Standard Anti-Nuclear Assertions

(24/7/06)

Contents:

Foreword

Negative claims about nuclear power technology began in the 1960s as a consequence of the ban-the-bomb movement and continue to this day. However the main development of anti-nuclear power assertions took place primarily in the US in the 1970s due to a reactor licensing system that essentially fostered the establishment of an anti-nuclear industry which elaborated and expanded on these themes. This evolutionary process was essentially complete by the early 1970s and the same assertions continue to be repeated today. The only major difference has been the inclusion of assertions about the TMI and Chernobyl accidents.

The following lists the assertions commonly used and provides factual rebuts that apply to the current situation.

1. There is no safe level of radiation exposure.

The whole body dose-effect relationship currently recommended by the ICRP and adopted by most countries includes the Linear No Threshold (LNT) hypothesis that says the risk of cancer is proportional to dose. An extension of this concept is to use the LNT relationship to estimate statistical effects of small incremental doses to large populations. However, neither concept is supported by experimental evidence for doses below 50 mSv/yr [1].

Natural background radiation around the world ranges from about 1 to 100 mSv/yr with no observed differences to local populations. Further, for various reasons the real low-dose health effect relationship is likely to be much more complex than reflected by the LNT hypothesis. In fact, there is even evidence that humans have adapted to a range of low-level radiation that is necessary for maintaining health (i.e. a hormesis effect). Consequently the use of the LNT hypothesis at low doses is scientifically questionable [2,3].

It is generally granted that use of the LNT model at low doses causes adverse effects to be somewhat over-estimated. Thus in a majority of applications unquantified conservatism is required in design and operation leading possibly to excessive economic and social costs.

References:
1. "Health Effects of Low-Level Radiation," American Nuclear Society Position Statement, June 2001.
2. “Low-Level Radiation Dose Standards,” ANF Policy Paper 29/9/01.
3. UN Scientific Committee on the Effects of Atomic Radiation, 2000 Report.

2. It is unsafe to transport radioactive materials.

Radioactive materials are continually being transported internationally and within most countries. For example much of the radiopharmacuticals produced are made in Canada and are transported by air all over the world – even to Australia. In all approximately 20 million shipments of radioactive materials are shipped by land, sea and air every year with little difficulty.[1]

Radioactive materials associated with nuclear power such as uranium, separated plutonium and spent fuel waste are much smaller in volume than the waste from equivalent coal-fired generation. For example generating plants producing 8000 kWh produce for nuclear 30 grams of spent fuel as compared with coal of 8 tonnes of CO_2 and 300 kg of fly ash.[2]

When radioactive materials are transported they are packaged in containers that are designed to reduce surrounding radiation doses to safe levels while at the same time resist any damage that might occur from accident and/or fire depending on the type of material contained. Reactor spent fuel elements on their way to reprocessing or storage require the highest standard of packaging such that even if run into by a train would not break open.

Sea transportation of spent fuel waste is now fairly routine with, for example some 160 shipments of some 4000 containers occurring from Japan and Europe since 1969.

“Since 1961 the International Atomic Energy Agency (IAEA) has published advisory regulations for the safe transport of radioactive material. These regulations have come to be recognised throughout the world as the uniform basis for both national and international. transport safety requirements in this area. Requirements based on the IAEA regulations have been adopted in about 60 countries, as well as by the International Civil Aviation Organisation (lCAO), the International Maritime Organisation (IMO) and regional transport organisations.”[1]

References:
1. “Transport of Radioactive Materials,” World Nuclear Association, October 2003.
2. “Nuclear Electricity,” Uranium Information Centre, 2003.

3. Uranium resources are too limited.

The total world's Reasonably Assured Resources of uranium at $US40/kgU is about 1.88 Mtonnes which under present usage would last about 28 years (Australia has about 38% of this total). Adding in the Inferred Resources to $US130/kgU brings the total to 3.62 Mtonnes or about 53 years equivalent (Australia has about 24% of this total) [1]. If nuclear replaced all of the other methods of generation the 28 year figure would reduce to 4.5 years, but of course nobody is suggesting this should or even could happen. As far as the effects of uranium prices on generating costs go, uranium costs are a small percentage (about 3%) of overall nuclear generating costs so a doubling or tripling of the cost would not affect the price of nuclear generation appreciably, but would vastly increase the amount of uranium that could be economically recovered [2]. For example there are some 4.5 billion tonnes of uranium in the oceans that could be tapped if the price got high enough.

However before that occurred the use of fast breeder reactors would enable about 60 times more energy to be extracted from the existing reserves plus the 2.1 Mtonnes of depleted uranium that has been accumulating. In other words the 53 year figure quoted above would then extend to about 3000 years (5000 including the depleted U), and all without having to mine any more uranium than the 3.6 million tonnes. Also, thorium is about three times more plentiful than uranium in the earth's crust and although it is not fissionable itself it can be irradiated to produce uranium to fuel reactors. (Australia has about 25% of the world's thorium)[3].

References:
1. "Australia's Uranium and Who Buys It," UIC Nuclear Issues Briefing paper No. 1, 6/2006.
2. "The Economics of Nuclear Power," UIC Briefing Paper No. 8 5/05.
3. "Breeder Reactors: A renewable energy source," B. Cohen, Am Journal of Phys vol 51(1) Jan 1983.

4. Uranium mining is environmentally damaging and unsafe.

Most people in Australia have little concept of the size of the continent crowded as they are into the coastal strip. It is therefore instructive to examine the "footprints" of various land use activities to get some appreciation of their relative impacts. The table below shows agriculture occupies the most land, and even just the land devoted to crops is more than 100 times that given to mining. Further, the land devoted to mining constitutes only 0.02% of the total continental area and unlike the massive coal mines, uranium mines are all located well away from developed areas [1].

LAND USE IN AUSTRALIA

LAND USE	sq km
Total area	7,682,840
Grazing	4,200,000
Marine Parks	426,000
Parks, Nat., Wildlife, Rec	328,000
Pastures and Grasses	300,000
Crops	180,000
Roads	24,000
Serrated tussock grass	9,000
Housing (6.5 million dwellings)	6,500

All mining................................1,500
Reservoirs..................................860
Suburban driveways..........................312
Snowy Mountains Hydro roads..................48
Sydney sewer mains...........................40
Melbourne – Sydney gas pipeline..............14
Uranium mines (incl. Jabiluka)...............12
Proposed cycle way NSW coast..................6
PV producing 163 TWhe/y.................1,000

It can be argued that uranium mines should not be developed because they often infringe on areas that are subject to aboriginal land rights claims. However, the determination of whether a given mine may go ahead should be more a question of whether the affected aboriginal group can reach an accommodation with the mining interests rather than whether a particular political party based on the coastal fringe objects.

Environmental factors such as ground water contamination and the ultimate remediation of the minesite are also important factors. However, states such as South Australia that do have mines have shown themselves capable of forumulating and enforcing appropriate environmental controls as is the Office of the Supervising Scientist in the Northern Territory.

As far as safety goes, care is taken to make sure that radiation exposure in mines is as low as possible. Australian miners are well below the allowable limit of 20 millisieverts per year. Further, no operation involving radioactive materials is entered into unless: (a) it is justified in terms of net benefit to the exposed or society generally, (b) it is optimised by application of the ALARA principle, and (c) accumulated doses are kept within established limits.

The uranium mining industry is well controlled and monitored by appropriate organisations that ensure safety procedures are carried out. Government bodies make regular inspections of uranium mining sites. These sites are subject to Federal and State Government regulations, covering many aspects of their operations, including employee and public health and safety, environmental management and Aboriginal heritage protection.

Codes of practice apply to all uranium mining and milling operations as set by joint Commonwealth/State Consultative Committees under the Commonwealth Radiation Protection (nuclear Codes) Act 1978. the current applicable codes are: (a) The Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing, and (b) The Code of Practice for the Safe Transport of Radioactive Substances [2].

References:
1. “Electricity Generation Alternatives for Australia,” ANF Discussion Paper No. 1 (31/5/01).
2. “Occupational Safety in Uranium Mining,” World Nuclear Association, March 2006.

5. The nuclear fuel cycle emits vast amounts of greenhouse gases.

The energy efficiency of nuclear power was first raised by the FOE in the 1970s when it was asserted that nuclear power would provide no net energy gain. Recently a 40 year lifetime energy analysis of a

1000 MWe nuclear power plant published by the WNA shows that mining and milling of 195 tonnes U/year of Ranger ore of 0.234% U would contribute about 3% (mostly fossil) to the total energy inputs. If the grade of the ore were reduced to an uneconomic 0.01% the mining and milling would increase to contribute 41% of the total. However, the nuclear energy generated is huge by comparison, leading to an overall energy pay-back time achieved by the reactor in both cases of about four to five months out of the forty year plant lifetime [1,2].

As regards lifetime CO2 emissions a recent compilation from several countries provided the following for various methods of electricity generation [4]:

gCO2/kWh	Japan	Sweden	Finland
Coal	975	980	894
Gas Thermal	608	1170 peak load reserve	-
Gas Combined Cycle	519	450	472
Photovoltaic	53	50	95
Wind	29	5.5	14
Nuclear	22	6	10-26
Hydro	11	3	-

These figures are consistent with an earlier study by the IAEA which estimated that nuclear power was responsible for about 9-30 gCO2/kWh while LNG power stations produced 460-1234 gCO2/kWh a factor for nuclear of at least 15 times less [3].

And to complete the picture, the external costs of these emissions should be considered. Interpreting the health detriment and damage due to climate change as costs in Australia gives the following:

	A$/MWh		
Method	**Health**	**Global Warming**	**Total**
Coal	11.7	27.9	39.6
Coal (Liddell and Bayswater	2.1	40	42.1
Gas	2.4	10.2	12.6
Nuclear	0.1	0.5	0.6

References:
1. “Energy Analysis of Power Systems,” World Nuclear Association, March 2006
2. “Energy Balances and CO2 Implications,” World Nuclear Association, Nov 2005
3 “IAEA Bulletin Vol. 40, No. 1 1998; “Energy Analysis of Power Systems,”
4. “Introducing Nuclear Power to Australia – an economic comparison”, J.H. Gittus, March 2006.

6. Nuclear power is too expensive to build, operate and decommission.

A recent economic study of nuclear power for Australia showed that the generating cost breakdown would be [1]:

Generation Element	Percent
Decommissioning	2
Operations and Maintenance	25
Fuel	13
Spent Fuel Management	2

Capital and Financing	58

The study was based on Westinghouse AP1000 reactors and the predicted cost of generation was A$38.2/MWh. OECD data from 2005 shows that this figure is consistent with similar studies done for other countries [2]:

	A$/MWh		
Country	**Nuclear**	**Coal**	**CCGT**
Finland	37.71	49.73	
France	34.70	45.49	53.56
Germany	39.07	48.09	66.94
Switzerland	39.35		59.57
Netherlands	48.91		82.52
Czech Republic	31.42	40.17	67.90
Slovakia	42.76	65.30	76.37
Romania	41.81	62.16	
Japan	65.58	67.63	71.18
Korea	31.97	29.51	63.53
USA	41.12	37.02	63.80
Canada	35.52	42.49	54.65
Australia	38.20	40.83	43.55

In the US decommissioning and waste storage costs are included in the total generating costs. Operating US nuclear power plants charge about 0.1-0.2 US cents/kWh to cover decommissioning and pay a levy of 0.1 US cents/kWh to cover disposal of spent fuel [3].

Nuclear cost are usually competitive with coal being higher in locations with cheap coal and less in locations with expensive coal since fuel costs are the largest component of generating costs. (Charges for greenhouse gas emissions, however, would increase the costs of coal-fired generation much more, see Std Assrt. No.6 above.) Nuclear costs, however are fairly universal since plant capital costs (the largest component) are relatively uniform (subject, of course, to local wage rates, interest rates, shipping costs and materials costs). It should also be noted that generating costs may vary depending on the generating authority and the accounting methods it uses. For instance it has been claimed that generation by coal in Queensland costs only 2.8 Australian cents/kWh but this would be for plants whose capital costs have already been written off whereas other methods of calculation spread the capital costs over the life of the plant [4].

References:
1. “Introducing Nuclear Power to Australia – an economic comparison”, J.H. Gittus, March 2006.
2. “Projected Costs of Generating Electricity,” OECD (2005 update).
3 “The Economics of Nuclear Power,” UIC Briefing Paper No. 8, 4/05.
4. Comment by Martin Ferguson MP, ALP shadow minister of resources, ABC Sunday program 18/6/06.

7. Nuclear power reactors take too long to build.

This contention is influenced by the experience in the USA some twenty to thirty years ago. At the time extensive intervention in the licensing process (including that by those from the anti-nuclear camp) was allowed to delay the completion of plants already contracted or even those whose construction had begun. These impediments succeeded in raising the capital costs of new plants to unacceptable levels. Further, “Construction costs of nuclear plants completed during the 1980s and 1990s in the United States were high compared with what the industry believes is possible today. Regulatory delays, redesign requirements and difficulties in construction management and quality control all inflated costs. Many plants were also completed at a time of high general inflation, which dramatically exacerbated the impact of delays [1,2].

However, the experience in other countries having a more efficient approach to plant licensing such as France, Japan, South Korea and now China shows that nuclear plant construction times of about 5 years are routinely feasible. In addition Westinghouse, the manufacturer of the AP1000 design estimate that one of their 1150MWe reactors can be built in about 3.5 years given a mature industrial and regulatory climate [3]. Atomic Energy of Canada Ltd similarly estimates that one of its Advanced Candu Reactors (ACR700, 750MWe) can be up and running in 48 months given comparable conditions [3].

Construction of the early nuclear plants in this country would not necessarily be delayed by the fact that the technology would be new to the country. Key components such as pressure vessels, piping and pumps initially would have to be imported, and staff training could be done overseas and/or experienced operators could be hired from overseas. The main problem could be in establishing a competent regulatory agency. Again, staff could be trained overseas or imported, or the bulk of the safety evaluation work could be contracted to and an experienced overseas regulatory agency.

References:

1.“The New Economics of Nuclear Power,” World Nuclear Association, 2005.
2.A.M. Rivlin, Director Congressional Budget Office, Testimony before the Subcommittee on Energy and Environment, Committee on Interior and Insular Affairs, US House of Reps. 24/5/78.
3. Westinghouse website 2005.
4. AECL website 2004.

8. Nuclear power reactors routinely emit dangerous amounts of radioactive materials.

Nuclear power plants emit very little radioactive material during normal operation because most of is confined in the fuel assemblies. Reprocessing however, releases most of the krypton 85 (xenon isotopes are short-lived). All power plant radioactive releases are regulated by nuclear safety agencies.

The gaseous releases are thoroughly regulated and extensively documented. The USCEAR 2000 report says that emissions from nuclear operations give the average person a radiation dose of less than 0.2 μSv per year. The Average annual radiation dose from natural background radiation is 2.4 mSv per year. The same report says that the radiation dose from burning coal to make electricity is between 1 to 10 μSv per year – because of the releases of uranium and thorium and their daughter products such as radon [1].

Argon 41 is an activation product of air and occurs mainly with low power research reactors or in the gas cooled reactors in the UK. In light water reactors any radioactive waste gases are collected and confined for decay to meet emission requirements before release [2].

The noble gases krypton, xenon and argon are nearly chemically inert and are not readily absorbed by the body. Moreover, are not alpha emitters and do not reside in the lungs long enough to be an internal hazard. Thus exposure to their radioactive isotopes are usually considered as potential external radiation hazards only [3].

On the other hand, the isotopes of radon, which are natural decay products of uranium and thorium, are generally alpha emitters and thus can constitute an internal and external radiation hazard. Naturally occurring radon gas is responsible for most of the radiation dose received by people from the environment and can be a problem in enclosed spaces such as mines, and houses [4].

References:

1. REF: 2000 Report of the United Nations Scientific Committee on the Effects of Atomic Radiation.
2. Maine Yankee FSAR
3. Chart of the Nuclides, General Electric Co. 1977.
4. Radiation Atlas of Europe and 2000 Report of the United Nations Scientific Committee on the Effects of Atomic Radiation (Section 12).

9. The number of deaths caused by the accident at Chernobyl 4 will total in the tens of thousands.

In 2006 it was estimated by Greenpeace that the full consequences of the Chernobyl disaster could top a quarter of a million cancer cases and nearly 100,000 fatal cancers [1]. However, a more authoritative study was carried out by UN Chernobyl Forum in 2005. Its findings were published by the World Health Organisation and its conclusions were reported in a fact sheet also released in April 2006 [2,3].

The WHO reported that some 5000 children up to the age of 18 contracted thyroid cancer following the accident, but not all of these were caused by the accident itself and most (99%) were successfully treated. Amongst the “liquidator” (i.e. cleanup) group 28 died in 1986 from acute radiation sickness and others have also died but “their deaths could not necessarily be attributed to radiation exposure”. Further, there “may be up to 4000 additional cancer deaths among the three highest exposed groups [626,000 people] in their lifetime (i.e. a 3-4% increase in cancers from all causes). In addition, among the 5 million people in the Ukraine, Belarus and the Russian Federation that are now exposed to slightly elevated background radiation from fallout, there could be another 5000 early deaths (i.e. 0.6% increase in all cancer deaths).

It must be noted that the preceding estimated death rate increases are based on the linear no-threshold hypothesis that extrapolates from known effects accruing at high doses linearly down to zero at the background dose of 2.4 mSv/y. As such these estimates should be regarded as hypothetical only (see Standard Anti-Nuclear Assertion No. 1 above) [4].

References:

1. The Chernobyl Catastrophe – consequences on human health, Greenpeace, April 2006.

2. Health effects of the Chernobyl accident and special health care programmes, report by the UN Chernobyl Forum Expert Group “Health”, WHO 2006.
3. Health effects of the Chernobyl accident: an overview, WHO Fact sheet 303, April 2006.
4. “Low-Level Radiation Dose Standards,” ANF Policy Paper 27/9/01.

10. Reactor accidents could release vast amounts of radioactive materials with consequences comparable with Chernobyl 4.

The most serious commercial nuclear power plant accident was the one that happened at the 1000MWe Chernobyl 4 unit in the USSR in 1986. The initial cause of this accident was a poorly designed and executed test of the plant behaviour at low power. The plant design, unique to the USSR, was also a major contributor because the reactor had essentially no containment building consequently the accident released massive amounts of radioactive materials ($8X10^{10}$ Becquerels)into the air and thence across the Ukraine, Belarus and much of Europe (see Standard Assertion 9 above).

After the accident the remaining 12 reactors of this vintage were upgraded but the last of these will be phased out of operation by 2018 as replacement plants are built. More than likely these will be of the Russian VVER design which is a pressurised water reactor similar to the major type used in the western countries.

The second most serious commercial nuclear power plant accident was to the 900 MWe Three-Mile Island 2 plant in Pennsylvania USA in 1979. “The accident resulted in some radioactive gases from the melted fuel being vented from the plant. Subsequently, off-site radiation exposures within 16 km were determined to average 0.08 mSv (about the same as a chest X-ray) with a maximum of 1 mSv (about 1/3 of the annual natural background dose). A study of the 30,000 people who lived within 5 miles of the site was kept for 18 years after the accident and no adverse public health effects were found, other than psychological stress immediately following the accident.”[3]

The cause of the accident was a loss of secondary coolant flow to the steam generators which led to a quick pressure rise in the primary system and then an uncontrolled loss of primary water to the containment building. Subsequent mistakes in controlling the situation led to a core melt-down but the melted fuel was mainly confined to the bottom of the pressure vessel and the radioactive gases were released were mainly confined to the containment building. This type of PWR with its low water capacity once-through steam generators is no longer being built.

References:

1. UNSCEAR 2000 Report. “Sources and Effects of Ionising Radiation”, United Nations Scientific committee on the effects of Atomic Radiation, Vol.2, Annex J. ISBN 92-1-422396.
2. “RBMK Reactors” UIC Briefing Paper 64A (2/02).
3. “Health Effects of the Three Mile Island and Chernobyl Nuclear Power Plant Accidents, ANF Information Paper No.6, (18/12/03).

11. Commercial power reactors produce plutonium which can be used to make nuclear weapons.

The international Nuclear Non-proliferation Treaty as administered by the IAEA and most countries in the nuclear business (including Australia) ensures that no diversions to weapons production are made. India, Pakistan are not signatories to the NPT but do not use their power reactors for such purposes [1]. Iran is a signatory and is currently under international pressure not to enrich uranium for fear that it could be used for weapons. Similarly North Korea was a signatory, but withdrew and is now under international pressure not to develop nuclear weapons. Iraq too is a signatory and was developing nuclear weapons but this program was stopped by the UN.

The fact remains that no nuclear weapons country uses plutonium from commercial power reactors to make bombs because it is simpler to use special weapons grade material, plus by being a party to the NPT they have agreed not to do so. The world ultimately relies on the NPT and other non-proliferation treaties plus an extensive international monitoring system to ensure that diversions of commercial power reactor plutonium for weapons does not occur.

Reference:
1. D. Albright, "India and Pakistan's Fissile Material and Nuclear Weapons Inventories, end of 1999," ISIS, October 11, 2000.
2. "Nuclear Electricity," Uranium Information Centre, 2003
3. "Safeguards to Prevent Nuclear Proliferation," World Nuclear Association, October 2004.

12. Breeder reactors do not work.

Fast breeder reactors have been proven through the operation of a number of prototypes in various countries including the USA, UK, France, and the USSR. Research on this concept was begun early in the development of nuclear technology because it was believed at the time that uranium resources were limited and FBRs would be the only way of extending the life of the uranium that was available. Then, as more uranium was found it was decided to defer R&D. Another aspect was that in the 70s the Carter administration in the US was promoting nuclear non-proliferation and wanted to ban all reprocessing of reactor spent fuel. Now, however not only is there a coming need for FBRs to extend the use of the present uranium resources but fast neutron reactors are under development under the Generation IV program as a means of eliminating much of the present and future high level waste arisings.

Fast reactors extract much more energy from fuel than thermal reactors. Fast reactors with recycling of fuel have fuel efficiencies more than 60 times greater than is currently obtained with the once-through process in thermal reactors. This is because fast reactors burn mainly uranium-238 (rather than uranium 235 which is much less abundant), and are much more likely to cause heat-producing fission reactions with heavy elements than neutron capture which produces little heat. In this way, the transuranics (plutonium, neptunium, americium, curium), which are formed in the reactor and constitute most of the long-lived radioactive waste from thermal reactors, are burned and produce useful energy [1].

Another type of breeder reactor irradiates thorium to produce uranium 233 and isotope that is even more fissionable than U235. Currently only India is pursuing the development of these breeders because they have little uranium but much thorium resources [2]. Australia too has about 25% of the world’s thorium resources along with it’s 25% of the world’s uranium.

References:
1. “Fast Neutron Reactors,” ANF Information Paper (2/6/06).
2. “Thorium Reactors,” ANF Information Paper (2/6/06).

13. Plutonium is one of the most toxic substances known to man and minute amounts can cause cancer.

“As far as dangerous radioactive isotopes go, plutonium-239 is not even in the top ten. In soluble form two of the isotopes of radium are 100 times more toxic than soluble forms of plutonium.

“By inhalation, naturally occurring actinium-227 is the most dangerous radionuc1ide, 16 times worse than plutonium-239. Thorium-232, in fourth place among the ten most toxic, is very common, especially in beach sand deposits. By ingestion, all compounds of radioactive lead-210 are more than twice as dangerous radiologically as the most toxic compound of plutonium.

“When it comes to toxic or poisonous chemical elements, plutonium is scarcely in the running. In the massive Handbook of Toxicology of Metals it does not rate a mention except in passing in the entry for uranium. One aspect rarely mentioned is that non-radioactive elements have an infinite half-life - they never decay away to less harmful elements. Deadly elements like thallium retain their toxicity forever.

“Where chemical compounds are considered, cyanides are far more to be feared. Then there are highly toxic organic chemicals, such as the organoch1orides. The herbicide and pesticide sprays found in the average garden shed are more likely to cause harm than the majority of radioactive substances. And as for 'natural' chemicals, curare and hemlock will dispatch you when plutonium won't. Ask Socrates.

“And regarding the cancer question, the word “can” is very significant because the chances are so extremely small. Cancer induction is a complex process with, in general at least three stages of initiation. So since a single particle can only be responsible for a cancer if the predisposing events (not necessarily radiation related) have occurred at the same site.”[1]

Reference:
1. “Nuclear energy Fallacies- Forty Reasons to Stop and Think,” C. Keay, Enlightenment Press 2001.

14. There is no solution to Nuclear waste.

It is often claimed that high level waste would have to be stored for something like 150,000 years but this is a gross exaggeration. Nuclear waste consists of various radionuclides including fission products plutonium and minor actinides that all decay at various rates. International research programs for the development of the new Generation IV reactors includes the use of new separations technologies that can extract plutonium and the minor actinides from the waste stream and reuse these substances as fuel in reactors. Similarly the fission products can also be destroyed by irradiation in reactors or stored for decay – the latter being a process that requires secure isolation for about 400 years [1,2,3,4].

References:
1. "Reactor Spent Fuel Radioactive Waste," ANF policy paper (8/12/05)
2. "Heavy-Metal Nuclear Power," E.P. Loewen, American Scientist, Nov-Dec 2004
3. "Destruction of long-lived radioactive waste" OECD Nuclear Energy Agency
4. "Processing of Used Nuclear Fuel," UIC Nuclear Issues Briefing Paper #72, (3/05)

15. Nuclear power will not stop global warming.

No responsible person would claim that nuclear power would achieve this. Another related false claim is that nuclear power could not be built fast enough to make a difference. On the latter approximately 1400 1000MWe nuclear power plants would be required to replace the world's presently fossil fuel plants, however, no one is suggesting that a rapid substitution be attempted.

It is interesting to note that the anti-nuclear protagonists in the developed countries through political pressure have helped to restrict the growth of nuclear power in the world; meaning that the increased demand for electricity had to be met primarily by more coal-fired generation. If the growth rate of nuclear generation between 1980 and 1990 had been maintained to the present the generation of about 8.5 billion tons of CO_2 would have been avoided – somewhat more than the annual total presently generated by the USA, Europe, India and China using coal-fired generation [1][2]. This hardly seems to be a commendable outcome for those in the anti-nuclear movement who at the same time also claim to be protectors of the environment.

The electricity generated in the world comes from: hydro 19%, coal 39%, oil 10%, gas 15% and nuclear 16%. The fossil fuel plants then generate about 65% of the total or about 10,000 billion kWh/year. A nuclear plant at 85% capacity factor would generate about 7.5 billion kWh/year. The addition of nuclear plants would best be done as the need for new base-load generation arose and then only when they showed an advantage over other non-fossil methods of generation [3].

There can be no denying that modern societies need reliable base load electricity generation to function. This means fossil, nuclear or hydro sources must be used. Other sources such as wind or solar are too intermittent in their operation to be relied upon for the majority of generation since there exists no large-scale method for storing electric power for when it is needed. Still other methods such as tidal or geothermal are either still under development or are too localised. Nuclear power should and must be used as part of the energy mix if global warming is the problem it is purported to be [4]. Greenhouse emissions could be reduced further if nuclear power were utilised to generate substitutes for primary energy fuels such as hydrogen for oil.

Another little appreciated aspect of the campaign to reduce Australian CO_2 emissions from electricity generation is that actually it would make little difference to the global situation. Australia generates 1.66% of world CO_2 emissions and about 40% of this comes from electricity generation [5]. Thus if all CO_2 emissions from this country's electricity generation were eliminated, global emissions would be reduced by only 0.7%, and since global warming is a worldwide phenomenon, there would be little physical difference for Australia aside from a possible collective feeling of self-righteousness.

References:
1. US EIA International energy Annual, 2004.
2. "CO2 Emissions Accruing from Forgone Nuclear Power Generation 1990-2006," J.R. Fredsall (ANF Technical Paper, 24/7/06)
3. "Nuclear Power in the World Today," UIC Briefing Paper No. 7 (1/05).
4 "Nuclear Power for Australia," ANF policy paper (31/1/03).
5. World Almanac, 2005