Submission on Appendix E10: Air Quality Report

Mike Kantey, Watercourse cc

1. INTRODUCTION

1.1.1 Nuclear Power Technologies

It has been our contention from the beginning that no truly scientific assessment can be possible of the environmental impact of a nuclear power station if that station is not clearly identified. Indeed, this point was accepted in the Scoping Issues Report at page 86, in answer to a question raised by Graham Noble of the Greater Cape Town Civic Alliance:

> An EIA provides information on an incremental basis, as it becomes known. Once a Pressurised Water Reactor (PWR) plant type has been selected by Eskom, **the kind of technical detail that is requested will be made available in the public domain and, indeed, will be assessed in the EIA.** [emphasis mine]

At page 15 in the current Draft Environmental Impact Report for Nuclear-1 (hereinafter called "the draft EIR"), however, and after a long and fruitless discussion of the different types of nuclear technology found worldwide, we discover no more than a brief mention of four relevant technologies:

> The plant types found under the PWR category include:
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> EPR;
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> AP1000;
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> RSA1000; and
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> VVER1000.

Nowhere else is the actual technology referred to, but rather reference is made to the existing Koeberg Nuclear Power Station (KNPS), a much older version and design of the Pressurised Water Reactor (PWR) by some thirty years, and to the much vaunted but redundant Pebble Bed Modular Reactor (PBMR) – an entirely different design altogether. Even when the emissions from the EPR and AP1000 are provided in a comparative table, it makes no sense again, since none of these reactors have been built and are actually running, anywhere in the world.

Furthermore, the literature shows that – in order to build 4 000 MW of capacity – the proposed site would require two EPRs or three AP1000s, thus automatically requiring a very different set of environmental impacts in construction alone, let alone actual routine operation. At no stage is this tangible difference in design and operation demonstrated in the draft EIR.

In a letter addressed by Deouty Diector-General Joanne Yawitch of the Department of Environment Affairs and Tourism to Tim Liversage of Arcus Gibb, and copied to Deirdre Herbst of Eskom, on 19 November 2008, the following observation is made:

2.27 Human Health Risk Assessment

2.27.1 A risk assessment would require plant-specific and site-specific data not available at present and therefore it is not feasible to include this as part of the EIA. It is recommended that the report could refer to R388 on Safety

It follows from this remark that the department itself is not at liberty to discuss the potential impacts on human health in this phase of the EIA, for lack of evidence. What we require for a scientific assessment, therefore, is an opportunity to test the proposed technology in a real-time situation and to have tangible measurements with regard to air quality actually measured by truly independent scientists and engineers. Any desk-top study or computer modelled suggestion of a data set by the very people who stand to gain the most material gain from the successful implementation of this project can hardly said to be scientifically independent.

We would further like to take this opportunity to refer to a resolution taken by the St Francis Bay Ratepayers Association on 2 November 2009 and sent to the then Department of Environmental Affairs and Tourism, where reference is made to the need for full information in respect of public participation, as laid down by the Constitution, the National Environmental Management Act and relevant regulations. It is my foremost submission, therefore, that the current version of the draft EIR has in itself a fatal flaw in this regard, a flaw which – at its very outset failing to meet the rigorous demands of the regulatory framework– then proceeds to permeate the entire report with its erroneous assumptions, and which further renders much of its own contentions superfluous.

1.1.2 Legislative Framework

On page 16 of the Draft EIR, reference is made to the "The International Basic Safety Standards for Protection against Ionising Radiation and for the Safety of Radiation Sources (BSS) (IAEA, 1996)", which is claimed to have established the "basic and detailed requirements for protection against the risks associated with exposure to radiation and for the safety of radiation sources that may deliver such exposure." These standards are further proclaimed to have been based –

> ... primarily on the 1990 Recommendations of the International Commission on Radiological Protection (ICRP) (ICRP, 1990) and other International Atomic Energy Agency (IAEA) Safety Series publications. The BSS (IAEA, 1996) place requirements on both the Regulatory Authority and on the legal person responsible for a source. These requirements and the procedures required to fulfil them are outlined in more detail by the IAEA (2000).

Although rarely reported in the mainstream media, some controversy exists with regard to the IAEA and the ICRP's complicit role in white-washing the harmful effects of low-level ionising radiation on human health. Given their prior mission to promote the expansion of nuclear technology worldwide, it has been alleged that they have more often than not actively glossed over the public harm derived from the continued development of nuclear weapons, depleted uranium ordnance, and civilian power plant operations (including the travesty of Chernobyl in April 1986). It is of some considerable significance at least, that the conventional function of the World Health Organisation has been usurped in this regard.

This is not a controversy that we want to enter into on this occasion, but suffice it to say that – in an allegedly independent enquiry into the environmental impacts of a conventional nuclear power reactor – an attempt to appeal to "the authorities" does not constitute proper science in my opinion. One only has to ask the question as to whether the Catholic Church "authorities" or the objective and learned scientist Galileo Galilei himself was "right" with regard to the movement of the sun relative to the earth. An appeal to "authority" seems to us a poor excuse for an independent investigation of this nature – especially when human lives, fully functioning regional economies, and actual livelihoods are at risk from a non-scientific, politically or economically motivated decision.

1.2 Study Approach

1.2.1 Terms of Reference

On pages 18 and 19 of the EIR, a list of the issues to be considered has been provided by the specialist with regard to Arcus Gibb's Scoping Report:

- Identify sensitive receptors (e.g. residential areas) and potential impacts on air from both non-radioactive and radioactive air emissions;
- The receptors to be identified should include ecological (non-human) as well as human receptors;
- Establish an emissions inventory, conduct dispersion simulations and health risk impacts through cross-reference to the human health risk specialist assessment study;
- Detailed analyses of the atmospheric dispersion potential, current air quality (using available air quality data) and syntheses of legal and health criteria;
- Assess the contribution of the atmospheric pathway to a human health impact through cross-reference to the human health risk specialist assessment study;
- Assess the intensity of the expected impacts, based on existing information along the routes;
- Simulate emissions using NNR approved atmospheric dispersion model/s;

  [Page 19]

- Address the assumption that insignificant amounts of radionuclides would be released during the decommissioning and closure phases.
- Detailed assessment of the radionuclide content of ventings and purgings; decay periods involved; whether or not they could be cumulative; types of radiation predicted; and potential impact on surrounding communities;
- Assessment of potential radionuclide emissions during malfunction or accident, to determine time frames and significance of risk;

  [NOTE: The last bullet on page 19 ends on "and ..." – which lacuna suggests an over-hasty edit or production of the report.]

While admirable in its scope, the issues do not address directly my own checklist provided on page 51 of the Scoping Issues Report, and we hereby reproduce the relevant submission for comparative purposes:

4.2. ... what is the nature of that "impact" w.r.t.:

(a) conventional operation, in terms of

(i) liquid effluent; and

(ii) gaseous, or airborne emission, and

(b) unscheduled releases of:

(i) liquid effluent, and

(ii) gaseous, or airborne emissions

4.3 Can we have these impacts declared in terms of Bq/m^3 with regard to:

(a) Strontium-90;

(b) Iodine-131, and

(c) Cesium-137?

4.4 Can we further have these impacts benchmarked in terms of

(a) dairy products, especially milk?

(b) filter feeders, especially black, and white mussels, and abalone?

(c) lamb, mutton, beef, and pork?

(d) fruit and vegetables?

Once again, these datasets are very specific and designed to address the most long-lived isotopes escaping in gaseous emissions and effluents. They are equally specific in targeting foodstuffs, the pathway likely to lead to ingestion, as opposed to inhalation. Yet, the report is silent throughout in this regard and – when an attempt was made to put the matter back on the issues trail at the recent Public Meeting in Bredasdorp (March 2010) – Eskom Stakeholder Manager Ms Carien de Villiers tried to gloss over the point with some irrelevant Power Point presentation, prepared before the question was even asked, or put back on the table.

We submit, therefore, that the really important issues: emissions and effluents, as well as their impacts on foodstuffs, have been scoped out of the report altogether. Furthermore, where they might have posed some real challenges for the proponents in terms of hard, scientific evidence (so-called "show stoppers"), the issues have then been further deferred by legislative sleight-of-hand through a "Co-operative Agreement" between the Minister of Energy (the Honourable Ms Dipuo Peters, MP) and the Minister of Water and the Environment (the Honourable Ms Bujelwa Sonjica, MP) – both known supporters of nuclear power – to the National Nuclear Regulator, with the Minister of Energy having the final say in the event of a dispute.

This "legislation by stealth" is reminiscent of the days of the Apartheid State, when uncomfortable legal realities were taken out of the public domain by Ministerial *diktat*.

1.2.2 Methodological Overview

> [page 21]
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> The impact of radio-nuclides is assessed in a similar fashion as non-radioactive substances, i.e. comparison to a "dose limit" (8) and/or the application of cancer risk factors to individual nuclide concentrations and deposition rates. Furthermore, radionuclide exposure calculations require the summation of effective doses through all pathways, including inhalation, external radiation (i.e. immersion in a cloud containing radionuclides and irradiation from surface soils containing radionuclides) and ingestion. **<u>This study focuses only on inhalation, immersion in a cloud and irradiation from surface soils.</u>** The ingestion pathway (water and food) is dealt with in the overall health risk study using the air concentration and deposition rates results from this study.

The challenge here is not to the assessment of risk, which is fair enough, but to the data sets on which such a calculation is based. Without such hard-data sets, as suggested in this submission above, any attempt at such a calculation is meaningless. What we see here is a backwards determination of risk, where the assumed impact overall is first given as an assumption. This in itself glosses over the specific impact to a specific group of cell nucleii from a specific isotope, but rather averages out the impact over a whole ADULT body. It also begs the question of impacts *in utero* to a fast-growing foetus, as well as a steady growing child in the 0-14 year-old cohort. Once the overall impact has been considered, the actual limit is set in stone, as if – Chernobyl, Sellafield and Three Mile Island notwithstanding – those limits will never be exceeded.

The international standards for "dose limits" have thus come under steady fire since 1942 and have become smaller and smaller in scale, tending to zero in fact, with regard to the "low-threshold dose" theory. To cite only one scientific article in the literature, see for example Christopher C. Busby, 2009: "Very Low Dose Fetal Exposure to Chernobyl Contamination Resulted in Increases in Infant Leukemia in Europe and Raises Questions about Current Radiation Risk Models" in the *International Journal of Environmental Research and Public Health,* Volume 6. www.mdpi.com/journal/ijerph]

What is far more disturbing, however, is the deliberate exclusion of pathways through the food chain (ingestion), since it appears that Cesium-137 and Strontium-90 both have a half-life close to thirty years and therefore tend to accumulate in the environment over many decades. Moreover, scientific evidence around Koeberg Nuclear Power Station and in the Gulf of Mexico has been led to show that radio-active isotopes can become concentrated in especially abalone and black mussels, since they operate as filter feeders. It logically follows, therefore, that some consideration should be given in the Marine Biology Specialist Report to this end, but again and again, whenever a "show-stopper" may appear to intrude into the blithe tranquillity of the report, you will not find any such evidence led.

It may be, furthermore, that the very nature of the scientific paradigm at issue here is flawed: more 19th Century structural-functionalist – and therefore reductionist by definition – rather than operating according to a Twenty-First Century "holistic" and eco-systemic approach. Thus, what ought to have been conducted as a well-rounded, systematic, and ecologically sound approach to an environmental impact assessment in the truest sense of the phrase, ends up being a piece-meal and shabby attempt to pull off yet another Public Relations stunt, only serving to overwhelm the long-suffering public in irrelevant and meaningless red herrings. Nevertheless, we shall pursue this process as faithfully as we might.

[page 22]

The effective dose calculation followed the methodology presented in the IAEA Safety Report No. 19 (IAEA, 2001). This report provides the information necessary to allow the legal person responsible to "make an assessment of the nature, magnitude and likelihood of the exposures attributed to the source" (IAEA, 1996). It provides a practical generic methodology for assessing the impact of radionuclide discharges in terms of the resulting individual and collective radiation doses. This methodology allows for the specification and use of site-specific climatic and environmental conditions and is therefore not restricted to specific locations.

While admirable in its intentions, this still begs the question of what the actual airborne emissions and liquid effluents will be, measured in Becquerels per annum, with particular reference to long-lived Strontium-90 and Cesium-137. If any calculations are then to be done, at least we have an agreed base of assumptions.

1.2.3 Assumptions and Limitations

[page 22]

(a) Baseline Air Concentration Data

(i) Radiation Observations

On-site radiation dose measurements at Koeberg NPS for the period 1984 – 2006 were provided by Eskom for the assessment. The NNR 2009 Annual Report was used to supplement these dose values for the period including 2008. Radiation measurements from Eskom's Environmental Surveillance Programme, which covers [page 23] a larger area, were also made available for the study. The programme monitors natural radio-nuclides in terrestrial samples. These observations are useful for comparative purposes against the predicted dose values for the current Koeberg NPS.

Cumulative impacts will be quantified at the Duynefontein Site, thereby taking into consideration the existing radio-nuclide emissions from the Koeberg NPS and the proposed Pebble Bed Modular Demonstration Power Plant (PBMR DPP). The impact of the proposed NPS at the other two sites was assessed according to incremental dose, as stipulated by the NNR.

Given the alleged collapse of the PBMR programme in South Africa, this last observation hardly seems necessary and further betrays a lack of editing and review of the document. We also cannot verify Eskom's data set independently, but would nevertheless like to see all the data sets in the EIR, including the years to 2008, as well as the terrestrial samples, and in all designated foodstuffs. Taking data from the NNR Annual Report can hardly be considered helpful, since they only describe the projected dose in humans in microSieverts, an educated guess at best. We need to know environmental impacts in Becqeurels per annum; Becquerels per cubic metre in effluents and airborne emissions; and Becquerels per kilogram or per litre (i.e. fresh milk) of specified foodstuffs.

[Page 23]

A three-month monitoring campaign (March 2009 to May 2009) has been included in the study to determine baseline sulfur [sic] dioxide and nitrogen dioxide air concentrations at all three sites.

It would be equally useful to measure background levels of Strontium-90 and Cesium-137, as well as rates of cancers and birth defects in the surrounding population, since "dose rate" has been raised in a consideration of air quality.

[page 25]

(c) Emission Rates and Estimation Methods

(i) Radionuclide Emissions

The Koeberg NPS and proposed PBMR DPP emissions were provided by Eskom and PBMR for the impact assessment. The assumption was made that these emissions were accurate and correct.

Again, the offering of the PBMR data sets are irrelevant, while any assumption that the proponent's data sets are "accurate and correct" is unacceptable. The scientifically acceptable approach is to actually test those assumptions in the real world by way of truly independent assessment, totally free of any possible influence or "skewing" by the proponent.

Moreover, an objection has already been raised by the Department of Environment and Tourism in the Scoping Phase as follows:

2.45 Issues raised with regards to radiology seem to have been addressed by Eskom and not by the EAP's independent nuclear expert. It is recommended that the EAP's specialist provide the responses or at least review these responses to the I&APs.

Thus the use of data sets provided by the proponent cannot be justified as science.

[page 25]

Radio-nuclide emissions for the preferred alternative reactor designs were obtained from the respective vendors via Eskom.

In Appendix B at page 191 in the Air Quality Specialist Report, the following figures are given for airborne emissions of Cesium-137 and Strontium-909 for the two reactors (converted to Bq/a):

	Strontium-90	**Cesium-137**
EPR-Areva	nil	71 400
AP-1000	440	1 300

Yet, on the following page 192, the maximum recorded emissions for Cesium-137 for Koeberg Nuclear Power Station are given as 20 000 000 in 1994, with the lowest of 40 000 Bq/a in 2001. While Strontium-90 is more likely to be found in liquid effluents (unmentioned in the Air Quality Report, but equally absent in the Marine Biology and Freshwater reports), a lone figure of 600 000 Bq/a is given, translated in the main body of the Air Specialist Report as "only once".

If you were to consult the actual reports to the National Nuclear Regulator from Eskom's Environmental Science Laboratory at Koeberg Nuclear Power Station, however, you will find as expressed in the Table below, a figure for Cesium-137 under the year 2001, which is given as "4.49E +10". This may be translated as 4.49 X 10^{10} or 44 900 000 000 Bq/a.

How is it possible that the Air Quality Specialist Report can get it so wrong? Have the figures been distorted deliberately by Eskom, to allay public fears? By the NNR? What is to be gained by underplaying the scale of environmental impact, except the deliberate and wilful manipulation of "public perceptions"?

TABLE II(a): IODINE-131 IN GASEOUS EFFLUENT FROM KNPS 1984-1992

	1984	1985	1986	1987	1988	1989	1990	1991	1992
Sr-90	0	0	0	0	0	0	0	0	0
I-131	7.39E+07	1.27E+08	3.17E+08	6.66E+08	2.62E+09	2.05E+09	6.32E+08	2.13E+09	9.17E+08
Cs-137	0	0	0	0	0	0	0	0	

TABLE II(b): IODINE-131 IN GASEOUS EFFLUENT FROM KNPS 1993-2002

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Sr-90	0	0	0	0	0	0	0	0	0	3.02E+05
I-131	5.61E+08	4.41E+08	5.29E+08	2.29E+08	2.69E+08	7.48E+07	1.91E+08	2.80E+08	1.03E+09	5.27E+08
Cs-137	1.28E+06	1.94E+07	0	0	0	1.42E+06	6.40E+05	1.40E+06	4.49E+10	3.54E+06

On page 193 of the Air Specialist Report, 18 types of accidents are described, including a full loss of coolant, or "meltdown" scenario, akin to Chernobyl in scale. In the description on page 194 of accidental releases, however, all that Specialist Report can come up with is an alphabetical list of radioactive isotopes. No quantities are provided whatsoever. We can nevertheless imagine from the simple evidence of Chernobyl itself that the sheer quantities of Cesium-137 that were too released are too ghastly for even a hardened air quality scientist to contemplate.

2. DESCRIPTION OF AFFECTED ENVIRONMENT

An endless discussion then follows from page 29 on the finer details of meteorology. While dispersion models are significant when determining risk from airborne emissions, the sheer quantity of detail tells me more about the specialist's discipline, than his competency to study the genuine risks from routine airborne emissions from a nuclear power station. Would that an equal amount of detail had been provided on the actual risk from the long-lived isotopes Strontium-90 and Cesium-137.

> [page 88]
>
> A more holistic approach is required to establish the impact of radionuclide emissions, which include all exposure pathways i.e. inhalation, cloud immersion, soil radiation and ingestion. This assessment focuses on the radionuclide impact due to air releases and deposition on soil. Therefore only preliminary results can be provided in the assessment. The comprehensive health

risk assessment consolidates the radionuclide impacts from all exposure pathways. As a guideline, the public exposure dose constraint value, as discussed in Appendix A will be used as a measure of significance.

The doses to humans at KNPS are given on page 92, but are of no real value because we need the actual quantities in Becquerels per kilogram of solids or cubic metre of liquids and air, as reported above in this submission.

Nevertheless high values in mSv (0.94) of 2004 and 2007 (1.062) are cause for concern, since previous values were well below 0.5 mSv. This "creep" in higher mSv values would confirm the perception of an ageing nuclear reactor, whose original life was designed for 25 years only (i.e. original "sell-by" date would be 2008 for Koeberg-1 and 2009 for Koeberg-2 respectively).

[page 96]

The emissions included 27 radio-nuclides and are given in Becquerels per annum (Bq/a). These nuclides may not necessarily all occur in all these years. For example, Strontium-90 has been noted to occur only once (2003) during this period (i.e. 2x10 5 Bq/a). Ceasium-137 occurred eight times with the maximum during 1994 of 2x107 Bq/a. Argon-41, Iodine-131 to 135, and the noble gases Krypton and Xenon are the most common radionuclide releases.

Since these reports are all tucked away in Appendices and rarely extracted in the main body of the report, a false impression is given by the use of the phrase "has been noted to occur only once (2003)". Begging the question as to what such a large quantity of Strontium-90 was doing in the air in that year, one has to remind the audience (if anyone is reading the reports at all) that the following amount of Strontium-90 was recorded in liquid effluents at Koeberg in the EMS Reports to the NNR in Becquerels per year:

1988 =	302 000
1990 =	95 300
1991 =	79 600
1994 =	53 600 000
1995 =	9 560 000
1997 =	15 100 000
2001 =	3 140 000

What is self-evident from these greater quantities of effluents, is that they increase substantively over time, as the reactor ages under constant neutron bombardment.

[page 96]

The highest on-site inhalation and immersion radiation dose for the current Koeberg NPS was predicted to be 1.8 μSv, approximately 875 m, north-northwest of the power station. The highest inhalation and immersion radiation dose predicted in a radius of 2 km from the power station is 0.7 μSv, also north-northwest of the power station. Based on the NNR regulations (Appendix A), the highest predicted dose is less than 0.2% of the annual effective dose limit of 1000 μSv for members of the public and about 0.7% of the dose constraint of 250 μSv. Similarly, the maximum predicted dose at a distance of 2 km from Koeberg NPS is less than 0.1% of the annual effective dose limit and less than 0.3% of the dose constraint.

[page 96]

These predictions compare very favourably with the NNR projected public dose for gaseous discharge (Table 2-35).

We can only repeat that these "predicted doses" according to the National Nuclear Regulator (NNR) are not good enough, we need to know the actual emissions for the specified technology in Becquerels per annum in all media, and the projected levels of radioactivity in all foodstuffs, terrestrial and marine, for a proper evaluation to be done.

3. IMPACT IDENTIFICATION AND ASSESSMENT

[page 97]

The air quality impacts of the proposed NPS are expected to occur with construction, operation, and decommissioning phases. Only non-radioactive emissions would occur during the construction period, whereas radionuclide emissions may additionally also be associated with the operational phase.

The use of the passive present tense "are expected" in the first sentence, and the future subjunctive "would occur" in the first clause of the second sentence is in sharp contrast with the second clause of the second sentence, where the future potential mood is used, namely: "may additionally also be associated". The redundant double adverbs "additionally" and "also" and the choice of the word "associated" (i.e. "indirectly" rather than "directly") all betray a distinct linguistically marked bias in favour of the development and cannot by any stretch of the imagination be classified as a scientific and technically appropriate use of language. The hidden agenda is that "non-radioactive" emissions have more weight and are more certain than "radioactive" emissions. In reality – as the KNPS emission reports themselves have shown – the radioactive emissions WILL occur during routine operations and ARE substantive. This bias is borne out further below where "non-radioactive emissions" enjoy five pages of treatment, while "radioactive emissions" are afforded only half a page.

3.1.2 Radionuclide Impact Criteria

[Page 102]

Appendix A includes a summary of the NNR dose limits and constraints (Government Notice No. R.388 of 2009 (DME 2009). The maximum annual average effective dose limit for visitors to the sites and those not deemed to be occupationally exposed is 1mSv (1000 μSv). The annual dose equivalent limit for individual organs and tissues of such persons is 10 mSv.

The annual effective dose limit for members of the public from all authorised actions is 1 mSv. No action may be authorised which would give rise to any member of the public receiving a radiation dose from all authorised actions exceeding 1 mSv in a year.

The NNR Regulation R388 additionally provides a dose constraint, which is applicable to an average member of the critical group within the exposed population.

This effective dose should not exceed 0.25 mSv (or 250 μSv) in a year from potential exposure from the site.

A dose limit for events such as design basis accidents is not specified in Government Notice No. R. 388 of 2009. In a separate document the NNR [page 103] specifies an accumulated total individual design dose limit of 50 mSv per event (NNR, 2007).

3.3.2 Radionuclides

(a) Source Terms

Radionuclide source terms[15] were obtained for Areva (EPR) and Westinghouse (AP1000) technologies to determine the envelope (i.e. worst-case) impact prediction. [15] Small amounts of radionuclides are released during normal operation of the NPS. Most of these emissions are, however, captured by High Efficiency Particulate Air filters, known as HEPA filters. HEPA filters, by definition, remove at least 99.97% of airborne particles 0.3 μm in diameter. The radionuclide emissions that still manage to find their way to the atmosphere include tritium, carbon-14, iodine isotopes, noble gases and a small amount of other fission/activation products (mainly cobalt and caesium). Noble gases typically include krypton, xenon and argon. These emissions are continuously monitored and reported to the NNR for compliance proposes.

[page 120] These source terms are provided in Appendix B. The main source of gaseous radioactive emissions during normal operation is the gaseous component arising within the coolant circuit. These gases are collected by the gaseous radwaste system and held for decay storage in the activated carbon bed delay system. This delay system includes a gas cooler, a moisture separator, an activated carbon-filled guard bed, and two activated carbon-filled delay beds. The effluent from the delay bed passes through a radiation monitor and discharges to the ventilation exhaust duct.

All of this is superfluous. What we really want to know is how much Cesium-137 escapes in Bequerels per annum. The language is also obnoxious. Emphasis on "99.97" percent airborne particles (NOT radionuclides!!!); the insertion of the clause "that still manage to find their way"; the phrase "small amount" – all are wilfully and deliberately designed to mislead both the proper authorities and the observant public.

[page 120] The Appendix also includes source terms for Koeberg NPS, as reported to the NNR and an estimated worse-case source term for the proposed PBMR DPP. These given source terms provided no information on the exact chemical forms. **All emissions were therefore simulated as gases. This assumption allows for a more conservative air concentration estimate.** [emphasis mine]

We think it disingenuous, to say the least to suggest that a gaseous release is one and the same as a radioactive particle of Cesium-137 in suspension in air. The fact of the matter is that Cesium-137 will fall to earth (or freshwater body or marine body) and will accumulate in the environment over its lifespan of 200 years. Surely, a scientifically based environmental impact assessment has to take this simple fact into consideration? This is both a scientifically and legally unacceptable assumption.

[page 120] On the other hand, fallout of particulates is important for deposition rates and this may be under-estimated if the correct particle size distributions are not used. The dry and wet deposition rate models internal to the AERMOD model were used in the assessment. These models incorporate land use information as well as atmospheric stability. Using the air concentration and deposition rate results from the AEMOD model, the calculated deposition velocity varies between 0.018 m/s to 0.33 m/s. This is fairly conservative when considering typical dry deposition velocities for radionuclides of 0.0004 m/s (^{137}Cs) and 0.003 m/s (^{131}I) [Roed (1987) and Nicholson (1987)].

Since the deposition rates are measurable, and the very existence of "dry deposition" (i.e. real-time solid deposition or precipitation from airborne status) is acknowledged, we need to have a follow-up data set of what the actual quantities of Cesium-137 are likely to be in Becquerels per annum, and what the accumulated radioactivity will be over 200 years. It is of no use to us having such a data set stuck away in an obscure Appendix of an Appendix.

> [page 120]
>
> (b) Predicted Doses
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> The methodology described in IAEA Safety Report No. 19 (IAEA 2001) was adopted in the estimation of inhalation and immersion dose. The first step in this approach is to estimate the nature and magnitude of the proposed discharge of radioactive material into the environment (Appendix B). The transport of materials discharged to the atmosphere system is modelled and the concentration distribution of radionuclides in the study area of 40 km by 40 km is assessed. The model is designed to estimate the maximum annual dose received during the period of the practice**. <u>The inventory of long-lived radionuclides builds up in the environment, with the result that exposures may increase as the discharge continues</u>.** For screening modelling purposes the maximum annual dose was assumed to be the dose that would be received in a discharge period of 30 years. In the absence of any better knowledge, the emission rates were kept constant for this 30-year period. [emphasis mine]
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> [Page 121] Therefore with the given discharge rates (source terms) in Appendix B, the next step in the procedure is to estimate the relevant annual average radionuclide concentration in air. The AERMOD atmospheric dispersion model (see Section 1.2.3) was used to estimate annual average radionuclide concentrations in air and the annual average rate of deposition.

This is a much more acceptable approach, but the data must still be brought out of hiding in "Appendix B" (no page reference given, but actually page 191 of the Specialist Report). The issue of ingestion, however, is not addressed at all. It is also irrelevant to discuss the calculated dose (which in itself has been challenged in the scientific literature), but rather we need to know what those accumulated deposits are by volume, and what the projected accumulation may be in edible foodstuffs (marine and terrestrial), so that we can get an idea of the impact for ourselves. This approach has to be squared with Appendix E24 "Health Assessment" which in itself refers only to prescribed, permissible and regulated doses in microSieverts and says absolutely nothing about the real risks in scientifically measurable terms, including risks from excessive emissions of Cesium-137 by accident or design, including that occurring through human error and misjudgement of risk.

> The calculated average radionuclide concentrations in air (Bq/m^3) is then combined with the annual rates of intake (m^3/annum) to obtain an estimate of the total radionuclide intake during a year (Bq/annum). This total intake over the year is then multiplied by the appropriate Dose Conversion Coefficient ICRP (1996) in Sv/Bq to obtain an estimate of the maximum effective dose (Sv/annum) in one year from inhalation. ICRP 72 ICRP (1996) is a summary of data on age-dependent committed effective dose coefficients for members of the public from intakes by ingestion and inhalation of radioisotopes of the 91 elements described in ICRP Publications 56, 67, 68, 69 and 71. These dose coefficients have been adopted in the International Atomic Energy Agency in their publication on "International Basic Safety Standards for Protection against Ionising Radiation", and in the Euratom Directive. In all cases, the assessment adopted the highest Dose Conversion Coefficients.
>
> In a similar manner, the concentrations of radionuclides in surface soils in the 30th year of discharge are used with appropriate dose coefficients to estimate the effective dose received during that year from external irradiation. The effective dose in one year from immersion in a cloud containing radionuclides may be calculated by multiplying the average concentration in air by the appropriate external dose coefficients. The total maximum effective dose in one year (representative of the 30th year of discharge) due to inhalation and immersion is obtained by summing the effective doses from inhalation, cloud immersion and ground radiation. The predicted maximum effective dose (inhalation and external) for Duynefontein is given in Figure 3-12. The predicted maximum effective doses for Bantamsklip and Thyspunt are given in Figure 3-13 and Figure 3-14, respectively.

The model-wide maximum predictions for the three sites are summarised in Table 3-13.

Table 3-13: Maximum inhalation and external effective dose predicted in the 40 km by 40 km study area for 4000 MWe NPS Site Effective Dose (µSv/annum)

Duynefontein 4.07

Bantamsklip 4.60

Thyspunt 11.31

Government Notice No. R 388 of 2009 specifies that the annual effective dose limit for members of the public from all authorised actions is 1 000 µSv (Appendix A) with an additional provision of an annual dose constraint of 250 µSv. The highest predicted inhalation and external effective dose of 11.3 µSv is therefore about 4.5% of the dose constraint and about 1% of the annual effective dose limit. With the addition of more units to eventually generate 10 000 MWe, the maximum external effective dose would be less than 30 µSv.

While this is all laudable and helpful, it does not specify in the body of the Specialist Report, what precise emissions of Cesium-137 were the calculations based on to start off with. Moreover, it is unhelpful to appeal to international authorities alone for the proper calculations when the very nature and intention of those authorities is designed to "manage public perceptions" and allay public fears in the interest of actively promoting the growth of the nuclear power industry worldwide.

Inasmuch as pharmaceutical companies are often subject to sharp scrutiny with regard to their practises and promotional activity, so must the nuclear industry be subjected to the same scientifically rigorous and commercially independent review to determine the truth or otherwise of their assumptions, their allegations and their assertions. It is all too sad to see that – being cognitively and psychologically no different whatsoever – even internationally reputable medical doctors, scientists, engineers and technicians may be just as easily swayed by "public perceptions" as might be those who come from more modest academic faculties. What is even more depressing, however, is that such allegedly "objective opinion" may just as easily be informed by the prospect of long-term employment by the very academic institutions and organs of the State, as well as those international bodies falling under the United Nations. Suffice it to say, that their potential for impartial study and learned opinion is more often than not unduly subverted by the global nuclear weapons and nuclear power industries, including the extremely powerful uranium mining lobby.

Here follows an extract from the DEAT letter to consultants Arcus Gibb:

3.5 Section (l), last bullet, P10-17 - This paragraph indicates that the specialist study will assess the potential radionuclide emission during accidents to determine potential time frames and significance of risk. Clarification is requested on what documents will form the basis for the assessments, what methodologies and models will be used and what will be the assessment criteria.

Here is the response from the Air Quality Specialist Report at page 124 ff:

> [Page 124] (c) Design Basis Accident Releases
>
> The NPS must be designed and built to withstand a number of postulated accidents without loss to the systems, structures, and components necessary to assure public health and safety. Design Basis Accidents (DBAs), which could include pipe ruptures, component failure, etc. must be controlled by the safety facilities in such a way that effects on the environment are kept below the specified planning values of the NNR, i.e. the effective dose to a worker or members of the public is less than 50 mSv. A number of DBA releases have been defined for typical PWR technologies. These are described further in Appendix B. The predicted maximum ground level air concentration levels for each of the anticipated radio-nuclides per DBA were calculated at increasing downwind conditions. The maximum effective dose per DBA was subsequently calculated using the most conservative Dose Conversion Coefficient (ICRP, 1996) for inhalation. The results have been provided for inclusion in the Health Risk Assessment.
>
> [Page 125]: Assuming the DBA releases to be at ground level (worst-case scenario), the highest whole body dose at 1 km downwind from the NPS at Thyspunt was predicted to be 49 mSv. At 2 km downwind from the NPS the predicted whole body dose was 20 mSv. Similarly, at 5 km, the highest whole body dose was predicted to be 8 mSv, 3.8 mSv at 10 km and 1.0 mSv at 20 km, respectively. These doses are within the maximum allowable public dose of 50 mSv applicable to accidental releases. Similar values were obtained for Bantamsklip and Duynefontein.
>
> **It must be emphasised that whilst it is believed that this assessment has provided a realistically conservative envelope of DBA impacts, a proper evaluation of DBAs can only be completed once the actual reactor design has been selected.** These impacts are shown to be within the NNR requirement of 50 mSv. Long-range concentrations will therefore be significantly less. [emphasis mine]

Once again, instead of getting a direct answer to a simple question – namely, "What are the radionuclide emissions projected from an accident?" – we get a whole lot of gobbledygook about DBAs and microSieverts, and "Dose Conversion Coefficients". As our emphasis shows, however, the real "smoking gun" in this sordid tale of incompetence and downright practised deceit, lies in the consultant's gleeful confession that "a proper evaluation can ONLY be completed once the actual reactor design has been selected".

At this stage, we do not wish to embark upon a lengthy disquisition on the lessons learned from Chernobyl in April 1986, and the subsequent development of the International Energy Emergency Scale (INES) by the International Atomic Energy Agency (the IAEA). Again it might suffice to mention that Chernobyl has been adopted as the greatest credible accident scenario, expressed as INES-7: the total emptying out of the core material into the upper atmosphere as a result of a meltdown and subsequent pressure burst, followed by an uncontrollable radioactive fire. In this real-time and credible accident scenario, the surrounding population was permanently evacuated beyond a 200-km radius. After nearly 25 years, sheep in Wales remain inedible, the levels of Cesium-137 in the Ukraine remain critically high, and the numbers of projected deaths are calculated in the thousands by some, in the tens of thousands by other, highly credible, Russian, Belorussian, Lithuanian, and Ukrainian health authorities, with all the consequent deaths to the population concerned. But of this harsh reality, this Specialist Report (and that of the allied "Health Assessment" Specialist Report alluded to in Appendix E24) is totally silent, as silent as the streets of once-thriving Pripyat.

> [page 166]
>
> The impact assessment is very sensitive to the definition of the radionuclide source term. An attempt was made to bind the impact through using the emissions from two reactor technologies. Any significant changes to the source term, outside this envelope would have a direct effect on the predicted dose. It is therefore important that the source term of the final selection be checked against the assumptions made in this assessment**. The conclusions reached in this assessment will not be supported if the source term is outside of the envelope used in this assessment.** [emphasis mine]

In other words, this is an irrelevant exercise in the manipulation of "public perceptions".

6.1.2 Operational Phase

> [p.167] During normal operation, small quantities of radiological materials are released to the environment. This assessment only considered inhalation, cloud immersion and radiation from soil deposition pathways. **Ignoring the ingestion pathway,** the predicted effective dose from these pathways indicates LOW *consequence*. However, since the emission is considered to be *definite*, the *significance* of the impact is rated MEDIUM. This rating applies for all three sites.

While not specifying any quantities of any substantive measurements for the proposed, unstated reactor, the Specialist Report further seeks to diminish the overall human health impacts by dismissing out of hand the most critical pathway to chromosomal damage: human ingestion. At one stroke therefore, and buried deliberately deep in the body of an obscure and mystifying specialist report, the entire foundation for risk assessment of the proposed, unspecified "Nuclear-1" reactor is demolished by its own admission.

This for us is the final nail in the coffin of this preposterous exercise and we submit that the entire process has been overhasty and ill-conceived, especially when one considers that the Department of Energy is yet to concede the presence of a nuclear build programme in the much-vaunted Integrated Resource Plan II (IRP2).

We therefore further submit that the entire Air Quality Report and the accompanying Draft Environmental Assessment Report for Nuclear-1 be dismissed out of hand until such time as:

1. A firm and irrevocable decision has been taken – with popular national consent – by the Ministry of Energy to pursue a nuclear build programme; and

2. A directive has been given to Eskom's Generation team to pursue a specific and named type of nuclear power station at one only specific location.

APPENDIX 1

Reasonable Doubt: Children living near nuclear facilities face an increased risk of cancer.

by Ian Fairlie, Global Research, April 24, 2008

http://globalresearch.ca/index.php?context=va&aid=8785

AMONG the many environmental concerns surrounding nuclear power plants, there is one that provokes public anxiety like no other: the fear that children living near nuclear facilities face an increased risk of cancer. Though a link has long been suspected, it has never been proven. Now that seems likely to change.

Studies in the 1980s revealed increased incidences of childhood leukaemia near nuclear installations at Windscale (now Sellafield), Burghfield and Dounreay in the UK. Later studies near German nuclear facilities found a similar effect. The official response was that the radiation doses from the nearby plants were too low to explain the increased leukaemia. The Committee on Medical Aspects of Radiation in the Environment, which is responsible for advising the UK government, finally concluded that the explanation remained unknown but was not likely to be radiation.

There the issue rested, until a recent flurry of epidemiological studies appeared. Last year, researchers at the Medical University of South Carolina in Charleston carried out a meta-analysis of 17 research papers covering 136 nuclear sites in the UK, Canada, France, the US, Germany, Japan and Spain. The incidence of leukaemia in children under 9 living close to the sites showed an increase of 14 to 21 per cent, while death rates from the disease were raised by 5 to 24 per cent, depending on their proximity to the nuclear facilities (European Journal of Cancer Care, vol 16, p 355).

This was followed by a German study which found 14 cases of leukaemia compared to an expected four cases between 1990 and 2005 in children living within 5 kilometres of the Krümmel nuclear plant near Hamburg, making it the largest leukaemia cluster near a nuclear power plant anywhere in the world (Environmental Health Perspectives, vol 115, p 941).

This was upstaged by the yet more surprising KiKK studies (a German acronym for Childhood Cancer in the Vicinity of Nuclear Power Plants), whose results were published this year in the International Journal of Cancer (vol 122, p 721) and the European Journal of Cancer (vol 44, p 275). These found higher incidences of cancers and a stronger association with nuclear installations than all previous reports. The main findings were a 60 per cent increase in solid cancers and a 117 per cent increase in leukaemia among young children living near all 16 large German nuclear facilities between 1980 and 2003. The most striking finding was that those who developed cancer lived closer to nuclear power plants than randomly selected controls. Children living within 5 kilometres of the plants were more than twice as likely to contract cancer as those living further away, a finding that has been accepted by the German government.

Though the KiKK studies received scant attention elsewhere, there was a public outcry and vocal media debate in Germany. No one is sure of the cause (or causes) of the extra cancers. Coincidence has been ruled out, as has the "Kinlen hypothesis", which theorises that childhood leukaemia is caused by an unknown infectious agent introduced as a result of an influx of new people to the area concerned. Surprisingly, the most obvious explanation for this increased risk – radioactive discharges from the nearby nuclear installations – was also ruled out by the KiKK researchers, who asserted that the radiation doses from such sources were too low, although the evidence they base this on is not clear.

Anyone who followed the argument in the 1980s and 1990s concerning the UK leukaemia clusters will have a sense of déjà vu. A report in 2004 by the Committee Examining Radiation Risks of Internal Emitters, set up by the UK government (and for which I was a member of the secretariat) points out that the models used to estimate radiation doses from sources emitted from nuclear facilities are riddled with uncertainty. For example, assumptions about how radioactive material is transported through the environment or taken up and retained by local residents may be faulty.

If radiation is indeed the cause of the cancers, how might local residents have been exposed? Most of the reactors in the KiKK study were pressurised water designs notable for their high emissions of tritium, the radioactive isotope of hydrogen. Last year, the UK government published a report on tritium which concluded that its hazard risk should be doubled. Tritium is most commonly found incorporated into water molecules, a factor not fully taken into account in the report, so this could make it even more hazardous.

As we begin to pin down the likely causes, the new evidence of an association between increased cancers and proximity to nuclear facilities raises difficult questions. Should pregnant women and young children be advised to move away from them? Should local residents eat vegetables from their gardens? And, crucially, shouldn't those governments around the world who are planning to build more reactors think again?

Ian Fairlie is a London-based consultant on radiation in the environment

RELEVANT SOURCES FOR FURTHER STUDY AND COMMENT

Christopher C. Busby (2009): "Very Low Dose Fetal Exposure to Chernobyl Contamination Resulted in Increases in Infant Leukemia in Europe and Raises Questions about Current Radiation Risk Models" in: *International Journal of Environmental Research and Public Health* Vol.6 ISSN 1660-4601 www.mdpi.com/journal/ijerph

Chris Busby et al (2006): *A survey of cancer in the vicinity of Trawsfynydd nuclear power station in north wales* Report 2006/3, Green audit Aberystwyth, June

Communities adjacent to nuclear facilities in the U.S. and U.K. have increased rates of leukemia and other childhood cancers (Cragle *et al.* 1988; Morris and Knorr 1996; Beral *et al.* 1993; Pobel and Viel 1997; Cardis *et al.* 2007).

Arjun Makhijani (2008): *The Use of Reference Man in Radiation Protection Standards and Guidance with Recommendations for Change*, December (Revision 1, April 2009). Institute for Energy and Environmental Research, Takoma Park, Maryland

Kaatsch P, Spix C, Schultze-Rath R, et al. *Leukemia in young children living in the vicinity of German nuclear power plants.* Int J Cancer. 2008; 1220:721-726

Baker PJ, Hoel DG. *Meta-analysis of standardized incidence and mortality rates of childhood leukemia in proximity to nuclear facilities.* Eur J Cancer Care. 2007:16:355-363

Laurier D, Jacob S, Bernier MO, et al. *Epidemiological studies of leukemia in children and young adults around nuclear facilities: A critical review.* Rad Prot Dosim. 2008; 132:182- 190