let the facts speak

AN INDICTMENT OF THE NUCLEAR INDUSTRY

Foreword by Jo Vallentine

The nuclear industry has been churning out poisons, power and bombs for over sixty years. So, far they haven't managed to figure how to deal with their waste. In this highly technological age, that is a huge failure.

Nor will the industry admit to its accidents, always portraying itself as cleaner than coal and less dangerous than other kinds of mining or toxic industries.

Wonderful foresight back in 1983 led ALP Senator Ruth Coleman to start documenting nuclear accidents as they occurred. We have in "Let the Facts Speak" an extraordinary record, showing how damaging this industry has been since its inception with the Manhattan Project in 1942.

But what's listed here is the bland reporting, just the facts of the accidents, not the human stories of the pain and suffering which many of those accidents have caused. There is no record here of the number of deaths caused by the 1986 Chernobyl disaster. These figures are highly contested due to the fact that in 1959 the World Health Organization signed a Memorandum of Understanding with the fledgling International Atomic Energy Agency to the effect that neither would comment on nuclear health issues without consulting the other (resolution WHA 12.40). So the very organisation which should be giving details about such accidents demurs from its international responsibilities for fear of upsetting its nuclear alliance partner. That is shameful.

The whole truth about nuclear accidents will never be fully exposed: this is a highly secretive industry, which has to be dragged, kicking and screaming to be open and transparent. It is a master of concealment and obfuscation. And it is an international cartel like no other. This is an industry with friends in high places, which works across international boundaries, at the expense of the world's safety. There have been many near misses with nuclear weapons, which are frightening to contemplate.

Since global warming seriously hit the international agenda, the nuclear industry has positioned itself as part of the solution to climate change. It brags of a nuclear "renaissance" which is more in the minds of its exponents than being a reality. The facts are that nuclear power is too expensive, too slow, too dirty and dangerous to be supported as the world struggles to move towards low-carbon economies. Nuclear power generation has always been a smokescreen for nuclear weapons development. The two aspects of the industry are inextricably linked: weapons proliferation is an intrinsic part of the nuclear chain, as is the use of so-called "depleted" uranium in weapons of current warfare.

"Let the Facts Speak" makes a significant contribution to the nuclear debate: citizens have a right to know the risks that their Governments are prepared to take on their behalf.

Unfortunately, the tales of nuclear accidents is a never-ending story ..... just like the never-ending efforts to find a safe way to deal with radioactive waste over thousands of years.

Full commendation to Senator Scott Ludlam and his researchers for updating this important work.

Jo Vallentine

Chairperson of the Anti Nuclear Alliance of Western Australia and former Senator for WA

Let the facts speak: fourth edition

In introducing a document of this kind, the first thing to note is that the text speaks for itself. This is not a work of analysis or opinion, but a straightforward chronology of accident, incompetence and disaster spanning seven decades. The key unifying theme here is nuclear technology, roaring into modern history out of the blinding singularity that lit the sky over Hiroshima on August 6, 1945.

The twin industries of nuclear weapons and civil nuclear power hold a unique and forbidding place in our lives as the 20th century recedes and the forgotten struggles of the Cold War mutate into something more complex. Nuclear weapons slumber uneasily in our mass subconscious, an amnesia broken by irregular and violent cameo appearances in popular culture.

The hypnotic concept of a device small enough to fit in the boot of a sedan and capable of instantly obliterating a whole city will be with us as long as we give our collective consent to their continued existence. A vast multinational endeavour of atomic weapons design, maintenance and deployment grinds away far from the headlines, born out of the terribly flawed Cold War doctrine of mutually assured destruction. It is a work of calculated, unthinkable institutional violence all the more terrible for the way in which its existence has been sublimated and largely forgotten.

The enrichment plants and atomic reactors which gifted Manhattan Project scientists and engineers with their first precious traces of highly enriched uranium and Plutonium 239 have taken a different path since the first white flash sent shadows fleeing across the desert of New Mexico in 1945.

The formative weapons plants producing the world's first fissionable material also shed colossal amounts of heat in operation. It took the US Navy to realise such a compact and energy-rich power plant could form the heart of nuclear powered submarines which could prowl the world's oceans for months without needing to refuel. From there the race was on to engineer these plants to utility scale for electricity 'too cheap to meter'. A few hundred tonnes of fissioning uranium would take the place of millions of tonnes of coal at the heart of steam generating power stations, and humankind would face a kind of liberation from the earthly constraints of energy poverty.

We shouldn't underestimate the genuine intent of the policy makers and engineers determined to substitute horrific afterimages of mushroom clouds boiling into the stratosphere with something more benign: atoms for peace, an energy source big enough to fire the optimism of post-war industrialisation. While military planners knew full well that development of civil nuclear power would happily call forth identical industrial capacity to undertake a weapons programme, many saw the potential of an unlimited energy source that would free us from the 19th century fossil economy and eventually lift us into space.

This manual documents the fracturing and ultimate failure of this hopeful vision. It is a story of an unforgiving technology which never lived up to expectations but instead bequeathed a daunting legacy which will be with us for many generations. Three Mile Island, Chernobyl and Fukushima are familiar names to us now. But how many have heard of the fire at Narora, the horrific blast at Chelyabinsk, the ongoing and deadly gamble of Rokkasho?

If this manual can play even a tiny part in blowing away the mythology of a benign and proven climate saving technology, if it can turn even one critical thinker away from the seductive mythology of civil nuclear power, it will have been worth it. We owe a debt of gratitude to all those who have documented the accidents and crimes committed within these pages, those who came before, took a hard look at the reality of the nuclear industry, and chose not to look away.

As I write this, the campaign to ramp up uranium mining and introduce nuclear power to Australia is in full effect, blanketing editorial pages and filling conference venues. While the Australian Uranium Association cranks out glossy brochures with a strange desperation, the volcanic wreckage of four reactors at Fukushima Daiichi still smoulder a year on, and more than 160,000 radiation refugees have fled the world's newest nuclear sacrifice zone. The impossible economics of domestic nuclear power will hopefully do some of the work in cooling pro-nuclear ardour in Australia, but it is the human story that most needs to be told.

We will not allow the terrible human and environmental costs of this flawed and obsolete technology to be forgotten.

Everywhere this industry touches down it leaves an imprint of misery and injury, and everywhere it goes it is challenged and fought. If each of us is called on to choose a side in the coming contest over nuclear energy on a warming planet, then at the very least, let the facts speak.

Scott Ludlam

Fremantle, February 2012

This publication is a tribute and a follow up to the years of work carried out by retired Western Australian ALP Senator Ruth Coleman. Awareness Education subsequently carried out three years of research, detailing accidents to September 1990.

The next edition of Let the Facts Speak was published in June 1991, by the Office of Jo Vallentine, Senator for The Greens (WA). It was re-released in 2006 by Australian Greens Senator Rachel Siewert, and this fourth edition updates the chronology to 2012.

This document is a representative summary of the 'dirty dozen': the worst of the worst. The full version - featuring hundreds of lesser known accidents and near misses - can be found at

www.letthefactsspeak.org

LET THE FACTS SPEAK:
THE DIRTY DOZEN

This 'Dirty Dozen' list covers some of the most dangerous and infamous moments in the history of the nuclear industry.

It includes some major reactor accidents - Chernobyl, Fukushima, Three Mile Island, and Windscale. Three entries remind us that serious risks are not limited to reactors - the Chelyabinsk liquid nuclear waste explosion in the Soviet Union, the theft of a radiotherapy source in Brazil and subsequent fatalities, and the fatal accident at a fuel fabrication plant at Tokaimura, Japan.

The list includes an example of strikes on a nuclear plant directed by a national government (Israel's destruction of the Osiraq research reactor in Iraq) and strikes against a nuclear power plant by a sub-national group (Basque ETA terrorists).

A number of the entries remind us of the links between the 'peaceful' nuclear industry and the proliferation of Weapons of Mass Destruction – the failure to account for 160 kgs of plutonium in the UK for a period of at least eight months in 2004-05, and Israel's destruction of the Osiraq reactor because of concerns that the reactor would be used for weapons production.

The Superphenix fast breeder reactor in France is included as an example of a nuclear 'white elephant' - a plant that failed spectacularly to meet its promised performance levels with billions of dollars wasted in the process (other such examples include reprocessing and fuel fabrication plants at Sellafield, UK). Superphenix also provides a reminder that some of the 'next generation' nuclear power technologies that are now being promoted as 'new' and 'safe' are in fact old and unsafe.

Several entries - including Three Mile Island, Fukushima and Tokaimura - demonstrate the industry's failure to learn from past accidents.

Of course there are countless other incidents that could be included in a 'Dirty Dozen' list. To give a few examples:

- The 1985 "deal of the century" with Germany promising to provide Brazil with the full suite of nuclear fuel cycle facilities despite Brazil's obvious pursuit of nuclear weapons.
- The theft of enrichment technology from the European consortium URENCO by Pakistani scientist A.Q. Khan - a significant moment in the development of Pakistan's nuclear weapons capability and a prelude to the spread of weapons technology by the Khan network to North Korea, Iran and Libya.
- North Korea's use of an 'experimental power reactor' to produce plutonium for weapons in recent years has provided yet another reminder of the power-weapons link - a link that the nuclear industry is keen to deny.
- It was difficult to omit Dounreay in Scotland, and Hanford in the USA, from this 'Dirty Dozen' list - monumental environmental disasters in wealthy, technologically-sophisticated countries.

The list focuses on the 'civil' nuclear industry and therefore does not include military disasters such as the atomic bombing of Hiroshima and Nagasaki or the profound social and environmental impacts of nuclear weapons testing. The list does however include some military accidents involving technology also used in the 'civil' sector - namely, the Chelyabinsk liquid nuclear waste explosion and the 1957 reactor fire at Windscale.

Perhaps the most significant omission - albeit an unavoidable one in a list such as this - concerns the routine impacts of the nuclear industry. It is possible that routine emissions from the nuclear fuel 'cycle' - with uranium mining and milling, and nuclear reprocessing being the main culprits - have resulted in greater human exposure to ionising radiation than all nuclear accidents put together.

CHERNOBYL REACTOR EXPLOSION

CHERNOBYL, USSR

26 April 1986

The Chernobyl #4 reactor accident on 26 April 1986 was the world's worst nuclear disaster and is rated Level 7 ('Major Accident') on the 7-point International Nuclear Events (INES) scale.

The accident occurred when a safety test went badly wrong. Operators switched off important control systems and allowed the reactor to reach unstable, low-power conditions. A sudden and uncontrollable power surge resulted in violent explosions and a graphite fire which burned for 10 days. The release of radioactive gases, aerosols and fragmented nuclear fuel particles was "extremely high in quantity" as the OECD's Nuclear Energy Agency stated.

An estimated 8.4 million people were exposed to radiation across Europe, with the worst effects in Belarus, Ukraine and Russia. Estimates of the long-term Chernobyl cancer death toll range from 9,000 (in the most heavily contaminated areas) to 93,000 (across Europe). The disaster resulted in more than 6,000 cases of thyroid cancer in children and adolescents who were exposed at the time of the accident, with a fatality rate of approximately 1%.

The broader social impacts included those resulting from the permanent relocation of about 400,000 people and from widespread and long-lasting restrictions on agriculture and fishing in former Soviet states and in many European and Scandinavian countries.

For Belarus alone, the total economic cost of the disaster is estimated at a staggering US$235 billion (in 2005 dollars).

While the name has faded from the headlines, the site poses an ongoing risk, with an unknown quantity of melted fuel remaining within the ruined reactor. A hastily erected concrete sarcophagous shrouds the complex today, which engineers advise needs urgent replacement lest its partial collapse leads to the further release of radiation.

WINDSCALE REACTOR FIRE

WINDSCALE, UK

10 October 1957

A fire in one of the graphite-moderated, air-cooled reactors at Windscale burned for 16 hours, releasing substantial radioactive contamination. The reactor was being operated beyond its design limits in order to produce tritium for nuclear weapons. Operators responded to an increase in the temperature of the reactor core by increasing airflow - but this fed more oxygen to the fire and fanned the flames. Water was pumped into the reactor and the crisis was slowly brought under control.

The reactor was beyond repair and was never used again. The accident is classified as Level 5 ('Accident with off-site risk') on the 7-point International Nuclear Event Scale.

Bans on milk consumption were imposed for six weeks after the fire, extending over an area of 200 square miles.

Radioactive contamination from the fire was detected as far away as south-east England and even on mainland Europe. A canister of polonium-210 burned in the fire and contributed significantly to the off-site radiation release.

Estimates of non-fatal cancers vary from none to 248 and for fatal cancers between 10 and 100 (and the death toll may be still higher because of the polonium-210 release).

Subsequent to the fire, the complex was renamed 'Sellafield' in an attempt to rehabilitate its image.

CHELYABINSK LIQUID WASTE EXPLOSION

CHELYABINSK, SOVIET UNION

29 September 1957

This explosion of a liquid high-level nuclear waste tank led to a “significant release of radioactive material to the environment” according to the International Atomic Energy Agency. It was rated Level 6 (‘Serious Accident’) on the 7-point International Nuclear Event Scale.

The event occurred at the Ozyorsk/Mayak nuclear plant (also known as Chelyabinsk) near the town of Kyshtym. Following removal of plutonium, liquid high-level wastes were stored in underground steel tanks in concrete trenches, surrounded by coolers. Failure to repair a cooling system in one of the tanks led to an increase in temperature and eventually - after about a year - to a chemical explosion. The design of the cooling system did not allow for repair in the event of damage. A concrete lid weighing 145 tonnes was thrown into the air and the explosion released about 60-70 tonnes of nuclear waste.

The contamination was “very serious” according to Soviet scientists. The total release was of the order of 740,000 terabecquerels (20 megacuries) with about 90% deposited in the immediate area and 10% widely dispersed. The accident resulted in long-term contamination of more than 800 sq kms, primarily with caesium-137 and strontium-90; this area is referred to as the East-Ural Radioactive Trace.

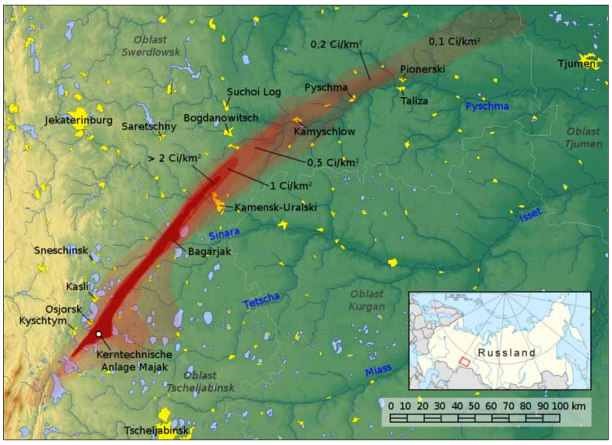
Over 10,000 people were evacuated in the 18 months following the accident. Over 1,000 sq kms of land in Chelyabinsk province and Sverdlovsk province were removed from agricultural use. Soviet scientists noted that clean-up measures were “inadequately effective” and produced “comparatively poor results”. Nevertheless, all but 220 sq kms were returned to agricultural use between 1961 and 1978.

The accident was shrouded in secrecy as Chelyabinsk was a secret military site and not marked on maps. It was not until 1976 that the disaster was officially acknowledged.

It is estimated that direct exposure to radiation from the accident caused at least 200 long-term cancer deaths - although other estimates put the figure significantly higher and others significantly lower.

Over 50 years after the disaster, victims are continuing with their political and legal battle for proper compensation. “They are paying us huge,” a Chelyabinsk liquidator said (ironically) at a 2008 protest. “We receive a rouble daily allowance. At a security firm, a guard dog can count on 80 roubles a day.”

Chelyabinsk /Kyshtym memorial



Map of radioactive fallout from the Chelyabinsk disaster by Jan Rieke.

THREE MILE ISLAND REACTOR MELTDOWN

THREE MILE ISLAND, PENNSYLVANIA, USA

28 March 1979

A malfunction in the secondary cooling circuit of the Three Mile Island #2 pressurised-water reactor caused the temperature in the primary coolant to rise. The reactor shut down acutomatically. A relief valve failed to close, but instrumentation did not reveal that fact. Much of the primary coolant drained away so heat in the reactor core was not removed and the core suffered severe meltdown with around 18 tonnes of fuel forming a mass at the bottom of the pressure vessel. The reactor vessel maintained integrity, thus greatly reducing radiation releases.

The accident was caused by a combination of operator error, design deficiencies, and component failures. Metropolitan Edison pled guilty to charges of falsifying safety test results prior to the accident.

The accident was rated Level 5 ('Accident with Off Site Risk') on the 7-point International Nuclear Event Scale.

The Governor of Pennsylvania advised the evacuation of pregnant women and pre-school age children within a 5-mile radius, later extended to 20 miles. An estimated 140,000 people left the area.

About 150,000 litres of radioactive waste water was deliberately released into the Susquehanna River. Government and industry sources state that approximately 2.5 million curies (92,500 TBq) of radioactive noble gases and 15 curies (0.56 TBq) of radioiodine was released. They further claim that although around two million people were exposed to radiation from the accident, the average dose was extremely small - figures cited range from 1.4 to 8 millirem (0.014 to 0.08 mSv). Those claims are disputed by some scientists on the basis of radiation monitoring data and epidemiological evidence of increased disease rates among exposed populations. There is however no dispute that radiation releases and exposures were several orders of magnitude lower than those arising from the Chernobyl disaster.

Clean-up operations officially ended in 1993 - 14 years after the accident - but the reactor will not be decommissioned for some decades to come.

Valve failures, most leading to coolant escape, had been observed on 11 occasions prior to the Three Mile Island meltdown; indeed the initial causal sequence of events at Three Mile Island had taken place 18 months earlier at another Babcock and Wilcox reactor. Preventive and precautionary measures ought to have been taken which would have prevented the Three Mile Island meltdown - but they were not.

RADIATION SOURCE THEFT AND EXPOSURE

GOIANIA, BRAZIL

September 1987

Two people stole a radiotherapy source from a disused medical clinic on 12 September 1987. A security guard did not show up to work at the clinic on the day of the theft.

The radiotherapy source - a 5-cm diameter capsule - contained 93 grams of caesium-137. It was then on-sold to a junkyard dealer. Many people were exposed to the radioactive caesium and they spread the contamination to other sites within and beyond the town.

With many people sick by 28 September, the radioactive source was taken on a bus to a hospital. The following day, authorities began identifying contaminated areas and organising treatment of injured people in facilities set up in the Olympic stadium. About 112,800 people were examined, of whom about 250 were contaminated.

Five people died from exposure to the small radiation source; an additional 23 people suffered radiation burns, several requiring amputations; nine suffered bone marrow depression with three displaying symptoms of acute radiation sickness.

The incident was rated Level 5 ('Accident with Off Site Risk') on the 7-point International Nuclear Event Scale.

TOKAIMURA CRITICALITY ACCIDENT

TOKAIMURA, JAPAN

30 September 1999

This accident occurred as poorly-trained, part-time workers prepared uranium fuel for an experimental fast breeder reactor in a tank at JCO's Fuel Fabrication Plant. The tank was not designed to dissolve this type of solution and was not configured to prevent a runaway atomic chain reaction (a criticality accident).

When a critical mass of enriched uranium was poured into the tank, unexpected and uncontrolled criticality began and continued intermittently for 20 hours. Local residents were evacuated and others within a 10 km radius were advised to stay indoors.

The incident was rated Level 4 ('Accident with local consequences') on the 7-point International Nuclear Event Scale. Two workers died and another was hospitalised for three months. A total of 667 JCO workers, emergency workers and nearby residents received smaller radiation doses.

Countless subsequent accidents, incidents and scandals would have been averted had the lessons of the Tokaimura accident been properly learnt and acted upon. In 2002 and again in 2007, details of several hundred safety breaches and data falsification incidents were revealed, stretching back to the 1980s.

Yet the underlying problems had not been addressed by the time of the March 2011 Fukushima disaster. Those recurring problems include cost-cutting and time-saving at the expense of safety; data falsification and concealment of accidents (including the concealment of a criticality accident); inadequate regulation; and the failure to learn from previous accidents including criticality accidents very similar to the 1999 Tokaimura accident.

PLUTONIUM UNACCOUNTED FOR

SELLAFIELD, UK

April 2005

The hazards associated with nuclear reprocessing were highlighted in April 2005 with the revelation of an accident at the THORP reprocessing plant at Sellafield. A broken pipe led to the leaking into a containment structure of 83,000 litres of a highly radioactive liquor containing dissolved spent nuclear fuel. The leakage went undetected for at least eight months.

The accident was classified as Level 3 ('serious incident') on the 7-point International Nuclear Event Scale and British Nuclear Group Sellafield Limited was fined 500,000 pounds plus costs after pleading guilty to three serious, prolonged breaches of its licence conditions.

What is significant about the leakage is not the environmental and health risk it posed but the fact that the liquid spill contained 160 kgs of plutonium - enough to build 15-20 nuclear weapons - yet the loss went undetected for at least eight months.

The UK Health and Safety Executive concluded: "An underlying cause was the culture within the plant that condoned the ignoring of alarms, the non-compliance with some key operating instructions, and safety-related equipment which was not kept in effective working order for some time, so this became the norm. In addition, there appeared to be an absence of a questioning attitude, for example, even where the evidence from the accountancy data was indicating something untoward, the possibility of a leak did not appear to be considered as a credible explanation until the evidence of a leak was incontrovertible."

There have been numerous other serious accidents and incidents at the Sellafield site (previously called Windscale) including the 1957 fire, a data falsification scandal and a serious sabotage incident in the late 1990s. Moreover the site has been a major source of radioactive emissions to the environment and has been the subject of formal complaints and opposition from European Governments.

REACTOR DESTROYED BY MILITARY STRIKE

AL TUWAITHA NUCLEAR CENTRE, NEAR BAGHDAD, IRAQ

7 June 1981

On 7 June 1981, Israeli fighter planes destroyed the French-supplied 'Osiraq' (or 'Osirak' or 'Tammuz 1') 40 MW research reactor located at the Al Tuwaitha Nuclear Centre, 17 kms from Baghdad.

Ten Iraqi soldiers and one French civilian were killed in the attack, and three Israeli army personnel died during training for the mission. Other than those deaths, the attack was of little public health or environmental consequence as the reactor had not begun operating and had not been loaded with nuclear fuel.

The significance of the attack (and surrounding events) was that it starkly demonstrated the realpolitik of nuclear weapons proliferation - Iraq's pursuit of weapons under cover of a 'peaceful' nuclear program and Israel's willingness to respond with a 'pre-emptive' military strike. It also highlighted the nightmare scenario of how to deal with a strike on an operating reactor.

The safeguards system of the International Atomic Energy Agency was put to the test and was found wanting. IAEA inspections failed to uncover Iraq's weapons program and other research reactors were later found to have been used in various ways to advance Iraq's weapons program. Israel clearly had no faith in the IAEA safeguards system as demonstrated by its attack on Osiraq (and more recently with its attack on a suspected reactor site in Syria in 2007).

In April 1979, Israeli agents in France allegedly planted a bomb that damaged the partially-built Osiraq reactor while it was awaiting shipment to Iraq. Israel is also alleged to have murdered a scientist working on Iraq's nuclear program in June 1980 and to have bombed several of the French and Italian companies it suspected of working on the project.

The Iranian military also attacked and damaged the Al Tuwaitha Nuclear Centre with air strikes on September 30, 1980, shortly after the outbreak of the Iran-Iraq War. And Al Tuwaitha was bombed during the 1991 Gulf war and yet again during the 2003 Gulf war.

SUPERPHENIX, SUPER WHITE ELEPHANT

CREYS-MARVILLE, FRANCE

1985-98

The French Superphenix fast breeder reactor could be included in a 'Dirty Dozen' list on the basis of numerous accidents including a large sodium leak, the collapse of the roof of the turbine hall and an argon leak. However it is included in this list as an example of a multi-billion-dollar 'white elephant' - a plant that failed spectacularly to meet its promised performance levels.

Superphenix was promoted as the first commercial-scale plutonium-fuelled 'fast breeder' reactor in the world. However it was shut down more often than not from its 1985 start-up until it supplied the grid for the last time in 1996, and it was permanently shut down in 1998.

The reactor's lifetime load factor - the ratio of electricity generated compared to the amount that would have been generated if operated continually at full capacity - was a paltry 7 percent, making it one of the worst-performing reactors in history.

Superphénix was an expensive white elephant - the construction cost was about $9.5 billion (in 2008 US dollars). Total costs (including decommissioning) are estimated at $23.75 billion (in 2008 US dollars).

The Superphenix fiasco reminds us that industry spin about 'inherently-safe', 'next generation' reactors is mostly old wine in new bottles. Now we are encouraged to talk about 'burner' reactors (potentially consuming more plutonium than they produce) rather than 'breeders' (which do the opposite). We're encouraged to drop the term 'fast breeder' (and forget about their highly problematic history) and instead to talk about the 'next generation' of 'integral fast reactors' or 'travelling wave reactors'. But the basic technology remains accident-prone, unreliable, and expensive.

The technology can also be used or misused for weapons production. France used the Phenix breeder reactor to make weapon-grade plutonium. India used plutonium (ostensibly) separated for its breeder program to build and test a nuclear bomb. Yugoslavia used its professed interest in fast reactor technology as a cover to pursue weapons.

TERRORIST ATTACKS ON SPANISH REACTOR

LEMONIZ NUCLEAR POWER PLANT, SPAIN

18 December 1977

On 18 December 1977, Basque ETA separatists set off bombs damaging the reactor vessel and a steam generator at the Lemoniz nuclear power plant under construction in Spain. Two workers died and one of the terrorists sustained fatal injuries.

On 17 March 1978, ETA planted another bomb in the plant, again causing the death of two workers and inflicting substantial damage to the plant. The explosives were smuggled into the plant by site workers.

On 3 June 1979, an anti-nuclear activist was killed by police during a peaceful protest (the peaceful public movement against Lemoniva attracted as many as 150,000 people to protest rallies).

On 13 June 1979, ETA planted another bomb inside the plant and the explosion caused the death of one worker.

On 11 November 1979, ETA kidnapped guards and exploded bombs at another nuclear plant, causing extensive damage.

On 29 January 1981, ETA kidnapped the chief engineer of the Lemoniz nuclear plant and later killed him.

ETA also destroyed hundreds of electricity pylons connected to the site.

In 1983, the Spanish nuclear power expansion program was cancelled following a change of government and construction of the Lemoniz plant was never completed.

Dozens of incidents of nuclear terrorism have taken place around the world, with a bewildering variety of perpetrators and motives. To date there has not been an incident resulting in mass casualties. UN Secretary General Kofi Annan warned in 2005: "Nuclear terrorism is still often treated as science fiction. I wish it were. But, unfortunately, we live in a world of excess hazardous materials and abundant technological know-how, in which some terrorists clearly state their intention to inflict catastrophic casualties. Were such an attack to occur, it would not only cause widespread death and destruction, but would stagger the world economy and thrust tens of millions of people into dire poverty."

JAPAN'S NUCLEAR SCANDALS

1977-2011

On 29 August 2002, the Japanese Nuclear Industrial Safety Agency shocked the nation with the revelation of a massive data falsification scandal by the Tokyo Electric Power Company (TEPCO), operator of the Fukushima and Kashiwazaki-Kariwa nuclear power plants. It was later reported that these practices had gone since at least 1977. The total number of incidents was put at nearly 200, and all Japanese nuclear utilities were involved.

Some of TEPCO's serious '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;
- faking tests of the leak rate of a Fukushima reactor containment vessel; and -
- deleting records of cracks in neutron-measuring equipment at Fukushima.

TEPCO admitted to 'dishonest acts' but few if any improvements were made. In 2007, 12 Japanese utilities submitted reports detailing 306 cases of malpractice.

TEPCO acknowledged breaches which had not previously been revealed including:

- concealment of at least six emergency shut-downs of reactors at Fukushima;
- concealing a criticality accident in 1978 in which nuclear fuel rods fell out of position in one of the Fukushima reactors and unplanned criticality (a nuclear chain reaction) continued for over seven hours;
- concealing another criticality accident in 1984;
- making adjustments to make it appear to the regulator that the residual heat removal pump (part of the emergency core cooling system) was functional although it was not;
- falsifying data on the concentration of radioactivity emitted from one of the reactors at Fukushima and repeatedly falsifying data on radioactive emissions from the Kashiwazaki-Kariwa plant;
- failing to record or report the breakdown of a diesel back-up generator at Kashiwazaki-Kariwa; and
- concealing an accident in which 34 fuel rods slipped 15 cms out of position in one of the Fukushima reactors.

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." But few if any improvements were made. TEPCO's failure to adequately protect back-up power generators was a direct cause of the 11 March 2011 disaster at Fukushima. A former TEPCO executive said. "I now doubt how serious we were about preparing for a severe disaster. If only we'd put the back-up generators on even higher ground away from the reactors, the Nos. 1 to 4 reactors might not have been damaged."

FUKUSHIMA MELTDOWNS AND EXPLOSIONS

FUKUSHIMA, JAPAN

11 March 2011

A powerful tsunami generated by a magnitude 9 earthquake caused extensive damage to the Fukushima Daiichi nuclear power plant. Grid power was lost due to earthquake damage, and back-up generators soon failed due to the impact of the tsunami. Batteries provided power for some hours but plant operator TEPCO then had no method of powering the reactor cooling system.

The situation spiralled out of control leading to nuclear fuel melting and damage in reactor cores and spent fuel stores (located in the reactor buildings), multiple fires and hydrogen explosions. Four of the six reactors were seriously damaged, one of them loaded with mixed uranium/plutonium fuel.

The disaster was rated Level 7 (‘Major Accident’) on the 7-point International Nuclear Events Scale. Only Chernobyl and Fukushima have been rated Level 7.

More than 100,000 people have been displaced. As of early 2012 most had not been able to return, and some areas will remain uninhabitable for decades. Profound misery has resulted from the Fukushima disaster including poor physical and mental health, numerous suicides, financial losses and stigmatisation of evacuees. Total economic costs from the disaster will amount to hundreds of billions of dollars.

Agriculture and horticultural industries in the Tohoku region have been shattered, and heavy marine contamination has forced the closure of fisheries.

The Japanese government established an Investigation Committee in June 2011. The Committee’s interim report, released six months later, is a damning indictment of the Japanese government, nuclear regulatory agencies, and TEPCO. The report states 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”.

Although the Japanese Government knew that fuel melting had occurred within 24 hours of the tsunami, the public was not alerted to the true magnitude of the disaster for several months.

The Fukushima disaster has put the spotlight yet again on the failures of Japan’s nuclear power industry: widespread safety breaches, widespread data falsification, inadequate regulation, inadequate worker training, inadequate disaster risk mitigation, and inadequate emergency planning.

LET THE FACTS SPEAK: KEY ISSUES

‘NEXT GENERATION’ REACTORS

Nuclear advocates claim significantly reduced risks for the ‘next generation’ of nuclear power reactors. However risk assessments of reactor types that have yet to be built or operated are speculative. As one cynic from within the nuclear industry has quipped, “the paper-moderated, ink-cooled reactor is the safest of all.”

‘Advanced’ reactor designs will probably always be distant dreams. The Generation 4 International Forum states that “commercial deployment of Gen-IV reactors is not foreseen before 2030 at the earliest” while the World Nuclear Association states that “progress is seen as slow, and several potential designs have been undergoing evaluation on paper for many years.”

The Massachusetts Institute of Technology Interdisciplinary Study of Nuclear Power states: “We do not believe there is a nuclear plant design that is totally risk free. In part, this is due to technical possibilities; in part due to workforce issues. Safe operation requires effective regulation, a management committed to safety, and a skilled work force.”

Serious, unresolved problems remain on all three fronts – regulation, management, and workforce skills.

THE SILVER TSUNAMI AND THE BATHTUB EFFECT

The ageing of the global nuclear workforce, and the loss of expertise as waves of skilled workers reach retirement (a ‘silver tsunami’), will be a major challenge for nuclear safety in coming years and decades.

Reactors are most accident-prone in their early years (break-in phase, e.g. Chernobyl, Three Mile Island) and in their old age (wear-out phase, e.g. Fukushima Daiichi). This is known as the ‘bathtub effect’ as the risk curve declines after the early years of operation then increases as problems with ageing set in. This is of great significance to debates over nuclear safety with a large fraction of the world’s power reactors approaching old age and some countries planning to build new reactors.

INADEQUATE REGULATION

Inadequate regulation is evident in advanced nuclear countries such as the US and Japan. Typical problems include 'captured bureaucracies', the revolving door between regulatory bodies and regulated organisations, and shortages of skilled personnel to adequately carry out regulatory functions.

Conflicts of interest and other problems with nuclear regulation are belatedly being addressed in Japan in the wake of the Fukushima disaster. Inadequate regulation has been a major cause of inadequate safety standards including the failure to adequately address earthquake and tsunami risks. Collusion between the so-called regulator and nuclear utilities in Japan included working together to rig the outcome of public forums and public surveys of attitudes towards nuclear power.

Regulation has been highly problematic in Australia. In 2011, the Australian Health Department found an improper relationship between the Australian Nuclear Science and Technology Organisation and the regulator, the Australian Radiation Protection and Nuclear Safety Agency, following an investigation into several accidents at Lucas Heights and ANSTO's alleged mistreatment of whistle-blowers.

SAFETY AND ECONOMICS

There are many points of intersection between safety and economics - the most obvious being the pressure felt by nuclear operators to cut costs by cutting back on safety features, training and procedures.

Since no commercial insurer will insure a nuclear power station, the industry has negotiated legislated caps on insurance payouts in the event of an accident, such as the Price-Anderson Act in the US. Physicist David Lochbaum states: "Price-Anderson may prevent safety upgrades from being incorporated into new reactor designs. Without Price-Anderson, the added cost of developing and incorporating safety features is offset by reduced annual insurance premiums. With Price-Anderson providing equal liability protection regardless of risk, the cost of additional safety features becomes a financial impediment."

MILITARY ATTACKS AND TERRORISM

Historical examples of military strikes on nuclear plants include the following:

- On 7 June 1981, Israeli fighter planes destroyed the French-supplied 'Osiraq' research reactor at the Al Tuwaitha Nuclear Centre, 17 kms from Baghdad. Eleven people were killed.

- Iranian air strikes damaged the Al Tuwaitha site on 30 September 1980, shortly after the outbreak of the Iran-Iraq War and both Iran and Iraq attempted military strikes on nuclear plants on other occasions during the 1980-88 war.

- The United States air force destroyed research reactors in Iraq in 1991.

- Iraq's attempted missile strikes on Israel's nuclear facilities during the 1991 Gulf War.

- Israel's destruction of a suspected reactor site in Syria in 2007

The above examples have been motivated by attempts to prevent nuclear weapons proliferation. Nuclear plants might also be targeted with the aim of widely dispersing radioactive material or, in the case of power reactors, disrupting electricity supply.

Reprocessing plants and stores for spent nuclear fuel and high-level nuclear waste typically contain enormous quantities of highly radioactive materials in readily dispersible forms, and are more vulnerable to attacks than reactors as they are generally less well protected.

Terrorism (i.e. threats from sub-national groups) involving nuclear weapons or radioactive materials can take many forms including attacking nuclear facilities or the theft or purchase of material for use in nuclear weapons or 'dirty' radiation bombs.

The International Atomic Energy Agency's (IAEA) Illicit Trafficking Database contains more than 1,000 confirmed reports on incidents involving smuggling, theft, loss and illegal disposal, illegal possession and transfer, and attempted illegal sales of nuclear material. Around 800 additional incidents are as yet unconfirmed. Globally, the number of reported incidents of nuclear trafficking has been increasing.

The IAEA relies on voluntary funding (as opposed to predictable core funding) for 90% of its nuclear security program. Dr Mohamed El Baradei, who was at the time the IAEA Director-General, said in 2006: "Everybody says nuclear terrorism is the No.1 national and international security issue. But until they translate this grandstanding statement into dollars and cents, we will not be able to deal effectively with the danger we are facing."

Dozens (perhaps hundreds) of cases of nuclear terrorism have been documented. These include:

- In 1972, hijackers took control of a plane and threatened to crash it into the Oak Ridge nuclear research reactor.

- In 1973, guards at a nearly completed nuclear power reactor at Lima, Argentina were overpowered in an attack by 15 armed men.

- In 1977, Basque ETA terrorists set off bombs damaging the reactor vessel and a steam generator and killing two workers at the Lemoniz nuclear power plant under construction in Spain. There were several other attacks in the following years causing more deaths and more damage to the plant.

- In November 1979. a bomb damaged a transformer at the Goesgen reactor in Switzerland just after it had gone into operation.

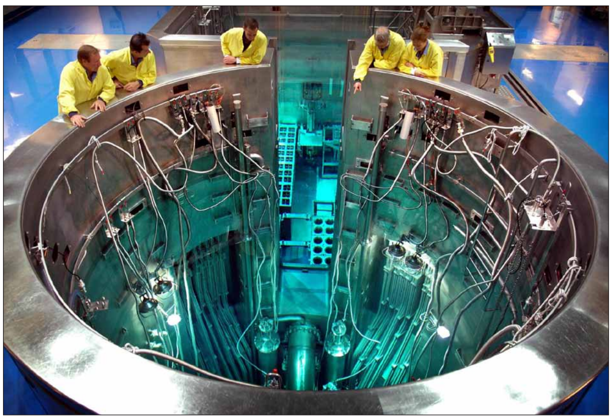
- In 1982, four rockets were fired at the nearly-completed Superphenix fast breeder reactor at Creys-Malville, France, damaging the containment vessel.

- In 1982, ANC fighters set off four bombs inside the Koeberg plant under construction in South Africa, despite tight security.

- In 1983, nine sticks of gelignite, 25 kg of ammonium nitrate, three detonators and an igniter were found in an electrical substation inside the boundary fence at the Lucas Heights nuclear site south of Sydney. A detonator was set off but did not detonate the main explosives.

- In 1993, a man crashed his station wagon through the security gate and into the turbine building of the Three Mile Island nuclear power plant.

There are frequent reports of inadequate security at nuclear plants. In November 2005, for example, a reporter and photographer were able to park a one-tonne van for more than 30 minutes outside the back gate of the Lucas Heights nuclear site without being challenged. The gate, 800 metres from the research reactor, was protected by a simple padlock. The Australian reported: "The back door to one of the nation's prime terrorist targets is protected by a cheap padlock and a stern warning against trespassing or blocking the driveway."



IS LOW-LEVEL RADIATION HAZARDOUS?

The weight of scientific evidence holds that there is no safe dose of exposure to ionising radiation. The 2005 report of the Committee on the Biological Effects of Ionising Radiation of the US National Academy of Sciences concluded that "the risk of cancer proceeds in a linear fashion at lower doses without a threshold and ... the smallest dose has the potential to cause a small increase in risk to humans."

Likewise, the 2010 report of the United Nations Scientific Committee on the Effects of Ionising Radiation (UNSCEAR) concluded that "the current balance of available evidence tends to favour a non-threshold response for the mutational component of radiation-associated cancer induction at low doses and low dose rates."

As scientific understanding of the effects of ionising radiation has advanced, permitted dose limits have been dramatically reduced. For workers, the permitted annual dose has decreased from 500 millisieverts (mSv) in 1934 to 20 mSv in 1991.

Radiation exposure from a particular nuclear plant over a short period of time may be very small but the cumulative exposure from many facilities over many years is significant. The United Nations Scientific Committee on the Effects of Atomic Radiation has estimated that the world population's exposure to radiation from nuclear facilities over a 50-year period was two million person-Sieverts. Applying a standard risk estimate, that dose equates to 100,000 cancer deaths.

Uranium mining and milling, and nuclear fuel reprocessing, are the stages of the nuclear 'cycle' responsible for most human radiation exposure. Radiation exposure from nuclear power reactors is typically very low, yet there is disturbing evidence of increased rates of childhood cancer near nuclear power plants.

Sections of the nuclear industry refuse to accept the scientific evidence that there is no threshold below which radiation exposure is risk-free. Nuclear Radiologist Dr Peter Karamoskos wrote in a 2010 article: "On several occasions in recent years uranium mining companies have brought guest speakers to Australia to argue that low-level radiation exposure is not only harmless but actually good for you. To promote such marginal views without any counter-balance is self-serving and irresponsible ... Recent research has heightened rather than lessened concern about the adverse health impacts of low-level radiation."

WHERE TO FROM HERE? MORE SOURCES ON NUCLEAR HAZARDS

Timelines of nuclear accidents:

- http://en.wikipedia.org/wiki/List_of_nuclear_accidents
- Wm. Robert Johnston provides lists of criticality accidents, terrorism incidents, etc: www.johnstonsarchive.net
- The IAEA's International Nuclear Event Scale (INES) provides some information on nuclear accidents but the complete accident database is confidential (as is the accident database of the OECD's Nuclear Energy Agency). http://www-ns.iaea.org/tech-areas/emergency/ines.asp
- Greenpeace, 2006, 'An American Chernobyl: Nuclear Near Misses at U.S. Reactors Since 1986', www.greenpeace.org/usa/en/media-center/reports/an-american-chernobyl-nuclear

Accidents and incidents in Australia:

- The Australian Radiation Protection and Nuclear Safety Agency publishes lists of radiation incidents in Australia: http://arpansa.gov.au/RadiationProtection/arir/arir_reports.cfm
- Accidents and incidents at South Australian uranium mines http://outernode.pir.sa.gov.au/minerals/mines__and__developing_projects/approved_mines

Aanalysis and information on nuclear accidents:

- M. V. Ramana, 2011, 'Beyond our imagination: Fukushima and the problem of assessing risk', Bulletin of the Atomic Scientists, http://thebulletin.org/web-edition/features/beyond-our-imagination-fukushima-and-the-problem-of-assessing-risk
- Academic Benjamin Sovacool has documented 99 accidents at nuclear power plants worldwide from 1952 to 2009. Benjamin Sovacool, August 2010, 'A Critical Evaluation of Nuclear Power and Renewable Electricity in Asia', Journal of Contemporary Asia, Vol. 40, No. 3, , pp.393–400.
- Mycle Schneider et al., 2007, 'Residual Risk: An Account of Events in Nuclear Power Plants Since the Chernobyl Accident in 1986', http://archive.greens-efa.eu/cms/topics/dokbin/181/181995.residual_risk@en.pdf

Risks associated with ageing nuclear plants:

- David Lochbaum, 2004, 'U.S. Nuclear Plants in the 21st Century', Union of Concerned Scientists, www.ucsusa.org/assets/documents/nuclear_power/nuclear04fnl.pdf

Nuclear power and weapons proliferation

- www.choosenuclearfree.net/power-weapons

Hazards of 'new' reactor types (e.g. fast breeders):

- Helmut Hirsch et al., 2005, "Nuclear Reactor Hazards: Ongoing Dangers of Operating Nuclear Technology in the 21st Century", www.greenpeace.org/international/press/reports/nuclearreactorhazards
- International Panel on Fissile Materials, September 2010, 'The Uncertain Future of Nuclear Energy', Frank von Hippel (ed.), www.fissilematerials.org/blog/rr09.pdf
- Antony Froggatt, 2006, 'Potential Environmental Risks of the Next Generation of Nuclear Power Plants', www.no2nuclearpower.org.uk/reports/gp-safety-af.pdf

Criticality accidents

Criticality accidents are when a nuclear chain reaction is accidentally allowed to occur in fissile material such as enriched uranium or plutonium. A Los Alamos National Laboratory report provides details of 60 criticality accidents worldwide from 1945 to 2000 resulting in 21 fatalities. Of the 60 accidents, 38 occurred at research or experimental facilities such as research reactors, while 22 occurred in commercial nuclear facilities. The study excludes major reactor accidents such as Chernobyl.

Monahan S, T McLaughlin, N Pruvost et al., 2000, 'A review of criticality accidents', Los Alamos National Laboratory, www.orau.org/ptp/Library/accidents/la-13638.pdf

Details of numerous criticality accidents:

- www.johnstonsarchive.net/nuclear/radcrit.html
- http://www.cddc.vt.edu/host/atomic/accident/index.html
- http://en.wikipedia.org/wiki/Criticality_accident

Nuclear terrorism

- Frank Barnaby, 2003, 'Nuclear Terrorism: The Risks and Realities in Britain', Oxford Research Group, www.oxfordresearchgroup.org.uk/sites/default/files/cdr27_sample.pdf
- Tilman Ruff, 2006, 'Nuclear Terrorism', EnergyScience Coalition Briefing Paper #10, www.energyscience.org.au
- Hirsch et al., www.greenpeace.org/international/press/reports/nuclearreactorhazards
- www.johnstonsarchive.net/nuclear/wrjp1855.html

The full version of this document can be found at www.letthefactsspeak.org

Let the Facts Speak was first published in June 1991, by the Office of Jo Vallentine, Senator for The Greens (WA).

This summary edition was produced by the office of Scott Ludlam, Australian Greens Senator for Western Australia in March 2012.

The full version can be found at www.letthefactsspeak.org

Text by Jim Green :: Design by www.werkshop.com.au
Authorised by Senator Scott Ludlam, 8 Cantonment Street Fremantle WA 6160