Nuclear Fuel Cycle Royal Commission

Investigating opportunities and risks for South Australia

Submission from Cancer Council Australia

Cancer Council is Australia's peak national non-government cancer control organisation. Its members are the eight state and territory Cancer Councils, which work together to undertake and fund cancer research, prevent and control cancer and provide information and support for people affected by cancer.

Cancer Council Australia's goal is to lead the development and promotion of national cancer control policy in Australia, in order to prevent cancer and reduce the illness, disability and death caused by cancer.

Cancer is the leading cause of the total burden of disease and injury in Australia. In 2011, there were 118,711 new cases of cancer in Australia (65,983 new cases in men and 50,598 new cases in women), excluding non-melanoma skin cancer (1). Between 1982 and 2014, the number of new cancer cases diagnosed more than doubled from 47,417 to 123,920. An estimated 149,990 are expected to be diagnosed in 2020 (2). Given the impact of cancer on the community, cancer prevention including minimising exposure to known carcinogens, must be a public health priority.

To identify instances of cancer causation mediated by particular occupations or workplaces, and cancer arising as a consequence of environmental pollution, Cancer Council Australia has convened the Occupational and Environmental Cancer Committee. Members of the Committee have national standing in diverse relevant disciplines including epidemiology, molecular and cellular biology, occupational health and hygiene, clinical oncology, public health, workplace relations and include those actively engaged in cancer control through various authorities.

This submission for Cancer Council Australia by the Committee specified has been prepared to comply with the Rules of the Supreme Court of South Australia concerning expert evidence. Members of the Committee providing this submission on oath or by affirmation are specified in Appendix One.

Contact: Terry Slevin, Chair of Cancer Council Australia's Occupational and Environmental Cancer Committee,

This submission

It is noted that the Commission's remit is to inquire into both the opportunities and the risks of South Australia's participation in four areas of activity that form part of the nuclear fuel cycle. Given Cancer Council's core business is public health, and that the carcinogenic properties of ionising radiation are well-documented, our interest in this commission of inquiry is focused on the associated cancer risks of the nuclear fuel cycle.

In this context, Cancer Council's concern is the potential exposure of workers and the community to cancer-causing agents as a result of proposed expansion of the activities related to the nuclear fuel cycle in South Australia.

This submission is made primarily in relation to Question 3.13 in Issues Paper Three. Namely:

> What risks to health and safety would be created by establishing facilities for the generation of electricity from nuclear fuels? What needs to be done to ensure that risks do not exceed safe levels?

Apart from that specific Question, the information provided in this submission is relevant to health and safety issues raised in other Issues Papers, in relation to, for example, the mining, transport and ultimate waste disposal of nuclear fuels, and to that extent, the submission addresses multiple questions. The submission describes the evidence that establishing facilities for generation of electricity from nuclear fuels will increase the likelihood of cancer firstly amongst those employed in the industry, and secondly in the general population.

The ordering of evidence regarding cancer causation.

The generation of electricity through nuclear fuels is consequent upon harnessing ionising radiation once characterised as 'radioactivity'. Clearly, the nature and specification of relevant ionising radiation will be elucidated in evidence provided to the Commission apart from this statement. Accordingly, description of relevant sources and nature of ionising radiation fundamental to nuclear power generation is not provided here. This submission is concerned with the burden of cancer attributable to ionising radiation inherent to generation of electricity through nuclear facilities.

The issue of whether any agent, and specifically ionising radiation arising in the course of the nuclear fuel cycle, may increase the incidence of cancer involves two levels of evidence. The first level – hazard identification –concerns the evidence that ionising radiation is biologically capable of causing cancer in humans. The second level – risk assessment – concerns evidence that particular circumstances of exposure to ionising radiation results in increased incidence of cancer in the relevant population. Information concerning risk assessment may sometimes include numerical determinations of risk.

Hazard identification: Ionising radiation is proven to cause cancer

Evidence that ionising radiation is capable of causing cancer in humans, or to use alternative phraseology, that ionising radiation is carcinogenic to humans, is not delineated here because the matter is settled definitively.

An arm of the World Health Organization, the International Agency for Research of Cancer (IARC) is recognised as providing definitive authority concerning determination of the carcinogenicity of particular agents through the publication series *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans* (the use of the term 'risk' in this title is an anomaly).

IARC Monographs identify agents proven to cause cancer in humans by categorising such agents as Group 1 and describing them as *carcinogenic to humans* (italics in the original). Agents for which evidence is less than definitive may be identified as Group 2A, *probably carcinogenic to humans* or Group 2B *possibly carcinogenic to humans* or certain other categories that are indicative of a lack of evidence or negative evidence.

Recently, through the *Monograph* programme, re-evaluation was made of evidence concerning the carcinogenicity of all types of radiation which were at the time categorised as Group 1 (3). In this context, the following determination was made:

> All types of ionising radiation are *carcinogenic to humans* (Group 1).

Additionally, the following types of radiation which occur during nuclear power generation, were each categorised as *carcinogenic to humans* (Group 1)

> X- and γ-radiation
> Neutron radiation
> Internalized β-particles emitting radionuclides

Overwhelmingly, the evidence concerning cancer causation by ionising radiation concerns X- and γ-radiation. X- and γ-radiation cause cancer of the stomach, colon, lung, skin (specifically basal cell carcinomas), female breast, and thyroid as well as leukaemia (excluding chronic lymphocytic leukaemia) with other tumour types also being caused, although the association is not as strong.

Some of these types of malignancy have been studied in relation to exposure to ionising radiation which occurred as a consequence of nuclear power generation.

Carcinogenic risks related to the nuclear fuel cycle

Workplace risks

Studies of increased risk of cancer amongst nuclear power workers have, for some time, provided less-than-definitive evidence. However, an international collaboration involving data from relevant workforces in 15 countries has provided clearer evidence. The research involved monitoring a cohort of 407,391 workers in the nuclear industry, including 877 from Australia, this Australian workforce being based at a single facility (4). The results suggested that there is a small excess risk of cancer, even at the low dose rates of ionising radiation typically received by nuclear power workers. This publication based on the data from 15 nations overall has been supported by multiple reports each based on the various national studies from the 15 countries collaborating. However, no increased understanding of the overall situation is achieved by reviewing each of those national studies in this submission.

The clear inference of an increased burden of leukaemia among nuclear power workers indicated by the research outlined above was confirmed by further monitoring of a subset of these workers for up to 60 years. The subset was based on those workers from France, the UK and the USA: a grouping which totalled 308,297 workers. In technical terms, follow-up of these workers totalled 8.22 million person-years. The study revealed excess relative risk of leukaemia mortality (excluding chronic lymphocytic leukaemia), with an association between radiation dose and mortality from chronic myeloid leukaemia, the excess risk per Gy (a unit of radiation strength) being 10.45 (per 1000 millisieverts), 95% confidence interval, 4.48-19.65. The relevant publication specifies:

> This study provides strong evidence of positive associations between protracted low-dose radiation exposure and leukaemia.

The use of the word ‘association’ in this context is a technicality, insofar as epidemiological evidence always concerns determination of an association. In respect of the association demonstrated, however, there is no credible interpretation of the data apart from that based on the radiation exposure experienced by these workers in the course of their employment causing the excess leukaemia that was recorded.

Biologically, the finding that leukaemia was caused by exposure to low doses of radiation in the course of normal operations in the nuclear power industry is consistent with the recognised mechanism whereby ionising radiation causes cancer. In this regard, the United Nations Scientific Committee on the Effects of Atomic Radiation concluded (5):

> Even at low doses of radiation, it is likely that there is a very small but non-zero chance of the production of DNA mutations that increase the risk of cancer developing. Thus, the current balance of available evidence tends to favour a non-threshold response for the mutational component of radiation-associated cancer induction at low doses and low dose rates.

Community/environmental risks

Generally, the occurrence of occupational cancer raises the prospect that apart from the relevant workforce, the local community may also be exposed to carcinogen(s) resulting in a burden of cancer 'beyond the factory gate'. Such increased cancer in the local community has been repeatedly demonstrated in relation to, for example, lung cancer caused by air pollution consequent upon iron and steel founding and mesothelioma due to asbestos from mining or manufacturing operations using that carcinogen. Typically, cancer in the community in this context occurs at lower rates than in the relevant workforce because the level of exposure is less.

Increased incidence of childhood leukaemia and other cancers in communities located adjacent to nuclear power plants has been investigated for decades. Tens of studies have been published and review of each such study is not attempted in this submission. Rather, evidence in relation to one site is indicated and then reference is made to reviews and assessments of the totality of available data which provide a clear understanding of progress and current knowledge.

The single most intensively investigated community living near a nuclear facility almost certainly involves those living near the Sellafield reactor at Seascale in the UK. As noted in the most recent update, earlier studies showed raised risks of leukaemia and non-Hodgkin lymphoma in children, teenagers and young adults resident in Seascale at birth or at time of diagnosis. The most recent follow-up (involving Sellafield and another reactor) reported that:

> "Apart from previously reported raised risks, no new significantly increased risks for cancer overall or any diagnostic subgroup were found among children or teenagers and young adults living around either nuclear installation. Individuals born close to the installations from 1950 to 2006 were not shown to be at any increased risk of cancer during the period 1971 to date." (6)

Beyond the immediate findings, this statement illustrates the huge scope, in terms of both time and population that such studies necessitate. This, and similar studies, have indicated that there are two fundamental issues to be addressed.

1. Whether, in the community under investigation, there is an excess of particular cancers in children or others.
2. In circumstances where such an increase is evident, is the burden of cancer caused by the nuclear facility or is some other independent factor(s) at play.

Neither of these issues has been definitively resolved at Sellafield or in respect of many other communities so investigated. Recent editorials indicate that these issues remain subject to ongoing study with little prospect of resolution in the immediate future (7;8).

In 2012, a Workshop was organised on this topic with two objectives: (a) review of results and discussion of methodological limitations of studies near nuclear installations; (b) identification of directions for future research into the causes and pathogenesis of childhood leukaemia. Among the determinations from this workshop were the following statements (9):

> Based on the available literature, the Workshop participants concluded that there was no elevated risk of childhood leukaemia globally near nuclear power plants in children less than 15 years old.
>
> The rather consistent pattern of increased leukaemia risk in the 0-4 year olds needs to be verified in the future and should not be interpreted as a causal association, but it may provide clues about a possible link between childhood leukaemia and living in the close proximity of a nuclear facility.

The ongoing and intense investigation of childhood leukaemia near nuclear facilities is illustrated by the consideration that this report notes that since the Workshop occurred, there have been two more investigations published (one from Canada involving three reactors, the other from UK involving 13 reactors) together with a relevant report from US National Research Council.

In short, the question of whether living close to a nuclear power facility causes increased incidence of childhood leukaemia remains unresolved.

Reactor failures and accidents

The Occupational and Environmental Cancer Committee of Cancer Council Australia is not qualified to address the cause and likelihood of facility failure in any aspect of the nuclear fuel cycle. The Committee is, however, able to address the documented cancer burden consequent upon reactor failure or destruction.

Consequences of reactor failure, in terms of cancer causation, have been documented in respect of a number of sites. This submission is restricted to the Chernobyl failure as illustrative of the disease burden which may be so caused, and the long term investigation which a comprehensive understanding of the situation necessitates.

The Canadian Nuclear Safety Commission recently summarised the Chernobyl disaster as follows (10):

- The 1986 accident at the Chernobyl nuclear plant in Ukraine was the largest uncontrolled radioactive release in history.
- The initial steam explosion resulted in the deaths of two workers. 134 plant staff and emergency workers suffered acute radiation syndrome due to high doses of radiation; of those, 28 of them later died from acute radiation syndrome.
- From 1986 to 2005, more than 6,000 cases of thyroid cancer were reported in children who were exposed at the time of the accident; 15 of these cases were fatal.
- There were no other demonstrated increases in the rates of solid cancers, leukaemia and non-cancerous diseases from the radiation exposure.
- In the three most-affected countries – Belarus, the Russian Federation and Ukraine – radiation doses to the general public were relatively low.

Among many other considerations, the circumstances at Chernobyl illustrate that the cancer burden has primarily involved children. The relevant studies also further establish how passage of time and ongoing study are necessary for clear understanding of the nature and extent of cancer causation. Causation of thyroid cancer in the affected community has been well-documented for more than a decade (11). Yet publications only this year have

elucidated different pathological types of thyroid cancer variously evident as time passes (12) and indicated that while increased non-thyroid cancer is not presently evident, continuing monitoring is required (13). The cost of reactor failure, in terms of lives lost and lives subject to an ongoing requirement for medical and other care, is clear.

The cancer burden and preventive options

Taking account of the most recently published data, the likelihood of an increased incidence of leukaemia occurring among nuclear power workers worldwide now approaches certainty, and hence establishes that a known burden of radiation-induced malignancy is a consequence of nuclear power generation. This disease burden is inherent; there is no evidence of it being eliminated by conventional approaches to occupational safety and health predicated upon measures extending from good engineering practice to personal protective equipment. Neither is this burden of disease amenable to prevention by good work practices in respect of those exposed.

Nuclear power generation is not proven to cause cancer in children and others from the surrounding community. But neither can the possibility be excluded to the point of recommending that the matter need not be subject to further investigation. The risk of such cancer is low, but awareness of the risk is universal in relevant communities, if only because of the inevitable request to register children in monitoring programs. Research on this risk is ongoing; there is no prospect of preventive measures apart from re-location.

The burden of cancer and any other health outcomes caused by a major reactor failure in Australia cannot be specified. The risk is reduced by rigorous adherence to engineering and workplace standards which are enforced by competent statutory authority.

Conclusion

The establishment of nuclear industry for power generation will result in some cases of malignant disease, most likely leukaemia, which would not otherwise arise in the relevant workforce. Independently, the community located near such a facility will be subject to a burden of anxiety concerning the prospect of childhood leukaemia.

References

(1) AIHW. Australian Cancer Incidence and Mortality (ACIM) Books – All Cancers combined for Australia (ICD10 C00-C97, D45-46, D47.1, D47.3). Australian Institute of Health and Welfare. Available at http://www.aihw.gov.au/acim-books/; 2015.

(2) AIHW. Cancer incidence projections: Australia, 2011 to 2020. Cancer Series no. 66. Cat. No. CAN 62. Canberra: Australian Institute of Health and Welfare; 2012.

(3) IARC. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Vol 100 D. Radiation. Lyon: International Agency for Research on Cancer; 2012.

(4) Cardis E, Vrijheid M, Blettner M, Gilbert E, Hakama M, Hill C, et al. Risk of cancer after low doses of ionising radiation: retrospective cohort study in 15 countries. Brit Med J 2005 Jul 9;331(7508):77.

(5) United Nations Scientific Committee on the Effects of Atomic Radiation. UNSCEAR 2010 Report: Fifty-Seventh Session: Includes Scientific Report: Summary of Low Dose Radiation Effects on Health. New York: United Nations; 2011.

(6) Bunch KJ, Vincent TJ, Black RJ, Pearce MS, McNally RJ, McKinney PA, et al. Updated investigations of cancer excesses in individuals born or resident in the vicinity of Sellafield and Dounreay. Br J Cancer 2014 Oct 28;111(9):1814-23.

(7) Muirhead CR. Childhood leukaemia near nuclear power plants. Br J Cancer 2013 Nov 26;109(11):2763-4.

(8) Wakeford R. Childhood leukaemia and nuclear installations: the long and winding road. Br J Cancer 2014 Oct 28;111(9):1681-3.

(9) Laurier D, Grosche B, Auvinen A, Clavel J, Cobaleda C, Dehos A, et al. Childhood leukaemia risks: from unexplained findings near nuclear installations to recommendations for future research. J Radiol Prot 2014 Sep;34(3):R53-R68.

(10) Canadian Nuclear Safety Commission. Health effects of the Chernobyl accident. Available at http://www.nuclearsafety.gc.ca/eng/resources/health/health-effects-chernobyl-accident.cfm; 2015.

(11) Cardis E, Howe G, Ron E, Bebeshko V, Bogdanova T, Bouville A, et al. Cancer consequences of the Chernobyl accident: 20 years on. J Radiol Prot 2006 Jun;26(2):127-40.

(12) Yip L, Carty SE. Systematic screening after Chernobyl: insights on radiation-induced thyroid cancer. Cancer 2015 Feb 1;121(3):339-40.

(13) Hatch M, Ostroumova E, Brenner A, Federenko Z, Gorokh Y, Zvinchuk O, et al. Non-thyroid cancer in Northern Ukraine in the post-Chernobyl period: Short report. Cancer Epidemiol 2015 Jun;39(3):279-83.

Appendix One

This submission was prepared for Cancer Council Australia by the Occupational and Environmental Cancer Committee. Members of the Committee providing this submission on oath or by affirmation are:

Mr Terry Slevin (Chair)
Professor Bernard Stewart
Associate Professor Deborah Glass
Professor Tim Driscoll
Professor Lin Fritschi
Mr Paul Grogan
Ms Alana Sparrow
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