COMMISSIONER: Good morning.

DR CALDICOTT: Good morning.

COMMISSIONER: Welcome, Dr Caldicott.

DR CALDICOTT: Thank you.

COMMISSIONER: This morning we're talking the effects and threats of radiation, and as our first witness, we welcome Dr Helen Caldicott. Counsel.

MR JACOBI: Inquiring into the risks associated with potential future nuclear activities, our primary concern is the risks to humans, animals and environmental health posed by radiation. Indeed, that is a risk particular to the engagement in nuclear activities. This issue has been the subject of considerable attention in the submissions received by the Commission from a broad range of groups. Those submissions contain not only strongly held but widely disparate views. This is remarkable because radiation has, for more than a century, been scientifically studied.

The types of radiation and sources, both from the natural environment and human made, are, from a scientific stand, well known and it has since been the subject of considered analysis and study, among other matters, as to its health effects, its utility and treatment, the nature of occupation risk, and the availability of measures to protect humans from exposure in those contexts. It is essential that on this topic, the Commission can identify the areas of broad agreement with respect to risk, the scope of disagreement, and where there are differences in views, the underlying reasons for them.

It is also essential that the Commission is able to describe with accuracy the consequences and risks when facilities operate both as expected and the extent of the risks presented by accident or emergency scenarios. The notable examples to be addressed in the evidence today are the incidents at Chernobyl and again, it having been addressed in the evidence last week by Dr Stephen Solomon, the events at Fukushima Daiichi. For that reason, the focus of this session is on radiation, and the effects and threats of radiation is upon the evidence that is said to support the various claims.

It will, for that reason, be an important theme of this session as it is for the Commission generally that witnesses can identify for the basis of the statements made and be able to explain the rationale for their views and the reasons for any differences of opinion. Without that it's difficult for the Commission to proceed with forming an evidence-based conclusion as to the nature of the risks presented by prospective witnesses.

Dr Helen Caldicott received her medical degree from the University of Adelaide Medical School in 1961 and founded the Cystic Fibrosis Clinic at the Adelaide Children's Hospital, was an instructor in paediatrics at the Harbour Medical School and on the staff of the Children's Hospital Medical Centre in Boston until 1980. In 1978, she was the founding president of Physicians for Social Responsibility, which was awarded the 1985 Nobel Peace Prize. In 1978, she founded the Women's Action for Nuclear Disarmament. She was nominated for the Nobel Peace Prize by Linus Pauling.

In 2002, Dr Caldicott founded the Nuclear Policy Research Institute, NPRI. She is currently the president of the Helen Caldicott Foundation, which arranges forums through which to provide information to the public on the risks of nuclear energy and nuclear weapons. Helen Caldicott has made numerous television and radio appearances and has written nine books and peer-reviewed articles on the health risks of radiation. She is a paediatrician and a fellow of the Royal Australian College of Physicians, a diplomat at the American Board of Paediatrics and a member of the American Thoracic Society, and the Commission calls Dr Helen Caldicott to give evidence today.

DR CALDICOTT: Thank you.

COMMISSIONER: Dr Caldicott, in your submission you tendered evidence about the medical implications of the release of radiation following the Chernobyl and Fukushima accidents, and we want to get to that in some detail.

DR CALDICOTT: Mm-hmm.

COMMISSIONER: But perhaps to start, you might just give us a very brief precis of what you think the medical implications from both those accidents are, and then we'll move into the specifics.

DR CALDICOTT: Thank you for asking me. There are basically four sorts of radiation: x-rays, to which we've all been exposed, that goes straight through your body and you don't become radioactive; then there's gamma radiation given off by many radioactive elements made in nuclear power plants and by uranium and its daughters, and that's like x-rays too. So miners who are mining uranium are exposed to consistent gamma radiation to their whole bodies, including their testicles where the genes and sperm could be mutated. That's dangerous.

Then there's alpha radiation, which is particulate, emitted from an alpha emitter like plutonium or uranium, two protons and two neutrons. You can hold an alpha emitter like plutonium in your hand and the radiation doesn't get through the dead layers of skin. However, if you inhale plutonium, one-millionth of a gram - and I've got a picture here of, like, a little star - in the liver or the lung

kills most of the cells in that area because it's so toxic, but on the periphery, as radiation decreases with the square of the distance, cells remain viable and there's a mutation in the regulatory gene that controls the rate of cell division.

The cell will sit latent and quiet for any time from four to 80 years. That's called the latent period of carcinogenesis, the incubation time for cancer. Then one day, instead of it multiplying by mitosis into two, it goes crazy and produces trillions of cells. That is cancer. A single mutation in a single gene in a single cell can cause cancer, and we usually can't stop the growth of cancer.

Then there's beta radiation which is emitted and that's just an electron from an atom. These alpha and beta emitters, many of which are made in nuclear power plants, need to get inside the body, inside - they're called internal emitters - to damage you, but gamma radiation in x-rays can damage you from the external. Now, we're all exposed to external radiation, natural radiation. It's thought about 30 per cent of cancers we see are caused by that. No radiation is safe. Each dose you get from a dental x-ray, medical x-ray, adds to your risk of getting cancer.

COMMISSIONER: I wonder if we could just move directly on to your evidence about the accidents and what you saw from that. I think we've got the background from - so perhaps going to the Fukushima accident.

DR CALDICOTT: Okay. Fukushima. So do you want me to walk you through the accident and location?

COMMISSIONER: Just briefly and then we'll go into the detail.

DR CALDICOTT: Yes. Okay. So I knew the three GE engineers who designed the Mark 1 GE reactors. They resigned in 1975 because they said these reactors were too dangerous.

COMMISSIONER: I'm really looking for the accident rather than - - -

DR CALDICOTT: Yes. Okay. So they built the reactors at sea level. They dug a cliff and built them at sea level. Big earthquake.

COMMISSIONER: Yes. I understand that.

DR CALDICOTT: Yes, tsunami. So they lost their external electricity supply. They lost the pumps to pump the million gallons of water per minute into each reactor. They had diesel generators underneath, which then drowned from the tsunami. Therefore, within a few hours three reactors melted down. The Japanese government didn't inform the people for three months that that

had happened. In that time, huge amounts of radiation was released, three times the amount of noble gases, argon, krypton and xenon, than at Chernobyl. Three reactors. Large amounts of caesium, about the same as at Chernobyl, and many other isotopes, which I will refer to shortly, not just caesium but many, hundreds, very short-lived ones which are very dangerous because they're very radioactive.

The wind blew from west to east across the Pacific for two days, so people escaped, but it changed and blew across Japan, as you know. People fled into the path of the highest radiation levels. The Japanese government did not inform the people. They knew where it was going. The Americans were monitoring the radiation by planes and the Japanese had a speedy system to monitor. They didn't want to create panic. So the people fled into the highest radiation doses. And it was an horrific accident with four explosions. One at cooling pool 2, I think, experienced an excursion, which probably was a nuclear explosion. The others were hydrogen explosions.

COMMISSIONER: The evidence of which, you say, there was a nuclear explosion?

DR CALDICOTT: Yes. An excursion, that comes from Arnie Gundersen, a nuclear engineer who actually testified before my symposium in Europe at the Academy of Medicine last year.

COMMISSIONER: The implications, health implications from that – from those activities.

DR CALDICOTT: Okay. Huge amount of radiation was released and I'd like to go to the fourth slide. These are all the elements in a reactor. Now people only just talk about caesium and tritium and iodine and strontium. Some are very short lived but some are very long lived, hundreds or thousands of years and I want to just walk you through very quickly to see how many radioactive elements there are. The polonium that's an alpha emitter, some are beta, some are alpha, many are gamma. All the way down to tunium, terribly dangerous like plutonium, plutonium many isotopes. (indistinct) and that. So what we are talking about when there is a meltdown, those elements are released in to the air and people only virtually measure the caesium and the radioactive iodine. They don't measure the tritium and they tend not to measure the noble gases. Noble gases are called noble because they don't combine chemically in the body, argon, krypton and xenon. However when you inhale noble gases, xenon, it's absorbed through the lung. It's a very high-energy gamma, like x-rays and it is absorbed by the fatty tissue of the body. We used to use it in medicine to measure fat.

I used to use it for ventilation for fusion scans in my patients and the fatty

deposits tend to be the abdominal fat pad and the upper thighs where the gonads are. And therefore, the testicles and ovaries can be exposed to high-level gamma radiation which won't matter in this generation, nor for many generations hence because mutations are usually recessive, like cystic fibrosis, one in 25 of us carry that gene but the normal gene negates the cystic fibrosis gene. You need two cystic fibrosis genes to have the disease, so it takes a long time for generations, for those two genes to get together. There are 2,600 genetic diseases now described. Almost all mutations cause disease and deleterious effects upon the human population, in not just humans but animals and plants. So that's the noble gases but all the other isotopes which are not being measured and which land on the ground and which concentrate in the food and to which people are exposed, are not measured. What's your next question?

COMMISSIONER: We might go straight on now and examine the evidence in relation to the medical implications after that. Mr Jacobi.

DR CALDICOTT: Yes.

MR JACOBI: I just wonder perhaps, you made a submission to the Commission which is available on the Commission's website and I just wanted to start off by asking – we have seen significant conflicts or diverse views expressed with respect to radiation effects in the submissions that we have received. I am just interested to understand what you regard as the critical sources of information concerning the radiation effects - - -

DR CALDICOTT: Yes.

MR JACOBI: - - - of Chernobyl and Fukushima. What do you say are the critical sources?

DR CALDICOTT: I don't regard the IAEA as credible because it has two missions; one to promote nuclear power and one to regulate it. The IAEA signed an agreement with WHO in 1959 that WHO could not examine any nuclear accident unless the IAEA said it could. Therefore it did not examine on the ground the medical effects of Chernobyl, nor Fukushima so WHO in this context is highly compromised. In other contexts, it's not. UNSCEAR is – much of it is populated with pro-nuclear people or not physicians or people who really understand radiation - - -

MR JACOBI: Sorry, I just - - -

DR CALDICOTT: - - - and let me - - -

MR JACOBI: Sorry. Can I just say for the transcript that you have referred to

UNSCEAR, that is the United Nations.

DR CALDICOTT: Yes, sorry. I missed - - -

MR JACOBI: Scientific Committee - - -

DR CALDICOTT: Yes, on radiation.

MR JACOBI: - - - on the effects of atomic radiation.

DR CALDICOTT: Now let me say that my colleagues, the medical profession, really understand radiation and the biological ramifications of radiation and in fact, we are the biggest irradiators of the public at the moment, let's be frank. CT scans give you a hell of a dose, mammograms and the like, and we are not careful enough with radiation and we should be and there are more and more articles coming out about that. But - - -

MR JACOBI: Sorry. Could I just interrupt, what was your specific criticism of UNSCEAR because - - -

DR CALDICOTT: I am going to read it to you.

MR JACOBI: Okay.

DR CALDICOTT: So here is a critique from IPPMW, the International Physicals for the Prevention of Nuclear War, which I helped to found, criticising the UNSCEAR report. I will read it:

> *Before detailing the multiple inaccuracies of the UNSCEAR report, the doctors list four major points of agreement. First, UNSCEAR improved on the world - - -*

Well I won't go through that. What was - - -

MR JACOBI: Perhaps if you could just give us the reference, that is fine.

DR CALDICOTT: Yes. But I want to read out the rest, because this is very important.

> *The total amount of radiation – radioactivity released by the disaster was under estimated, this is Fukushima, by UNSCEAR, and its estimate was based on disreputable sources of information. It ignored frequent five years of non-stop emissions of radioactive materials that continued unabated and only dealt with releases during the first weeks of the disaster. Fukushima is presently*

*releasing huge amounts of radiation in to the air and water in petabecquerels. That is ignored. UNSCEAR relied on a study by the Japanese Atomic Energy Agency which the IPPMW points out was severely criticised by the Fukushima Nuclear Accident Independent Investigate Commission for its collusion with the nuclear industry. The Independent Norwegian Institute for Air Research estimate of caesium was four times higher than UNSCEAR figure, even Tokyo Electric Power itself estimated that iodine 131 releases were over four times higher than UNSCEAR estimate. Internal radiation taken up with food and drink - - -*

Which I told you about the internal emitters,

*- - - significantly influences the total radiation dose that an individual exposed to, the doctor's note and their critique warns pointedly, UNSCEAR uses as one of – one – as it's one and only source, a still unpublished database of the IAEA and the Food Agricultural Organisation. It therefore has profound conflict of interest. Food sample data from the IAEA should not be relied on as it discredits the assessment of the internal radiation doses; it ignores them and makes the findings vulnerable to claims of manipulation, as with its radiation release estimates. IAEA, UNSCEAR ignored the presence of strontium in food and water which is a major carcinogen. Internal radiation dose estimates made by the Japanese Ministry for Science and Technology were 20, 40 and even 60 times higher than the highest numbers used in IAEA, UNSCEAR reports. To gauge radiation doses endured by over 24,000 workers, and it's more than that; UNSCEAR relied solely on figures from TEPCO, that severely compromised owners of the destroyed reactors.*

*The UNSCEAR report disregards current scientific fieldwork on actual radiation effects and this is the only scientific work that has been conducted at the moment in Japan on plant and animal populations. Peer reviewed ecological and genetic studies from Chernobyl and Fukushima find evidence that low dose radiation exposures cause, the doctors point out, genetic damage such as increased mutation rates as well as developmental abnormalities, cataracts, tumours, smaller brain sizes in birds and mammals and further injuries to population. The special vulnerability – the embryo and foetus to radiation was completely discounted by UNSCEAR, the physicians note. The doses to the foetus or breastfed infants would have been similar to those of other age groups which goes against basic principles of neonatal physiology and understanding. Because the foetus is by hundreds – the orders*

*of magnitude more sensitive to radiation than others and they ignored that. And also in utero exposure can be teratogenic which can produce damages such as this. Damages the foetus in the first three months of intrauterine life, killing a cell that's going to form the right arm, or the left part of the brain.*

*And here are some other shocking pictures which I currently have lost of women who were exposed to caesium in an area in the Ukraine where they harvest their own food and they've got very high body levels of caesium. They have conjoined twins, Siamese twins and encephalopathy, babies born with no brains, spina bifida, microcephaly, microphthalmia and the like. Non-cancerous diseases associated with radiation doses, and this is very important, because UNSCEAR only looks at cancer, such as cardiovascular diseases because seizing concentrates in cardiac muscle and the thyroid and endocrine glands and there are a lot of sudden heart attacks in the Ukraine and the like from Chernobyl, especially in children. Endocrinology because there's a lot of diabetes because seizing concentrates in the pancreas where insulin is formed, infertility, genetic mutations in offsprings and miscarriages.*

*This has been documented in peer reviewed medical journals but are totally dismissed by UNSCEAR. The physicians remind us that large epidemiological studies have shown undeniable associations of low-dose radiation to noncancer health effects and have not been scientifically challenged. The report plays down the health impact of low-dose radiation by misleadingly comparing radioactive fallout to natural background exposure. IPPNW scolds UNSCEAR saying it's not scientific to argue that natural background radiation is safe, which it's not, and that excess radiation from nuclear fallout that stays within the dose range of natural background radiation is harmless, and that's what UNSCEAR proposes. In particular, ingested or inhaled radioactive materials deliver their dose directly and continuously to the surrounding tissue, bone, thyroid, muscles, et cetera, and therefore pose a much higher danger to internal organs, and they ignore that.*

*Their measurements of food stuffs were totally inaccurate and they only took a few measurements of foodstuffs.*

COMMISSIONER: Perhaps we could - - -

DR CALDICOTT: I'm sorry, it's long but it's terribly important.

COMMISSIONER: I guess we want to question some of that evidence.

DR CALDICOTT: Why?

MR JACOBI: Why do we want to question it? Because we're trying to get to understand it.

DR CALDICOTT: But this is all sourced from peer reviewed articles in the medical literature by a group of very highly qualified physicians.

MR JACOBI: Can I just ask you for it, Ms Caldicott. Who is the author of what you're currently reading from?

DR CALDICOTT: This is a summary from UNSCEAR document written by John LaFarge but he took out the main points of the IPPNW document but I didn't have time to print the main IPPNW document, which you can certainly access on the Internet.

COMMISSIONER: We'll do that.

DR CALDICOTT: And I would suggest that you do that, and I apologise for not having the original IPPNW document, which is imperative. The other thing I do want to say - - -

MR JACOBI: Can I also ask you, what's been the response in terms of the criticism that's been made, that's just been made there? When was that particular criticism made? That was made in 2014. Is that right?

DR CALDICOTT: Yes.

MR JACOBI: What was the response of the organisations to that?

DR CALDICOTT: The report was - actually UNSCEAR was 13 and this report by IPPNW - I'm sorry, I don't have the date that it was - 2014.

MR JACOBI: Perhaps if I - - -

DR CALDICOTT: The response is very little because not very many people either read the UNSCEAR documents or the IPPNW documents. They're not available to the public and there are not many people on television or radio promoting or talking about the results of this. I want to say one other thing: the only cancer that's being studied now in Japan is thyroid cancer. Thyroid cancer is caused by radiation, but all cancers - all cancers - are caused by radiation, and leukemia and the other abnormalities or pathologies I've

described.

They examined about 400,000 children under the age of 18 at the time of the accident by ultrasound, by fine needle biopsy and by removing the nodules. At this time - and they've still got more to go - 127 children have been diagnosed with thyroid cancer.

MR JACOBI: You suggested that the only cancer that's being studied is thyroid cancer.

DR CALDICOTT: In Japan.

MR JACOBI: What's your source for that particular statement?

DR CALDICOTT: God. The source - well, I'll have to send it to you.

MR JACOBI: If you don't know right now, that's fine. But I'd appreciate - - -

DR CALDICOTT: I need to take a note.

MR JACOBI: - - - if you could send it to us because these are - - -

DR CALDICOTT: Anyone got a pen?

MR JACOBI: Yes, I can make a note and provide it to you there after.

DR CALDICOTT: No, that's your pen. I cannot - where's my pen? Sorry, I don't have the source but it's not one source, it's many sources and I just want to finish that by saying the normal incidence of thyroid cancer in a population of children under the age of 18 is one to two per million and we've now got 127. These cancers appeared two to three years later. The cancers of thyroid in Chernobyl appeared four years later, although they didn't start looking for thyroid cancers until four years afterwards because the Soviet government denied what was going on in Chernobyl. There's been a huge number of thyroid cancers post-Chernobyl. I've got references to that in my books.

So thyroid is the first to appear but leukaemia will start appearing at five years. So the latent period for thyroid cancer is about two to four years. Leukaemia is five to 15 years. We get that from the Hiroshima and Nagasaki data. Solid cancers start appearing about 25 years later. Their latent period of carcinogenesis is any time from 25 to 80 years, and no cancer denotes its origin. So you have to do big epidemiological studies - many of which have been done.

COMMISSIONER: Let's move on to some of the specifics of your

submission.

MR JACOBI: Can I just - in fact it's come up in something that I think you've already said, which is that you've expressed a view in your submission that no dose of radiation is safe and in fact that's something that you said today about your submission at page 3. I just wonder whether you want to offer a reference to support the conclusion.

DR CALDICOTT: Yes, I can.

MR JACOBI: I think you've otherwise expressed it in terms that even background radiation will give rise to a risk of cancer.

DR CALDICOTT: Yes.

MR JACOBI: I'm just interested in what is the source for that particular proposition.

DR CALDICOTT: BEIR VII report, the biological effects of radiation by the National Academy of Sciences. BEIR VII, biological effects of ionising radiation. They - - -

MR JACOBI: I'm interested particularly at low or very low doses; that is - - -

DR CALDICOTT: Yes, right down to zero. In fact a new study has been reported where about 400,000 nuclear workers have been studied and they've been studied by Public Health Department of England, the Institute of Radiation and Protection in France, the Centre for Research of an Epidemiological in Spain, et cetera, et cetera. It's an international study and it shows that the risk of cancer to nuclear workers - excluding neutrons, which are very carcinogenic - was double what they thought it was originally in their estimates and the doses go down to .1 rem per year, or .1 millisievert per year.

MR JACOBI: I think that's slightly different than my question. My question was directed at the idea of - I think the proposition was advanced that even background radiation can be demonstrated to cause cancer.

DR CALDICOTT: Yes.

MR JACOBI: I'm just interested in the evidence that supports that particular proposition.

DR CALDICOTT: That's just generally known in the medical literature. I didn't bring the medical literature with me but I'm sure it's written in the BEIR report for biological effects of ionising radiation. We accept that, and I'll

tell you why - - -

MR JACOBI: But can I just raise that we've at least seen some contention in submissions about - - -

DR CALDICOTT: I know.

MR JACOBI: - - - the LNT hypothesis and its - - -

DR CALDICOTT: It's not a hypothesis; it's proven. It's proven by this extraordinary study of all these nuclear workers were right down to zero there's an excess incidence of cancer, right down to zero. This is a peer reviewed study done by international Centres for Disease Control, National Institute for Occupational Safety, Department of Health and Human Services. This is all done by international organisations and they all agree and it was published in I think The Lancet. So there's no disagreement.

Now, let me just go back for a second. It's background radiation when the earth was much radiologically hotter that induced mutations that caused fish to develop lungs, birds to develop wings and eventually this wonderfully species of us developed with opposing thumbs and huge brains. However, most mutations are deleterious and cause disease and they cause cancer, and they cause abnormalities like mutations and - which I'll show you with the swallows and the like. So background radiation is a cause of mutation. Mutations in a regulatory gene in a cell can cause cancer. Mutations in other genes can cause genetic disease. Therefore background radiation is responsible for I think about 30 per cent of the cancers we already see.

MR JACOBI: I was going to ask you about that as well.

DR CALDICOTT: Even the mummies in Egypt had cancers. So that's why cancer is more common in older people, because we live longer and are exposed to more background radiation and x-rays, and also the 80,000 chemicals that are in common use now, many of which are carcinogenic. So there's a synergism between radiation and chemicals in the environment.

MR JACOBI: Can I also ask you - I'm interested actually to go back to the 30 per cent. Do you have a source for that particular division between cancers that are said to be induced from background and otherwise the 70 per cent, which I assume is from other intermediate or anthropogenic sources?

DR CALDICOTT: Yes, I do. I think it's in my book here, but I'll have to look it up for you, okay, and I - - -

MR JACOBI: That's all right. Perhaps we can write you an email after this

and ask you - - -

DR CALDICOTT: Why don't you write me an email? I'll send you the reference.

MR JACOBI: We'll do that. That would be terrific.

DR CALDICOTT: Yes. Sorry, I can't - - -

MR JACOBI: That's all right.

DR CALDICOTT: I couldn't come with all references in hand.

COMMISSIONER: No, that's fine. Well, it's not a quiz in that sense. So we haven't - - -

DR CALDICOTT: Well, it kind of is, but I have to have everything in my hand. Background. Here we are. 40, 44. I don't know if it says it. Radiation, health.

> *It's thought that about 80 per cent of cancers we see are caused by environmental factors, whereas only 20 per cent are inherited. Cancer has plagued the human race. It is generally accepted that many cancers in the past and the present have been and are caused by background radiation.*

And then I said because aging exposes people to increased levels it's a disease of old age. But I can certainly send you the reference to that.

MR JACOBI: Can I just ask you, in your submission under a heading - this is page 4 at fact number 3 - you refer to acute radiation sickness.

DR CALDICOTT: Yes.

MR JACOBI: And then there's a statement following it that, "Reports of such illnesses, particularly in children, appeared within the first few months after the Fukushima accident." I'm interested in the source of that particular statement.

DR CALDICOTT: Okay. Acute radiation sickness is - I was actually wrong with that. Acute radiation sickness is when you get a hell of a dose of radiation and it was newly described by - we'd never seen this before until Hiroshima happened, and one of our journalists - and I can't remember his name - got in past the American military and looked at the disease in the hospitals and doctors were scratching their heads. People were dying with their hair falling out, blood under their skin, vomiting, and bleeding to death, and what we

realised was that very high levels of radiation kill the actively dividing cells of the body, which is hair, gut and blood cells.

And that man, Litvinenko. Do you remember the Russian man who took tea in Claridge's and someone dropped some polonium in his tea, and he died within two weeks of acute radiation illness, hair dropping out and the like? Actually patients we give high radiation doses to with cancer trying to cure them and get - - -

COMMISSIONER: We're trying to understand your evidence in relation to Fukushima.

DR CALDICOTT: Yes. That's right. So there's a report, and they're anecdotal. They're not collected by physicians, because physicians aren't collecting on the ground this sort of data. Anecdotal reports of lots of children developing nose bleeds, meaning they were low in platelets. And I do have some physicians' reports from Tokyo where the fallout was very high, and there are a lot of infectious diseases. So when radiation damages the white blood cells, you're much more predisposed to infection than normal people, particularly children.

MR JACOBI: Yes. UNSCEAR - and though I understand your views you've expressed about UNSCEAR - have expressed a view in its report, and this is at page 11, paragraph 38, that, "No radiation-related deaths or acute diseases have been observed amongst the workers or general public exposed to radiation from the accident."

DR CALDICOTT: Well, that's because they haven't been studied by doctors, or analysed and written up in the literature. So they're winging it, because they don't know. There's no data and the data I have comes from my colleagues who are treating patients in Tokyo and high radiation areas and it's anecdotal and I'll send you that, but please send me an email.

COMMISSIONER: Yes, we will. The UNSCEAR report we had the other day had doctors involved - - -

DR CALDICOTT: What sort of doctors? Medical doctors?

COMMISSIONER: Medical doctors, yes. Well, that was the evidence we were given.

DR CALDICOTT: Well, I'd like to see their credentials, please.

COMMISSIONER: Okay. Well, I'm just trying to understand the differences of view.

DR CALDICOTT: Yes. I understand from your perspective as a lay person who it's very hard to understand this. It's very complex, but if you ask any of my colleagues - what I'm saying is - - -

COMMISSIONER: What is complex is that you say that there are no medical doctors in that and the people responsible for the UNSCEAR report say there is.

DR CALDICOTT: All right. Well, I need to see them.

COMMISSIONER: Okay.

DR CALDICOTT: Yes, and their affiliations.

MR JACOBI: Your submission says that, as I understand it, that Fukushima will cause an epidemic of cancer as people inhale or ingest radioactive elements, I think expressed in terms of eating or drinking, and as I understand it, that's an argument that is based on biological accumulation. Is that right?

DR CALDICOTT: Well, too, their initial exposure by very high levels of gamma radiation from the short-lives isotopes as they fled into plumes of radiation, and also with what's being discharged daily from the Fukushima reactor, and into the water, three to 400 tonnes per day since the accident of very highly polluted radiation water into the Pacific per day, three to 400 tonnes, and the oceanographers are examining this. It's now starting to be found on the west coast of America and Canada.

Tuna are being caught in California with caesium emanating from Fukushima. We could be catching fish now that swim south instead of west to east with radiation in them from Fukushima. And it's going to get worse, because there's no way they can stop that flow of water into the Pacific. It's very, very serious.

MR JACOBI: Again, though I understand what you said about WHO and UNSCEAR, WHO, in their report in 2013, expressed the view that - and I'm quoting here - "Outside the geographic areas most affected by radiation, even in locations within Fukushima, the predicted risks remain low and no observable increases in cancer above natural variation in baselines are anticipated."

DR CALDICOTT: How the hell do they predict that? No one measured the doses that people received. No one has put the people in whole-body counters to find out how much caesium, et cetera, they have in their bodies. No one knows how much radioactive iodine they inhaled or ate in their food or drank in their milk, because radioactive iodine only lasts for 120 days and then it

decays to zero. The measurements haven't been done. In fact, the only scientist in Fukushima and Chernobyl actually getting data is Tim Mousseau, an evolutionary biologist who's looking at the birds. Can we go back to the slide, please, Lucy, of the swallows?

Yes. Okay. He's examining the barn swallows both in Chernobyl and Fukushima. The little white patches are albinism. Their mutations producing white feathers, and under the beak there's albinism. That's a beak deformity, number F, caused by a mutation. That's their air sacs, abnormal air sacs, number G. These are abnormal tail feathers caused by mutation, and I don't have one with cataracts actually. That's a normal one in A, but many of the birds have cataracts. 40 per cent of the male birds are sterile. Their brains are smaller than normal. Their populations are decreasing. What happens to birds happens to humans.

Look at me Chad. We test our drugs on animals to make sure they'll be safe for humans. That's how we practice medicine. Animals have the same biological systems as us. So you can extrapolate from the barn swallows and other animals, they've been - and they've written several hundred papers in peer-reviewed literature. This is only actual data collection that is going on in Japan right now. So it is for WHO and UNSCEAR to extrapolate with no data, no dose. They're just guessing. They guess the measurements, and that's not science.

This is science, and this man will win the Nobel Prize, I think, because he's changing our attitude towards radiation by doing basic research which no one else is doing. He can't even get funding for the research, because the nuclear industry is so powerful, it influences government so he can't get funding to do this basic biological research.

MR JACOBI: You've expressed that in terms of exposure, and as I understand it the UNSCEAR report, and your submission refers to the fact that people were exposed to high levels of whole-body gamma radiation.

DR CALDICOTT: Yes.

MR JACOBI: And the UNSCEAR report on that topic states that for adults the effective dose - and that's expressed in millisieverts - estimated to have been received before and during the evacuation was on average less than 10 millisieverts and about half that level for those evacuated on 12 March 2011.

DR CALDICOTT: It's an estimate. They didn't measure. No one measured it. It's an absolute estimate. That's what they did about Chernobyl, the Chernobyl report. They estimated. They don't get on the ground and actually

measure the food, measure people with whole-body counters. They don't, like these doctors in Russia - this is the only document that actually looks at diseases in people in the Ukraine and Belarus and around the area. I may say that there's a war going on in the Ukraine at the moment. There are 15 reactors the same size as Chernobyl. Any bomb dropping on a reactor could cause a meltdown. This is the most extraordinary document. I'm a paediatrician and highly trained, if I may say so. It's the most extraordinary medical document I've ever read. Now, it's not very carefully peer reviewed. Therefore the New York Academy of Sciences, they published it but after a few years they disclaimed it because there were quite a few pro-nuclear people on the academy and they said, "Well, it's not peer reviewed." It's the only document that's been done. The only medical data on the ground to look at patients.

MR JACOBI: On that topic, perhaps we'll come to Chernobyl. I know about the - the document you're referring to is Yablokov document, as I understand it.

DR CALDICOTT: Yes, Alexey Yablokov and Nesterenko.

MR JACOBI: Prior to that time there was the Chernobyl Forum. This was a - - -

DR CALDICOTT: Who organised that? WHO and IAEA.

MR JACOBI: It was UNSCEAR, the World Bank, WHO, the IAEA.

DR CALDICOTT: The World Bank? What are they doing - - -

MR JACOBI: And the governments of Belarus, the Russian Federation and Ukraine. They expressed the view - - -

DR CALDICOTT: What year was that?

MR JACOBI: That was between 2003 and 2005 and I understand they produced a report for 2006. The Yablokov document you've just taken us to, as I understand it, has been criticised by the Australia of the UNSCEAR work in 2008.

DR CALDICOTT: Of course. But the UNSCEAR people did not go to the doctors, to the clinics, to look at the children, to look at the leukaemia, to look at the diabetes, to look at the premature aging in children, to look at the micro carefully. In Sweden where they got a high fallout there's a very good report to show that babies in utero at the time of the accident had lower IQs than normal. That's because the developing embryonic brain is very sensitive to radiation. There's another study I want you to know about, the KiKK study. Germany - and you know they're very meticulous with their data - looked at children under

the age of five who lived within five K of nuclear power plants all over Germany. They found that the incidence of leukaemia in children under the age of five is double normal and the incidence of solid cancers is high. That study was repeated in England and France.

If you live near a nuclear reactor with its normal emissions every day - tritium, carbon-14 and all the rest - it's dangerous and children are 10 to 20 times more radiosensitive than adults. Little girls are twice as sensitive as little boys and foetuses hundreds of times more so. But the nuclear industry takes a normal 70-kilogram white 20-year-old male as a standard to apply radiation doses.

COMMISSIONER: Can you go back and answer that question again please, so that we get an answer on it.

MR JACOBI: The question I asked was with respect to - I was interested to understand why you prefer the work that was done by Yablokov - that is, the document which you've just come to - over either the Chernobyl Forum work, which was the joint work, or the UNSCEAR 2008 report.

DR CALDICOTT: Because all their data was gleaned by calculations and guesswork. They didn't go on the ground to take actual measurements of food, actual measurements of radioactive elements in people by whole body counters, go to the clinics to see the long-term effects. You know, Chernobyl was 86. What's this now? It's about 30 years since Chernobyl. We're still waiting for more cancers to develop. The Hiroshima data showed cancers are still arising amongst the hibakusha many years since that bomb dropped. You've got to understand how cryptogenic and latent cancer, and silent cancer, is post-radiation. You can't rely on guesses by nuclear engineers and calculations. That's not science. Science is knowing what - if I guessed about my patients without actually doing the tests, I'd be deregistered.

COMMISSIONER: We'll explore those comments with the authors of the report.

DR CALDICOTT: Well, they will deny it. There's a lot of emotion in this issue, Commissioner.

COMMISSIONER: I do appreciate there is a lot of emotion. Can we proceed.

DR CALDICOTT: Especially as I've treated dying patients with cystic fibrosis - I mean children. Yes, I'm emotional. I took the Hippocratic Oath. I'm here to save lives, not to help to induce epidemics of cancer, leukaemia and genetic disease in all future generations from nuclear power.

COMMISSIONER: I doubt whether the UNSCEAR experts would say they

were either.

DR CALDICOTT: Really?

COMMISSIONER: Yes.

DR CALDICOTT: Then they're denying data. I just want to say one other thing, and it's anecdotal. I gave Grand Rounds - I don't know if you know that. It's a weekly medical meeting that Royal Adelaide Hospital has to discuss diabetes or neurosurgery. I did Grand Rounds at the Children's Hospital Medical Centre at Harvard recently where I worked. The top paediatricians in the world. I walked them through the whole nuclear fuel chain and the medical implications. They were stunned. They turned ashen-faced and one of them said, "What are we going to do about this?" Now, these are the top paediatricians in the world. They did not question my data. It's self-evident. We all know what I talked about. It's medicine.

COMMISSIONER: I guess it needs to be proven. That's what we're here to do.

DR CALDICOTT: It is proven because we've got the documents. Well, as far as we can go. I mean, you know, there's a lot more work to be done obviously.

COMMISSIONER: Indeed. Indeed.

MR JACOBI: I think coming back to Yablokov's work, I think your submission cites that work in support of the statement that over 1 million people have already perished as a direct result of the catastrophe, and the catastrophe referred to was that of Chernobyl.

DR CALDICOTT: Yes.

MR JACOBI: And I'm just interested to understand whether you could explain how that million people has been arrived at.

DR CALDICOTT: Okay. So let's go back to the first slide. This is the fallout from Chernobyl and I don't know what - it was 2000. I guess I will go - can I go up to the slide?

COMMISSIONER: Sure. June 2002.

DR CALDICOTT: So here's Chernobyl, right. This is the Ukraine where there's a war going on, and Belarus. Now, the very dark areas got a huge amount of fallout and people - these are exclusion zones. They can't live there any more. The lighter ones are also extremely high fallout. You can see how it

spread throughout Europe, Austria. What they don't have here is Turkey. Turkey got a very high fallout and the Turks were so annoyed they picked all their radioactive tea and sent it to the Russians because they were so annoyed with them. But Turkey is still - don't buy Turkish dried apricots or Turkish food because Turkey is still very radioactive and it will last for hundreds or thousands of years.

Finland, Sweden - so the accident was first picked up in Sweden and the Swedes said, "What's going on?" Gorbachev denied it, until he had to admit it. Norway - there are farms in the United Kingdom now, in Cumbria, over 300 farms farming lambs and the lambs are so full of caesium the government went to the farmers and said, "You've got to shut your farms down." They said, "What? For how long?" and they said, "Oh, about a hundred years." It's not. It's 300 years. That's how long caesium lasts because the caesium lands on the ground, concentrates by orders of magnitude in the grass and in the lands.

There are wild boar running around Germany at the moment so radioactive they almost glow in the dark, and it's ongoing. As plutonium-241 decays to americium-241, as all these elements decay, americium-241 is much more dangerous than plutonium-241 which is all over the place. It's because it's a very high gamma emitter. So these areas will become more and more radioactive over time.

MR JACOBI: Can I just take you back to the question that I asked, which was about the 1 million figure.

DR CALDICOTT: Yes.

MR JACOBI: Is that calculated by multiplying an LNT prediction against a large population set? Is that how the million is arrived at or how was the million arrived at?

DR CALDICOTT: Would you please send me that question and I will give it to you in the reference.

MR JACOBI: I just want to just raise something with you, which is that again going back to UNSCEAR, it's 2008 report - and this is at page 64 and 65 of its report, states that there were a total of 28 deaths of plant staff with 134 diagnosed with ARS and there were 6000 thyroid cancers observed, of which 15 proved fatal. Their conclusion at paragraph 100 is that the vast majority of the population should not live in fear of serious health consequences.

DR CALDICOTT: So they said 39 people died, the liquidators?

MR JACOBI: No, sorry, I'll start again. A total of 28 deaths - - -

DR CALDICOTT: 28?

MR JACOBI: - - - of plant staff with 134 diagnosed with ARS. 6000 thyroid cancers observed, of which 15 proved fatal. Then I'm interpolating from another paragraph that the vast majority of the population should not live in fear of serious health consequences. I'm just interested in the difference between the million and - - -

DR CALDICOTT: It's extraordinary. I can't understand what they're talking about because the data shows that it's been collected by the Russians that over half the - there were 600,000 liquidators. They were farmers, soldiers, people brought from all over Russia and they were handling spent fuel rods in their bare hands, over half have been seriously ill but I can't – I will have to send you the exact figures of how many have died. I've got them in this book; I'd need to look it up, if you want me to.

COMMISSIONER: Well, you can send us the data.

DR CALDICOTT: Please send me the email and I'll send it to you. An enormous number have died from cancers, leukaemias, their babies many are being born deformed, so I don't know where UNSCEAR thinks it gets its figures from. It's guess work. Twenty-eight people died.

MR JACOBI: I need to qualify what has been said. As I have said, they said the - - -

DR CALDICOTT: Makes me tear my hair out, I'll tell you. As a doctor it's just – they're lying.

MR JACOBI: Well, I'm - - -

DR CALDICOTT: You can't lie about human health. If I lied in medicine, I'd be dismembered – I mean deregistered.

MR JACOBI: I am endeavouring to quote from paragraph 99, which I have read, which says that:

> *The observed health effects currently attributable to radiation exposure is as follows, 134 plant staff and emergency workers received high doses of radiation that resulted in ARS. The high radiation doses proved fatal for 28 of those people, while 19 (indistinct) survived and died up to 2006.*

DR CALDICOTT: And what year was that?

MR JACOBI:

- - - *(indistinct) various reasons.*

This is a 2008 - - -

DR CALDICOTT: But when did they take that data from? From what year was that data gleaned?

MR JACOBI: I can't give you an answer.

DR CALDICOTT: Well, then that's very important because since the accident it has been horrendous for the liquidators.

MR JACOBI: Well – and my understanding is that from the following - - -

DR CALDICOTT: And it's wrong. It's absolutely wrong.

COMMISSIONER: Just finish - - -

MR JACOBI: Sorry - - -

DR CALDICOTT: Okay.

MR JACOBI: - - - just to answer your question Ms Caldicott, the – paragraph 100 suggests that that annexe is based on 20 years of studies and from the previous UNSCEAR reports.

DR CALDICOTT: Twenty years of studies of what? The Chernobyl liquidators, or 20 years of studies of what?

MR JACOBI: As I understand it, the complete body of scientific material that was available at the time.

DR CALDICOTT: There was no body of scientific material except that gleaned from Russia and the clinics treating these patients. Where did they get that scientific material from? What's their source please?

MR JACOBI: Well, that's indeed the question that I'm asking you with respect - - -

DR CALDICOTT: Well, that's a question I'm asking.

MR JACOBI: - - - (indistinct) indeed, that is the reason why we (indistinct) understand it.

DR CALDICOTT: Well, I can certainly source you the correct information for that. Certainly.

MR JACOBI: Right.

DR CALDICOTT: There has been a lot of work done on this and it continues as these people still die with horrendous stories from their relatives.

MR JACOBI: Now - - -

DR CALDICOTT: See what staggers me is that – I mean I know you're a lawyer and I know you're a (indistinct) man but these people have no understanding of what they're talking about and – but they sound very formal and they're a UN body and the like but they haven't got the data on the ground. It's like me trying to guess what I do with a patient without reading the literature and knowing absolutely what I'm doing.

COMMISSIONER: We'll certainly quiz them about where they get their data.

DR CALDICOTT: Well, I'm sure you will but whether you'll get honest replies, I don't know. I'll tell you where I get my data and it's valid.

COMMISSIONER: Well, okay that's certainly what we need to - - -

DR CALDICOTT: Yes.

COMMISSIONER: - - - complete our investigations.

DR CALDICOTT: And thank you for having me, if I may say.

COMMISSIONER: Pleasure. Are there any other - - -

MR JACOBI: Yes. There was just one matter that I just want to just - - -

DR CALDICOTT: Yes.

MR JACOBI: - - - deal with, and that is you have referred, I think by reference to the map, to areas in which there are – there is existing contamination and I think you referred to increasing risks. Again, as against the UNSCEAR report, and the UNSCEAR report refers to the areas that are contaminated and perhaps particularly with respect to caesium, because its decay rates are in fact shrinking.

DR CALDICOTT: Yes.

MR JACOBI: And I'm just interested to understand what the basis of your view is in contrast to that, which I think suggests that it was in fact increasing risks as opposed to decreasing risks.

DR CALDICOTT: But remember that I showed you the chart of all the radioactive elements.

MR JACOBI: Mm'hm.

DR CALDICOTT: Why have they just picked out caesium?

MR JACOBI: Well, they haven't. I have picked out caesium and asked them about that.

DR CALDICOTT: Well, what else have they picked up?

MR JACOBI: Well - - -

DR CALDICOTT: Please?

MR JACOBI: - - - they include at page 52, a chart which shows the total activity of radionuclides by petabecquerels.

DR CALDICOTT: Yes, but what - - -

MR JACOBI: And deals with caesium, plutonium, americium, caesium - - -

DR CALDICOTT: Americium.

MR JACOBI: Americium and both of the plutoniums, 239, 240 and 241.

DR CALDICOTT: Yes. So let me read you this, if I can find it, and I'm sorry I have to look, I know exactly where it is on the page but - - -

MR JACOBI: That's all right.

DR CALDICOTT: You know, these Russians looked a chromosome elaborations in cells, hugely important scientific investigation. Sorry about this, and I'm wasting time.

MR JACOBI: That's all right.

DR CALDICOTT: It's not really – very specific. Yes, the territory contaminated by plutonium today where the level of alpha radiation which I explained, is usually low, will again become dangerous as a result of the future disintegration of plutonium 241 to americium 241, and I referred to that, in the ensuing tens and even hundreds of years. An additional danger of americium 241 is its higher solubility and consequent mobility in to ecosystems and food compared with plutonium. It's very complex. All these isotopes, many of which have never been examined from the biological perspective, we don't know where they go in the body, we don't know what isotopes – I mean for instance, caesium is a potassium analogue, it's like potassium, so it goes to muscles and to brain where it induces tumours and cancers and rhabdomyosarcomas and heart attacks, strontium is a calcium analogue, it goes for bone but there are very few isotopes studied by the Health Physics Association of America and I read all their – I wrote an article for the New England Journal of Medicine about all of this and spent a year researching it at the Harvard Library. Very few of the isotopes have actually been studied about their biological consequences and I showed you the number of them. It's quite extraordinary. So they are sort of skimming on the surface, just looking at caesium and strontium and maybe tritium but not really and maybe americium but the others are ignored. This is very serious because they all got out when you have a meltdown.

COMMISSIONER: Dr Caldicott, than you very much for your evidence this morning. Thank you for coming across to - - -

DR CALDICOTT: Thank you.

COMMISSIONER: - - - give us your views. We will follow up with some - - -

DR CALDICOTT: Yes.

COMMISSIONER: - - - questions about - - -

DR CALDICOTT: Yes. And I will send you more references, so you know what I'm talking about.

MR JACOBI: Perhaps we can indicate that we will publish the letter and the response.

DR CALDICOTT: That would be good (indistinct)

MR JACOBI: But we will deal with it by reference to - - -

DR CALDICOTT: And I appreciate you inviting me.

MR JACOBI: - - - specific sources.

DR CALDICOTT: As I have spent my life trying to work on this subject. I started when I read *On The Beach* when I was 15 and then I did medicine in 56 and learnt about radiation and genetics, so I've been on to this always.

COMMISSIONER: Thanks Dr Caldicott. We will adjourn until 13.00 when we will have Dr Carl-Magnus Larsson, the Australian Radiation Protection and Nuclear Safety Agency.

**ADJOURNED** **[11.57 am]**