The Non Hodgkin Lymphoma of Steve Dornan and his previous exposure to contamination from uranium weapons in Bosnia

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Causality and the non-Hodgkin lymphoma of Mr Steve Dornan

1. I have been asked by Mr Steve Dornan to examine documents relating to his illness, non-Hodgkin lymphoma (NHL) and to give my expert opinion on the relation between the development of this disease and his previous exposure to uranium weapons contamination during his deployment as a weapons inspector in Bosnia. The question which I shall address in this report is one of causality: is it more likely than not that his non-Hodgkin lymphoma was caused by exposure to uranium contamination originating in the NATO use of uranium weapons in the Bosnia conflict in 1994-6?

I have read a large number of documents sent to me by Mr Dornan.
I note that the chronology of his involvement with the Veterans Agency Canada is as follows:

Oct 21 2003 Applied to Veterans Affairs Canada (VAC) for Disability Claim
Jul 06 2004 Denied
Oct 18 2006 Review Hearing
Jan 12 2007 Denied
Sep 24 2009 VAC Appeal Board Hearing
Dec 10 2009 Denied

He is, as I understand it, appealing this final denial decision.
With respect to this appeal, I note that the protocols in cases like his where a pension has been refused are similar to those which exist in the UK, namely that the appeal is allowed if the appellant can show *reasonable doubt* over the arguments employed in the appealed decision. Specifically in relation to the relevant litigation:

39. *In all proceedings under this Act, the Board shall*
(a) draw from all the circumstances of the case and all the evidence presented to it every reasonable inference in favour of the applicant or appellant;
(b) accept any uncontradicted evidence presented to it by the applicant or appellant that it considers to be credible in the circumstances; and
(c) resolve in favour of the applicant or appellant any doubt, in the weighing of evidence, as to whether the applicant or appellant has established a case

Having read the evidence in this case I will proceed to show that Mr Dornan's NHL was more likely than not caused by his previous exposure to weapons uranium. The denials which have been made throughout this affair have been sloppy and based on ignorance, outdated science and bias. I will be happy to appear in any court to substantiate this opinion and to address any contrary opinion advanced by the Canadian military or anyone else.

This is not a new matter for me. In the last three years I have been involved as an expert witness in a significant number of cases involving exposure to uranium, including veteran appeal tribunals in the UK and a class action in the Royal Courts of Justice, and I have succeeded in every single case in persuading the tribunal judges that the evidence

advanced by the UK Defence Ministry is outdated and has been overtaken by new scientific research.

The most recent case involved a similar uranium exposure to that of Mr Dornan. This was the official coroner's inquest in September 2009 into the death of Stuart Raymond Dyson, a Gulf War veteran who developed colon cancer and died aged 38. This coroner's inquest was unusual in that it involved a jury, and evidence as to the cause of death was presented by the UK Ministry of Defence who argued that Mr Dyson (a) had not been significantly exposed to Depleted Uranium and (b) if he had it could not have caused his cancer as the radiation dose was too low. This is very similar to the arguments deployed in the case of Mr Dornan. Her Majesty's coroner employed me as an expert witness to examine the case and I concluded that in my opinion Mr Dyson's cancer was most likely caused by his previous exposure to DU. The jury found that the MoD was wrong and that Mr Dysons cancer was caused by his exposure to DU. This is a landmark verdict which is clearly of relevance to Mr Dornan's situation since the circumstances were very similar. I attach the papers I produced for the coroner as Attachment1 in which I also copy the MoD arguments.

2. I have studied the health effects of radiation for almost 20 years.

My affiliations and expertise are outlined in the CV which I attach. I am Visiting Professor at the University of Ulster in the Faculty of Life and Health Sciences and also Guest Researcher at the German Federal Agricultural Laboratories (Julius Kuehn Institute) in Braunschweig. I have been a member of two government committees on radiation and health, The Committee Examining Radiation Risk from Internal Emitters, CERRIE (www.cerrie.org) and the MoD Depleted Uranium Oversight Board DUOB (www.duob.org). In the area of radiation risk I have conducted epidemiological studies, theoretical cell biology studies and laboratory experiments. I have surveyed radioactively contaminated sites in the field. I have visited Iraq and also Kosovo and measured Uranium in both those theatres of war. I gave evidence to the UK Royal Society and to the US Congressional Committee on Veteran Affairs on the issue of uranium weapons and health. As a result of my researches I have concluded that the current radiation risk model is in error for internal exposures, that is radioactivity that is inhaled or ingested and chronically irradiates tissue from within. This is particularly the case of Uranium, for reasons which I will elaborate below. My research on Uranium and health was the top news story in *New Scientist* for 6th September 2008 and I wrote a major article for the *United Nations Disarmament Forum* on the issue of Uranium Weapons in early 2009 (see references). I have acted as expert witness on the health effects of radiation exposure in many courts in the UK and the USA. I am currently an expert witness and advisor in the current Royal Courts of Justice case where the A-Bomb Test veterans are suing the government. I am the Scientific Secretary of the European Committee on Radiation Risk ECRR (www.euradcom.org) and senior author of the ECRR2003 Report which presented an alternative risk model to that of the ICRP (ECRR2003). I have written two books on the health effects of internal radioactive contamination, the more recent one also dealing with the causes of cancer and the responses of the authorities to evidence presented at the science policy interface (Busby 1995, 2006), a subject I have experience with as former leader of the Science Policy Interface group of the EU Policy Information Network for Child Health and Environment PINCHE.

3. According to the papers I have been supplied with by Mr Dornan, he was deployed as a weapons inspector in Bosnia and Croatia between December 1995 and July 1996. This was the period shortly after the bombing by the US air force. Among his duties, he apparently was involved in examining areas where uranium weapons had been employed and looking at vehicles and buildings which had been contaminated with the uranium dust which is dispersed when uranium weapons burn on impact. To frame the argument I briefly outline the relevant events of the period. A NATO bombing campaign, *Operation Deliberate Force*, began in August, 1995, against the Army of the *Republika Srpska,* after the Srebrenica massacre. Operation Deny Flight, the no-fly-zone enforcement mission, had begun two years before, on 12 April 1993, and was to continue until 20 December 1995. NATO air strikes that year helped bring the war in Bosnia to an end, resulting in the Dayton Agreement, which in turn meant that NATO deployed a peacekeeping force, under *Operation Joint Endeavor*, first named IFOR and then SFOR, which ran from December 1996 to December 2004.

4. There is no doubt that significant quantities of uranium weapons were employed in Bosnia, and particularly in the early part, before December 1995. Depleted Uranium DU had been employed against armour in the 1991 Gulf war. Later it has been demonstrated that weapons containing Depleted Uranium and also Natural and slightly Enriched Uranium began to be employed in heavy weapons (Cruise missiles, smart bombs etc.) to destroy hard targets, deep bunkers etc. I have found evidence of the use of non-Depleted Uranium in bomb craters in the Lebanon and also Gaza (Busby 2007, 2009) and this was reported by the UN (Busby UNIDIR 2009) and also reported in the national newspapers. The United Nations Environment Program UNEP visits to survey for uranium contamination in Kosovo and Bosnia found widespread dispersion, shown by the data UNEP reported. I met with the UNEP leader Pekka Haavisto in Sweden and also with his replacement Klaus Topfer in Slovenia. In 2001 in Strasbourg I advised the project director for the Bosnia survey Dr H-O Snihs that, in view of my findings in Kosovo in 2001 of uranium resuspension in the air, he should deploy air measuring devices, and this was carried out, first in Montenegro and then in the Bosnia surveys. He agreed to do this. It's an important matter as the route for exposures is mainly by inhalation of resupended material. Although it was not until 2002/2003 that the Bosnia post conflict assessment for uranium contamination was completed, seven years after the bombing, evidence of uranium weapons usage was still found (UNEP 2003) and it was found, as I predicted, in the air. This was a surprise to UNEP.

Page 72 of UNEP 2003 states:

DU in air was detected in five of the samples, including inside a building in which contamination points were identified, in another building where no DU contamination was found with field instruments, and on the cobblestone area where numerous contamination points and penetrators were found. This was a new finding as it was the first time that contamination of air had been found in the natural environment.

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The amount of DU measured in the air inside the building was much higher than that measured outside. The concentration was about 50 times normal value for uranium and consisted of almost 100 per cent DU. The reason for resuspension could be due to air coming through the openings in the building near the floor and blowing the DU dust on the floor. However, as the dust was found to be highly contaminated with DU, it should be noted that any regular activities occurring inside the barn would create further resuspension. The resuspended DU particles outside the storage barn are diluted in the open air, which explains the wide difference.

Soil contamination may be seen in UNEP 2003. This table, like many in the UNEP results in all their publications is displayed in a way that makes it difficult to understand except for an expert in this field, and no explanation is given for the units employed. Water samples were also analysed and results shown in Table E2, again with different quantities and units to those used for the soil samples. In Table 1 below I have converted the results into the quantities most usually employed in examining Uranium isotope ratios, the atom ratio of U238/U235. The normal value for this in the environment is 137.88. Any deviation from this indicates uranium of man-made origin. I discuss this matter at some length in the report of the UK Ministry of Defence Depleted Uranium Oversight Board (www.duob.org). In Table 1 I assign the result to Depleted Uranium, Natural Uranium and Enriched Uranium. It will be clear that most of the water samples contain significantly Enriched Uranium and are therefore of man-made origin and are not natural.

Table 1. Uranium in water samples from Bosnia reported by UNEP 2003. Ratios of activity converted to atom ratio. Colour blocks assign the origin of the uranium on the basis of 2 SDs. Note that most of the uranium is significantly Enriched.

	mBq/l		alpha		U238/235 ratio	
Sample	U238	2SD	ratio	2SD	atom	assign
BHW01	16.24	0.8	0.04	0.01	158.8025	DU
BHW02	4.81	0.24	0.06	0.01	105.8683	EU
BHW03	12.21	0.57	0.03	0.01	211.7367	
BHW04	12.05	0.46	0.06	0.01	105.8683	EU
BHW05	0.66	0.11	0.1	0.05	63.521	EU
BHW06	1.3	0.14	0.13	0.04	48.86231	EU
BHW07	1.29	0.13	0.08	0.03	79.40125	EU
BHW08	0.6	0.09	0.1	0.05	63.521	EU
BHW09	0.33	0.06	0.04	0.07	158.8025	unknown
BHW10	4.29	0.24	0.08	0.02	79.40125	EU
BHW11	1.3	0.12	0.05	0.02	127.042	Natural
BHW12	1.52	0.21	0.05	0.04	127.042	unknown
BHW13	2.63	0.16	0.08	0.02	79.40125	EU
BHW14	0.82	0.1	0.09	0.04	70.57889	EU
BHW15	0.84	0.1	0.09	0.04	70.57889	EU

BHW16	0.27	0.1	0.14	0.09	45.37214	EU
BHW17	2.11	0.16	0.08	0.02	79.40125	EU
BHW18	4.05	0.28	0.07	0.02	90.74429	EU
BHW19	3.87	0.19	0.06	0.01	105.8683	EU

4. Enriched Uranium in wars

The origin of Enriched Uranium in wars following the first Gulf War in 1991 is puzzling. It has been found in the Balkans, in Lebanon and in Gaza, and urine measurements made by the UK military on personnel deployed in the second Gulf War in 2003 suggest that there was Enriched Uranium employed there also (see www.duob.org). A number of suggestions have been made. One is that EU has been substituted for DU in large bunker busting bombs and Cruise missiles in order to disguise the use of DU so as to make later analysis impossible. The second is that the EU is a component of a new weapon developed by the US (see Busby, UNIDIR 2009). There is also the possibility in Bosnia that the EU originates in fuel particles from the Chernobyl accident, but this is unlikely since it is found in Iraq and the Middle East areas where there was no Chernobyl fallout; in addition, survey measurements made in the UK in 1997 showed no EU in more than 500 soil samples analysed by the University of Southampton. Nevertheless, the existence of EU in the environment, whatever its origin, has one very important consequence. It means that using the U238/U235 ratio as an analytical indicator for the existence of Depleted Uranium is no longer possible. Therefore the results of all the surveys carried out by UNEP and others are meaningless.

5. The health effects of DU have been and remain the subject of significant scientific controversy. Government and Military continue to assert that the exposures suffered in the various theatres where the material was employed were negligible and had no subsequent health effects. In this they are supported by a number of so-called independent organisations, e.g. The Royal Society, the National Radiological Protection Board and the World Health Organisation. However all these groups base their *desktop predictions* of the health effects of DU upon a *single risk model*, that of the International Commission on Radiological Protection (ICRP) an organisation that has been criticised for being close to the nuclear industry and funded directly and indirectly by governments of nuclear nations. This ICRP risk model has been increasingly questioned by a number of organisations in the last ten years particularly in its seeming inability to predict or explain a wide range of health effects reported following exposures to internal, that is, ingested and inhaled, radioactive material (ECRR2003, CERRIE 2004, IRSN 2005, Busby 2009). These include:

- The health effects of the Chernobyl accident
- The many reports of child leukaemia and female breast and other cancer excess near nuclear sites
- Cancer excess including childhood cancer on the Irish Sea coast contaminated by Sellafield
- Health effects in those exposed to DU; Gulf War Syndrome

This area of radiation risk from internal exposures is one of major and polarised scientific controversy. However, more and more evidence is appearing in the peer-review literature and the grey literature also, both from epidemiology and from laboratory experiments or theoretical work, that there are many serious shortcomings with the current risk model that of the ICRP. A significant piece of evidence in this area has recently been published. This shows that there was a statistically significant increase in infant leukaemia in those children who were in the womb at the time of the Chernobyl fallout (Busby 2009). The importance of this finding is twofold: first it shows the ICRP model, on which the safety of Depleted Uranium exposure is bases, top be in error by a very large amount. Second it is unequivocal: unlike the nuclear site leukaemia clusters (e.g Sellafield) there is no possible confounding cause.

6. The health effects of Uranium weapons

This is a question which has been the subject of more than one hundred reports, books and articles. However, I am interested here in the illness and death from non Hodgkin Lymphoma of Mr Dornan and will try to focus on that without too much digression. I will attach an article I recently was commissioned to write for the United Nations Disarmament Forum which lays out my position on the issue and the science supporting it. I have studied the health effects of uranium weapons since 1996 and was one of the first to point out that the health effects seen after Gulf War I in the Iraqi populations and also in the veterans was likely to be due to Uranium exposure. Since then I have addressed many bodies concerned with the question, including the Royal Society, the US Congress, the European Parliament, the Swedish Parliament and, of course the MoD, whose DUOB I was a member of. I was also one author of the final report of the DUOB which can be found on the website www.duob.org.

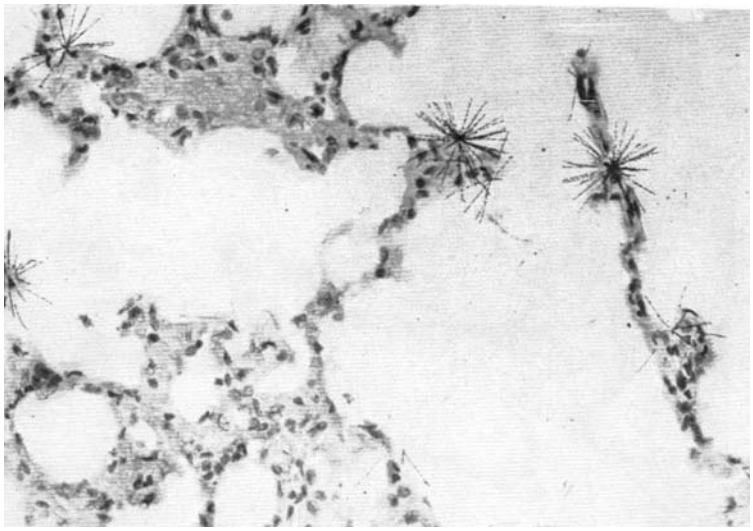
Uranium is an element which occurs naturally on earth and is widespread. So, of course, is Arsenic; and so the *naturalness* of Uranium should not let us imagine that it is somehow safe. It is not. Uranium is radioactive, and is peculiar in that it decays with the emission of alpha particles which are short range, weakly penetrating and highly ionizing (therefore dangerous) radiations. These alpha radiations would not penetrate skin but if the uranium atoms are internal, inside tissue, the alpha particle radiations cause high levels of damage along their short tracks, which involve about four cells. In addition Uranium has two other singular properties. The first is that it has the highest atomic number if any natural element, Z=92. This makes it have a very high stopping power for gamma rays compared with normal living tissue. (Lead, which is used for this purpose by radiographers has Z = 82). Second, it binds very strongly to DNA. These two properties make uranium in the body bind to DNA and focus background gamma radiation into the nuclear DNA of cell where it will have the greatest genetic harm (Busby 2003,Busby 2005, Busby and Schnug 2008, Pattison et al 2009)).

There are three natural isotopes U-238, U-235 and U-234. The main isotope, U-238 comprises 99.3% of natural uranium as refined from ore; the fissile isotope U-235, used for nuclear power and atomic bombs represents 0.3% by weight. The U-234 is a decay product of the U-238: there are also two other decay products, the beta emitters Protoactinium and Thorium-234 but these latter here need not concern us here although they do add to the radioactivity. DU is uranium that has had much of the U-235 removed; it is a waste product of the nuclear fuel cycle. DU is a very dense (density = 20) metal

which is also pyrophoric, that is, it burns in air on impact with a target. The combination of properties has made DU shells (penetrators) capable of transforming armoured warfare. It was the employment of DU weapons that was probably the cause of the US and UK success against Saddam Hussein's tanks in the Gulf War.

On impact, the DU burns to a fine aerosol of ceramic uranium oxide particles of mean diameter from about 1000nm (1μ) down to below 100nm. These particles are long lived in the environment (and in tissue), and can travel significant distances from the point of impact up to thousands of miles (Busby and Morgan 2005). They become resuspended in air, are found in air filters in cars at some distance from the attacks, and of course are respirable. They were found in air filters in Bosnia (UNEP 2003).Because their diameters are so small, below 1000nm, they are able to pass through the lung into the lymphatic system and in principle can lodge anywhere in the body. Here they may remain for several years in the same place. The half life of such particulate uranium is unknown but is very long. According to research with animals it can be greater than 13 years (Royal Society 2001). Although uranium itself is weakly radioactive (owing to its long half life or 4.5 million years) because the DU particles are made of solid uranium oxide, they are significantly radioactive and can deliver several high dose alpha tracks to the same local tissue. This is an important point as it goes to the core of the argument about the ICRP risk model, the one that has been employed to argue that DU is not a significant hazard. The ICRP models cancer on a quantity termed 'absorbed dose' which is defined as energy per unit mass. This is an average of the ionisation over large amounts of tissue, kilograms, and is a reasonable unit for quantifying the effects of external radiation e.g. from an atom bomb's gamma rays but is not scientifically justified for internal anisotropic radiations where there are large doses in one place and no dose everywhere else. An analogy would be to compare the same acquired by warming oneself in front of a fire with eating a red hot coal. This 'hot particle effect' has been the basis for most of the arguments about cancer and DU (and indeed also plutonium and fuel particles after Chernobyl and the Atomic tests and near nuclear power stations). A photograph (radiograph) of the alpha tracks (called an 'alpha star') from such a particle in rat lung is shown in Fig 1.

Fig 1 Radiograph of alpha track stars from sub micron diameter radioactive 'hot particles' in rat lung (IRSN France).



But there is another far serious error in the ICRP model for DU. DU oxide particles are made largely of uranium, atomic number Z=92. The absorption of gamma radiation is proportional to the 5^{th} power of the atomic number. This means that if we compare the absorption of natural background gamma rays by a DU particle with the absorption of an equivalent tissue mass (whose highest atomic number element is oxygen in the water Z = 8) we see that the uranium particle absorbs more than 201,000 times the background radiation. For particles smaller than 1000nm diameter we have shown (Busby et al 2005, 2008) that all the energy is transferred to the local tissue as photoelectrons of various ranges. Thus the tissue that contains such a particle receives a continuously high level of radiation damage, as if from a microscopic embedded radioactive speck. This effect is in addition to any alpha emissions from the uranium and is purely a consequence of the atomic number of the element. It is 'phantom radiation'.

5. Mr Dornan's Non Hodgkin lymphoma and DU particles

In an environment where Mr Dornan was deployed it is inevitable that he will have been contaminated internally both through inhalation and inadvertent ingestion. Inhalation of the DU and EU particles will result in transfer through the lung to the tracheobronchial lymph nodes and thence to the lymphatic system. Autopsy measurements made in the UK of members of the public living near the Sellafield contaminated Irish Sea, and of nuclear workers at the Sellafield reprocessing plant showed high levels of plutonium in the tracheobronchial lymph nodes. These people had inhaled resuspended plutonium oxide particles from the air. It is the enhanced radiation exposure to Mr Dornan's lymphatic system from the uranium particles in Bosnia that will have been the cause of his NHL.

6. Non-Hodgkin lymphoma and its causes.

Non Hodgkin lymphoma comprises a group of diseases which consist of certain malignant cell expansions within the lymphatic system, and which are distinct from Hodgkin's Disease, which is a proliferation of a specific type of cell that can be detected by microscopic analysis. The non-Hodgkin lymphomas are essentially cancers of the immune system: they are subdivided through consisting of proliferations of many different types of cell. There are two main types of lymphocytes involved: B-lymphocytes (B-cells) and T-lymphocytes (T-cells). It is malignant cancerous growth of B or T-cells that is the main basis of NHL. B-lymphomas are more common, accounting for 85% of all cases, compared with 15% of cases from the T-cell origin.

Normal B-cells produce antibodies that guide the immune responses to harmful elements e.g. bacteria. T-cells are involved in the recognition of virus-infected or cancer cells; in organ transplantation it is the T-cell suppression that is necessary to prevent rejection. This immune system suppression, through drugs that kill the T-cells (and the other cells also) results in significant increased risk of NHL in later years. Thus NHL incidence is associated with prior immune suppression, or with substances or exposures that cause or contribute to immune system suppression. There has been a significant increase in the incidence rate of NHL in the last twenty years which has puzzled the international scientific community, resulted in considerable epidemiological and other investigation, and led to many suggestions about its cause. What remains is a general agreement that the origin of this increase is unknown, and that there are many risk factors for NHL, one of which has been conceded to be ionising radiation exposure, although there have also been studies suggesting that ionising radiation is not a major cause. Nevertheless, NHL has been designated as a specified cancer under the Energy Employees Occupational Illness Compensation Plan and is included in the NIOSH-IREP causality system for ionising radiation exposures.

Causes of non-Hodgkin lymphoma

Since the condition begins, like all cancers and leukemias, with a fixed genetic mutation or collection of mutations in a single cell, it is clear that any agent which confers an increased risk of mutation must be a risk factor for the disease. Bende et al (2007) discuss molecular pathways in the development of B-cell lymphoma and conclude that the initiating event for more than 90% of cases of the most common form is a mutation (a chromosome translocation) which leads to expression of an anti-apoptotic protein BCL-2. Ionising radiation is the largest single class of mutagen, and therefore exposure to ionising radiation must contribute excess risk. In children, the association with leukaemia and non-Hodgkin lymphoma has been highlighted in a number of studies of nuclear sites, the most famous being the Sellafield reprocessing site in the UK, but excess risk was also found near other nuclear sites which release uranium and other radioactivity e.g. the Atomic Weapons Establishment Aldermaston (Beral et al 1990). Nevertheless, the literature is confusing on this issue especially with regard to the disease in adults. BEIR V (p329) cite Anderson and Ishida 1964 who found an increased incidence of NHL in the Japanese A-Bomb Lifespan Study (LSS) cohort although later studies by Shimizu et al 1987 (now the RERF group) no longer showed an excess of the disease. I interpret this as a time lag problem with exposure and controls in the Hiroshima LSS cohorts. The lag period for these cancers (lymphomas and leukemias) is believed to be shorter than for the

solid tumours (BEIRV 1990) and so these findings are in agreement with the earlier increases of NHL found by Anderson and Ishida and reported in 1964. By 1987, all those who were going to develop the disease will have done so. Therefore, the implicit conclusions of the BEIRV committee are misleading and perhaps disingenuous. BEIRV do, however, draw attention to significant excess mortality rates of NHL in patients treated with radiation for Ankylosing Spondylitis (Darby et al, 1987); O/E = 2.24. Wagoner, 1984, reported an excess of NHL in women who were treated with ionising radiation for benign gynaecological disorders. More recently Inskip et al, 1992 have reported that NHL risk was *not* elevated in a study of women treated for benign disorders. On the other hand, excess risk was found in women treated with radiation for cervical cancer, RR = 2.5 (90% CI 0.8, 7.6) (Boice et al. 1988). BEIRV, 1990 also draw attention to increased mortality (RR = 2.73) from *lymphosarcoma* (strictly, lymphoma) in US radiologists who entered practice in the 1920s to 1930s , though apparently this excess risk does not exist in more recent radiologist cohorts.

Studies of radon exposure and NHL have given various results. The analysis of non-lung cancer mortality in miners by Darby et al 1995 did not identify excess risk from lymphoma, but the number of cases was only 36 in 1179 cancers, other than lung. However a number of ecological studies of radon and cancer have found excess risk from lymphoma. A discussion in BEIR VI focuses on epidemiology and the biological arguments of Henshaw et al 1990 that the fat solubility of radon will result in increased exposure to cells in the bone marrow and hence increases in leukaemia and lymphomas, which they pointed out could be seen in an ecological analysis of radon exposure by country. I have spoken with Denis Henshaw about this issue and he is sure that radon doses to the bone marrow are significant. Chromosome aberration analysis by Bauchinger et al (1994) of the peripheral lymphocytes of people living in houses where the radon levels were higher than 50Bq m^{-3} did in fact show significant 3-fold excess chromosome damage even at these low exposures, thus supporting Henshaw's arguments. Despite various criticisms, the weight of evidence reported in BEIR VI does seem to support an association between radon exposure and NHL. Supporting the causal link, in the USA, an ecological study by Cohen (1993) using radon concentrations and cancers in 1600 counties also found association between radon and NHL. BEIR VI cites a number of studies which do not, however, find any association with radon exposure and conclude, incorrectly in my opinion given the clear association with chromosome damage, that radon need not be considered as a cause of non-lung cancer illnesses. A recent study by Karunanayake et al[64] found a significant increased risk of NHL with exposure to ionizing radiation (radium) in a case-control study of Canadian men diagnosed with NHL between 1991 and 1994 (adjusted OR: 3.26, 95% CI: 1.38-7.73).

I will now review some of the general epidemiology relating to causation of non-Hodgkin lymphoma and then draw some general conclusions.

McNally and Parker (2006) review environmental factors in the causation of childhood NHL and identify a range of exposures including magnetic fields, pesticides, benzene, maternal alcohol consumption, contaminated drinking water, infections and high birth weight. For NHL they highlight *ionising radiation,* pesticides and *in utero* exposure to cigarette smoke, benzene and nitrogen dioxide. Gurney and Cartwright 2002 studied NHL in England and Wales from 1986-1993 confirming the real increases in the disease, proportionally greater for middle aged men; they suggested that environmental factors

such as sunlight may be responsible. Sunlight was also suggested as a factor by Bentham (1996) who made geographical analyses across areas with different ultraviolet light indices. UV light is, of course both mutagenic and causes immune system suppression. Immune system suppression is certainly a strong cause of NHL: the increase in the disease in people who have been treated with immune suppression drugs for bone marrow or organ transplants and those with inherited immunodeficiencies, has been reported to be as high as 30% (Filipovich et al 1992). This is also true of those who have HIV/AIDS related immunodeficiency who have high rates of NHL, as do those who have been treated with radiation or chemotherapy for an earlier cancer. Patients treated with chemotherapy or radiation for Hodgkin's disease have a 5% excess risk of developing NHL over a ten year period.

Linos et al 1991 found elevated risks of NHL in those living near industrial facilities in Iowa and Minnesota particularly associated with residing near stone, clay or glass industry facilities. Scherr et al (1992) examined occupational risk using a case control study and concluded that excess risks for NHL was associated with working in agriculture, forestry and fishing (RR = 3.0), the construction industry (RR = 2.1), and the leather industry (RR = 2.1). Particular jobs that carried high risk were farmers (RR = unbounded), painters and plasterers (RR = 6.0) and carpenters, brick and stone masons (RR = 12). Johnson et al (2003) studied proximity to industrial plants in Canada and found a significant association with residence near copper smelters and sulphite paper mills. Others have found associations with organic solvents (Rego et al 2002) although a meta-analysis (Lamm et al (2005) concluded that a reported association with benzene (Blair et al 1992) was not supported. Viral exposures, particularly to the Epstein Barr virus also represents a significant causal association but whether the infection is a result of (due to immune system inadequacy) or a cause of the NHL is not established.

Weisenburger (1994) regarded the cause of the NHL 'epidemic' as being a result of many different environmental factors each of low risk acting on large segments of the population, and this seems plausible. However, the largest single exposure element affecting the immune system has been to ionising radiation, from the weapons test fallout components in the food chain which peaked in the environment in the late 1960s early 1970s, and which were supplemented in the USA by releases from the many nuclear sites and by the large amounts of technologically enhanced natural materials (TENORM) increasingly released to the environment with industrial expansion, particularly in the USA where the increase in NHL has been greatest. Occupations which have been particularly associated with NHL are those where there is significant exposure to dusts and respirable particles e.g farmers, carpenters, stonemasons. The association with farming has also been ascribed to the agricultural use of toxic chemicals. In my opinion, and from consideration of the epidemiology and the likely aetiology, it is both the assault on the lymphatic system by inhaled particulate matter, and the suppression of the immune system, which represent the major causal hazards for NHL.

7. NHL in Gulf War and Balkan populations

Cancer in populations exposed to uranium weapons has not been studied adequately, or at all. In Iraq, there are reports of enormous increases in cancer, yet no proper official or believable epidemiological study has been carried out. One study which has been carried

out is that of the Ialian peacekeepers in the Balkans. This apparently showed a 3-fold excess of Hodgkins lymphoma but no increase in Non Hodgkins Lymphoma relative to a national average. Of course, the soldiers were more healthy than the national average so the excess risk can be approximately doubled. However I have obtained more detailed information on this report, and it is clear that although the rates were expressed for all the Balkan peacekeepers, the cancers were manifest only in those who were stationed in Bosnia. This represented about half of the base population, and so we can say that the relative risks reported should be for the Bosnia peacekeepers and should be multiplied roughly by two. In Table 2 I reproduce part of the final 2001 epidemiological report on the Italian peacekeepers in the Balkans which I have obtained from colleagues in Italy. The follow up to this study was considered in 2008 and showed enormous increases in cancer leukaemia and lymphoma and was not released following a decision made in the Italian Parliament. The study is currently being re-examined to ensure that the results are accurate. However, it is clear from the numbers from the first report that I reproduce in Table 2 that there was a significant increase in NHL in Italian veterans who were based in Sarajevo. The numbers are approximately equal to the numbers of Hodgkins cases. In the group diagnosed, the expected background rates aged 25 to 29 are 4.6/100,000 for Hodgkins lymphoma and 3.2 per 100,000 for non Hodgkins lymphoma. Therefore it is clear that there is a significant excess of NHL in this population. When sorted by mission date, it is clear that the numbers of NHL in those deployed in the early post war period are about twice the numbers of Hodgkins cases.
This is relevant to Mr Dornan since he is in this early group.

Table 2 Reproduction of Table 5. *(Tabella 5. Descrizione dei casi accertati al 31/12/2001.)* from the first report of the Italian Government peacekeepers epidemiological study, 2001.

Data 1a Missione	Data diagnosi	Età Diagnosi	Diagnosi	Località Missioni*
04/12/1995	16/12/1996	31	LNH	SARAJEVO
05/01/1996	19/04/2000	44	TM cerebrale	SARAJEVO - BANJA - LUKA
09/01/1996	14/04/2000	39	TM faringe	SARAJEVO (2) - PEC
13/01/1996	16/07/1998	35	LNH	SARAJEVO (3) - KOSOVO
09/05/1996	03/09/1998	28	LH	SARAJEVO
08/06/1996	17/04/2000	29	TM intestino	SARAJEVO
17/06/1996	23/09/1998	24	TM testicolo	SARAJEVO
03/07/1996	27/11/1996	30	LNH	SARAJEVO
24/07/1996	17/12/1999	35	TM laringe	SARAJEVO (2) - KLINA
23/09/1996	18/12/2000	26	LH	SARAJEVO - DAKOVICA (2)
12/10/1996	05/11/1999	25	LNH	SARAJEVO - DAKOVICA (2)
21/10/1996	20/03/2000	56	TM intestino	SARAJEVO
09/12/1996	18/05/1998	29	Melanoma	SARAJEVO
30/12/1996	09/10/2000	41	TM intestino	SARAJEVO (2) - MOSTAR (3)

27/01/1997	02/03/1999	23	LH	SARAJEVO
12/03/1997	06/05/2000	38	Melanoma	SARAJEVO
28/04/1997	01/03/1998	36	LH	SARAJEVO
21/05/1997	21/09/2000	26	TM cerebrale	SARAJEVO
26/08/1997	13/10/1999	26	TM testicolo	SARAJEVO
18/09/1997	02/07/1998	43	TM renale	SARAJEVO
14/10/1997	27/05/1999	22	LLA	SARAJEVO
23/10/1997	15/08/1999	47	TM intestino	SARAJEVO
27/11/1997	05/04/2000	23	Melanoma	SARAJEVO
27/11/1997	06/10/1998	21	TM tiroide	SARAJEVO
13/01/1998	07/04/2000	32	LH	SARAJEVO
01/02/1998	24/07/2000	39	LH	SARAJEVO
03/02/1998	20/04/2001	28	LNH	MOSTAR (2) - DAKOVICA
31/08/1998	22/07/1999	25	LNH	SARAJEVO
02/10/1998	29/06/2000	23	TM bronchi	BANJA LUKA - SARAJEVO
18/11/1998	27/04/1999	23	LLA	SARAJEVO
03/03/1999	21/03/2000	26	TM tiroide	SARAJEVO
01/04/1999	30/11/1999	22	LH	PEC
29/04/1999	10/02/2000	35	TM testicolo	SARAJEVO
13/05/1999	24/02/2000	22	LNH	SARAJEVO
22/05/1999	20/10/2000	22	LH	PEC
07/06/1999	27/11/2000	23	LH	SARAJEVO
24/06/1999	18/01/2001	28	TM testicolo	PEC
02/08/1999	08/02/2001	39	LH	SARAJEVO
05/08/1999	13/07/2000	33	TM tiroide	DAKOVICA
23/09/1999	15/11/2000	29	TM stomaco	SARAJEVO
05/10/1999	30/01/2001	42	LNH	SARAJEVO
21/10/1999	09/05/2000	24	LH	BANJA LUKA
10/02/2000	28/04/2000	47	TM polmone	SARAJEVO
15/02/2000	02/02/2001	22	LH	DAKOVICA

The increases in cancer rates in Sarajevo following the conflict there are alarming. I was in Brussels at a conference on DU in 2002 where I was leaked some figures from the Sarajevo cancer registry
I show these in Table 3 below.

Table 3. Cancer incidence in Sarajevo (Source: Sarajevo Tumour Registry).

Table 1 Cancer incidence in Sarajevo 1996-2000. Cases (crude rates per 100,000). (Source: Sarajevo Tumour Registry)

Tumour Site	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***
Mouth and Throat	*1 (1.1)*	*-*	*--*	*2 (2.1)*	*4 (4.3)*	*4 (4.3)*
Digestive	*15 (16.0)*	*50 (53.2)*	*36 (38.3)*	*55 (58.5)*	*68 (72.4)*	*82 (87.3)*
Respiratory	*12 (12.8)*	*15 (16.0)*	*20 (21.3)*	*34 (36.2)*	*44 (46.8)*	*51 (54.30*
Skin and ligaments	*-*	*2 (2.1)*	*1 (1.1)*	*10 (10.6)*	*8 (8.5)*	*9 (9.6)*
Breast	*3 (3.2)*	*11 (11.7)*	*14 (15.0)*	*29 (30.9)*	*34 (36.2)*	*37 (39.4)*
Urogenic	*8 (8.5)*	*8 (8.5)*	*11 (11.7)*	*18 (19.2)*	*27 (28.7)*	*28 (29.6)*
Eyes	*3 (3.2)*	*-*	*1 (1.1)*	*2 (2.1)*	*1 (1.1)*	*4 (4.3)*
Lymphatic and Blood	*1 (1.1)*	*6 (6.4)*	*1 (1.1)*	*7 (7.4)*	*19 (20.2)*	*26 (27.7)*
Divers	*-*	*1 (1.1)*	*11 (11.7)*	*18 (19.2)*	*11 (11.7)*	*7 (7.4)*
All above	*43 (45.3)*	*93 (99.0)*	*95 (101.0)*	*175 (186.)*	*216 (230)*	*248 (264)*

Since cancer is a disease caused by exposure to carcinogen, these figures certainly point to the existence of a carcinogenic agent in the environment before 1995 when the epidemic began. I have reported this increase in my UN paper (Busby 2009). Although the figures do not separate out the NHL but provide only the combined lymphatic and blood cancers, it is clear that there is a remarkable increase in the incidence of this group of diseases, more than 20-fold from 1995 to 2000. This evidence supports the discovery by the Italian epidemiologists that the rates of cancer in their peacekeepers is alarmingly high.

7. Can this account of Mr Dornan's history be further investigated?

I am assuming that Mr Dornan was exposed to uranium particles and all my arguments are based upon this. If he was, then it is likely that there will still be uranium particles in his body, and he should have a higher level of uranium in his bones and teeth. If he were to die from this disease, and I trust he can survive it, analysis of the tracheobronchial lymph nodes would show the presence of uranium particles. Mr Dornan has not been analysed for Uranium and so we cannot say whether there is evidence which might be useful for his case. However, the MoD funded a urine analysis of the GW1 veterans but this was carried out some 13 years after their exposures and owing to the existence of enriched uranium in the environment, the results were useless. In addition, it is likely that the ceramic uranium particles will not give risk to any uranium in the urine but will

remain *in situ* in the body until death. Despite many suggestions that a deceased Gulf War veteran be analysed by an independent laboratory for DU this has never been done.

8. Valuable evidence from another Balkans veteran

Whilst researching the case of Mr Stuart Dyson for the coroner inquest I came across a report in *The Lancet* which has crucial relevance to the case of Mr Dornan (Ballardie et al 2008).

A team from the UK, directed from the Manchester Royal Infirmary investigated the health problems of a veteran from the Balkans, from Bosnia. This man exhibited most of the symptoms of Gulf War syndrome, but instead of ignoring him or writing him off as a stress case (as the MoD do) they decided to carry out comprehensive tests. Among these were electron microscope and radiological analysis of kidney tissue. They found that the DNA in the kidney was saturated with Uranium and further that the Uranium was significantly enriched. The enrichment gave an atom ratio of about 65. This result strongly supports the belief that there was contamination of Bosnia by Enriched Uranium, presumably from weapons usage, and that the contamination was such that it could become incorporated into human tissue. It follows that Mr Dornan will have been thus contaminated.

8. Conclusions

On the basis of the information I have seen I conclude that Mr Steve Dornan's Non Hodgkin lymphoma was more probably than not a late consequence of his exposure to Uranium aerosols whilst serving in Bosnia

Signed

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Dec 10th 2009

Attached to this report:

1. Dyson coroner case papers (.pdf)
2. My CV

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Nationality: British

FURTHER/HIGHER EDUCATION

Education: 1966-69 Chemistry, University of London

TRAINING AND QUALIFICATIONS

BSc, PhD, C.Chem, MRSC

Qualifications: 1969 University of London First Class Honours Special Degree in Chemistry
1970-71 SRC research studentship for PhD Physical Chemistry (nmr spectroscopy), Queen Mary College, London
1974 Elected Member of Royal Society of Chemistry
1974 Chartered Chemist
1981 PhD Chemical Physics (Raman spectroscopy/electrochemistry) University of Kent, Canterbury

Learned Societies:

Member: Royal Society of Chemistry
Member: Royal Society of Medicine
Member: International Society for Environmental Epidemiology
Member: Ukraine Committee: Physicians of Chernobyl

UK Government Committees

Member: (Department of Health and DEFRA) CERRIE
Committee Examining Radiation Risk from Internal Emitters 2001-2004
www.cerrie.org

Member: Ministry of Defence DUOB
Depleted Uranium Oversight Board
2002-2007
www.duob.org

Other Committees

Scientific Secretary: European Committee on Radiation Risk
www.euradcom.org

Policy Information Network on Child Health and Environment PINCHE
www.pinche.org

1.2 EMPLOYMENT

1969 – 1975	Research physical chemist, Wellcome Foundation, Beckenham
1975 - 1978	Self employed scientific consultant and science writer
1979 - 1981	PhD student University of Kent
1981- 1982	SERC Research Fellow University of Kent
1983- 1992	Self employed scientific consultant and science writer
1992- present	Science Director, Green Audit, commissioned to research the health effects of ionizing radiation and funded by a number of charities and independent bodies.
1995	Funded by the Joseph Rowntree Charitable Trust to write and produce 'Wings of Death- The health effects of low level radiation.'
1997-2000	Directed research at Green Audit Funded by Irish State to research health effects of Sellafield
1997	Appointed UK Representative of European Committee on Radiation Risk (ECRR)
1997	Foundation for children with leukaemia; research on non-ionising radiation
2001	Appointed Scientific Secretary of ECRR and commissioned to prepare the report ECRR 2003- The Health effects of low doses of Ionizing Radiation (Published 2003**)**
2001	Appointed to UK Government Committee Evaluating Radiation Risk from Internal Emitters (CERRIE)
2001	Appointed to the UK Ministry of Defence Oversight Committee on Depleted Uranium (DUOB)
2002	Funded by the Joseph Rowntree Charitable Trust to write a new book on the epidemiological evidence of health consequences of exposure to ionizing radiation: 'Wolves of Water'
2003	Appointed Honorary Fellow, University of Liverpool, Faculty of Medicine, Department of Human Anatomy and Cell Biology
1992-2008	Science Director, Green Audit
2003	Funded by Joseph Rowntree Charitable Trust to write Book *Wolves of Water Cancer and the Environment*
2004	Leader of Science Policy for(EU) Policy Information Network for Child Health and Environment ***PINCHE*** based in Arnhem, The Netherlands
2005	3 year research funding by Joseph Rowntree Charitable Trust; Corporate Responsibility in Science and Policy
2008	3-year research funding from The Joseph Rowntree Charitable Trust; Corporative Responsibility in Science
2008	Appointed Guest Researcher, German Federal Research Laboratories, Julius Kuhn Institute, Braunschweig, Germany
2008	Appointed Visiting Professor, School of Molecular Bioscience, Faculty of Life and Health Sciences, University of Ulster, Coleraine, Northern Ireland

1.3 TEACHING EXPERIENCE

1970	Taught O-level Chemistry part time, Inner London Education Authority
1980-1981	Gave tutorials in quantum mechanics at the Dept. of Chemistry. University of Kent
1995-1997	Invited lecturer at the University of Sussex Dept. of Physics.
1995-1997	Invited lecturer in the University of Wales, `Aberystwyth, Physics Department and Geography Department
2000 – 2005	Invited lecturer in the University of Liverpool Faculty of Medicine SSM5 'Environment and Health' addressing internal radiation risk and cancer epidemiology of small areas.
2005	Invited lecturer University of West of England; Radiation Risk and epidemiology
2006	Invited lecturer: Dept. of Law, University of Wales, Aberystwyth
2006	Invited lecturer: Dept. of Environment, University of West of England
2007	Invited lecturer: Centre for Molecular Bioscience, University of Ulster

1.4 ADMINISTRATIVE EXPERIENCE

Professional Administration:
Senior Scientist
Dept of Physical Chemistry, Wellcome Research Laboratory, Langley Park, Beckenham
Science Director, Green Audit
2004-2006 Leader: Workpackage 6 Science and Policy; PINCHE (EU)

Editorial boards (Current):
European Journal of Biology and Bioelectromagnetics

Invited Reviewer
European Journal of Biology and Bioelectromagnetics
European Journal of Cancer
Journal of Public Health (Royal College of Physicians, School of Public Health)
Science and Public Policy
The Lancet
Occupational and Environmental Medicine (BMJ)

1.5 EXPERT WITNESS

Since 1997 Chris Busby has been engaged as an expert witness in several cases that relate to the effects of radioactive pollution on health, in several refugee appeals (Kosovo) based on Depleted Uranium risks, several trials of activists accused of criminal damage at weapons establishment and one at the House of Commons (evidence on Depleted Uranium and other radioactive substances), one MoD pension appeals tribunal for the widow of a A-Bomb test veteran and once in the Connecticut State Court for an appeal against licensing releases of radioactivity from the Millstone reactor on Long Island Sound. He is currently acting or has recently acted as expert witness on two cases in the UK involving the health effects of internal irradiation from Depleted Uranium. One of these is in the Royal Courts of Justice and also in three cases in the USA. Two of these (against Exxon) have recently been settled. The third, a landmark case involving childhood cancer near a nuclear plant in Florida is currently being appealed in the US Supreme Court. He also advised on the case of Rocketdyne (Boeing) and the Santa Susana Field Laboratory childhood retinoblastoma cluster in Western Los Angeles which was settled in January 2008 and a TENORM radiation case involving Ashland Oil in Martha Kentucky, also two other TENORM cases in Louisiana. He is currently also expert witness and advisor on the UK Atomic Test veteran litigation in the Royal Courts of Justice.

1.6 APPOINTED or INVITED ADVISOR

Various national and supra-national groups have sought advice from or appointed Dr Busby as an advisor on various issues e.g.
Green Group European Parliament; Radiation and Health (Caroline Lucas MEP)
Canadian Government: Uranium and Health (appointed by Alex Atamenenko MCP, British Columbia)
UK Committee on Radioactive Waste Management (invited by Prof Gordon McKerron)
Royal Society Committee on Health Effects of Depleted Uranium Weapons (invited by Prof. Brian Spratt)
US Congressional Committee on Veterans Affairs and Security (Uranium weapons) (invited by Senator Christopher Shays)
UNIDIR Geneva (United Nations Institute for Disarmament Research) (Kirstin Vignard)

1.7 RESEARCH INTERESTS.

Overview of major lines of investigation

Chris Busby spent seven years at the Wellcome Foundation, where he conducted research into the physical chemistry and pharmacology of molecular drug receptor interactions. He subsequently moved to the University of Kent at Canterbury where he studied Laser Raman Spectro-electrochemistry in collaboration with Shell Research and later as SRC Research Fellow, a project which resulted in a PhD in Chemical Physics. He developed and published theoretical and experimental details of silver and gold electrodes with surface array properties which enable acquisition of laser Raman spectra of adsorbed molecules in dilute solution.

In the late 1980s he became interested in the mechanisms of low dose internal irradiation and developed the Second Event Theory, which distinguishes between the hazards of external and internal radiation exposure. In 1995 he was funded by the Joseph Rowntree Charitable Trust to develop his arguments and write 'Wings of Death: Nuclear Pollution and Human Health', an account of the results of his research into radiation and cancer and also into cancer increases in Wales, which he argued were a result of global weapons fallout exposure. In 1997 he became the UK representative of the European Committee on Radiation Risk. His analysis of the increases in childhood leukaemia in Wales and Scotland following Chernobyl was recently published in the journals Energy and Environment and the International Journal of Radiation Medicine.

From 1997-2000 he was funded by the Irish Government to carry out research into cancer incidence and proximity to the coast. In June 2000 he was invited to present evidence to the Royal Society committee on Depleted Uranium and health, and shortly after this was invited to Iraq to measure DU in the country and relate exposure to health effects which followed the Gulf War. In 2001 he was asked to visit Kosovo to investigate the dispersion of DU using field monitoring equipment. He discovered DU in many areas from analytical measurements made on samples he collected (paid for by the BBC) he showed that there was atmospheric resuspension of DU particles. His work and expertise in the field of environmental health and radioactivity was recognised by his appointment to CERRIE a Government committee reporting on the effects of low level radiation on health. Following his evidence to the Royal Society on the effects of Depleted Uranium, he was appointed to the UK Ministry of Defence committee on Depleted Uranium in 2001. He was invited to address the US Congressional Committee on Veterans Affairs of the Health effects of Depleted Uranium in 2002. He is presently also the Scientific Secretary of the European Committee on Radiation Risk and was commissioned to organise the preparation of the new risk model on radiation exposure and to organise the publication of ECRR 2003: The Health Effects of Exposure to low Doses of Ionizing Radiation, published in January 2003 and now translated into and published in French, Russian, Japanese and Spanish. In 2004, he (jointly with two other colleagues) published the *Minority Report of the CERRIE committee* (Sosiumi Press). In 2006 he produced and jointly edited with Prof. Alexey Yablokov of the Russian Academy of Sciences *ECRR2006 Chernobyl 20 Years On*.

Between 2004 and 2006 he was leader of the Science and Policy Interface Group of the EU funded Policy Information Network for Child Health and Environment and organised the discussions and collation of information leading to their final report on the issue which he wrote large parts of. The culmination of this project which involved over 40 scientists and physicians from all major EU countries was the recommendation that as a result of bias in scientific advice to policymakers, all advice committees involving areas of dispute and possible harm to the public should be oppositional committees with reports including all sides of any argument.

From 2006 Dr Busby has been conducting laboratory experiments researching photoelectron emission from Uranium and elements of high atomic number. He is currently co-supervising a researcher at the Centre of Molecular Biosciences in the University of Ulster on this.
He is also currently engaged in experimental and theoretical development of a novel theory of living systems and their origin.

1.8 RESEARCH EXPERIENCE

Dr Busby's early research was in the Physical Chemistry aspects of molecular pharmacology at the Wellcome Research Labs. This involved the use of spectroscopic and thermodynamic methods for examining cell drug interactions at the molecular level. For a year he began a research degree in NMR on molecular conformational changes on protonation but left to return to Wellcome and resume his drug interaction research. From there he moved to developing descriptions of intercellular and intracellular communication mechanisms, a subject which he is still engaged in researching in the laboratory. Later he moved to examining molecular behaviour at charged interfaces and developed a Surface Raman spectroelectrochemical method as a Science Research Council Fellow at the University of Kent.

Between 1992 and 2004 Dr Busby was engaged in research in three areas associated with ionising radiation and health and also was funded for a year (1997) by the *Foundation for Children with Leukemia* to research the interaction between non ionising radiation and ionising radiation. His research in the area of ionising radiation has been split between the development of theoretical descriptions of radiation action on living cells and the epidemiology of cancer and leukaemia in small areas. After 1994 he conducted survey epidemiology of Wales and England and was the first to point out (in a letter to the British Medical Journal) that increases in cancer in Wales might be related to weapons fallout. Later he examined childhood leukaemia mortality near the Harwell and Aldermaston nuclear sites and suggested that the excess risk might be related to inhalation of radioactive particles. These results were also carried in a research letter in the BMJ which attracted considerable criticism. His description of the mode of radiation action from sequential emitters (his Second Event Theory was developed originally in 1987) has attracted a great deal of interest and also criticism. Between 1997 and 2000 he was funded by the Irish State to carry out epidemiological studies of cancer rates and distance from the Irish Sea using data from Wales Cancer Registry and through a collaboration with the Irish National Cancer Registry. Following this he and his team in Green Audit developed novel small area questionnaire epidemiological methods and

applied them to a number of areas in different studies which included Carlingford Ireland, Burnham on Sea in Somerset and Plymouth, Devon and Trawsfynydd, Gwynedd, Wales, which resulted in a TV documentary in 2004. In addition he carried out cancer mortality small area studies in Somerset and later in Essex. He extended these to wards in Scotland in 2002. He has supervised a PhD student, who has subsequently graduated, at the University of Liverpool in the Faculty of Medicine in an epidemiological study of cancer mortality in Scotland with regard to proximity to putative sources of cancer risk. In all the small area studies he carried out it was possible to show a significant effect of living near radioactively contaminated intertidal sediment. The papers and reports were all published by Green Audit and most have been presented by invitation at learned conferences in Europe including through invitations by the Nuclear Industry itself.

In addition to this, in 1998 Busby set up a radiation measurement laboratory and equipped it with portable alpha beta and gamma measuring systems including a portable gamma spectrometer made in Dresden which uses a 2" NaI detector. He used these to show the presence of Depleted Uranium in Southern Iraq in 2000 when he was invited by the Al Jazeera TV channel to visit the country as a consultant and examine the link between leukaemia in children and levels of Depleted Uranium. In 2001 he visited Kosovo with Nippon TV and was the first to show that DU was present in dust in towns in Western Kosovo and through isotope measurements funded by the BBC was able to report to the Royal Society in 2001 and the EU Parliament in Strasbourg that DU became resuspended in dry weather and was rained out, and that it remained in the environment for a considerable time. This subsequently led to UNEP deploying atmospheric particle measuring equipment in areas where DU had been used. More recently, from 2006, Dr Busby has been developing laboratory methods for measuring radiation conversion and amplification by high atomic number micron diameter metal and metal oxide particles (Uranium, Gold). It is his recent contention that such particles amplify background radiation effectiveness by photoelectron conversion and he is the author of a provisional patent application for the use of photoelectrons in cancer therapy to destroy tumours.

In 2005 he was invited by various organisations in New Zealand (NZ Royal Society) to give evidence on the health effects of Depleted Uranium. In 2005 and 2006 he worked with Prof Alexey Yablokov on the ECRR2006 report on Chernobyl which was published on the 20th anniversary of the accident. Most recently he has conducted a study of the health of people living in the vicinity of the Trawsfynydd Nuclear plant in Wales for HTV and also a study of the veterans of the Porton Down human experiments in the 50s. The results of the Porton Down veterans study led to a settlement and an apology by the government to the veterans in 2008. In 2007 he began epidemiological studies of the children of A-Bomb Test veterans and also of people living near mobile phone base stations. The A-Bomb veterans epidemiology study highlighted high rates of miscarriage and congenital illness in their children and grandchildren. The results were presented to the House of Commons committee investigating this issue in November 2007 and have led to a recent agreement by the UK government to fund further epidemiological research on this issue, research which Dr Busby will oversee on behalf of the Test Veterans. He is currently an expert advisor on the Test Veterans' litigation and official scientific advisor to the British Nuclear Test Veterans' Association. He was

appointed Visiting Professor in the School of Molecular Biosciences in the University of Ulster in 2008 where he is co-supervising research on the health effects of uranium. His research on uranium and genetic damage was the main news story in the New Scientist of 6th September 2008. Also in 2008 he was appointed Guest Researcher at the German Federal Government Julius Kuhn Institute in Braunschweig where he is co-supervising research on Uranium uptake in plants.

1.9 INVITATIONS TO SPEAK.

Year	Place, Subject etc.
1995	House of Commons. Symposium on Low Dose Radiation
1995	Jersey, Channel Islands: International conference on nuclear shipments; Health effects of low dose radiation
1995	Oxford Town Hall: Low dose radiation effects
1995	Drogheda, Ireland: Sellafield effects
1997	Strasbourg EU Parliament: Euratom Directive
1997	Brussels, EU Parliament STOA workshop on criticisms of ICRP risk models
1997	Kingston Ontario: World Conference on Breast Cancer: paper on cohort effects and weapons fallout
1998	Muenster, Germany, International Conference on Radiation: Second Event effects
1998	Manchester Town Hall, Ethics and Euratom
1999	Copenhagen: Danish Parliament: Euratom Directive and low dose effects
1999	Carlingford, Ireland: Sellafield effects
2000	Kos Island: ASPIS (EC) meeting on 'Is cancer an environmental effect'; low dose radiation and cancer
2000	London: Royal Society: low dose effects and Depleted Uranium
2001	Strasbourg: Green Group; Health effects of Depleted Uranium
2001	Bergen: International Sellafield conference, Sellafield effects on health
2001	Oslo: Nobel Institute: Health effects of low dose radiation and DU
2001	London: Royal Society: Health effects of Depleted Uranium (again)
2001	Kiev: WHO conference on Chernobyl: paper on infant leukaemia
2001	Prague: *Res Publica* International Conference on Depleted Uranium
2001	Strasbourg: EU Parliament, with UNEP; Health effects of Depleted Uranium
2002	Bergen: Conference on Sellafield
2002	Helsinki: Health effects of low dose radiation
2002	London: US Congressional Committee on National Security: Gulf war syndrome and Depleted Uranium
2002	London Greenpeace: Small area statistics and radiation effects
2002	Chilton: Health effects of radioactive waste
2002	Oxford, British Nuclear Energy Society: Effects of low doses of radiation
2002	Royal Society of Physicians: Small area health statistics and radiation
2003	Birmingham: Non ionising radiation. Chaired

2003	Liverpool University: Depleted Uranium and Health
2003	Oxford University: Health Effects of Radiation from Internal Emitters
2003	Munich: Whistleblowers
2003	Copenhagen: Radiation and the foetus
2003	Hamburg: Depleted Uranium
2004	Berlin: Low level radiation
2004	London: PINCHE, child health and environment
2004	London, Westminster: Children with leukaemia
2004	Chicago: Radiation studies
2005	New Zealand Royal Society, Wellington
2005	New Zealand, Auckland University
2005	Chicago: Small area epidemiology by citizen groups
2005	Salzburg, Austria. PLAGE; International Nuclear Law and Human Rights
2005	Stockholm, Swedish Parliament; Low Dose Radiation and Depleted Uranium
2006	ECRR, Charite Hospital, Berlin, Health effects of the Chernobyl Accident
2006	Hiroshima Japan, Depleted Uranium
2007	Kuala Lumpur, Depleted Uranium: War Crimes Tribunal
2007	London, House of Commons: Chernobyl and health; anniversary lecture.
2007	London: Safegrounds Nuclear Industry CIRIA conference; low dose effects
2007	Blackpool: A-Bomb Veterans and low dose radiation effects
2007	University of Ulster: Childhood leukaemia in Ireland and Sellafield
2007	Hanover: Federal Agricultural Laboratories; Uranium chemistry and physics
2007	Geneva: United Nations. Health effects of Uranium weapons
2007	Geneva: United Nations. Chernobyl: WHO and the IAEA
2007	London, House of Commons Select Committee: Nuclear Test Veterans Children Epidemiology study
2007	London, Royal Society: Science Policy Advice and Scientific Dishonesty
2008	Ljubljana Slovenia: Parliament; Nuclear Energy and Human Health
2008	Malmo Sweden; Uranium and health- new discoveries
2008	Helsinki; Chernobyl effects
2008	Moscow, Russian Academy of Sciences; A new theory of living systems.
2009	Stockholm; Parliament. Inadequacy of current radiation models and laws
2009	Greece, Lesvos. Criticisms of current radiation risk system
2009	Riga, Latvian Academy of Sciences: Radiation Risk, the New Era Begins
2009	Stockholm: Final repository for nuclear waste
2009	Arusha Tanzania: Health Hazards of Uranium
2009	Dar es Salaam, Tanzania: Health Hazards of Uranium Mining

2. PUBLICATIONS AND SUBMITTED PAPERS

PEER REVIEWED PAPERS.

Busby Chris, Lengfelder Edmund, Pflugbeil Sebastian, Schmitz Feuerhake, Inge (2009) The evidence of radiation effects in embryos and fetuses exposed by Chernobyl fallout and the question of dose response. *Medicine, Conflict Survival* 25(1) 18-39

Busby Chris (2008) Is there a sea coast effect on childhood leukaemia in Dumfries and Galloway, Scotland, 1975-2002 ? *Occupational and Environmental Medicine* 65, 4, 286-287

Busby Chris and Schnug Ewald (2008) Advanced biochemical and biophysical aspects of uranium contamination. In: (Eds) De Kok, L.J. and Schnug, E. *Loads and Fate of Fertilizer Derived Uranium.* Backhuys Publishers, Leiden, The Netherlands, ISBN/EAN 978-90-5782-193-6.

Busby C C and Howard CV (2006) **'**Fundamental errors in official epidemiological studies of environmental pollution in Wales' *Journal of Public Health* March 22nd 2006

Busby C and Fucic A (2006) Ionizing Radiation and children's health: PINCHE conclusions *Acta Paediatrica* S 453 81-86

Van den Hazel P, Zuurbier M, Bistrup M L, Busby C, Fucic A, Koppe JG et al (2006) Policy and science in children's health and environment: Recommendations from the PINCHE project. *Acta Paediatrica* S 453 114-119

Koppe JG, Bartonova A, Bolte G, Bistrup ML, Busby C, Butter M et al (2006) Exposure to multiple environmental agents and their effects. *Acta Paediatrica* S 453 106-114

Van den Hazel P, Zuurbier M, Babisch W, Bartonova A, Bistrup M-L, Bolte G, Busby C et al, (2006) 'Today's epidemics in children: possible relations to environmental pollution' *Acta Paediatrica* S 453 18-26

Busby CC (2005) Does uranium contamination amplify natural background radiation dose to the DNA? *European J. Biology and Bioelectromagnetics.* 1 (2) 120-131

Busby CC (2005) Depleted Uranium Weapons, metal particles and radiation dose. *European J. Biology and Bioelectromagnetics.* 1(1) 82-93

Busby CC and Coghill R (2005) Are there enhanced radioactivity levels near high voltage powerlines? *European J. Biology and Bioelectromagnetics.* 1(2) Ch 7.

Busby Chris and Bramhall Richard (2005) Is there an excess of childhood cancer in North Wales on the Menai Strait, Gwynedd? Concerns about the accuracy of analyses carried out by the Wales Cancer Intelligence Unit and those using its data. *European J. Biology and Bioelectromagnetics.* 1(3) 504-526

Busby Chris and Morgan Saoirse (2005) Routine monitoring of air filters at the Atomic Weapons Establishment Aldermaston, UK show increases in Uranium from Gulf War 2 operations. *European J. Biology and Bioelectromagnetics* 1(4) 650-668

Busby C.C (2002). 'High Risks at low doses.' *Proceedings of 4th International Conference on the Health Effects of Low-level Radiation: Oxford Sept 24 2002.* (London: British Nuclear Energy Society).

Busby, C. C. and Cato, M. S. (2000), 'Increases in leukemia in infants in Wales and Scotland following Chernobyl: evidence for errors in risk estimates' *Energy and Environment* 11(2) 127-139

Busby C.,(2000), 'Response to Commentary on the Second Event Theory by Busby' *International Journal of Radiation Biology* 76 (1) 123-125

Busby C.C. and Cato M.S. (2001) 'Increases in leukemia in infants in Wales and Scotland following Chernobyl: Evidence for errors in statutory risk estimates and dose response assumptions'. *International Journal of Radiation Medicine* 3 (1) 23

Busby Chris and Cato, Molly Scott (1998), 'Cancer in the offspring of radiation workers: exposure to internal radioisotopes may be responsible.' *British Medical Journal* 316 1672

Busby C, and M. Scott Cato, (1997)`Death Rates from Leukemia are Higher than Expected in Areas around Nuclear Sites in Berkshire and Oxfordshire', *British Medical Journal*, 315 (1997): 309.

Busby, C. (1994), `Increase in Cancer in Wales Unexplained', *British Medical Journal*, 308: 268.

Busby C and Creighton JA (1982)' Factors influencing the enhancement of Raman spectral intensity from a roughened silver surface'. *J.Electroanal. Chem.* 133 183-193

Busby CC and Creighton JA (1982)' Efficient silver and gold electrodes for surface enhanced Raman spectral studies' *J. Electroanal Chem* 140 379-390

Busby CC (1984*) J.Electroanal Chem* 162 251-262

Busby CC (1984) 'Voltage Induced intensity changes in surface Raman bands from silver electrodes and their variation with excitation frequency'. *Surface Science* 140 294-306

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Busby, C. C. (1992), Low level radiation from the nuclear industry: the biological consequences. (Aberystwyth: Green Audit)

Busby C.C (1992) Peledriad isaf o'er diwydiant niwcliar: yr canleniadau biolegol. (Aberystwyth: Green Audit)

Busby, C. C. (1994), Radiation and Cancer in Wales (Aberystwyth: Green Audit).

Busby, C. C. (1995), *Wings of Death: Nuclear Pollution and Human Health* (Aberystwyth: Green Audit)

Busby C.C (2003) ed with Bertell R, Yablokov A, Schmitz Feuerhake I and Scott Cato M. *ECRR2003: 2003 recommendations of the European Committee on Radiation Risk- The health effects of ionizing radiation at low dose--Regulator's edition.* (Brussels: ECRR-2003)
2004 Translations of the above into French Japanese Russian and Spanish (see www.euradcom.org for details)

Busby CC, with Bramhall R and Scott Cato MS (2000) *I don't know Much about Science: political decision making in scientific and technical areas.* Aberystwyth: Green Audit (this book influenced the structure and formation of the CERRIE committee and advocates an oppositional structure to science advisory committees in order to allow for cultural bias in science advice. It has now been carried forward by PINCHE in Europe.).

Busby CC, Bramhall R and Dorfman P (2004) *CERRIE Minority Report 2004: Minority Report of the UK Department of Health/ Department of Environment (DEFRA) Committee Examining Radiation Risk from Internal Emitters (CERRIE)* Aberystwyth: Sosiumi Press

Busby CC and others (2004) Report of the Committee Examining Radiation Risk from Internal Emitters (CERRIE) *Chilton, UK: National Radiological Protection Board*

Busby C and Yablokov AV (2006) ECRR 2006. Chernobyl 20 year On. The health Effects of the Chernobyl Accident. Brussels: ECRR/ Aberystwyth: Green Audit

Busby Chris (2006) *Wolves of Water. A Study Constructed from Atomic Radiation, Morality, Epidemiology, Science, Bias, Philosophy and Death.* Aberystwyth: Green Audit

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Busby, C. C. (1996*a*), ' in Bramhall, R. (ed.), *The Health Effects of Low Level Radiation: Proceedings of a Symposium held at the House of Commons, 24 April 1996* (Aberystwyth: Green Audit).

Busby, C. C. (1998), 'Enhanced mutagenicity from internal sequentially decaying beta emitters from second event effects.' In 'Die Wirkung niedriger Strahlendosen- im kindes-und Jugendalter, in der Medizin, Umwelt ind technik, am Arbeitsplatz'. Proceedings of International Congress of the German Society for Radiation Protection. Eds: Koehnlein W and Nussbaum R. Muenster, 28 March 1998 (Bremen: Gesellschaft fur Strahlenschutz)

Busby C.C and Scott Cato M (1999) 'A Planetary Impact index' in Molly Scott Cato and Miriam Kennett eds. *Green Economics- beyond supply and demand to meeting peoples needs.* Aberystwyth: Green Audit

Busby C (2004) Depleted Science: the health consequences and mechanisms of exposure to fallout from Depleted Uranium weapons. In *The Trojan Horses of Nuclear War* Kuepker M and Kraft D eds. Hamburg: GAAA

Busby Chris (2007) New nuclear risk models, real health effects and court cases. Pp 35-46 in- *Updating International Nuclear Law* Eds—Stockinger H, van Dyke JM *et al.* Vienna: Neuer Wissenschaftlicher Verlag

Busby C (2008) Depleted Uranium. Why all the fuss? *United Nations Disarmament Forum Journal UNIDIR, Nov 2008*

ARTICLES

Numerous articles for 'The Ecologist' on low dose radiation effects have been translated into most languages and reprinted.

Numerous articles and reports in *Radioactive Times: the Journal of the Low level Radiation Campaign*

Main Green Audit published papers

Busby C and Scott Cato M (2001) *Increases in leukemia in infants in Wales and Scotland following Chernobyl: Evidence for errors in statutory risk estimates and dose response assumptions. Kiev WHO conference paper.* Occasional Paper 2001/7. Aberystwyth: Green Audit

Busby C C, Bramhall R and Dorfman P (2001) *Environmental risk methodology and Breast cancer mortality near Bradwell nuclear power station in Essex 1995-1999. Occasional Paper 2001/8* Aberystwyth: Green Audit

Busby C C, Kaleta R and Rowe H (2000), *The effects of Sellafield on cancer incidence in Ireland from 1994 to 1996. Analysis of national Cancer Registry small areas data.*, Report 2000/12 (Aberystwyth: Green Audit)

Busby C, (1994), 'Investigation of the Incidence of Cancer around Wylfa and Trawsfynydd Nuclear Installations, 1974-86- Welsh Office Report A-EMJ28. An appraisal for Wales Green Party', Aberystwyth: Green Audit

Busby C, Dorfman P, Rowe H (2000) *Cancer Mortality and Proximity to Hinkley Point Nuclear Power Station in Somerset: Part I Breast Cancer*. Occasional Paper 2000/2 Aberystwyth: Green Audit

Busby C, Dorfman P, Rowe H (2000) *Cancer Mortality and Proximity to Hinkley Point Nuclear Power Station in Somerset: Part II Prostate Cancer*. Occasional Paper 2000/3 Aberystwyth: Green Audit

Busby C, Dorfman P, Rowe H (2000) *Cancer Mortality and Proximity to Hinkley Point Nuclear Power Station in Somerset: Part III All malignancies, lung and stomach cancer. Summary* Occasional Paper 2000/4 Aberystwyth: Green Audit

Busby C, Rowe H (2000) *Cancer Incidence in Carlingford and Greenore, County Louth: Results of the STAD/ Green Audit Questionnaire* Report 2000/06 Aberystwyth: Green Audit

Busby C.C (2000), Science on Trial: On the Biological Effects and Health Risks following exposure to aerosols produced by the use of Depleted Uranium weapons. Invited presentation to the Royal Society, London July 19th 2000 and also given at the International Conference against Depleted Uranium, Manchester 4th November 2000.Occasional Paper 2000/10

Busby C.C (2001) ' Depleted Uranium in Kosovo: Review of UNEP Report of 13th March 2001' Occasional Paper 2001/3 *Aberystwyth: Green Audit*

Busby C.C (2001) *Health Risks following exposure to aerosols produced by the use of Depleted Uranium Weapons. Presentation to Res Publica International Conference Prague 24th Nov 2001. Occasional Paper 2001/12* (Aberystwyth Green Audit)

Busby C.C (2002) 'Review of the Home Office statement on the health Consequences of exposure to Depleted Uranium in Kosovo' Report 2002/2 *Aberystwyth: Green Audit*

Busby C.C, (2000) *Radiation from Sellafield and Cancer near the Irish Sea. The Second Annual progress report from the Irish Sea Group in support of the litigation* Short and Others vs BNFL and Others Aberystwyth: Green Audit

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