05 August 2015

Our Ref: J27035 / J31314
Your Ref: Email received 05 August 2011

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Dear Ms Macdonald

RE: ESKOM EIA CONCERNS FOR THE PROPOSED NUCLEAR POWER STATION AND ASSOCIATED INFRASTRUCTURE (DEA Ref. No: 12/12/20/944)

Current Chair Koeberg Public Safety Information Forum

Human Health Risk Impact Report Appendix E24

PLEASE NOTE: Whilst "Site Safety Reports" prepared as part of the authorisation process for nuclear licensing have been included as appendices in this draft EIA Report (Appendices E24, E26 and E27), radiological issues will not be assessed in detail Since this is the mandate of the NNR.

> *Footnote [7] The Emergency Response (Appendix E26) and Site Access Control Report (Appendix E27) and Human Health Risk Assessment (Appendix E24), which have been prepared on a high level,, are appended to this EIR for information only. Further details on these reports will be prepared as part of the NNR nuclear licensing process, as their findings will be evaluated by the NNR."*

Conclusion, we should not have entertained this submission. The EIA do not deal with researching medical health applied techniques and tools.

I will consider a few of the major flaws of this report below:

Comment 1:

ICRP model inadequacies

The following was part of the response from Arcus Gibb (ref J27035) to my last submission:

"The report is based on a dose assessment, with qualitative interpretation of health risk. This is in line with the regulatory requirements as set out by the National Nuclear Regulator on safety standards and regulatory practices (R388) which is based on the accepted international system of radiation protection to ensure that public and the environment are not at risk from the effects of ionising radiation. Regulatory limits set by the National Nuclear Regulator are in line with ***recommendations from the International Commission of Radiological Protection (ICRP).*** *The ICRP is an advisory body that offers its recommendations to regulators and advisory agencies..."*

The ICRP risk model has been shown to be outdated.

As per the recent edition of the European Committee on Radiation Risk's report for 2010, the ex scientific secretary of the ICRP and editor of its reports, stated that the ICRP risk model could not be employed to predict or explain the health effects of exposures to human populations. This was because the uncertainties for internal exposures were too great.

Response 1:

The European Committee on Radiation Risk (ECRR) is an organisation with no formal links to official bodies, described as "self-styled" by the UK Health Protection Agency (HPA). The HPA reviewed the ECRR report.
(http://www.hpa.org.uk/Publications/Radiation/NPRBArchive/NRPBResponseStatements/nrpbResponseStatement303/).

The HPA is an independent UK organisation that was set up by the government in 2003 "*to protect the public from threats to their health from infectious diseases and environmental hazards. The Agency combines public health and scientific knowledge, research and emergency planning within one organisation – and works at international, national, regional and local levels. It also supports and advises other organisations that play a part in protecting health*".

According to the HPA, the weight of evidence and considerations of biological plausibility argue against ECRR's views that ICRP's risk assessment methodology seriously underestimates risks from internal emitters. HPA strongly referred to ECRR's proposed methodology as arbitrary, without having a sound scientific basis. HPA pointed out many misrepresentations of ICRP, misunderstandings, inconsistencies and unsubstantiated claims in the ECRR report. According to the HPA, the report compares poorly with the detailed justification and referencing of published data characteristic of ICRP reports.

Dr Mike Thorne, internationally recognised scientist and specialist in radiological risk assessment reviewed the ECRR document (J Radiol Prot 32 (2012) 369–372). Dr Thorne concluded: " —*in my opinion, it is poor science from cover-to-cover and should not be taken seriously in any deliberations on radiological protection policy and standards*".

Current understanding of effects of exposure to radioactivity radiological risks is based on extensive interpretation of large volumes of epidemiology and laboratory studies by internationally recognised scientists over many years. The ECRR report does not provide a basis for changing radiological protection standards.

Comment 2:

The Linear No Threshold model is used by the ICRP to predict radiation damage. However this model does not take into account the bystander effects demonstrated with regards to low level radiation.

Response 2:

Bystander effects are not new. As referenced in EU (2009)[1], there is extensive literature on clastogenic factors and other "compounds" that stimulate or modify responses in cells that were not damaged. The relevance of bystander effects to carcinogenic risk has not been determined and acknowledgement of this effect does not "*prove the inaccuracy*" of the current linear-no-threshold hypothesis that is used in radiation protection practice. Research in this field is continuing and findings are interesting. However, these are not sufficient to support a new and completely different paradigm of radiological risk assessment. It must be acknowledged that there is a large volume of radiobiological and epidemiological evidence that is in line with the classical paradigm.

Comment 3:

Research on "non-(DNA)-targeted" radiation effects prove the inaccuracy of a simplistic linear relationship[i] [ii] especially at low doses.

[1] EU. 2009. Radiation Protection No 151. EU Scientific Seminar 2005. Alpha Emitters: Reliability of Assessment of Risk for Radiation Protection. Proceedings of a scientific seminar held in Luxembourg on 21 November 2005. Working Party on Research Implications on Health and Safety Standards of the Article 31 Group of experts. Director-General for Energy and Transport, Directorate H – Nuclear Energy. Unit H.4 – Radiation Protection. European Commission.

These effects include radiation-induced bystander effects (Morgan, 2003a; Morgan, 2003b), genomic instability (Wright, 1998; Wright, 2000), adaptive response (Wolff, 1998) and low dose hyper-radio sensitivity (HRS) (Joiner, et al., 2001).[iii] Radiation-induced bystander effect (RIBE), which was found in the 1990s, challenged the conventional dogma that no effects were expected in the cell population that had not been exposed to radiation. With the RIBE, the irradiated cells could secrete some signal factor(s) to affect the nearby non-irradiated cells or cells that had received the transferred conditioned medium, and then to induce DSBs, mutation and cell death etc. in the non-irradiated cells.[iv]

An essential feature of "non-targeted" effects is that they do not require a direct nuclear exposure by irradiation to be expressed and they are particularly significant at low doses.

Response 3:

See response to comment 2.

Comment 4:

In 2003, the European Committee on Radiation Risk (ECRR) produced a report that directly challenged the 1991 ICRP recommendations. The ECRR, which arose from criticisms of the ICRP dose model at a European Parliament workshop, used over 500 professional references to support its conclusions, most of them after 1991. The ICRP model is lacking, states the ECRR report, because of recent discoveries in biology, genetics, and cancer research suggesting the ICRP model of cellular DNA is not a good basis for risk analysis. Thus, the maximum permissible dose to the public should be no more than 0.1 millisievert (mSv), rather than the ICRP "safe" dose of 100 mSv.

Response 4:

See response to comment 1.

Comment 5:

The elevated risk to foetus and infant is important to note. The U.S. Environmental Protection Agency draft paper EPA/630/R-03/003 from 2003 concludes that harm from radiation exposure is considerably higher in young persons than in adults (children age 2-16 have three times the risk, while children under age 2 have ten times the risk). This paper officially acknowledges that use of risk models based on "average" humans minimizes risk to those who are especially vulnerable.

Response 5:

The comment reflects a fair conclusion arising from the referenced USEPA document. However, it is trusted that the commentator also noted the remedy for the problem of sensitive of vulnerable receptors, as explained in the referenced USEPA document; namely, the adjustment of relevant risk factors to reflect the perceived increased risk. It might have been easier to explain the specific application of the adjustment to the case of radiation risks, if the EIA assessment had progressed to the calculation of cancer risks, in stead of being terminated at the dose calculation level. It should suffice to say that the referenced USEPA document specifically mentions, with regard to radiation cancer risks, that age-specific relative risk coefficients were developed (***Section 2.4. IONIZING RADIATION*** in that document). Specifically, ***Section 3.2.3. Ionizing radiation*** in that document states:

"*The report developed mortality risk coefficients using several models that took into account age and gender dependence of dosimetry, radiogenic risk, and competing causes of death as well as transporting of risks across populations. … For most of the sites in the table* (Table 11 in the document)*, the risk coefficients are higher in the earlier age groups; liver, bone, skin, and kidney coefficients are age-independent and only esophageal cancer coefficients increase with increasing age. … Similar to the information from the UNSCEAR (2000) Annex, most sites show greater risks in the younger ages than the older ages."*

It is therefore fair to conclude that the vulnerability of younger receptors was recognized, and is reflected in higher risk coefficients in the earlier age groups. While the EIA does not address risk in

terms of cancer risk, a similar principle is at work in the calculation of the total effective dose for regulatory purposes. It is known that *"the dose to organs of the body from external radiation increases with decreasing body size. This effect is more pronounced at low photon energy, and for organs located near the middle of the body, which are shielded by overlying tissues"*[2]. This is reflected in higher dose coefficients for younger age groups, found also in updated guidance documents (e.g. United States Nuclear Regulatory Commission (2007), **Radiological Toolbox**. Version. 2.0.0. Eckerman, K.F and Sjoreen, A.L. [Internet]. Available from <http://www.nrc.gov/about-nrc/regulatory/research/radiological-toolbox.html> [Accessed January to December 2010]. Dose coefficients (also referred to as dose conversion factors) are used to relate radionuclide uptake to the dose of ionizing energy in the tissues of the body. Total effective dose calculations are required by the NNR.

Comment 6:

Since 1956, when Dr. Alice Stewart demonstrated that prenatal pelvic X-rays yielding a dose as low as 10-20 mSv significantly raised the risk of cancer deaths by age ten, the risk radiation poses to the foetus and infant has been a focus of research.. In the most recent document the ICRP stated that below 100 milligrays, lethal effects to the foetus are "infrequent" (100 mGy equals 100 mSv). The following are among the more recent studies to identify radiation risks to the foetus and infant (other than childhood cancer):

-The October 23, 1999 Lancet published research showing that every additional 100 mSv of radiation exposure to external ionizing radiation before conception added a 25% risk of a child being stillborn.

Response 6:

The context of this comment must be clarified. The publication in Lancet refers to heritable genetic changes affecting the risk of stillbirth and neonatal death following preconception radiation treatment. The study investigated the risk of stillbirth and neonatal death among the offspring of men and women who had survived childhood cancer. Radiation technology was applied in the treatment of cancer and patients were subjected to high radiation doses.

The authors of the study concluded that careful management of pregnancies is warranted in women given high doses of pelvic irradiation before puberty. The outcome of the study cannot be related to environmental levels of radioactivity that are within the dose limits and dose constraints stipulated by the NNR.

Comment 7:

An article in the January 2004 British Medical Journal documented that males irradiated for cutaneous haemangioma under 18 months had a progressively lower attendance rate in high school, documenting lower rates even at doses of under 20 mSv.

Response 7:

The researchers analysed cognitive function in a large population based cohort of men at the time of military enlistment who had received low dose ionising radiation for cutaneous haemangioma before age 18 months. The average estimated absorbed dose to the brain in the study was 52 mSV (median 20 mSV, range 0-to-2800 mSV) and the largest contribution came from irradiation of haemangiomas in the head region.

The purpose of the study has not been to assess effects of public exposure to low environmental levels of radioactivity, but to assess effects of radiation treatment on infants, in particular effects that radiation treatment may have on the development of the human brain. The authors concluded on the basis of their findings that the risk and benefits of computed tomography scans (which involve

[2] United States Environmental Protection Agency (1993), External Exposure to Radionuclides in Air, Water and Soil. Federal Guidance Report 12. Washington, DC.

radiation) in minor head trauma need re-evaluating. This interpretation is very specific and cannot be related to radioactivity at environmental levels below dose limits and dose constraints.

Comment 8:

The April 28, 2004 Journal of the American Medical Association presented a study associating risk of low weight births with prenatal dental radiography at a dose of over 0.4 mGy (0.4 mSv).

Response 8:

The study did show an association with X-ray exposure, but this should not be mistaken to be a definite cause-and-effect conclusion. The study was designed as a retrospective, population-based case-control study. Case-control studies cannot prove cause and effect; they can be used only to demonstrate associations. The authors raised the possibility that radiation-induced thyroid dysfunction might play a role in causing the low weight births. However, alternative explanations have not been ruled out. For example, it has been noted that women who need radiographs during pregnancy may have serious dental disease and already may be at risk of having a low-birth-weight baby because of the disease (Reported by Mark Berthold, senior editor, ADA News). Overall, the study is interesting but it has no bearing on exposure to radioactivity at levels below population dose limits and dose constraints.

Comment 9:

In 1991, U.S. public health officials had not admitted that fallout from 1945-1963 atmospheric nuclear weapons tests caused any harm. However, the release of a 1997 report by the National Cancer Institute estimated that Iodine-131 from tests – still considered low dose exposure - caused between 11,000 and 212,000 Americans to develop thyroid cancer. No acknowledgement of this landmark research study was made by ICRP.

Response 9:

The association of thyroid cancer with exposure the iodine-131 has been known long before the publication of the National Cancer Institute in 1999. ICRP deals with exposure to I-131 separate from the other radionuclides, with emphasis on assessment of exposure through milk.

The well-documented Windscale accident in October 1957, which was a plutonium production factory, resulted in release of iodine-131. This led to the establishment of a widespread milk monitoring programme and of the development of radiological criteria for the protection of the population in the UK. Herbert John Dunster, a leader in the development of radiological protection philosophy, played an important role in the decisions that were required following the Windscale accident. He became an ICRP Committee member in 1959 and played a prominent role in the development of ICRP publications.

Without distracting from the value of the study of the National Cancer Institute, it must be pointed out that the ICRP was not ignorant about I-131 and its association with cancer, as inferred by Comment 9.

Comment 10:

In 2000, the U.S. Department of Energy released a report summarizing many research studies, and concluding that workers at American nuclear weapons plants suffer from disproportionately high rates of various cancers. Congress subsequently passed a law entitling affected workers to compensation. Again, the ICRP made no note of this important development and its implications for radiation safety standards.

Response 10:

Refer to Response 9. The ICRP set standards for occupational exposure to radionuclides long before the US DOE publication in 2000. The issue of cancer in nuclear weapons plants is not relevant to the evaluation of a nuclear power station.

Comment 11:

The series of assumptions that radiation exposure carries no risk that were later reversed by empirical research – for pelvic X-rays to pregnant women, atomic bomb test fallout, and occupational exposures in nuclear weapons plants – suggests strongly that the ICRP re-evaluate health risks of low-dose exposures, and lower the current limits.

This evidence shows that the ICRP model is outdated and is not necessarily protective of human health.

If there is an image of the ICRP as comprising a balanced medical and scientific team free from government involvement and political pressures, this is a myth.

Response 11:

This comment suggests that the ICRP is an incompetent institution that is unaware of events and developments in the nuclear industry. It also infers that the ICRP is dishonest and unethical. See also responses to earlier comments that had the intention of discrediting the ICRP. This kind of derogatory discourse is not constructive.

Comment 12:

A complete list of the members responsible for the ICRP Document #2 [1959] (see Appendix 1), Standard Setting for Internal Radiation Doses, indicates quite clearly that they were chosen with respect to their employment by their respective governments. They were all involved in the research and development of nuclear energy and/or national regulatory agencies. They do not represent public health concerns or interests and they cannot be said to have maintained structural independence from governmental influence. Many members were also involved in their nation's nuclear weapon development and testing programs.

Membership in ICRP is by recommendation of present members of the ICRP, subject to approval by the Executive Committee of the International Congress of Radiology (ICR).

Response 12:

See Response 11.

Comment 13:

Mutagenicity

The Precautionary Principle states that if consequences of an action are unknown but have potential for negative consequences, it is better to avoid that action.

In the health field, this belief has existed since the **Hippocratic principle of "first do no harm"** of over 2,000 years ago.

The nuclear industry goes against this basically ethical principle.
Page 5 states: "Ionising radiation has sufficient energy to change the structure of molecules, including DNA, within the cells of the human body. Although there are repair mechanisms, it is possible to damage the genetic code permanently by means of ionising radiation, resulting in faulty genetic information. Faulty genetic information may result in cell death, or the cell may survive and divide, transferring the faulty genetic information to the next cell lineage. Faulty genetic information may result in abnormal cell function, manifesting as harmful effects in the organism. However, the evidence is

that only a very small fraction of such changes would be expected to result in cancer or other health effects.

There are two types of cells in the human body – somatic cells and germ cells (spermatozoa and ova) in the reproductive system. Tissues with particular specialised functions are referred to as organs. Cells, tissues and organs are maintained through regulated processes of cell division. The division, structure and functioning of cells are controlled by DNA in the nucleus of the cell. The DNA in cells carry the blueprint of the cell structure and function, and this information is commonly referred to as the genetic code. During cell division, the genetic code is transferred from one lineage of cells to the next with remarkable fidelity. "

To analyse the excerpt from the EIR above:

*i) " the evidence is that ...would be expected to result in cance*r."

The "evidence " alluded to here, is not enough.

The issue of calculating/ estimating cancer rates due to radioactive releases from nuclear plants due to routine emissions, from an incident or an accident, is fraught with difficulty and inaccuracies.

Response 13:

The description of the precautionary principle in the comment is not in line with the intention of the concept. The 1992 Rio Declaration on Environment and Development states that:

"*The precautionary principle should be invoked when:*

- *there is good reason to believe that harmful effects may occur to human, animal or plant health or to the environment; and*
- *the level of scientific uncertainty about the consequences or likelihood of the risk is such that the best available scientific advice cannot assess the risk with sufficient confidence to inform decision-making."*

The United Kingdom Interdepartmental Liaison Group on Risk Assessment (UK-ILGRA) placed the following limitations on application of the precautionary principle:

- "*The precautionary principle should be distinguished from other drivers that require caution such as society's view on the extent of protection afforded to children or others considered to be vulnerable, or the wish to ensure that conventional risk assessment techniques deliberately over rather than under-estimate risk."*
- *"Action in response to the precautionary principle should accord with the principles of good regulation, i.e. be proportionate, consistent, targeted, transparent and accountable."*
- *"Applying the precautionary principle is essentially a matter of making assumptions about consequences and likelihoods to establish credible scenarios, and then using standard procedures of risk assessment and management to inform decisions on how to address the hazard or threat."*
- *"Decision-making should bring together all relevant social, political, economic, and ethical factors in selecting an appropriate risk management option."*
- *"Invoking the precautionary principle shifts the burden of proof in demonstrating presence of risk or degree of safety towards the hazard creator. The presumption should be that the hazard creator should provide, as a minimum, the information needed for decision-making."*
- *"Decisions reached by invoking and applying the precautionary principle should be actively reviewed, and revisited when further information that reduces uncertainty becomes available."*

The precautionary principle is thus applied out of context in the comment. *The statement that "(T)he issue of calculating/ estimating cancer rates due to radioactive releases from nuclear plants due to*

routine emissions, from an incident or an accident, is fraught with difficulty and inaccuracies" is typical of the bullets in the limitations in applying the precautionary principle placed by UK-ILGRA.

The Hippocratic Principle of "first do no harm" is also interpreted out of context. It refers strictly to the doctor/patient relationship. From the Hippocratic writing Epidemics[3]:

"The physician must be able to tell the antecedents, know the present, and foretell the future - must mediate these things, and have two special objects in view with regard to disease, namely, ***to do good or to do no harm.*** *The art consists in three things - the disease, the patient, and the physician. The physician is the servant of the art, and the patient must combat the disease along with the physician."*

Comment 14:

Whilst it is scientifically proven that ionising radiation causes DNA double strand breaks and deletions, the result of this genetic damage varies tremendously depending on where it occurs, how rapidly the cell is dividing, extent of the damage and cellular radio-sensitivity.

Response 14:

This is regarded as a general statement that does not require a response.

Comment 15:

The range of deleterious results are enormous and range in severity from mild endocrine, vascular , immune system disorders to cancers and death. Any genetic anomaly is possible.

The actual number of deaths in the mid to long term from these mutations is impossible to record or attribute with any certainty as related to exposure to a specific release of radioactivity - from an accident or an incident at a nuclear plant or from routine emissions.

Response 15:

Health risks depend on the level of exposure (dose). The hazards of radiological exposure are recognised, but if exposures are very low, as in the case of a power station operating within the regulatory limits, risks would be in the *de minimus* range. It must also be remembered that there are many natural sources of radioactivity and mere exposure to these sources does not mean that there would be health risks. This is analogous to many natural sources of chemicals in the environment.

Comment 16:

What is also impossible to ascertain is the exact extent of radiation contamination. The picture shown in Figure 3.1 of air dispersion at Thyspunt would obviously only apply for a short period.

Response 16:
The air dispersion isopleths actually depict annual averaged concentrations, which are relevant for assessment of chronic exposures.

Comment 17:

We have seen with dispersion models from Fukushima how 'hotspots 'of high concentration of radiation have emerged at large distances to the site. The dispersion is not necessarily highest closest to the plant with gradually diminishing effects. Particularly as the released isotopes are dangerous for decades, unusual and unpredictable dispersion is inevitable.

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[3] Gill N S, online. Is "First Do No Harm" From The Hippocratic Oath? Myth Vs Fact. http://ancienthistory.about.com/od/warfareconflictarmor/u/Heroes.htm.

Response 17:

Atmospheric dispersion depends on such factors as topography and meteorology, which are accounted for in the mathematical models. The comment refers to the nuclear accident at Fukushima, which is not relevant to this EIR that deals with normal operation and anticipated operational occurrences.

18 Jan 2012 (NucNet) News reported; About 30 workers at the Fukushima-Daiichi nuclear power plant in Japan received between 100 millisieverts (mSv) and 250 mSv of radiation exposure, which would have increased their chances of cancer by about one percent to 2.5 percent, a parliamentary committee in the UK was told. Her Majesty's chief inspector of nuclear installations, Mike Weightman, told the House of Commons Energy and Climate Change Committee that in terms of the workers, "there don't appear to be any acute radiation effects".

He said 30 of them have had "a significant dose", but it is not in the sense of an immediate life-threatening dose. In a declared nuclear emergency, the recommended limit is 100 mSv. The International Commission on Radiation Protection is mandated to sanction a maximum accumulated dose of 250 mSv in extraordinary circumstances. Mr Weightman said public evacuation was well-organised and exposure countermeasures for the public have been "effective so far", and there will be a longer-term health monitoring programme."

Comment 18:

With regard to death rates from nuclear accidents, it is interesting to note the following:

In1959 an agreement was passed between the World Health Organisation and the IAEA giving the IAEA a veto right over WHO pronouncements as regarding nuclear power. It also requires that any investigation into the health effects of nuclear radiation by the WHO be first agreed to by the IAEA. The mandate and objective of the IAEA is to promote atomic energy. Of course WHO findings which do not align themselves with the IAEA's mandate would not be supported.

Response 18:

There is a large volume of independent peer reviewed research documents and views of credible organisations and individuals that are within broad consensus about the scientific understanding of the science. It is preposterous to believe that the entire nuclear industry and nuclear science across the world is controlled in an unethical way by the IAEA. The conspiracy theory is unconvincing.

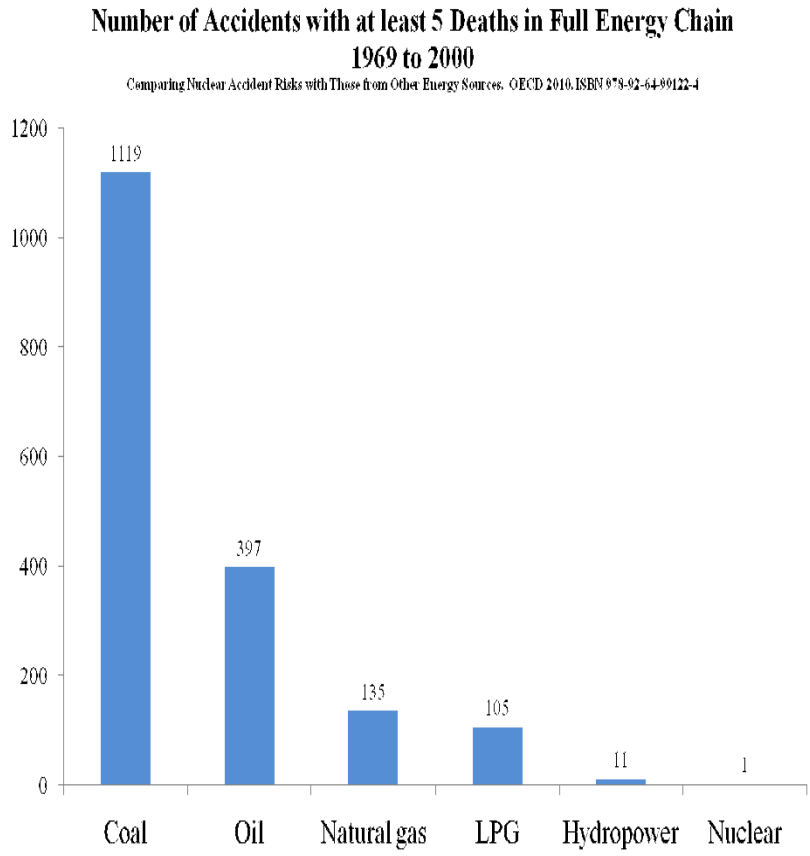
Comment 19:

The fact that there are such massive discrepancies in estimations regarding deaths due to the Chernobyl accident proves the point that estimations are impossible. Even using the exact formulae used by the WHO to extrapolate their 4000 deaths the Union of Concerned Scientists found a very different figure of 34 000.

Response 19:

Cannot comment without reviewing the methodologies followed respectively by WHO and UCS. Nevertheless, this EIR does not deal with nuclear accidents.

However, can one use the graph below to counter argue the statement? Or will this become a ping pong game where various research materials are countered against each other?



Comment 20:

ii) *" only a very small fraction of such changes would be expected to result in cancer or other health effects."*
In the above excerpt, it states that though the cell's DNA structure has been damaged and altered, this does not mean that cancer or health effects arise in every case.

This assumes that genetic mutations are acceptable provided they do not result in dramatic health effects.

I would like to see a consensus from the general public to show that they agree with this point.

Response 20:
The comment refers to scientific fact saying exactly what is underlined in the comment above. The interpretation that "*genetic mutations are acceptable provided they do not result in dramatic health effects*" is that of the person who made the comment and not that of the authors of the EIR.

Comment 21:

Especially when the implications as stated, are fully understood:
"The DNA in cells carry the blueprint of the cell structure and function, and this information is commonly referred to as the genetic code. During cell division, the genetic code is transferred from one lineage of cells to the next with remarkable fidelity."

Only 10% of genetic damage is visible in the first generation. It becomes more apparent in later generations.

Response 21:

Generally, it is understood that effects may not show up until future generations, but to attach a percentage to effects in the first generation is questionable.

Comment 22:

iii) "However, there is no direct evidence of increased risk of non-cancer diseases at doses below about 100 millisieverts (mSv)."

This is deceptively stated. There is a lot of evidence showing that non-cancer diseases are **likely** to arise as a result of low-dose radiation. There is simply no direct evidence that they are the only causal factor.

Response 22:

If causality is not demonstrated, clearly there is no direct evidence. It is not a deceptive statement.

If this point has to be argued for identified health effects, specific toxicological and/or epidemiological evidence must be produced to support one of the following relationships:

- Causal relationship
- Likely to be a causal relationship
- Suggestive of a causal relationship
- Inadequate to infer a causal relationship
- Suggestive of no causal relationship

The comment offered a generalised statement without scientific support for the relationships listed above.

Comment 23:

The Independent Advisory Group on Ionising Radiation in the UK produced a document in October 2010[v] showing the following results amongst others:

1. Radiation predisposes to the formation of an inflammatory, thrombotic plaque phenotype in arteries.
2. A radiation-induced persistent decrease in capillary density is associated with focal loss of alkaline phosphatase.
3. Many of the underlying contributory mechanisms associated with the development of circulatory disease, particularly atherosclerosis, are also associated with radiation exposure.
3. Vessel occlusion can occur many years after irradiation, and the precise mechanisms of this are not fully known etc.

Response 23:

The comment does not refer to the radiological doses in the study. The study was conducted on patients that received radiotherapy at high and very high doses. On the lower-dose side, survivors of the atomic bomb in Japan were studied. Even in these cases the doses on the lower end were in the order of hundreds of mSV, which is much higher than the regulatory dose limits.

The study is interesting and appears to have been well conducted, but it is of no relevance to the EIR under discussion.

Comment 24:

There have been numerous studies showing that DNA mutation and cellular damage results in both cancer and a variety of non cancerous diseases.

Response 24:

This statement must be made in context with exposure. These effects are not measured at low exposure doses. Keep in mind that there are background levels of radioactivity everywhere, which do not translate into numerous cases of these effects.

Comment 25:

However working backwards (so to speak) it is virtually impossible to isolate radiation as the only causal factor of the disease in question.

The report acknowledges this and states:

Insights from mechanistic experimental studies might eventually provide the required weight of evidence of causality at low radiation doses. (pt 4 pg 87)

The fact that it cannot be isolated as the only cause, providing direct evidence, does not mean that it is innocent of harm.

Response 25:

Refer to response 22.

Comment 26:

3. Assumption of compliance with NNR dose limits

Page 20 states: *"For purposes of the EIA, it is assumed that quantified radiological doses through all pathways and routes of exposure at any of the sites with a proposed new nuclear power station will be within the NNR dose limits and dose constraints for public exposure."*

There are two assumptions here.
Firstly the assumption that the NNR dose limits are protective and secondly that these limits will be adhered to.

This report calls for the EIR to be passed **on the assumption** that NNR levels will be held **on the assumption** that these levels are safe. These assumptions need to be tested and to be found acceptable before this EIR would be valid. One cannot assume that the claims of reactor manufacturers or claims of current operators and proponents of the industry, are accurate. This necessitates a study done outside of the confines of the NNR, Eskom, NECSA environment.

Response 26:

The dose limits and dose constraints are supported by credible scientific data and are accepted to be protective of human health.

The reactor manufacturers will have to comply with the dose limits and dose constraints of the NNR. It is not helpful and without basis to distrust the NNR, Eskom and NECSA.

Comment 27:

No independent, peer-reviewed or publicly available studies have been done around our existing nuclear power station to assess health impacts and all data regarding radioactive emissions from Koeberg are from ESKOMS internal laboratory (ESL).

It certainly seems to me to be extraordinary that we are claiming the safety of nuclear power without any decent, publicly available, peer reviewed, independent study of our existing plant to prove to the public that this is in fact so.

Response 27:

The internal Laboratory data is scrutinised by the NNR of which their mandate explicitly is to protect persons, property and the environment against radioactive emissions form nuclear power plants. Hence, Koeberg is complying with the NNR regulatory requirements and has been doing so for over 20 years.

Comment 28:

Understanding also that these emissions are sometimes unavoidable and often unintentional, there is little basis for the assumption that plants will in fact comply with NNR emission levels set.

Response 28:

Eskom**/** SSR Specialist to input See response 27. If the vendor designs do not comply with the NNR requirements, the plant cannot be build

Comment 29:

The fact that all data regarding the plant arises from Eskom's internal Environmental laboratory cannot be tolerated.

I pose the question as to whether ESKOM management would allow a report to be published by an internal division implicating ESKOM as a major offender?

An example of a discrepancy noted with regard to data is shown below.

The original report from 2002 as signed off by the national nuclear regulator shows that in 2001, the amount of Caesium 137 emitted was 4.49E+10.

This is 4 490 000 000Bq Cs 137.

		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

In the EIRs report Appendix 10 Air quality Assessment I would like to draw your attention to the table 8.12 on page 202 where measured emissions of radionuclides from Koeberg Nuclear Power station are shown. In the year 2001, the amount of all radionuclides coincides with the amounts above for every year except for 2001 the amount for Caesium 137 as emitted is shown as 4E+04. This is 40 000Bq.

This is an exceptionally significant discrepancy and indicates that either Eskom or ESL cannot be trusted with regard to accurate record keeping.

Response 29:

Your comments are noted however as responded to Mr. Mike Kantey in IRR 37 which was attached in Appendix D8 of the Revised Draft EIR Version 1 the figures in the Air Quality Report correspond to

the emission values provided by Eskom (Enviromental Survey Laboratory Report for 2001 Eskom Reference K-16696-E Appendix A). The original list of radionuclide emissions provided by Eskom agrees with all other values. It is possible that the table given above mistakenly refers to the liquid effluent for Cs 137 which is 1.26x1010.

Comment 30:

Nuclear power emissions to take note of are the fission products Strontium 90, Caesium 137 and Iodine 131. When internally ingested these isotopes are absorbed by the body for eg Sr90 is a calcium analogue so is deposited in bone from which it is able to irradiate sensitive hematopoeic (blood forming) tissue at close proximity resulting in the development of leukemia. Sr 90 is not found naturally and its only source is nuclear fission processes.

The most recent ESL report states that activity of Caesium and Strontium have been consistently found in sewerage sludge from Melkbos and Westfleur Sewerage works and in terrestrial and marine samples.

It notes that the detection of activation product in both kelp and seawater collected from Springfontein in November coincides with outage 118. Outage 118 refers to the refuelling incident which resulted in the internal contamination of 90-odd workers at Koeberg. This is a direct example of the fact that when there is too much fission product created (accidentally in this case) it must be released which it is into sea and air.

It states that Sr 90 analysis will be completed by mid 2011 and that thus excludes Sr 90 (possibly the most important readings from a health perspective) from the report.

We have yet to see the figures for Sr 90 from the latest ESL report.

Response 30:

Let us be specific to issues related to this particular EIA. We request that you submit this commentary to the Koeberg Public Safety Forums. As you know, these meetings normally take place four times per year. The Koeberg Visitors Centre is also open Mon-Thus from 07:30.- 16:30 and Fri : 07:30 – 13:00.The contact number is 021 550 4667 during office hours….

Comment 31:

4. Emissions and accidents.

Page 24 states : "Furthermore, should components or materials fail, or should human errors lead to consequences that may have adverse effects on human health and the environment, several layers of backup systems and other controls are automatically introduced to stop the propagation of the IE or to mitigate its consequences. In addition to regulatory dose constraints and dose limits set to protect human health, the NNR also applies the ALARA principle, thereby assuring by a large margin of safety that radiological doses to members of the community would be in the de minimis lifetime risk range.

Furthermore, should radiological doses approach the de manifestis level of risk, the NNR would intervene by taking regulatory action to reduce the risk. There are thus several layers of mitigation to protect human health against the consequences of radiological exposure.

This contradicts the previous assumption that "*For purposes of the EIA, it is assumed that quantified radiological doses through all pathways and routes of exposure at any of the sites with a proposed new nuclear power station will be within the NNR dose limits and dose constraints for public exposure."*

The first excerpt demonstrates the undeniable fact that accidents can happen**.** What this in effect is saying is that emissions will be within the NNR limits except when they aren't.

This is simply not acceptable.

This report makes a mockery of an authentic EIR process. Arcus Gibb and its consultants have not sought to accurately present all data, both positive and negative in a truly unbiased environmental assessment demonstrating the true impact of a new nuclear plant. I would like to state that this EIR and indeed this specific report relating to Human Health, with its heavy reliance on nuclear industry literature and lack of acknowledgment of the latest medical research with regard to exposure to ionising radiation, is fundamentally flawed.

Response 31:

Your comments are noted. The author is reminded that GIBB as independent Environmental Impact Assessment Practitioner responds to its mandate of independency by working within the legislative provisions of the relevant Acts, namely the National Environmental Management Act, 1998 and the National Nuclear Regulator Act, 1999, as well as the DEA / NNR co-operative agreement in order to present the Competent Authority with all relevant information which is in its mandate to do. Therefore as indicated repeatedly in public forums and in EIA documentation the issues of radiological safety are within the mandate of the NNR.

Furthermore, it is not within the mandate of the Environmental Assessment Practitioner to question the legal mandates of either of these statutory bodies or the validity of their agreement within an EIA process. We must, therefore, conduct the EIA based on their legal mandates and their co-operative governance agreement.

In this regard you are also referred to the then DEAT's approval of the Scoping Report, dated 19 November 2008, where the following is stated:

> 2.21 All radiological issues raised during the EIA process, which are not comprehensively addressed, must be explicitly referred to the NNR to be addressed as part of their process.

This response by the DEAT clearly acknowledges that there are some radiological issues that cannot be comprehensively addressed in the EIA process and can only be addressed in the NNR's nuclear licensing process.

Thus in terms of its Assessment of the radiological emissions during emergency events and the readiness of the relevant role players to deal with such events is clearly within the ambit of the NNR owing to its legal mandate in terms of the National Nuclear Regulator Act, 1999 (Act No. 47 of 1999). As with many different forms of development, construction is dependent on authorisations from a number of different legal entities, including local, provincial and national authorities. Construction of such developments is reliant on all these authorisations being obtained from entities with vastly different legal mandates. Reporting requirements to satisfy all these authorisations vary hugely, and it cannot reasonably be expected that information relevant to all these authorisations should be contained in an EIR.

Comment 32

Management of radioactive waste Appendix E29

I will deal briefly here with some of the more obvious flaws:

pg 49 Disposal of Spent Fuel

The National Radioactive Waste Management Policy and Strategy (see Section 2.2) clearly suggests that a long-term management strategy for spent fuel in South Africa has not been agreed upon. Internationally, several counties are in the process of formulating and developing long-term management solutions for their spent fuel. The preferred solution is geological disposal, mainly for its passive safety features, multiple safety functions in terms of natural and engineered barriers,

containment of the waste and excellent ability to isolate the waste from the biosphere and humans over the long term.

i) It is unacceptable that an EIR might be passed where " *a long-term management strategy for spent fuel in South Africa has not been agreed upon"*

Surely a prerequisite for the passing of an EIA would be that there would be an acceptable strategy for the disposal of waste.

In fact the only way to 'solve' the thorny issue of high level waste disposal is to remove it from the public domain and from the EIA process. The only way to do this is to form a separate 'body' which would be responsible for matters regarding high level waste and ensure that this body is adequately protected from public scrutiny. To do this one requires complex legislation in the way of laws and bylaws setting limits and regulatory procedures which would be enforced by another nuclear industry affiliated body, thus releasing it from standard forms of scrutiny.

And thus we now have a National Radioactive Waste Disposal Institute. The clumsy management of this issue is unethical and unacceptable.

ii) Any "*multiple safety functions in terms of natural and engineered barriers"* would merely retard the integration of this waste into the earth which is ultimately inevitable, as there is no known containment vessel which can be manufactured and can possibly remain intact for thousands of years.

iii) On page 14 the report state that the government should investigate the best long term options for disposing of spent fuel, including
1) reprocessing, conditioning and recycling;
2) geological disposal and
3)"transmutation"

On 'transmutation' the author himself says that this is unproven and rather unlikely, so one wonders why it has been included, if not in desperation to provide some form of alternative.

Rudimentary research into reprocessing shows it to be very unsatisfactory also - la Hague in France has been found to be extremely costly and far from solving the nuclear waste problem has amplified it, with discharges from this plant significantly more than dry or wet storage would have been over this period.

We know the difficulties with regard to geological disposal with reference to the experiences of various countries, even though the report refers to several national programs that are I quote "within a decade" of operating a geological repository for HLW and spent fuel, notably Finland, Sweden, and the USA. There was talk that a geological repository would be available in the next decade in a report by the IAEA a decade ago.

Since the beginning of the nuclear industry in the 1940's there have been promises of a plan for high level waste. And yet globally this remains the Achilles heel of the industry and a problem which has not yet found a suitable answer.

There remain globally no adequate long term solutions or disposal sites.

iv) I quote "*The National Radioactive Waste Management Policy and Strategy recognises that the storage of spent fuel is not sustainable indefinitely.*

Government should thus ensure that investigations are conducted within set timeframes to consider the various options for safe management of spent fuel and high-level radioactive waste in South Africa."

Even though this is an issue which has not yet found a satisfactory solution anywhere in the world, the author is optimistic that South Africa will come up with a solution for the spent fuel within a "set timeframe".

CONCLUSIONS

I hold that this EIA is illegal and unethical without adequate analysis of solutions regarding the issue of high level waste.

Failure to assess all potential impacts of nuclear waste violates National Environmental Management act. It also violates EIA Regulations, read together with PAJA 6(2) (b)

Response 32:

Your comments regarding the assessment of the impacts of radioactive waste disposal are noted.

I - iv Please refer to Response 31 in terms of the separation between the EIA process and the NNR licensing process where the then DEAT clearly acknowledges that there are some radiological issues that cannot be comprehensively addressed in the EIA process and can only be addressed in the NNR's nuclear licensing process.

Your comments on the National Radioactive Waste Disposal Institute are noted. However, the above-mentioned specialist study and the EIR are based on on-site storage (as currently applied at Koeberg Nuclear Power Station), as this is the currently applied storage mechanisms for high level waste (HLW). The impacts of on-site storage of HLW may indeed be regarding as significant if no mitigation is applied. However, the on-site storage of HLW is subject to very strict controls that are monitored by the NNR. After the application of these mitigation measures, and based on the experience with the application of these measures at the Koeberg Nuclear Power Station (where long-term storage of HLW has not resulted in health impacts), the impacts of this activity are assessed to be of low significance.

Yours faithfully
for GIBB (Pty) Ltd

The Nuclear-1 EIA Team

Appendix 1

RESPONSIBLE FOR ICRP DOCUMENT #2 (1959) ON STANDARD FORINTERNAL DOSES OF IONIZING RADIATION:

L. BUGNARD: 1956: Member, Conseil Scientifique du Commissariat a la Energy Atomique, France 1956 -1965; Vice-President, Comite de Biologie Commissariat a l'Energie Atomique. 1956 - 1965: Member Scientific and Technical Committee EURATOM.

L.S. TAYLOR: 1948 - 1961: Organized and headed the Biophysics Section in the Division of Biology and Medicine of the U.S. Atomic Energy Commission during above ground nuclear bomb testing (1946 -1963). He was trained as a physicist.

W. BINKS: 1953 - 1963: Secretary of the U.K. Medical Research Council Committee on Protection against Ionizing Radiations. He was trained as a physicist.

J.C. JACOBSEN: 1956 - 1958: Research Director, Atomic Energy Research Station, Risoe, Denmark. 1958 -1969: Consultant to Danish Atomic Energy Agency. He was trained as a physicist.

E.A. WATKINSON: 1959: Principal Medical Officer,University of Toronto; also Department of Environmental Health and Special Projects, Health and Welfare, Canada. He was a physician.

R.G. JAEGER: 1950 - 1962: Chairperson Committee III Protection against Xrays and electrons up to energies 3 MeV and beta and gamma from sealed sources; 1960: International Atomic Energy Agency. He was a West German physicist.

W.V. MAYNEORD: 1947 - 1962: U.K. Medical Research Council committee on Medical and Biological Applications

G. FAILLA: 1946 - 1960: Consultant to U.S. National Council on Radiation Protection and Measurements. Physicist, Director of the radiological research laboratory at Columbia University (died 1961).

R.M. SIEVERT: 1941: Professor of Radiophysics, Karolinska Institute, Stockholm; Co-founder of International Xray and Radium Protection Committee (1928) and of ICRP (1950); Swedish delegate to UNSCEAR 1960. He was trained as a physicist.

H. HOLTHUSEN: 1937 - 1960: Physicist, Member of International Commission on Radiation Units; 1960: Member of West German Atomic Energy Commission.

K.Z. MORGAN: 1934 - 1943: Member of the Research Staff, Atomic Bomb Project, University of Chicago; 1953- 1959: Chairperson of committee II (Internal Doses) of ICRP - Responsible for ICRP Document #2; 1943 - 1972: Director of Health Physics Division, Oak Ridge National Nuclear Laboratory, U.S. Atomic Energy Agency. He was a physicist.

R.S. STONE: 1952 - 1960: Project Director for Health, U.S. Atomic Bomb testing; Member of the Executive Committee of the U.S. National Commission on Radiological Protection. He was trained as a radiologist.

[v] Lehnert, B.E., Goodwin, E.H. Cancer Res. (1997), 57, 2164-71.

[v] Wei Han and K. N. Yu Ionizing Radiation, DNA Double Strand Break and Mutation Advances in Genetics Research. Volume 4 City University of Hong Kong, Hong Kong (2010) Nova Science Publishers, Inc.

[v] Oleg V. Belyakov, Heli Mononen and Marjo Perälä; Radiation Effects Studies of Non-Targeted Effects of Ionising Radiation STUK - Radiation and Nuclear Safety Authority, Helsinki, Finland

[v] Wei Han and K. N. Yu Ionizing Radiation, DNA Double Strand Break and Mutation Advances in Genetics Research. Volume 4 City University of Hong Kong, Hong Kong (2010) Nova Science Publishers, Inc.

[v] Jacob P, Rühm W, Walsh L, Blettner M, Hammer G, Zeeb H., Is cancer risk of radiation workers larger than expected? Occup Environ Med. 2009 Dec;66(12):789-96. Epub 2009 Jun 30. Hemholtz Zentrum München, Institute of Radiation Protection, D-85764 Neuherberg, Germany.

[v] Professor T J McMillan, Professor M R Bennett, Professor B A Bridges, Professor J Hendry, Professor B Jones, Dr C Kanthou, Dr M P Little, Dr A Taylor, Dr I Tzoulaki Circulatory Disease Risk Report of the independent Advisory Group on Ionising Radiation, Health Protection Agency UK, 2010