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A revolution in radiation protection that would lead to safer and cheaper nuclear power

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Months of dramatic press reports of radioactive leakage from the Fukushima Daiichi Nuclear Plant in Japan have carried an apparently dire safety message; and industry, governments and the public worldwide have reacted that, at whatever cost, such an accident should never happen again. But, this is a mistake. Another accident like Fukushima, somewhere, sometime, should be avoided but would represent no global disaster.

In most fields of activity there are exceptional accidents, usually with some loss of life – but seldom in the case of nuclear technology. Confusion persists between nuclear reactor safety and the effect of radiation on human health, often described as *radiation protection* or *radiological safety*. Official pronouncements make no attempt to clarify this contrast, although both the extensive damage to reactors and the resilience of life have been evident in every major accident in 60 years: Windscale (1957), Three Mile Island (1979), Chernobyl (1986) and now Fukushima (2011)[1]. A deep aversion to nuclear technology was implanted in the public mind in the days of the Cold War and has been reinforced by recent pictures and accounts of reactor destruction, but these are rarely matched by any direct impact on humans. At Fukushima after 21 months this outcome was belatedly confirmed by the UN[2] although a couple of weeks after the accident enough was known that the panic which followed could have been avoided[3]. There have been no health consequences from radiation at Fukushima and none is expected in the next 50 years[4]. The absence of early strong leadership unnerved the public and social mistrust grew unchecked to fill the information vacuum; this itself lead to loss of life[5], serious social stress and economic damage.

Fundamentally, nuclear radiation is a powerful agent and the forces that hold life together are feeble, so the resilience of life is a surprise -- that is, until you realise that in 400 million years life has had time to evolve many ingenious defences that enable it to survive powerful attacks. Designed first to protect plants and later animals, they are subconscious. In recent biological research many have been studied including action by anti-oxidants, DNA repair, cell death, and long-term immune protection against cells detected as foreign. Indeed the whole design of cellular biology with its dispersed DNA copies, its cycle of cellular replacement, overlaid by the life-and-death cycle of individuals, is optimised to ensure survival of the species against attack by physical and chemical agents -- and, less certainly, by other biological systems too. Small wonder then that humans and other life forms survive low and moderate radiation levels without a scratch[6]. Nature has matters well in hand at the cellular level and adaptive mechanisms actually bolster radiological protection based on previous moderate exposures[7].

At the highest intensity of radiation the defences fail and living cells are unable to repair the damage it causes – such rates are used to kill cancer cells in a clinical course of radiotherapy. The radiation used in such treatment, whether from a radioactive source inside the body or from radiation shone in from outside, cures hundreds of thousands of cancers every week and offers

1 Oxford Magazine "Life and Nuclear Radiation: Chernobyl and Fukushima in Perspective" (May 2011), also publ. Europ J Risk Regulation Volume 3 (2011) 373

2 www.world-nuclear.org/RS_UM_approves_radiation_advice_1012121.html

3 www.bbc.co.uk/news/world-12860842 also publ. Philosophy & Technology: Volume 24, Issue 2 (2011) 193

4 www.radiationandreason.com

5 http://nextbigfuture.com/2012/08/fear-of-radiation-has-killed-761-and.html

6 Doses below 100 mSv are affirmed as harmless by the medical profession http://www.aapm.org/org/policies/details.asp?id=318&type=PP

7 This was discussed by biological and medical experts from around the world at the Special Session on Low Dose Radiation, June 2012 American Nuclear Society Meeting, Chicago. The papers are available at http://ansnuclearcafe.org/2012/07/11/lnt-examined-at-chicago-ans-meeting/

palliative respite to others. This beneficial use of very high dose radiation is associated in the public mind with Marie Curie whose name is revered throughout the world.

Exceptionally, cancer can also be caused by high doses of acute radiation, as, for example too much ultraviolet radiation from the sun, itself a nuclear reactor on which life depends. Illogically, many of those most concerned about radiation seek their holidays in the sun rather than in the dark. Although moderate exposure to the sun is healthy, skin cancer is particularly serious and in the USA 3000 people a year die from it. Fortunately, there is no plethora of international committees giving instruction -- just common sense advice passed to families by doctors and pharmacists. The dangers of skin cancer are not global and, thankfully, do not frighten people to death or put any major economy at risk.

Although ultraviolet sunshine and nuclear radiation are closely related, only nuclear carries the stigma, yet there is no scientific reason for this distinction. Threatened by protesters and activists in the Cold War period governments came to rely on international advice, in particular from the ICRP[8] who still recommend today that nuclear radiation safety levels be kept to small increases over natural levels – the acronym is ALARA, as low as reasonably achievable. This is not a scientific safety level but a policy of appeasement. The ALARA principle ignores recent advances in biological understanding and the effects of other more dangerous risks in its dogmatic pursuit of caution. Yet this does not succeed in providing reassurance and has itself proved dangerous. It has been acknowledged by the UN, WHO and others[9] [10] that the evacuation and food restrictions at Chernobyl caused social stress, economic damage and premature loss of life that were more harmful than the radiation itself. These published reports were not read in Japan, it seems, and the same errors of judgement were repeated at Fukushima, including closing down the power stations vital to the Japanese economy and beneficial to the environment. At the same time a visceral pursuit of nuclear safety was joined by authorities around the world, resulting in increased stress for workers and future costs to tax payers and consumers, without benefit or reason. An illustrative example comes from an unsolicited email received in December 2012 from Ken Chaplin, a senior long-time inspector in the nuclear industry, who writes

> *"There are two negative impacts of Radiation Protection on my workers. First, concerns for radiological protection outweigh concerns for industrial safety. One example, four of us were working in a relatively high temperature environment in lead jackets and plastic lined tyvex suits. The radiological hazards were insignificant, but two of us almost passed out from the heat in a very difficult to access location. A second example, I had staff climbing ladders attached to walls, with very little space to get their feet on the ladder rungs. They were required to wear steel toed shoes, inside rubber "one size fits all" boots, inside paper booties. The extra layers were in the name of contamination control; however, I am far more concerned about people falling 8 metres onto piping.*
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> *A second issue is increased psychological stress. I have had my inspection staff worried and declaring tasks too dangerous to perform. Upon discussion with radiation protection staff, I convinced the inspection staff that the work was possible. The work resulted in only 4% of the allowable dose. A second example, staff are increasingly worried about low levels of contamination in spite of ever increasing efforts to eliminate contamination. In my opinion, this results in much lower productivity and higher stress levels caused, and experienced, by the entire organization pursuing ALARA, without accompanying health benefits.*
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> *I am watching as radiological protection dogma, in particular ALARA, stops the nuclear industry dead in its tracks. It is hard to prevent this, but I am trying."*

8 International Committee for Radiological Protection.

9 Health effects of the Chernobyl accident and Special Health Care Programmes. Report of the UN Chernobyl Forum, World Health Organization. http://whqlibdoc.who.int/publications/2006/9241594179_eng.pdf

10 Dagens Nyheter (2002). Article published in the major Stockholm morning paper on 24 April by Swedish Radiation Protection Authority. English translation, http://www.radiationandreason.com/uploads /dagens_nyheter_C3D.pdf

This testimony shows how safety restrictions, intended to allay fears, achieve exactly the opposite. Radiation regulation and personal stress to workers combine to drives up costs and kill professional motivation; these bring no benefit and are economically harmful.

Nuclear is a source of energy that has no downside. Freed from the shackles of misapprehension and regulation induced by ALARA, it would be inexpensive and its waste would not be a major problem. Unlike biological or fossil fuel waste, nuclear waste is not volatile or released into the environment. By its nature nuclear activity does not "spread like wildfire" or propagate like the disease that follows biological waste. Nuclear waste does not even persist indefinitely like toxic chemical waste. For the same energy production nuclear waste is about a millionth of that of fossil fuel and can be safely disposed of, once cooled and separated, by simple burial for a few hundred years. Indeed a debate to discontinue the use of fire would be rather finely balanced compared to the case to discontinue nuclear. Those of our cautious cave-living forbears who voted against fire and returned to their uncooked food and wretched existence of cold and damp had undeniably strong points to make, although those who actually chose that way made a big mistake and probably perished as a result. In today's debate those who argue against nuclear have no strong points that are scientifically defensible.

Much is now known of the biological impact of radiation on life and the scientific consensus is clear. Like sunshine, low levels of radiation can be beneficial and only very high levels in acute exposures can cause death or cancer[6] [7]. Only the extremely conservative advice from ICRP continues to support ALARA as a basis for nuclear safety. Yet this influence, however discredited, still entrenches the bureaucratic structure of radiation protection today. Current "safety" standards are unfounded in science and were born of a "mediaeval" fear of radiation. If the money spent on implementing absurd regulations was redeployed towards proper explanatory public education, the public safety limit could be relaxed from 1 mSv per year to 100 mSv per month with complete safety[11] -- and society could have the benefits of nuclear energy cheaply without fear and without carbon. But no government has yet had the confidence to do the obvious; instead, they are either phasing out nuclear power completely, or planning to make it absurdly expensive with quite unnecessary extra "safety" appeasement, or relying on natural gas that is only fractionally less destructive to the atmosphere than coal. This is mad. In all probability climate change is upon us and the chances that civilisation will survive it are falling. We should have a better chance to survive by using our scientific judgement. Unfortunately big untruths are difficult to expose, especially when internationally entrenched and spread across several fields of expertise.

Generally, those in authority have no understanding of science. But new prosperity depends on science, as it has in the past, and the country that first sets aside the legacy of ALARA and embraces cheap nuclear technology with proper safety will reap great rewards. As well as power, this technology can provide unlimited fresh water by desalination and cheap food preservation harmlessly by irradiation without refrigeration. The world needs these opportunities but the philosophy of ALARA stands in the way. Adam Smith said "Science is the great antidote to the poison of enthusiasm and superstition", and fear of nuclear is such a superstition, now ripe for exorcism.

11 As discussed in common-sense terms in "*Radiation and Reason*", Wade Allison (2009) ISBN 9780956275615.