused by a 9.5-magnitude earthquake in Chile in 1960 — as a reference point. The 13-foot-high cliff on which the plant was built would serve as a natural seawall, according to Masaru Kobayashi, an expert on quake resistance at the Nuclear and Industrial Safety Agency, Japan's nuclear regulator.

Eighteen-foot-high offshore breakwaters were built as part of the company's anti-tsunami strategy, said Jun Oshima, a spokesman for Tokyo Electric. But regulators said the breakwaters — mainly intended to shelter boats — offered some resistance against typhoons, but not tsunamis, Mr. Kobayashi said.

.....

Two independent draft research papers by leading tsunami experts — Eric Geist of the United States Geological Survey and Costas Synolakis, a professor of civil engineering at the University of Southern California — indicate that earthquakes of a magnitude down to about 7.5 can create tsunamis large enough to go over the 13-foot bluff protecting the Fukushima plant.

Mr. Synolakis called Japan's underestimation of the tsunami risk a "cascade of stupid errors that led to the disaster" and said that relevant data was virtually impossible to overlook by anyone in the field.

.....

..... even through the narrow lens of recorded tsunamis, the potential for easily overtopping the anti-tsunami safeguards at Fukushima should have been recognized. In 1993 a magnitude 7.8 quake produced tsunamis with heights greater than 30 feet off Japan's western coast, spreading wide devastation, according to scientific studies and reports at the time.

On the hard-hit island of Okushiri, "most of the populated areas worst hit by the tsunami were bounded by tsunami walls" as high as 15 feet, according to a report written by Mr. Yanev. That made the walls a foot or two higher than Fukushima's bluff.

But in a harbinger of what would happen 18 years later, the walls on Okushiri, Mr. Yanev, the expert in seismic risk assessment, wrote, "may have moderated the overall tsunami effects but were ineffective for higher waves."

And even the distant past was yielding new information that could have served as fresh warnings.

Two decades after Fukushima Daiichi came online, researchers poring through old records

> *estimated that a quake known as Jogan had actually produced a tsunami that reached nearly one mile inland in an area just north of the plant. That tsunami struck in 869.*

This catalog of what I would characterise as [poor] engineering practice makes the case for a continuously-maintained, public safety case for safety-critical infrastructure-components to be overwhelming, I would say.

27.03.2011

....The NYT at http://www.nytimes.com/2011/03/27/world/asia/27japan.html ..... from news conferences:

> *[NISA, specifically Nishiyama, the deputy DG] said that water seeping out of the crippled No. 2 reactor into the adjacent turbine building contained levels of radioactive iodine 134 that were about 10 million times the level normally found in water used inside nuclear power plants. The higher levels further suggested there was a leak from the reactor's fuel rods — either from damage to the piping or suppression chamber under the rods — or a breach in the pressure vessel that houses the rods.*
>
> *Tests also found increased levels of radioactive cesium, a substance with a longer half-life, it said.*
>
> *"Because these substances originate from nuclear fission, there is a high possibility they originate from the reactor," said Hidehiko Nishiyama... He said that it was likely that radiation was leaking from the pipes or the suppression chamber, and not directly from the pressure vessel, because water levels and pressure in the vessel were relatively stable.*
>
> *He also said that radioactive iodine in seawater just outside the plant had risen to 1,850 times the usual level on Sunday, up from 1,250 on Saturday.*

Lighting has also been restored to the control room at R2. This in NISA's report from 26.03@18.30.

Amano says that no one really knows what is going on in the SFPs, whether the effort to spray seawater in "*has been successful*". Unnamed US and international experts suggest that the claim that the rods are covered in the pools is just "*inferences*", based on how much water has gone in and how much steam has come out. .....

IAEA has a couple of interesting items at
http://www.iaea.org/newscenter/news/tsunamiupdate01.html
Today at 0330 GMT they say that the estimate of 2-6 Sv exposure of the workers subjected to radiation in the turbine building of R3 comes from inspection at the National Institute of Radiological Sciences in Chiba Prefecture and the "Japanese authorities" gave out the numbers.

> *.....Off-site power is now connected to Units 1 to 4.*
> *Power distribution panels in the Power Centres of Units 2 and 4 have been connected to the off-site electricity supply, but individual components are still being checked prior to being energised.*
> *The lighting in units 1, 2 and 3 control rooms has been restored. Some instrumentation was recovered for units 1, 2 and 4.*

Off-site power has been restored [to R5 and R6].

Water sample taken from the stagnant water on the basement floor of the turbine building [of R1] shows the presence of iodine-131, cesium-137 and cesium-134 to a level comparable to that measured in the turbine building of unit 3 where three workers were exposed to elevated levels of radiation on 24 March.

The dose rate in the reactor containment vessel [PCV] and suppression chamber [of R3] continued to decrease to 36.1 sieverts per hour and 1.4 sieverts per hour, respectively, as of 13:00 UTC 26 March.

27.03.2011

Thomas Netter just summarised the [lack of foresight] ..... beautifully in a private note:

> *I expected that since submarines exist they'd be able to design generators that can survive a tsunami.*

28.03.2011

> > *Yes. They put Onagawa on a 15m platform. The tsunami was estimated to be equally high in both places.*
>
> *What if the tsunami had been 15.5m? Would Onagawa have also been flooded? Wouldn't it have suffered the same fate as Dai-ichi if it were flooded?*
>
> *Apparently credible reports claim debris has been found on top of 20m tall buildings, so it seems entirely plausible that a tsunami **could** reach well over 15m at Onagawa in some future event.*

First, there is a large difference between considering what mitigation would be reasonable, and the documented evidence of [apparent lack of concern] that I reported yesterday here .....

If the reportage [from] yesterday is true, and this were Britain, then [there would be good reason to consider formally if there might be criminal-law consequences]

Second, you ask about protection and what is enough. Here are some obvious answers. Thomas Netter's comment about submarines is sufficient to show there exists technology which can protect backup power against flooding. To protect against physical destruction I think 20m is current best guess on worst-case. One can build diversion walls, wedges, to channel the water away from vulnerable buildings so they are not physically destroyed by waves. It can be done. Airplane wings are built to withstand 150% of design load. Nuclear power plant physical protection can be designed to withstand 150% of the wave height of the highest projected tsunami. So, build your wedges to channel a 30ft wave. And position your reactors so that the total width of the wedge perpendicular to the wave front is as small as possible.

On 3/27/11 10:54 PM, Steve Tockey wrote:

> *.....would it be possible for you to estimate the total number of column-inches ..... of newspaper space that's dedicated to auto accidents in the course of a typical year?*

> *Then compare that with the total number of column-centimeters of space dedicated to the nuclear plants in Japan since the tsunami?*

No, not really. To be useful rather than anecdotal, such a task would have to be more thoroughly designed. .....

> *I'd be willing to bet that the totals are heavily weighted in favor of the nuclear plants .....*

You won't find anyone to bet against you. Germany has a continual political debate about what to do with nuclear power [2011.07.18 and it has been decided to close all plants by 2022]

Whereas there is more or less consensus on what to do about auto traffic politically - nothing much. Long-time politically hot issues such as nuclear power always get newspaper coverage priority.

> *... But hydroelectric and geothermal aren't going to be of much use in, say, Iowa*

Most definitely not so.

One of the options in Germany for household heating is to sink a thermal well into the ground. You can do that anywhere in the world. .....

I have no idea whether thermal wells work for every building but I see no reason why not. ....

> *I'd be interested to hear what specific, viable alternative energy sources you are thinking about for Korea and Japan.*

I bet Japan could do a lot more with [for example] large geothermal plants. And with thermal wells for individual buildings.

28.30.2011

http://www.nytimes.com/2011/03/28/world/asia/28japan.html

Bad news. The water pooling around R2 is showing activity of 1 SV per hour.

At one point, they thought they had measured I-134, which would mean that fission had restarted, but those readings were apparently in error.

NISA thinks the radioactive water is coming from piping or the suppression pool, and not an RPV.

According to the BBC, http://www.bbc.co.uk/news/world-asia-pacific-12877198 , the Japanese Govt Cabinet Spokesman Edano said that the high levels of radiation demonstrate a partial meltdown in R2. That is the first time in my recollection that anyone official has made a categorical statement on meltdown.

There is significant technical insight in the Washington Post article today:
http://www.washingtonpost.com/world/radiation-levels-reach-new-highs-as-conditions-worsen-for-workers/2011/03/27/AFsMLFiB_story.html

That also says that Edano said that the water around R3 has been in contact with the core.
.....

NISA's latest is also from yesterday (local time). The Putzmeister is spraying into R3. High concentrations of I-131 have been found in the Water Discharge Canal, 74 Bcq/cc.

28.03.2011

The Süddeutsche Zeitung has published pictures of the tsunami hitting Fukushima Dai-ichi http://www.sueddeutsche.de/panorama/japan-zwei-wochen-nach-der-katastrophe-der-moment-der-alles-aenderte-1.1076810

29.03.2011

On 3/29/11 2:43 AM, Steve Tockey wrote:

> ..... *Here in the US, the design engineers would have had to be licensed ...[and] the licensed engineer takes on* ***personal*** *liability (for which they normally carry liability insurance).....*
>
> *Anyone know if there's a similar system in Japan?*

Good question.....

I read yesterday a report by Marlene Weiss of an interview. in the Süddeutsche Zeitung from a week ago (pointed out to me by Carsten Felgentreff, who also gave me the link to the picture of the tsunami reaching Fukushima 1). Shiro Ogura, a retired employee ..... worked on the cooling system for all reactors except R4 at Fukushima 1. He says "*I was given the requirements for the cooling system, and I fulfilled them*". Apparently within the firm it was "*always said*" that "*there is no earthquake stronger than Richter 8*"..... The article goes on to assert that "*because of lack of experience and subject-matter knowledge, the Japanese engineers simply adopted the plans from GE. Those were developed, however, for the US market and tsunamis were not taken into account*". Ogura said "*Later, as we developed our own reactors, we stayed with that*" for example, R2-R6 at Fukushima 1. "*We had no experience, we didn't know anything. We couldn't critically analyse the assumptions.*" Later on, shortly before his retirement, it was considered whether the safety systems would function in case of a tsunami. "*But I believe the tsunamis that were considered were much smaller than the one that just occurred.*" Another former Toshiba engineer, Masashi Goto, said that the emergency cooling system was "*improvised*" and "*not seen as a protection system*". The valves and pipes were not designed to withstand the increased pressures in case of an accident. Because of that (he claims) radioactivity was released even at the beginning of the event. Ogura was asked whether he had ever criticised the "*lax*" safety requirements during his time. "*That never occurred*".

I guess we can assume that Ogura is an engineer..... Ogura says he was responsible for implementing the cooling system, but he doesn't indicate if anyone was responsible for a HazAn. ... in a HazAn as performed nowadays according to, say, the standards for FMEA or HAZOP, one imagines he would have had to have been involved.

What is not clear is whether there was any retroactive and maintained HazAn, say a HAZOP.

BTW, if performing a HAZOP and considering the event of a tsunami, which looks as though did happen later on in operations, one would be required to consider what might happen if the tsunami is larger than foreseen - that's what HAZOP does. At that point, one imagines the participants would

have observed that the secondary power would be flooded.

I am not sure what Goto might mean by the "*emergency cooling system*". As far as I know, there is one cooling system (which is thereby critical) and emergency power for it.

> ..... *the Dai-ichi buildings seemed to have stood up pretty well against the current and whatever junk got pulled out on the outbound wave, but the problem was flooding not current, right?*

They obviously did the earthquake mitigation pretty well, although of course we don't know what exactly the level of destruction inside the reactor buildings is. Looking at SZ's picture of the control room of R2, and all those ceiling panels hanging down, it looks as though they could have done a better job on the ceiling. But that might also have happened post-quake.

> *Have the problems with the caustic nature of geothermal water been solved?*

I guess. According to http://www.energy.ca.gov/geothermal/ there are 43 plants operating, producing just less than 5% of California's total consumed energy, mostly using "dry steam" technology, whatever that is.

> *...They gave up when they couldn't solve the chemistry problem from the caustic water.*

Apparently most of the plants are in the Geysers Thermal Area still, so they haven't given up.

> *Different reports claim different mortality statistics [concerning Chernobyl].*

Yes. That is one of the big problems with adjudicating risks in this area. The figure of "62" for Chernobyl was quoted again on a mailing list of safety-critical system engineers to which I subscribe. How is is possible, 25 years after the fact, for technical people, professionals in the field, to have estimates of risk which differ by two full orders of magnitude?

> *there's a serious double standard going on. .....doesn't explain why people are calling for a standard of perfection on nuclear but not on chemical (or other hazardous endeavors). Don't single out nuclear just because it's radioactive when there are other technologies that are just as dangerous that nobody seems to be questioning.*

I think we can agree on that. [Perrow and Clarke] have pointed out the danger of HazMats in railroad cars that roll through the centers of cities all over the US. It's the sociologists who tell us. You hardly hear about it from the engineers. Why not?

29.03.2011

NYT is saying that contaminated water with activity .....exhibiting an equivalent dose rate of 1 Sv/hr has been found in a U-shaped pipe from R2 which vents openly a couple hundred feet from the ocean. The level of water in the pipe is a few feet below ground level.

I just looked for the news article on the NYT WWW site, but it has been replaced by this. Apparently they consider the contaminated-water-leakage the major problem at present: http://www.nytimes.com/2011/03/30/world/asia/30japan.html

I did find the details on the WP post for today, however: http://www.washingtonpost.com/world/contaminated-water-found-in-underground-tunnels-at-japan-

nuclear-plant/2011/03/28/AFD4rHoB_story.html The water in the tunnel attached to R2 has indicated the high level; WP says that readings from the tunnels at R1 and R3 are "*much lower*".

Higher amounts of plutonium than normal have been found around the plant. They are within acceptable levels, but it does indicate that there has been some leakage. This could be either from the core or from spent fuel rods, not necessarily from the MOX in R3. According to the NYT, the government considers this evidence of a partial meltdown.

It looks as if the contaminated water in the pipes is being considered a major emergency. That is, amongst the major emergency that is Fukushima Dai-ichi, this is the prime concern at present, and it is time-critical. The point is, I take it, that they have been pumping all this water in to keep the cores cool and now it is coming out, contaminated and uncontained and there is no clear idea how to deal with this situation. The water must continue to go in to the RPV-system (to try to introduce a term for the open pressure circuit which includes RPV, piping, turbine, cooling pump) but it is coming out uncontrolled, and will eventually drain into the ocean. Sandbags will buy only a little time. The words being spoken in public do not give me the impression that anyone has a solution yet.

Maybe TEPCO and others are now persuaded that there is, indeed, an RPV-system breach. Rather than endless comments about whether there might be or not, wouldn't it have been preferable to have heard about them planning for what they were to do in which there was such a breach? I can't imagine that the existence of these tunnels draining the buildings was a surprise.

The IAEA gave a briefing yesterday, some text on their daily-news site at
http://www.iaea.org/newscenter/news/tsunamiupdate01.html , and these links:
Briefing paper: http://www.slideshare.net/iaea/japan-monday28final
Summary of reactor unit status (I don't know what the colors mean):
http://www.slideshare.net/iaea/summary-of-reactor-unit-status-at-28-march-0500-utc
Notice that they think half of the fuel in the reactor is uncovered in R1, R2 and R3.

Radiological Consequences: http://www.slideshare.net/iaea/technical-briefing-march-28
and a couple other slide sets on the dispersion projections and the consequences for the marine environment.

NISA's damage assessment from yesterday afternoon is at
http://www.nisa.meti.go.jp/english/files/en20110329-3-1.pdf but doesn't say much, that I can see

30.03.2011

Iodine levels in the ocean near the Fukushima Dai Ichi plant have risen threefold. News reports appear to be similar; here is the WP:
http://www.washingtonpost.com/world/2011/03/30/AF3iw01B_story.html

There is no word on what they are doing about the highly active water in the pipes that come near the ocean. Yesterday, there was water exhibiting EDR of 1 Sv /hour within a few inches of the top of a U-shaped pipe and threatening to spill over on to the ground (and into the ocean).

24 hrs later, there is no mention of this, or of how it was coped with (if it was).

In fact, if you read the NISA briefing, it looks as though not much has happened.

But you can't go from a situation that is critical and that nobody yet knows how to cope with, to all-is-calm, without passing through a stage in which the criticality has been diminished by specific measures taken. That is just a fact about causality. [But a]pparently, ... [some people think] this is possible. Because that seems to be what has happened.

The IAEA has a lot of stuff that NISA doesn't have. I reproduce in full, because the URL will be overwritten by new stuff tomorrow:

> *1. Current Situation*
>
> *Overall at the Fukushima Daiichi plant, the situation remains very serious.*
>
> *With respect to the water that is present in the turbine buildings. In Unit 1, water has continued to be pumped into the condenser with 3 pumps (6.5 ton/hour each) and the water level has reduced from 40cm to 20cm. In Unit 2 from 07.45 UTC, pumping of water from the Condensate Storage Tank into the Surge Tank was started so that the that condenser can be drained to the Condensate Storage Tank and contaminated water can be pumped out from the Turbine building into the condenser. The same process of pumping the water from the Condensed Water Storage Tank into the Surge Tank was started on Unit 3 at 08.40 UTCon March 28.*
>
> *Near the Unit 3 building, 3 workers spilled water over themselves when removing a flange from seawater pipes on the residual heat removal system (RHR). After showering, contamination was not detected.*
>
> *Fresh water has been continuously injected into the Reactor Pressure Vessel (RPV) through feed-water line at an indicated flow rate of 8.0 m3/h at Unit 1. The pumping of freshwater into the RPV has been switched from fire trucks to temporary electrical pumps with diesel generator. At Units 2 and 3 fresh water is being injected continuously through the fire extinguisher line at an indicated rate of 7 m3/h using a temporary electric pump.*
>
> *The indicated temperature at the feed water nozzle of the RPV of Unit 1 has decreased from 323 oC to 281 oC and at the bottom of RPV remained stable at 134 oC. There is a corresponding decrease in Drywell pressure. At Unit 2 the indicated temperature at the feed water nozzle of the RPV has increased from 154 oC to 177 oC and at the bottom of RPV has increased from 78 oC to 88 oC. Indicated Drywell pressure remains at atmospheric pressure. For Unit 3 the indicated temperature at the feed water nozzle of the RPV is about 75 oC and at the bottom of RPV is about 116 oC. The validity of the RPV temperature measurement at the feed water nozzle is still under investigation.*
>
> *With respect to the Spent Fuel Pools. It was planned to commence the pumping of water into the Unit 1 Spent Fuel Pool by concrete pumping truck from 29 March. Also on 29 March pumping of fresh water into the Unit 2 spent fuel pool commenced via a temporary electrical pump. The temperature of the spent fuel pool is 46o C as of 19:00 UTC 29 March. For Unit 4 it was planned to commence pumping freshwater into the spent fuel pool on March 29. The IAEA has not received information on implementation of spraying activities in units 1 and 4.*

Units 5 and 6 remain in cold shutdown

31.03.2011

IAEA [report from today]

Fresh water is being injected into the R1 core, and R2 and R3 (presumably also the cores) at the rate of 7-8 m3 / hr by means of "*temporary electric pump with diesel backup*". They seem to be trying to figure out what to do with the water coming out from what they are pumping in, and I can't get a clear idea of where it's going. The R1 condenser .... is "*full*", and in R2 and R3 they are pumping water from the condenser to the "*suppression pool water surge tank*" so they can pump it out of the turbine halls.

All mention of water in the underground pipes that nearly reach the ocean have disappeared. This is very odd. It seems there is a theme for a day or so, and then somebody just rips the page out and it's not an issue any more. That cannot be right. ..... this cannot be representing causality correctly. Serious situations don't just disappear. They either get resolved or they get worse, and one expects a few words on either.

02.04.2011

As usual, The Economist has it right in this week's print edition: http://www.economist.com/node/18488463?story_id=18488463 They talked to Kenichi Ohmae. I didn't realise he was a former nuclear engineer. According to Wikipedia he has a doctorate in it from MIT. He is scathing.

The Economist has other articles which have appeared on the WWW site during the week, not in the print edition. Such as this comment on the columnist Banyan's blog: http://www.economist.com/blogs/banyan/2011/03/japans_nuclear_crisis

02.04.2011

Steven Chu said on 01 April that R1 has suffered 70% meltdown, his department that R2 is one-third melted: http://www.nytimes.com/2011/04/02/world/asia/02japan.html Given Ch's credentials. I think one can assume this is an accurate an estimate as is possible.

The [material] on NISA's WWW site has a URL which indicates it is from today, but it contains only two-day-old information, from the (Japanese) afternoon of March 31. One [wonders how] serious [they are] about keeping people informed: http://www.nisa.meti.go.jp/english/files/en20110402-1-1.pdf

Despite the brouhaha two weeks ago, none of the four reactors R1-R4 have external power, neither are they connected to external diesel generators. All SFPs at all four are damaged (and thus need water injection, which apparently is continuing with the Putzmeister, and the "*Residual Heat Removal System*" at all four is also not working. Additionally, R2 has problems with the Suppression Pool. http://www.nisa.meti.go.jp/english/files/en20110402-1-2.pdf .....

According to the IAEA on 1 April, the Putzmeister seems to be rotating amongst all four SFPs. http://www.iaea.org/newscenter/news/tsunamiupdate01.html Water is being pumped around the various parts of the reactor construction. Unit 1 condenser is full. In order to pump water on the floor of the turbine building into the condenser, the water in the condenser is being transferred to the

suppression pool surge tank. At some point, everything will be full and they will have to pump some of that contaminated water into external storage, presumably a truck or barge. No hints of what they will do with it then. It looks to me as though the problem with contaminated water will soon become really pressing and nothing is being said about plans for it. If R1 is 70% melted down then this is going to be a continual problem without foreseeable end. How is it going to be solved?

02.04.2011

On 4/2/11 2:26 PM, Werner U wrote:

> *+ TEPCO has discovered a 20cm break/tear in the containment (unclear to me if that is the length or width) ...wants to try to plug by injecting concrete.*

Length. Details on IAEA briefing of 02.04.20111 @ 1200 GMT

> *+ leak into the underground cable tunnels "extremely contaminated"*
>
> *+ contaminated water overflows into the ocean*
>
> *+ radiation extremely high at the site -- NTV reports it as 1000 MilliSb/hour, N24 <http://www.n24.de/> reports 1MilliSb/hour (and called it the max acceptable yearly total)*

From the NYT at http://www.nytimes.com/2011/04/03/world/asia/03japan.html :

> *The space directly above the water leaking into the sea had a radiation reading of more than 1,000 millisieverts per hour, Mr. Nishiyama said. Tests of the water within the pit later showed the presence of one million becquerels per liter of iodine 131, a radioactive substance. However, iodine 131 has a half life of about eight days.*

03.04.2011

[L]et me point out that something like the Fukushima accident was explicitly foreseen, in detail, by Chick Perrow in his .... book, The Next Catastrophe (Princeton University Press, 2007), which I am now reading. Chapter 5 considers nuclear power.

> [p134] *Emergency power at nuclear plants is provided by diesel generators (which have a long history of failing to start and other problems). Clearly visible in some places, these generators could be taken out with grenades. Or, a hurricae could do the work of the terrorists' dynamite and take out the power, and the storm could easily render the emergency generators inoperative as well.*

He then recounts an occasion, in 1996 at Nine Mile Point, when power and emergency power were out for twenty minutes.

> [p173] *[Nuclear power plants] are vulnerable to natural disasters. There have been emergency shutdowns in the face of hurricanes, for example, though no storms of floods have as yet disabled a plant's external power supply and its backup power generators.*

One has now.

Nobody can seriously argue that no one saw it coming. It is there in black and white in an easily-accessible public document written by somebody whose expertise in the area has been apparent to

everybody for at least a quarter century. This is key.

04.04.2011

The IAEA says today (3. April, 17:15 UTC) that external power is now being used to power all the freshwater injection pumping into R1, R2, R3, as of ca. 0300 UTC today.

Nothing about where the water is going, or how they solve the issue of contaminated runoff water. Also nothing further about sealing the crack. There is a good picture of the crack issuing water somewhere on the news sites I usually look at today, but I can't seem to find it right now.

04.04.2011

The picture of water gushing out accompanies the article http://www.nytimes.com/2011/04/04/world/asia/04japan.html . Apparently water is escaping at a rate of about 7 tonnes an hour. To me, that seems to be a huge amount. The article says efforts to stem the leak were unsuccessful.

NISA has http://www.nisa.meti.go.jp/english/files/en20110404-1-1.pdf, its report from 04 April, which is from 1600 (I presume local time) Saturday. They seem to be publishing reports [in English] with two days' delay. They say the crack is 20 cms in length, but if one looks at the picture in the NYT article above, one can see what they mean. They mean that the dimension perpendicular to the flow is 20 cms. We might rather call that width. .....

I don't quite know how to judge this [overall] situation. The reactors apparently are now being kept cool from the inside. The temperature readings, the ones we hope we can trust, say they are moderately cool. But we have 70% meltdown of one core and unknown meltdown of others, and the worry must surely be that they melt through the foundation and this highly toxic matter comes in contact with the ground and stays there. Is it possible that the temperature readings are OK on one thermometer, but that the melted core is still going through the foundation? Or can we rule out ground contamination from core meltdown as long as the temperature readings stay where they are?

If so, then the problems are reduced to
(1) keeping the SFPs cool, which is going to be hard with R4 if it is no longer watertight, but should work with the others if pumps are adequate and are now on external power. But that doesn't seem quite to be the case - the Putzmeister is still going from one to the other.
(2) What to do with runoff and the runoff of water leaking out of some RPV system or other. That is obviously seen as a massive problem at the moment, and so it is. But it is probably not as big a problem as having core material get into the ground.
(3) What to do with the whole thing long-term.

04.04.2011

On 4/4/11 7:11 AM, Karl Swartz wrote:

> *[PBL] Apparently water is escaping at a rate of about 7 tonnes an hour. To me, that seems to be a huge amount.*

Roughly 7,124 liters per hour or 1,882 gallons per hour. The seems like a lot to me, too, considering what's in the water.

I would calculate the other way round. A tonne of water is [almost exactly] a cubic meter, so that is 7 m3/hr. For comparison, the rates at which fresh water is being pumped into the RPVs of R1, R2, R3 are respectively 8,9,7 m3/hr. So what is coming out of the crack is about a third of what is being pumped in to all the RPVs together. Of course, there is water going in to the SFPs as well, and we don't know where that is going.

05.04.2011

I like new words..... Fukushima is sooo not chernobly. It's fukusheemly.

On the essay I put up on my blog, Bernd [Sieker] queried whether "fissive" was a word.... it is now.....

To [Perrow]'s query whether the scenario [contained in “Worse Then Chernobyl”, an article written by Tom Burnett of Hawaii News Daily on 4 April 2011] is possible, I would agree with [Tockey] that everything is dependent on amounts, concentrations, pressures, basic physical quantities and it is not so easy to judge these in advance as the article writer suggests he can.

I don't see, for example, that an explosion is inevitable once a core-melt mass meets groundwater. How does an explosion occur? When there is sudden overpressure sufficient to overcome the containment. I think you get at least superheated water from the core melt contacting ground water. But there is substantial natural containment, and I haven't seen any calculation which shows that the overpressure overcomes it. So I think [Perrow]'s question whether it is possible is still open.

I do think it is clear that the water will become highly toxic, and I would be very surprised if anyone has demonstrably-accurate diffusion models for contaminated water in the aquifer. I bet there are some people now working on it furiously.

05.04.2011

On 4/5/11 2:55 PM, Lee Clarke wrote:

> *Since cooling nuclear plants is, ... mission critical it seems conservative to conclude that not enough thought was accorded the risks to the cooling systems. What would be the aviation analog to a failure of imagination of this magnitude?*

We are talking very unlikely but not impossible common-cause failures.

[One possible analog] Putting all the electronics on the same couple of buses.

[Another] Even when they they are separated, putting all the buses in the same wiring bundle.

[Another] Putting the fuel-measurement circuit (carries a few milliamperes on an unshielded line in the fuel tank) in the same wiring bundle with wiring carrying serious current, so that when the insulation deteriorates (over the years) it can short circuit heavy current into an uninsulated wire in the fuel tank, which when nearly empty contains lots of nice vapor waiting to ignite (TWA 800, off New York 1996)

[Another] Running all three hydraulic systems through the same place in the tail of the DC-10 so

they can all be severed at the same time when the number two engine sheds a blade (United, Sioux City)

06.04.2011

The NYT in http://www.nytimes.com/2011/04/06/world/asia/06nuclear.html gives some details of a report written by the NRC Reactor Safety Team, includ[ing] outsiders such as from [the Electric Power Research Institute, in Palo Alto] EPRI, giv[ing] details about the accident which paint a different picture than that we are getting from the NISA and IAEA reports. Apparently there is a version from March 26 which "*closely reflects current thinking*". In other words, the American consultants have a different view from that [which] we are hearing in public, and this for a week and a half now.

David Lochbaum, who directs the nuclear project at the [Union of Concerned Scientists] UCS, who used to work on [General Electric Boiling Water Reactors:] GE BWRs, and who writes quite a lot in http://allthingsnuclear.org, said that the problems detailed (NYT says "*revealed*") in the report make "*a successful outcome even more uncertain*". Apparently the problems are the results of what the team infer from (NYT "*appears to rely on*") data provided by Japanese organisations; they are not the result of direct observation. However, the report "*provides a more detailed technical assessment than Japanese officials have provided*".

1. "*New*" threat: "*mounting*" stresses on the "*containment*" (I assume they mean RPV) as they fill with water, making them vulnerable to earthquake aftershocks, which are continuing.

2. "*New*" threat: the possibility of explosions in the "*containment structures*" as they fill with hydrogen and oxygen as a result of the external cooling water being pumped in.

3. Semimolten fuel rods and salt build-up will be (NYT says "*are*") impeding the flow of cooling water.

4. The report "*raises new questions*" about whether the pumping of external cooling water can be continued indefinitely. It raises a host of new "*challenges that the nuclear industry is only beginning to comprehend*".

5. Fragments or particles of fuel from the SFPs were blown "*up to one mile from the units,*"

6. "*pieces of highly radioactive material fell between two units and had to be "bulldozed over," presumably to protect workers at the site.*"

The NYT suggests that 5 and 6 may have occurred during one of the oxyhydrogen explosions and may indicate more damage to the SFPs than "previously disclosed".

The report apparently recommends injecting nitrogen to inhibit oxyhydrogen explosions, and adding boron to cooling water to prevent any resumption of criticality, although they do not think resumption of criticality is imminent.

Damage assessment:

7. In R1 RPV, "*slumping fuel*" and salt from the seawater is "*probably*" blocking coolant circulation: flow in No. 1 "*is severely restricted and likely blocked.*" (quote from report, quoted by the NYT).

8. In R1, "*Inside the core itself*" (whatever that means) "*there is likely no water level*," (quote from report, quoted by the [NYT]), therefore "*it is difficult to determine how much cooling is getting to the fuel.*" (quote from report, quoted by the NYT).

9. "*Similar problems exist in No. 2 and No. 3, although the blockage is probably less severe*".

10. The report is worried about a "*hazardous atmosphere*" (quote from report, quoted in the NYT) within the containment "*structures*" because of the oxyhydrogen released, deriving from seawater coolant in a highly radioactive environment.

11. The report thinks at least one "*containment structure*" may have been damaged by the oxyhydrogen explosions, which hydrogen, they suggest, "*was produced by a mechanism involving the metal cladding of the nuclear fuel*".

So there are at least two mechanisms producing hydrogen, contrary to what it seems to say in 10. Why would the second one, in 11, now have stopped?

12. The report thinks that the explosion early on in R4 SFP could have sent a lot of radioactive material into the environment, "*a major source term release.*" (quote from report, quoted in the NYT).

I am once again surprised at how relatively difficult it is to extract facts ... from even a well-written newspaper article. ..... why can't the writers ..... use more precise terminology (e.g. RPV and "secondary containment structure" rather than, say, "concrete-and-steel containment" or just "containment structures"), and distinguish this from third-party commentary ....? It involved a certain amount of .... effort to extract the 12 points above from the article. .....

06.04.2011

The Washington Post is reporting that the 7 tonnes/hr leak has been plugged with "sodium silicate". http://www.washingtonpost.com/world/radioactive-water-no-longer-leaking-into-sea-nuclear-plant-operator-says/2011/04/05/AFVsbvlC_story.html

It is not on the IAEA briefing from yesterday at 20.25 UTC, so it must be recent news.

06.06.2011

On 4/6/11 9:38 AM, Karl Swartz wrote:

> *[PBL] 10. The report is worried about a ?hazardous atmosphere? (quote from report, quoted in the NYT) within the containment "structures" because of the oxyhydrogen released, deriving from seawater coolant in a highly radioactive environment.*
>
> *11. The report thinks at least one "containment structure" may have been damaged by the oxyhydrogen explosions, which hydrogen, they suggest, "was produced by a mechanism involving the metal cladding of the nuclear fuel".*
>
> *So there are at least two mechanisms producing hydrogen, contrary to what*

it seems to say in 10. Why would the second one, in 11, now have stopped?

I only see one hydrogen-production mechanism: water reacts with the zirconium cladding of the fuel rods, producing zirconium dioxide and free hydrogen.

What other mechanism do you perceive is being claimed?

Point 10 says "*seawater in a highly radioactive environment*". That suggests that if I put seawater into a "*radioactive*" environment with the radiation spectrum similar to that in the RPV, I get hydrogen.

Point 11 says reaction with zirconium. That is a chemical reaction.

You are apparently saying that reaction with zirconium is **the** generator of hydrogen. OK, then the radioactivity has nothing to do with it, contrary to point 10.

06.04.2011

The NYT at http://www.nytimes.com/2011/04/07/world/asia/07japan.html says that TEPCO has announced that it is shortly to begin injecting nitrogen into the containment vessel of R1. R2 and R3 might follow later; R1 was chosen at first because that is where temperatures and pressure are highest, says the article.

07.04.2011

Rep. Edward Markey sent questions to the NRC, and some of the answers were contained in a House hearing. So the NRC has issued a statement. They think some of the core in R2 has escaped into the drywell (lower part of primary containment vessel). They say it is "*speculation*", but it is, they think, the reason for the extremely high levels of radioactivity measured in the drywell, enough to "*kill a person within minutes*" (NYT)

http://www.nytimes.com/2011/04/07/world/asia/07japan.html

The NRC "*does not believe that the reactor vessel has given way, and we do believe practically all of the core remains in the vessel.*" They also said "*part of the Unit 2 core may be out of the reactor pressure vessel and may be in the lower space of the drywell.*" The said after the hearing in response to questions "*there are possible leakage paths from the reactor vessel into the drywell.*" (All quotes from NRC, quoted in the NYT).

The NRC is not speculating on whether the leaked core material is melted. A spokesman for the NRC replied to an NYT query that there are other paths for material to get into the drywell than a melt, for example a broken seal around (I am interpreting) one of the pipes belonging to the RPV System (as we have been calling the larger pressurised circuit including the RPV).

The NYT describes a core melt and its possible consequences, by interpreting an unidentified training manual from 2009. "*Creep rupture*" is when molten corium seeps through a hole in the "*vessel*" (the NYT does not say whether the RPV is meant or the PCV) and ablates it. The corium could then "*burn through the steel at the bottom of the drywell and interact with the concrete, producing carbon monoxide and hydrogen, which could react explosively*" (NYT quote).

They then say that "*some engineers have speculated*" that the concentrated corium could further burn through the concrete under the drywell and indeed go critical, but "*other experts*" say a resumption of criticality would be "*difficult or impossible*" with the type of fuel involved.

The NRC doesn't believe the "*vessel*" has "*given way*", so they say "*Every available method should be used to add fresh water to the Unit 2 reactor vessel and to continue cooling the core.*" (NRC quote, quoted by the NYT).

TEPCO says it disagrees with the NRC interpretation. "*We believe the containment for the reactor is still functioning at Unit 2; however, the damage to the suppression pool may be the source of the radiation.*" (TEPCO quote, quoted by the NYT).

NISA is "*familiar*" with the NRC statement and agrees that it is possible there has been a leak of corium into the PCV. .....

All Things Nuclear http://allthingsnuclear.org/ has an April 6 post by Lisbeth Gronlund which makes a serious attempt to estimate the deaths due to the Chernobyl accident. She concludes that 70,000 excess cancers and 35,000 cancer deaths are "*reasonable estimates*".

All Things Nuclear also has a report by Ed Lyman on internal NRC documents requested by UCS under FOIA before the Fukushima accident but received after. The NRC's Jaszko is on public record as saying the "*B.5.b*" measures, taken after a post-9/11 review of safety and threats, suffice to ensure continuity of power for cooling. One can conclude something different from the documents, however - according to Lyman, there is no internal consensus within the NRC that this is the case.

There is a summary by David Wright from April 2, entitled "*3-Week Summary.....*" which I think provides a good reference for newcomers to the history who want to get up to speed (as of end of last week).

There is nothing [much] on NISA's release today of the April 5th @ 0800 local time report number 74. On April 4 the Putzmeister was used on R3 SFP, and release of the low-contaminated water into the ocean took place. Report at http://www.nisa.meti.go.jp/english/files/en20110407-1-1.pdf

The IAEA reported at April 6, 1515 UTC that NISA had authorised TEPCO to begin nitrogen injections. Earlier (1400 UTC) it reported that the leak appears to be plugged, and that release of 11,500 tonnes of low-contaminated water had started. Updates as usual at http://www.iaea.org/newscenter/news/tsunamiupdate01.html

09.04.2011

....in the NYT...there is an article on the differences between the US view and the Japanese view (NISA +TEPCO) of what is happening, and interviews with quite a lot of Japanese nuclear engineers who seem to believe, on the one hand, that NISA and TEPCO are not telling the full story that can be told (lack of public analysis), and all but one believing that corium has indeed escaped the RPV of R2. It [seems to me to be] more of an article about engineering politics than about what is happening at Fukushima Daiichi. Entitled "Lack of Data Heightens Japan's Nuclear Crisis".....at http://www.nytimes.com/2011/04/09/world/asia/09nuclear.html

The Washington Post reports that an enormous concrete pump built by Putzmeister America is on

its way to Fukushima via an Antonov http://www.washingtonpost.com/national/huge-water-pumps-being-loaded-in-2-us-cities-to-be-flown-to-damaged-nuclear-reactors-in-japan/2011/04/08/AFoPI82C_story.html It can be operated remotely from up to two miles away. It is built on a 26-wheel flatbed, so it will need a certain amount of bulldozer help to get it near. But some core material is apparently lying on the ground around the reactors (suggested to be pieces of spent-fuel rods from the SFPs ejected during the oxyhydrogen explosions during the first week - sorry, I misplaced the reference) and has had rubble bulldozed over it to reduce the environmental radiation. Whether it can work in that ground environment I guess remains to be seen.

The German Association of Water and Energy Industries, BDEW, the umbrella organisation for, amongst others, operators of nuclear power plants, called Friday for a complete withdrawal from nuclear energy within the time frame 2020 to 2030. This is the most radical statement yet by any industry group, and reflects the concern about the safety of nuclear power in Germany. It is significant that a country's whole energy industry has apparently decided to opt out. The organisation represents about 1,800 utilities, including the operators of all 17 nuclear power plants. However, the two biggest energy companies, E.ON and RWE have said they are opposed to the decision. According to the WP article, about a quarter of [electrical] energy [in Germany] comes from nuclear sources ..... http://www.washingtonpost.com/world/association-of-german-utility-companies-calls-for-abolishing-nuclear-power-by-2020/2011/04/08/AFfZF82C_story.html

The major news from the IAEA seems to be that Onagawa lost two out of three external power supply lines after the aftershock, and the aftershock did not hinder efforts at Fukushima Daiichi. They were still injecting nitrogen and freshwater as they have been, and the crack in the well has remained sealed. New is that a retaining wall is being built up to hinder runoff of radioactive fluids into the sea. http://www.iaea.org/newscenter/news/tsunamiupdate01.html

NISA's latest press release on damage, the 77th, has a URL indicating release today, but a date of three days ago, April 6 at 14.40 local time. Talks about tracer dye injection into the crack and injection of "*soluble glass*" verifiably stopping the leak. And that the water level in the R2 turbine building did not thereby rise. http://www.nisa.meti.go.jp/english/files/en20110409-4-1.pdf

Ed Lyman on http://allthingsnuclear.org reports that the USC has received the second batch of documents from the NRC on "State of the Art Reactor Consequence Analyses" which it requested under FOIA. These are now available on the NRC WWW site at links provided in Lyman's post. These sound like worst-case analyses of the sort proposed by [Clarke].

10.04.2011

This blog post http://dotearth.blogs.nytimes.com/2011/04/04/disaster-memory-and-the-flooding-of-fukushima/ wonders why on earth it took until 2006 for the word "tsunami" to show up in government guidelines relating to Fukushima Daiichi. The author points out a 1933 tsunami over 90 ft high along part of the same stretch of coast that the 2011 tsunami hit, and he quotes Roger Bilham of Uni Colorado Boulder:

> *In 1896 a 33-meter high tsunami drowned the Sanriku coastline 200 kilometers to the north of Fukushima. A 23-meter wave surged on the same coast in 1933, and in 1993a 30-meters wave swept over Okushira Island.* [from a paper by Bilham at http://cires.colorado.edu/~bilham/MalletMilneXIIBilham.pdf]

11.04.2011

There was a magnitude 7.1 earthquake Monday 11 April which took out the external power to the cooling at R1, R2, R3. That was restored; Washington Post says "*within 50 minutes*". http://www.washingtonpost.com/world/71-magnitude-aftershock-rattles-japan-tsunami-warning-issued/2011/04/11/AFrtJ1ID_story.html IAEA says only that power from the 7 April earthquake has been restored at all sites. News about Fukushima Daiichi remains similar to before. NISA has little...., and ..... three and a half days [behind on the English versions of] its damage reports and progress on mitigating the dangers.

12.04.2011

Fukushima has now been upgraded to a Level 7 accident. The BBC calls it a "*crisis level*" at http://www.bbc.co.uk/news/world-asia-pacific-13045341 but that is not what the INES scale is. It is a measure of severity, not a measure of crisis. A crisis level would have been at the highest in the days after the quake, and would have lowered since then as the chances of individual extreme events without warning have reduced. INES estimates impact, total release of radiation, and therefore is necessarily monotone increasing with time. .....

NISA is saying they estimate radiation release to be 10% of that at Chernobyl. That will go higher, especially if no one can figure out what to do with all the highly-radioactive water they are storing. If water is pouring out of the R4 SFP due to structural damage, as was mooted weeks ago, then that is going to continue indefinitely until someone can figure out how to get a robotic repair to the pool. Maybe that is part of the purpose of the enormous pump from Putzmeister America with remote control?

The BBC reports Reuters as reporting an unnamed TEPCO official saying the final release could well go higher than at Chernobyl. ..... this comment seems to come from a TEPCO news conference - see NYT article below.

The BBC makes out the decision to upgrade as a point decision made upon observation of a specific phenomenon:

> *The decision to raise the threat level was made after radiation of 10,000 terabequerels per hour had been estimated at the stricken plant for several hours.*
>
> *That would classify the crisis at level seven on the International Nuclear and Radiological Event Scale (Ines).*
>
> *It was not clear when that level had been reached. The level has subsequently dropped to less than one terabequerel an hour, reports said.*

However, the NYT (below) says the two figures come from two different reports.

According to the BBC, NISA also said that "*it was a preliminary assessment that was subject to confirmation by the International Atomic Energy Agency (IAEA).*" [To the contrary, the] IAEA has said that setting the INES accident level is strictly the decision of the local authorities. They said that when NISA was saying it was 4 or 5 a few days after the accident started, and the French were [suggesting] it was at least 6.

This is made clear in the NYT report at

http://www.nytimes.com/2011/04/12/world/asia/12japan.html which has to my mind a misleading title, that Fukushima is "on a par" with Chernobyl.....it's not. Indeed the article reports the 10% figure also, but it might become so (the article also reports the comment from the TEPCO official at another news conference). The scale is logarithmic, which means that on any one level two events at that level can differ by an order of magnitude. Level 7 is also the top of the scale, which means that two level seven events can have an arbitrary relation to each other. If the entire planet was contaminated with EDR of 1 Sv/hr, we'd all die in short order, and that would still be INES Level 7. Neither Chernobyl nor Fukushima could reasonably be argued to be on a par with such an event.

Concerning the level, the NYT reports the NISA head Nishiyama as giving the "*tens of thousands of terabequerels per hour*" figure, but the Kyodo news agency as reporting other government officials saying it had dropped off from that.

The WP doesn't include much more than above: http://www.washingtonpost.com/world/japan-to-raise-rating-of-nuclear-crisis-to-highest-level/2011/04/11/AFxrFEND_story.html except for one significant point. It quotes an IAEA document that the reading of tens of thousands of terabequerels per hour "*corresponds to a large fraction of the core inventory of a power reactor, typically involving a mixture of short- and long-lived radionuclides,.....With such a release, stochastic health effects over a wide area, perhaps involving more than one country, are expected.*"

So, "*large fraction of the core inventory*"? If this is what the INES document says, is NISA still saying that they don't actually know whether they have a partial meltdown or breached containment anywhere?

I conclude there is data we are not seeing that tells NISA and IAEA that a large fraction of the core inventory of one reactor has been released. Or maybe one-third of a "*large fraction*" from each of three reactors?

Don [Hudson] suggested to me in private that the situation looks stabilised. "Stabilised" is a word with many different possible meanings. Day-to-day it may look as if they are coping, but let us not forget the data we are not seeing, telling about a "large fraction of core inventory" being released. There are two reasons why I do not consider the situation "stabilised". First is Bernd [Sieker]'s observations about R1. The situation in the RPV of R1 does not look stable to me, looking at his graphs at http://nuxi.homeunix.org/Fukushima/Fukushima-Plots.pdf . Second is that current procedures are generating large amounts of highly-contaminated water, with no reasonable plan for long-term disposal, and no obvious plan to switch to any other method of cooling or physical-process containment of another sort. I also refer to what I said above about R4 SFP. If it is damaged, how will it be fixed?

The IAEA puts a different slant on the INES upgrade to that of the news agencies, as usual at http://www.iaea.org/newscenter/news/tsunamiupdate01.html (12 April, 0445 UTC). It says that the reclassification comes as the events at R1, R2, R3 are being considered as one level-7 event, whereas previously they had been considered three level-5 events. R4 is still regarded as a separate level-5 event. So, an ontology change led to reclassification.....

This is not what the NISA press release at http://www.nisa.meti.go.jp/english/files/en20110412-4.pdf says, however. It says that the reclassification has proceeded on the basis of data analysed since March 18 (the date of the Level 5 classification) on the **total amount of radiation released**. It does not separate R1, R2, R3 from R4; indeed it does not mention the reactors by name at all. It states the 10% figure.

12.04.2011

On 4/12/11 11:13 AM, Jan Sanders wrote:

> *One of the questions asked was how dangerous the contamination of the ocean due to Fukushima was. The answer was: not really dangerous.*

Unless you should happen to eat any of the fish living in the dispersal area from the point in the ocean at which somebody decides to dump all that highly-contaminated water, continually.

12.04.2011

It does look as if the world's press is mostly doing what the Japanese government seems to have feared, namely putting Fukushima on a par with Chernobyl..... it is still an order of magnitude smaller. The TEPCO official whom I quoted earlier, who said it has the potential to be at least as big, [is] Junichi Matsumoto. He is the first person in an official capacity whom I recall saying that it could get **really that bad**.

Bernd [Sieker] pointed out....that I got the rating of R4 wrong by saying it was level 5.... [indeed,] the R4 SFP events were rated Level 3.
.....
I noted earlier that..... the INES scale is not a scale assessing a level of crisis (which would have been high in the first week and lowered since then), but one assessing severity, which is necessarily monotone increasing. Here it is, in black and white, in the Handbook, p14: "*The scale should not be confused with emergency classification systems, and should not be used as a basis for determining emergency response actions.*"

There is a flow chart at the end (pp 145-6) from which it definitely follows that release of O(10^4) TBq qualifies directly as Level 7 (p 145).

There are three criteria in the flow chart: Impact on People and Environment is the first, Impact on Radiological Barriers and Controls is the second, Defence in Depth is the third.

Chapter 2 deals with impact on people and environment. Here is the definition of Level 7 from Section 2.2.2, p17:

> *Level 7*
>
> *"An event resulting in an environmental release corresponding to a quantity of radioactivity radiologically equivalent to a release to the atmosphere of more than several tens of thousands of terabecquerels of 131-I."*
>
> *This corresponds to a large fraction of the core inventory of a power reactor, typically involving a mixture of short and long lived radionuclides. With such a release, stochastic health effects over a wide area, perhaps involving more than one country, are expected, and there is a possibility of deterministic health effects. Long-term environmental consequences are also likely, and it is very likely that protective action such as sheltering and evacuation will be judged necessary to prevent or limit health effects on members of the public.*

So that is where the connection to "*large fraction of the core inventory*" comes from.

Chapter 3, impact on radiological barriers and controls (one of three criteria to be considered in assigning a level) only goes up to Level 5, for an event involving reactor fuel, explained as "*An event resulting in the melting of more than the equivalent of a few per cent of the fuel of a power reactor or the release of more than a few per cent of the core inventory of a power reactor from the fuel assemblies.*" This, then, was the criterion used publically before [on March 18] in assessing R1 R2 and R3 to involve Level 5 events. It seems you can't go higher than Level 5 with purely physical criteria involving loss of barriers and controls.

So it is strictly correct to say that the reclassification was based on the assessment of O(10^4) TBq equiv of I-131 (there are equivalency factors for other isotopes). It is also correct to say this is equivalent to a large fraction etc. But "equivalent to" does not strictly mean "caused by", although it is very hard to see where else it can have come from.

Finally, a guess as to why Matsumoto surmises it might get worse than Chernobyl yet. They have to cool the RPVs, which are apparently leaking in at least one reactor. All that water becomes highly contaminated, and it has to go somewhere. It does not yet count as "contained". And that for an indefinite period of time until they figure out what permanently to do with the cores (let them cool down over years?). If they are thinking of counting that, or a fraction of that, as potentially "released to the environment", given that they will have to tow those barges somewhere and do something with the waste water such as let it out, then, yes, given the rate of accumulation so far, inside another ten months it could well get up to Chernobyl proportions.

13.04.2011

The IAEA says that the pressure increase in R1 is due to the addition of nitrogen.

They also say that Monday's quake has been revised to 6.6 from an earlier 7.1; the workers at Fukushima Daiichi were evacuated to the "*seismic safety building*", external power to Units 1-3 was interrupted for 50 minutes, and the nitrogen supply to R1 was interrupted but later resumed.

http://www.iaea.org/newscenter/news/tsunamiupdate01.html

NISA says in http://www.nisa.meti.go.jp/english/files/en20110413-1.pdf that what actually happened is that the external power to R1 and R2 was cut, which cut the injection pumps for water into the core, and the injection pump for R3, which was connected to that supply, also stopped. The external power to R3 was in fact not interrupted. Power resumed later. They say that nitrogen injection was also stopped but do not say it resumed, which it has. NISA seems to have stopped putting out the continual-assessment reports (titled "Seismic Damage Information") and the plant-status annotated diagrams.

The NYT at http://www.nytimes.com/2011/04/13/world/asia/13japan.html is saying that the new Level 7 assessment is based "*largely on computer models showing very heavy emissions of radioactive iodine and cesium from March 14 to 16*". In other words, they misclassified the accident at first on March 18, and it has taken them nearly four weeks to analyse the data, and they have concluded that their initial classification was two orders of magnitude too low. I think the NYT is right to say this is a "*fresh example of confused data and analysis*".

A member of the Nuclear Safety Commission, Seiji Shiroya, said that the government had delayed issuing the data because the margins of error in the modelling were large, and also added that the government did not want to set off a "*panicky reaction*". In other words, there was a political as well

as a scientific reason for the misclassification.

The NSC is tasked with introducing regulation and policies for safety (see its mission statement at http://www.nsc.go.jp/NSCenglish/). So they may well generally be feeling that they [misspoke] too.

NISA's Nishiyama has said that he does not understand the reasoning which led TEPCO's Matsumoto to say that the accident could eventually become as big as Chernobyl.

The NYT says of his information that "*The peak release in emissions of radioactive particles took place following hydrogen explosions at three reactors, as technicians desperately tried to pump in seawater to keep the uranium fuel rods cool, and bled radioactive gas from the reactors in order to make room for the seawater*" and that he says that "*almost all*" the material that is going to escape has already come out.

So he is not thinking about what they are going to do with all the contaminated waste water (unlike the Vice-Chairman of the atomic-power promoter, the Japan Atomic Energy Commission, see BBC interview below). And he is assuming that the situation they have now is a stable state. But we may recall that they actually don't know what the state of the cores and RPVs is, and that one of them is likely breached. And I can't yet see a long-term plan. You can't sarcophagise the reactors if you still need to cool them, and I doubt very much if you can reliably design a sarcophagus to resist permanently any physical process that might be going on in or around the core if you just quit cooling them in their present apparent states.

The NYT goes into some details about the calculations. Commissioner Shiroya used to be director of the Reactor Research Institute at Kyoto Uni, so he may be presumed to be scientifically well-informed. He said the computer model is known as "Speedi", and it was only when they had reduced the possible margin of error from an order of magnitude to a factor of two to three that the "*data was released*".

So let's look at that a little closer.

1. NISA's estimate is apparently 370,000 TBq. However, NSC's estimate is 630,000 TBq.

2. If they were concerned about an order of magnitude error, that should not have delayed reclassification. An order of magnitude less than NISA's estimate is still 37,000 TBq which still fulfils the Level 7 criterion of "tens of thousands" or TBq. And even two orders of magnitude would give 3,700 TBq, which is already a third of the Level 7 criterion. And two orders of magnitude lower than NSC's estimate is two-thirds of the Level 7 criterion. So it seems to me implausible that they didn't know weeks ago that they would have to reclassify: I [therefore] don't [accept] the suggestion that there was "*no delay*", as Shiroya is reported to have said at the news conference

3. The NYT points out that NISA's figure is 20% of the official Soviet estimate of the release at Chernobyl. But "*experts*" think the true figure was 1.5 to 2.5 times as high as that, and NISA is obviously using the factor 2 when it says the release is 10% of that of Chernobyl.

4. The NYT also points out that NSC's figure is 34% of the official figure and 17% of the unofficial figure of releases from Chernobyl. And given the possible error factor of three, the paper says that the range thus appears to be from 6% to 54% of Chernobyl releases.

Taking a factor of three literally, NSC would be saying that the releases range from 210,000 TBq to 1,890,000 TBq. If we take the "official" figure, derived from NISA's estimate divided by two, that would be 1,850,000 TBq. Then Fukushima would look like 11% to 102% of Chernobyl. If we take NISA's implied figure for Chernobyl, then it looks like 6% to 51%. Taking the NYT's 54% figure literally, we obtain an estimate for Chernobyl of 3,500,000 TBq. Talk about reading tea leaves!

I tried to find an (apparently-)independent figure for the Chernobyl release, rather than simply taking NISA's implied 3,700,000 TBq or the NYT's implied 3,500,000.

At http://www.nukeworker.com/pictures/displayimage-460-5246.html I found figures of 250,000 TBq for Chernobyl, 750 TBq for Windscale and 0.55 TBq for TMI. That figure for Chernobyl is an order of magnitude lower than NISA's estimate, so I don't think I'll trust these figures. I looked at UCS and IAEA but haven't found any figures. .....

On the consequences of Chernobyl in terms of deaths, I looked at the UCS's 2007 report "Nuclear Power in a Warming World" [http://www.ucsusa.org/assets/documents/nuclear_power/nuclear-power-in-a-warming-world.pdf] and found on in the Chapter on Safety on p14 the estimate for Chernobyl deaths of 4,000 thyroid cancers so far, and 60,000 cancers with 40,000 cancer deaths overall. They have looked hard at the BEIR reports, which are the best single source of mortality estimates, so these estimates are probably as good as it gets. It doesn't seem to have any estimates of radiation releases at the accidents, though.

There is a BBC Radio 4 interview with Tatsujiro Susuki, Vice-Chairman of the Japan Atomic Energy Commission (AEC), at http://www.bbc.co.uk/news/world-europe-13057612 . He says that there is a risk of further releases, and that cooling and managing waste water has to be handled very carefully; that he is mostly concerned about releases into the air (rather than into water). AEC's self-described mission is to promote nuclear power technology "*in a democratic manner*".

The NYT is reporting the "*the media*" has "*become more aggressive in response to public unhappiness about the nuclear accident*". Let me speculate a little about the social. The NYT has found expert academics all over the place whose assessments of what is going on is far more conformant with, say, the concerns that people have expressed on this list. It seems that there was far more scepticism of [the performance]of TEPCO and NISA in the public mind from the start of this accident.

Or maybe it is simply that the accident itself was [regarded as] public proof of the failure of both organisations, and since both organisations are in charge of the accident recovery there is open scepticism that they are capable of it. I don't know how much the Japanese media have been reporting of the prior expert concerns about tsunami resistance/tolerance that the NYT and other Western newspapers have been reporting.

On the other hand, both these possible explanations suggest that the scepticism arose immediately after the initial accident events..... I recall the BBC ticker ..... containing a lot of complaints from Japan about Western media scare-mongering and how everything was really OK, how people were helping each other, and they would recover. Maybe four weeks of fighting over bottled water in supermarkets has changed the "public mood"?

Or maybe it is because this accident is different. It is not a point event, like the tsunami, or Hiroshima or Nagasaki, or the 1933 earthquake and fire, in which something happens over a short period of time, and then the question is how one recovers and adapts afterwards. This is an ongoing

accident, covering now a month and sure to go longer since many of the big problems have not been resolved, and maybe the public is of its nature less tolerant of ongoing accident processes than it is of point events, but this phenomenon has not been discovered before because there haven't been any comparable processes.

13.04.2011

[Jan Sanders: references a list of radioactivity accidents in The Economist]
http://www.economist.com/blogs/dailychart/2011/04/radioactive_accidents

13.04.2011

[a relevant recent publication on nuclear waste disposal from, amongst others, Charles Perrow]
http://www.nd.edu/~kshrader/pubs/final-ksf-science-2010-article-Rosa-master-final.pdf

14.04,2011

The Washington Post is reporting that they are having trouble with R4 SFP and are trying to figure out ways to remove the spent fuel. http://www.washingtonpost.com/business/surging-radiation-in-storage-pond-means-more-trouble-at-japans-tsunami-hit-nuclear-plant/2011/04/13/AFfx2dZD_story.html Apparently they have recorded 131-I 134-Cs and 137-Cs in the pool, and the Post is talking about high levels of radioactivity that need to be reduced. Apparently spraying was interrupted "*for several days until Wednesday*"; apparently water was inadvertently sprayed into a surge pool, which might have led people to think the R4 SFP was full when it wasn't. This suggests to me, more clearly than anything so far, that indeed the R4 SFP is damaged and leaking, as the NRC and others surmised weeks ago.

The IAEA briefing of 13 April at 1430 UTC has downgraded the earthquakes of 11-12 April further, to 6.2 resp. 6.0. http://www.iaea.org/newscenter/news/tsunamiupdate01.html .....

Here is the statement to the Senate made on April 6 by Edwin Lyman of the Union of Concerned Scientists, which self-describes as neither pro nor con nuclear power, but acts as a "watchdog" http://www.ucsusa.org/assets/documents/nuclear_power/lyman-energy-and-commerce-statement-04-06-11.pdf . It contains some interesting details which I don't think have appeared here yet, in particular "*The Austrian Central Institute for Meteorology and Geodynamics has estimated that up to approximately 80 percent of the quantity of the long-lived isotope cesium-137 that was released after the Chernobyl accident was released from the Fukushima site in the first week after the accident. As large as this may sound, it only represents about one-tenth the total amount of cesium-137 in the three damaged reactor cores themselves.*" He goes on to point out that the other nine-tenths are by no means secure, somewhat contrary to the view of NISA from yesterday, that they believe the majority of the material that will be released has already been released.

What distinguishes the Fukushima accident from others is that it is not a point event..... Chernobyl and TMI were more or less point events. Chernobyl did its thing, all the stuff got out there uncontrolled, and then it was done. That means it was relatively easy to build a sarcophagus, since most of the dangerous material was gone. TMI was also a relatively brief event. But at Fukushima, nine-tenths of the dangerous stuff is still in there, in an unknown state, and it is not clear at this point how to keep it in there.

The NYT has a story primarily about the psychological effects of living with so many aftershocks. It does include the following gem:

> *"A week ago we thought the major risk was a hydrogen explosion," a senior official in the office of the prime minister said Tuesday. "I think the major risk at the moment is an aftershock and tsunami."*

I am glad to see that someone is thinking that a tsunami might be possible and what the consequences might be.....!

NISA said Wednesday that three mitigating measures are on the table for a 15m tsunami. Apparently they think that the site can withstand a tsunami of about 5.6m.

> *One measure is to interconnect the external power lines that have been built to the power plant, so that if one power line is broken, the others can still carry electricity to the various reactors.*
> *A second measure is to put a generator on a small hill inside the plant site, and the third is to place a fire pumper engine on the hill that could send water into the reactors and spent fuel pools even if electricity was interrupted.*

Put an emergency generator on a small hill inside the site! [Indeed!] It won't work against .....Perrow's hurricane (called a typhoon [in the Pacific]), and I don't think we need to worry about terrorists [in this case], but it might work against tsunami or SFP collapse, providing the cables between generator and powered devices are secured.

Concerning terrorists, I wonder if somebody is not trying to work out how to get to Dai-ichi with a truck bomb. Because if they took out the countermeasures for even a couple of days, horrendous consequences could result. I think we might presume that US military surveillance is keeping a close watch on movements within the prohibited zone. It is not just concerning radiation that one wants to keep people out! That is why I think we don't need to worry, but it is based on the presumption that there is adequate surveillance.

On to the essay promised at the beginning. Those impatient for the conclusion can jump to it in the last paragraph. .....

Richard Dawkins has this notion of memes. They are, crudely speaking, thoughts or ideas or ways of thinking or cultural traits, that spread through society. The idea occurs in The Selfish Gene, published 45 years ago this year. As I have said before, I am interested in - and often frustrated by - the ways that ideas, particularly about safety or the lack of it, are spread or not spread.....

One is the issue about ensuring continual cooling in these reactors and others, as I wrote in my blog post. I cite, again, ... Perrow from his 2007 book, p134: "*a hurricane...could take out the power, and the storm could easily render the emergency generators inoperative as well*"; and p173: "*..no storms or floods have as yet disabled a plant's external power supply and its backup power generators*". He is pointing out the specific vulnerability and the mechanism, four years before it happened. I don't think that can be too strongly emphasised. (Recall more local occurrences: http://www.washingtonpost.com/world/japanese-nuclear-plants-evaluators-cast-aside-threat-of-tsunami/2011/03/22/AB7Rf2KB_story.html and http://www.nytimes.com/2011/03/27/world/asia/27nuke.html)

So what is going on here? Why are these memes not getting through? Why and how are they

blocked?

I think it is important to understand how [this occurs], in greater depth, because the success of measures to improve safety depend on the success of measures to improve thinking about safety, and if we don't understand how accurate thinking about safety (such as Perrow's above, and that of tsunami expert Yukinobu Okamura at NISA in 2009) is blocked, sometimes passively ([as obviously happened with] Perrow) and sometimes actively ([as with] TEPCO's response to Okamura at the NISA meeting) then we will not be able to judge whether the measures will translate into appropriate action.

Allow me a couple more safety-related but nuclear-power-unrelated examples of weird meme behavior. I shall come back to the point at the end.

Martyn Thomas and I experienced this over the years with measures for SW safety as embodied in the functional safety standard for electrical, electronic and programmable electronic systems. Certain ideas - and I mean here also proven scientific results that have appeared in the literature and been widely cited - just don't get through. .....

I think we simply don't understand the meme-transmission process around critical memes.

Here is another example. The British parliament is currently considering a bill which introduces specific punishment for cyclists who kill pedestrians while cycling. It made the BBC and is still on the home page of the News WWW site: http://www.bbc.co.uk/news/magazine-13040607 Notice that the bill, if it becomes law, will have at most one application every few years. Notice also that there are many laws already on the books to deal with unlawful killing, by bicyclists and others. All this effort is being put into a bill whose associated law will almost never be applied, and which does not fill any ostensible gap in existing law. How does this get to be? How does it get to be supported by such a person as Stephen Glaister, Professor of Transport and Infrastructure at Imperial College London http://www.cts.cv.ic.ac.uk/documents/cv/cvglaister.pdf , by everybody's tables one of the top twenty universities in the world?

He is quoted as saying "*Subjecting everyone who uses the public highway to the same laws might actually forge better relationships between us all and erode the idea held by many that those who travel by an alternative mode routinely make up rules of the road to suit themselves.*"

First, observe he is mostly concerned about a meme, not about supposed dangers posed by cyclists.

Second, everyone who lives in Britain is subject to the same laws; that is a tautology. He might be meaning that they are differentially enforced, and he would be right. But the solution to differential enforcement is - obviously, I should have thought - not a new law but a change in enforcement policy.

The BBC goes on to observe that "*some bike-users reject the idea that anecdote and mutual suspicion should drive policy.*" This bike-user/driver/bus-user certainly does.

Back to the point. I advocated in a blog post at http://www.abnormaldistribution.org/2011/03/27/fukushima-the-tsunami-hazard-and-engineering-practice/ that there should be a public. maintained safety case for every piece of critical infrastructure. Martyn [Thomas] has been advocating something similar for years. Nancy [Leveson] suggested a hazard case (I read this as: leave off the risk analysis). I take it this would be something

similar to ....Clarke's possibilistic analysis so it looks prima facie as though there is some agreement on this measure. But [Leveson] and [Thomas] also pointed out it would not be workable because industry would object to the potential publication of their intellectual property, since details would necessarily be included.

[I believe they] are right that industry would object, and on these grounds. But it is not inconceivable that methods might be found to secure the intellectual property while at the same time reaping the benefits of public discussion of the safety/hazard case.

However, the benefits I was anticipating are based on the assumption that once something is public, it gets transmitted widely and there becomes pressure to act. That would only be true if the resulting memes are not blocked. ..... Perrow's book is public: meme blocked. Okamura's observation reached the place to which it was addressed: meme blocked. So a public safety case will not by itself necessarily bring benefit; one needs concomitant measures to ensure that resulting memes are not blocked, and I don't know what those should be.

15.04.2011

The NYT at http://www.nytimes.com/2011/04/15/world/asia/15cleanup.html has started talk about the cleanup. Apparently both Hitachi and Toshiba have submitted cleanup plans to TEPCO.

Toshiba is teaming with Westinghouse and Babcock and Wilcox, and claims to need 10 years. Hitachi is teaming with GE, Exelon and Bechtel, and claims it will take 30 years. Westinghouse and Babcock & Wilcox cleaned up TMI, which the NYT claims took 14 years and $1 billion.

An academic at Toyko City University said how long it will take will depend upon the state of the fuel, which no one knows at present.

The NYT also reports on new plans by [the Tennessee Valley Authority] TVA. A presentation by TVA from 3 years ago at http://www.tva.com/power/nuclear/future_presentation.pdf suggests that nuclear is very clean and "*high reliability*", that they "*manage the risk in a planned deliberate manner*", and that TVA is "*proceeding to develop additional nuclear options in a conservative and planned manner*".

How very different things sound now. ..... the NYT at http://www.nytimes.com/2011/04/15/science/earth/15nuclear.html is saying that TVA is considering accelerated transfer of spent fuel from SFPs to dry casks, adding additional backup generators, and three other changes: "*improving electrical switchyards to make them more resistant to earthquakes, adding small generators to recharge cellphone batteries and keep the lights on, and reinforcing the pipes that provide cooling water to spent fuel pools.*" In other words, TVA has identified additional measures it needs to take at existing plants. [It looks as though] "*planned and deliberate*" proved not to be sufficient by itself to manage the risks; they needed more consideration as a consequence of a severe BWR accident on the other side of the world.

It shows, once again, the limitations of marketing vocabulary and behavior, and the futility of making important decisions based on such vocabulary and behavior. The important thing is to manage the risks responsibly, and TVA is perfectly aware of the controversy over overfilled SFPs and conversion to dry cask operations in the US, as exemplified by the August 2010 letter to Science http://www.nd.edu/~kshrader/pubs/final-ksf-science-2010-article-Rosa-master-final.pdf . So why the rethink? One answer could be: the measures cost resources, translated into money, and

TVA may be thinking that Brown's Ferry could now be shut down unless they introduce additional protection, and that additional protection will cost less over the long run than shut-down and loss of revenue. Airlines are fond of saying "*safety is our Number One priority*", whereas it is at most Number Two; staying in business is Number One..... somehow one never finds on marketing literature the saying "*as much safety as we think we can afford*".

TVA operates, NYT says, six reactors of which three are BWRs "similar" to those at Fukushima. The BWRs at Brown's Ferry are oldish, but I don't know whether they are Mark 1's or Mark 2's. The figure seems wrong; it should be 7. TVA at http://www.tva.com/power/nuclear/nuclear_fact_sheet.pdf reports three BWR units operational at Brown's Ferry, two PWR units operational at Watts Bar, and two PWR units at Sequoyah. At Bellefont, the site "will" be used as the reference combined licence application for the Westinghouse "Advanced Passive" design (AP1000) but TVA doesn't say what is going on there.

The NYT also reports today a "*sweeping legal settlement*" reducing TVA's dependence on coal. The NYT says that coal makes up more than half the fuel burnt by TVA, which generates electricity for 9 million people. It will shut 18 of its coal-fired plants and spend $3-5 billion on reducing emissions at its remaining plants. The agreement was reached with the states of Alabama, Kentucky, Tennessee and North Carolina as well as "*three environmental groups*", all of whom sued the TVA over its emissions. It will eliminate 16% of TVA's coal-fired generation capacity. By the end of 2017, TVA's "emissions of nitrogen oxides, a crucial component in smog and ground-level ozone, will be reduced by at least 69 percent, and sulfur dioxide emissions will be cut by 67 percent, the E.P.A. said, compared with 2008 levels."

The EPA estimates that this will avoid "*at least 1,200 premature deaths and prevent hundreds of cases of bronchitis and nonfatal heart attacks, as well as 21,000 asthma attacks.*"

Assuming the total cost is $5 billion, and it will certainly be higher because the TVA will have to replace that 8% (16% of coal, taking coal as half its capacity) somehow, that seems to be a cost of $4.2 million per life saved. Well within the bounds of appropriate, I should say.

The real worries are India and China. Quickly: India. The NYT has an article at http://www.nytimes.com/2011/04/15/business/global/15engineers.html on the logistics of India's planned 44 new nuclear plants. According to the article, PriceWaterhouseCoopers says that India needs to add 10,000 to 19,000 skilled people to the nuclear industry, which amounts to 1,000 to 1,900 people a year, but India's "*top universities*" are graduating only about 50 nuclear specialists a year. There are "*special graduate programs*" but they will add "*about 100 master's-level graduates this year.*" That is quite simply not going to work. If they import the specialists, there [is the possibility of] ..... political troubles with indigenous versus foreign labor and management. On the other hand, maybe the country thinks it can survive a major accident; after all it "*survived*" Bhopal. Recent commentary on the situation in and around Bhopal suggest the use of quotation marks is appropriate; by our standards Bhopal is an ongoing disaster. The immediate controversy in India centers on the planned plant at Jaitapur, by the ocean. "*Opponents note that the area was hit by 95 earthquakes from 1985 to 2005, although Indian officials counter that most were minor and that the plant's location on a high cliff would offer protection against tsunamis.*"
http://www.nytimes.com/2011/04/15/business/global/15nuke.html

The IAEA at 14 April 1530 UTC reports no significant impact from the 5.4-level earthquake at Hamadori on 13 April. It says that steel plates have been erected "*on the ocean-side of the Inlet Bar Screen*" to stop water leaking out of the inlet bay of Unit 2, and a "*silt fence in front of the Screen*"

for Units 3 and 4, all on 13 April.

New material from NISA at http://www.nisa.meti.go.jp/english/files/en20110415-1.pdf ...refers to TEPCO's nuclide analyses.

18.04.2011

The NYT is reporting in http://www.nytimes.com/2011/04/18/world/asia/18japan.html about TEPCO's plans to disable the damaged reactors, communicated by TEPCO at a Sunday news conference.

There are to be two phases. A three-month phase, followed by a six-month phase. The first phase apparently includes installing a cooling system for the reactors and SFPs, and covering the reactors with fabric and introducing particle filtration, I presume to reduce the amount of radioactive material escaping in the air. They are also going to convert a waste-treatment building into a storage tank for 30,000 tonnes of contaminated water. The second phase includes clearing wreckage, building a permanent cooling system to maintain cold shutdown, and encasing the reactors in concrete buildings. The NYT wasn't very specific. It also didn't say whether Toshiba/Westinghouse/Babcock or Hitachi/GE/Exelon/Bechtel won the cleanup contract (they submitted proposals for 10 years, respectively 20 years, as I reported in News20110415, so this 9 months is just a start). The WP also has a short story on it, attributed to AP, at http://www.washingtonpost.com/world/2011/04/17/AFRfOpwD_story.html

There is also a short NYT blog post on the robots being used in and around the plant, but without useful info. There are robot helicopters as well as ground-based ones. According to the BBC at http://www.bbc.co.uk/news/world-asia-pacific-13107846 , a couple of tracked robots from Qinetiq (the commercialised part of the UK's former defence research agency) are being used at the site, but in fairly straightforward roles, checking radiation levels and temperatures. Apparently the Japanese don't have the right kit for such jobs. The WP has an article from the AP on it at http://www.washingtonpost.com/business/polls-show-diminishing-support-for-japanese-governments-handling-of-triple-disasters/2011/04/17/AFGXSfwD_story.html

.....Somehow one thinks that [legged robots] would have advantages in rubble and wreckage, but apparently there is nothing robust enough on the market. I talked recently with .... Axel Schneider [of the Biological Cybernetics group at Bielefeld University], about applications such as at Fukushima. He [suggested] that there is just not much commercial interest (in Germany). That surprises me. There are large defence firms here .....making vehicles and exporting all over the globe, and no one has interest in a rubble-capable robot? Are tracked devices still so much better?

IAEA has no update yet today. NISA has resumed its "seismic damage information" bulletins. That from today suggests they are trying to separate **inlet** water to different reactors by inserting "*sandbags*" (filled with Zeolite,.....), presumably to control the efflux of contaminated water. And they removed eight containers-full of rubble using remote-controlled vehicles. http://www.nisa.meti.go.jp/english/files/en20110417-4-1.pdf

19.04.2011

The NYT reports in http://www.nytimes.com/2011/04/19/world/asia/19japan.html on the results of sending two robots in to reactors (at least R1 and R3) to measure radiation levels. The robots are tracked, with one arm, called PackBots, from iRobot of Bedford, Mass. "They can lift about 30

pounds, go up and down steps, send images back to an operator and carry a hazardous materials kit that senses radiation." iRobot has sold about 3,800 PackBots, primarily to government and military.

They measured 49 milliSv/hr in Unit 1 and 57 milliSv/hr in Unit 3. The NYT says that in recent weeks, "*far higher*" readings have come from areas where contaminated water has accumulated, such as Unit 2. However, with the limit for (emergency) working set at 250 milliSv/yr, to put Sunday's nine-month-plans into effect they have to find a large number of people willing to risk 5 hours of work before being furloughed.

The WP reports on a different development in http://www.washingtonpost.com/world/japan-nuclear-plant-starts-pumping-out-radioactive-water-to-clear-access-to-damaged-reactors/2011/04/19/AF1xpD3D_story.html There is 25,000 tonnes of contaminated water in the basement of the turbine building of Unit 2 and it is now being pumped into a "*temporary storage area*". This might be the one reported to be able to hold 30,000 tonnes, in some article from the last few days (I don't think I reported that fact). The water will be removed in stages, with "*the first third of it to be handled in the coming 20 days*" according to NISA. It is not clear to me if "the first third" refers to one-third of 25,000 tonnes, or to one-third of the 70,000 tonnes total - NISA says there is about 70,000 tonnes of highly contaminated water that they need to shift.

I wonder what they are going to do with the other 40,000 tonnes? It is also increasing on a daily basis, because the runoff from the cooling operations is not contained yet, as far as I know.

NISA also said that TEPCO is working on means to decontaminate the water so that it can be reused in cooling. If they can pull that off, then that will really mean that the situation is (what I would call) stable. But this is going to take months.

The BBC is still reporting on the use of Qinetiq Talon robots, and has pictures at http://www.bbc.co.uk/news/technology-13114310 in a photographic entry dated 18 April (Monday). There are also Bobcat diggers modified for remote use. The pictures show the control laptops (plus an XBox 360 games console for the Bobcats), also the PackBot in service. There are also two other machines with the Qinetiq logo and light-colored tracks in the forefront of the group photo.....

..... If you read http://www.bbc.co.uk/news/world-asia-pacific-13112444 and the BBC's previous missive, you would form the impression that the Talons were used to perform the radiation checks. Although it is not actually said in black and white. But [apparently] it's the US Packbots that were used.

The IAEA update on 18 April at 1535 UTC is informative. The IAEA says, first, where it obtains the information which it compiles. That likely means that it is not getting its information from one source alone, and it is synthesising it. It follows that there is - still - no one reliable source of information in Japan on the status of prophylaxy. That either means that no one organisation knows everything, or that information is still being ..... controlled by the various [organisations]. In my view, neither phenomenon bodes well for planning to solve the as-yet-unsolved engineering problems, because I see integrated planning as essential for solving the problems (necessary, but also not sufficient!).

The point of the Zeolite sandbags is not just to hinder movement but also to capture some of the contaminants for analysis. Apparently looking at what is captured will say how effective sandbagging is at hindering release of contaminated water into the ocean.

I don't yet understand why this measure is being taken at the **inlet** screens. There are two "*cooling systems*". One is the closed RPV system, which contains "*cooling pumps*". The other is the open system of which the "*inlet screens*" are part, which contains a heat-exchanger to transfer heat from the RPV water. Why this second system is contaminated has not been made clear. For even if the RPV has been breached in Unit 2, that contaminated water would not necessarily enter the second "open" cooling system. The sandbagging suggests that the operators suspect that the second systems at all three units have been compromised.

On Friday 15 April, the "*distribution boards*" for the pumps used for injecting the water into R1, R2 and R3 were moved to higher ground to protect against another tsunami. .....

NISA is publishing more recent updates. The latest, April 19 (today) at 0800 (GMT + 10) says that they sprayed about 30 tonnes of fresh water into Unit 2 using the Putzmeister over about an hour on Monday afternoon 18 April. They don't say what was being aimed at, or why Unit 3 (which consists not only of the reactor building but also the turbine building, or even what the purpose is (we may presume cooling?). They also say that robots removed 4 containers-worth of rubble, also on Monday 18th. But they haven't said how big a container is. Those offered by Fischer Abfallentsorgung (Rubbish Disposal) of Bielefeld are of sizes 1, 3, 4.5, 5.5, 7, 10, 20, 40 m3 (according to http://www.fischer-abfall.de/groessentabelle.php), so it is kind of important to say how big they are.

I am a little puzzled by the [information distribution policy] here. It seems the regular Seismic Damage Reports have been resumed, but they are very brief, and contain pseudo-detail ("4 containers").

21.04.2011

A tidbit from the NYT today in http://www.nytimes.com/2011/04/21/world/asia/21japan.html , which is mainly about keeping people out of the 12-mile evacuation zone around the plant and why, is that NISA says that "*the authorities were looking for ways to shore up the bottom of the spent uranium fuel-rod storage pool at Reactor No. 4 to prevent it from collapsing.*" (I think "were" means "are"!)

There is a NYT piece .....from Matt Wald on what is likely to be involved in the cleanup, with comparisons with the experience at TMI: http://www.nytimes.com/2011/04/20/world/asia/20nuclear.html This also includes the tidbit that the NRC apparently doesn't regard the situation as "stable" either, so it is not just me ..... Indeed, according to the BBC at http://www.bbc.co.uk/news/world-asia-pacific-13153339 , " *"The plant has not been stable," said the chief government spokesman, Yukio Edano.*" ..... I am beginning to wonder who, officially, if anyone, considers the plant/situation "stable"?

The current part of Tuesday's AP piece published in the NYT is http://www.nytimes.com/aponline/2011/04/19/business/AP-AS-Japan-Earthquake.html but that elides some details in the original, namely that there is 25,000 tonnes of contaminated water collected in the basement of the turbine building of Unit 2 that will take 20 days to pump out (into what the later version says is a "*makeshift storage area*" and the IAEA in its 20 April 1600UTC briefing to be the main building of the radioactive waste treatment facilities) and that it will likely take "*months*" to remove all 70,000 tonnes.

If it took at most a month to get all that water in, and will take months to remove, then it is obvious that water cannot be pumped in at the rate at which it has been if one wants to contain the outflow,

which must be done.

NISA just reports (104th Release, 0800 on 20 April) that they are doing the usual things: cooling, removing rubble, that they injected fresh water into the SFP of R2, and that they transferred "stagnant water" from the basement of the turbine building of Unit 6 to the Condenser. What's that about? I thought Units 5 and 6 were undamaged apart from the power supply to the cooling.

The WP reported yesterday in an AP article about the difficult working conditions at the plant - lack of basic amenities, let alone comforts, lack of sleep, fatigue, poor nourishment - in http://www.washingtonpost.com/world/doctor-says-japans-nuclear-plant-workers-are-close-to-edge-of-their-physical-endurance/2011/04/20/AFQYNdBE_story.html As the doctor interviewed said, that situation is not going to be sustainable in the long term and worker performance will suffer concomitantly.

There was an article in the WP by Andrew Higgins about a local construction company who had two Putzmeisters which it offered to the government to help, but that offer was not taken up. http://www.washingtonpost.com/world/early-disorder-added-to-japans-nuclear-crisis/2011/04/10/AFHuRw5D_story.html

21.11.2011

On 4/21/11 9:13 AM, John Downer wrote:

> *This is interesting. It's from almost seven years ago.*
>
> *http://search.japantimes.co.jp/cgi-bin/fl20040523x2.html*

Good spot!

Though from a Berkeley politician-scientist. Berkeley.....declared itself a nuclear-free city, even though there is a hospital there, and a research reactor on Hearst Avenue, in Etcheverry Hall - but that, you see, is UC land, not Berkeley, even though it is surrounding by Berkeley on all four sides of the building. [so there is some sleight of tongue being used here]

23.04.2011

The Economist in a leader today is proposing, in the wake of Deepwater Horizon and Fukushima, what I proposed: the maintenance of a safety case: http://www.economist.com/node/18586658

The "first lesson" on the way to this conclusion is [Clarke]'s extended observation: "disasters still happen".

21.04.2011

On 4/21/11 5:20 PM, Lee Clarke wrote:

> *"Safety case" looks a lot like "precautionary principle." We don't say those words in the United States, however.*

It is a technical term stemming from the UK. The UK MoD has been writing them for deployed

systems for a long time, and it was exactly the unthoughtful use of them that was criticised by Charles Haddon-Cave in his report on the Nimrod accident in Afghanistan. Lord Cullen suggested them in the wake of Piper Alpha. The functional safety standard for E/E/PE-based systems, IEC 61508, requires them but doesn't call them "safety cases". What they are is supposed to be a reasoned argument demonstrating that, and how, a safety-related system is fit-for-purpose (that is, is actually safe-as-claimed). Safety cases according to IEC 61508 are risk-based. That needs to change to accomodate worst-cases ("extreme events", disasters) but that is going to be long and hard.

24.04.2011

1. I went to the piece in enenews referenced by John [Downer: http://enenews.com/daily-radioactive-release-from-fukushima-is-150-times-higher-than-previously-announced-154-trillion-becquerels-released-everyday]. There is a link to Yomiuri Shimbun, on of Japan's mail dailies, http://www.yomiuri.co.jp/science/news/20110423-OYT1T00667.htm Google translation says that the amount of caesium released was not previously calculated in 131-I equivalents, and now that it has been, the releases amount to 154 TBq/day. That is two orders of magnitude larger than previous estimates. The article references the NSC, but the English parts of the [NSC] WWW site only go up to April 20, and I can't seem to find an appropriate document by translating parts of the Japanese WWW site. I found the daily meetings (audio) and the daily measurement reports.

How it could have happened that 137-Cs was not converted into 131-I equivalent will make an interesting story. The INES User Manual is explicit on how to calculate and you can't miss it (Section 2.2.1, p 15 and table 2, p 16). The conversion method is quite apparent within minutes of picking up the Handbook.

However, this story, sourced to NISA by Yomiuri Shimbun, has not been picked up by the NYT, WP or BBC.

2. From the TEPCO WWW site, Plant Status 24 April 1000 (local time), http://www.tepco.co.jp/en/press/corp-com/release/11042402-e.html the following about Unit 4:

> *Unit 4 (outage due to regular inspection)*
> *- At approximately 6:00 am on March 15th, we confirmed the explosive sound and the sustained damage around the 5th floor rooftop area of the Nuclear Reactor Building.*

To my knowledge, there has been no suggestion on the TEPCO site as to the cause.

But there is on the JAIF site. This takes me back to the old question of what happened to the R4 building on March 15-16, coming from treating the JAIF assessments as veridical.

The JAIF says in http://www.jaif.or.jp/english/news_images/pdf/ENGNEWS01_1300171089P.pdf that at 15 March 1030 (local) the building of Unit 4 is not damaged. Then it says in http://www.jaif.or.jp/english/news_images/pdf/ENGNEWS01_1300168169P.pdf at 15 March 1300 (local) the building of Unit 4 is partially damaged, and that remained true until 16 March 0800 (local) http://www.jaif.or.jp/english/news_images/pdf/ENGNEWS01_1300240000P.pdf . But between 16 March 0800 (local) and 16 March 1230 (local) the status changed from "*partially damaged*" to "*severely damaged*" http://www.jaif.or.jp/english/news_images/pdf/ENGNEWS01_1300252224P.pdf and we still have

no explanation of this phenomenon. If TEPCO is emphasising a March 15 event and no March 16 event a month later, we could presume that this is a change on 16 March in JAIF's assessment, not representing a change in plant status, that they did not make retroactive. The status changed again from Release 16, on 19 March 2200 local, http://www.jaif.or.jp/english/news_images/pdf/ENGNEWS01_1300544332P.pdf to Release 17, on 20 March 1000 local, http://www.jaif.or.jp/english/news_images/pdf/ENGNEWS01_1300584349P.pdf from "*severely damaged*" to "*severely damaged (hydrogen explosion)*".

So it looks as if someone in the JAIF determined five days later that it was a oxyhydrogen explosion.

It looks to me as if the JAIF status diagrams, which Bernd [Sieker] and I initially found useful, do not represent veridical plant status as of a particular date, but represent rather a state of knowledge of plant status. I don't find this mixture particularly helpful, either to determine what the facts were and are, or to determine who knew what and when. .....

26.04.2011

There is a report by Matt Wald in the NYT today http://www.nytimes.com/2011/04/26/science/earth/26nuke.html about spent fuel. Apparently there is an MIT study on it, due to come out today. A summary was released a few months ago, before the Fukushima accident, at http://web.mit.edu/mitei/docs/spotlights/nuclear-fuel-cycle.pdf

In Europe and Japan, says the article, spent fuel is reprocessed to recover plutonium, which is then reused as fuel in reactors instead of uranium. The MIT study apparently says there is no need to do this, as the supply of uranium is adequate, indeed enough to fuel ten times the global number of reactors, running for 100 years each.

Rather than reprocessing now, Wald says the report suggests that the spent fuel should be "*managed*", maybe by storing it for up to a century, to maintain the option of reprocessing.

The report also considers "dry cask" storage; apparently all the fuel used so far could be stored in dry casks on about 300 acres.

There is also the option of developing a new class of reactors which could use and "*break down*" the current waste, but this potential technology has many open questions. There is still waste, and the question of what to do with it, but it is different waste.

Apparently there is a presidential commission studying alternatives to Yucca Mountain which is also due to release a preliminary report "*this spring*".

Just to be clear, I am reporting above what Wald wrote, not my own point of view. I haven't yet read the summary document at the URL above. I recall from my note of 13 April the short note on dealing with waste from [Perrow] and colleagues in Science from last August: http://www.nd.edu/~kshrader/pubs/final-ksf-science-2010-article-Rosa-master-final.pdf

I am .....sceptical about almost all suggestions as to what to do with the waste. It's there; it doesn't go away; it is highly toxic; all methods of treatment retain toxicity. I don't see anything which strikes me as a plausible "solution".

I am presumably not alone; that is why SFPs at reactors in the US are apparently much more full than those at Fukushima - they are used to continue storing waste, which ideally should be going elswhere, but it seems nobody can obtain consensus on where.

That is surely an enormous political problem. One is producing all this stuff, and in forty years nobody has figured out what to do with it in any way which obtains US-society's acquiescence (let alone approval). Storing it in dry casks above ground has got to be better than filling up the SFPs, yet above-ground storage must be highly secure; impervious to attack, for example, (or to extreme weather, but that can be dealt with, I imagine). And the casks have to be transported to wherever storage is, subject during the journey to accidents and attack. And this constantly. Can it be done, or are the security issues just too much?

..... I really don't see any kind of social consensus developing on any of this in the US. There is going to be an imposed solution somehow, and whoever imposes it is not going to be liked. It will be a presidential second-term action, for whatever one does will get one thrown out at the next vote; the solution will axiomatically be unsatisfactory.....

Even if Germany "solves" its nuclear-power dependency soon, as the country appears poised to do, there is still the issue of what to do with the fuel. There are massive protests every time a dry-cask train ("Castor") trundles over to the storage facility at Gorleben from the reprocessing facility in France, and those trains aren't necessarily going to stop when the power plants are shut down. The temptation to off-shore the waste will be enormous, I should think. But it would surely also be immoral?

NISA's plant-status diagrams are back: http://www.nisa.meti.go.jp/english/files/en20110425-1-2.pdf

111th damage report (April 24, 1500 local) http://www.nisa.meti.go.jp/english/files/en20110425-1.html says 140 tonnes water was pumped into SFP4 via the 62m Putzmeister over two hours on the afternoon of the 24th.

112th report (April 25, 0800 local) http://www.nisa.meti.go.jp/english/files/en20110425-2.htmlsays it was actually 165 tonnes over 2.5 hours when they were finished. Also surface stabilisation agent was tested, and rubble was removed.

The 113th report (April 25, 1130 local) http://www.nisa.meti.go.jp/english/files/en20110426-1-1.pdf says that 38 tonnes were added to SFP2 via the Spent Fuel Cooling Line; and pumps injecting water into the RPV (it doesn't say which Unit(s)) were put on diesel generation so that the external power supply could be "enhanced".

There is a substantial report on the flow of contaminated water out of Unit 2 at http://www.nisa.meti.go.jp/english/files/en20110425-3-2.pdf that apparently was delivered on April 21. It concerns the outflow April 1-6, and estimates that total release was 4.7 x 10^(15) Bq. There are 8 pp of report, following by a large number of detailed diagrams. Apparently the 70,000 tonnes of highly contaminated water spoken of in past days, that they are going to be trying to ship into a storage tank, lies on the basement floors of the turbine buildings of Units 1, 2 and 3. That means that no one is going to be able to go into any of those turbine buildings for months, until they get that water out. The first third was going to take a little less than a month to remove. Apparently radioactivity in the Sub Drain near Units 1 and 2 has been "at relatively high values" since April 13th, although there is "no sign" that the highly contaminated water has leaked there. I find the report somewhat hard to decipher for details.

24.04.2011

Reading what I wrote, it seems that is a continuing problem with SFP4.

..... here is an article from CNN saying that an SFP contains about 1,150 metric tons of water: http://articles.cnn.com/2011-04-04/world/japan.nuclear.reactors_1_radioactive-water-fuel-pool-tokyo-electric-power

That means they pumped in about a seventh of the entire capacity of the SFP4 in those 2.5 hours. Compare with the fifth of that amount they injected into SFP2. Now, SFP4 has more fuel in it, I believe. Is that alone sufficient to make this enormous difference?

Nothing has been said of leakage of water from Unit 4 in the bulletins. Is it thus all evaporating?

27.04.2011

On 4/26/11 10:06 PM, Don Hudson Telus wrote:

> *"Secrecy is the worst enemy of nuclear power safety."*
> ....
> *In short, ... is nothing being learnt?*

..... very slowly in the context of industry cultures. And even more slowly across cultures.....

There is a small independent bookstore in the center of town known for its novels and literature (it's the best place to buy poetry) and its social engagement. Last weekend it had in the window a display of books on and around Chernobyl, including two on risks and lessons learnt. One looked largely like a technical tract produced largely by associates of the Bündnis 90/Green political party (aka the "Greens"). The other was a more academic publication, largely with people working out of Berlin, with a small but known German/Austrian academic publishing company, [Many] authors were shared between the volumes.

[Perrow's] Normal Accidents book in its first edition is available in German. Second edition, and [The] Next Catastrophe, not; neither is [Clarke]'s Worst Cases or Vaughan's Challenger Launch Decision. [These are fundamental works, essential reading for US/English safety engineers]

Moral: countries are cliquish too, as regards "safety culture".

On largely the same theme, safety culture, the NYT today has at http://www.nytimes.com/2011/04/27/world/asia/27collusion.html , entitled "*Culture of Complicity at Stricken Nuclear Plant*", or in the printed version (IHT) "*Culture of collusion in Japanese disaster*" an article about the revolving doors between politics, TEPCO and regulator. It talks inter alia of Kei Sugaoka, a Japaense-American nuclear inspector who informed NISA in 2000 about a cracked steam dryer that he believed was being "*covered up*" (the paper means "*not reported to the regulator*"). Despite the existence of protective "*whistle blower*" laws, NISA told TEPCO who he was and he was "*blackballed*". NISA devolved inspection of the defective component to TEPCO itself, and extended the operating permit for two more years, even though far more serious problems were ultimately shown not to have been reported, such as "*cracks in the shrouds that cover reactor cores*". And so on. It is quite an extensive article.

29.04.2011

The monster storm [which] cut through Tuscaloosa and parts of Birmingham, and then went into Georgia, and was photographed from the Fox TV studios in downtown Tuscaloosa, was apparently just one tornado.

Power was cut, including that to Brown's Ferry, which is the TVA plant running BWRs (the other TVA plants are PWRs). The secondary power generation kicked in as planned.

http://www.washingtonpost.com/national/tornadoes-carve-path-of-death-destruction-across-south-with-at-least-250-dead/2011/04/28/AFJ1os7E_story.html

I think the UCS report on US reactor safety highlighted in the Rolling Stone article referenced by [Perrow] is the one accessible from http://www.ucsusa.org/nuclear_power/nuclear_power_risk/safety/nrc-and-nuclear-power-2010.html

The IAEA says at 28 April 1800 UTC that white smoke continues to be emitted from Units 2 and 3, but no longer from Unit 4 as of 21:30 UTC on 25 April.

In Unit 1 fresh water is still being injected into the RPV through the feedwater line at 6 m3/h. On 27 April at 01:02 UTC (that would be 28 April local time) they increased the flow rate gradually to 14 m3/h "*to determine the amount of water required to flood the reactor core*". The results of that are not reported.

85 tonnes of water was sprayed onto the Unit 4 SFP on 27 April.

Nitrogen gas is still being injected into the PCV in Unit 1. The pressure indicated in the RPV is still increasing.

NISA confirms the 85 tonnes in http://www.nisa.meti.go.jp/english/files/en20110428-1-1.pdf, the 118th seismic damage report from 28 April 0800 local. The 119th report from 28 April 1200 local http://www.nisa.meti.go.jp/english/files/en20110428-2-1.pdf says that about 43 tonnes of fresh water was injected into SFP2 via the "*Spent Fuel Pool Cooling Cleaning Line*". So they have a line to clean the cooling of the SFP?

Does anyone know at what rate normally-operating SFPs evaporate water? It can't be at the rate of 43 tonnes in a few days, because it is possibly contaminated and they would have to have a recovery mechanism within the reactor building ("secondary containment"). Where did that 43 tonnes go now? Out through the roof, we may presume. Which, if it continues, which it presumably will for a while, contradicts NISA's claim, when it upgraded the severity to INES Level 7, that most of the radioactivity has been released already. There must be even more coming out of SFP4, unless that pool is indeed leaking and the contaminated water is accumulating underneath in the building. And that at the rate of hundreds of tonnes every few days. That contaminated water in SFP4 is also going somewhere. Where?

I think Bernd [Sieker]'s point about Units 5 and 6 is significant. They have lost "*defence in depth*". Neither of those Units is being satisfactorily cooled by permanent systems. It seems that one system is being used altenately on the one, then on the other. This is apparent from the temperature readings that Bernd has cataloged. The solution appears to be: restrict the information flow. Only

take readings at the same point in the alternation each day. No one outside will see the temperature fluctuations. The consequence is that those outside can no longer point to data to argue, as Bernd has argued, correctly in my opinion, that Units 5 and 6 are at least at INES Level 1 (if not 2) due to loss of defence in depth.

I have just read Malcolm Gladwell's "Outliers" (Penguin, 2008). In Chapter 7, he recounts the Korean Airlines Guam CFIT and the consequences, namely that after a continuing string of accidents Korean Airlines asked Delta to come in to develop its training programs (and rebranded itself as Korean Air). Gladwell talks a lot about Geert Hofstede and his cultural parameters, noting that South Korea comes high up in the Power Distance Index ratings, and that this correlates with certain kinds of crew interaction that, he suggests, are apparent in the CVR traces from the last moments of the flight. I remember Boeing also coming out with its reports about cultural differences in the East and how these led to different forms of crew behavior that, Boeing suggested, were contrary to what had been learnt about the helpfulness of CRM for safe operations. It was mildly stated, caused a furore at the time, and is now just accepted as largely factual.

In a similar vein, it might be instructive for someone who knows about it to correlate Hofstede or Hofstede-like cultural parameters with the information politics of the Fukushima incident as we have detailed it en passant here. I'll have a quick go, using info from http://www.geert-hofstede.com/hofstede_japan.shtml . The parameters are

* Power Distance Index (PDI), a measure of the social distance between power-holders and others (bosses and employees, captains and first officers, people with social status and those with lesser);

* Individualism (IDV), versus collectivism, a measure of how the interests of the individual are weighed in importance against the interests of a group of people to which one belongs.

* Masculinity (MAS), versus femininity, a measure of social roles and how they correlate with gender.

* Uncertainty Avoidance Index (UAI), a measure of how important it is to avoid uncertainty, of how societies tolerate ambiguity or work with unclear situations, or not.

* Long-Term Orientiation (LTO), which Hofstede says was added primarily to help characterise Buddhist-Shinto societies, and was applied to twenty-three of the original fifty in his study (!!)

The ratings are as follows, on a scale of 100. "-" means "a bit less than"; correspondingly "+"; "--" means a bit less than "a bit less than"; and so on.

	PDI	IDV	MAS	UAI	LTO
Japan	50+	40	90	90-	80--
Asia	60	20	50+	60	85
World	50	40+	50-	60+	40++
US	40--	90-	60	40+	20++
UK	30	85	60+	30	20

D 30 60+ 60+ 60 30-

Now, I can't read these expertly, not having worked with them personally (although I have a colleague .... who did, I Made Wiryana, with Gunadarma University in Jakarta.....).

That said, let me throw out a couple of thoughts.

I would hazard a guess that the big difference in UAI between Japan and us correlates with the phenomenon I pointed out early on ..... that the reasoning coming from the Japanese authorities seemed to be based on "what we definitely know", rather than enumerating the possible futures consistent with what was known. I pointed out that the possible futures consistent with what was known looked bleak, in stark contrast to the rosier picture presented by selecting the certainties of the present. **That** assessment ..... was right, as shown by the retroactive INES upgrade to Level 7 on the basis of events during this period. Now, a preference for saying just what is known, and not what could be, could well be associated with high UAI. On the other hand, logically the set of all possible futures consistent with the facts as they are today is also at least as well-defined a class as the facts themselves, so a preference for one over the other is not grounded in logical uncertainty.

On the other hand, it is the people (in my experience) in Germany, the UK and the US who have been worrying about the long-term effects on the land, and the Japanese government who has been trying to persuade its citizens (with some success?) that evacuation is just "temporary", which some might see as conflicting with the shown differences in LTO!

I guess it is stereotypical to say that the lower IDV value could correlate with subsumption of individual judgement to organisational identity in the various public statements of the organisations involved, but intuitively I don't think that would work as any kind of explanation of anything important here. Western companies control as completely as others what their employees say in public, or indeed what their employees say to other involved organisations, which is why we have "whistleblower" laws - which don't work! And on the other hand the NYT and WP have found plenty of senior Japanese nuclear-technology academics who have been severely critical of what NISA and TEPCO have been saying and doing.

02.05.2011

Matt Wald has reported in the NYT on a NRC briefing, 90 minutes long.

http://green.blogs.nytimes.com/2011/04/28/the-latest-from-the-n-r-c-on-fukushima-and-more/

The NRC was apparently considering its "*station blackout rule*", which supposedly governs what happens when you lose primary power. The NRC had asked the industry how long it would take to restore primary power (either through starting secondary, or by restoring primary), and the answers ranged from 0.9 hrs to 2 hours, so they set the tertiary system (batteries) to last "twice as long", 4 hours. There has been just one station blackout, at the Alvin Vogtle plant near Augusta, GA, when the secondary was undergoing maintenance and a truck knocked over a utility pole and cut the primary. It took 55 minutes to restore power.

People are also talking about the electricity grid itself as a redundant system. One may question this attitude, as Chick Perrow does with good reason in another chapter of his The Next Catastrophe.

Apparently there is still no definitive answer from the industry about how long it takes.....

Why are people not saying that it is **imperative** and **must be guaranteed** that power is not cut, by storms, any natural disasters, or by bombs and human actions? Somehow the question doesn't appear to me to be taken as seriously as the HazAn suggests it must be.

Bill Borchardt, a senior staffer at the NRC, also gave an update on its views on Fukushima, as he last did on March 21. "*The situation has definitely improved, but we're still in the accident mitigation phase,*" he is quoted as saying, meaning attempting to stop the flow of radioactive material into the environment. "*They're still using temporary pumps and hoses to inject water into the reactor vessels and spent fuel pools and into the containment. There are still many unanswered questions regarding the status of various pieces of equipment*", meaning RPVs, PCSs, SFPs. "*I would describe the situation as not being quite stable but certainly not as highly dynamic*" as he briefed on March 21.

There is also an opionion piece from Helen Caldicott of the Physicians for Social Responsibility on May 1, "Unsafe at Any Dose", http://www.nytimes.com/2011/05/01/opinion/01caldicott.html which refers to an Annals of the NY Academy of Sciences publication consisting of translations from Russian about Chernobyl in a volume originally issued in 2007. She says one estimate in this volume http://www.nyas.org/publications/annals/Detail.aspx?cid=f3f3bd16-51ba-4d7b-a086-753f44b3bfc1 puts the deaths from diseases contracted through the Chernobyl accident at 1 million. This is by far the highest figure I have heard so far.

NISA 120th Seismic Damage Report (April 29, 1500 local) http://www.nisa.meti.go.jp/english/files/en20110428-3-1.pdf says that they upped the injection rate into some unnamed RPV from 6 m3/hr to 10m3/hr for two days, when the test was stopped. No results are mentioned. The report also says that transfer of "*stagnant water*" from the Turbine Building Trench of Unit 2 was stopped, to do other work. Anti-scattering agent was sprayed on various land (Antiscat), and rubble was removed, 4 "*containers*" worth (RubRem=2).

121st Report (April 30, 1200 local) http://www.nisa.meti.go.jp/english/files/en20110430-3-1.pdf talks about AntiScat and RubRem=4, and about exposure of workers to radiation.

122nd Report (May 1 1500 local) talks about AntiScat and RubRem=4.

There is an article from Dave Lochbaum of UCS on the http://allthingsnuclear.org/ blog on April 26 about an emergency at the Brunswick plant (Wilmington, SC) in June 2010. Halon gas was released from extinguishers into the secondary power plant. There was no fire in itself, but workers cannot work in a Halon environment. They tried to activate the emergency callout system (it used to be manual but is now semi-automated). Nobody could figure out how to do it for an hour, when a worker at home succeeded. They also tried to activate the Emergency Response Data System (ERDS), and they couldn't do that either, for 80 minutes (the rules say 60 minutes response time).

Lochbaum also wrote an article on April 21 about Susquehanna, which uses BWRs and which he inspected in 1992. During a reactor accident, the SFP cooling will be shut off. The cooling for the building can cope with 5.2 million BTUs, which is the amount to cope with equipment during normal operation, but the heat load from the spent fuel is 12.6 million BTUs. Which meant that water would boil off the spent fuel pool. This water would

> *condense and drain down into the basement of the building where it would submerge and disable emergency equipment—at least the emergency equipment that had not already been*

> *disabled by excessive temperatures in the building. In addition, as water boiled out of the pool and exposed the fuel, the radiation levels inside the reactor building during an accident would prevent workers from entering to open the manual valves that supply makeup water to the spent fuel pool.*
> *Hence, a reactor accident would lead to a spent fuel pool accident. And the boiling spent fuel pool would create conditions inside the reactor building that would disable the emergency equipment needed to cool the reactor core.*

This is another instance in which flooding of the secondary power of a BWR was explicitly considered.

[Lochbaum] continues: "*The NRC failed to take our report seriously. They didn't even read it.*"

So

> *Don and I wrote letters summarizing the spent fuel pool problems to the governors and US senators in the states with BWRs like Susquehanna. We also sent letters to the three congressional committees that oversee the NRC. Congressmen Phil Sharp wrote several letters to the NRC about our concerns, as did several governors and US senators. The NRC granted our request for a public meeting for us to communicate our concerns to the agency. About 15 minutes into that meeting on October 1, 1993, the NRC project manager for Susquehanna was sound asleep and snoring in the first row.*

He ended up writing a book about the general issues and problems, in 1996. Excerpts are here: http://www.ucsusa.org/assets/documents/nuclear_power/nuclear-waste-disposal-crisis-excerpts.pdf

Finally, "*The tragedy at Fukushima Dai-Ichi involved many of the same concerns Don and I raised at Susquehanna.*" It certainly appears to have done so.

What surprises me and worries me yet again is the blocking of memes. This HazAn item, flooding of the SFPs, is a meme. It occurred to Lochbaum and colleague in 1992 and they wrote it up. It went nowhere. [Perrow] brought it up, last time in 2007 in his book [The Next Catastrophe]. Now, one can bury a 1992 safety report, and even a 1996 book from a small publisher (Lochbaum's), but surely not one from [Perrow] and Princeton U.P. And then it was brought up again in a 2009 NISA meeting with specific reference to tsunamis. How does it get blocked? How is it possible? How do we stop this kind of thing happening? (I have already suggested what I believe to be part of an answer: public, maintained safety cases.)

03.05.2011

The NYT has another blog article by Matt Wald at http://green.blogs.nytimes.com/2011/05/02/what-will-the-n-r-c-learn-from-fukushima/ Apparently the NRC's Jaczko met with "*a forum organised by an anti-nuclear group*" yesterday to tell them about lessons learned from Fukushima for US nuclear power.

Jaczko said they are not primarily focused on seismic events. Vulnerability to flooding might be more important but it will "*take time*" to figure that out. I think "figure out" means to draw detailed conclusions, because such vulnerability has been apparent for years. Indeed, the NRC inspects plants for propensity to both internal and external flooding.

There are 23 BWR reactors in the US with "*the same type of containment*" as at Fukushima,

apparently. I take it that means Mark 1. The type of containment might not be the biggest issue, according to the NRC.

TVA has alread pointed out to reporters at Brown's Ferry, apparently, that the switchgear for the reactor equipment (pumps, valves and so on) is located up "*three flights of stairs*", whereas the switchgear at Fukushima was on the ground floor and "*was destroyed.*" Apparently that is one reason why it took so long to reconnect Units at Fukushima to external power.

A major issue, of course, is the storing of used fuel permanently in the SFPs at US reactors. Jaczko apparently discussed that, and the alternative of dry-cask storage. Nothing new over what is already in the literature.

There is also a general article by William Broad on atmospheric radiation at http://www.nytimes.com/2011/05/03/science/03radiation.html It quotes von Hippel of Princeton that the amounts from Fukushima are negligable compared with the usual background radiation; Dale Dewar of "Physicians for Global Survival" making the point that the increments all add up: "*'No immediate danger' is an easy way for the nuclear industry to duck the long-term effects.*" Apparently the US Surgeon General, Regina Benjamin, said soon after the accident that stocking up on iodine pills was "*a precaution*", which sounds neutral enough, but then was "*forced to backpedal*" after [President] Obama said no measures were necessary. That points out nothing so much as the exigencies of politics, where you can say "*one might as well*" and then everyone does! Mettler and Slovic pointed out that people don't have a good handle on the risks (that has been Slovic's speciality for decades, of course).

Apparently the UN estimates the fallout from atmospheric bomb testing at 70 billion curies (that's an American billion, I take it, 109), compared with Chernobyl at 100 million curies, Fukushima at (figure from the reclassification in April) 10 million curies, and TMI at about 50 curies. A curie is 3.7 x 10^(10) Bq, the activity of 1 gm of radium-226.

There is a short comment on ocean dumping. Apparently about 4 billion curies, unsourced estimate. The ex-Soviet Union is cited, but so is the dump off the Farallon Islands off SF.

Apparently a recent UN report said that for the first time in history the radiation exposure worldwide from medical X-rays and CT scans exceeds that from background.

The WP reports in http://www.washingtonpost.com/world/japans-parliament-set-to-pass-48-billion-budget-focusing-on-tsunami-recovery/2011/05/02/AFw5s3VF_story.html that the Japanese parliament approved a reconstruction budget equivalent to USD 48 billion, targeted to clearing of debris, building new homes, reconstructing fishing grounds, and support for businesses. The article estimates cost of damage at USD 300 billion, so this is compensation at a rate of one in six.

TEPCO retains full liability for the consequences of the Fukushima accident: "*Chief Cabinet Secretary Yukio Edano made clear Monday that TEPCO bears unlimited liability because the tsunami and quake were "not impossible to foresee" and not an exception under the nuclear accident compensation law.*"

IAEA in their May 2 1950 UTC report at http://www.iaea.org/newscenter/news/tsunamiupdate01.html now say that the situation remains "*very serious*" and the phrase about "*signs of recovery in some functions*" has disappeared. There is a revised assessment from TEPCO on 27 April of core damage. 15 March figures are given second:

R1 55% (70%); R2 35% (30%); R3 30% (25%). So they think R1 is slightly better and R2 and R3 slightly worse than they did.

White smoke is being continuously emitted from Units 2 and 3. Core cooling as before. On 29 April a robot was sent into Unit 1 and noted "no significant leakage" of water from PCV. Nitrogen still goes into PCV, and the pressure in RPV is still rising.

The report is quite lengthy, talking also about radiation monitoring in the environment. I haven't been tracking that .....

NISA's 123rd Report at http://www.nisa.meti.go.jp/english/files/en20110502-2-1.pdf says that work was started to block the "*trench pit*" of Unit 2; that they injected 55 tonnes of water into SFP2 on May 2; that 120 m3 of "*stagnant water*" in the basement of the turbine building of Unit 6 was transferred to a "*temporary pool*", AntiScat and RubRem=4. On May 1, one more person was confirmed to have overdosed (meaning: exceeded the limit of 5 mSv per 3 months).

04.05.2011

The WP at http://www.washingtonpost.com/world/japan-crisis-management-means-extremely-long-polite-news-conferences/2011/05/04/AFrufmkF_story.html has an article on the daily briefings. Apparently they have coalesced into one, which can be four hours long, with apparently masses of technical detail.

Not much of "*masses of technical detail*" seems to make it into the on-line sources I have been reviewing.

NISA's 124'th Report http://www.nisa.meti.go.jp/english/files/en20110503-2-1.pdf suggests that there is some work to restore permanent power to Units 5 and 6. They have tested "*Start-Up Transformers*" for "*external power reception*". And they are installing alarm systems for the pumps for the injection in RPV 1 and RPV 2. Otherwise AntiScat.

05.05.2011

The NYT is carrying an AP report http://www.nytimes.com/aponline/2011/05/04/world/asia/AP-AS-Japan-Earthquake.html which says that workers have entered the Unit 1 reactor building to install air filtering equipment.

From the same AP wire, the WP says in http://www.washingtonpost.com/world/workers-enter-damaged-japanese-reactor-building-for-1st-time-since-right-after-quake/2011/05/04/AFRxlItF_story.html that six ventilators are being installed and the work is expected to take four or five days.

NISA's 125th Damage Report (4 May, 1200 local) http://www.nisa.meti.go.jp/english/files/en20110504-1-1.pdf says that they transferred 114 m3 water in the basement of Unit 6 to a temporary tank. Otherwise AntiScat and RubRem=2.

06.05.2011

The WP is reporting in an AP article http://www.washingtonpost.com/world/workers-enter-damaged-japanese-reactor-building-for-1st-time-since-right-after-quake/2011/05/04/AFRxlItF_story.html with dateline yesterday that

> *TEPCO is proceeding with a plan to fill the Unit 1 containment vessel with water to soak the core and cool it, and also plans to install big fans as an external cooling system, [TEPCO spokesman Junichi Matsumoto] said. TEPCO hopes to take similar steps at Units 2 and 3 but is struggling with tougher obstacles such as contaminated water leaks and debris.*

This is the first I have seen of more-or-less concrete plans. In both senses, because the PCVs are by no means watertight in their current state.

There is a similar report, with fewer details, by Martin Fackler in the NYT at http://www.nytimes.com/2011/05/06/world/asia/06fukushima.html

NISA's 126th Report (5 May, 1430 local) http://www.nisa.meti.go.jp/english/files/en20110505-2-1.pdf They have completed the transfer of the accumulated water, 600 m3, from the basement of the turbine building of Unit 5 to the condenser. That work started on March 27 and ended May 2. And then took three days to make it into the NISA Report. Antiscat, and RubRem=5. They are now apparently removing "rubber" rather than "rubbish" [but I bet they mean “rubbish”]

06.05.2011

Something from the New Scientist about entering Unit 1. It was spotted by Myriam Mencke

http://www.newscientist.com/blogs/shortsharpscience/2011/05/humans-enter-stricken-fukushim.html

07.05.2011

The NISA 127th Damage Report (6 May 1200 local) http://www.nisa.meti.go.jp/english/files/en20110507-1-1.pdf says that the 6 air filtration units have all been installed in Unit 1 reactor building and are operational. The top of Unit 1 has of course been open to the air since the oxyhydrogen explosion early in the accident. The drone pictures available on Cryptome, cited by Werner U at http://cryptome.org/eyeball/daiichi-npp/daiichi-photos.htm I found instructive and disturbing.

I would like to know what is being filtered, and whether it is an enclosed space or open somehow to the atmosphere, but I can't really figure it out. There is an architectural picture of the Mark II containment on p133 of Dave Lochbaum's book excerpt published on the UCS site (which I referenced), but I don't have my fingers on one for the Mark I containment. .....

They also changed the rate of injection into RPV1 from 6 m3/hr to 8 m3/hr. We recall that they experimented with 10 m3/hr for a couple days a short while ago. TEPCO appears to be trying to cover the core in RPV1 with water, part of their long-term damage-control plan, according to IAEA in its briefing of 5 May 2000 UTC.

Otherwise, AntiScat and RubRem=4.

I found the IAEA briefing of 5 May 2000 UTC at http://www.iaea.org/newscenter/news/tsunamiupdate01.html to be moderately instructive. The IAEA announces that it has developed "*new charts*" to track progress made towards fulfilling the three basic safety standards: prevention of criticality, removal of decay heat, and mitigating release

(to the environment) of radioactive material.....apparently the public doesn't get to see them. It is said that "*countermeasures*" against leaking radioactive water into the environment (in particular, the sea) are "i*n place*" but IAEA does not say explicitly how well they appear to be working. Fresh water is being injected "*as necessary*" into the SFPs. I seem to recall that in Units 1-3 this is being accomplished through integral systems, but Unit 4 seems to require the Putzmeister. That suggests that Unit 4 building infrastructure is more damaged than we have so far heard, and indeed more than the others (it is obviously more damaged than Unit 2 reactor building, but Unit 2 has serious problems inside, as we know.)

The damage to Unit 4 reactor building is substantial, as may be seen from the drone photographs. And it apparently occurred without anyone getting a video of it, as they got videos of the oxyhydrogen explosions at Units 1 and 3.

The IAEA notes that the highly radioactive stagnant water in the turbine buildings of Units 1-3 is being transferred to condensers, radioactive waste treatment facility and temporary tanks, as we know, and that Unit 6 turbine building stagnant water is being transferred into a temporary tank.

.....USC's 7-week briefing on 3 May by David Wright at http://allthingsnuclear.org/ ..... is very instructive. They seem to have access to information which I don't think we have seen yet.

Wright says that the NSC estimates the total release between March 11 and April 5 to be 150 petaBq, that is, 1.5 x 10^(17) Bq, within a factor of ten of that at Chernobyl. The estimate is preliminary and UCS estimates it amounts to 2.5% of the total I-131 in the fuel in all reactors at time of shutdown.

He also says that the highly contaminated water outside the buildings came primarily from a crack in the reactor building of Unit 2, and that some of that water flowed into the ocean for at least a week before the leak was fixed. This led to "significant contamination" of the ground around the reactors and coastal sea water.

He talks about the March 15 explosion in SFP4, "*believed to have been caused by hydrogen produced by spent fuel that overheated when the pool lost water and exposed the fuel rods.*" The uncovering of the fuel that early suggested a leak in SFP4, since calculations also available in an earlier blog post (referenced) show that water could not have boiled off that quickly by that time. He says the leak "continues to complicate efforts" to keep the fuel cooled. He refers to a NYT report from April 6 in which it is suggested that the March 15 explosion also blew pieces of fuel out of the building, where they had to be bulldozed over, and indeed pieces have been found in the environment up to a mile beyond the plant. There is thus concern that the explosion might have damaged the fuel remaining in SFP4. There are pictures. TEPCO has some at http://www.tepco.co.jp/en/news/110311/ A picture taken from under the surface of the water in SFP4 appears not to show damage, but shows only a fraction of the fuel. Wright points out that if there is damage, the particles found away from the plant could have come from crumbling fuel, transported by the water vapor evaporated from SFP4. This would then be a continuing release and not just a one-time event.

Wright says that pumping nitrogen into PCV1 reflects concern that fuel damage is still occurring, since that is how hydrogen is generated and it is the presence of hydrogen which requires nitrogen to displace the atmospheric oxygen to prevent an explosion. He says it is unclear why this measure is not being applied to Units 2 and 3. He also says that radioactive measurements in Unit 1 preclude letting workers inside, but we have recently seen that people have indeed been inside and have

installed air filters.

Apparently TEPCO is trying to create a "*water sarcophagus*" in Unit 1 by flooding the PCV to a level above that of the fuel in the RPV. The goal is apparently to cover the fuel, but attempts to do that inside RPV1 have not been successful. I don't quite see how that is supposed to work, since if the fuel is partly uncovered in RPV1, filling PCV1 with water is not going to change that unless there is a breach in RPV1, which no one has yet suggested.

Apparently there are also worries about a leak in RPV3, not just in RPV2. Wright refers to an interesting article at http://www.ambersharick.com/Day%2043.html referring to a briefing on April 22, which inter alia points out that more water than the volume of the PCV has been pumped into each of Units 2 and 3, which implies that water is leaking out of both.

The NYT says in http://www.nytimes.com/2011/05/07/world/asia/07japan.html that the government has ordered the Hamaoka plant, where there are 3 reactors, to shut down. This is the plant near Tokyo, also aging, about which concerns have been expressed that it is potentially as vulnerable as Fukushima has been shown to be. This has to be good news. The material I referred to some weeks ago about megaquakes suggest that after the Tohoku slippage the chances of a slippage on a neighboring part of the plate overlap should be rated higher, and Hamaoku sits on the ocean near where that could happen. Also in the WP at http://www.washingtonpost.com/world/japan-tells-utility-to-halt-3-nuclear-reactors-out-of-safety-concerns-in-event-of-major-quake/2011/05/06/AFFNnl6F_story.html which has rather more technical info. The government request is a "*virtual order*" to Chubu Electric Power Co., which runs the plant. The article suggests that some people have estimated the chance of a magnitude 8.0 quake or greater within 30 years in the region to be 90%. Such estimates aren't worth that much in the current state of earthquake knowledge, but, even if one cannot trust the numbers, the message "*much greater chance*" does get through.

Chubu is planning to build a seawall 12m high, and apparently there are sandhills 10m to 15m high also between the plant and the ocean. Chubu Electric is said to have estimated a tsunami to 8m.

The WP reports TEPCO as saying the height of the tsunami waves at Fukushima was 14m. The WP says "In 2001, TEPCO told [NISA] that waves would not exceed 18 feet (5.7 meters) at the Dai-ichi plant, based on an anticipation of a magnitude-8.6 quake. It assumed the backup power generators, which were stored in basement areas, would stay dry in a tsunami triggered by a magnitude-9.0 quake."

So TEPCO was wrong by nearly a factor of 3, but Chubu is reckoning that they might be wrong by at most a factor of 1.5.

One presumes that the government wants the reactors shut down until the seawall is actually built, and one may hope that they revisit the estimates of needed protection very carefully before restarting.

09.05.2011

The WP reports that Chubu Electric Power Co has agreed to shut down Hamaoka until the defences against natural hazards have been improved http://www.washingtonpost.com/world/utility-to-shut-down-hamaoka-nuclear-plant-in-central-japan-over-safety-concerns/2011/05/09/AFLVqNWG_story.html

One would hope they are improving the mitigation of all hazards, not just the natural ones.

The NYT reported in http://www.nytimes.com/2011/05/09/world/asia/09japan.html that Prime Minister Kan reaffirmed the nation's commitment to nuclear power, also reiterated by another government official on a TV talk show, reported by AP in the WP at http://www.washingtonpost.com/world/top-official-says-japan-wont-abandon-nuclear-power-as-part-of-energy-policy-despite-crisis/2011/05/08/AF3M6aMG_story.html

The NYT article also says that TEPCO is preparing to open the doors to Unit 1 reactor building, to "*air [it] out*" in preparation for allowing workers in. The internal air filtration has been in progress for a couple of days and they think it has worked. The idea is to replace the damaged cooling system. Plans for how have not been published. .....

NISA's 128th Report (May 7, 1500 local) http://www.nisa.meti.go.jp/english/files/en20110508-1-1.pdf says that about 180 tonnes water was sprayed over SFP4 on May 6, and they started again with an unspecified amount May 7. It says also that the accumulated water, about 120 tonnes, was transferred from the basement of the turbine building into a temporary tank on May 6. Then it says that such transfer was started, on May 7. I take it that they didn't move it all on May 6. Also AntiScat and RubRem = 7 (we are back to "rubble" from "rubber").

The 129th Report (May 8, 1200 local) http://www.nisa.meti.go.jp/english/files/en20110508-2-1.pdf says that 120 tonnes was sprayed over SFP4 on May 7. About 200 tonnes of accumulated water was transferred from the basement of the turbine building of Unit 6. AntiScat and RubRem = 8.

The 130th Report (May 9, 0800 local) http://www.nisa.meti.go.jp/english/files/en20110509-1-2.pdf talks about Unit 1. From May 5 to May 8 the air filtration system was working. At 2008 on May 8, the "*duct penetrating the double-entry doors*" to reactor building 1 was "*cut*" and the doors partially opened. Then they opened them fully at 0417 May 9, and dismantled the "positive-pressure housing" at 0510 May 9. About 60 tonnes of water was injected into SFP3 on May 8. Also, an action which I am having trouble interpreting: "*The transfer of the water in the Condenser to the basement of the turbine building was started due to the construction of the pipes (the Reactor Feedwater System Piping) used for water injection into the RPV of Unit 3. (From 16:18 May 8)*" If I remember rightly, they have been trying to store turbine-basement-building water elsewhere, in the condenser and in temporary tanks, but now they are reversing that in Unit 3 in order to build RPV piping? Other than that, AntiScat and RubRem=9.

Included in these bulletins are reports of NISA directives to TEPCO. The points of these are generally hard for me to discern; usually they amount to directing that proposed measures be untertaken with "*adequate*" care. It seems a little odd to Western eyes and ears that such directives would need to be explicit. Under Western law, at least, when someone proposes something dangerous but likely beneficial if conducted properly, there is a duty of care to minimise dangers (in English law, ALARP) and thus no need for an explicit directive to do so. There is some cultural and legal context here which I am missing.

09.05.2011

On 5/9/11 5:11 PM, Werner U wrote:

> *Improvement of the environment within the Reactor Building of Unit 1*

<http://www.tepco.co.jp/en/press/corp-com/release/betu11_e/images/110504e13.pdf>
<http://www.tepco.co.jp/en/press/corp-com/release/betu11_e/images/110504e13.pdf>

.....This appears to be quite a detailed explanation of what they are going to do, prepared in English for the international community.

What is not clear is how the possible states of RPV1 are going to affect the success of these plans.

10.05.2011

The NYT reports on energy politics in Japan at http://www.nytimes.com/2011/05/10/business/energy-environment/10yen.html Apparently, the plan was to supplement the 54 existing reactors with 14 more by 2030, which would increase the electricity supplied by nuclear power to 50% of the total, from about 30% now. Recent events have called this plan into question, as one might imagine.

There is of course considerable disagreement about how much electricity is feasible from renewables. Current costs at about 30 yen per kwh from renewables, 9 yen per kwh from fossil fuels and 6 yen per kwh from nuclear. Given that it has directly cost the government 5 trillion yen (48 billion dollars, 33 billion euros) for reconstruction, and who knows how much for the actual engineering rescue work (and how much still to come), one imagines that the cost equation should be recalculated. Indeed, such assumptions about cost calculations (which I take to be) implicit in the 6 yen per kwh figure surely yield to the kinds of critique proposed by [Perrow and Clarke]

In Germany, every meter of land is officially evaluated, given a so-called "Bodenrichtwert". For example, my house sits on two large surveyed pieces of land (Flurstück"), I own 1 m2 further on the sidewalk, in the form of a triangle about 10m long (one will observe that the base of this triangle is about 20cm). And there is an entrance cubicle which juts out a few centimeters onto a 4 m2 Flurstück owned by the city. It seems reasonable to swap the Flurstücke (indeed, the city will fuse the 4 m2 into one of the two I already own if I agree). But the city also wants €630 for the extra 3 m2 of sidewalk I shall now own, based on the Bodenrichtwert of €210 per m2.

Helge Ritter suggested taking an exclusion zone 50 km around the nuclear power plant at Grohnde, from whence the city electricity company currently gets about 50% of its power, I understand, and evaluating the Bodenrichtwert of that zone. That's 2.5 x 109 m2. At even €50 per m2, that would be a nominal cost of € 1.3 x 10^(11) just for the land. That is rather a lot of money. And that is just the lost value of the land according to somebody's reckoning.

The point being that costing nuclear energy and its attendant problems is a not entirely technical exercise with plenty of hidden assumptions that would benefit from public discussion.....

There is a further article in the NYT at http://www.nytimes.com/2011/05/10/world/asia/10tokyo.html about the political problems becoming apparent over the closure of Hamaoka. The industrial-political public "*consensus*" is visibly lacking in the PM's "*request*" and Chubu's three days to take a decision, argues the article. Yes, major disasters do have a way of reshaping politics....

NISA's 131st Report included a couple of details about further restrictions on foodstuff. The 132nd Report at http://www.nisa.meti.go.jp/english/files/en20110510-1-1.pdf says TEPCO completed the transfer of water in the Condenser of Unit 3 into the turbine building basement at 0541 May 10, so

it took about 38 hours. They injected about 80 tonnes into SFP3 on May 9, as well as 0.5 m3 of hydrazine. About 100 tonnes of water, and about a quarter m3 of hydrazine, was sprayed over SFP4 using the 62m Putzmeister (I take it the designations of the Putzmeister pumps are the meter reaches) on May 9. A "supporting structure" for the floor of SFP4 is also being built. 60 tonnes more of water was transferred from Unit 6 TB basement into "temporary tank" on May 9. AntiScat and RubRem=6.

10.05.2011

The River Bend nuclear power plant, a BWR installation, sits just up river from Baton Rouge, http://en.wikipedia.org/wiki/River_Bend_Nuclear_Generating_Station about half-way to Natchez, where the Atchafalaya River and the Old River Control Structure, which joins the Mississipi and Athcafalaya rivers, is likely to be under threat from the flooding: http://blog.xkcd.com/2011/05/08/michael-bays-scenario/

Of course, it it all washes out west, there won't be much of a problem east. Nevertheless, I wonder if they are busy putting the secondary power generators up on stilts?

10.05.2011

The government of Japan has announced it is scrapping plans for the 14 more nuclear plants planned: http://www.nytimes.com/2011/05/11/world/asia/11japan.html

.....How quickly things can change [politically]!

13.05.2011

It's Friday 13th. The NYT reports that damage to Unit 1 is far worse than "*expected*" .....: http://www.nytimes.com/2011/05/13/world/asia/13japan.html

TEPCO suspects RPV1 may be leaking. The water level is three feet below the **bottom** of (where) the fuel rods (should be), and is much lower than it should be given the amount of water injected. It seems likely then that the meltdown is as severe as first feared by some, but the good news is that the fuel mass obviously hasn't gone recritical, and if the temperature readings are to be trusted it looks as though the cooling measures are working to some extent.

NISA's 133rd Release is 10 May, 1200 local time http://www.nisa.meti.go.jp/english/files/en20110511-1-1.pdf Water transfer continued to be suspended in Unit 2; water transfer continued at Unit 6, and the water gauge in RPV 1 was "*calibrated*".

NISA's 134th Release is 11 May, 0800 local time http://www.nisa.meti.go.jp/english/files/en20110511-2-1.pdf 56 tonnes fed into SFP2, AntiScat, RubRem=5. However, there is a bunch of other linked information from the WWW page at http://www.nisa.meti.go.jp/english/files/en20110511-2.html

NISA's 135th Release is 11 May 1200 local time http://www.nisa.meti.go.jp/english/files/en20110511-3-1.pdf There was some interruption to operations due to "*restoration*" of a power transmission line.

NISA's 136th Release is 12 May 1500 local time

http://www.nisa.meti.go.jp/english/files/en20110513-1-1.pdf and is somewhat lengthier. The water level gauge of RPV1 and the pressure gauge of PCV1 were calibrated. There was inflow of water into a pit near the Intake Channel of Unit 3, and some outflow from the pit into the sea. The exchange was stopped by blocking with concrete. A further 120 tonnes sprayed over SFP4. Other routine stuff, including Antiscat and RubRem=7. Nothing about what the NYT reported.

Apparently UCS's Dave Lockbaum is due to testify today on Nuclear Risk Management before the Senate Subcommittee on Investigations and Oversight. His testimony has not yet been released.

16.05.2011

This disturbs me.

On 5/11/11 8:50 PM, Werner U wrote:

> *The government is assuming that, in the case of nuclear reactors, the legal principle of the protection of legitimate expectations -- under which individuals and companies who made decisions that complied with a law in the past should not be adversely affected if that law is later changed -- expires after 27 years of operation, at the latest. By then, the government argues, the plants have been fully written off and have yielded an adequate profit. According to the government, after the end of this period lawmakers would have the right to revoke a plant's operating license without having to pay damages.*

The condition of "*adequate profit*". If one makes a decision to engage in a business which provides socially essential infrastructure under "*reasonable expectations*", then it seems morally defensible to insure that business against a certain loss incurred **solely** through a change in law.

I can also see how that could be very hard to argue. For there is moral hazard involved. One could plan for contingencies such as a change in politics that arises because a constituency grows. German energy providers have known for years that there is considerable public opposition to provision of nuclear power plants and one past government even had it as a cornerstone of policy to move out of nuclear power within a relatively short time frame.

And still the utilities were designed and planning nuclear power plants, even in the face of this obvious substantial political opposition. Why? Answer: they are insured, they think, by law. If the law weren't there, they wouldn't do it. Obvious moral hazard.

That "*adequate profit*" should also be guaranteed seems to me to be crazy. There is a law that guarantees that, if you enter into a specific business, you reap "*adequate profit*"? Anyone want to form a power company with me? We can buy home heater-generators now; the local utility is selling them and we can go into competition. It doesn't really matter about competition if "*adequate profit*" is guaranteed.

16.05.2011

Dave Lochbaum's testimony before the House Committee ..... on Friday is available at http://www.ucsusa.org/assets/documents/nuclear_power/lochbaum-house-testimony-05-13-2011.pdf

Important things to note.

Loss of primary and secondary power is known as "*station blackout*". They have occurred in the US before; Fukushima was not the first time. UCS advocates specific measures to ensure station blackouts are appropriately handled: longer battery lifetimes, and portable generation facilities that can be brought in and installed from off-site.

The NRC requires that operators provide "Severe Accident Management Guidance" but the NRC is prohibited from evaluating its adequacy. UCS suggests that SAMG should be subject to evaluation.

Storage of spent fuel. UCS notes that the passive dry-cask storage at Fukushima continued to function throughout the accident, but that there have been significant problems with spent-fuel pools. UCS advocates more dry-cask storage.

As far as I can tell, everyone in the US advocates dry-cask storage, except the people who will pay for it.

UCS points out that existing procedures for dealing with SFP accidents are inadequate and recommends revision. The testimony also includes the following information about Fukushima Dai-ichi which I have not read elsewhere:

> *After the water level in the Unit 4 spent fuel pool at Fukushima Dai-Ichi dropped below the top of the fuel assemblies, the fuel rods heated up, producing large amounts of hydrogen gas. That hydrogen exploded, destroying the reactor buildings walls and roof and creating a pathway for radioactivity to freely escape to the environment. To lessen the likelihood of similar explosions, workers cut openings in the roofs and walls of the reactor buildings on Units 2, 5, and 6. Their efforts were ad hoc and reactive.*

Finally, UCS advocates additional safety regulation for defueled reactors, such as Units 4-6 at Fukushima. They speak of a "*gaping hole*", and that there are almost no technical safety requirements which apply after a reactor has been entirely defueled, such as Units 4-6 at Fukushima.

The IAEA has a May 13 update on its site, the first for eight days. Apparently TEPCO's plan for Unit 1 is to

> *Reduce radiation levels in the reactor building by installing a filtered air circulation system (completed), remove rubble, decontaminate and install shielding;*
>
> *Recalibrate existing reactor pressure vessel water level and pressure instruments and install additional reactor pressure vessel water level gauges to improve monitoring of conditions inside the reactor pressure vessel;*
>
> *Install primary and secondary closed-loop cooling systems;*
>
> *Flood the containment to provide a water supply for the primary system.*

NISA's 137th release from 13 May at 1200 local http://www.nisa.meti.go.jp/english/files/en20110513-2-1.pdf speaks of transferring the accumulated water from the turbine building of Unit 6 to temporary tanks, and from the reactor building into the Radioactive Waste Treatment Facility. Water is being injected into RPV3 through two different lines now. Plus AntiScat and RubRem=4.

The 138th release at 14 May 1500 local http://www.nisa.meti.go.jp/english/files/en20110514-3-1.pdf speaks of investigating Unit 1 reactor building with a robot, injecting 56 tonnes water into SFP2, and spraying 100 tonnes water over SFP4, and tranferring water at Unit 6. AntiScat and RubRem=8.

The 139th release at 15 May 1400 local http://www.nisa.meti.go.jp/english/files/en20110516-1-1.pdf says that they apparently tried to spray SFP1 with a 62m Putzmeister, but quit after 11 minutes because of "*strong winds*". Why that? They were *injecting* water into SFP1 before, as far as I remember. More Unit 6 water transfer, AntiScat and RubRem=7.

16.05.2011

Pro Publica's John Sullivan has a long article about fire safety and regulations at US nuclear plants at http://www.propublica.org/article/nrc-waives-enforcement-of-fire-rules-at-nuclear-plants .....

17.05.2011

The NYT has an extensive article at http://www.nytimes.com/2011/05/17/world/asia/17japan.html on what I shall call the political culture around Japan's nuclear power.

In 2003 a lawsuit was filed that asserted that the Hamaoka plant was susceptible to damage during an earthquake. This was apparently one of a succession of lawsuits concerning various plants. All were lost by the plaintiffs. The Japanese government's "*own experts*" said in 2010 that there was a 90% chance of a magnitude 8.0 earthquake (or greater) within 30 years. I haven't yet read it explicitly, but I read it as implicit in the various reports that Hamaoka may well suffer serious damage of the sort which could cause a serious accident in an earthquake of such magnitude.

> *The lawsuits reveal a disturbing pattern in which operators underestimated or hid seismic dangers to avoid costly upgrades and keep operating. And the fact that virtually all these suits were unsuccessful reinforces the widespread belief in Japan that a culture of collusion supporting nuclear power, including the government, nuclear regulators and plant operators, extends to the courts as well.*
>
> *Yuichi Kaido, who represented the plaintiffs in the Hamaoka suit, which they lost in a district court in 2007, said that victory could have led to stricter earthquake, tsunami and backup generator standards at plants nationwide.*
>
> *"This accident could have been prevented," Mr. Kaido, also the secretary general of the Japan Federation of Bar Associations, said of Fukushima Daiichi.*
>
> .....
>
> *The court appeared to rely greatly on the testimony of Haruki Madarame, a University of Tokyo professor and promoter of nuclear energy, who since April 2010 has been the chairman of the Nuclear Safety Commission of Japan, one of the nation's two main nuclear regulators.*
>
> *Testifying for Chubu Electric, Mr. Madarame brushed away the possibility that two backup generators would fail simultaneously. He said that worrying about such possibilities would*

> *"make it impossible to ever build anything." After the Fukushima Daiichi disaster, Mr. Madarame apologized for this earlier comment under questioning in Parliament.*

In other words, here is .... a technical expert..ignoring an obvious hazard in public for extraneous non-technical reasons. We may recall that this is the second such instance that has come to light in the press.

The first I reported on 24 March: the tsunami expert Yukinobi Yokamura's concerns about tsunami damage being "*rebuffed*" by a TEPCO official at a meeting at NISA in 2009, reported in http://www.washingtonpost.com/world/japanese-nuclear-plants-evaluators-cast-aside-threat-of-tsunami/2011/03/22/AB7Rf2KB_story.html

Two of the issues appear to be
(a) some degree of judicial conservatism; in case of doubt (which there almost always is when talking about technological dangers), courts are by their nature conservative; they hew to past decisions;
(b) increasing seismic knowledge which reveals dangers that were not known when the plants were built.

There are in fact some decisions, in 14 "major" lawsuits over the years, which turned out for the plaintiffs, namely concerning Shika in Ishikawa in 2006, over which a district court ruled that the operator had not demonstrated safety as required, and required shutdown. This decision was reversed, though, by a higher court in 2009.

There has been an ongoing (12-year) legal battle concerning the Shimane plant in Western Japan, less that five miles from Matsue, a city of 200,000 people. There is a fault, but the operator apparently is continually revising estimates of its length and thus the possible strength of an earthquake that could occur on it. The operator claimed the area was free from faults, until 1998 when it discovered one. A lawsuit was filed in 1999. The operator apparently claimed the fault was too small to cause significant earthquakes. In 2006, a seismologist judged it was capable of a 7.1 magnitude quake. The operator disputed the claim, but then agreed with it in 2008, but said the plant could withstand it. Now, the estimate has gone up to 7.4, and it's back in court. It was found out last year that the operator had falsified inspection records, and consequently it was required to shutdown one reactor.

TEPCO operates the Kashiwazaki-Kariwa nuclear plant in Niigata prefecture. TEPCO "*did not disclose the existence of an active fault line [nearby] until an earthquake forced it to*." Strong claim, and it appears to be 100% true. In 1979, local residents sued the government to try to stop the plant being built, claiming the area had not been adequately inspected. It is said that the government indeed acknowledged this "*years later*". In 2005 (26 years later!), The Tokyo High Court ruled against the plaintiffs, and concluded that there was no fault. In 2007, a magnitude 6.8 quake damaged the plant, causing "*a fire and radiation leaks*". TEPCO then acknowledged that in 2003 it knew of the existence of a 12-mile-long active fault nearby. In other words, a court in 2005 made a mistaken factual determination, and TEPCO knew that.

This is **very serious** stuff. Senior professional engineers, including someone on the NSC, have been ignoring the mitigation of obvious hazards for extraneous reasons. Plant operators have allowed a court to make a mistaken finding which they knew was mistaken at the time it was made.

18.05.2011

NISA's 140th Report, Monday 16 May 1200 local time
http://www.nisa.meti.go.jp/english/files/en20110517-1-1.pdf reports that on Sunday the rate of water injection into RPV1 was increased to 10 m3/hr. Borated water was injected into RPV3. They must be somewhat concerned about criticality. Transfer of water in Unit 6 progressing. Another 100 tonnes sprayed on SFP4. AntiScat and RubRem=5.

There is a correction by TEPCO to reports of the "Major Plant Parameters", announced with link in http://www.nisa.meti.go.jp/english/files/en20110518-2.pdf

The 141st Report, Tuesday May 17, says 106 tonnes of water was injected into SFP3. More Unit 6 water transfer, AntiScat and RubRem (we are back to "rubber")=4.

The NYT is really heating up this week. In
http://www.nytimes.com/2011/05/18/world/asia/18japan.html they report that there is a venting system in the BWR Mark I reactors to release accumulated hydrogen in the PCVs. And.....the control of various valves in the venting systems is electrical. So when you have station blackout and you don't try to open the vents until later, you can't! And that indeed happened, which is why the oxyhydrogen explosions. Apparently the government ordered TEPCO to vent early on, but TEPCO didn't want to, and this apparently led to shouting matches,.....The NYT is concerned that [similar occurrences] could happen in the US.

The NYT says that TEPCO now thinks there has been 100% melting of fuel in RPVs 1, 2 and 3 (according to the UCS, see below, the term "*meltdown*" is only used if the fuel melts through the RPV, which it is not believed to have done), as well as that RPV1 has been breached and is leaking highly contaminated water. I would imagine that has shot their plans for dealing with Unit 1, because those plans depended on people working inside the Unit 1 reactor building, which they cannot if there is continuing contamination.
.....
The UCS nuclear blog at http://allthingsnuclear.org/ has a new post by David Wright from yesterday on the full melting of fuel in RPV1. TEPCO now thinks that the water level was below the bottoms of the fuel rods within 4 hours of the earthquake. UCS is not sure why that happened at Unit 1 but apparently not at Units 2 and 3, but Dave Lochbaum says Unit 1 has a different "*water makeup system*". Apparently, modelling says all the fuel has melted in all three, but cooling has prevented the corium from melting through the RPV bottoms, which would have otherwise happened within about 7 hours after the corium settled to the bottom.

In short, damage is far worse than thought, and it seems TEPCO - people in Japan, and ultimate we all - were really, really lucky with the cooling. It was well on the way to going catastrophically wrong. I cannot figure out from current information how the RPVs managed to keep cool enough. Can someone come up with a decent story? My guess as we opening this mailing list on Tuesday 15th March was more accurate than it appeared in the intervening two months.

18.05.2011

[From Mark Bowell, UK HSE]

> *The UK's Chief Inspector of Nuclear Installations, Mike Weightman, has today published his interim report on the implications and lessons*

learnt for the UK nuclear industry from the nuclear crisis in Japan.

See http://www.hse.gov.uk/nuclear/fukushima/interim-report.htm for further details.

19.05.2011

The NYT is saying today (article by Matt Wald) that the US NRC knew of the hazard of having vents electrically operated, because they wouldn't operate during a station blackout, for a long time. An engineer wrote them about it, but it was decided things were OK as they were.
http://www.nytimes.com/2011/05/19/science/earth/19nuke.html

NISA's 142nd Report from 18 May 1200 local time
http://www.nisa.meti.go.jp/english/files/en20110519-1-1.pdf says that on May 17th at 1150 the rate of water injection to Unit 1 core was changed back down to 6 m3/hr. That 120 tonnes water was sprayed over SFP4, Unit 6 water transfer continues, AntiScat and RubRem=6.

20.05.2011

In the NYT "Green" blog, http://green.blogs.nytimes.com/2011/05/19/the-importance-of-venting-when-a-reactor-threatens-to-blow-its-stack/ Matt Wald writes yesterday about venting and the various design philosophies.

The idea is that, in the case of overpressure, the RPV can vent into the torus/wetwell and the wetwell will purge the vented material of bits of fuel element and dilute the remaining radioactivity in the water, so that when steam is vented from the wetwell into the environment, if it should be necessary, the vented material will be less toxic. Good idea if the electric control works.....

A key point; the argument about active venting versus passive venting (a "*rupture disk*", which is a weak point which fails just before the overpressure-failure point of the RPV) is "*essentially over*": "*the next generation of boiling water reactors*" includes passive venting. There is a "*next generation*" of BWR's? The Westinghouse AP1000 is a PWR and I thought all new designs were. The idea being that there is no phase change in the reactor coolant, which means you cannot "*uncover*" the fuel elements and thereby allow them to melt unless there is a loss of integrity in the RPV to begin with. The UK ONR believes for this reason that UK reactors are not susceptible to Fukushima-type events (the Brits use gas-cooled reactors, and are unique in doing so. The Magnox and AGR designs use carbon-dioxide as a coolant. Some new planned reactors are PWR, though).

On Wednesday, Hiroku Tabuchi at http://www.nytimes.com/2011/05/18/world/asia/18tepco.html said that the longer-term plans for dealing with the accident have been changed since the 100% melting of the fuel rods was discovered. Rather than filling the containment with water, TEPCO says it will now try to effect the necessary cooling by building self-circulating cooling systems in Units 1-3. It also says it will "*drape a large polystyrene cover*" around the Unit 1 reactor building "*to reduce radiation emissions, and to shield the building from summer typhoons*". "*Stone-filled cages*" will be built along the shoreline as protection against further tsunamis. Apparently the time-line for performing all this will not change from the 6-9 months already announced!

This just doesn't seem realistic. They have discovered that RPV1 is leaking, and they don't know from where. They have to stop the leak there and in RPV2. At the same time as cooling RPV1 and RPV2. Which means there is going to be more highly contaminated water flowing out into the

environment until they can stop the leaks. But I doubt they can stop the leaks with robots alone, and people very likely can't go in near wherever it is leaking. It appears the situation is stable now, but that stability includes continuous highly contaminated water flowing into the environment. That cannot just continue to happen.

Observe that NISA suggested, when revising the accident severity upwards to Level 7, that most of the radioactivity that was going to escape had already done so. Then there were problems with the trench containing highly-contaminated water around Unit 2. And now there appears to be no plausible plan which has been publicised to stop the leaking of highly-contaminated water from the necessary cooling operations. Let's hope that the IAEA committee which will visit next week can ask the right questions, get plausible answers, and shed light on the continuing accident. I understand the committee will be chaired by Mike Weightman, HM Chief Inspector of Nuclear Installations and head of ONR.

A snippet I missed earlier this week - the NRC 24-hour operations center has stopped monitoring Fukushima. http://www.nytimes.com/2011/05/17/world/asia/17briefs-Fukushima.html

Some comments on the UK ONR report at http://www.hse.gov.uk/nuclear/fukushima/interim-report.htm

The report consists of numbered paragraphs, as many British government and legal reports do.

From paragraph 21 onwards, the report distinguishes hazard from risk, in the usual appropriate way. This is a Good Thing.

The safety analysis seems to be in terms of "*barrier analysis*", or should that be "*Barrier Analysis*"? The barriers are stated in para 33: contain (shielding, and containment vessels), cooling, and controlling the reaction. However, the hazards to which these are "*barriers*" aren't stated until later - in para 37, "*hazard potential*" is said to be radioactivity, and heat energy.

This harks back to the old process-industry definition of "*accident*" as "*uncontrolled/unwanted release of energy*", which probably leads one to Barrier Analysis: put a shield in the way of "*release[s] of energy*" but is not very helpful for thinking about, say, transportation accidents. Some transportation device being where it shouldn't be is a much more helpful, but by no means perfect, way of thinking about transportation accidents. A better way is likely in terms of injury to people and damage to the environment (and, here, "damage" may be taken to be socially defined).

I am not so sure the "*hazard potential*" defined in para 37 is very helpful as a way of thinking about nuclear power plant accidents, because the two potentials are intertwined. It is possible to have a major release of radiation into the environment without having a problem with heat control, but it is likely not possible to have a major problem with heat control without incurring a release into the environment, although that could be relatively "minor" (TMI). Notice the INES accident severity scale in its upper levels is concerned entirely with how many teraBqs make it into the environment. It seems there is scope for reconceptualising the way accidents are thought about here.

Para 39 says the "*strategy for [...] safety*" is a "*defence in depth approach*": prevent "*faults*" occurring, control the faults should they nevertheless occur (explained as "*provide protection to control...*"), and mitigate the consequences "*should the protection fail*". Bernd [Sieker] has noted that the loss of "defence in depth" at Fukushima Units 5 and 6 should surely have resulted in an INES rating for Units 5 and 6 of at least 1 if not 2. I think I may well conclude that the mantra

"*defence in depth*" has multifarious meanings. I believe it is wise to think about safety using precise technical terms, and it seems there are all too many imprecise terms floating around: "*barriers*" to "*hazard potential*"; "*defence in depth*" as a "*strategy*" for safety.

Accidents are the unwanted states or behaviors that result from physical processes and physical processes are causes. Interrupting a behavior that is a precursor to an accident may or may not be fruitfully thought of in terms of "*barrier*" and "*defence in depth*" but it is the key action to avoid an accident. Whatever one's favorite metaphors, the right, and only, "*strategy for safety*" is to ensure that all such behaviors that are precursors to accidents are interruptible and indeed interrupted. The right analysis method is to determine all such behaviors, and the right prophylaxis is to ensure they are all interrupted. This is basic state-machine ontology. It applies to all engineered systems, everywhere. This is neither opinion nor metaphor, but basic conceptual foundations.

Para 47 notes that a safety case is required for the licensing and indeed continuing operation of any nuclear plant in the UK. So the UK is already doing what I suggested in my first post on the accident at http://www.abnormaldistribution.org/2011/03/27/fukushima-the-tsunami-hazard-and-engineering-practice/ . One of the reasons I was led to this was not only my exposure to the idea, but also surveying the timeline of PG&E's Diablo Canyon reactor near San Luis Obispo in California, which was already controversial when I arrived [in California in 1973], a fault having been discovered offshore in, I think, 1969. It took over twenty years from initial planning to operating licence, and then and subsequently the oversight of the plant has been subject to legal challenge, ending up at the Supreme Court more than once. As I read all of that, I suspected that any argument for safe operation of the plant is likely buried in hundreds if not thousands of legal documents, and that, I felt, is no way for a society to ensure safe operation of an enterprise with risks.

The UK nuclear industry, and its regulator ONR, has a set of published Safety Assessment Principles (SAPs, first noted in para 39 but recurring throughout) which it uses as a benchmark which the Safety Case (let me capitalise that) must address.

Para 67 notes that the Mark 1 drywell is steel, in part with a concrete covering. I remember some discussion on this with Bernd and Jan. The Mark 2 containment is post-stressed reinforced concrete with a steel lining and a steel cap. I think the structures are denoted this way to show there are primary and secondary structural elements of PCV, although I don't know the import of this distinction.

Para 107 notes that the Fukushima reactors are "*heavily instrumented*", but that limited information has been made available.

Para 113 and the accompanying Figure 6 gives an overview of historical earthquake strengths/tsunami heights which indirectly makes it very clear (to me, at least) that ignoring these hazards is a social phenomenon not to be explained through lack of knowledge. There were plenty of geologically recent events, 12 since 1896, listed in the diagram.

Para 117 notes that "*it is believed*" that the batteries were rated for 8 hours, obviously insufficient time to cope with a station blackout of this nature. Why this important technical info should be internationally unavailable is not clear, but this is just one instance of many in which the operator appears not to be sharing important technical details.

Para 127 says "*It is expected that future investigations will establish that Reactor Unit 3's pond also*

suffered mechanical damage in the explosion of 14 March 2011." The reason for this is given in Para 129: "*It is known that much more water has been directed towards the ponds (Reactor Units 3 and 4 especially) than their capacity.*"

Much of the preceding is material that we have already seen here in some form. I sense some underlying frustration at the lack of information, but maybe I am projecting my own views on the formal wording of a UK technical quasi-governmental document. Comparing with the astonishing attempts to cover up the Chernobyl accident (of which there are some astonishing stories:.....), there is plenty of information from Japan. But it does seem as if the operators have not been sharing all the information they could be sharing from this "heavily instrumented" facility.

Much of the rest of the document is concerned with the UK nuclear power plants and their assessment in the light of the Fukushima accident. Interesting material, but not primarily concerned with Fukushima.

23.05.2011

NISA 143rd Report, 19 May 1230 local http://www.nisa.meti.go.jp/english/files/en20110520-3-1.pdf Apparently people went into the reactor building of Unit 2 (RB2) for somewhat under 15 minutes, and RB3 for about 10 minutes, to conduct a "*preliminary survey*". That must mean that they have most of the highly-contaminated water out of RB2. 53 tonnes water was also injected into SFP2, so there is still work to be done to keep it cool. 80 m3 water was transferred from Unit 6 to a temporary tank, and a further 10.5 m3 to the Radioactive Waste Treatment Facility. AntiScat and RubRem=3. The two barges of US Forces Japan left Fukushima Dai-ichi for Fukushima Dai-ni. Doesn't say why or whether empty or full or with what.

NISA 144th Report, 20 May 1500 local http://www.nisa.meti.go.jp/english/files/en20110521-1-1.pdf RB1 entered; water levels and radiation dosage measured, over three hours. 100t water was sprayed over SFP4. Zeolite sandbags were placed by the Inlet Bar Screens of reactors in two places. AnitScat and RubRem=5. NISA also instructed TEPCO to report on an alternative cooling and cleanup system for SFP2, so there seems to be some issue there.

NISA 145th Report, 21 May 1200 local http://www.nisa.meti.go.jp/english/files/en20110521-2-1.pdf 60t water was sprayed (not injected, sprayed) over SFP1. AntiScat. RubRem=9. The Mega-Float (whatever that is) entered the Fukushima Dai-ichi port. I take it that is something into which water (whether relatively clean or contaminated) is going to be pumped.

NISA 146th Report, 22 May 1500 local http://www.nisa.meti.go.jp/english/files/en20110522-1-1.pdf 56t injected into SFP2, 130t sprayed over SFP4, 80m3 removed from TB6 into temporary tank, RubRem=11.

So there seems to be something going on with SFP2, and that after they went in to take a look.

24.05.2011

The WP http://www.washingtonpost.com/world/operator-of-japans-damaged-nuclear-plant-says-fuel-rods-in-2-more-reactors-mostly-melted/2011/05/23/AFRaq89G_story.html says that TEPCO has now said that the fuel in Units 2 and 3 has undergone a similar "*meltdown*" to that in Unit 1, but that the melted fuel is now being sufficiently cooled.

I notice some uncertainty about use of the term "*meltdown*". I read that it is supposed to mean a situation in which the fuel is melted, **and melts through the containment into the ground**. If that is so, we obviously need a word for 100% melted but contained. If one uses "*meltdown*" for the latter, one could use "*meltthrough*" for the former. If one uses "*meltdown*" for the former, one could use "*core melt*" for the latter. I find the first suggestion more amenable: the fuel has melted **down** but not **through**, but I don't want to go against established usage if there is such. However, there are three cases to consider. Fully-melted fuel inside RPV; fule melted through RPV but still contained inside PCV; fuel melted through PCV. I note that David Wright uses the term "melt-through" for the case of melted through RPV but still contained in PCV in his note of May 22 on http://allthingsnuclear.org/ How about "*meltdown*", "*meltthrough*" and "*uncontained meltthrough*"?

WP also suggests that TEPCO is having problems with figuring out what to do with all the contaminated water, a situation I have been emphasising recently. TEPCO says they now have 80,000 tonnes of it and it could go up to 200,000 tonnes, and it will likely take until the end of December to dispose of it.

The "mega float" is apparently for water that is "less radioactive" and can hold about 10,000 tonnes. It is described as "giant". If that is "giant", then there is a significant problem with 8 times that amount of highly-contaminated water, and possibly up to 20 times that amount! Areva is apparently helping on reprocessing the highly-contaminated water.

David Wright points out in his short note on decay heat from May 22 on http://allthingsnuclear.org/ that a meltthrough would lead to corium interacting with the concrete floor of PCV and creating "*additional radioactive gases*", which would then be prone to leak into the environment. He talks about the likelihood of an RPV breach, which depends on the decay heat, and points out that after 2 months the decay heat is only about 30% of its initial value, after 6 months 20%, and after 12 months 10%. So if it hasn't gone through so far, time is on our side.

25.04.2011

NISA's 146th Report, 23 May 1200 local http://www.nisa.meti.go.jp/english/files/en20110524-1-1.pdf say there was a temperature problem with the nitrogen injection device at Unit 1, solved by replacing the device. RB1 wsa "*opened*" and airborne radioactivity was sampled for almost an hour and a half. 90t water was sprayed over SFP1. RubRem consisted of removing 16 felled trees (remotely, so we may suppose they were assumed to be contaminated).

What's this with SFP1? This is new. I recall they tried on 15 May, but gave up because of "*high winds*", and I asked the question then why spray rather than inject. 60t sprayed on 21 May, now 90t on 23 May. I repeat my question of two weeks ago: what's up with the injection and why do they need to do this? It could be that they had to disable the injection into SFP1 in order to get other work done, but nothing has been said.

We have been over the spent fuel issue here before. The NYT's Matt Wald reports at http://www.nytimes.com/2011/05/25/business/energy-environment/25nuke.html on a paper from the Institute of Policy Studies by Robert Alvarez at http://www.ips-dc.org/files/3201/spent_nuclear_fuel_pools_in_the_US.pdf on the vulnerability of the fuel in SFPs in the US. Apparently the amount of spent fuel in SFP at Vermont Yankee alone, a single BWR with Mark I containment, is more than the entire amount in Fukushima Units 1-4. About 75% of the spent fuel in the US is in SFPs, and 25% in dry cask. The US has 104 working reactors. Alvarez apparently recommends that as much as possible be transferred to dry casks ASAP:

> "*The largest concentrations of radioactivity on the planet will remain in storage at U.S. reactor sites for the indefinite future," the report's author, Robert Alvarez, a senior scholar at the institute, wrote. "In protecting America from nuclear catastrophe, safely securing the spent fuel by eliminating highly radioactive, crowded pools should be a public safety priority of the highest degree.*

The NYT notes that one of the WTC attack aircraft flew over the plant at Indian Point in Westchester County on its way to the WTC. The reactors are relatively well protected, but the auxiliary structures, such as the SFP, not so well protected.

The history of spent fuel in the US is recounted thus:

> *In the 1960s, when most of the 104 reactors operating today were conceived, reactor manufacturers assumed that the fuel would be trucked away to factories for reprocessing to recover uranium. But reprocessing proved a commercial flop and was banned in the United States in the 1970s out of concerns that the plutonium could find its way into weapons worldwide.*

I am not sure what's new about any of this except the publication of the report. There seem to be a lot of moderately recent reports on spent fuel and they are all saying the same thing. Maybe it is simply a question of opportunity; people have been pushing for dry cask storage for a long time, but now nuclear plant safety is in the public eye. The arguments for spending the money to put much of the spent fuel into dry case storage do appear to me to be incontrovertible, but getting such money spent is always a political issue, and much of politics is driven by current events: "yes, let's put old fuel into dry casks, but why now? Why 500 dry casks in the current fiscal year? Nothing is going to happen - let's just do 100 this year and then we'll have more money for other pressing things, such as Bridges to Nowhere in Alaska." Then something does happen, and the argument no longer works in this form, for a while, until the next catastrophe (did I hear somebody mention tornados and floods?). Proper-storage advocates are making good use of the temporary invalidation of a trope.

26.05.2011

Switzerland has voted to end nuclear power, as the current reactors are decommissioned between 2019 and 2034: http://www.nytimes.com/2011/05/26/business/global/26nuclear.html and http://www.washingtonpost.com/business/swiss-to-decommission-all-nuclear-power-plants/2011/05/25/AG69lFBH_story.html (an AP story). Also yesterday the EC agreed on a "*stress test*" procedures for all reactors in the EU, all 143 of them (see the NYT story above). The tests will also consider man-made events as well as natural disasters. Commissioner Oettinger said "*The quality and the depth of this stress test is such as to fulfill the requirements of the European citizen to live in a safe environment,.... All of this will be done in as transparent way as possible*" but apparently Greenpeace disagrees that the tests will be sufficient. There are going to be 7-person "*peer review*" teams going around, with the authority to enter plants and units to check them out. And this is all to start June 1. Greenpeace apparently singled out Britain, France and the Czech Republic as those members who "*fought hardest*" to "*water down*" the tests. (The Czechs apparently have uranium mines.)

The EC apparently says that a key goal is to prevent a Fukushima-Daiichi-type event. Well, that's OK for Britain, for example, as - as the ONR said - the Brits don't have earthquakes or tsunamis where the reactors are. But I think they really mean station blackouts (StBl). Apparently StBls will be considered lasting "*several days*" and operators also need to describe what measures are in place if the batteries go out as well.

> NYT: "*The tests would include a review of containment systems to ensure they could withstand an air crash or the explosion of a nearby oil tanker, whether as a result of an accident or a terror attack. The tests would also seek to ascertain whether there were adequate systems to put out any resulting fire from explosions occurring near nuclear power plants.*"

A schedule has not yet been set for checking against "*a wider range*" of terrorist attacks, including cyber attacks. The problem there is that governments don't want to reveal possible vulnerabilities.

NISA's 148th Report 24 May 1200 local http://www.nisa.meti.go.jp/english/files/en20110525-2-1.pdf speaks about injected water into SFP3 on May 24, and they took air samples after "*opening*" RB4 for about 20 minutes on May 23. 100t more water sprayed over SFP4 on May 23; more water transferred out of Unit 6; AntiScat and RubRem=4.

NISA's 149th Report 25 May 1200 local http://www.nisa.meti.go.jp/english/files/en20110526-2-1.pdf says that 100t water was injected into SFP3 on May 24, and 400 m3 of water was transferred out of Unit 6. AntiScat and RubRem=2. Nitrogen injection in to PCV1 and transfer of highly contaminated water out of the trench of Unit 2 was briefly interrupted on May 25 in order to "*switch the power supply*", as was transfer of water out of Unit 3 to the Radioactive Waste Treatment Facility in order to "*inspect the transfer lines and buildings*".

NISA has a report on the outflow of contaminated water at
http://www.nisa.meti.go.jp/english/files/en20110525-1.pdf

26.05.2011

.....I just checked the All Things Nuclear blog at http://allthingsnuclear.org/ Dave Lochbaum has posted three notes with a reconstruction of what happened at Units 1, 2, and 3 in the first 30, resp. 60, resp. 80 minutes after the quake.

Details are at http://www.ucsusa.org/assets/documents/nuclear_power/fukushima-daiichi-ucs-analysis-unit-1-first-30-minutes.pdf for Unit 1,
http://www.ucsusa.org/assets/documents/nuclear_power/fukushima-daiichi-ucs-analysis-unit-2-first-60-minutes.pdf for Unit 2, and
http://www.ucsusa.org/assets/documents/nuclear_power/fukushima-daiichi-ucs-analysis-unit-3-first-80-minutes.pdf for Unit 3.

27.05.2011

A very interesting article in the WP today http://www.washingtonpost.com/national/japanese-scientist-fukushima-meltdown-occurred-within-hours-of-quake/2011/05/26/AGYXSJCH_story.html

A committee of the US National Academy of Sciences is holding hearings. Naoto Sekimura of the Uni Tokyo told them that core melting began five hours after the start of the accident. He said that full core melt was complete 11 hours later, and the core had melted through the "*thick steel lining*". Now, according to the UK ONR's report, the primary structure of the PCV with Mark I containment **is** the steel; sheathed in concrete. So he is saying it melted through the PCV; it's a meltthrough, not just a core melt.

NRC Commissioner George Apostolakis said that NRC staff members thought the cores were melting quite early on in the accident. That fed the decision to evacuate to 50 miles, which he said

was "*very conservative*".

It is noted that there continues to be radioactivity emitted from the plant into the environment.

Scientists from the National Cancer Institute (Kiyohiko Mabuchi is cited) said they expect 120 additional cases of childhood leukemia, based on the assumption that the people now in Fukushima Prefecture stay put.

At another meeting, of the NRC Advisory Committee on reactor safety, John E. Kelly, deputy assistant secretary for nuclear reactor technologies at the Department of Energy, said

> *that protective components at the facility could crack because of high salt levels. There "is still a concern about more massive failure" of steel in the "lower head," an important part of the containment system..... About 100 to 200 tons of salt left by the emergency pumping of salt water to cool the reactors are probably corroding the containment components.*

He thinks TEPCO will have to continue pumping water in and venting radioactive steam for a year or more.

They have build "*low-level*" waste storage on the site but there are no plans to move waste elsewhere. Kelly is quoted: "*It could be almost 30 years before they could use the site, so it's almost permanent.*"

He also said that a lot of unknowns remain, including the cause of the explosion at Unit 4, the condition of the SFPs and of "*key protective components*" (I am interpreting a bit here).

TEPCO apparently said Thursday "*a new leak*" in a storage container had released 60 tonnes of radioactive water into the environment.

NISA's 150th release, 26 May 1200 local http://www.nisa.meti.go.jp/english/files/en20110527-1-1.pdf says that they had to change the compressor injecting nitrogen into PCV1, that the transfer of the highly contaminated water in the trench at Unit 2 to the treatment facility was halted for a few hours to switch the power supply, and that 336 m3 was transferred out of Unit 6 building. They injected 53t into SFP2 and sprayed 121t over SFP4. AntiScat; RubRem=3.

Whatever is going on with SFP2 seems to be continuing. No hint as to what it is.

30.05.2011

The WP, in http://www.washingtonpost.com/world/ap-exclusive-japan-regulators-trusted-paper-thin-review-of-nuclear-plants-tsunami-risk-level/2011/05/27/AGXjXdCH_story.html publishes an AP report that I had somehow missed last week. Apparently TEPCO's assessment of the tsunami risk was extremely brief, one single "double-sized" page, dated Dec. 11, 2001, and was nevertheless accepted by NISA. AP got it through the Japanese law on public records (an FOI act, I take it), and says TEPCO "*rules out the possibility of a tsunami large enough to knock the plant offline and gives scant details to justify this conclusion, which proved to be wildly optimistic.*"

A team of inspectors headed by the UK's Chief Inspector of Nuclear Installations, Mike Weightman, was on-site last week (IAEA has ..... updated its background photo).

NISA's 151st Report, 27 May 1200 local http://www.nisa.meti.go.jp/english/files/en20110528-1-1.pdf says that transfer of water from the condenser in Unit 2 to the basement of TB2 was suspended due to work on the RPV2 Feedwater pipe. The transfer of the highly contaminated water from Unit 2 trench into the RWTF was suspended because RWTF is becoming full. 400 m^3 of water was transferred out of TB6. AntiScat and RubRem=1

NISA's 152nd Report, 28 May 1530 local http://www.nisa.meti.go.jp/english/files/en20110529-2-1.pdf says workers went into Unit 1, installed a gauge for measuring the water level in RB1, sampled basement water, and installed a hose to SFP1. They continued transferring water from U2 condenser into the basement of the TB2. 50t water was injected into SFP3, 100t sprayed over SFP4. 336.6(!) m3 was transferred out of Unit 6. AntiScat and RubRem=5.

NISA's 153rd Report, 29 May 1530 local http://www.nisa.meti.go.jp/english/files/en20110530-1-1.pdf says they tested and then started injection of water into SFP1 using a different line. In addition to the 7 m3 /hr being injected into the "*Reactor Core*" of Unit 2 (I take it they mean RPV2), injection has commenced using a second line. Injection into RPV3 (again "*Reactor Core*") was stopped in one line, and started in another at a rate of about 13.5 m^3/hr. 60t was sprayed over SFP4. The RHRS pump on Unit 5 stopped working late on May 28 and after 15 hours its replacement was started. Unspecified amounts of water continued to be transferred out of TB6 and 12m^3 out of RB6. AntiScat and RubRem=7.

Bernd [Sieker]is obviously right about losing defence in depth in Units 5 and 6. Maybe the IAEA will have discussed that in general with the Japanese authorities last week.

I wonder where the highly-contaminated water from U2 is going to go, now that they have run out of space in RWTF? Into the "mega-float!? That has reportedly 10,000t capacity and they have 70,000-80,000 tons to treat/dispose of.

01.06.2011

On 6/1/11 8:27 AM, Werner U wrote:

https://hardware.slashdot.org/story/11/05/30/1143239/Germany-To-End-Nuclear-Power-By-2022

Just for the record (corrections welcome) :

The article at http://en.wikipedia.org/wiki/Nuclear_power_in_Germany seems to be pretty accurate.

To look at the graphic, you need a bit of German "*stillgelegt*" means decommissioned. "*In Betrieb*" means "*operating*". "*Reaktor*" is what it sounds like. "*Standort und Name*" is "*location and name*". "*Hochtemperaturreaktor*" is "*high-temperature reactor*" ....., of which there are two, decommissioned, both in [the state of North-Rhine-Westphalia], one nearby at Hamm and the other at Jülich. There is one fast breeder ("*schneller Brutreaktor*") near Karlsruhe which is decommissioned, and one "*pressure pipe reactor*" ("Druckröhrenreaktor") near Niederaichbach in Bavaria which is also decommissioned.

Operating reactors are 6 BWR ("*Siedewasserreaktor*") and 11 PWR ("*Druckwasserreaktor*"), producing about just under 23% of Germany's electricity (this is a theoretical figure of course: the exact percentage varies temporally with consumption patterns and grid loading).

There are seven PWRs in the former East Germany. Five at Greifswald and one at Rheinsberg have been decommissioned. There is one BWR at Krümmel in Mecklenburg-Vorpommern, very close to the border with (the state of) Hamburg (which is a bit larger than the city itself). It is shown on the graphic as operating, but it was in shutdown at the time of the Fukushima accident and by Chancellor's decision will be decommissioned.

There were 6 operating BWRs ("*Siedewasserreaktor*") and 11 operating PWRs ("*Druckwasserreaktor*") producing about just under 23% of Germany's electricity (the exact percentage of course varies with use and grid loading).

The following older reactors have been shut down, by order of the Chancellor since just after the beginning of the Fukushima accident, and will be decommissioned (site name is followed by state):

* Biblis A und B in Hesse (Hessen)

* Neckarwestheim 1 und Philippsburg 1 in Baden-Württemburg

* Brunsbüttel in Schlweswig-Holstein

* Isar I in Bavaria (Bayern) (the Isar is the river which flows through Munich and into the Danube about 40km upstream from Passau, on the Austrian border)

* Unterweser in Lower Saxony (Niedersachsen)

* In addition, Krümmel, as above

There has been political opposition to nuclear power for some time, which since the Fukushima accident has reached an overwhelming majority. When the Greens came to power in coalition with the Social Democrats in 1998, one of the very controversial agreements was to phase out nuclear power in Germany by (I think) 2021.

Germany processes its spent fuel before storing it in dry casks. There are special rail cars, called "Castor", which are used to transport the processed spent fuel from the reprocessing plant in France to the storage facility at Gorleben in Lower Saxony. The Castor train trips are always the scene of significant political protest and attempts at disruption of the transport.

The government of Chancellor Merkel has now determined to shut all the plants by 2022 and build no more. This is essentially what the Greens proposed in their platform and agreed with the coalition government in 1998. Then, it was controversial. Thirteen years later, apparently no longer (except if you're senior management of or major shareholder in an energy company.....). Siemens, one of the world's largest engineering companies, made a major decision very early on. They build most of the atomic power plants in Germany and have a division devoted to it. Already in mid-April the decision had been made to shut it down. Energy will stay, but now it will all be "renewables" (a euphemism for wind, solar, wave power); this from a senior Siemens ...engineer....

06.01.2011

One [WP article] is about the IAEA team's report at http://www.washingtonpost.com/world/iaea-team-says-japan-underestimated-tsunami-threat-on-nuclear-plants-but-praises-response/2011/06/01/AGRkC0FH_story.html The team was led by Mike Weightman, the UK Chief

Inspector of Nuclear Installations. Apparently the report says the risk of a tsunami was underestimated but the response was "*exemplary*".

What about the help and equipment offered by the US and others that was all declined in the first week? Help was declined from the only people ever to have handled a core melt.....? That is not [what I would call] "exemplary" ..... The NRC, assessing from afar, was far more accurate in its (publically available) assessments than TEPCO or NISA in its (publically available) assessments. [Neither is that] "exemplary"; [it] is, rather, "could be improved". Even yours truly did better than TEPCO's public comments. I said when we opened the list on March 15 that "*So I think at this point that it is more likely than not that there will be full meltdown of one of the reactors.*" At that point, there had been three meltdowns. However, I significantly misjudged the consequences: "*Then, inevitably, of all of them because any personnel left on site will have martyred themselves with the first one. Equally, no one will be able to keep the spent-fuel ponds filled and we will be looking at multiple fires exhausting into the atmosphere.*" TEPCO somehow managed to contain the catastrophe so that people could work around the Units, and later occasionally inside the RBs. They have got themselves 80,000 tonnes of highly-contaminated water and don't know what to do with it, but a meltthrough was stopped and whatever it was that they were doing has contained the temperatures and pressures within appropriate limits for the structures. I don't mind calling that "exemplary"; compared with what could have happened with three full meltdowns it is probably the best possible outcome. Dave Lochbaum also had his criticisms of what was done in the first 30-80 minutes after the quake. For example, he said in his blog post that Safety (pressure) Relief Valves (SRV) would have been reverted to manual operation in the US, and cycled through, so that each SRV was opened as little as possible. This is because they have a tendency to stick when used a lot. however, the Fukushima operators of Units 2 and 3 (which are equipped with SRVs) left them on automatic, which meant the same ones were cycling open/shut (see Lochbaum's graphs in his longer PDF articles). That also could have been better.
.....

As a final thought, given the public rows they have been having with TEPCO, I doubt whether the Japanese government itself would consider the response "exemplary". The Japanese public certainly doesn't. 85% of those polled by the Fuji Television Network told the pollsters that they thought TEPCo had been dealing with it "poorly" http://www.washingtonpost.com/world/poll-more-than-80-percent-of-japan-voters-distrust-government-information-on-nuclear-crisis/2011/05/30/AGzHXUEH_story.html

But maybe I am just overreacting to one word in one sentence of an AP report.

It seems to me to be factual that the design and hazard analysis of these installations was vulnerable, respectively, poor by current standards. ("Vulnerable" is ..... an objective term; "poor" is a value judgement and of course there is significant debate about whether value judgements can be "factual".) Further, I take the ethical position that since they are (were) operating up until 11.03.2011, current standards are applicable. I don't know what the terms of reference of the IAEA inspectors were, but they may well not have been broad enough to incorporate such issues.

As a side note, the latest blog post on http://allthingsnuclear.org/ by Lochbaum concerns an incidents at the Edwin I. Hatch plant in Georgia in 1986. During this incident, 141,000 gallons of water leaked out of the SFP of one of the reactors due to a deflated seal, and Lochbaum says this lowered the water level in the SFP by five feet. Hatch has two BWRs, of which construction of the first began in the 1960's and it was commissioned in 1975; the other commissioned in 1979. So they did have Mark I containment and I think it is likely that their secondary containment building is

very like those at Fukushima. A US gallon is 3.7854l, so 141,000 gallons is about 533 tonnes. So translating capacity into levels, that is 107t per foot depth. And Fukushima SFP4 has been getting about 100t a day sprayed. So the loss per day at SFP4 is about a foot in depth. That is not huge, compared with a deflated seal, apparently, so whatever damage is there is relatively minor.

.....

NISA's 154th Report 20110512@1200 local http://www.nisa.meti.go.jp/english/files/en20110531-1-1.pdf says 168t was injected into SFP1 on 29 May; water was transferred from TB6, AntiScat and RubRem=8.

NISA's 155th Report 20110531@1230 local http://www.nisa.meti.go.jp/english/press/2011/06/en20110601-1-1.pdf talks about a leakage test and trial run of the "*secondary system*" of the "*alternative cooling system*" of the SFP of some unnamed Unit. 52t was injected into SFP2. They stopped using one method of injecting water into RPV2 and started using another, at a rate of 5m3/hr. Transfer of water out of TB6 continued, RubRem=7. Some leaked oil was found on the sea surface in the "*dedicated port*" of the NPS.

The WP reports on a meeting at Brown's Ferry, on concerns about the amount of damage that the recent Level 5 tornado, which came quite close, could have caused http://www.washingtonpost.com/business/nrc-tva-tell-skeptical-ala-crowd-that-browns-ferry-nuclear-plant-built-to-withstand-tornado/2011/05/31/AGrOPhFH_story.html

The WP also reports on the oil spill mentioned in NISA's 155th Report, and an explosion at Unit 4 that apparently was peripheral http://www.washingtonpost.com/world/oil-spill-blast-hit-crippled-japan-nuclear-plant-but-no-additional-radiation-leak/2011/05/31/AGc80KFH_story.html

02.06.2011

Bernd [Sieker] pointed out that the TMI partial core melt occurred ..... to a PWR (manufactured by Babcock and Wilcox, according to Wikipedia), not a BWR, and is thus of a quite different design. .....

I have some comments on CBA and FTA and assessment in general. The issues are well-rehearsed, but I guess I have felt the need for a long while to put them (relatively) succinctly, and this is yet another attempt. I am not sure whether everyone here will be au fait with the techniques. I am also not sure this is suitable for a blog post, but it certainly has the length of one.

On 5/19/11 4:34 PM, Werner U wrote:

> *[Pro Publica wrote:] Last week, a truck delivering flammable hydrogen to the Duane Arnold plant in Iowa burst into flames near a building holding machines that control the reactor.*

I may be wrong, but I had the impression that other organisations do much better on this kind of transient-danger management. Doesn't the military have strict rules on such proximity?

If so, it is likely because they have different situations of enforceability. The military can say: no flammables of such-and-such an energy within x meters radius of this facility, and enforce it by building new transitways (in this case, a road). Whereas a plant operator balances it against cost, and the chances of rare events are malleable enough that one can often make a CBA say what one

wants (in other words, it can be constructed to confirm an existing prejudice) unless the case is really egregious.

This is the old argument about CBA, which has generated lots of writing. I tend to think the issues are simple (although their solutions are complicated, which is what generates the writing). Let me say something about that, with apologies to those who know these rehearsed arguments.

On the one hand, a CBA is in general a good idea. It is a certain amount of arithmetic, a hoop to jump through, which sifts out the most extreme forms of irrationality. However, on the other hand, for accuracy it depends on three things: (1) an "appropriate" classification of events, (2) an "accurate" estimate of likelihoods, and (3) an "accurate" estimate of severities, and this is where use of CBA can become very misleading, because without these three characteristics, there is no known way of judging how good a guide it may be.

There is a similar issue with an engineering technique known as Fault Tree Analysis (FTA), which has been around now for some half a century. Let me rattle on a little about this, for those here who might not know and might want to be informed. FTA gets (1) right, and does not address (3), which is addressed by a formally similar but mirror-image technique called Event Tree Analysis (ETA). Put the two together, and one has a causal analysis method known as Cause-Consequence Analysis (CCA). FTA suffers largely from weaknesses associated with (2), and this leads it to be a very suspect technique in the minds of most leading system-safety analysts.

FTA starts off with a consequential failure (identified maybe through hazard analysis), attempts to list all the other events which can causally lead to this failure, using the analyst's implicit understanding of what a "cause" may be, in a hierarchical fashion, rather like a decision tree (and since decisions often commute, that is, A followed by B has the same effect as B followed by A, the tree structure is not unique). This part can be called "qualitative FTA". It is what decision theorists, artificial-intelligence people, and game strategists know as an "AND-OR tree". It is not as good as, say, WBA, which has an explicit (and well-grounded) notion of cause, but qualitative FTA does give an insight into how failures can occur, especially with complex systems. A colleague on this list who uses FTA (and ETA) for safety analyses in a transportation domain deals with relatively small FTAs, and says that a main advantage is just getting the clients to think analytically about the issues.

FTA has been highly successful in engineering complex systems with lots of subsystems. However, it is a technique which does not lead to accurate judgements of likelihood of failure. The FTA technique is to assume that all events that are not related as ancestor-descendant in a Fault Tree are independent. If you do that, then to calculate the probability of a parent event you simply multiply the probabilities of its children (for an "AND" node) or add them (for an "OR" node). The weakness is that most of the events in a complex tree are not independent, but have complex dependencies. Most leading system safety experts are very suspicious of (quantitative) Fault Trees.
One of the most striking examples is a Byzantine failure (this is a technical term) in the communications bus of a fly-by-wire control system of a major commercial airliner. It occurred repeatedly and almost led to the airworthiness certificate being withdrawn - then they found the problem and fixed it. The analysis had estimated the probability of it happening as 10^(-23) per operating hour, a chance of less than one in somewhat longer than the lifetime of the universe!

So that is just the problem with (2). But CBA has issues with (1) and (3) as well, and (3) is at least as problematic.

Nevertheless, as with FTA, the very act of performing a CBA forces people to think about the issues. The trouble comes when one uses it as the primary decision mechanism. Because it is weak on the foundations of (2) and (3) in particular, it is a technique open to manipulation in favor of a preferred conclusion and this is why its use as the primary decision mechanism for prophylaxis against unlikely unsafe events is questionable.

> *.... The Browns Ferry blaze .... began with a tiny flame..... The accident riveted the NRC's attention on the damage fire could do to control cables. Nuclear companies already were required to have backup cables for safety-related equipment, but Browns Ferry showed that a fire could destroy both sets if they were near each other, a situation common to the design of many plants.*

This is known in engineering as an unidentified common-cause failure mode. Something very similar happened to the United Airlines DC-10 at Sioux City (check out You Tube for videos of the landing. Keep in mind as you watch it that two-thirds of the people on the airplane survived!). The airplane was in cruise flight, when the number two engine (the one in the tail on the DC-10) "threw" a turbine blade which went through the cowling (known as an "uncontained blade failure"). The DC-10, like many airplanes, is equipped with three separate hydraulic systems for moving the aerodynamic control surfaces, for redundancy. But they all were routed through the same place on the tail, and were severed by the thrown blade. So the airplane had no aerodynamic control any more.

The crew were very inventive, and learned how to influence the flight path using differential engine thrust alone. They practiced in the air for the better part of an hour, and then tried the landing at Sioux City. There, they were caught in a Catch-22. They needed a certain airspeed to maintain control, but this airspeed was far higher than appropriate landing speed. They had a long runway, but it is questionable whether it would have been enough. So, on short final, they chose to reduce power. The airplane rolled, caught a wing tip, and cartwheeled, as we see. Keep in mind that the DC-10 is a very large airplane! .....

The reaction of many aerospace engineers to that event was "*how could they route all the hydraulic lines through the same place in the plane of a turbine?*"

The lesson has subsequently been very well learned by the industry. When the Qantas A-380 threw a disk (not a blade, but an entire turbine disk) over Indonesia last year, the disc severed structure, and controls - even controls in two separate parts of the wing, near the main spar where it was anticipated and near the trailing edge where it wasn't - and the airplane still had plenty sufficient, albeit reduced, aerodynamic control authority to accomplish a normal landing back in Singapore.

> *So after five years of study, the agency adopted rules that required companies to separate primary and backup cables by at least 20 feet.*

The effect in aerospace was much more rapid. The FAA came out with an Airworthiness Directive very quickly and the DC-10 hydraulics were reengineered within a much shorter period of time.

It seems the process industries have bigger issues with such measures than the industries with which I am mostly familiar. For me, this observation derives primarily from four sources. First, the extensive sociological studies, especially [Perrow]'s. Second and third, Deepwater Horizon. Second is the lengthy NYT investigation and report on what happened on the rig **after the explosion had taken place**. I think that is a fine piece of investigative journalism

and deserves to be more accessible, say in a book. Third is [Leveson]'s private and professional comments on her experiences on the Baker Commission which investigated the Texas City accident and as an advisor to the Presidential Commission on Deepwater Horizon. Fourth, the obviously inadequate hazard analysis concerning flooding performed over years with Japanese nuclear plants, that has recently come to light.

As I have said before, engineers cannot solve such issues alone. (Refs: here, in http://www.abnormaldistribution.org/2011/03/31/fukushima-dai-ichi-accident-sociologist-needed/ , and in a version of that essay which appeared in the ZiF Mitteilungen 2/2011, the dual-language journal of the Center for Interdisciplinary Research in Bielefeld, the ZiF.)

06.06.2011

The n-tv article from Saturday referenced by Werner U http://www.n-tv.de/panorama/Tepco-misst-Rekordstrahlung-article3499876.html says that steam was found issuing from an opening in the "*floor*" in the south-east corner of RB1. A robot measured the dose rate around the steam at 4 Sv/hr. This is reported to be the highest dose rate measured anywhere since the beginning of the accident. There is a tube coming through the opening, which is undamaged. It is presumed that the steam is issuing from RPV1.

The other n-tv article http://www.n-tv.de/panorama/Wasser-steht-bis-zum-Rand-article3492066.html notes that 100,000t of highly-contaminated water are around the plant (the figure is confirmed by an AP story in the WP from Sunday 5 June at http://www.washingtonpost.com/world/japan-nuclear-plant-moves-more-radioactive-water-to-storage-to-prevent-spill/2011/06/05/AGPhKIJH_story.html). This is up from the 70,000t reported in [my news message of 19.May]. This shouldn't surprise us: leaks in various RPVs as suspected and cooling water is being injected into all of them and that water, after being contaminated, must go somewhere; in other words out of the RPV, intentionally or not.

According to TEPCO (says n-tv) there are 16,200 in Unit 1, 24.600t in Unit 2, 28,100 in Unit 3 and 22,900t in Unit 4 of contaminated water (it doesn't say where in the Units this water is; whether the cooling water actually inside the RPVs is being counted, but I would suppose not). 13,300t contaminated water has already been pumped into another facility (storage or treatment; doesn't say). The total amounts to 105,100t with 720,000 Tbq = 7.2 x 10^(17) Bq when I have my units right.

Compare with what NISA said when they upgraded the accident to Level 7 on 12 April http://www.nisa.meti.go.jp/english/files/en20110412-4.pdf . They said 3.7 x 10^(17) Bq = 370,000 TBq. NSC said 6.3 x 10^(17) Bq and Chernobyl was 5.2 x 10^(18).

So what is going to happen to all that contaminated water? It is increasing in size and I haven't heard of any measures to deal with it, apart from the 30,000t that TEPCO said they could handle, in regard to the 25,000t contaminated water they discovered in Unit 2 (see News20110418). The 70,000t figure that NISA said was present is reported first in News20110419 as far as I can tell, but I didn't give a reference for that figure. We can use that to estimate the increase. From 19 April until today is just under 6 weeks and the estimate has apparently gone up to 100,000t. So that is on average 5,000t more contaminated water per week. And six weeks ago (News20110418) TEPCO had said it could handle 30,000t.

We are of course not the only outsiders noting the problem. Here an article from Friday 3 June in

the WP http://www.washingtonpost.com/world/asia-pacific/at-stricken-japanese-nuclear-plant-water-is-the-biggest-worry/2011/05/31/AGLe01HH_story.html . This article suggests there is about 15 million gals (I presume US gals) altogether. There is no indication how this quantity is calculated or what it includes. 15 million gallons is about 57 million liters which is only about 57,000t, if I am calculating correctly. That is only just over half what NISA apparently says is there and must be disposed of (according to the n-tv article cited).

There is an article in the WP also from Friday but updated Saturday 4 June on tanks that are being brought in to store the contaminated water http://www.washingtonpost.com/business/tepco-says-2-workers-at-tsunami-hit-nuclear-plant-exceeded-japan-radiation-exposure-limit/2011/06/03/AGJLksHH_story.html There are 370 tanks due to arrive, and the WP says confusingly that 200 of them can store 100t (which makes it 50 tonnes each) and in the same sentence that 170 of them can store 120 tonnes. The article says tanks will continue arriving through August, and will store 40,000t. There are 370 on order, and two arrived Saturday.

The arithmetic is completely awry. According to the article tanks can store either half a tonne each, or 07t, depending which of the two figures one takes. That is between half and three-quarter of a m3 each, so they must be pretty small (but with very thick walls, I take it). They will need between 57,000 and 80,000 of them to store the 40,000t which it is intended to store, which means delivering them at the rate of between 500 and 1,000 per day between now and the end of August, and the article reports 370.

It makes far more sense to take the 40,000t planned to be stored in them, the 370 tanks there are supposed to be, and conclude that each tank is intended to hold just under 110t, in other words a 110m3 container.

But if that is so, they are still going to need 50 new tanks per week just to deal with the extra contaminated water produced in that week (the contamination, not the water). At 370 in twelve weeks that is a rate of 30 a week. So the rate of delivery of tanks is only 60% of the rate of contamination of water.

IAEA has a 2 June update at http://www.iaea.org/newscenter/news/tsunamiupdate01.html Items which were not clear to me is that the re-instrumentation of RB1, whence they discovered the water level and concluded a full core melt, has not been able to proceed in RB2 and RB3, I take it because of the level of radioactivity in the buildings. Also TB1 and TB3 contain stagnant highly-contaminated water, which is being transferred to a number of facilities.

NISA has said that the explosion reported to have been heard in previous commentary was an oxygen tank bursting and had no impact on critical parameters or on work in progress http://www.nisa.meti.go.jp/english/press/2011/06/en20110601-3.pdf

NISA's 156th Report 20110601@1200 local http://www.nisa.meti.go.jp/english/press/2011/06/en20110602-2-1.pdf says that injection rate into RPV1 was lowered from 6m3/hr to 5m3/hr on May 31, and a leakage test was conducted on the "*alternative*" cooling system for SFP2. RB3 was investigated by a robot. AntiScat and RubRem=6. Oil was found floating in the NPS harbor, and the "*impact sound*" was heard.

NISA's 157th Report 20110602@1530 local http://www.nisa.meti.go.jp/english/press/2011/06/en20110603-1-1.pdf reports rate of injection to RPV3 changed from 13.5m3/hr to 12.5m3/hr then to 11.5m3/hr on June 1. 40t was injected into

SFP3. Transfer of water out of TB6, AntiScat, RubRem=12.

NISA's 158th Report 20110603@1200 local
http://www.nisa.meti.go.jp/english/press/2011/06/en20110603-1-1.pdf says a water transfer was started in Unit 3 from the Condenser to the Condensate Storage Tank on June 2, so that water in the basement of TB3 may be transferred into the condenser. AntiScat and RubRem=11.

NISA's 159th Report 20110604@1530 local
http://www.nisa.meti.go.jp/english/press/2011/06/en20110603-1-1.pdf says that on June 3 a robot was used to look around RB1 (the "*situation*" was "*confirmed*"), that RPV injection was temporarily suspended in order to reroute the water supply lines to "the reactors", that highly-contaminated water in the TB2 trench was tranferred into the "*Condenser Hotwell*" in TB2 (continued to June 4), that 210t was sprayed over SFP4, AntiScat and RubRem=7.

NISA's 160th Report 20110605@1530 local
http://www.nisa.meti.go.jp/english/press/2011/06/en20110606-1-1.pdf says that 15t was injected into SFP1 on June 5, that water in TB2 trench was transferred to RWTF on June 4, that water from Unit 3 Condenser was transferred to the Condensate Storage Tank, that water was injected into SFP3, that 180t was sprayed over SFP4, AntiScat and RubRem=8.

07.06.2011

The NYT says that NISA now estimates that the radiation released is double what it estimated in mid-April when it upgraded the accident to Level 7
http://www.nytimes.com/2011/06/07/world/asia/07japan.html 770,000TBq. The NSC was reported by NISA to have estimated 630,000 TBq in mid-April.

The WP is saying that NISA thinks that not only a full core melt has taken place in three reactors, but that the core has also melted through the "*inner containment vessels*". The PCVs are steel with a concrete outer hull, as I understand. http://www.washingtonpost.com/world/japan-doubles-estimate-of-radiation-leak-from-tsunami-hit-nuclear-plant/2011/06/07/AGsb3xKH_story.html

The IAEA report from the mission two weeks ago is at
http://www.nisa.meti.go.jp/english/files/en20110601-1.pdf It seems excessively bland. Awful accident, very good job of reporting, cleanup, planning for disposal, etc, but underestimated tsunami risk. I have addressed this already in a previous note.

Ministers of various countries are meeting under the auspices of the IAEA in Paris this week, and the Japanese government has submitted a report to the meeting
http://www.kantei.go.jp/foreign/kan/topics/201106/iaea_houkokusho_e.html

NISA's 161st Report 20110606@1200 local
http://www.nisa.meti.go.jp/english/press/2011/06/en20110607-1-1.pdf says that 60t was injected into SFP3, transfer of water from TB3 to condenser was started, AntiScat and RubRem=2.

NISA's 162nd Report 20110607@0800 local
http://www.nisa.meti.go.jp/english/press/2011/06/en20110607-4-1.pdf says 90t was sprayed over SFP4 using the shorter Putzmeister (58m), AntiScat, RubRem=4, and they collected some highly contaminated rubble (950 mSv/hr) on the west side of RB3 on June 6.

10.06.2011

Dave Lochbaum in Fission Stories #43 on June 7 on the blog http://allthingsnuclear.org/ talks about two floods at the Sequoyah plant in Tennesee, in which the TB was flooded by two 15-minute rainstorms, one on July 11, 1994 that dumped about an inch (2.5 cm), and one five years later that dumped about 2/3 inch (1.7 cm). The electrics in the basement of the TB were partially inundated but continued to function. Apparently, the NRC looked at it after the **second** incident and determined the ground around the TB was improperly graded.

How about not putting sensitive electrical equipment where it can flood? Have we heard this before?

Lochbaum concludes "*The design flaws, equipment malfunctions, and worker performance issues identified by .... precursor events have to be corrected expeditiously if skill is to be a larger factor than luck in protecting public health and safety.*" In other words, do the analysis the first time round and fix. We've been promoting that for a decade and a half, and have methods, WBA, and software, SERAS, for WBA which can be used. In some industries, such as commercial aviation, it is the international rule. Having been more used to such behavior, it continues to open my eyes wide to see how much different it seems to be in a industry prone to EUE.

Major commercial aircraft accidents with no or few survivors from (sad to say) rich countries cost somewhere between €200 million and €1 (U.S.)billion to settle, largely at the lower end of that. The NYT today, writing about TEPCO's commercial viability, or rather lack of it (equivalent to $1.85 per share, 7% of pre-March-11 levels) in http://www.nytimes.com/2011/06/10/business/global/10tepco.html , says that an analyst at Nomura Securities estimates cost at about $64 billion, and Merrill Lynch puts it at twice that, $130 billion. The article points out that BP's fund for the Deepwater Horizon spill is $20 billion.

So now we know. Put in monetary terms with the current valuations of society, which does not take all important issues into account (such as the true costs of pollution), a nuclear EUE costs two orders of magnitude more than the worst commercial airplane accident and three orders of magnitude more than most.

What of those true costs? One needs to compare what a farmer would have earned in hisher lifetime (and his descendants in theirs, for decades and maybe centuries, who knows?) with the likely compensation, which is probably an apartment in some town somewhere else and some pocket money to "start over". Let alone the previous commercial value of the land that can no longer be used and the fishing industry that can no longer sell its produce because of heightened radiation levels. The true costs could thus be many orders of magnitude larger than what compensation will be paid out for the accident.

Let's figure the comparison another way. There are currently six or seven major commercial airline accidents a year (the rate has been going down steeply in the last three decades, but appears to have stagnated since, oh, let's say 2004). I will guess that costs the insurance overall €1-2 billion per year (I don't know; I'll ask). One major oil spill every decade would cost about the same. One Level 7 nuclear accident every quarter century costs, apparently, two to five times that amount.

Ed Lyman of the UCS also gave evidence on so-called "*small modular reactors*" to the U.S. Senate Committee on Energy and Natural Resources, available at http://www.ucsusa.org/assets/documents/nuclear_power/lyman-testimony-06-07-2011.pdf Apparently, a 2007 paper by Westinghouse people and others said that there are no apparent cost

savings associated with small and modular. The UCS is concerned that proponents of SMRs are therefore trying to weaken regulatory requirements so that costs will be lower, and thereby possible compromise safety, which is at least as big an issue as for larger reactors. The NRC apparently regulates on the basis of what Germans call MGS: "*mindestens gleiche Sicherheit*" or the French GAMAB: "*globalement au moins aussi bon*", at least as safe (good) as what is already operating. UCS believes that current safety practice is insufficient and needs to be improved (as do I now) and promotes that also for the new technology being proposed: it should fulfill a higher safety standard and not a lower standard than the current insufficient one.

Here, I can see clearly the advantages of the English legal principle ALARP: "*As Low As Reasonably Practicable*". Risks of any enterprise are to be reduced by its executors ALARP, which is to the point at which the costs of any further measures to reduce risk are "grossly disproportionate" to the benefit gained by the reduction (as it was formulated in Lord Asquith's 1949 judgement). It seems that Japanese regulators could have used this principle to [humanity's] considerable advantage.

People in England have been trying to turn ALARP into an engineering principle but it isn't. You cannot produce a piece of paper in court and say "*we did ALARP, look here!*" and expect a judge to say "*oh, that's all right then, case dismissed*". Judges and juries have a tendency to make up their own minds. Where it might work is in bringing cases to trial. The watchdog is the Health and Safety Executive, HSE, which decides whether to prosecute or not. If you can waive the piece of paper at them, you might avoid prosecution. Providing they continue to behave that way. At best it can be an engineering principle based on assumed-constant regulatory behavior, and that doesn't sound at all like science to me

NISA's 163rd Report 20110608@1200 local
http://www.nisa.meti.go.jp/english/press/2011/06/en20110609-1-1.pdf says that a second RHRS pump has been added to Unit 5, AntiScat and RubRem=10.

NISA's 164th Report 20110609@1530 local
http://www.nisa.meti.go.jp/english/press/2011/06/en20110610-1-1.pdf has a lot of stuff. There was a temporary outage to the power supply for the Mein Control Room lighting of Units 1 and 2. The nitrogen injection into PCV 1 was affected, as was the transfer of contaminated water out of TB2. The transfer of water in TB3 to the condenser was continued, and workers entered RB3 to measure radiation dose rates. 55t was injected into SFP3 and 120t sprayed over SFP4 on June 8. Water is being transferred out of Unit 6 buildings, AntiScat and RubRem=5.

18.06.2011

[Arnold] Gundersen [has drawn our attention for his commentary. Perrow related a recent article based on an interview with him]. For those who don't yet know, he does videos at
http://www.fairewinds.com/

Two things stand out. First, the article suggests that TEPCO announced that more radiation has been released into the atmosphere than at Chernobyl. I haven't read that in any of the usual sources. Official estimates (NISA, NSC) are now aligned at about 3/4 of a million TBq. That is a fifth of Chernobyl, I believe. Gundersen believes it is more and he may well be right.

Second, the risk to the West Coast of the US. I think it's negligible at the moment.

There has been a bunch of interesting stuff in the last few days, ...

NYT says today that TEPCO is bringing a water-filtering facility quickly on-line http://www.nytimes.com/2011/06/18/world/asia/18tepco.html The idea is that the filters get rid of "*the worst*" contamination, and the resulting water can be reinjected back into the RPVs. TEPCO bringing it on-line early because they are running out of storage for the water (so much for the accuracy of their 9-month plan!). They are generating about 500 tonnes per day of contaminated water from fresh, and have about 105,000 tonnes of it to filter/store/dispose of. The facility is said to be able to process 1,200 tonnes per day.

I estimated 5,000t per week in News20110606, from figures about the increase in total contaminated water given there. That's 43% more than 500t per day. I would imagine that I would more trust the earlier figure.

On Wednesday 15th June, the NRC met. They have a task force on safety due to report in July (or August) and this was an interim report. The WP (here, an AP report) says http://www.washingtonpost.com/business/nrc-says-spent-fuel-pool-likely-never-went-dry-in-japan-earthquake/2011/06/15/AGluSvVH_story.html that new video evidence indicates that SFP4 likely never went dry, as Chairman Jaczko had proposed in March. The safety task force's Chair, Charles Miller, said that current rules on station blackouts are probably inadequate - there apparently was an assumption about no common-cause failure. Commissioner Apostolakis queried the current rule that power could be restored in 4-5 hours, which is one of the assumptions he called "*unrealistic*".

The NYT had yet another piece on how close to the edge this came http://www.nytimes.com/2011/06/13/world/asia/13japan.html On the evening of March 12, amongst political and technical confusion, TEPCO ordered the Fukushima plant manager to stop pumping seawater into the RPVs to keep them cool. The plant manager, Masao Yoshida, did something "*unthinkable in corporate Japan: he disobeyed the order and secretly continued using seawater*" to cool the RPVs, which almost certainly prevented a far more severe meltdown and meltthrough than what had occurred.

The NYT's report on the NRC meeting is at http://www.nytimes.com/2011/06/16/business/energy-environment/16nrc.html The NYT highlights the station-blackout problem, and the possibility of common-cause blackout, and Apostolakis's comment about the short assumed time period of a blackout, also that "*some of the [added] safety equipment .... is not maintained or inspected as diligently*" as the original plant components. This latter was addressed by William Borchardt, the NRC executive director for operations, who also said of the cores of reactors 1, 2, and 3 that they are "*to some degree, ex-vessel*", meaning there has indeed been a meltthrough, not just a meltdown.

The NRC was also concerned about "*emergency vents*" added to "*reactors*" (I think RPV is meant) to prevent hydrogen explosions might not function, as they did not function at Fukushima, as reported already on May 17 in http://www.nytimes.com/2011/05/18/world/asia/18japan.html That article includes the entire story around not venting, which is worth reading, but we know most of the technical stuff already. Masao Yoshida comes up in that also: apparently he wanted to start venting earlier but TEPCO's nuclear chief disagree, and the exchange became a "*shouting match*". As the Times says, the results of the failed venting were "*disastrous*". The events were fitted with "*numerous safeguards*" which are....wait for it .... electrically driven.

I see a huge market in this whole industry for half-way-competent hazard analysts.

11.06.2011

The Japanese goverment said it was going to make the regulator (NISA) independent. It is currently part of the Ministry of Trade and Industry, part of whose job has also been to promote industrial policy, including nuclear power. IAEA has criticised a lack of independence before, in 2007, after an earthquake caused damage at another plant, and the IAEA inspectors's report a short while ago also

IAEA Chief Amano is chairing a "*high-level*" IAEA meeting this week in Vienna, meaning ministerial level, on necessary improvements in oversight and regulation of nuclear power facilities. The problem is that IAEA is here just a talking shop.
http://www.washingtonpost.com/world/europe/iaea-convenes-high-leve-nuclear-safety-talks-prompted-by-fukushima-disaster/2011/06/20/AG9rKWcH_story.html The IAEA's take on the same conferences is at http://www.iaea.org/

25.06.2011

I liked that article. [http://www.scientificamerican.com/article.cfm?id=fukushima-meltdown-radioactive-flood , referenced by Charles Perrow] "Down to earth" is the phrase that comes to mind.

On 6/25/11 7:38 AM, Mark Brown wrote:

> *Amazing that in a supposedly hi tech industry they still have these problems with valves.*

Amazing, but unfortunately not all that unusual. This is one of the important data points when one is considering whether, and how, large groups of people (organisations) can effectively run a complex process subject to EUEs.

It is one of the basics of good safety-critical system design that the status of critical parameters is known to the operators. This follows from the MCRC criterion in my 2009 IET paper http://www.rvs.uni-bielefeld.de/publications/Papers/LadkinSecTheInt.pdf (That paper addressed cooperating agents and is so phrased, but applies equally well to systems such as these: if you manually move a valve control and the valve moves, then you and the valve are engaging in cooperative action - it is just a matter of vocabulary and phrasing.) The nuclear power industry in particular and process industries in general have long had problems with operator instrumentation not showing the correct state of critical parameters. Not labelling a valve control is a very low-tech instance of it.

Not even the NRC had an appropriate high-level HazAn in place. Station blackout had its own name, had happened in the past, its criticality level is as high as can be, and yet they are only just revisiting their requirement(s) that 4 to 8 hours of battery-supplied current is sufficient.

Lochbaum commends the NRCs previous actions to reduce the risk of flooding at Fort Calhoun in http://allthingsnuclear.org/post/6795320523/the-nrc-in-action

27.06.2011

On 6/27/11 1:58 PM, Mark Brown wrote:

> *Today TEPCO started cooling the reactor with recirculated filtered water, only to*

discontinue after 1.5 hours due to water leaking from a failed hose joint. This is even lower tech than the valve problem.....

I suspect one trouble is.... that you can't get people near the crucial (engineering) places because of the radiation intensity. One cannot work with the usual failure model, and there is no one to replace it. You can assemble a whole system outside the reactor building, test it as much as you like, but it still must be brought into the RB and connected up and that is where problems are likely to occur if you can't stay long enough to do a thorough job of it.

29.06.2011

TEPCO had its shareholder meeting yesterday. About 9,300 investors attended. It was rowdier than usual.

A motion was brought by 402 shareholders to shut down existing nuclear power plants and cease to build new ones. Such a motion has been brought at every meeting for the last 17 years. It was defeated, like the others.

The appointment of 17 board members, all of whom except one are company executives, was approved. Since the purpose of a board, in most Western countries, is to exercise oversight over the actions of company management, one wonders how TEPCO's board can possible fulfil this task, since it is composed essentially of company management.

All in http://www.nytimes.com/2011/06/29/business/global/29tepco.html

The article also says that the recycled-water cooling system was started on Monday, shut down after 90 minutes, and restarted Tuesday, and that they now have 110,000 tonnes of contaminated water to process (one can achieve similar estimates by simple arithmetic from already-given figures).

BTW, I don't think it has yet been noted here that Fort Calhoun has been in cold shutdown with its fuel rods removed. Flooding from a rising river is obviously different from the Fukushima events, since there is (prima facie!) nothing to break the grid-based electricity supply. The worry would be that key equipment (electric distribution kit, or control kit) would be at a level at which flooding could affect it and the NRC has said risk is "*really low*"
http://www.washingtonpost.com/national/top-federal-regulator-says-2-nebraska-nuclear-plants-remain-safe-despite-floodwater-challenges/2011/06/28/AGVN4joH_story.html

.....I haven't summarised NISA's reports since the 164th, that is for about 3 weeks. The reports from 165th on are available at http://www.nisa.meti.go.jp/english/ , and earlier ones in the archives linked from there. I'll summarise here in running text without links the most significant issues. This procedure does have the advantage that I can more easily spot trends or histories, and ignore some syntactically prominent but really just formal items. On most days, AntiScat was performed, and the usual RubRem from 0-6 containers, but on one day there was RubRem without containers being filled.

Report 165: A water flow test for the Circulating Seawater Decontamination System (henceforth CSDS; sometimes they say "Unit" instead of "System") installed in the "*Screen Area*" of Units 2 and 3 was carried out on 09.06.

Report 166: The "*ambient air filtration system*" for RB2 was tested, the RB double doors were

opened, and the system commenced operations on 11.06. Workers entered RB4 for 30 mins on 10.06 to look at support for SFP4.

Report 167: Water transfer from TB3 basement to RWTF 11.06 39 trench pits were blocked to stop water outflow 10.06

Report 168: Water transferred from TB3 to RWTF, 12.06. Water injected into SFP3 13.06. CSDS full ops commenced 13.06.

Report 169: 150t water sprayed over SFP4, 13.06.

Report 170: 150t sprayed over SFP4, 14.06. Rate of water injection into RPV1 decreased from 5 m3/hr to 4.5 m3/hr 15.06

Report 171: Highly-contaminated water in TB2 trench transferred to RWTF, 16.06. TB3 basement water transferred to RWTF, 16.06. RB6 water transferred to RWTF, and TB6 water to "*temporary tank*", 15.06. This seems to me to indicate that the water accumulated in the RBs of U5 and U6 might be somewhat contaminated. There was a trial of the "*Decontamination Unit*" in the "*Water Treatment Facility*" on 15.06 (I presume a "DecontamU" in the RWTF is meant), and on 16.06 a joint test and then commencement of joint operation of the Caesium Absorption Unit (CAU) and Decontamination Unit (DU) on 16.06.

Report 172: 49t water injected into SFP3 on 17.06, and 75t over SFP4 using a "*temporary spraying facility*", no longer the Putzmeister, on 16.06. Ops with CU were suspended on 16.06 after "*water leakage*" was confirmed.

Report 173: Transfer of highly-contaminated water from TB2 trench into the Condenser Hotwell was started but then suspended on 17.06. TB3 basement water transferred to RWTF, 18.06. "*Full-fledged*" operation of the "*Water Treatment Facility*" (I presume the DU is meant) was started on 17.06, but suspended on 18.06 because the surface radiation dosage on CAU reached "*replacement standard*", in other words it took enough Caesium out in a day that the filter already needed to be replaced.

A report was published on 17.06 about possible radiation release during planned operations in Unit 2 to install and calibrate water-level gauge for RPV2 and to installe piping for nitrogen injection into PCV2.

Report 174: 99t water into SFP4 using "*temporary spraying facility*", 18.06. Water leakage in CAU was confirmed, 18.06. Also, various measures in preparation for switching external power supply to "*Okuma Number 2*" line.

Report 175: Workers entered RB2 on 19.06, and the double doors were "*slightly*" opened, followed by "*fully*" on 20.06. TB2 basement water transferred to RWTF, 18.06-20.06. TB3 basement water transferred to RWTF, 20.06. Water was injected into the "*Steam Dryer Storage Pool*" of Unit 4 (DSP4), about 80t on 19.06, and more on 20.06. CSDS ops suspended for maintenance 18.06-20.06. CAU was tested on 19.06, again on 20.06.

Report 176: Water injection into RPV1 reduced from 4.5 m3/hr to 4.0 m3/hr, in RPV2 from 5 m3/hr to 4.5 m3/hr, in RPV3 from 11 m3/hr to 10 m3/hr, on 21.06. TB2 trench water transfer into U1 Condenser started on 20.06. "*Truck bay doors*" of RB2 opened, 20.06. Water injected into DSP4,

20.06 and 21.06. Water flow test of CAU performed on 19.06 and 20.06. Trial of WTF (I presume DU) was started 21.06 but later stopped.

Report 177: Water injection into RPV1 reduced further to 3.5 m3/hr, into RPV2 to 4.0 m3/hr, 22.06. TB2 trench water was transferred into Unit1 Condenser until 21.06. Workers went inside RB2 for 10 minutes on 21.06 to calibrate instruments and survey points for nitrogen injection. TB2 trench water is now transferred to RWTF on 22.06. TB3 basement water went to RWTF on 21.06. Water was injected into DSP4 on 20.06, 21.06 and 22.06. Water in RB6 to WTF (!!) on 21.06. (So it seems indeed as if the accumulated water in RB6 is contaminated.) Trial of Water Treatment Facility (WTF, possible to confuse with RWTF!) started on 21.06, and suspended on 22.06 for "*flushing*". It seems WTF consists of DU+CAU+whatever.

Report 178: Pressure gauges were installed in RPV2 on 23.06 Water injection to RPV3 reduced further to 9.5 m3/hr on 23.06. Water was further injected to DSP4 on 22.06 and 23.06; they are doing this daily. Water "*injected*" into SFP4 using "*temporary spraying facility*" (!) on 22.06.

Report 179: Water injected into RPV1 **and** RPV2 using RPV1 pump, on 23.06. Installation work for "*temporary pressure gauges*" for RPV2 was carried out on 23.06. Water injection into RPV3 further reduced to 9.0 m3/hr on 24.06. A trial of the WTF started on 23.06 and was suspended for "*flushing*" later on 23.06.

Report 180: 24.06 was quite a day! A UAV helicopter landed on the roof of RB2 (the newspaper said it was an "*emergency landing*" and the thing was lying on its side), and the installation of water-level gauge for the basement of Unit 2 by robot was suspended. A radiation dose survey was, however, carried out by robot in RB3. Cooling of SFP5 was started using "*Fuel Pool Cooling and Clean-up System*".

Report 181: 45t borated water injected into SFP3 on 26.06. Operation of CSDS was suspended for maintenance, first from 18.06 to 20.06 and again on 25.06. Trial operations of WTF were "*suspended*" to "*exchange*" CAU on 23.06, 24.06, 25.06 and 26.06. WTF was shut down on 25.06 due to "*drawdown alarm of the oil separators*" but then restarted.

Report 182: Some operations modified/temporarily suspended because of work to change the external power supply to "*Okuma Nr. 2*", again on 27.06. Trial ops of WTF again suspended to change the "adsorption unit vessel" on 26.06.

Report 183: More operations affected because of work on Okuma Nr. 2, 27.06. RPV1-3 water injection commenced using WTF water and water from "*filtrate tank*", on 27.06, later stopped due to "*pipe leak*", and restarted on 28.06. 60t borated water injected into SFP3 on 27.06. Water from TB3 basement transferred to RWTF from 21.06 until 28.06. DSP4 "*filled*" on 28.06. The emergency diesel generators for U5 were started and then returned to standby on 27.06, and again on 28.06. In Unit 6, there was "*verified leakage*" of low-contaminated water from the "*temporary tank*" on 28.06.

Various questions arise. Why is the injection rate for RPV3 so much higher than for RPV1 and RPV2? Is RPV3 running hotter, or do we think that it is leaking more? I had thought RPV2 was the most suspect for leaks. And it looks as though the "*accumulated water*" in Units 5 and 6 was indeed contaminated in part, although "*low*". There have been obvious problems getting the WTF working, but it seems these are being slowly solved.

NISA says nothing at all in these reports about the big problem: what is being done with all that rapidly-accumulating contaminated cooling water, where it is and how rapidly it is accumulating, and how much is being processed through the WTF.

05.07.2011

No surprise that the Guardian has found evidence of people who think that the biggest problem with nuclear energy is a tsunami, rather than the current state of nuclear safety.

On 7/5/11 8:41 AM, Werner U wrote:

> *"British Energy and Climate Change Secretary Christopher Huhne complained that the German decision to phase out nuclear energy was driving up the price of natural gas. "*

What an irony. Britain used to have lots of natural gas. But they used it all up, didn't they. So they have to buy it from Norway, don't they. That's why the price went up, isn't it. The resolution? Complain about the Germans, like every Brit after Queen Victoria of Saxe-Coburg-Gotha (now known as Windsor because we can't pronounce the long words,.....)