

JAPAN'S NUCLEAR SCANDALS AND THE FUKUSHIMA DISASTER



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"I can find no escape from Fukushima Daiichi. Words I hoped never to read in a news report, like loss of coolant accident (LOCA), exposed core, hydrogen explosion: Here they are."

-- Robert Socolow, 21 March 2011, 'Reflections on Fukushima: A time to mourn, to learn, and to teach', [Bulletin of the Atomic Scientists](#).

"The Fukushima Daiichi accident is one of the most serious and complex disasters which human beings have ever had to deal with."

-- International Atomic Energy Agency Director-General [Yukiya Amano](#), 27 July 2011.

"I wish there wasn't a nuclear plant."

-- [suicide note](#), cattle farmer, Fukushima Prefecture, June 2011.

CONTENTS

1. Safety breaches and cover-ups

p.2

The Japanese nuclear industry has been plagued by safety breaches, scandals, cover-ups, inadequate regulation and a myriad of other failings over a long period of time.

2. Corruption and collusion in Japan's 'nuclear village'

p.5

Japan's nuclear industry is run by a clique of public- and private-sector interests that have promoted personal and corporate gain at the expense of public safety.

3. Nuclear accidents in Japan

p.6

Managerial and regulatory failures have contributed to numerous nuclear accidents in Japan.

4. Earthquake and tsunami risks

p.7

TEPCO (operator of the Fukushima plant) did not adequately protect against earthquake and tsunami risks, nor was it forced to by the government regulator.

5. Responsibility for the Fukushima disaster

p.11

Primary responsibility for the disaster lies with TEPCO. Others are culpable including Japanese government agencies and regulators, and overseas suppliers who have turned a blind eye to serious problems in Japan's nuclear industry over a long period of time.

6. Australia's role in the Fukushima disaster

p.12

Australia's uranium mining industry has done nothing to try to rectify the patterns of unsafe mismanagement in Japan's nuclear industry, or the inadequate regulation. Successive Australian governments have been equally passive.

Appendix: Spinning Fukushima

p.13

Two ABC opinion articles (March 2011 and February 2012) on the 'spinning' of the Fukushima disaster by nuclear power advocates.

References

p.17

1. SAFETY BREACHES AND COVER-UPS

"It's a fact that there was an unreasonable overconfidence in the technology of Japan's nuclear power generation."

— Banri Kaieda, head of the Ministry of Economy, Trade and Industry, quoted in Norimitsu Onishi, 24 June 2011, ["Safety Myth' Left Japan Ripe for Nuclear Crisis"](#), *New York Times*.

The Fukushima Dai-ichi meltdowns, fires and explosions of March 2011 were by far Japan's worst-ever nuclear accidents, but they can also be seen as the latest in a long line of accidents in Japan's nuclear industry – an industry notorious for its dangerous mismanagement, secrecy, dishonesty and slack regulation.

Whereas the earthquake and tsunami were natural disasters, Fukushima was a man-made disaster. Establishing that argument is the purpose of this paper. The paper does not consider the consequences of the accident but some are briefly summarised here:

- Three people died (not from radiation exposure) at Fukushima Dai-ichi from March 11–14 and dozens of people were injured. Other nuclear disaster-related deaths have been [reported](#) – for example Japan's self-defence force discovered 128 elderly people abandoned by medical staff at a hospital six miles from the Fukushima plant; most were comatose and 14 died shortly afterwards.
- More than 110,000 people were evacuated because of the nuclear disaster according to the Japanese government's [Investigation Committee](#). Most are still unable to return to their homes and some never will. The toll on people's health and mental well-being has been significant – one indication being the [sharp increase in suicide rates](#) as a result of the tsunami, earthquake and nuclear disaster.
- It will be decades before the ruined reactors are decommissioned. Decades before the legal battles have concluded. Contamination with long-lived radionuclides will persist for many generations – caesium-137 will be a concern for around 300 years.
- One preliminary [study](#) estimates a long-term cancer death toll of "around 1,000"; [another preliminary study](#) estimates "~100s cases" of fatal cancers from Fukushima fallout.
- TEPCO could face compensation claims amounting to [US\\$136 billion](#). Direct and indirect economic costs from the disaster will amount to hundreds of billions of dollars.

Failure to properly protect back-up power generators was a direct cause of the Fukushima disaster. To understand why a power utility would fail to properly protect vital safety equipment at a plant with six nuclear power reactors, we need to understand the systemic mismanagement of Japan's nuclear industry. A logical starting-point is the scandal which broke in 2002.

On 29 August 2002, the Japanese Nuclear Industrial Safety Agency (NISA) [revealed](#) details of multiple 'malpractices' by the Tokyo Electric Power Company (TEPCO). The information initially came from a whistleblower who worked with a TEPCO contractor, General Electric International Inc.

At that point [29 cases](#) of 'malpractice' had been identified involving 13 TEPCO reactors, including reactors at Fukushima. It was [reported later](#) that these practices had gone since 1977 (if not earlier), the total number of incidents was put at nearly 200, and all Japanese nuclear utilities were involved.

TEPCO's 'malpractices' included:

- falsification of inspection records over many years;
- covering up data about cracks in water circulation pumps and pipes which are critical for reactor cooling;
- failure to report cracks in reactor core shrouds (stainless steel cylinders surrounding the reactor core), steam dryers, access hole covers, and components associated with jet pumps (which circulate cooling water inside the reactor);
- in 1991 and 1992, tests of the leak rate of a Fukushima reactor containment vessel were [faked](#) by surreptitiously injecting compressed air into the containment building;
- written records of cracks in neutron-measuring equipment at Fukushima were deleted by contractor Hitachi at TEPCO's request; and
- eight TEPCO reactors were still operating although required repairs had not been carried out.

Kei Sugaoka, who used to conduct inspections at Fukushima, [warned](#) the government in a 28 June 2000 letter about TEPCO's continued operation of a damaged steam dryer 10 years after he first pointed out the problem.

The government sat on the warning for two years. In 1989 Sugaoka was ordered to edit out footage showing cracks in steam pipes in a video being submitted to regulators. "I always thought it was just a matter of time," he said of the March 2011 disaster. "This is one of those times in my life when I'm not happy I was right."

TEPCO admitted to "dishonest acts" in a press release on 25 October 2002. TEPCO head Tsunehisa Katsumata said the data falsification was "the gravest crisis since the company was established", and that the company had lost so much "it should start again from zero". Three TEPCO executives [resigned](#) and another 35 received penalties such as reprimands and small pay cuts.

On 9 October 2003, TEPCO [announced](#) that over 1,000 foreign objects had been found in the pressure suppression pools of a number of its reactors. These included an iron pipe, an electric grinder, a wrench, dust masks, work shoes, plastic sheets, barbed wire, and so on.

Incidents involving other utilities [included](#):

- Chubu admitted it had failed to report signs of cracking in water pipes of two reactors at its Hamaoka plant. (In 2001, a water pipe at Hamaoka-1 [exploded](#), releasing radioactive steam into the containment building. In 2002, 16 workers were irradiated after a water pipe leak at Hamaoka-2.)
- Tohoku Electric admitted that it failed to report cracks found in recirculation piping at Onagawa 1 in 1988.
- Japan Atomic Power Co. acknowledged that cracks in the core shroud of Tsuruga-1 had been covered up in 1994, 1996 and 1998.

Inspection standards were strengthened in 2003, fines for cover-ups were increased and the possibility of jail for up to one year was introduced. However these improvements were incommensurate with the scale of the problem. TEPCO and other utilities did little to improve their performance. Moreover they lobbied (successfully) to [weaken standards](#) with the adoption of the concept of 'allowable reactor defects', which increased their capacity to keep reactors online even after defects were discovered.

NISA, the main nuclear regulator, [said](#) on 1 October 2002: "NISA regards the recent cases as a very serious problem, not only with safety arrangements at licensees who have performed inappropriate acts but also with Japan's nuclear safety regulatory administration itself. The cover-up cases have made us painfully aware that we must frankly reflect on what we have done, take the plunge and mend our ways. As nuclear safety regulatory authorities, we must seriously recognise that the relevant cases caused tremendous anxiety among local residents living near nuclear facilities, and destroyed public trust in nuclear safety regulations."

However NISA did not 'mend its ways' as later scandals would demonstrate. It remained a small division within the powerful, pro-nuclear Ministry of Economy, Trade and Industry (METI).

Another [admission](#) from TEPCO in 2006: coolant-water data at two of its nuclear plants had been falsified in 1985 and 1988.

On 30 March 2007, 12 Japanese utilities [submitted reports](#) to METI about malpractices at their plants. The reports included 306 cases of malpractice, of which 97 related to nuclear power plants (104 if each incident is counted separately).

In 2007, TEPCO acknowledged breaches which had not previously been disclosed, including:

- concealment of at least six emergency stoppages of reactors at Fukushima Dai-ichi, and concealment of emergency shut-down/s at TEPCO's Kashiwazaki-Kariwa plant.
- further examples of falsification of temperature readings at sea-water intake and outlet pipes.
- concealment of criticality accidents – one in 1978 (nuclear fuel rods fell out of position in one of the Fukushima reactors and a nuclear chain reaction continued for over seven hours) and one in 1984.
- in May 1992 at Kashiwazaki-Kariwa, TEPCO made adjustments to make it appear from the central control room that the residual heat removal pump – part of the emergency core cooling system – was functional although it was not.
- in May 1995 the concentration of radioactivity from rare gases emitted from the exhaust stack of Fukushima reactor #4 was falsified.
- in 1995, TEPCO failed to record or report the breakdown of a back-up generator during a trial at Kashiwazaki-Kariwa.

- in 1998, 34 fuel rods slipped 15 cms out of position in one of the Fukushima Dai-ichi reactors although the reactor did not reach criticality.
- at Kashiwazaki-Kariwa, from around 1995 to 1997, measurements of the concentration of radioactive iodine released from the exhaust stack were falsified.
- from 1979 to 1998, in order to pass inspections, internal pressure readings in steam pipes connecting the reactor to the turbines at one of the Fukushima Dai-ichi reactors were falsified to match the specifications in the inspection guidelines.
- from 1983-2005, at one of the Fukushima Dai-ichi reactors, a device which controls the concentration of flammable gases was "set inappropriately" (this incident, among others, gives the lie to TEPCO's claim that there were no instances of malpractice since 2002).

TEPCO Vice-President Katsutoshi Chikudate said in 2007: "We apologize from the bottom of our heart for causing anxiety to the public and local residents." Yet TEPCO's failings persisted. On 17 June 2010, a power failure stopped pumps providing cooling water to one of the Fukushima reactors. TEPCO was repeatedly asked what would happen if the back-up diesel generators also failed but the company [waived this concern away](#) according to former Fukushima Prefecture governor Eisako Sato.

On 28 February 2011 – less than a fortnight before the disaster – TEPCO [reported](#) to NISA that it had [failed to carry out scheduled inspections](#) of 33 pieces of equipment in the six reactors at Fukushima Dai-ichi, including a motor and a back-up power generator

As with TEPCO, barely a year has passed without further revelations of safety breaches and cover-ups by other nuclear utilities:

- in November 2006, Chugoku Electric revealed it has altered a computer program used to measure the temperature differential between water intake and outflow pipes. Subsequent checks revealed similar alterations at seven reactors operated by various utilities.
- in 2007, Hokuriku revealed that it had covered-up an 18 June 1999 criticality accident at one of its Shika reactors. During an inspection, one control rod was meant to be inserted but instead three control rods were withdrawn, leading to criticality. This set off an automatic 'stop' signal but the control rods were not automatically inserted as the isolation valves were closed for the test. Fifteen minutes later, operators reopened the valves and the control rods were reinserted.
- in August 2007, work at three nuclear research units run by Japan's Atomic Energy Agency was [halted](#) due to concerns over the handling of fuel material and other problems. The Agency reported 46 problems at its Tokaimura plant following initial revelations by a whistleblower. One of the units is a critical testing facility for a fast breeder reactor – safety rods had not been checked and approved by the government. At the other two units, nuclear material had been stored for about a decade in containers meant for temporary storage.
- in 2009, Hitachi (a contractor) [announced](#) it was carrying out an investigation after discovering falsification of testing data on heat-welded pipes in moisture separator heaters it had supplied to two Japanese nuclear plants (Chubu's Hamaoka and Chugoku's Shimane).
- in March 2010, Chugoku Electric [apologised](#) for its failure to carry out inspections on 123 pieces of equipment at its Shimane nuclear plant (motor-driven isolation valves were not inspected and/or replaced as scheduled). The company found 74 such cases at unit 1 and 49 at unit 2. Two months later, the number was [increased](#) to 506 pieces of equipment.
- Japan Atomic Power Company admitted that a valve that compromised the airtight status of the containment vessel of one of its Tsuruga reactors was hidden from inspectors before replacement two days later.
- in 2011, two reactors (at the Tomari and Oi plants) ran at full capacity for several months despite not receiving the [final clearance from NISA](#).

2. CORRUPTION AND COLLUSION IN JAPAN'S 'NUCLEAR VILLAGE'

"Just as in any Japanese village, the like-minded – nuclear industry officials, bureaucrats, politicians and scientists – have prospered by rewarding one another with construction projects, lucrative positions, and political, financial and regulatory support. The few openly skeptical of nuclear power's safety become village outcasts, losing out on promotions and backing."

— Norimitsu Onishi and Ken Belson, 26 April 2011, ['Culture of Complicity Tied to Stricken Nuclear Plant'](#), *New York Times*.

Most of the nuclear utilities and numerous contractors have been complicit in the never-ending safety breaches, cover-ups and scandals in Japan's nuclear industry. The problems have been allowed to fester because of slack regulation. As mentioned the regulator NISA is part of METI, the government agency responsible for promoting nuclear power. Officials are transferred repeatedly between the regulatory and promotional divisions of METI. Only in the wake of the Fukushima disaster has the government moved to separate NISA from METI. NISA will become an agency of the Ministry of Environment and its functions will be integrated with those of the other regulator, the Nuclear Safety Commission.

Eisako Sato, governor of Fukushima Prefecture from 1988-2006, said that between 2002 and 2006, 21 problems at the Fukushima plant were reported to his office. Whistleblowers bypassed NISA for fear that their identity would be revealed to TEPCO. Those fears were well founded. Sugaoka Kei, a General Electric inspector, notified NISA of safety breaches in June 2000. Instead of [protecting his identity](#), NISA [provided his name](#) to TEPCO.

One of the scandals to emerge in 2011 concerns NISA's role in rigging the outcomes of public surveys and public fora. In 2011 a [committee uncovered seven instances](#) of government agencies – including METI and NISA – arranging to have people attending public fora on nuclear energy ask questions that favour nuclear power. At a press conference, NISA Director-General Hiroyuki Fukano said, "I apologise from the bottom of my heart."

Just as there is a revolving door between the regulatory and promotional divisions within METI, so too there is a revolving door throughout Japan's 'nuclear village' – the network of like-minded government agencies, utilities, contractors, academics, scientists and others. Government officials often ['descend from heaven'](#) – moving from government agencies to well-paid jobs with nuclear utilities. The most senior officials are likely to move to the largest utility, TEPCO, while less senior officials tend to land jobs with the smaller utilities. TEPCO appears to have a 'reserved seat' – the vice presidency – set aside for government officials. From 1959 to 2010, the *New York Times* reports, four former ministry officials successively served as vice president of TEPCO.

In another process known as amaagari, or 'ascent to heaven', the regulator NISA employs retired or active engineers from nuclear utilities.

There is also a revolving door between nuclear utilities and Parliament. For example the Liberal Democrats [selected](#) Tokio Kano, a former TEPCO vice president, for a seat in Parliament. He served two six-year terms in Parliament until 2010, working tirelessly to promote the interests of the nuclear utilities, and more recently he returned to TEPCO to work as an adviser.

Corporate money lubricates the nuclear village. For example, executives from nine utility companies (including TEPCO) [donated](#) US\$595,000 to the ruling Liberal Democratic Party in 2009, which amounted to nearly three-quarters of total individual donations to the party.

"It's all about money," [said](#) a politician not linked to the nuclear village.

There is also a revolving door between Japan's nuclear village and the International Atomic Energy Agency (IAEA). In 2009, a US cable released by WikiLeaks [said](#) that over the past decade, the IAEA's department of safety and security "suffered tremendously because of [deputy director general] Taniguchi's weak management and leadership skills."

Tomihiko Taniguchi moved to the IAEA after decades working in the private- and public-sector arms of Japan's nuclear village. Another 2009 US cable said: "Taniguchi has been a weak manager and advocate, particularly with respect to confronting Japan's own safety practices, and he is a particular disappointment to the United States for his unloved-step-child treatment of the Office of Nuclear Security."

The IAEA carried out safety inspections at Fukushima in 1992 and at Chubu's Hamaoko plant in 1995, finding a total of [90 deficiencies](#) in safety procedures including "weakness in emergency plan procedures", "insufficient event analysis on near-misses" and "lack of training for plant personnel on severe accident management". The IAEA was not invited to carry out any further safety inspections after 1995 and TEPCO and Chubu [resisted](#) the recommendations of the IAEA experts.

Thus there has been precious little scrutiny from the IAEA – it is compromised by its revolving doors and by its promotional aims and activities, and it has too little authority and too few resources for its safeguards and safety roles. With the exception of a few courageous whistleblowers, overseas suppliers and contractors to Japan's utilities – including Australia's uranium mining companies – have done nothing about safety breaches, scandals and accidents in Japan.

3. NUCLEAR ACCIDENTS IN JAPAN

"Japan's nuclear officials have tried to juggle promotion and regulation but the result has been numerous accidents and troubles."

— Kenji Sumita, a former deputy chairman of the Nuclear Safety Commission, quoted in Yuka Hayashi, 28 March 2011, ['Nuclear Regulator Tied to Industry'](#)

Given the recurring patterns of mismanagement and inadequate regulation in Japan's nuclear industry, it is no surprise that there have been dozens of accidents over the past 20 years. Some of the most serious are listed here (much of the information comes from the Tokyo-based [Citizens Nuclear Information Centre](#)):

In December 1995, there was a leak of eight tonnes of sodium from the Monju fast breeder reactor as well as a fire. The plant operator lied about the timing of the fire and supplied a doctored video attempting to downplay the accident.

In March 1997, there was a fire and an explosion at the Tokai reprocessing plant. At least 37 workers were exposed to low doses of radiation. The operator, Donen, later acknowledged it had initially suppressed information about the fire. Donen initially reported radiation levels 20 percent above normal outside the building, but later admit that the true level was at least 10 times higher.

In April 1997, at the Fugen test reactor in Tsuruga, a tritium leak was announced to the responsible authorities 30 hours after the event. It was later found that 11 similar incidents had previously occurred at the reactor. Five managers at the Power Reactor and Nuclear Fuel Development Corporation resigned.

On 12 July 1999, 50 tonnes of primary coolant leaked from a cracked pipe in a reactor at Tsuruga, leading to a sharp increase of radiation levels inside the reactor building.

On 18 June 1999, a 15-minute criticality accident resulted from the accidental removal of three control rods from a commercial power reactor, and this accident was not reported until 2007.

In September 1999, a criticality accident at a fuel fabrication plant at Tokaimura led to the deaths of two workers and another worker being hospitalised for three months; short-term evacuation of the surrounding population; and 667 plant workers, emergency workers and nearby residents receiving low doses of radiation. The accident resulted from poor worker training, poor management and inadequate regulation.

In 2000, TEPCO had to temporarily [shut-down three reactors](#) at Fukushima in five days – one because of an increase in iodine levels (probably because of a faulty fuel rod), one because of an oil leak and one because of a rise in the emissions of waste gas following an earthquake.

In 2001, there were two accidents at Chubu's Hamaoka plant. One involved an explosion leading to pipe rupture in the Residual Heat Removal System and leakage of contaminated water. The other involved leakage from the bottom of the pressure vessel.

In 2002, 16 workers were irradiated after a pipe leak at Hamaoka-2.

In 2002, two workers were exposed to a small amount of radiation and suffered minor burns during a fire at Onagawa.

On 9 August 2004, [five workers were killed](#) and six injured after a pipe rupture and steam leak at the Mihama-3 nuclear power plant. It was later revealed that failed pipe had not once been checked since the plant went into operation in 1976. NISA later said that there had been nine previous incidents at Japanese reactors involving pipes eroded by coolant water. Lessons had not been properly learnt and acted upon.

On 22 March 2006, A fire broke out at Kansai's nuclear plant at Oki, in a waste disposal facility. Employees were evacuated. Two were taken to hospital.

On 16 July 2007, a powerful earthquake hit Japan's northwest coast, killing at least eight people and causing malfunctions at TEPCO's Kashiwazaki-Kariwa plant, including radioactive water spills, burst pipes and fires. Radiation releases included small leaks of radioactive liquids from Unit 6 reactor building, a spent fuel pool and other sources; 12 MBq of iodine and 402 MBq of particulate radioactivity released from an exhaust pipe; and the release of small quantities of radionuclides from 400 drums of low-level nuclear waste which were knocked over, 40 losing their lids. Fire broke out in a transformer building. TEPCO was sharply criticised for its handling of the accident.

In September 2007, there was a leak of about three tonnes of radioactive water from one of Kansai's reactors at Ohi power station.

On 2 December 2009, 29 workers were exposed to low doses of radiation after 53 litres of highly-concentrated liquid nuclear waste leaked at one of Chubu's reactors in Shizuoka Prefecture.

In March 2011, the earthquake and tsunami which devastated TEPCO's Fukushima Dai-ichi plant and also caused damage at several other nuclear plants.

4. EARTHQUAKE AND TSUNAMI RISKS

"TEPCO did not implement measures against tsunami as part of its AM [Accident Management] strategy. Its preparedness for such accident as severe damage at the core of reactor as a result of natural disasters was quite insufficient."

— Japanese government's [Investigation Committee](#), December 2011

There is a long history of TEPCO and other utilities trivialising earthquake and tsunami risks and failing to take adequate steps to prevent accidents:

- TEPCO ignored scientific evidence of historical earthquakes well in excess of that it had based its defences on;
- efforts were made to strengthen the back-up generator system but those efforts were unimpressive and on 11 March 2011 they were proven to be inadequate to prevent major problems in four reactors;
- problems with the location and vulnerability of electric switching stations were not addressed;
- a problem during the manufacture of a reactor pressure vessel for the Fukushima #4 reactor was covered up;
- problems with piping systems were not adequately addressed;
- concerns about the robustness of the containment vessels of General Electric's Mark 1 boiling water reactors were not adequately addressed.

Those problems are briefly discussed in turn.

Earthquake and tsunami predictions and emergency planning

For many years, TEPCO either denied the possibility of an earthquake and tsunami of 11 March 2011 proportions or argued that such events were so improbable that they could be ignored. TEPCO [downplayed or ignored](#) mounting evidence to the contrary, including:

- evidence of historical earthquakes and tsunamis comparable to the 11 March 2011 events;
- evidence regarding tectonic plates which indicated an increased probability of events as serious as those that unfolded in March 2011; and
- examples of nuclear plants being subjected to seismic forces exceeding their design basis.

TEPCO lacked "common sense" and "absolutely should have known better," [said Dr Costas Synolakis](#), a US engineering professor with expertise in tsunami modelling.

The [document](#) on tsunami preparedness at Fukushima that TEPCO submitted to Japan's Nuclear Safety Agency in 2001 fit onto a single page.

The Japanese government's [Investigation Committee](#) into the Fukushima disaster noted in its December 2011 interim report that the Nuclear Safety Commission started a revision process of its seismic design regulatory guide in July 2001 but no tsunami specialist was involved in the revision process. "It indicates the [Nuclear Safety Commission's] insufficient awareness of the significance of tsunami in nuclear safety."

The Investigation Committee noted that in 2008, TEPCO re-evaluated tsunami risks at the Fukushima Dai-ichi and got the wave heights exceeding 15 metres, but the company failed to act on this information.

The Investigation Committee concluded that: "specific measures against tsunami should have been in place including measures against severe accidents for the purpose of preventing nuclear disasters."

The Investigation Committee stated:

"TEPCO did not implement measures against tsunami as part of its AM [Accident Management] strategy. Its preparedness for such accident as severe damage at the core of reactor as a result of natural disasters was quite insufficient. Listed below are some of the specific issues that were revealed through the Accidents.

i. Inadequate measures against Station Blackout (SBO)

The risk of tsunami exceeding design basis had not been considered. Therefore, no preparation was made for the eventuality such as "simultaneous and multiple losses of power" and the "Station Blackout including DC power supplies". No operational manuals were in place for recovering instrumentation equipment and power supplies, PCV venting, etc. in such conditions. Staff education was not organized for such eventuality and equipments and materials for such recovering operations were not ready for use on stock.

ii. No previous plan for water injection and seawater injection by fire engines

Fire engines were brought in for water injection and seawater injection for responding the Accidents. These steps were not placed as part of the AM. Therefore, specific procedures were not planned in advance and extra time was needed for their operation.

iii. Breaking down of emergency telecommunication lines

The in-house telecommunication lines in an emergency were not sufficiently in place. As a result of the SBO, all personal handy phone system (PHS) became inoperative and information sharing among the people concerned was seriously disrupted.

iv. Securing of materials and operators in an emergency

There were no specific procedures decided in advance for handling materials in an emergency or in an extraordinary situation, causing delay in securing operators of fire engines or heavy machinery."

A June 2011 [IAEA report](#) found that there were "insufficient defense-in-depth provisions" for tsunami hazards at Fukushima. The report states:

- *"although tsunami hazards were considered both in the site evaluation and the design of the Fukushima Dai-ichi NPP [nuclear power plant] as described during the meetings and the expected tsunami height was increased to 5.7 m (without changing the licensing documents) after 2002, the tsunami hazard was underestimated;*
- *thus, considering that in reality a 'dry site' was not provided for these operating NPPs [nuclear power plants], the additional protective measures taken as result of the evaluation conducted after 2002 were not sufficient to cope with the high tsunami run up values and all associated hazardous phenomena (hydrodynamic forces and dynamic impact of large debris with high energy);*
- *moreover, those additional protective measures were not reviewed and approved by the regulatory authority;*
- *because failures of structures, systems and components (SSCs) when subjected to floods are generally not incremental, the plants were not able to withstand the consequences of tsunami heights greater than those estimated leading to cliff edge effects; and*
- *severe accident management provisions were not adequate to cope with multiple plant failures."*

Despite the frequency of accidents, the Japanese 'nuclear village' has tirelessly promoted the '[safety myth](#)' – the hubristic belief that serious accidents were inconceivable. A March 1994 TEPCO report on action to be taken in the event of a serious accident [said](#): "It is inconceivable that a severe accident could actually occur."

The Tokyo-based Citizens Nuclear Information Centre has produced and compiled a great deal of information regarding earthquakes and nuclear risks in Japan: <http://cnic.jp/english/topics/safety/earthquake/index.html>

Generators

Fukushima Dai-ichi was equipped with 13 emergency diesel generators, one of which was out of service for maintenance on 11 March 2011. TEPCO had three air-cooled backup generators located 10–13 metres above sea level. In addition there were 10 water-cooled generators, [most](#) of them [located in the basement of a turbine building](#). They were located in a turbine building instead of better-protected reactor buildings because of space constraints. On 30 October 1991, one of two back-up generators for reactor #1 failed after it was [flooded](#) in the basement of the turbine building – water was leaking from a corroded pipe.

On 11 March 2011, only one of the air-cooled generators, which sat 13 metres above sea level, was [still functional](#) after the tsunami (it helped protect reactors #5 and #6). The other two air-cooled generators were rendered useless by the tsunami despite being 10 metres above sea level. All 10 of the plant's water-cooled generators were inundated by the tsunami.

Batteries supplied power for some hours, after which there was no cooling and this [led to meltdowns, fires and explosions](#). The failure to maintain power supply to reactor cooling systems was a direct cause of the disaster.

Former TEPCO engineer Toshio Kimura [said](#): "I asked my boss back in the late '90s what would happen if a tsunami hit the Fukushima reactors. I said surely a meltdown will happen. He said 'Kimura, you are right'. But it was made clear that the issue of a big tsunami was taboo. ... If they'd moved the emergency diesel generators to a position above the expected tsunami level it would have cost the company a lot. So nobody proposed it. ... A few years later I quit the company because of its culture of cover-ups."

Another TEPCO engineer [said](#): "Some of us knew all along and were concerned about the inconsistent placements of diesel generators at Fukushima Daiichi between reactor No. 6 and the older reactors 1 through 5, and their potential vulnerability." When he was preparing for a government inspection in 1987, the inconsistent placement of the generators "stood out like a sore thumb."

Former TEPCO executive Masatoshi Toyota [said](#): "Backup power generators are critical safety equipment, and it should've been a no-brainer to put them inside the reactor buildings. It's a huge disappointment that nobody at TEPCO – including me – was sensitive enough to notice and do something about this discrepancy."

Another former TEPCO executive [said](#): "We took it for granted that the quake-resistant design of our Fukushima and other nuclear plants was fail-safe. But I now doubt how serious we were about preparing for a

severe disaster. If only we'd put the backup generators on even higher ground away from the reactors, the Nos. 1 to 4 reactors might not have been damaged."

The International Atomic Energy Agency [noted](#) TEPCO's failure to prepare adequate back-up systems at Fukushima Dai-ichi; in particular TEPCO needed more varied and redundant back-up systems to maintain reactor cooling. Specifically, the June 2011 IAEA [report](#) said the elevation of some generators was "too low" and that "the physical separation and water-tight sealing of the of EDG [Emergency Diesel Generator] room need to be improved."

An [MIT report](#) into the Fukushima disaster states: "Emergency backup generators, needed to keep the systems running when outside power is cut off as it was in this case, should be well separated into at least two locations — one situated high up, to protect against flooding, and the other down low to protect against hazards such as an airplane crash. These generators should also be housed in watertight rooms, as they already are at many U.S. plants."

Switching stations

Other concerns included the [placement](#) of electric switching stations (which send power from back-up generators to the reactor cooling systems) in the turbine building which is less well protected than the reactor building. The failure of switching stations as they were swamped by the March 11 tsunami contributed to the disaster which followed.

Former TEPCO executive vice president Katsuya Tomono [said](#) he believes that "engineers on the ground took the easy way out and used the switch yard that already existed in the turbine buildings. As far as I know, there was no debate on this matter among engineers who led the move to add backup generators."

"Once water gets in there, the whole thing is kaput," said Mr. Tomono.

Whereas reactors #1–4 were all seriously damaged, reactors #5 and #6 and the four reactors at nearby Fukushima Daini, [safely reached cold shut-down](#) through some combination of generators being housed inside the reactor building instead of the generator building, the location of a generator on high ground at a distance from the reactor, and undamaged switching stations securely located within reactor buildings. This seriously undermines the argument that the problems experienced in reactors #1–4 were the unavoidable impacts of a major natural disaster. At Fukushima Daini, according to a June 2011 IAEA [report](#), three out of 12 generators survived the tsunami (if only due to "luck") and some off-site power was maintained.

Integrity of piping

The adequacy of critical safety-related piping in Mark 1 boiling water reactors has been controversial. Onda Katsunobu, author of the 2007 book 'TEPCO: The Dark Empire', [said](#): "I've spent decades researching TEPCO and its nuclear power plants and what I've found, and what government reports confirm, is that the nuclear reactors are only as strong as their weakest links, and those links are the pipes."

'Mark 1' reactor design flaws

Other aspects of the [design](#) of the five General Electric 'Mark 1' boiling water reactors at Fukushima have been controversial including concerns about the robustness of the containment vessel which (hopefully) protects against external radiation releases even in the event of an accident.

In 1972, Stephen Hanauer, a safety official with the US Atomic Energy Commission, [recommended](#) that the Mark 1 design be discontinued because of its safety risks.

Joseph Hendrie, who would later become chairman of the Nuclear Regulatory Commission, [said](#) the idea of a ban on such systems was attractive.

In the mid-1980s, Harold Denton, an official with the Nuclear Regulatory Commission, [voiced concerns](#) about the Mark 1 design.

In the late 1980s, several utilities [threatened to sue](#) G.E. after internal company documents were released suggesting that the containment vessel designs were insufficiently tested or had safety flaws.

In 1976, Dale Bridenbaugh, Gregory Minor and Richard Hubbard [resigned](#) from General Electric after becoming increasingly convinced that the Mark 1 boiling water reactor design was unsafe. They became known as the 'G.E. Three'.

The Wall Street Journal based a July 2011 [article](#) on interviews with 12 current and former senior TEPCO engineers, including some involved in the design decisions made in the 1970s. Some of them said that TEPCO had opportunities over the decades to retrofit the Mark 1 reactors but did not adequately do so because of a combination of complacency, cost-cutting pressures and lax regulation.

Construction accident

Mitsuhiko Tanaka worked as an engineer with Babcock Hitachi on the design and manufacture of the steel pressure vessel for the #4 reactor at Fukushima Dai-ichi. Tanaka [says](#) the vessel was damaged in the production process and that he himself orchestrated the cover-up – with Babcock Hitachi's blessing. The walls of the vessel warped because of incorrect procedures during a steel-strengthening heating process. Tanaka says he got a US\$38,000 bonus and a plaque for his efforts.

"At the time," Tanaka reflected after the 2011 disaster, "I felt like a hero." Two years after the Chernobyl disaster, Tanaka went to METI to report the cover-up. Hitachi and the government were unresponsive. In 1990, Tanaka wrote a book titled 'Why Nuclear Power Is Dangerous' documenting his experiences working in the industry.

5. RESPONSIBILITY FOR THE FUKUSHIMA DISASTER

"TEPCO did not take precautionary measures in anticipation that a severe accident could be caused by tsunami such as the one hit at this time. Neither did the regulatory authorities."

— Japanese government's [Investigation Committee](#), December 2011

"The best place to be whenever there's an earthquake is at the perimeter of a nuclear plant because they are designed so well."

— Ziggy Switkowski, 14 March, 2011, [ABC](#).

"There is no credible risk of a serious accident. The risk of meltdown is extremely small, and the death toll from any such accident, even if it occurred, will be zero. There will be no breach of containment and no release of radioactivity beyond, at the very most, some venting of mildly radioactive steam to relieve pressure. Those spreading FUD [fear, uncertainty and doubt] at the moment will be the ones left with egg on their faces. I am happy to be quoted forever after on the above if I am wrong ... but I won't be."

— [Prof. Barry Brook](#), Adelaide University

Many nuclear advocates want to absolve TEPCO from responsibility for the March 2011 disaster – they want to [blame natural events instead – the earthquake and tsunami](#). A clear example is [provided by Toro Energy](#), an Australian uranium mining company: "It was therefore a sequence of extraordinary forces unleashed by an unprecedented natural disaster which caused the accident at the reactors, not any operating failure, human error or design fault of the reactors themselves."

However, responsibility for the disaster lies with TEPCO for its failure to protect back-up power generators and, more generally, its frequently-demonstrated willingness to put profits ahead of safety. Thus TEPCO bears primary responsibility for the human radiation exposure and human suffering that has resulted from the disaster.

The Japanese government's [Investigation Committee](#) into the Fukushima disaster noted in its December 2011 interim report that tsunami risks were "grossly underestimated" and the response to the disaster was characterised by "poor communication and delays in releasing data on dangerous radiation leaks at the facility".

The Investigation Committee's report states: "TEPCO did not take precautionary measures in anticipation that a severe accident could be caused by tsunami such as the one hit at this time. Neither did the regulatory authorities. Even for an accident of low probabilities so long as extremely large scale damages are anticipated once it occurs such as the tsunami of this time, due consideration should be given to the risks involved and precautionary measures should be taken. ... The nuclear disaster prevention program had serious shortfalls. It cannot be excused that the nuclear accidents could not be managed because of an extraordinary situation that the tsunamis exceeded the assumption."

A secondary level of culpability lies with others in the Japanese 'nuclear village' – not least METI, NISA and the Nuclear Safety Commission – who have encouraged the pursuit of personal and corporate enrichment at the expense of public safety. NISA is [sharply criticised](#) in the Investigation Committee's report.

It would be naive to believe that the Fukushima disaster will inevitably lead to root-and-branch improvements in Japan's nuclear industry. The problems run too deep. Former Fukushima Prefecture governor Eisako Sato [argues](#) that ordinary people must "take democracy into their own hands" and "if they do not, in 10 years time we will see another disaster."

A third level of culpability lies with organisations and companies outside of Japan. These include the IAEA, which has not been nearly proactive enough in demanding improved standards. Culpability also lies with the many overseas organisations that have helped to construct, supply and service Japan's nuclear power industry and have done little or nothing about the recurring patterns of safety breaches, cover-ups and so on.

Those suppliers include three companies operating uranium mines in Australia.

6. AUSTRALIA'S ROLE IN THE FUKUSHIMA DISASTER

"Japan is not the sole nation responsible for the current nuclear disaster. From the manufacture of the reactors by GE to provision of uranium by Canada, Australia and others, many nations are implicated."

— Yuki Tanaka, 28 March 2011, [The Atomic Bomb and "Peaceful Use of Nuclear Energy"](#), *The Asia-Pacific Journal*, Vol. 9, Issue 13, No. 2.

There is no dispute that Australian uranium was used in the Fukushima reactors. The mining companies [won't acknowledge](#) that fact – instead they hide behind claims of 'commercial confidentiality' and 'security'. But the Australian Safeguards and Non-Proliferation Office acknowledged in October 2011 that: "We can confirm that Australian obligated nuclear material was at the Fukushima Daiichi site and in each of the reactors – maybe five out of six, or it could have been all of them; almost all of them".

It is likely that TEPCO has been supplied with uranium from BHP Billiton's Olympic Dam mine, ERA's Ranger mine, and Heathgate's Beverley mine. Mirarr senior Traditional Owner Yvonne Margarula said she is "deeply saddened" that uranium from the Ranger mine in the Northern Territory has been exported to Japanese nuclear power companies including TEPCO. No such humility from the uranium companies. They reject any suggestion of culpability, with the Australian Uranium Association [describing](#) it as "opportunism in the midst of human tragedy" and "utter nonsense".

Moreover, the Association said: "The Australian uranium industry has led the global nuclear industry's efforts to create a framework of stewardship for the safe and responsible management of uranium throughout the nuclear fuel cycle." Here is an example of the industry's 'stewardship' [rhetoric](#): "When the principle is actively applied, Stewardship becomes a driver for innovation in the ways we view our businesses and operate them. ... Leading companies will see Stewardship not as a compliance issue but as a means to shape their future operational processes, products, services and relationships."

However there is little or no substance behind the rhetoric. Australia's uranium industry did nothing as TEPCO lurched from scandal to scandal and accident to accident over the past decade. It did nothing in 2002 when it was revealed that TEPCO had systematically and routinely falsified safety data and breached safety regulations for 25 years or more.

The industry did nothing in 2007 when over 300 incidents of 'malpractice' at Japan's nuclear plants were revealed. It did nothing even as the ability of Japan's nuclear plants to withstand earthquakes and tsunamis came under growing criticism from industry insiders and independent experts. It did nothing about the multiple conflicts of interest plaguing the Japanese nuclear 'regulator' (and is silent about the conflicts of interest plaguing the Australian nuclear 'regulator').

Australia could have played a role in breaking the vicious cycle of mismanagement in Japan's nuclear industry by making uranium exports conditional on improved management of nuclear plants and tighter regulation. Even a strong statement of concern would have been heard by the Japanese utilities (unless it was understood to be rhetoric for public consumption) and it would have registered in the Japanese media.

But the uranium industry did nothing. And since the industry is in denial about its role in fuelling the Fukushima disaster, there is no reason to believe that it will behave more responsibly in future. Likewise, successive Australian governments did nothing about the unacceptable standards in Japan's nuclear industry. And since Prime Minister Gillard said the Fukushima disaster "doesn't have any impact on my thinking about uranium exports", there is no reason to believe that the government will behave more responsibly in future.

APPENDIX: SPINNING FUKUSHIMA

Two opinion articles (March 2011 and February 2012) on the 'spinning' of the Fukushima disaster by nuclear power advocates.

Experts protect a nuclear interest

16 March 2011, ABC, Jim Green

<http://www.abc.net.au/unleashed/45210.html>

How have Australian scientists handled the difficult task of keeping us informed about the unfolding nuclear disaster in Japan?

The first thing to note is that precious few Australian scientists have featured in the media. The most prominent have been Professor Aidan Byrne from the Australian National University, RMIT Chancellor Dr Ziggy Switkowski, and Professor Barry Brook from Adelaide University.

A clear pattern is evident – those with the greatest ideological attachment to nuclear power have provided the most inaccurate commentary.

The best of the bunch has been Byrne. He has presented the facts as he understands them and has willingly acknowledged major information gaps.

Switkowski has been gently spinning the issue, repeatedly reassuring us that lessons will be learned, improvements will be made. However, history shows that nuclear lessons are not properly learned. The OECD's Nuclear Energy Agency notes that lessons may be learned but too often they are subsequently forgotten, or they are learned but by the wrong people, or they are learned but not acted upon. The Nuclear Energy Agency says the pattern of the same type of accident recurring time and time again at different nuclear plants needs to be "much improved".

The situation in Japan illustrates the point – it has become increasingly obvious over the past decade that greater protection against seismic risks is necessary, but the nuclear utilities haven't wanted to spend the money and the Japanese nuclear regulator and the government haven't forced the utilities to act.

Brook is a strident nuclear power advocate and host of the bravenewclimate.com blog, which has received an astonishing 500,000 web 'hits' since the crisis in Japan began. Brook has egg on his face. Make that an omelette. He has maintained a running commentary in the media and on his website insisting that the situation is under control and that there is no reason for concern. His message remained unchanged even as it was revealed that efforts to cool the nuclear reactor cores were meeting with mixed success, even as deliberate and uncontrolled radiation releases occurred, even as the outer containment buildings exploded, even as 200,000 people were being evacuated, even as a fire led to spent nuclear fuel releasing radiation directly to the

environment, and even as radiation monitors detected alarming jumps in radioactivity near the reactor and low levels of radiation as far away as Tokyo.

On Saturday Brook came out swinging, insisting that: "There is no credible risk of a serious accident". Phew. That afternoon, after the first explosion at Fukushima [*correction – a few hours before the first explosion*], Brook made numerous assertions, most of which turned out to be wrong: "The risk of meltdown is extremely small, and the death toll from any such accident, even if it occurred, will be zero. There will be no breach of containment and no release of radioactivity beyond, at the very most, some venting of mildly radioactive steam to relieve pressure. Those spreading FUD [fear, uncertainty and doubt] at the moment will be the ones left with egg on their faces. I am happy to be quoted forever after on the above if I am wrong ... but I won't be. The only reactor that has a small probability of being 'finished' is unit one. And I doubt that, but it may be offline for a year or more."

On Saturday night, Brook asserted that: "When the dust settles, people will realise how well the Japanese reactors – even the 40 year old one – stood up to this incredibly energetic earthquake event." The dust is (hopefully) settling and it seems likely that four reactors will be write-offs.

On Sunday morning, Brook said of the unfolding disaster: "I don't see the ramifications of this as damaging at all to nuclear power's prospects" and that "it will provide a great conversation starter for talking intelligently to people about nuclear safety."

But Fukushima will likely prove a great conversation starter for talking intelligently to people about nuclear hazards. Not recommended at parties.

On Sunday afternoon, Brook was congratulating himself on his 'just the facts' approach in media interviews. He pondered: "What has this earthquake taught us? That it's much, much riskier to choose to live next to the ocean than it is to live next to a nuclear power station."

Well, the lesson for people in Fukushima is that if you live next to the ocean and next to a nuclear power station, then you're really stuffed.

On Monday, when the second explosion at Fukushima occurred, Brook was still insisting that "the nuclear reactors have come through remarkably well". On Monday evening, half a dozen people were banned from posting comments directly on Brook's website. True, some of their comments were silly and unhelpful, but by that criterion Brook ought to have banned himself.

On Tuesday, with a fire at Fukushima spewing long-lived radioisotopes directly into the environment, Brook was rallying the pro-nuclear lobby, arguing that "now, more than ever, we must stand up for what we believe is right" while introducing a guest web post by someone who announced that Japan gets electricity "from y nuclear reactors at z locations".

But cracks were starting to emerge by Tuesday night, with Brook acknowledging an "ongoing crisis situation", banning another 40-50 "random nobodies" from posting comments directly on his website, and quoting Rudyard Kipling:

*If you can bear to hear the truth you've spoken
Twisted by knaves to make a trap for fools
Or watch the things you gave your life to, broken,
And stoop and build'em up with worn-out tools*

Make of that what you will.

One contributor to Brook's website said: "Unfortunately, Prof. Brook has really abdicated a neutral position on this event. His clear support of nuclear power seems to have impacted his critical thinking skills. ... Every time he states something in this crisis is 'impossible', it seems to happen the next day."

Andrew Bolt at the Herald Sun has been urging people to read the "marvellously sane and cool explanation" from "our friend Professor Barry Brook".

Both Bolt and Brook claim that no more than 50 people died from the Chernobyl catastrophe. More on that next month – the 25th anniversary falls on April 26. The scientific estimates of the Chernobyl death toll range from 9,000 to 93,000.

One year on, Fukushima is still spinning

15 February 2012, ABC, Jim Green

<http://www.abc.net.au/unleashed/3832080.html>

The first anniversary of the Fukushima disaster is fast approaching and it promises to be another silly-season for Australia's pro-nuclear zealots.

They have form. While the crisis was unfolding in March last year, Ziggy Switkowski advised that "the best place to be whenever there's an earthquake is at the perimeter of a nuclear plant because they are designed so well." Switkowski wants 100 nuclear power plants built in Australia – 100 places to shelter from earthquakes.

Even as nuclear fuel meltdown was in full swing at Fukushima, Adelaide University's Prof. Barry Brook reassured us that: "There is no credible risk of a serious accident. ... Those spreading FUD [fear, uncertainty and doubt] at the moment will be the ones left with egg on their faces. I am happy to be quoted forever after on the above if I am wrong ... but I won't be."

Eggs, anyone?

John Borshoff, CEO of uranium miner Paladin, described the Fukushima crisis as a "sideshow". A Fukushima farmer was equally succinct in his suicide note: "I wish there wasn't a nuclear plant."

Here are some of the arguments we will likely hear from nuclear boosters in the lead-up to the March 11 Fukushima anniversary.

Expect a barrage of personal attacks since the boosters will want to avoid discussion about the horrendous impacts of the nuclear disaster – and how the disaster could so easily have been prevented if plant operator TEPCO had taken straight-forward measures to properly protect back-up power generators from flooding.

Cameron England said in the week following the Fukushima meltdowns, fires and explosions that "some parts of the environmental movement will be quietly high-fiving each other this week." There's a nod in the direction of that offensive drivel in Barry Brook's claim that I was "delighted" to hold him to account for his asinine statements as the nuclear disaster unfolded. Academic Allan Patience said "it appears that the opponents of nuclear energy are almost beside themselves with delight at the tragedy that is happening in Fukushima".

No evidence for any of those claims, of course.

The nuclear lobby will attack critics for overstating the scale of the disaster. Any comparisons with Chernobyl will be howled down. True, radiation releases from Fukushima have fallen short of the radioactivity spewed into the environment from Chernobyl. But TEPCO itself drew the comparison a month after the disaster began: "The radiation leak has not stopped completely and our concern is that it could eventually exceed Chernobyl."

And while they're attacking nuclear critics for overstating the radiation releases, the boosters will be trivialising the problem or ignoring it altogether. Brook wrote an ABC opinion piece in December which states that "no-one was killed by radioactivity from the event" and is silent on the problem of long-term cancer deaths from exposure to radioactive fallout.

The boosters will repeatedly use this quote from a June 2011 International Atomic Energy Agency (IAEA) report: "To date no confirmed long term health effects to any person have been reported as a result of radiation exposure from the nuclear accident."

How could long-term health effects be evident three months after the event? Cancers typically have a latency period measured in years. Perhaps it's worth remembering that one of the IAEA's objectives is to promote nuclear power.

To cut a long story short, on the basis of available evidence it's difficult to see how the long-term cancer death toll from Fukushima could be lower than a few hundred deaths, and difficult to see how the number could exceed a few thousand. For comparison, the IAEA estimates 9,000 long-term cancer deaths from Chernobyl and other scientific studies put the figure 10 times higher.

The nuclear lobby is keen to point out that the earthquake and tsunami caused much greater damage (including human deaths) than the Fukushima nuclear disaster. Brook states: "What has this earthquake taught us? That it's much, much riskier to choose to live next to the ocean than it is to live next to a nuclear power station."

But the impacts have been cumulative; one disaster doesn't negate or excuse another. And areas affected by the nuclear disaster stretch inland, well beyond distances reached by the tsunami.

There's a tired old argument about Chernobyl – the (false) claim that the death toll amounted to no more than about 50 people, whereas 200,000 unnecessary abortions were carried out across Europe as a result of radiophobia spread by greenies. Nuclear power: safe. Greenies: mass murderers.

Now we're seeing variations of that argument in relation to Fukushima. Ted Rockwell, winner of the American Nuclear Society's Lifetime Achievement Award, has been thinking laterally. He blames the "radiation police" who won't "let the good people of Fukushima return home and get on with their lives". No-one has received a life-altering injury from radiation at Fukushima, Rockwell claims, and the "atrocities" are caused by the application of excessively cautious international radiation standards.

It's not entirely clear who the "radiation police" are in Rockwell's diatribe but Andrew Bolt will have them wearing koala suits as the Fukushima anniversary approaches.

Nuclear boosters are unsure whether to defend TEPCO or to cut the company loose and portray it as a rogue operator. Toro Energy, an Australian uranium mining company, defends Toro: "It was therefore a sequence of extraordinary forces unleashed by an unprecedented natural disaster which caused the accident at the reactors, not any operating failure, human error or design fault of the reactors themselves."

Yet the Japanese government's Investigation Committee found that TEPCO's preparations for and protections against a disaster were "quite inadequate". And every step of TEPCO's response to the disaster was "a day late and a dollar short" according to a former vice-chairman of Japan's Nuclear Safety Commission.

Peter Alford and Cameron Stewart, writing in *The Australian*, prefer to cut TEPCO loose: "TEPCO may dwell in corporate infamy alongside Enron and BP", "the plodding utilities giant is a secretive nuclear behemoth that has been caught out for numerous safety violations", "one of TEPCO's more monstrous practices ... is the routine employment of deeply unqualified day labourers".

They could have pinched that language from media releases put out by Friends of the Earth over the years as TEPCO lurched from scandal to scandal and accident to accident; perhaps they did.

A related strategy from the boosters is to blame outdated 'Mark 1' boiling water reactor technology and to contrast it with long-promised gee-whiz fail-safe 'Generation 4' reactor technology. A sceptical industry insider quipped: "We know that the paper-moderated, ink-cooled reactor is the safest of all. All kinds of unexpected problems may occur after a project has been launched."

Lastly, we can expect the boosters to promote the message that lessons will be learnt, improvements made, and we need not therefore concern ourselves about nuclear safety. That is perhaps the most cynical of all the jiggery pokery from the boosters. If the nuclear industry had a track record of learning from past mistakes and accidents, the Fukushima disaster would not have happened in the first place. TEPCO only needed properly-protected back-up generators to maintain reactor cooling – that's all.

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