

Contents

No. 1 (June 2002)

Editorial



[The consequences of the Chernobyl accident](#)

News & Affairs



[Sunbeds and skin cancer](#) • [Mine detection using radiation sensors](#) • [Increases in childhood cancers](#) • [Health Protection Agency](#) • [WHO clarifies position on EMF](#) • [Cancer Research UK](#) • [Neutron dosimetry at Hiroshima](#) • [Post-combat syndromes](#) • [Antibiotic resistant bacteria](#) • [Hypothermia again](#)

Articles



[Magnetic fields and miscarriage](#)

A statement from the Advisory Group on Non-Ionising Radiation

[Royal Society report on depleted uranium](#)

Michael Bailey

[The future of nuclear power](#)

Sir Bernard Ingham

[Sunsense: Protecting yourself from ultraviolet radiation](#)

Jill Meara

[Nuclear weapons tests and human germline mutation rate: A commentary](#)

Simon Bouffler and David Lloyd

[Possible toxic effects from the nuclear reprocessing power plants at Sellafield \(UK\) and Cap de Hague \(France\)](#)

John Cooper

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Internal links

- [Health effects from ultraviolet radiation](#)
- [Sunsense](#)
- [Advisory Group on Non-Ionising Radiation](#)
- [FAQs on DU](#)

External links

- [The human consequences of the Chernobyl nuclear accident](#)
- [Exposures and effects of the Chernobyl nuclear accident](#)
- www.iaea.org (Worldatom)
- [Cancer Research UK](#)
- [Royal Society](#)

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Editorial

No. 1
(June 2002)

The consequences of the Chernobyl accident

[eBulletin](#) > [No. 1](#) >

Iodine-131 releases from the Chernobyl accident in 1986 led to mostly non-fatal thyroid cancers in the surrounding population, and there are stress-related health effects due to the economic and social consequences of relocation. Some indications of a radiation dose response for cancers in the Chernobyl emergency workers have also been reported, although the interpretation of these findings is unclear.

Anniversaries of the accident at the Chernobyl Reactor No. 4 on 26 April 1986 have a natural tendency to highlight reports, papers and articles on the effects of the accident. This year is no exception and there has been a steady stream of published work. Two publications are of particular interest. The first is a Report commissioned by the United Nations Development Programme (UNDP) and the Children's Fund (UNICEF), entitled 'The Human Consequences of the Chernobyl Reactor Accident: A Strategy for Recovery' (copies on www.undp.org/dpa/publications/chernobyl.pdf). The main conclusion of this study is that although there are some health consequences from radiation exposures, especially the increase in thyroid cancer due to ¹³¹I releases, the main deleterious effects are due to the large-scale relocation of people and the inevitable social and economic consequences of such actions. The accident led to an enormous disruption in the lives of people in the region. Those who were evacuated from their homes and re-settled have found it difficult to adapt to their new circumstances. Many continue to suffer high levels of stress, particularly if they are unemployed, and many report feelings that they are not in control of their lives. A significant number of people want to return to their old homes. People who have returned to their homes appear to suffer less stress, but they do face high levels of unemployment. There is also a larger group of people, numbering in millions, whose lives have been affected by the Chernobyl accident because they have been labelled as, or perceive themselves as, actual or potential victims. Here there is a clear need for open accurate and trustworthy information on the health effects of the accident. For example, there is a widespread perception, both in the region and elsewhere, that leukaemias and other cancers have increased in the vicinity of Chernobyl. There is no evidence for such an overall increase, but thyroid cancer incidence has increased. The most comprehensive and authoritative report on the health effects of radiation exposures from the Chernobyl accident is published by the UN Scientific Committee on the Effects of Atomic Radiation (Annex J, UNSCEAR 2000, Vol. II. Copies on www.unscear.org/pdf/annexj.pdf). Despite this, no clear consensus exists on how many other cancers might occur in the population in future.

The other group of people affected by the accident were the Chernobyl emergency workers, the people brought in from all over the former Soviet Union to help during the emergency and in the clean-up afterwards. A recent paper from the Russian Academy of Medical Sciences (V K Ivanov et al., *Health Physics*, **81**, 5, 514–21, 2001) has studied the mortality among Chernobyl emergency workers from Russia. The mean external gamma radiation dose was reported to be 0.1 Sv to 65,905 people with documented external doses in the range 0.005–0.3 Sv. A preliminary analysis shows the 'healthy worker effect' seen in many studies of this type. Those selected for the work were healthier and fitter than the average Russian citizen and the standardised mortality rate (SMR) varies between 0.62 and 0.90 over the period 1991–98. The authors also reported statistically significant increasing trends with radiation dose in mortality from malignant neoplasms and cardiovascular diseases, whereas the dose trend in all non-cancer causes combined was close to zero and not statistically significant. However, this is a preliminary analysis and the potential impact on the findings of incomplete follow-up and the uncertainties in the dose estimates need to be quantified before any firm conclusions can be made.

External links

- [The human consequences of the Chernobyl nuclear accident](#)
- [Exposures and effects of the Chernobyl nuclear accident](#)

News & Affairs

No. 1
(June 2002)

Sunbeds and skin cancer

[eBulletin](#) > [No. 1](#) >

Research in the USA has shown that people who have used artificial tanning devices are more likely to develop certain kinds of skin cancer than those who have never visited a tanning salon. The risks appear to be greatest for the young, with the chances of developing a tumour increasing by up to 20% per decade of sunbed use before the age of 56 (M Karagas et al., *J. Nat. Cancer. Inst.*, **94**, 3, 224–6, 2002). The study involved 1500 people aged between 25 and 74 living in New Hampshire in the USA. People who reported any use of sunlamps were 2.5 times more likely to develop squamous cell carcinoma than those who never used the devices. The risk of basal cell carcinoma increased 1.5 times with sunbed use. Both diseases are less serious than malignant skin melanomas and they are not normally fatal. However they can spread to other parts of the body if they are untreated, and they can lead to ulceration of the skin.

The publication of the paper by Dr Karagas coincided with the publication of the Advisory Group on Non-Ionising Radiation report ([Health Effects from Ultraviolet Radiation](#), *Doc. NRPB*, **13**, 1, 3–276, 2002) and readers should also note the launch of our [Sunsense](#) campaign.

Michael Clark

Internal links

- [Health effects from ultraviolet radiation](#)
- [Sunsense](#)

News & Affairs

No. 1
(June 2002)

Mine detection using radiation sensors

[eBulletin](#) > [No. 1](#) >

It is estimated that abandoned land mines kill or maim up to 30,000 people each year, and these are mostly (80%) civilians. The International Atomic Energy Agency (IAEA) is sponsoring a project to develop nuclear techniques to detect the mines. Various techniques based on neutron scattering have the greatest potential, and they are already in use in geological exploration, industry and security devices for explosives detection (e.g. at airports). However, the techniques are a long way from being able to be used in the field, especially the ex-battlefield. So the IAEA has set up a project to use Pulsed Fast and Thermal Neutron Analysis (PFTNA) to detect land mines under field conditions. Preliminary tests have shown that elemental analysis with neutrons can successfully identify various kinds of explosive and can also differentiate them from innocuous or 'dummy' buried objects. The main challenge of the project is to develop a device that is rugged, portable and not hideously expensive.

Source: www.iaea.org

Michael Clark

External links

- www.iaea.org (Worldatom)

News & Affairs

No. 1
(June 2002)

Increases in childhood cancers

[eBulletin](#) > [No. 1](#) >

Scientists from the Cancer Research Campaign have discovered that over the past 45 years, rates of some childhood cancers have steadily increased by up to 30 or 40%. These cancers include brain tumours and acute lymphoblastic leukaemia (R J McNally et al., *Cancer*, **92**, 7, 1967–76, 2001 and R J McNally et al., *Leukaemia*, **15**, 1612–8, 2001). The cause is not known but speculations concerning the environment are often made. Over the past 45 years general levels of environmental pollution have reduced considerably. Over that period our standards of health and food hygiene have also improved enormously, and yet this research suggests that some health risks have got worse. Of course, some new chemical or other new environmental factor could be responsible. An alternative hypothesis is that the reduced pollution in the environment could be the culprit because some pollutants kill viruses. This is controversial but there is some anecdotal support for such a view because, for example, black spot free roses thrive in areas of relatively high pollution.

Can society go too far in its quest to clean up the environment? If it is possible to go too far then how do we judge when we have gone far enough? Perhaps research such as this is giving us the first indications.

Alan Edwards

News & Affairs

No. 1
(June 2002)

Health Protection Agency

[eBulletin](#) > [No. 1](#) >

On 10 January 2002 the Chief Medical Officer for England, Sir Liam Donaldson, announced the formation of a new government agency to combat the increasing threat from infectious diseases and from biological, chemical and radio-nuclear hazards. The new agency was initially to be called the National Infection Control and Health Protection Agency (NICHPA), now to be the Health Protection Agency (HPA). The new Agency will subsume the Public Health Laboratory Service, the National Radiological Protection Board, the Centre for Applied Microbiology and Research, the National Focus for Chemical Incidents, the Regional Service Providers Unit and the National Poisons Information Service. In addition, the Agency will employ consultants in communicable disease control and their teams, and health emergency planning advisers.

The events of 11 September 2001 were a notable precursor to this high-level government decision, and it is argued that a single strong agency with a staff of nearly 4000 will carry considerable weight in Whitehall. One substantial agency should be better than several smaller ones. We look forward to a smooth transition with a retention of statutory functions. The NRPB's reputation for scientific excellence and independence needs to be guarded.

Michael Clark

News & Affairs

No. 1
(June 2002)

WHO clarifies position on EMF

[eBulletin](#) > [No. 1](#) >

The World Health Organization (WHO) has issued a statement to clarify the position on whether electromagnetic fields (EMFs) could cause cancer. It was in response to reports from Spain about a cluster of childhood cancers in the vicinity of a mobile phone base station. The statement (WHO/01, 23 January 2002) makes it clear that WHO's classification of low frequency (50/60 Hz) magnetic fields as a 'possible human carcinogen' could not be applied uncritically to mobile phone frequencies (over 10 million Hz). The WHO recognises that there are uncertainties in the knowledge required to assess fully the health risks of mobile phones. However, it felt that some of the statements attributed to WHO in relation to the potential health effects from mobile phones, were 'distortions'.

Michael Clark

News & Affairs

No. 1
(June 2002)

Cancer Research UK

[eBulletin](#) > [No. 1](#) >

In February 2002, the UK's two major cancer research organisations combined/merged to form the world's biggest non-governmental cancer research organisation, Cancer Research UK (see <http://science.cancerresearchuk.org/>). It is hoped that the complementary strengths of its founding partners, the Imperial Cancer Research Fund (ICRF) and the Cancer Research Campaign (CRC) will combine to produce more funds and results. The ICRF has been primarily a research organisation, supporting various laboratories in the UK, whereas the CRC has concentrated on prevention, treatment and diagnostic research via extra-mural grants. In total, there will be about 3,000 scientists employed by CRUK and the merger will allow a rationalisation of resources required to raise funds and to run the organisation. For example, both ICRF and CRC run networks of charity shops, selling clothing, bric-a-brac and books to raise funds. The merger will enable cost savings here, in addition to rationalisation of corporate or executive functions.

Michael Clark

External links

- [Cancer Research UK](#)

News & Affairs

No. 1
(June 2002)

Neutron dosimetry at Hiroshima

[eBulletin](#) > [No. 1](#) >

Calculations of neutron fluence and resulting doses at ground level in Hiroshima for 6 August 1945 are of fundamental importance in radiation risk estimates. Fleisher et al (*Health Physics*, **81**, 6, 720–3, 2001) have used a clear glass button discovered during recent evacuations in preparation for building the National Peace Memorial Museum in Hiroshima. It appears that the glass button was a decorative item, most probably used as a paperweight. The site was occupied in 1945 by a dense settlement of wooden houses. Ordinary silicate glass such as this item normally has about 1 part per million of natural uranium. The ^{235}U (n, f) reaction is widely used to measure neutron fluences in nuclear reactors, so standard techniques could be used to estimate the neutron fluence incident on the glass item in 1945. Fleischer's team estimate the free-air fluence to be $1.5 (\pm 0.5) \times 10^{12} \text{ cm}^{-2}$ which is within the uncertainties in the calculated value of $9 \times 10^{11} \text{ cm}^{-2}$ given by DS86 at the site (190 m from ground zero).

Michael Clark

News & Affairs

No. 1
(June 2002)

Post-combat syndromes

[eBulletin](#) > [No. 1](#) >

It is clear that service in the Gulf war is associated with an increased rate of reported health symptoms, although research in the UK, USA, France and elsewhere has not been able to confirm the existence of a specific syndrome. Various conjectures exist for the cause of the reported symptoms, including depleted uranium, preventative inoculations and the psychological stress of warfare on service personnel. Jones et al. in *BMJ*, **324**, 321 (2002) have reviewed the medical and military records of servicemen and applied cluster analysis to symptoms reported from the Boer War (1899–1902) to the Gulf War in 1991 (the authors note that post-combat syndromes were first recorded after the American Civil War, 1861–65). The symptoms appear to be affected by the changing nature of warfare and prevalent health concerns. For example, 41% of servicemen with psychoneurosis after World War II attributed their symptoms to psychological stress of military service. In contrast, only 9% of the equivalent Gulf war sample believed that stress had a causal role, whereas 34% thought their condition was the result of toxic exposure. The authors conclude that post-combat syndromes are an understandable pattern of normal responses to the physical and psychological stress of war.

Michael Clark

News & Affairs

No. 1
(June 2002)

Antibiotic resistant bacteria

[eBulletin](#) > [No. 1](#) >

New England Journal of Medicine (346, 630–1 2002) had a letter which caught the eye at today's NRPB where we have new interest in infectious diseases. It records an unfortunate patient, a previously healthy young man of 28, who was hospitalised with pneumococcal pneumonia. Not a problem nowadays? He responded well to antibiotics for the first three days but then drug resistance developed, his condition deteriorated sharply, there was multi organ failure, and he died.

The researchers believe that they understand the cause of his death at a molecular level. The resistant mutant had a duplicated run of six amino acids, which disrupted the site where the antibiotic binds to the ribosomal DNA. They say that theirs is the first report of a genetically characterized antibiotic resistant pneumococcal mutant emerging during therapy and serving as the cause of treatment failure.

We hope it is not the advance guard of a new army.

Gerald Kendall

News & Affairs

No. 1
(June 2002)

Hypothermia again

[eBulletin](#) > [No. 1](#) >

Previous items reported in this section have shown how lowering body temperature can be very good for those who are at risk of brain damage. Readers may remember the amazing case of a young Norwegian doctor who, while cross-country skiing, was trapped in icy water (Bulletin 221). Her heart stopped and her body temperature fell to 14 degrees, but after resuscitation and care, she made a complete recovery. She even took up cross-country skiing again. However, there was disappointment in Bulletin 230, which included an account of a large study demonstrating no benefit of hypothermia in patients with acute brain injury.

Our correspondents were cheered therefore by two papers in the latest *New England Journal of Medicine* (346, 8, 21 February 2002). The first compared neurological recovery in patients treated with and without hypothermia after being resuscitated from a heart attack. 55% of the former group made a good or moderate recovery compared to 39% of the latter (risk ratio 1.40, 95% confidence interval 1.08–1.81); broadly similar benefits were seen in levels of mortality at six months.

The second study also compared hypothermia and its absence ('normothermia') in patients who remained unconscious after resuscitation from out-of-hospital cardiac arrest. 49% of the hypothermia patients survived and were discharged home or to rehabilitation compared to 26% of controls (p for difference 0.046).

Both these studies involved cooling to 32–34 degrees, far more moderate than that experienced by the fortunate Norwegian doctor. The mechanism causing the apparent beneficial effects is not understood but may involve a number of biochemical processes – simple reduction in oxygen demand is now thought not to be the answer. It is suspected that the beneficial effects would be greater if hypothermia could be induced more quickly than the 8 hours or so of these studies.

In passing, we note that 'normothermia' and its derivatives have considerable potential to enrich our language:

'Are you cold/hot?'

'Thank you, no. I am entirely normothermative.'

Gerald Kendall

ArticleNo. 1
(June 2002)**Magnetic fields and miscarriage**[eBulletin](#) > [No. 1](#) >

Two studies reported by Lee et al. and Li et al. in January this year were carried out to test the hypothesis that women's exposure to power frequency magnetic fields somewhat above average, but yet well within the range to which women might be exposed, could, if the women were in the early stages of pregnancy, result in miscarriage. The hypothesis had arisen from the results of a few previous studies which had, however, given inconsistent results and had, for the most part, used unsatisfactory surrogate measures to estimate exposures.

The first report by Lee et al. was of a case-control study conducted within a cohort of some 3400 pregnant women who were participating in a prospective reproductive health study. The procedure for selecting women for inclusion in their study was complex. First, a random sample was drawn of 531 women of whom 219 allowed their exposures to be measured when they were or would have been 12 weeks pregnant, including 18 who miscarried. Of these women, 176 (10 with miscarriages) subsequently agreed to a second exposure measurement at 30 weeks gestation and they formed part of the study sample for the case-control analysis. In addition, the medical notes of the remainder of the cohort were examined when they were, or would have been, 25–30 weeks pregnant; 328 were found to have miscarried (cases) and a random sample of 806 of those who had not miscarried was selected to provide controls. These women too were invited to undergo exposure measurements, which were made during a day of 'usual activity', approximately 30 weeks after the reported last menstrual period. However, participation rates were low (51% of 'case' women and 55% of controls). Women who agreed to exposure assessment were asked to wear an EMDEX-C meter to measure exposure over 24 hours (the meter being put in a pouch on the mattress overnight) and to record their broadly defined activities over the period.

Of the five measures hypothesised to be associated with miscarriage, three were very weakly associated or not associated (residential wire code, very high current configuration¹, relative risk (RR) 1.2, 95% CI 0.7–2.1; front door spot measurement ≥ 0.2 μT , RR 1.2, 95% CI 0.6–2.5; 24 hour time weighted average personal exposure ≥ 0.2 μT , RR 1.0, 95% CI 0.5–2.1). Two, however, were associated (maximum exposure in 24 hours > 3.5 μT , RR 2.3, 95% CI 1.2–4.4; rate-of-change metric² > 0.094 μT , RR 3.1, 95% CI 1.6–6.0).

In an effort to validate the use of measurements made at 30 weeks gestation, use was made of the results obtained in the small subgroup for whom it had also been possible to make measurements at 12 weeks. Data were available for 155 paired measurements. The correlations were moderately good for the 24 hour time weighted average (0.64) but very poor for the maximum level (0.09) and the rate of change metric (0.19).

The positive associations observed in this study with maximum exposure and the rate-of-change metric must be interpreted in the context of two major limitations. First, the low response rate from potential cases and controls may have led to bias. In this respect, it is of note that participant cases were relatively more likely to live in houses with very high current configuration wire codes (16.1%) than non-participant cases (7.3%) whereas this was not so in the controls, the corresponding percentages being 13.2% and 11.7%. While no association was found between wire configuration and miscarriage, this differential response increases concern that unrecognised selection bias may have occurred in relation to other exposure metrics.

Secondly, the correlations between the 12 and 30 week measurements for the two metrics that showed associations with miscarriage were extremely weak. It is unclear to what extent this reflects variations in exposure from day to

day as compared with changes over a longer time scale (e.g. because of differences in activity early and late in pregnancy). Either way, however, it indicates that the exposures recorded at 30 weeks had little if any validity as markers of exposure earlier in pregnancy before miscarriages occurred. (If the poor correlations arose because of substantial day to day variations in exposure then a single 24 hour measurement would have low validity even if made early in pregnancy.) This lack of validity, and the absence of a similar association between miscarriage and 24 hour average exposure (measurements of which at 12 and 30 weeks did correlate), suggests that the most likely explanation for the observed associations with maximum exposure and the rate-of-change metric is a combination of bias and/or chance.

The second report by Li et al. was of a cohort study of 969 primiparous women who wore an EMDEX-II meter for 24 hours immediately after having been interviewed, not more than 15 weeks after they had become pregnant. Of the 159 that miscarried (16.4% of the participants) more than half had already done so before they were interviewed, 78 (8.0%) before the initial approach and 19 (1.9%) after having given consent but before their interview. Unlike standard cohort studies, there was, therefore, some possibility of bias in the selection of women, as only 39% of the potentially eligible women responded to the interview and had their exposure measured. The contract for the study required the risk to be estimated for 24 hour time weighted average exposures of 0.3 μT or more. The results gave a relative risk for such women of 1.2 with 95% CI 0.7–2.2. Thus the chosen metric failed to confirm the a priori hypothesis and there the study might have rested. It had been agreed, however, that the investigators would be free to evaluate associations with other exposure metrics and they consequently examined one of interest to them: namely, the maximum field encountered during the day. Examination of the results by deciles of maximum magnetic field showed a progressive increase in miscarriage rate over the first four deciles and a relatively stable rate thereafter. They chose, a posteriori, 1.6 μT , the upper limit of the lowest quartile, as the breakpoint and found a relative risk of 1.8 for maximum exposures at and above this level, without, however, there being any progressive increase with still higher exposures. Further analyses found that the RR at this level was higher (2.2) with gestational ages less than 10 weeks (when a high proportion of the miscarriages would have occurred before the women were interviewed) and was higher (3.1) in a sub-population of specially susceptible women (with a history of sub-fertility or multiple miscarriages). A check for potential confounding by more than 30 other known or suspected risk factors for miscarriage barely altered the estimates.

Superficially this paper provides somewhat stronger evidence for an effect than the first; but it too has major limitations. First the parameter that provided evidence of a risk was not chosen a priori on the basis of biological or epidemiological reasons to believe it might plausibly be of aetiological relevance (Li & Neutra, 2002). Secondly, the results were sensitive to the choice of breakpoint, which was made on the basis of the observations, three-quarters of which were above the breakpoint and showed no increase in risk with increasing level. Thirdly, the study is not a standard prospective study as more than half the miscarriages (and all those at all strongly related to maximum field exposure) occurred **before** the measurements were made, the compliance rate was low and the possibility of selection bias is not excluded.

In an editorial in the journal *Epidemiology* that appeared at the same time as the two papers, Savitz (2002) drew attention to one way in which high maximum fields might be artefactually associated with early miscarriage by pointing out that nausea is a common concomitant of successful pregnancy and that lack of nausea, indicating low oestrogen levels, is a predictor of miscarriage. Consequently, if nausea reduced mobility it could reduce the opportunity for experiencing occasional high exposure and so account for successful pregnancies having lower maximum exposures. Li and Neutra (2002) have, however, now shown that no such association could explain Li et al.'s (2002) findings.

Conclusion

Neither study provides substantial evidence of increased risk of miscarriage attributable to exposure to above average magnetic fields and neither justifies regulatory action. It would be expensive and difficult to carry out further epidemiological investigation that would address the issue robustly and, in the absence of a plausible biological mechanism that would link such exposure to miscarriage, it is arguable whether it would be justifiable to support research of this type. If further study is required, it would be worth financing only if a large cohort of (say) 2000 women could both be interviewed and have measurements made of their exposures over a period of at least 24 hours less than 8 weeks after their last menstrual period and have repeat measurements made on at least two further occasions within the next 8 weeks to determine the consistency of the exposures throughout early pregnancy and their temporal relationship to miscarriage.

1 The highest exposure surrogate category used in the American wire code system based on the arrangement of electricity conductors and their distance from homes.

2 A measure that assesses the absolute change in field levels between successive sample measurements.

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Advisory Group on Non-Ionising Radiation (Chairman Sir Richard Doll)

Internal links

- [Advisory Group on Non-Ionising Radiation](#)

Article

No. 1
(June 2002)

Royal Society report on depleted uranium

[eBulletin](#) > [No. 1](#) >

Part I (May 2001)

The Royal Society published the first part of its report on *The Health Hazards of Depleted Uranium in Munitions* in May 2001. That part dealt with the amounts of depleted uranium (DU) to which soldiers could be exposed on the battlefield, the risks from radiation and what is known from epidemiological studies, especially those on uranium workers. DU is known to be toxic, as are other heavy metals, and also weakly radioactive.

NRPB [questions and answers page on DU](#).

In response to public concern and discussion about the consequences for health arising from the use of DU weapons, in late 1999 the Royal Society convened an independent expert Working Group to review the present state of knowledge about the health and environmental effects of DU. The objectives were to inform public debate, and to provide the public with an independent opinion of the possible health hazards.

The Working Group was chaired by Professor Brian Spratt, FRS, Wellcome Trust Principal Research Fellow, Department of Infectious Disease Epidemiology, Imperial College School of Medicine.

Assessment of intakes

To provide an independent and transparent assessment the approach taken was to draw on original reports of studies so far as possible, and to provide details of the source information and methods used. Because of the lack of measurements of exposures in or soon after the conflicts in which DU has been used, the Group estimated intakes in a number of exposure scenarios, covering a wide range of situations that might occur. Thus Level I (high exposure) applies to soldiers in vehicles struck by DU penetrators; Level II (moderate) applies to personnel working on vehicles contaminated with DU, and Level III (low) applies to the majority of soldiers who might be downwind of impacts or fires involving DU, inhale resuspended DU-contaminated soil, etc. For both the assessments of intakes and for doses per unit intake, two assessments were made: a 'central estimate', based on what were considered to be the most likely situations, and which would be typical of the group involved, and a 'worst-case', which it was considered unlikely that any individual would exceed.

On this basis the following conclusions were reached.

- For most soldiers, intakes of DU were likely (central estimate) to be small (less than 1 milligram), and so were effective doses (less than 1 millisievert – the average annual effective dose from natural background radiation is about 2 millisieverts).
- The risks of radiation-induced cancer are also likely to be small (less than 1 in 10,000) and would not be detectable amongst the cancers that would occur in such a group without exposure.
- High exposures to DU should only apply to a small fraction of soldiers, such as survivors in vehicles struck by DU weapons. For them the central estimates give a lung cancer risk of about 1 in 1000. However, under worst-case conditions, the estimated risk of radiation-induced lung cancer up to about 1 in 15 could not be excluded, even though it results from inhaling a few grams of DU dust. This risk is similar to the rate in the

general population, and so would approximately double the lung cancer risk.

- In all exposure scenarios considered, the risks of death from leukaemia and other cancers are much smaller than (<1% of) the lung cancer risks.
- Many soldiers could be exposed to low levels of DU, downwind of impacts or fires, from which the estimated risks of radiation-induced cancer are very low, less than 1 in 1,000,000. Even if the risks were 100 times higher than estimated, it is unlikely that any excess would be detected in a cohort of 10,000 followed for 50 years.

Epidemiological studies

Epidemiological studies have been conducted of tens of thousands of workers exposed to uranium in the processing of uranium from its ore to reactor fuel elements over several decades. (Studies of uranium miners are less relevant here because of their exposure to radon gas and its radioactive decay products as well as uranium ore particles.) The clearest finding from the studies of uranium process workers is the expected 'healthy worker' effect: diseases and death rates tend to be lower than in the general population. There is no clear and consistent evidence for any increase in cancer, or serious kidney disease. However, in most studies the uranium workers were not categorised by the extent of their exposure. It was recognised that these studies cannot detect small increases in cancer risks, but support the view that exposure to DU is unlikely to increase the risks of cancer greatly.

Part II (March 2002)

The Royal Society published the second report of its assessment of the potential hazards to military personnel and members of the public from the use of depleted uranium (DU) in weapons on 12 March 2002. Further information is provided in a press release on its website www.royalsoc.ac.uk. Part II considers the chemical toxicity of uranium, the environmental impact, and some responses to Part I of the Report.

Chemical toxicity

The toxicity of uranium has been studied extensively in experimental animals. These studies, supported by limited human data, indicate that toxic effects mainly arise from kidney damage. The biokinetic models of the International Commission on Radiological Protection were therefore applied to calculate the uranium concentrations in kidney resulting from the various scenarios described in Part I. The Group was unwilling to rely on animal data to assess the consequences of these uranium kidney concentrations, because of marked differences between species in their susceptibility. It therefore reviewed the literature to find cases of human exposure to uranium that produced effects on the kidneys, and in each case the maximum uranium concentration in the kidneys was estimated. Although the number of cases was small and diverse (accidental inhalations and skin burns, volunteer experiments, and an attempted suicide), a consistent pattern of increasing severity of kidney damage with increasing uranium concentration was found. Concentrations above a few tens of micrograms per gram of kidney lead to kidney failure, which could be fatal without prompt medical treatment. Concentrations around a few micrograms per gram of kidney lead to changes in kidney function that can be detected by tests on urine samples (dysfunction) while the uranium concentration remains high: whether such levels would have any long-term effect on health is not known, but considered to be unlikely. It was estimated that for most soldiers, exposures to DU would result in kidney concentrations less than 0.1 microgram uranium per gram of kidney and no effects would be expected. For soldiers in struck vehicles the concentrations could well reach a few micrograms per gram, leading to dysfunction detectable in urine tests. The possibility of large intakes (a few grams of DU) in 'worst-case' level I and II scenarios leading to kidney concentrations above 50 micrograms uranium per gram of kidney could not be excluded. Such concentrations would be expected to lead to kidney failure, and the Group was not aware that any such cases had occurred.

Environmental impact

A review of information relating to the environmental impact of DU battlefield use was conducted, but assessments of intakes, doses and risks other than for inhalation of resuspended soil, were not made, because it was considered that the pattern of contamination and its subsequent behaviour were too variable, depending on the nature of the military action and the local conditions (soil type, etc). Surveys conducted in Kosovo indicate that contamination is

mainly confined to the immediate vicinity of penetrator strikes. It is recommended that areas should be cleared of visible penetrators and the contamination around them, particularly to avoid contamination of children at play. Many penetrators fired from aircraft miss their targets and may be deeply buried (a metre or more). If more than about 30 cm deep they can be very difficult to locate, and removal could be expensive and environmentally damaging. They pose little immediate hazard, but there is concern that in some circumstances groundwater could become contaminated, perhaps after several decades. Monitoring of water and milk supplies in affected areas is therefore recommended.

Responses to Part I

Several issues raised at the public meeting which followed publication of Part I of the report, and in correspondence and meetings with experts and veterans are addressed.

The use of modelling to provide quantitative assessments of exposures and risks in the absence of measurements of exposure, or of an exposure-response relationship for DU aerosols (as exists for radon) is explained. The possibility of radiation effects on the immune system is addressed, and it is considered that such effects are very unlikely from battlefield exposure to DU.

Evidence was taken from a former member of a US army unit involved in damage assessment and clean up of contaminated vehicles. He suggested that even the 'worst-case' estimates might in some cases be too low. He considers that vehicles were typically struck by four or five large rounds (rather than the one or two that had been assumed). He also claimed that men in his unit worked in or around DU-contaminated vehicles all day, every day for about three months, resulting in 600 hours exposure compared to the 100 hours 'worst-case'. This evidence conflicts with information in official US reports, but nevertheless assessments of its consequences were made.

Information was provided to the Group on measurements made in Canada of uranium isotopic ratios and concentrations in urine samples from UK veterans, about half of which indicated the presence of DU. A serious limitation of this study is the lack of corresponding measurements in a control group, which the Working Group considered essential in view of the potential difficulties in measuring the isotopic ratio in the tiny amount of uranium present in a urine sample. The results, however, suggest that modern mass spectrometric techniques could identify intakes of DU ten years earlier, that are well below the amounts likely to cause kidney damage or a detectable increase in cancer risk, and emphasised the need to validate such measurements.

Recommendations

A number of other recommendations for research and actions are made in both parts of the report. These include obtaining more information on the air concentrations (and hence intakes) of DU arising from penetrator impacts and by resuspension in contaminated vehicles (such tests are known to be under way in the USA and France, but the results are not yet available), better information on the dissolution of inhaled DU particles in the lungs, and information on the corrosion of DU penetrators in the environment.

Contributions from NRPB

Dr Michael Bailey, Head of the Dose Assessments Department at NRPB, was a member of the Working Group. In Part I, his main contribution (with support from other NRPB staff) was to the assessment of intakes of DU and calculation of the resulting radiation doses to tissues. In Part II the main contributions of NRPB staff were in assessing uranium concentrations in kidneys from the use of DU weapons, and those which arose in reported cases of high intakes leading to kidney damage or dysfunction; and assessment of intakes from inhalation of resuspended soil by people living in an area contaminated with DU.

Michael Bailey

Internal links

- [FAQs on DU](#)

External links

- [Royal Society](#)

- [Emergency Response](#)
- [Business Activities](#)
- [Local & Regional Services](#)

Article

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(June 2002)

The future of nuclear power

[eBulletin](#) > [No. 1](#) >

These are the speaking notes for a Chilton seminar given in February 2002. After a distinguished career in public service, Sir Bernard Ingham has developed a number of interests including public affairs and broadcasting. One of these is the Supporters of Nuclear Energy (SONE) for which he is Secretary. The NRPB has to remain impartial in such matters, but we make no excuses for publishing the notes here. Sir Bernard is as critical of the nuclear industry and its supporters as he is of some anti-nuclear pressure groups.

Thank you for inviting this layman to give this talk to a scientific community. I very much hope that you will still feel able to thank me when I have finished. I do not come here with a comfortable message.

Perhaps I should start by clarifying my position. I have no scientific or engineering background. I am primarily a generalist journalist turned Government media manager transformed back into a journalist and broadcaster. The only reason I am here is that I got interested in the communications challenge presented by the nuclear industry while I was in the Department of Energy from 1974–79 and became a consultant to BNFL on my retirement in 1990. I am also secretary to Supporters of Nuclear Energy, a pressure group of some 250 individuals – no corporate bodies – who came together in 1998 to do exactly what their organisation's title suggests – to support nuclear energy. This is more than can be said for many in the nuclear industry, a matter to which I shall return.

My talk is entirely devoid of visual aids. I am not deeply interested in the details of boilers called nuclear power stations or chemical works called Sellafield. I am interested in arguments which the nuclear industry has now been losing for some 30 years. I want to examine why it has been losing those arguments and what it needs to do to start winning them – a success which is important and probably crucial to any future which nuclear power may have.

Problems in the nuclear industry

I have little doubt that the nuclear industry would like to start winning the arguments but I am pretty certain that it hasn't much of a clue how to do so and probably lacks the will to do so even if it had a clue. I told you I did not have a comfortable message.

I speak against the background of the Government's energy review which has been treated to some appalling reviews, leave aside the environmentally politically correct *Guardian* and *Independent*. The review, published a week ago, was rescued by the politicians from the worse incredibility, judged by their first effort, of naïve and innumerate officials in the Performance and Innovation Unit. They think you can power the fourth largest economy by the winds, the waves, the tides, the sun, biomass, hen muck and all the energy you theoretically don't use by conserving it through efficiency. The report was eventually induced to keep the nuclear option open, whatever that means. It was the least it could have done and remained just this side of the border with fantasy.

There are some environmentalists hopelessly addicted to renewables and conservation, minus nuclear and all fossil fuels apart from gas, who argue that the review is in fact a crab-wise move towards nuclear. By keeping open the option and hinting, for example, at planning reform they claim the Government is in fact edging towards a nuclear future. For my part, I regard it as a typical best-of-all-worlds offering from a Government that desperately wants to be loved. As such, it is meaningless. There will, inevitably, be another round of consultation.

There are those who say that the outcome is the best nuclear could have hoped for. To me, that just demonstrates what little clout the industry has left in its locker following years of allowing its case to go by default.

Nonetheless, I have some considerable sympathy for the nuclear industry because of its history. It is not unlike that of the Government Information Service which I led for two years. The civil nuclear industry was born out of the defence industry just as the GIS was born out of the propagandist Ministry of Information during World War II. Both have had to bear these crosses ever since.

The nuclear industry gets no credit now for turning swords into ploughshares any more than the forerunner of the GIS gets the credit for eliminating rickets in children through its campaigns over diet during the war or, as I can personally testify, making the process of Government more open than it would otherwise have been up to 1997.

Both have been over-sold. Part of the anti-nuclear sneer is that nuclear electricity was once promised as being 'too cheap to meter'. Politicians, especially those without policies, have grossly exaggerated the role of presentation (and therefore of the GIS) as well as the press in winning elections. It was not 'The Sun wot won it' whether in 1992, 1997 or 2001.

And both the nuclear industry and GIS have most certainly failed miserably to secure a factual understanding of themselves by the public or, in the case of the GIS, by politicians, the Government machine and the media, Hence last week's spindoctor bloodletting which, Jo Moore apart, shed the wrong blood.

So, I sympathise with the nuclear industry just as I do with the GIS in its present travail with spindoctors. But that doesn't mean that I don't recognise where the fault lies. As Cassius put it: 'The fault, dear Brutus, lies not in our stars but in ourselves that we are underlings'. Each of us bears some responsibility – and will continue to bear some responsibility – until Britain becomes more rational about nuclear power.

Attitudes in the nuclear industry

The prime problem with the nuclear industry is attitude. We cannot divorce this from its background. Its Civil Service/Defence antecedents have reinforced each other in terms of secretiveness. The result is a tradition of not discussing the industry outside the plant – at least not in terms which ordinary souls can understand. Neither privatisation nor adversity has yet broken this down and, given the invisibility of the average industrialist in times of trouble, are not likely to do so. British industry is anything but open, and certainly not in public.

Over and above this, there is a curious arrogance in the nuclear community which I first encountered in the Department of Energy in the 1970s. Those of us who had the task of trying to make a case for nuclear energy used to nod at each other when we found it and mutter: 'Those who know. ...' The full quote was 'Those who know don't need persuading and those who don't know don't matter'. Such an attitude is death to public explanation.

The effect of all this has been for the industry to abdicate the field to its mortal enemies – and I use that term advisedly – who have made a dangerous, poisonous, polluting, killing monster of it. You could say that it is no more than the nuclear industry deserves. Unfortunately, while that may make people like me who have been fighting against the industry's wilful neglect of public opinion for 30 years feel better for saying it, it does not do much for what I conceive to be the national interest – namely reliable, economic, safe and greenhouse gas-free electricity.

Now, let me make it clear that I would prefer it if we lived in a rational, informed, unhysterical, unprejudiced world in which the media – press, radio and television – saw it as their duty to present both sides of the argument – any argument – and leave the people to judge. But that is nothing like the world I know. It is an irrational, astonishingly ignorant, chronically hysterical and highly prejudiced world and the media take sides in an irrational, ill-informed, highly hysterical and seriously prejudiced way. Some scientists contribute to this.

Professor John Krebs delivered himself of the self-serving remark before he was appointed head of the Food Standards Authority that the British had lost confidence in their food. Lost confidence in their food, my foot! They have never eaten out as much. They have never consumed such a variety of food. And they have never eaten it as much around the clock wherever they happen to be since the days when hunters grabbed what they could get when they could get it. Take the average train journey from Victoria to Purley if you don't believe it. The carriages are alive to sound of chomping.

So we have to face the world in which we live rather than the one in which we would prefer to live. That being so, the nuclear industry has to decide whether it is part of this world and wishes to remain in it. If it does, then it has to change its ways and not rely on people like me doing its dirty work for it all the way to our Zimmer frames.

What's to be done?

a) Make the case

Well, let me first say that I do not think the nuclear industry has to cobble together a case for its ability to provide reliable, continuous, safe, economic and pollution-free electricity. That case manifestly exists in its very being as a mature technology. It currently supplies roughly a quarter of Britain's electricity and nearly half of Scotland's and has been generating electricity successfully for getting on for 50 years. During that time there has not been a single death from a radiation accident in power generation, waste management or reprocessing. It must be the safest source of power ever devised, not excluding horses. Currently it avoids the pouring into the atmosphere of some 60 mt of carbon dioxide which would result if the same amount of electricity were generated by a mix of fossil fuels.

But if it has no need to cobble together a case, it most certainly has a need to proclaim it from every housetop at every opportunity. Otherwise, everybody – or even more than do now – will think it is dispensable.

It may well be that the nuclear generators are not now making any money out of the NETA short-term price fix which has cut the price for base load power to some 1.8p per unit. But that situation cannot continue for long. Otherwise, we shall find the country on a three day week since privatised companies cannot be compelled to lose money on producing artificially cheap power for ever. In other words, we are potentially heading for a California-style crisis which creates a wonderful opportunity for nuclear. And they call this a sustainable energy policy!

That crisis should be anticipated immediately by a nuclear campaign to demonstrate the extent to which the electricity market is distorted. This is not simply a question of the level playing field. I am not simply referring to the different obligations put upon nuclear generators and those of all fossil fuels and renewables to reflect in their current price their environmental, health, de-commissioning and waste management costs. That is bad enough.

It is nuclear's exclusion, along with "mature" hydro, as clean generation technology, from the so-called climate change levy, more accurately termed the Gordon Brown Benefit Fund, when the objective is supposed to be to encourage alternatives to dirty electricity generation. It is the coming obligation to supply a proportion of renewables electricity or face a penalty which is causing the nuclear generators to go in for uneconomic wind farms which provide them with a potential benefit of 4.8 p per unit.

In other words, the nuclear generators should be rising up against the contorted, contradictory, crackpot chaos which today passes for an electricity market. When you spot the revolt, please let me know. I fear that one of the problems inherited from the defence/nationalised past is subservience to political masters even when you have shareholders expecting something from investing with you.

b) Deal with the waste issue

The second thing the industry should be doing is to deal with the second argument against it after its unprofitable nature: the so-called problem of disposing of its waste. This is intensified by the nuclear industry's failure so far to distinguish in the public mind nuclear waste from recovered plutonium and uranium which are fuels. I am told we have in store at present some 70 tonnes of plutonium, sufficient to generate an entire year's UK electricity consumption.

The nuclear industry should demand that the Government move swiftly to resolve the long-term storage of the more radioactive wastes as distinct from recyclable fuel. This is because it is the Government's issue. It is a political problem. There is, so far as I know, having talked to those who should know, no scientific, technological or cost problem in building a repository. There is merely a political problem: the problem of finding a Government with the guts to make the political decision identifying a site.

Instead of allowing anybody and everybody to parrot on about the nuclear waste 'problem', the nuclear industry should say what I have just said loud and clear at every opportunity and demand and re-demand Government action.

It should, in fact, get extremely shirty and disdainful with the problem brigade and hold them up to ridicule. The fact that it doesn't do so lends credence to the problem brigade.

c) New nuclear power stations

The third thing the industry should do is to demonstrate its confidence in its own fuel by announcing plans for the redevelopment of a nuclear site or sites with a new power station or stations. In doing so, it should explain that it has to act prudently in its own and the national interest if it is to continue to supply a substantial proportion of clean electricity. The move towards replacement cannot be delayed any longer if this is to be achieved. And it has not the slightest doubt that over the expected 50-year life of the station it will be very profitable, even taking into account the heavy up front costs, provided two things happen:

- there is a guaranteed sale for economic, clean, pollution-free base load electricity; that would not create a precedent – renewables have been accorded such a preference.
- there are reasonably stable regulatory regimes and the elimination of the double-jeopardy rule for nuclear which requires a two-stage consent to build and operate in a way which would bring most industrial investment to a grinding halt if more widely applied – further evidence of the unlevel playing field.

In this context, it should also bruit abroad nuclear's likely price stability and security of supply, in stark contrast to those of oil and gas, over the longer-term. It should also emphasise the very long-term self-sufficiency of nuclear, given the amount of uranium and plutonium in store and available for recycling. This should be stated as graphically as possible: enough stable-priced nuclear fuel to supply the nation with electricity for x decades or centuries.

d) Nuclear regulation

The fourth thing the nuclear industry should be doing is nail its own regulators to the wall. It should be on the war path about the capitulation of science to public opinion in the costs being imposed upon the industry by the belt, braces, old school tie, safety pins and adhesive tape approach to safety measures.

In doing so, it must show some understanding of the position of regulators who, confronted by pressure group-induced hysteria on the part of politicians and activist members of the public, have loaded the nuclear industry with add on burdens of a crippling nature. You can understand why they play ultra-safe.

But it is one thing to play safe. It is entirely another matter to take leave of reality. This is what has clearly happened in the past at Sellafield. I love getting my hands on first drafts of any official documents. They are liable to be the most honest. They are what honest people write before the rats get at them. I shall never forget being asked to give an opinion on a document which revealed that measures were being required at Sellafield which, even in the opinion of the Radioactive Waste Management Advisory Committee, would save only two notional lives in the next 10,000 years. If that is where the money is going, then no wonder we have education, health and transport crises. It is environmentalism gone stark, staring bonkers.

Regulation must be based on sound science and not on politically-distorted science. Which brings me to the vexed issue of the linear no threshold theory which ratchets up nuclear costs. My understanding from a splendid talk by Professor Roger Clarke, director of the NRPB to SONE's AGM is that he is not interested in the effects of natural background radiation levels. What he is seeking to establish is the risk from increments of exposure above that. That seems pretty effectively to demolish the LNT theory. There is indeed a threshold, even if we don't know what it is but it certainly doesn't exist in our natural surroundings.

I fully accept that judgements have to be made and that those judgements will necessarily be prudent ones. But for God's sake let's have done with the damaging, unscientific and plain wrong theory which says no exposure to radiation is without risk.

Public attitudes

If attitude is the nuclear industry's main internal problem – as I have outlined – then its main external problem is attitudes, too – public attitudes. These are a real problem because attitudes within the nuclear community have allowed them to become one. They stem in part from the decades of public ownership and Government control which did not encourage popularisers of nuclear science in the pay of the taxpayer. They encouraged a certain

inertia. We have got to kill it.

To examine internal attitudes more closely, the first one is intellectual snobbery of the kind inherent in 'Those who know don't need convincing and those who don't know don't matter.' I have found, even among members of SONE, an astonishing sensitivity to the idea that we are a pressure group as if it is something infra dig; faintly disreputable; and rather wild-eyed.

This means that nuclear engineers, scientists and technologists are only too willing to fight red in tooth and claw with each other in the public prints of their institutions over the next generation of reactor while the environmentalists clap and cheer and say 'Thanks a million' for tearing yourselves apart and not our tendentious presentation of nuclear.

It also means that, while they ignore the public, they are only too ready to write learned papers which frankly cause mortal men like me to roll their eyes in exasperation when it is assumed we can make head or tail a) of modern academic jargon which somehow passes for English; b) the graphs; and c) the mind-boggling equations which we never came within hailing distance even when we were wrestling with sixth form maths 50-odd years ago. Or perhaps they are intended to make us laymen feel inadequate.

Whatever, there is clearly a place – a very important place – for learned material. But there is no place for it in speaking to the lay public. We have to translate it, simplify it and make it relevant to the lives of ordinary people. And if we are not prepared to make the effort to do that – or help people like me do that – then we perpetuate public ignorance and prejudice which hostile press groups will assiduously cultivate.

So what I am asking each of you to do today, in addressing the future of nuclear power, is to ask yourselves what effort you are prepared to put in to give it a future – a future based on a rational, unemotive but graphic exposition of the facts and a sustained and systematic correction of the facts and refutation of scaremongering. For nuclear has no future – or at least not a secure one – unless we can nail the lies, the prejudice, the fears, the misunderstandings and the confusion which have been promoted over the last 30 years – ever since Tony Benn went behind my back at the Department of Energy and, in league with Friends of the Earth and the Daily Mirror, dubbed Sellafield, the 'nuclear dustbin of the world'.

It is not enough for you to pass this responsibility off on to your employing organisations, professional bodies, trade unions or assorted institutes. Your employers are too busy playing the political game or required to be studiously neutral to be robust. Your professional bodies and institutes are riddled, so far as I can see, with idealistic nutters who can't count. And your unions are not much use in this matter outside a crisis.

No, it is what you as ordinary but expert individuals, acting either alone or in concert, do that really counts. It is the explosive refusal to put up with it that you feel when you see manifestly ignorant and prejudiced and unfair and just plain wrong assertions and how you act on that explosive refusal that matters. Because if you don't do anything not many other people will. Only Don Quixotes like me. And lies, prejudice and ignorance will be perpetuated.

You could usefully start within your own nuclear industry. I have just had this account sent to me by a friend and member of SONE of an encounter with two women, one from the British Nuclear Energy Society and the other from the British Nuclear Industry Forum groups attending an energy choices conference. My friend has been injected with plutonium and has inhaled it in the interests of science and remains as wick as a weasel in his heavily monitored old age. So much for plutonium being 'the world's most deadly substance'.

He was introduced to them as a phenomenon and the only amazing thing to me, in view of the following recorded conversation, is that they remained around to have it: He reports and I quote: 'Oooh, you're not as old as I thought; how can you be allowed to endanger your life by taking in deadly plutonium?' When I replied that 'deadly' plutonium was a myth and that radium, for example, is 22 times more dangerous they looked at me in disbelief. I then firmly made the statement that 'There is no evidence whatever that any person on earth has ever died or shown any detectable health consequences from plutonium'. That refers to plutonium as a radioactive contaminant by inhalation, ingestion, absorption or penetration. Several thousands died by its use as an explosive at Nagasaki. Facially expressing their total disbelief, the women turned away and started another conversation with their BNES/BNIF colleagues.

They clearly thought he was barmy and I shouldn't be surprised if, by now, they put it down to his plutonium

injection.

Chernobyl

Another example of the missionary work we need to do internal to the nuclear industry was culled from the same conference. One woman told my friend she had recently been connected with a group of Chernobyl children brought over to recover from leukaemia. My friend stated that there was no evidence of any raised incidence of leukaemia in the Ukraine, Belorussia or Russia or among evacuees from the exclusion zone. She flatly contradicted him, stating that large numbers of children had been brought over for the past 10 years. Yet UNSCEAR, the UN body of some 700 international scientists monitoring the effects of Chernobyl, has specifically stated that so far no raised incidence of leukaemia has been detected.

This same woman, from the nuclear industry, spoke of thousands of deaths resulting from Chernobyl. So did the BBC reporting the closure in 2000 of the Chernobyl power station. I eventually managed to persuade the BBC's investigations unit that this was entirely unsupported by UNSCEAR who, at the last count, had identified only 45 deaths so far resulting from Chernobyl. I am assured that this fact has been brought to the attention of journalists, producers and editors.

When I was writing a column for the *Daily Express* in the 1990s, the *Daily Star*, its sister paper, went utterly barmy over Chernobyl. A reporter who said he had been there claimed that the ground was so hot that the snow melted as it fell. I went at my own expense to Chernobyl with a scientist with a rather sophisticated geiger counter. He calculated that the *Daily Star's* exaggeration was an exaggeration to the power of billions. I gave the *Daily Star* the full benefit of my scorn.

Chernobyl has been allowed to frighten people off nuclear power in a quite unprincipled way. And the unprincipled have been allowed to frighten them off by the supine behaviour of the nuclear industry which can always find reasons for doing nothing – in this case, not drawing attention to Chernobyl. It's just like the Basil Fawlty syndrome in *Fawlty Towers* – don't mention the war to the Germans. Chernobyl happened. It is a sad fact of history. It is being exploited. Those of us who know it is have to put a stop to it – or suffer, as we have, the wider consequences.

Sellafield, politics and ethics

This brings me to the Irish and the Nordics. They want to close Sellafield. They say, without the slightest evidence, that it is a health hazard and should be shut. In one of those occasional displays of monumental hysterical ignorance by political parties, Bertie Ahern, the Prime Minister of Ireland, and his entire Parliamentary Fianna Fail party took a full page 'Shut Sellafield' advertisement in the *Times* last November 24.

I am still awaiting a reply to my letter to Mr Ahern, on behalf of SONE, which stated: 'There is no evidence whatsoever that Sellafield has created or continues to create a health hazard'. If it did, the British Government would have been forced to act against it. Indeed, the Irish Sea is much less radioactive than the seas around the Middle East and notably the (salty) Dead Sea to which thousands of tourists flock to swim in it.

I have in front of me a report from the Isle of Man, which is, of course, much closer to Sellafield, that states that Manx consumers of appreciable amounts of seafood are unlikely to receive more than 2 per cent of the acceptable exposure limit to the general public. Your Nordic colleagues in opposition to Sellafield also maintain a fierce resistance to evidence refuting their claims that it causes serious pollution. You would have to eat seven or eight locally caught lobsters in one go in those countries to ingest not a significant amount of radiation but only as much radiation as you would acquire from consuming a single brazil nut.

If only all of you would apply your minds to ridiculing every nonsense critic of nuclear power, we would soon make people much less inclined to air their ignorance. We should then narrow down the criticism to that which is legitimate and which has to be met and concentrate the argument on essentials. I hope I have achieved that with the chairman of The Carbon Trust, a British Government backed body which seeks to promote a low carbon future but won't embrace nuclear power. I had fired into the director for refusing to mention nuclear in this context. But then Ian McAllister, the Ford executive and chairman of the Trust, claimed we could achieve a low carbon economy without nuclear (while maintaining he was determinedly neutral on nuclear) and condescendingly said 'we recognise the value of nuclear as potentially a long-term option... which can make a small but still important contribution to carbon dioxide emission reductions'.

'Are you not aware,' I have inquired of him, 'that nuclear currently generates 25% of our electricity and avoids the production of some 60m tonnes of carbon dioxide? It isn't "potentially a long term option". Our economy would be on a three-day week without it.'

I await an answer. It is perfectly clear that Ian McAllister, for all his industrial eminence, hadn't a clue where the power that keeps Ford turning in Britain comes from. Neither had another eminent industrialist SONE had dinner with last year. Our chairman, Sir William McAlpine cleverly asked him what he thought the proportion was. 'Ten per cent', he said, somewhat hopefully. We had more of his undivided attention when the answer came '10% my foot. It's 25% – and falling fast.'

We – you – have an immense task in making British industry realise just how much it depends on nuclear. I tried my best with the ignoramuses who concoct such politically correct indices as the Footsie4Good ethical index. It automatically excludes nuclear power and uranium mining as unethical. So how do you feel being described as unethical? Doesn't it make your blood boil? If not, it should. And the City deserves jolly well to go on halftime since, if – as it logically and ethically should – it dispensed with nuclear electricity, it would find itself 50% short of power, the proportion in the south-east generated by nuclear means.

And so I could go on. The opportunities for corrective ridicule are endless. This is because until now the nuclear industry has allowed itself to be a codswallop-attracting zone. The issue is how much you as individual nuclear scientists, engineers and technologists are going to bestir yourself if not in the interests of the nuclear industry in the interests of scientific fact and truth to prevent further damage to nuclear power and undo that which has occurred.

It doesn't take much effort. One simple, scornful letter of 100 words a week, making sure you encapsulate your credentials, or a vigorous protest of similar length to the broadcasters is what is required. Copy your protests to me and let me know whether they have been published or not and we are going to be in the business within a few months of demonstrating either a) the extent of the ignorant prejudice against nuclear; or b) the extent of the willful suppression of the truth by our media which never ceases to profess it is in the business of truth, beauty and light; or c) more likely both.

You have also no idea how much morale in the nuclear industry would be lifted by evidence of such a campaign to put over the truth. I know from my experience as secretary of SONE how much many want to feel nuclear has a champion. I also know of the sterling efforts being made by a number of SONE members to challenge ignorance and prejudice through the media where they live. Why not join us in this?

Future energy needs

I must now deal with one issue which argues the case for continued inertia. It is an argument which I frankly confess to be all my own. It is not the Fabians' inevitability of gradualness but the Ingham theory of the inevitability of need. My argument is based on simple arithmetic which this audience will be able instantaneously to absorb without the crutch of visual aids.

If nuclear currently supplies 25% of our electricity and the industry is to be run down steadily by 2020 so that it is capable of generating mere three per cent, a huge gap of 22% is going to open up in supplies. If none of us thinks there is the remotest chance of even 10% of electricity supply being supplied by unreliable, uneconomic, unproven and intermittent renewables by 2020, something like 12% will have to be found from coal, oil or gas, thereby making us a muckier rather than a cleaner nation. Alternatively, ways could be found of extending the life of nuclear reactors. But the clear message is: kiss Kyoto a fond goodbye.

Moreover, those figures of 25 down to 3, leaving a gap of 22, offset by renewables of 10 leaving a net gap of 12 are pretty meaningless, given the likely annual growth in electricity demand of, say, around 2%. This being so, my argument goes, sheer force of necessity will require a new nuclear programme before the world is much older and overnight nuclear will become eminently desirable if not necessarily the best thing since sliced bread in the eyes of a power-hungry populace. That is the fear of those environmentalists who see the energy review edging nervously towards meeting that reality.

It's a nice theory. But it does not in any way render redundant the need to secure a clearer, more factual, less prejudiced and fairer understanding of nuclear, its potential and its potential liabilities than we have at present. Only

the nuclear industry and those working in it can achieve that. And only by doing that can nuclear have a secure future as a supplier of clean electricity. So my question to you today is 'What are *you* going to do about it?'

You will notice that I have not once in this talk so far mentioned global warming. This is because I am frankly a sceptic. I have grown old on scientific fashion. I have grown weary of scientists changing their minds as often I change my socks on, for example, what is good or bad for us. I thought science was supposed to proceed by way of proof. Why only recently I learned that, far from warming, the Antarctic has been cooling for years. I have grown increasingly embarrassed about what scientists told me to say in the 1970s in the Department of Energy about North Sea oil and gas running out long before the end of the 20th century. It's still pouring from every orifice.

I have reached the age when I apply my own judgements. And on global warming and climate change I am of the opinion that, while I think there are far too many scaremongers on the loose, common sense dictates we shouldn't unnecessarily further pollute the atmosphere. In avoiding that, I do not think we should wreck our countryside and coast with a dash for unreliable renewables. That being so, we should ensure a continuing substantial role for nuclear as a generator of electricity.

To ensure it, we need to stand up to those who seek to close it down by lies, distortions, exaggerations and stunts. The issue is – and has been for far too long – whether you agree to be one of those who stands up and fights – repeat fights – for his fuel. The future of nuclear power is in your hands.

Sir Bernard Ingham

Article

No. 1
(June 2002)

Sunsense: Protecting Yourself from Ultraviolet Radiation

[eBulletin](#) > [No. 1](#) >

Where does UVR come from?

Ultraviolet radiation (UVR) is produced by the sun and by some artificial sources. The human eye cannot see it. Two types of UVR from the sun reach the earth's surface. These are UVB and the less energetic UVA. Some people are also exposed to UVR at work, as a medical treatment or by using sunbeds.

Is UVR harmful?

The main source of human exposure to UVR is the sun. UVR can damage DNA in cells on the surface of the body. UVR causes the skin to burn. The skin may react to UVR exposure by tanning. It can increase the risk of developing skin cancer (melanoma, squamous cell skin cancer and basal cell cancer). Intense UVR exposure can inflame the eyes. Long-term exposure may cause cataracts. These effects can take many years to develop so overexposure now may increase risks in later life. UVR causes skin ageing and, in many people, troublesome photosensitivity rashes. It may also affect the immune system in the skin, although the consequences of this are not certain yet. The incidence of skin cancer is rising. There are now about 40,000 new cases and nearly 2,000 deaths from skin cancer in the UK each year.

Surely, sunlight can be beneficial to health too?

Exposing the skin to UVR produces vitamin D. This benefit only needs the amount of outdoor exposure people get as part of daily life. It may be more important for health in dark-skinned people with vitamin D deficient diets. Many people 'feel better' out in the sunshine. You can keep these benefits of sunshine without increasing the health risks by following our Sunsense Guide below.

Are some types of UVR less harmful?

We do know that UVB is the main cause of sunburn. UVA is thought to cause skin ageing. We do not yet know enough to say which types of UVR cause cancer. The International Agency for Research on Cancer, which is part of the World Health Organization, classifies all UVR as carcinogenic (cancer-causing) to experimental animals.

Is sunburn dangerous?

Although there is limited evidence whether sunburn directly causes cancer, sunburn is a sign that the skin has been damaged. Your risk of melanoma (the main cause of death from skin cancer) is related, among other things, to the number of times you have had intense exposure to UVR. Such exposures may be particularly damaging in children, although skin cancers usually develop in adult life.

I have a suntan, does that protect me?

A suntan is a sign that the skin has already been exposed to UVR and is trying to protect itself from further harm.

People with naturally dark or tanned skin can still suffer sunburn. A suntan only offers modest protection against further exposure.

Who is most at risk of UVR damage?

UVR damage occurs most easily in fair-skinned people and others who burn easily in the sun. Even dark-skinned people can get sunburnt. Everyone is at risk from UVR damage to the eyes.

How does UVR damage the eyes?

One-off intense exposure (as in snow blindness) can cause intense inflammation in the eye. High levels of exposure over a long time may increase your risk of a number of eye diseases including cataract.

Are there any other effects of UVR?

UVR can affect the immune system. The long-term consequences of this are not known. Some people find that cold sores are reactivated after exposure to UVR.

Why is it so important to protect children?

Children have many years ahead of them. Their skin needs to be protected from damage when they are young. This may help to reduce their risks of cancer and eye disease in adult life. Children cannot be expected to take responsibility for sun protection themselves. Carers of children have a responsibility to protect the skin and eyes of their young charges.

Are sunbeds safe?

Sunbeds emit UVR. Sunbeds cause tanning and can cause sunburn. There is no evidence to suggest that any type of sunbed is less harmful than natural sun exposure. NRPB discourages the use of sunbeds for cosmetic tanning.

How can I enjoy the sunshine without the risks of UVR?

The first line of defence is to know your skin type and keep alert for weather reports predicting that the global solar UV index will be 3 or more which can damage sensitive skin. This will let you plan adequate protection to be out and about on day when sunlight could damage your skin or eyes. A solar index of 6 or more is considered high.

Know your skin type

Which of the following best describes your skin's reaction to sun exposure?

- White skin that always sunburns easily, never or minimally suntans
- White skin that sunburns and suntans moderately
- White skin that sunburns minimally and suntans easily to a mid-brown colour
- Brown skin that rarely sunburns and suntans well
- Dark brown or black skin that almost never sunburns

Global solar UV index Approximate time for sunburn to begin in sensitive skin

1	sunburn unlikely
2	1 hour
3	50 minutes
4	40 minutes
5	30 minutes

6	25 minutes
7	20 minutes
8 or more	less than 20 minutes

The next line of defence is to protect the skin and eyes by seeking shade or wearing clothing, wide brimmed hats and wrap-around sunglasses. The best clothing is loose fitting with a close weave. The third line of defence is sunblock or broad-band sunscreen (at least [SPF 15](#)). It should be used generously and applied frequently to areas that cannot be shaded from the sun with clothing. If used correctly, sunscreens will prevent sunburn. However, if you use them in order to stay out longer in the sun, you may partially or entirely lose the benefits in terms of protection from UVR exposure.

The final line of defence is early detection of skin cancer. Remember the signs of early melanoma and check yourself and your family.

You should consult a doctor if you develop a major sign or a number of minor signs of melanoma

Major signs of malignant melanoma

- A mole with three or more shades of brown and black.
- An existing mole getting bigger or developing an irregular outline.
- A new mole growing quickly (months) in an adult.

Minor signs of malignant melanoma

- A mole that is larger than the blunt end of a pencil.
 - A mole becoming inflamed or developing a reddish edge.
 - A mole that develops bleeding, oozing or crusting.
 - A mole starting to feel different (e.g. itching or painful).
-

Ten ways to minimise UVR-induced skin and eye damage: NRPB sunsense guide

- Take sensible precautions to avoid sunburn, particularly in children.
 - Remember that a suntan offers only modest protection against further exposure. It is not an indication of good health.
 - Limit unprotected personal exposure to solar radiation, particularly during the four hours around midday, even in the UK.
 - Seek shade, but remember sunburn can occur even when in partial shade or when cloudy.
 - Remember that overexposure of skin and eyes can occur while swimming and is more likely when there is a high level of reflected UVR, such as from snow and sand.
 - Wear suitable head wear, such as a wide-brimmed hat, to reduce exposure to the face, eyes, head and neck.
 - Cover skin with clothing giving good protection – examples are long-sleeved shirts and loose clothing with a close weave.
 - Sunglasses should exclude both direct and peripheral exposure of the eye to UVR, i.e. be of a wrap around design.
 - Apply sunblocks, or broad-band sunscreens with high sun protection factors (at least [SPF 15](#)) to exposed skin. Apply generously and reapply frequently, especially after activities that remove them, such as swimming or towelling.
 - Remember that certain individuals have abnormal skin responses to UVR and may need medical help. Certain prescribed drugs, medicines, foods, cosmetics and plant materials can also make people more sensitive to sunlight.
-

Where has this advice come from?

This advice is based on a report by the National Radiological Protection Board (NRPB) expert Advisory Group on Non-Ionising Radiation (AGNIR). NRPB is an independent body that was set up by the Government in 1970 to provide advice on protection from radiation. AGNIR consists of UK experts who have reviewed all the science. The report considers what is known about the health effects of UVR and how you can protect against them.

The Sun Protection Factor (SPF) is the ratio of the UVR exposure to produce minimal reddening of the skin on a site protected by sunscreen to the UVR exposure to produce a comparable reddening on unprotected skin. An SPF of 10 would reduce exposure to 10% of that of unprotected skin.

Jill Meara

ArticleNo. 1
(June 2002)**Nuclear weapons tests and human germline mutation rate:
A commentary**[eBulletin](#) > [No. 1](#) >

A recent paper from Yuri Dubrova and colleagues (Dubrova et al. *Science*, 295, No. 1037 (2002)) reports a ~1.8-fold increase in the rate of minisatellite DNA mutation in the offspring of parents receiving relatively high doses of radiation (cited as >1.0 Sv) as a consequence of nuclear tests in the Semipalatinsk region of the former Soviet Union (FSU). There is some uncertainty on the actual doses received but the increased mutation rate observed is broadly consistent with the genetic doubling dose of 1 Sv used by the ICRP (1990) and UNSCEAR (2001) to make estimates on genetic risks after radiation exposure. Specific associations between such minisatellite locus mutations and human genetic disease remain most uncertain.

The report from Dubrova et al. (2002) provides the most convincing evidence to date of heritable mutations induced in humans following parental exposure to ionising radiation. Medical genetic studies on the offspring of Japanese A-bomb survivors failed to demonstrate a clear excess of genetic disease and current estimates of genetic risk rely substantially on studies with mice (UNSCEAR 2001). In addition, previous attempts to demonstrate excess minisatellite and other mutations in post-Chernobyl irradiated FSU populations and workers using molecular techniques have proved negative (Livshits et al. 2001) or methodologically controversial (Dubrova et al. 1996, 1997; Weinberg et al. 2001; Jeffreys and Dubrova 2001; Bridges 2001).

The strength of the Dubrova et al. (2002) report is provided by the use of a well validated molecular methodology, adequate controls and acceptably robust statistical features together with some evidence of the expected decline in excess mutations as population doses decreased.

It is important to note that the study population in the Beskaragai district of Semipalatinsk received relatively high radiation doses largely attributable to fallout from a nuclear test in 1949 (Gusev et al. 1997). The Gusev et al. data cited by Dubrova et al. give a dose estimate >1 Sv but others for the region range between <0.5 Sv and 4.5 Sv (WHO 1998). These doses may be compared with a mean dose to germ cells in the Japanese A-bomb survivors of ~0.4 Sv and doses from natural background radiation of ~1 mSv per year. Gusev et al. also show that the largest component of dose was received in the early period following the explosion as external gamma rays. In this way the genetic doubling dose for minisatellite mutation of, say, around 1 Sv for the Semipalatinsk study is consistent with current judgements from the ICRP (1990) and UNSCEAR (2001). This doubling dose also broadly accords with experimental estimates relating to minisatellite mutation rates in laboratory mice (Dubrova et al. 1998) but is inconsistent with the post-Chernobyl FSU data that has been criticised on methodological grounds.

Although the evidence available is limited, it seems most likely that the vast majority of minisatellite mutations are genetically neutral and very few of these loci are associated with heritable disease (UNSCEAR 2001; Bridges 2001). Those associations made for specific minisatellite loci refer largely to complex multifactorial conditions (diabetes, cancer and spontaneous abortion) involving multiple genes and their interaction with variable environmental and lifestyle factors. On current knowledge (UNSCEAR 2001) the incidence of multifactorial disease in a given population is only poorly responsive to an increase in mutation rate. Thus the absolute increase in minisatellite mutations recorded by Dubrova et al. (2002) will not relate directly to the incidence of genetic disease.

In summary, Dubrova et al. demonstrate the utility of minisatellite mutation rate as a biomarker of germ cell damage

in humans and there are also interesting mechanistic factors to explore (Bridges 2001). The reported data are broadly consistent with the genetic doubling dose used in current estimates of genetic risk but the mutations themselves are unlikely to impact significantly on the incidence of heritable disease.

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Update, April 2003

More recently Salomaa et al (2002) reported on chromosomal damage observed in blood lymphocytes of some of the parental and first generation offspring investigated by Dubrova et al (2002) using fluorescence *in situ* hybridisation (FISH). Radiation dose estimates derived from this analysis averaged 0.4 Gy as opposed to 2.9 Gy estimated from dose reconstruction. These data combined with those of Dubrova et al (2002), indicate a doubling dose of about 0.5 Gy for minisatellite mutations. This figure remains closer to conventional estimates than doubling doses of less than 100 mGy as implied from the studies of post-Chernobyl families (Dubrova et al 1997, 2002b)

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Simon Bouffler and David Lloyd

Article

No. 1
(June 2002)

Possible toxic effects from the nuclear reprocessing plants at Sellafield (UK) and Cap de la Hague (France)

[eBulletin](#) > [No. 1](#) >

This is a report prepared by an external contractor, WISE-Paris, in the context of the Scientific and Technical Options Assessment Workplan for 2000.

The report is published by the European Commission Directorate General for Research as a contribution to the scientific debate on the possible toxic effects from the reprocessing plants. Due to concerns about its lack of objectivity expressed by some members of the European Parliament, three independent experts were asked to provide reviews on the report. These reviews accompany the published report.

Overall, the report brings together a considerable body of information about the operation of the two nuclear fuel reprocessing plants. From a radiological protection perspective, however, some of the conclusions drawn in the report are based on erroneous comparisons or reflect a lack of objectivity. The report fails to make a central point that both Sellafield and La Hague have, at least in recent decades, operated within a closely regulated legal framework that derives not only from national considerations but also from regional multi-national requirements imposed by the Euratom Treaty.

The executive summary draws together many of the erroneous comparisons and misunderstandings that are present, although in a more diluted form, in the main text of over 60 pages. Particular points are as follows. The section on 'Conclusions on Sellafield releases' (section 5) discusses deposition of plutonium in the Sellafield environs, mentioning sea to air transfer, which is an extensively studied transfer mechanism. The report comments that:

the average activity due to actinides [presumably in air] from the sea may occasionally exceed the international limit of 1 mBq/m³:

there is no such international limit. The same section propagates the common error of comparing concentrations of technetium-99 from controlled discharges with standards that apply only in controlling foodstuffs following a radiological emergency.

Later in this section, critical group doses occurring in the mid 1970s to early 1980s from Sellafield discharges are discussed. Discharges from Sellafield were much greater during those years than now and so the critical group doses were correspondingly higher. Furthermore, the radiological standards against which doses and discharges were compared were generally less restrictive in those years than they are now. Nevertheless, the report makes the disingenuous comparison of *past* critical group doses with *current* dose limits. It attempts to justify this position by stating that doses from past discharges and direct radiation are not included in comparisons with the dose limit, whereas in fact in the UK they are. In particular, critical group doses from Sellafield discharges are assessed retrospectively using measurement data, which would of necessity include any contribution from historical discharges. This raises another point: critical group doses depend not only upon activity concentrations in the environment but also on the habits, food consumption patterns, etc. of the exposed individuals. For the major sites in the UK, including Sellafield, these habits are established from field surveys and so the resulting calculated doses can be viewed with a high degree of confidence. Therefore, comments in the report to the effect that dose limits would be exceeded if German statutory dose assessment assumptions were adopted are both irrelevant and misleading.

Section 7 of the executive summary refers to the ICRP radiological protection principles raising the issue of whether releases from the two reprocessing plants are justified in radiological protection terms. Justification is one of the three principles of protection of the ICRP. It requires that any use of radiation, referred to as a practice, should be beneficial in overall terms. Importantly, the ICRP states that the principle applies to the complete practice (in this case, reprocessing) and not one facet, the releases. To do otherwise would be analogous to condemning the internal combustion engine solely on the basis of its emissions.

The main text of the document contains the errors and misrepresentations noted for the executive summary. But there are additional points which illustrate a lack of understanding of radiological protection and of the environmental transfer of radionuclides. Section 5.4.1 refers to the amount of activity that can be transferred from sea to land as 'about a 1000 body burdens'; this is an archaic term which conveys no meaning to the reader and, in any case, to be present in the body in this manner, all of the activity would have to be inhaled or ingested which would be an extremely unlikely occurrence given the widely dispersed area over which sea to land transfer occurs. In section 5.4.3 the final sentence strongly suggests, because of the context of the paragraph, that the paper of Popplewell et al. showed higher concentrations of plutonium in autopsy samples from West Cumbria than had been predicted by models. It did not: that comparison was not made in the paper. Instead, Popplewell et al. showed that the concentrations of plutonium were generally higher than those found elsewhere in the UK.

The section on 'Comparative studies' (7.3.3) contains a statement that the collective doses from Sellafield (300 man Sv) and from La Hague (1100 man Sv):

may be compared with the reference level for releases from Swedish nuclear reactors of 5 person Sv per GW year capacity.

But how? It may be possible to make some sort of comparison if information on the electricity that had been generated from the fuel being reprocessed (in GW years) had been provided. The authors should have pointed this out instead of resorting to the expedient of comparing two relatively large numbers with one small one.

Finally, the report represents a substantial body of information and must have taken a considerable amount of effort to compile. It is, however, difficult to escape the conclusion that the objectivity of the report is compromised.

John Cooper