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Editorial

Dear readers of the WISE/NIRS Nuclear Monitor,

In this issue of the Monitor:

- M. V. Ramana deconstructs the arguments used to promote spent fuel reprocessing, and notes that the world is getting closer to the end of reprocessing spent fuel and plutonium separation.
- Ian Fairlie summarizes the health effects of the Fukushima nuclear disaster.
- Dominique Doyle writes about the controversial plans for new nuclear power reactors in South Africa.
- V.T. Padmanabhan, Paul Dorfman and A. Rahman write about safety issues at India's Kudankulam nuclear plant.

The Nuclear News section has reports on Switzerland's troubled nuclear power program; the growth of global renewable electricity generation; and a study linking nitrate contamination to the mobilization of uranium in groundwater.

Feel free to contact us if you have feedback on this issue of the Monitor, or if there are topics you would like to see covered in future issues.

Regards from the editorial team.

Email: monitor@wiseinternational.org

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An end to reprocessing?

Author: *M. V. Ramana*

NM809.4487 Nuclear power is in decline around the world. Globally, nuclear power provides about 11 percent of electricity generated (in kilowatt hours), down from its historic maximum of 17.6% in 1996. Even the International Atomic Energy Agency's projections for the future have been declining steadily and now project nuclear power as constituting 2 to 5.4% of the world's installed electricity generation capacity (in megawatts) in 2050, down from 6.5% in 2013. Despite sustained interest on the part of the politicians and governments, nuclear power has not even maintained market share, let alone grow.

Despite this reality, some nuclear enthusiasts continue to believe that eventually nuclear power would make a comeback and grow so much that the world will run out of uranium that is needed to fuel nuclear reactors. And so, they say, the world would have to construct what are called breeder reactors that would produce more fuel than they consume. This, they argue, is necessary not just to avoid running out of uranium but also make nuclear energy "sustainable" in the long term.[1] In line with that very environmental term and the constant effort to greenwash nuclear power, they also use the term recycling to talk about the use of plutonium as fuel.

This view is not new. It is nearly as old as nuclear power, and was widely prevalent and advocated by leading scientists and engineers in multiple countries. For example, in 1953, Franz Simon, a British physicist, wrote, "if we had to rely solely on the amount of [uranium-235] ... available in the known high-grade ore deposits, large scale power production would not be possible ... the real hopes for larger scale power production lie ... in the possibility of making use of uranium 238 or of thorium by the process of 'breeding'.

While there is yet no absolute certainty that this can be done the probability is nevertheless high."[2] Another physicist, Aleksandr Ilich Leipunskii, promoted breeder reactors in the Soviet Union using an argument that simply presumed that there would be a deficit of uranium resources for the future development of the nuclear industry.[3]

The expectation that it would become essential to fuel breeder reactors with plutonium was the original rationale for the reprocessing plants constructed in the 1960s and 1970s. With the benefit of hindsight, we can see that the early assumption about limited uranium availability was wrong. Indeed, even by the late 1970s, geologists had come to the conclusion that there were very large quantities of uranium ore available, and if one were to mine poorer grades of ore, there is an "approximately a 300-fold increase in the amount of uranium recoverable for each tenfold decrease in ore grade".[4] A recent comprehensive review of global uranium resources concludes that, "there is a strong case for the abundance of already known U resources, whether currently reported as formal mineral resources or even more speculative U sources, to meet the foreseeable future of nuclear power".[5] The range of futures considered in this assessment includes an extrapolation of the International Energy Agency's scenario to meet an atmospheric CO2 concentration of 450 ppm that calls for deploying about 2000 GWe of nuclear power by 2100. In addition to not running out of uranium, there has not also been any major increase in the price of uranium.

In the meantime, experience with breeder reactors around the world has shown that most have had persistent reliability problems, primarily because of their use of molten sodium as coolant.[6] The capital costs of breeder reactors have been consistently higher than those of light water reactors; further, their capacity factors have been much lower. As a result, electricity from these reactors was even more expensive than nuclear power from light water reactors. As a result, no country has commercialized breeder reactors and only a few demonstration reactors have been built.

France, the country that is most reliant on nuclear power in the world, did try to commercialize breeder reactors after operating pilot scale and demonstration reactors. The Superphenix started operating in 1986, experienced a series of accidents, and was shut down in 1997.[7] During this period it generated less then 7% of the electricity of what it could have done at full capacity. Currently, only a few demonstration reactors are being built or operated. With the exception of Russia and India, no other country has firm plans to deploy breeder reactors during at least the next couple of decades.

For all these reasons, the original rationale for reprocessing of spent fuel proved mistaken. But the die had been cast and reprocessing persisted in France, Japan and the United Kingdom. In an effort to find a rationale for continuing reprocessing, the French nuclear establishment proposed using the plutonium as supplementary fuel for conventional light water reactors. Because plutonium oxide is extremely carcinogenic if inhaled, MOX fuel, unlike uranium fuel, must be fabricated in sealed glove boxes. Even excluding the cost of reprocessing, the cost of MOX fuel fabrication is greater than the cost of the uranium fuel that it replaces. Including the cost of reprocessing, MOX fuel costs about ten times more. Again, the second rationale for reprocessing of spent fuel died in the face of economic realities.

Unfortunately, there are still holdouts, the most bizarre example of which is the Japanese nuclear village, the loose conglomeration of institutions that make nuclear policy in Japan. Even though there is enormous uncertainty about future of Japan's nuclear reactor fleet and about how to dispose of its already huge stockpile of separated plutonium, the nuclear village continues to be interested in starting operations at the Rokkasho Reprocessing Plant to separate out even more plutonium from spent power reactor fuel.

This persistence will be dear. In 2011, Japan's Atomic Energy Commission estimated that operating the plant would increase the electricity bills of Japan's ratepayers by about ¥7 trillion (US$60 billion) over the next 40 years.

With the failure of their first two justifications, reprocessing advocates have offered a third: facilitating spent fuel disposal. The argument is that plutonium and the other transuranic elements in spent fuel should be fissioned into mostly shorter half-life radioisotopes to reduce the long-term hazard from spent fuel. The reactors being proposed for the "burning" of plutonium and other transuranics, however, are modified versions of the costly and unreliable reactors that previously were being proposed for plutonium breeding. A U.S. National Academy review of a proposal to revive reprocessing and sodium-cooled reactors programs in the United States on this basis concluded in 1996 that "none of the dose reductions seems large enough to warrant the expense and additional operational risk of transmutation."[8]

Despite all the fond hopes of nuclear establishments around the world, reprocessing is not going to be a solution to the production of nuclear waste. Indeed, it may make it more difficult to solve. Reprocessing plants produce multiple waste streams; these are usually classified on the basis of their radioactive content. So-called low level waste, which has low concentrations of radioactivity but comprises over 80% by volume of the waste stream, is a major problem in terms of management. Because it is produced in such large volumes, nuclear establishments around the world find it expensive to store them and, so release them into the environment after some treatment. But nevertheless, this radioactivity makes it way into marine life and can be detected far away from the source.[9]

In addition to the economic and environmental arguments against reprocessing laid out above, there is another important reason to be concerned about the practice of reprocessing: that plutonium can be used to make weapons. Practically any kind of plutonium is considered weapon usable. Some make the distinction between weapon-grade plutonium that contains more than 90% of plutonium-239, and reactor-grade plutonium that has increased fractions of the higher isotopes of plutonium. A commonly cited problem with the use of reactor-grade plutonium is the increased risk of a "fizzle yield", where a premature initiation of the fission chain reaction by neutrons emitted by fissioning of plutonium-240 leads to pre-detonation of the weapon and an explosive yield only a few percent of the design value. However, as the U.S. Department of Energy has noted:

"At the lowest level of sophistication, a potential proliferating state or sub-national group using designs and technologies no more sophisticated than those used in first-generation nuclear weapons could build a nuclear weapon from reactor grade plutonium that would have an assured, reliable yield of one or a few kilotons (and a probable yield significantly higher than that). At the other end of the spectrum, advanced nuclear weapon states such as the United States and Russia, using modern designs, could produce weapons from reactor grade plutonium having reliable explosive yields, weight, and other characteristics generally comparable to those of weapons made from weapons-grade plutonium."[10]

The International Atomic Energy Agency assumes that 8 kilograms of plutonium would suffice for a first-generation nuclear weapon of the kind that was exploded on Nagasaki in 1945. The 8 kilograms includes inevitable losses during the production process. On this basis, the world's current plutonium stockpile is adequate for 30,000 weapons. Do we really need more?

The problems with reprocessing discussed above are not new. Over the decades, there has been increasing appreciation of the dubious nature of the arguments for reprocessing, and a steady decline in the number of countries that reprocess. As shown in a recent International Panel on Fissile Materials report[11], the world is getting closer to the end of reprocessing spent fuel and separating plutonium.

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Summing the health effects of the Fukushima nuclear disaster

Author: *Dr Ian Fairlie*

NM809.4488 New emerging evidence from Fukushima shows that nuclear disasters and their aftermaths kill thousands of people due to necessary evacuations. In future, these deaths from ill-heath and suicides should be included in assessments of the fatalities from nuclear disasters. In sum, the human toll from Fukushima is horrendous: 2,000 Japanese people have died from the evacuations and another 5,000 are expected to die from future cancers.

Deaths from necessary evacuations

Official data from Fukushima show that nearly 2,000 people died from the effects of evacuations necessary to avoid high radiation exposures from the disaster, including suicides.[1]

The uprooting to unfamiliar areas, cutting of family ties, loss of social support networks, disruption, exhaustion, poor physical conditions and disorientation can and do result in many people, in particular older people, dying.

Increased suicide have occurred among younger and older people following the Fukushima evacuations, but the trends are unclear.[2]

A Japanese Cabinet Office report stated that, between March 2011 and July 2014, 56 suicides in Fukushima Prefecture were linked to the nuclear accident.[3] This should be taken as a minimum, rather than a maximum, figure.

Mental health consequences

It is necessary to include the mental health consequences of radiation exposures and evacuations. For example, Becky Martin has stated her PhD research at Southampton University in the UK shows that "most significant impacts of radiation emergencies are often in our minds".

She adds "... imagine that you've been informed that your land, your water, the air that you have breathed may have been polluted by a deadly and invisible contaminant. Something with the capacity to take away your fertility, or affect your unborn children. Even the most resilient of us would be concerned ... many thousands of radiation emergency survivors have subsequently gone on to develop Post-Trauma Stress Disorder (PTSD), depression, and anxiety disorders as a result of their experiences and the uncertainty surrounding their health."[4]

It is likely that these fears, anxieties, and stresses will act to magnify the effects of evacuations, resulting in even more old people dying or people committing suicide.

The above sections should not be taken as arguments against evacuations: they are an important, life-saving strategy. But, as argued by Becky Martin, "we need to provide greatly improved social support following resettlement and extensive long-term psychological care to all radiation emergency survivors, to improve their health outcomes and preserve their futures".

Untoward pregnancy outcomes

Recently, Dr Alfred Körblein from Nuremburg in Germany noticed a 15% drop (statistically speaking, highly significant) in the numbers of live births in Fukushima Prefecture in December 2011, i.e. nine months after the accident.[5] This might point to higher rates of early spontaneous abortions. He also observed a (statistically significant) 20% increase in the infant mortality rate in 2012, relative to the long-term trend in Fukushima Prefecture plus six surrounding prefectures. These are indicative rather than definitive findings and need to be verified by further studies. Unfortunately, such studies are notable by their absence.

Cancer and other late effects from radioactive fallout

Finally, we have to consider the health effects of the radiation exposures from the radioactive fallouts after the four explosions and three meltdowns at Fukushima in March 2011. Large differences of view exist on this issue in Japan. These make it difficult for lay people and journalists to understand what the real situation is.

The Japanese Government, its advisors, and most radiation scientists in Japan (with some honourable exceptions) minimise the risks of radiation. The official widely-observed policy is that small amounts of radiation are harmless: scientifically speaking this is untenable. For example, the Japanese Government is attempting to increase the public limit for radiation in Japan from 1 mSv to 20 mSv per year. Its scientists are trying to force the ICRP to accept this large increase. This is not only unscientific, it is also unconscionable.

Part of the reason for this policy is that radiation scientists in Japan (in the US, as well) appear unable or unwilling to accept the stochastic nature of low-level radiation effects. "Stochastic" means an all-or-nothing response: you either get cancer etc or you don't. As you decrease the dose, the effects become less likely: your chance of cancer declines all the way down to zero dose. The corollary is that tiny doses, even well below background, still carry a small chance of cancer: there is never a safe dose, except zero dose.

But, as stated by Spycher et al[6], some scientists "... *a priori* exclude the possibility that low dose radiation could increase the risk of cancer. They will therefore not accept studies that challenge their foregone conclusion."

One reason why such scientists refuse to accept radiation's stochastic effects (cancers, strokes, cardiovascular system diseases, hereditary effects, etc) is that they only appear after long latency periods − often decades for solid cancers. For the Japanese Government and its radiation advisors, it seems out-of-sight means out-of-mind. This conveniently allows the Japanese Government to ignore radiogenic late effects. But the evidence for them is absolutely rock solid. Ironically, it comes primarily from the world's largest on-going epidemiology study, the Life Span Study of the Japanese atomic bomb survivors by the RERF Foundation which is based in Hiroshima and Nagasaki.[7]

Negative lottery tickets

The mass of epidemiological evidence from the Chernobyl disaster in 1986 clearly indicates that cancer etc increases will very likely also occur at Fukushima, but many Japanese (and US) scientists deny this evidence.

For example, much debate currently exists over the existence and interpretation of increased thyroid cancers, cysts, and nodules in Fukushima Prefecture resulting from the disaster. From the findings after Chernobyl, thyroid cancers are expected to start increasing 4 to 5 years after 2011. It's best to withhold comment until clearer results become available in 2016, but early indications are not reassuring for the Japanese Government. After then, other solid cancers are expected to increase as well, but it will take a while for these to become manifest.

The best way of forecasting the numbers of late effects (i.e. cancers etc) is by estimating the collective dose to Japan from the Fukushima fall out. We do this by envisaging that everyone in Japan exposed to the radioactive fallout from Fukushima has thereby received lottery tickets: but they are negative tickets. That is, if your lottery number comes up, you get cancer. If you live far away from Fukushima Daiichi NPP, you get few tickets and the chance is low: if you live close, you get more tickets and the chance is higher. You can't tell who will be unlucky, but you can estimate the total number by using collective doses.

The 2013 UNSCEAR Report[8] has estimated that the collective dose to the Japanese population from Fukushima is 48,000 person-Sieverts (discussed further below).

Unfortunately, pro-nuclear Japanese scientists also criticise the concept of collective dose as it relies on the stochastic nature of radiation's effects and on the Linear No Threshold (LNT) model of radiation's effects which they also refute. But almost all official regulatory bodies throughout the world recognise the stochastic nature of radiation's effects, the LNT, and collective doses.

Summing up Fukushima

About 60 people died immediately during the actual evacuations in Fukushima Prefecture in March 2011. Between 2011 and 2015, an additional 1,867 people (as of March 2015) in Fukushima Prefecture died as a result of the evacuations following the nuclear disaster. These deaths were from ill health and suicides.[9] (In addition, 1,603 people were killed directly by the earthquake and tsunami in Fukushima Prefecture, and approximately 1,350 tsunami evacuee deaths occurred in Miyagi and Iwate Prefectures: in the latter cases, the evacuations were not radiation-related.)

From the UNSCEAR estimate of 48,000 person-Sv, it can be reliably estimated (using a fatal cancer risk factor of 10% per Sv) that about 5,000 fatal cancers will occur in Japan in future from Fukushima's fallout. This estimate from official data agrees with my own personal estimate using a different methodology.[10]

In sum, the health toll from the Fukushima nuclear disaster is horrendous. At the minimum:

- Over 160,000 people were evacuated most of them permanently.
- Many cases of post-trauma stress disorder (PTSD), depression, and anxiety disorders arising from the evacuations.
- About 12,000 workers exposed to high levels of radiation, some up to 250 mSv
- An estimated 5,000 fatal cancers from radiation exposures in future.
- Plus similar (unquantified) numbers of radiogenic strokes, CVS diseases and hereditary diseases.
- Between 2011 and 2015, about 2,000 deaths from radiation-related evacuations due to ill-health and suicides.
- An, as yet, unquantified number of thyroid cancers.
- An increased infant mortality rate in 2012 and a decreased number of live births in December 2011.

Non-health effects include

- 8% of Japan (30,000 sq km), including parts of Tokyo, contaminated by radioactivity.
- Economic losses estimated between US$300 and US$500 billion (€260−430 billion).

Conclusions

The Fukushima accident is still not over and its ill-effects will linger for a long time into the future. However we can say now that the nuclear disaster at Fukushima delivered a huge blow to Japan and its people. 2,000 Japanese people have already died from the evacuations and another 5,000 are expected to die from future cancers.

It is impossible not to be moved by the scale of Fukushima's toll in terms of deaths, suicides, mental ill-health and human suffering. Fukushima's effect on Japan is similar to Chernobyl's massive blow against the former Soviet Union in 1986. Indeed, several writers have expressed the view that the Chernobyl nuclear disaster was a major factor in the subsequent collapse of the USSR during 1989-1990.

It is notable that Mikhail Gorbachev, President of the USSR at the time of Chernobyl and Naoto Kan, Prime Minister of Japan at the time of Fukushima have both expressed their opposition to nuclear power.[11] Indeed Kan has called for all nuclear power to be abolished.[12]

Has the Japanese Government, and indeed other governments (including the UK and US), learned from these nuclear disasters? The US philosopher George Santayana (1863-1962) once stated that those who cannot learn from history are doomed to repeat it.

Reprinted from www.ianfairlie.org/news/summing-the-health-effects-of-the-fukushima-nuclear-disaster/

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South Africa's Russian nuclear dream boat

Author: *Dominique Doyle, Energy Policy Officer at Earthlife Africa Johannesburg*

NM809.4489 The South African government is forging ahead with its plan to procure 9600 MW of nuclear power, even though the idea is extremely unpopular in most sectors of South African society. So far, several vendors have paraded their technology and Intergovernmental Framework Agreements have been signed with Russia, China, France, the United States and South Korea. The contents of which were kept secret from the South African public up until very recently − except for the Russian one which was leaked by Vladimir Slivyak of Ecodefense to the South African based environmental justice organization, Earthlife Africa Johannesburg.

The agreements with the United States, France and China were finally tabled at Parliament last week where the Minister of Energy announced that the nuclear procurement will proceed as soon as next month. The contents of the agreements show that Russia's Rosatom is clearly leading the pack.

The government's relentless nuclear vision has left many South Africans scratching their heads in confusion. While the country is in the midst of a power crisis, and power cuts are becoming a daily occurrence; most stakeholders, including the Energy Intensive Users Group, feel that 9600 MW of nuclear power will not be the solution. In short, it simply will be too expensive. One plausible reason for the aggressive push for an expanded nuclear fleet is a political union between Russian President Vladimir Putin and South African President Jacob Zuma, who is whispered to be at the core of the nuclear drive. The evidence that the odds are focused at Russia's favor in the bidding process is overwhelming; with the Intergovernmental Framework Agreement with Russia being concluded first and in far more detail than the other agreements.

South Africa's fanatical desire to procure nuclear energy, which will be the most expensive procurement in the history of the new dispensation valued at 1 trillion South African Rand (US$77b; €69b), peaks at a time when the South African electricity system and state owned single utility are at a crisis point.

The state owned electricity utility, Eskom, claims that it took the political decision to "keep the lights on" and neglected to do the maintenance on its aging and insufficient fleet of coal-fired power stations. As a result, the South African public is facing daily blackouts, or "load shedding," at an estimated cost to the economy of nearly 80 billion South African Rand per month. Eskom is also failing to complete its answer to the power crisis, the Medupi power station − the fourth largest coal-fired power station in the world − currently running over budget by at least 180 million South African Rand (US$14m; €12m), and most likely delayed until 2025.

Despite wasting billions over the years, Eskom is pointing the blame at the South African public, and requesting yet another rate increase of 25% to cover the cost of burning diesel in its Open Gas Turbine Cycles for peaking power during times of high electricity demand.

Despite being the thorn in the side of the South African public, Eskom is the entity entrusted as the applicant for the Environmental Impact Assessment (EIA) for the first two nuclear reactors dubbed Nuclear 1. The final EIA for Nuclear 1 has yet to be completed and is technology unspecific, showing once again how devious the nuclear plans are.

The suggested site is even as bizarre as the nuclear ambition itself. Nuclear 1 would be constructed in the idyllic and unique landscape of Thyspunt, off the coast of the Eastern Cape of South Africa and situated near the world-famous surfing hotspot, Jefferies Bay. The location is only accessible by one road built through sand dunes and so frequently gets blown away by the violent storms prone to the region. The area is also vulnerable to water shortages compounded by the failure of the local authorities to maintain water treatment plants and execute effective service delivery. Another one of the many reasons why a nuclear build is entirely unsuitable for the region is that about 4,000 people employed in the local calamari fishing industry would lose their jobs.

Besides the fact that nuclear procurement is commencing in the absence of an approved EIA, which is technology unspecific, the procurement is even forging ahead in the absence of an Integrated Energy Plan (IRP). By South African law, the IRP must be updated every two years. The most recent update was circulated for public comment towards the end of 2013, however that update, which did not support nuclear procurement because of the sheer expense, has mysteriously disappeared. The Department of Energy is now preferring to refer to the IRP 2010 which features nuclear as an integral part of the energy mix; rendering this procurement process quite obviously unlawful.

Sadly, what the South African government's nuclear ambitions reveal about current South Africa is a gradual melt-down of the principles of democracy and transparent governance enshrined in the new South African Constitution. This nuclear procurement process shows how forces are lining up within the government to support the political wish-list of an elite few. Even if many within government fundamentally disagree with Russian nuclear reactors to solve the energy crisis, it is doubtful that they will risk their positions by speaking out. But perhaps the most disheartening feature of the proposed nuclear deal is how it is being sold to the public. Through the nuclear deal the government is promising jobs, industry development and foreign investment. The government is using the pinch of poverty to the largely unemployed and energy impoverished mass to open up the flood gates to enrich its own cronies.

Safety issues at India's Kudankulam nuclear plant

Authors: *V.T. Padmanabhan, Paul Dorfman and A. Rahman*

NM809.4490 Though the trans-boundary contamination and trans-generational health impacts of the nuclear fuel cycle are recognized, there is no international regulatory framework to enforce uniform safety codes and standards and resolve the conflicts between nations. As reactors are ageing and nuclear technology is becoming widespread, there are risks of more Fukushima-type 'surprises' in future.

One such surprise has been unfolding in India's Kudankulam Nuclear Power Plant (KKNPP) since the fuel loading of a 1000 MWe pressurized water reactor (PWR) in October 2012. During the 33 months of its 'operation', the reactor could not clear the final mandatory test. The utility declared the commissioning of the reactor on 31 December 2014 and the regulator granted the licence to operate the plant on 8 July 2015. This is the only civilian nuclear reactor in the world operating without clearing the commissioning tests.

This case study reveals a total collapse of the regulatory mechanism and the rule of law for the first time in the three decades long history of civil nuclear sector. India is also planning to export reactors to other Asian-African countries, besides importing unproven technologies from abroad. These potential sources of future Fukushimas can be prevented by global intervention only. People interested in nuclear safety are seeking an international regulatory framework, which would be transparent, and participatory. There is no reason to delay this process now.

Introduction and brief history of the project

The construction work of two reactors at the Kudankulam Nuclear Power Plant (KKNPP) started in 2002 at a coastal village, off the Bay of Bengal, in Thirunelveli district of Tamil Nadu State. The first reactor has been under 'operation' since October 2012 and the second reactor is still under construction. Under the India-Russia inter-governmental agreement, Rosatom supplied the equipment and designs, while the Nuclear Power Corporation of India Ltd (NPCIL) did the construction and commissioning work. An independent safety evaluation of the project was impossible as the utility refused to share the documents like the Preliminary Safety Analysis Report, the Detailed Project Report, inspection reports of components etc. with any outside individual or organization. The only sources of information about the reactor were the press releases and annual reports of the utility, the regulator and industry sources in Russia.

Since the first reactor's grid connection on 22 October 2013, the Southern Regional Load Despatch Centre (SRLDC) has been publishing data on power generation and outages of KKNPP on a daily basis. The assessment of the reactor's performance in this report is based on the data from www.srldc.org

Equipment defects of the Kudankulam reactors

In spite of the 'iron curtain', a fairly accurate description of the reactor plant construction − counterfeit, underperforming and obsolete equipment and shoddy construction practices – can be made using the bits and pieces of information available from the official sources in India and Russia. These include a defective reactor pressure vessel, an under-performing polar crane, an overhaul of the turbine-generator even before the grid connection and replacement of blades after 4700 hours of operation, and breaking open the double containment to accommodate the missed cables.[1]

Alarmed by these anomalies, 60 eminent scientists from India's national institutes, including those "who believe that nuclear energy has a legitimate role in securing our energy future" appealed on 13 May 2013 that the government "should consult independent national experts to formulate an inspection regime and carry out a full-fledged inspection into the safety" of the reactors, paying "particular attention to the allegations of sub-standard equipment and components".[2]

International comparison

According to the US Nuclear Regulatory Commission, commissioning tests known as "initial start-up testing" is "normally completed during fuel loading, pre-critical, initial criticality, low power and power ascension phases to confirm the design bases and demonstrate, to the extent practical, that the plant will operate in accordance with design and that it is capable of responding to anticipated transients and postulated accidents as specified in the Final Safety Analysis Report. The power-ascension test phase should be completed in an orderly and expeditious manner. Failure to complete the power-ascension test phase within a reasonable period of time may indicate *inadequacies in the applicant's operating and maintenance capabilities, or may result from basic design problems".*[3]

Table 1 provides data on intervals between initial fuel loading (IFL) and the first act of criticality (FAC), and between FAC and commissioning (COM), and between IFL and COM for eleven 1000 MW PWRs commissioned during this century. (Dates of criticality and commissioning – not shown in the table − are from the International Atomic Energy Agency's PRIS database. Dates of IFL are from media reports.)

Table 1: Intervals between fuel loading and commissioning – 1000 MWe reactors

Reactor	Country	Initial Fuel loading	Interval in days		
			IFLFAC	FAC- COM	IFL- COM
Tianwan -2	China	03/01/07	61	107	168
Hongyanhe1	China	26/11/12	51	141	192
S.Wolsong 1	S Korea	12/02/11	34	208	242
Hanul -5	S Korea	10/01/03	58	244	302
Rostov-1	Russia	21/01/01	33	305	338
Rostov-2	Russia	24/12/09	29	322	351
Temelin-2	Czech Rep	03/01/02	91	322	413
Kalinin-4	Russia	20/10/11	19	413	432
Tianwan -1	China	18/10/05	63	513	576
Temelin-1	Czech Rep	15/07/00	88	607	695
KKNPP-1	India	02/10/12	286	723	1009

KKNPP stands out from all others. It should be noted that it has not been commissioned properly even after more than 1000 days.

Power ascension tests

The Atomic Energy Regulatory Board (AERB) lists 45 different tests in the C Phase Power Ascension Tests, in three sub-phases of C-1, C-2 and C-3, which are conducted after the generator is connected with the grid. In C-1 and C-2, reactor power is raised to 50% of Full Power (FP) and to 75% FP respectively. The main tests of C-3 phase are non-stop operation at 90% FP for 7 days and at 100% FP for 100 days. C-1 and C-2 tests take about 10 days, while C-3 tests need 120 days. Adding another 30-40 days for regulatory deliberations and the utility should have received the licence for regular operation 160-170 days after the grid connection. The commissioning was scheduled to be completed within 180 days of the grid connection, i.e. on or before 22 April 2014.[4]

The commissioning could not progress as pre-planned because of shutdowns due to trips (SCRAMs) and maintenance, and under-performance of the reactor during working days.[5] During the 435 days of grid connection from 22 October 13 to 31 December 2014, the reactor experienced 19 SCRAMs and three maintenance outages. Five of the SCRAMs that kept the generator off-grid for a total of 580 minutes could have been initiated by the operator as part of the commissioning tests. The remaining 14 SCRAMs – the 'real ones' − and three maintenance outages kept the reactor down for a total of 92 days and 139 days respectively. KKNPP's SCRAM rate (calculated per 7,000 reactor hours) is 20.8 per year as against 0.37 for all the reactors in the world and average loss of productivity per trip is 6.5 days as against 1.5 days for the reactors in a World Nuclear Association analysis.[6]

After the completion of the 'non-stop 7 days 90% FP' test on 23 June 2014, three attempts to conduct the 100% FP test failed and the plant was shut down for maintenance from 16 July until 15 September 2014. The output was less than 900 MW from 15 to 27 September 2014 and then the reactor tripped due to turbine problems. It resumed operation on 7 December 14 and attained full power three days later, heralding the fourth attempt for non-stop 100% FP. On 30 December 2014, the reactor had completed 20 days non-stop operation at 100% FP and the AERB had extended the deadline to complete the C-3 test till 30 April 2015.

Commissioning, post-commissioning performance and AERB consent

On 31 December 2014, the NPCIL hurriedly declared that the commissioning of the reactor was complete. A press release signed by the KKNPP site director said “unit No 1 has been declared commercial operation from midnight (0000 hours!) of 31 December 2014.”[7] Quoting him, a national newspaper reported: “We’ve received the nod from our high command for commencing the commercial power generation”.[8] As the ‘nod’ was received just six hours before the appointed time, there was no celebration, no song and dance, no fireworks and no press conference.

On 14 January 2015, on the 36th day of the non-stop 100% FP test, the reactor SCRAMed for the 15th time and was down till 17 January.[9] Full power was resumed on January 20 and continued for 89 days until 18 April 2015. From April 19 onwards, the output started declining systematically and on 9 May 2015, the reactor tripped for the second time since its commissioning due to a "problem in steam generator level control".[10] The decline of output continued even after the restart and the unit was shut down for 60 days maintenance on 24 June 2015.

Instead of asking the utility to repeat the 100% FP test, the AERB granted the Licence for Regular Operation of KKNPP on 8 July 2015. The press release said that the decision to grant the licence "is the culmination of in-depth review over many years of the safety aspects related to the design, construction and commissioning of the unit with respect to compliance with the specified requirements". It is silent about the final test and there is no mention about the Advisory Committee of Project Safety Review.

The Russian version of commissioning and licensing

The Russian News Agency TASS reported on 2 January 2015 that “the reactor has been commissioned for warranty-period operation. An act on a provisional transfer of power unit No. 1 to operation was signed by the Russian and Indian sides. This means that a year-long period of operation on warranty has begun. Upon the results of these twelve months, the power unit will be fully transferred to the Indian side".[11]

On 8 July 2015, the day the AERB Board of Directors met in Mumbai to grant the licence to KKNPP, the Prime Minister of India met the President of the Russian Federation at Ufa in Russia. At the press conference after the bilateral meeting, the Indian Ambassador to Russia said: "The Kudankulam 3 and 4 contracts have already been signed. There is a General Framework Agreement which has been signed. There is what is called the Long Cycle Supply of Equipment which is a contract that has been signed. That is what the (Indian) Prime Minister and President Putin noted with satisfaction as progress in the nuclear energy cooperation".[12]

International peer-review of India's nuclear regulator

In March 2015, two months after the declaration of completion of commissioning and three months before the grant of the licence, an IAEA mission reviewed India's regulatory framework for safety of nuclear power plants and recommended that "the Government should embed the AERB's regulatory independence in law, separated from other entities having responsibilities or interests that could unduly influence its decision making".[13]

Discussion

While the future of the reactor is uncertain, the NPCIL is busy constructing the third and the fourth units from the same vendors and negotiating for import of 20 more reactors from Russia, France and the USA. India is also planning to export nuclear power plants to other Asian-African countries.

Some six decades after the birth of the civilian nuclear energy and meltdown of six reactors, the world is now realizing the need for a global system of regulation that works. J.J. Bevelacqua, theoretical nuclear physicist, health physicist and senior reactor operator and a key player in the Three Mile Island and Hanford cleanup activities, says that "three major reactor accidents in a span of 35 years offer a sobering reminder that the current regulatory approach has not produced the desired results, and that change is warranted" and "an ideal regulatory framework would be proactive, internationally accepted, supported by the public, anticipate accident events, constantly challenge accepted practices, and prevent major accidents".[14]

The presence of a junk reactor in the South Indian coastal village loaded with 4,000 kg of fissile materials and fission products, poses a persistent threat of a global catastrophic risk. The experiences so far show that those who crafted this Frankenstein's monster will not de-craft it. As the reactor's instability has been demonstrated repeatedly and its future is unpredictable, the best option is to remove the fuel from the core and subject the project to a peer review by a credible international agency consisting of nuclear regulators, safety scientists and civil society representatives. The past nuclear disasters were accidents, in the sense that they were not predicted in advance. This predicted one, whose trans-boundary impacts may even be larger than the last one, can only be prevented by global action in which scientists, technologists and law-makers will have major roles to play. In this process, we will also be creating a truly global and democratic regulatory mechanism for the so-called civilian side of the fission technology. Like for the fissile material, an international regime is necessary for the control and regulation of fission technology also.

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NUCLEAR NEWS

Switzerland nuclear free – for two days

Due to a combination of circumstances Switzerland was nuclear free in mid-August – without having any power problems.

Usually the five nuclear power reactors are taken out of service in summer for annual maintenance – one after the other. Because of material problems in the pressure vessel of Beznau I and an incident in Gösgen, Switzerland this summer suddenly found itself nuclear free for two days.

In March 2015 Beznau I was taken off the grid for a longer than usual maintenance. The operator Axpo wanted to change the cap of the pressure vessel and make some upgrades to the standby cooling system during the annual overhaul. Other nuclear power plants of the same type around the world have shown corrosion problems at their cap. Axpo wanted to prevent that – and improve the image of its world oldest nuclear power plant. Even though Beznau I at 46 years and Beznau II at 44 years have achieved their technical lifetime (they were conceived for 30 years originally), Axpo wanted to invest 700 million Swiss Francs and hope that the two power plants will be authorized to operate for up to 60 years.

Axpo's dream is not about to become reality. Because of the cracks found in the vessel of the Belgian nuclear power plant Doel 3 and Tihange 2, Axpo had to carry out an extra examination of the vessel. Beznau I should have been connected to the grid in June 2015, but the results of the examinations showed material defects in the reactor pressure vessel. The atomic authority asked for more examination and Beznau I will not be producing any power at least until spring 2016.

The other Swiss nuclear power plant still had work to do: at the beginning of August Leibstadt and Mühleberg began the annual overhaul. In summer power demand and prices are low, and the annual overhaul of Swiss nuclear power plants sometimes overlap. Beznau II was then shut down in mid-August to allow, as with Beznau I, a longer overhaul to change the cap and carry out the pressure vessel tests.

Finally, because Gösgen had a steam-leakage in the non-nuclear part of the power plant, five Swiss nuclear power plants were shut down at the same time for two days. And did we have a power problem? No!

Situation of the five Swiss nuclear power reactors as of August 2015:

Beznau I	365 MW	1969	46 years old	Offline until 2016
Beznau II	365 MW	1971	44 years old	Offline until Dec 2015
Mühleberg	373 MW	1972	43 years old	Offline until end of Aug 2015
Gösgen	970 MW	1979	36 years old	Operating after incident.
Leibstadt	1190 MW	1984	31 years old	Maintenance until early Sept.

− Sabine von Stockar

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Global renewables surpass gas; climb to second place

The International Energy Agency's 'Electricity Information 2015' report states that renewable electricity generation has overtaken gas to become the second largest source of electricity worldwide, with renewables producing 22% of total electricity or 5,130 terawatt-hours (TWh) in 2013. That figure is more than double nuclear power's output of 2,359 TWh in 2013.

In 2013, 67.2% of world electricity production was from fossil fuel-powered plants (including 41.1% from coal). Renewables provided 22% (comprising hydro 16.6%, biofuels and waste 2.0%, with geothermal, solar, wind and other sources making up the remainder). Nuclear plants contributed 10.6%,

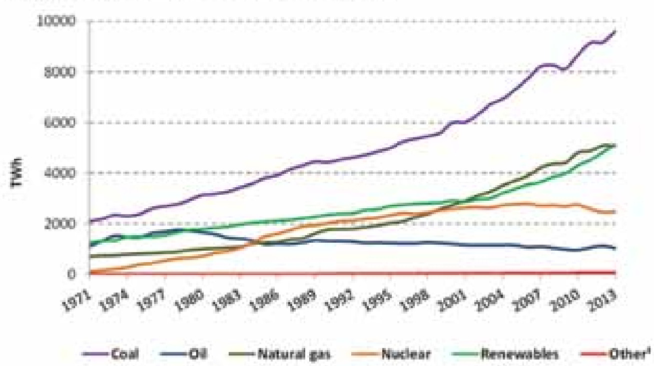
In 2013, global non-hydro renewable electricity, which rose to 1,256 TWh or 5.4% of global electricity production, surpassed oil-fired generation for the first time ever.

From 1973 to 2013, world gross electricity production increased from 6,144 TWh to 23,391 TWh, an average annual growth rate of 3.4%.

Sharp differences are evident between OECD and non-OECD countries:

- Between 2013−2013, in OECD countries there was a negative annual average growth rate of electricity production of -0.35%, compared to +5.6% in the rest of the world.
- In non-OECD countries over the past 40 years, electricity production increased at an average annual rate of 5.2%, while in OECD countries the average annual growth rate was 2.2%.
- In 2011, non-OECD countries produced more electricity than OECD countries for the first time in history. Total OECD electricity production in 2014 was lower than its 2007 level.

World electricity production by source from 1973 to 2013



1. Includes non-renewable wastes, electricity from chemical heat and other sources (e.g. fuels cells)

IEA, ‘Electricity Information 2015’, www.iea.org/bookshop/666-Electricity_Information_2015

Free excerpt: www.iea.org/publications/freepublications/publication/Electricitytrends.pdf

Media release: www.iea.org/newsroomandevents/news/2015/august/renewable-electricity-generation-climbs-to-second-place-after-coal.html

Uranium contamination in US aquifers linked to nitrate

A common agricultural pollutant can free up naturally occurring uranium and create the potential for increased radioactivity in drinking water and some crops, according to new research by Jason Nolan and Karrie Weber from the Department of Earth and Atmospheric Sciences, University of Nebraska.

Groundwater data from two major US aquifers revealed naturally occurring groundwater uranium exceeding the US Environmental Protection Agency maximum contaminant level across 22,375 sq km where 1.9 million people live. Analysis revealed a moderately strong correlation between uranium and nitrate, a common groundwater contaminant. Nitrate is recognized to alter uranium solubility by oxidative dissolution of reduced minerals. The authors state “these results indicate that nitrate, a primary contaminant, should be considered as a factor leading to secondary groundwater U contamination in addition to the recognized role of alkalinity and calcium.”

Their article concludes:

“Our data indicate that nitrate concentrations near the MCL [maximum contaminant level] are correlated to groundwater U contamination. Thus, nitrate-mediated U solubilization presents a threat to the quality of groundwater resources already under pressure because of population growth and global environmental change. This has the potential to negatively impact the health of millions of residents in the United States and around the world utilizing U-contaminated drinking water. Additionally, irrigation accounts for an estimated 43% of global groundwater use. Food crops irrigated with contaminated water have been demonstrated to accumulate U, thus leading to an additional route of U exposure through food crops. Given the ubiquitous nature of nitrate in aquifers and the strong correlation with U mobilization, increased testing of groundwater for U where nitrate is at or near the MCL should be conducted.”

Jason Nolan and Karrie A. Weber, 2015, ‘Natural Uranium Contamination in Major U.S. Aquifers Linked to Nitrate’, Environmental Science and Technology Letters, 2, 215−220, http://pubs.acs.org/doi/pdf/10.1021/acs.estlett.5b00174

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WISE/NIRS Nuclear Monitor

The World Information Service on Energy (WISE) was founded in 1978 and is based in Amsterdam, the Netherlands.

The Nuclear Information & Resource Service (NIRS) was set up in the same year and is based in Washington D.C., US.

WISE and NIRS joined forces in the year 2000, creating a worldwide network of information and resource centers for citizens and environmental organizations concerned about nuclear power, radioactive waste, proliferation, uranium, and sustainable energy issues.

The WISE / NIRS Nuclear Monitor publishes information in English 20 times a year. The magazine can be obtained both on paper and as an email (pdf format) version. Old issues are (after 2 months) available through the WISE homepage: www.wiseinternational.org

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