Australian Nuclear Forum Inc.

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18/2/05

Dr Ian Smith
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Dear Dr Smith

RE: ANSTO CD "Science in Society" (for school years 7-10)

Two of our members (Brough and Fredsall) have reviewed the CD recently produced by ANSTO for use in schools. Presumably the purpose of this CD is to provide some instructional material to teachers and students so as to engender a better understanding of nuclear science in general.

The ANF believes that such a teaching resource should be scientifically accurate especially so because it originates from this country's primary nuclear science research and development agency. However, we have discovered a number of inaccuracies in the presentation that could lead to misunderstandings of the technology and its historical background. The attached notes identify these inaccuracies and in some cases provide alternative approaches.

Please do not take this as a criticism of the overall idea of the CD or its general presentation, which are laudable considering the general lack of understanding of things nuclear amongst the general community. It's just that a little closer involvement by those experienced in the field could produce a product that would be a useful educational tool and a credit to ANSTO.

Yours sincerely

J. Brough
President

Comments on ANSTO's science resource for schools, "Nuclear Science in Society".

In Theme 1, Teacher Notes, page 8, the table headed Summary Task 1: Radiation and atomic particles lists U-238 as being non-radioactive. This is wrong. Likewise the corresponding table in Student Summary Task 1.

Teacher notes, Theme 4, page3. The table says silicone when it should be silicon.

Teacher Notes, Theme 3, page 2 gives answers on the hidden costs of electricity generation. I have some doubts as to the accuracy of these answers and I would like to know the sources of the statistics quoted so that I can examine them.

Without going into detailed argument I shall point out that Australia's uranium production is ~ 9,000 tonnes per year. Roughly 30 tonnes/y are used in a 1000MWe reactor every year, or 720 tonnes for 24 reactors for a year. If there were really 4.8 uranium mining deaths per year (as stated), the mining of 9,000 tonnes should result in 60 deaths per year.

Also, it is said that there will be 12 cancer deaths per year from the operation of 24 reactors, but no cancer deaths from coal burning. Presumably the nuclear deaths are caused by reactor emissions. If this is true there should be cancer deaths attributable to the substantial emissions of radioactivity from coal-fired power stations. UNSCEAR data say that emissions from all aspects of the nuclear cycle result in a radiation dose of less than 0.2 microSievert per year. The corresponding dose from coal-fired stations is estimated to be 1 to 10 microSieverts per year.

This section is very important to public perception of all things nuclear and should not be allowed to stand without thorough re-evaluation of the facts.

I was disappointed that the resource has not made prominent use of the latest ANSTO information leaflet on natural background radiation. I have already expressed my concern about the fact that the radiation dose in the CD does not appear to include internal dose from K-40, and the uranium and thorium series

I am delighted that ANSTO has produced this resource for science teaching.

J Brough, 17 Feb, 05

Comments on ANSTO's Nuclear Science in Society
J.R. Fredsall 15/2/05

Theme 1: About Radioactivity

Topic 1 What is Nuclear Radiation

Figure 1.1 why are gamma rays identified with a warning sign while the others are apparently benign.

Topic 2 Radioactivity and the Atom

Topic 3 Neutrons and Fission

Critical Mass

Paragraph 3 – it is not true that all fission weapons are detonated by combining two subcritical masses of almost pure fissile material – e.g. the Fatman bomb which operated by implosion. See also Topic 7 under nuclear weapons.

Paragraph 3 – the shockwave may flatten buildings at several km depending on the size of the blast, its altitude and the type of building.

Paragraph 4 – reactors can produce Pu239 but all power reactors produce higher plutonium isotopes as well. Plutonium with a purity of less than 94% Pu239 is generally not used for weapons and a typical light water power reactor discharges plutonium with about 60% Pu239.

Nuclear Fusion

Fusion does not produce more energy per event (e.g. <10MeV) than fission (~200MeV)

Theme 2: Life in the Nuclear Age

Topic 4 Biological Effects of Nuclear Radiation

See preceding comments by J Brough.

Dose and Effect

Paragraph 2 – 28 people died from radiation and 2 others from fire.

Paragraph 3 - Hiroshima and Nagasaki – the incidence of cancer at these is known but it is also essential to point out that no genetic effects have been observed.

A safe threshold?

Paragraph 2 – the higher levels of background radiation in locations that still have healthy populations (e.g. Kerala at about 10 times the Australian level) should be mentioned.

Figure 4.3 – a confusing table. If the 2 mSv figure is the average background, why include the 1 mSv figure with the comment that this can cause cancer? Here again an indication of the range of normal background radiation would be instructive.

Topic 5 Controlling the Atom

Protecting People

Paragraph 1 – most reactors have "fuel assemblies" that are handled as a unit (they do contain fuel rods integral with the assembly), whereas HIFAR and the RRR have "fuel elements" made up of fuel plates (not rods). "Fuel rods" is now an out-of-date term (but still generally preferred for some reason by journalists and the antis, etc.) for major fuel units.

Nuclear Reactors

Paragraph 1 – This is not what happened at Chernobyl. Some fuel did eventually melt through the bottom of the reactor (the text mentions the reactor vessel but this indicates confusion with pressure vessel reactors), but the main problem was that the top cover of the reactor blew off and the structural graphite of the reactor caught fire which then melted the fuel. The fire then spread radioactive contamination over the countryside. This type of reactor was unique to the USSR and is no longer being built.

Paragraph 2 – At TMI most of the radioactive material stayed inside the reactor vessel. Unlike Chernobyl, nobody in the vicinity of TMI received excessive radiation exposures.

The Fuel Cycle

Paragraph 2 – "the waste is also hot" hot indicates temperature, but temperature depends primarily on the rate of heat generation as balanced against the rate of cooling.

Figure 5.3 Caption – same as above.

Paragraph 3 – again "hot" is used. Perhaps the author is confusing the ordinary use of the word "hot" with the industry jargon that means "highly radioactive."

Weapons Proliferation

Paragraph 2 – the IAEA is an agency of the UN.

Topic 6 Current Controversies

Paragraph 1 – not all reactor produced nuclear waste lasts thousands of years. Currently plutonium increasingly is being separated out of the waste stream and recycled. Further, plans are underway to develop reactors and processing systems to separate, recycle and destroy all the longest lived isotopes (the transuranics) through recycle and transmutation. Most of the remaining radioisotopes have half-lives on the order of 30 years and will decay away in about 300 years..

Radioactive Wastes

Paragraph 1 – the pollution from coal fired plants includes radioactive materials that exist in the coal (not to mention mobilised heavy metals). Australian black coals have enough uranium in them such that if the uranium were extracted and burned in fast breeder reactors and amount of electricity that could be produced would equal that produced by burning the original coal. Further, the potential dose to the public from coal fired plant emissions exceeds that from nuclear power plants under normal operating conditions.

Figure 6.1 – This shows "fuel bundles" in the repository. This terminology is used only for Canadian reactors – a type of reactor that is not as numerous as light water reactors.

Nuclear Weapons

Paragraph 2 – nuclear fission and fusion

Theme 3: Using Radiation

Topic 7 Nuclear Energy

Nuclear Reactors

Paragraph 2 – 200 tonnes of U per year sounds kinda high. Perhaps this applies to the older magnox type stations.

Figure 7.1 & paragraph 2 – PWRs have "fuel assemblies" that are made up of fuel rods or pins. The fuel units that are individually inserted and unloaded from a PWR are the assemblies and not the rods.

Figure 7.2 caption – The "core" of a PWR is about 3.5 – 4 meters high and about the same in diameter. These must be numbers from a graphite reactor.

Paragraph 5 – Chernobyl did not suffer a "supercritical meltdown" but did suffer a supercritical power excursion that led to a steam explosion in the core and blew the top lid off the reactor.

A general comment – this section is incomplete in that it does not mention breeder reactors. FBRs can be used to multiply the utilisation of uranium by about 60 times thus providing a world energy resource that extends for about 5000 years (assuming the same rate of nuclear electricity generation). Moreover, there is at least again as much nuclear energy tied up in the world's thorium and Australia has an even larger share of that than of the world's uranium.

Nuclear Weapons

Paragraph 1 – the British and Canadians were not just supporters but participants.

Paragraph 2 – the 'two subcritical mass" approach is contradicted by Figure 7.4 – the figure is correct.

The Hydrogen Bomb

I don't think it is true that the fusion reaction causes a chain reaction – it's just that the temperatures and pressures are high enough to cause fusion to occur. It is true that a fission chain reaction is used to generate the temperatures and pressures that initiate the fusion reaction but the latter does not involve a chain reaction.

Topic 8 Radiation for Research

Topic 9 Radiation in Medicine and Industry

Theme 4: Choosing Nuclear Futures

Topic 10 Bombs and Breakthroughs: a History

Fission and the Bomb

Paragraph 2 - For historical accuracy it should say something like "The result of the Manhattan Project (actually Manhattan District), a joint US/UK project carried out in the USA……." This project was formed under the Quebec agreement between The UK and the USAl and both countries agreed to drop the bombs on Japan.

Atoms for Peace

The quote "too cheap to meter" came from Lewis L Strauss a financier and an early Chairman of the USAEC and it pertained to fusion not fission power (even so it was an overstatement since electricity always costs money to produce). This throwaway comment is a hoary cheap shot used by the anti-nukes and does not belong in this presentation.

Fallout

It is debateable whether the decisions to defer further nuclear power plants was caused by public pressure, politics or economic factors.

Topic 11 Nuclear Technology in Australia

Freedom and Power?

Paragraph 1 – Most of Australia's large coal deposits were discovered well before Jervis Bay.

Innovation and Precaution

It should be pointed out somewhere – and possibly here that Australia has the largest reserves of uranium in the world (28%) and in energy terms exports of uranium constitute some 40% of the energy exports of this country (95% if one considers the burning of the uranium in FBRs).

Topic 12 How Does Society Decide?

Figure 12.1 Caption – As we have seen, national decisions may also be affected by the States.

Risks and Opportunities

The figure in Figure 12.3 for being within 80 km of TMI2 doesn't make much sense – isn't it different for 1 km and 80 km? Also this risk was presumably calculated from the "more conservative 'no threshold' concept" (see Theme 2, Topic 4, A Safe Threshold?) thus it should be identified as being a conservative estimate.

Similarly in reference to the risk of being 1.5 km from ground zero at Hiroshima – was this a conservative estimate or an actual measurement?