RESUMED **[2.30 pm]**

COMMISSIONER: We will reconvene at the time 14.30 and I welcome from the Australian Nuclear Science and Technology Organisation Mr Hefin Griffiths and Mr Mark Summerfield.

MR DOYLE: Hefin Griffiths is the Head of Nuclear Services and the Chief Nuclear Officer at ANSTO. Prior to working at ANSTO Mr Griffiths spent over 20 years working in both the civil and military fields of the nuclear industry in the United Kingdom with a focus on nuclear safety and emergency planning and is joined by Mark Summerfield, the Leader Technical Support, Nuclear Operations Division at ANSTO. Prior to moving to Australia in 1998, Mark trained in nuclear engineering at the University of Manchester and worked for many years in the nuclear industry in the United Kingdom as a systems safety engineer.

COMMISSIONER: Gentlemen, thanks for joining us. We’re on the subject of nuclear reactor safety. I’m sure you’re well aware. Might we start with looking at how the development of reactors since the first generation have changed and the safety implications of those various generations of reactors? Just to get a sense of how the technology has changed the safety of activity?

MR GRIFFITHS: Certainly, Commissioner. I mean if we look at the slide, the Generation I or the – actually the difference in the generations can be in some ways based on the time that they were produced but there are also some significant defining design criteria that have been incorporated through the development. So a Gen I reactor would be basically an early prototype, so an example of that would be the Magnox reactors in the UK which are natural uranium fuelled, a graphite moderated carbon dioxide cooled. They were developed through the 1950’s. Actually the last one was put in to service in 1974. I happen to know that because that’s the last one that’s currently operating and I grew up about eight miles away from it on the Island of Anglesea in north Wales. The Generation II probably make up the majority of operating reactor systems, power reactor systems around the world and they’re largely light water reactors, the pressurised water reactor or the boiling water reactor but also include the CANDU reactors that are operated in Canada.

Largely the Generation II reactors rely on active safety systems. Within the nuclear industry, as with most hazardous industries, you apply the hierarchy of controls and that will be to put in – to favour engineered systems over administrative controls. The engineered systems on Gen II systems tend to be active, so they rely upon external cooling and auxiliary systems to maintain that external cooling following any significant event or challenge. The Generation III reactors which are like the European pressurised reactor, the advanced boiling water reactors and the AP-1000 have followed on, I think from a recognition that passive engineered systems, i.e., ones that rely on the physical characteristics of a material rather than an active intervention, represent a further step change in the safety and reliability of those reactor systems. An example of that would be instead of a reliance on external cooling to maintain the temperature of the fuel below that which – at which the cladding would fail, the modern design of reactors try to incorporate natural convection to ensure that – provide that the core is covered with a cooling media such as light water. The natural convection processes will be enough to remove the decay heat once the reactor has been safely shut down.

COMMISSIONER: Okay. And the Generation III+ is a continuation of a passive safety system?

MR GRIFFITHS: Yes.

COMMISSIONER: Yes.

MR GRIFFITHS: And moving – again with a focus on a further development of operability, maintainability, reliability, so these feed in to the – I guess the operational efficiency of the reactor systems. But generally, as with most industrial processes, the more efficient they are to operate and maintain, the more reliable they are. Serves a dual function of improving the efficiency but also the safety.

COMMISSIONER: What is the aspiration of Gen IV in terms of safety? What do we see? I know there are lots of variants - - -

MR GRIFFITHS: Yes.

COMMISSIONER: - - - out there but are there any safety principles we see being developed within that newer generation of reactor?

MR GRIFFITHS: I think as Professor Peterson was saying in the last session, it's an extension of this focus on intrinsic safety. So to looking at intrinsic features of new media for cooling for example, that would be intrinsically safe. So as he was mentioning, in terms of the molten salt reactors, the fact that they can operate them significantly lower pressures is a significant potential improvement over the current high-pressure systems. Is that fair to say Mark?

MR SUMMERFIELD: Yes. One of the things is with moving to molten salts, you don't have the phase change from a liquid to gas, as you do with water, and that makes a massive difference in how you need to address things. It's always a problem is when the water changes from water to steam is when you start getting problems with cooling and all the rest of the other safety aspects.

But also operational availability and reliability of systems and simplified systems all go – are also things which are also addressed in the – as a progress to the evolution. You see the AP-1000 here shown as a Generation III and there's a number of these figures available and others show the AP-1000 as a III+, so there's – the lines are very blurred what is II and III, what's III and III+. There's even a II+ which is, again, a very vague line.

COMMISSIONER: Yes.

MR GRIFFITHS: So again, I think they're all still basic light water systems but are evolutions of those whereas the Gen IV is reaching in to as yet undeveloped territory.

COMMISSIONER: I'll ask this question because I've asked it of all the other experts. Do you have a view on which Gen IV technology you think might be the first to be commercialised? And if so, when?

MR GRIFFITHS: I - - -

COMMISSIONER: I am quite happy for you to say - - -

MR SUMMERFIELD: I don't actually – I think the sort of time scales may be in the next decade or beyond.

MR GRIFFITHS: Obviously you're looking at 20 years and my personal preference – and this is just my opinion are towards – put the pebble beds designs where you have the beads and effectively a (indistinct) of – in the fuel and moderators all in that. Some of that work, particularly from South Africa's been very interesting but the very high temperature gas cooled reactors go back to my youth as effectively they're a very vast version of the AGRs in many respects, using helium. Which one is the optimum one? I'm afraid I have really no opinion on this.

COMMISSIONER: Okay. Well, we might move to something that I'm sure you do have an opinion on.

MR DOYLE: At this point we might just take a step back. We've addressed the inherent slipperiness in the descriptions of Generation II, III, III+ but as I understand it, there's a reasonably clear distinction between the active safety systems that you've mentioned Mr Griffiths and - - -

MR GRIFFITHS: Yes.

MR DOYLE: - - - the passive systems. And while we certainly understand that at a general level, we thought it would be useful for you to use a graphical illustration to just explain in practical terms the way the two different systems address the critical function of core cooling.

MR GRIFFITHS: Yes. As you can see on the design here, on the left hand side, you’ve got a Generation II pressurised water reactor of the Westinghouse type and the APR-1000 on the right hand side. Essentially the main functions of any reactor safety system are to effectively shut down the nuclear reaction by removing reactivity. Once it’s shut down there is still a significant amount of decay heat that needs to be removed in order to ensure that the core and the fuel within the core remains within its integrity boundaries. As you can see on the left hand side, there’s a significant amount of auxiliary equipment outside of the pressure vessel. All of which is required to maintain that heat removal capability. Each of those pumps needs to be serviced either through an external grid connection, or through diesel generators. On the right hand side, the APR-1000 has passive means of both injecting water in to the core to ensure that you’ve got coverage of the reactor core, but also then it allows the natural circulation which Prof Peterson was talking about where the coolant is allowed to boil off. It condenses at the top of the stainless steel pressure vessel, and then there's a heat sink to essentially the external chimney that takes that heat away. The boiled off coolant is then condensed back to go back into the system, so you get that natural circulation without reliance on external pumps. I think it's important to note, as Prof Peterson was saying, that that doesn't take away the emergency auxiliary pumps, that that is still a preferred method. The use of diesel generator back-up for those would still be incorporated, but it adds another line of defence, and defence in depth is essentially the mantra for nuclear safety.

MR DOYLE: I think the next slide shows that the difference - - -

MR GRIFFITHS: Yes.

MR DOYLE: - - - these designs can make to a plant layout arrangement.

MR GRIFFITHS: Yes.

MR DOYLE: Can you just explain what might be the advantages of the passive system in terms of plant layout?

MR GRIFFITHS: Yes. So you can see that there are a number of the buildings on the left-hand side, which is the Generation II building, are not replicated for the APR 1000, that you would still have the shielding and containment functions, but a lot of the safety related mechanisms are now incorporated in there rather than being in the auxiliary buildings. So essentially items 3 through to 10 are removed from the new design. Their functions are still provided, but they're provided in a passive manner within the containment building, but you still have the diesel generators still in place there.

What that means for a site, obviously there's economic benefits in terms of the footprint for the site, but it also removes some vulnerabilities for the items that are present in the GenII design are all outside of the building, outside of potentially the (indistinct) enclosure, and therefore more vulnerable both to external events or potential security related events.

MR DOYLE: Thank you. I wanted to come to another of a passive system, namely the OPAL reactor with which you're intimately familiar. But before we look at the safety system, I wonder if you could give the Commission a brief overview of the purpose and function of the OPAL reactor?

MR GRIFFITHS: Yes. Well, obviously we were tremendously fortunate to be allowed to build the OPAL reactor to operate it on behalf of Australia. It is an approximately 20 megawatt multipurpose reactor that is of an open pool type. It is low enriched uranium fuelled, and the purposes range from the irradiation of low enriched uranium targets for the production of molybdenum 99 which is the precursor for technetium-99m, which is the most widely used diagnostic nuclear medicine.

We also irradiate silicon ingots for neutron transmutation doping of those ingots for applications throughout the silicon (indistinct) industry, and we supply a range of different energy neutrons to the Bragg Institute, which is adjacent to OPAL, which conducts neutron based nuclear science and technology using multiple neutron scattering instrumentation.

MR DOYLE: Thank you. I wonder if we could come now to - - -

COMMISSIONER: Just before you go there.

MR GRIFFITHS: Yes.

COMMISSIONER: You said low enriched fuel. Can you give us a - - -

MR GRIFFITHS: Yes. Many of the older types of research reactors were run on highly enriched uranium, which is equivalent I guess to weapons grade uranium. So that brings in obviously security issues and safeguarding issues in terms of nuclear non-proliferation. The OPAL reactor runs on less than 20 per cent enrichment, so it's classed as low enrichment, and also our target is low enrichment as well, so they are less than 20 per cent. So we are one of the few low enriched multipurpose reactors in the world and as such that's essentially the vanguard of where modern research reactor design is going to remove or certainly mitigate those issues around nuclear safeguards and non-proliferation issues.

MR DOYLE: Wonder if you might give us a brief outline of the reactor design, but then explain how it uses passive safety to remove decay heat in the event of a shutdown.

MR GRIFFITHS: Yes, okay. As Prof Peterson was saying that passive systems can rely on either the natural properties of the material or rely on something that's ever present, such as gravity. So in terms of first of all safely shutting down the reactor, in addition to the insertion of control rods, which is generally accepted for shutting down reactor systems, we actually rely on the reflection back of neutrons into the core from the reflector vessel which is heavy water which surrounds the main pool. So as another means of shutting down the reactor we can dump the heavy water essentially under gravity into a holding tank. That again is another mechanism of shutting down the reactor.

Once the reactor is shut down again we need to still maintain the heat removal capability to combat the decay heat. Within OPAL, although we have multiple pumping systems backed up again by diesel generators, if all those were to fail in a complete station blackout situation such as Fukushima, then the natural convention within the pool would be sufficient to maintain adequate coverage over the core until the spent fuel had reached its what's called eversafe time period. That is if it was exposed to air then although it will still get very hot, it wouldn't get hot enough to breach the (indistinct) of the fuel.

MR DOYLE: Thank you for that. We might move back very briefly to the different types of reactor designs only to mention one category that you haven't yet touched on, and that's small modular reactors. Just give us a brief overview of what defines a small modular reactor, and what are its typical features.

MR GRIFFITHS: A small modular reactor is essentially what it says on the term. It is a reactor that, unlike the very large current Gen3 and Gen3 plus reactors, it is in the range of 10 to 300 megawatt electric. Also the modular design would allow you to essentially build up that load capacity that you might need for specific purposes by just adding on further modules of a similar reactor type. That increases the flexibility of applications so that it can be used potentially as floating reactor systems to power small island nations, to be looking at supplying power to large and remote industrial applications, or for powering small townships or cities. The small size and the small power obviously have inherent safety benefits in terms of some of the - sorry, averting some of the issues with far larger and more power dense systems.

MR DOYLE: Look, turning away from the conceptual reactor designs to some lessons learnt from history, the Commission has heard some evidence already about some of the developments and lessons that have followed from accidents that have occurred over the last half century. What would be the major developments either in design or safety philosophy that you have observed as a result of those accidents?

MR GRIFFITHS: I think, as I've discussed previously I think, the move from active systems to passive systems obviously is a potential step change in terms of the management of safety, so as you're not relying on active intervention of systems themselves that are potentially vulnerable to failure.

From a safety point of view, I think the biggest single change is the development of a robust safety culture which is a phrase that the nuclear industry claimed to have invented in the aftermath of the Chernobyl accident of 1986 and really came from work that the International Atomic Energy Agency established when they established an expert group to develop the IAEA 15 guide on safety culture, and that really has continued to be a work in progress up until I think as recently as last year, the US NRC released their most recent guidance on nuclear safety culture and how to develop and maintain that safety culture through all aspects of nuclear operations.

I think it's that integral approach to applying such standards as conservative decision-making, addressing the attitude to the full life cycle, so through the design, to look at potential fault sequences, how they can be best either safeguarded against or mitigated through operation, through maintenance, and then into the transition to safe shutdown state.

MR DOYLE: You mentioned the different fault sequences and the capacity to predict and manage them. The Commission has heard evidence, and there's wide reference in the literature to two different conceptual approaches to safety assessments.

MR GRIFFITHS: Yes.

MR DOYLE: The so-called deterministic approach and the probabilistic approach. These can be difficult concepts to grapple with in the abstract. I wonder if you could try and unpack the concept firstly to the deterministic safety approach before we then take a look at a probabilistic model that OPAL has adopted.

MR GRIFFITHS: Yes. The use of deterministic safety assessment is really the standard across the industry now and has been for some years. Essentially it involves a robust comprehensive assessment of potential initiating events using aspects such as HAZOP, hazard and operability studies, failure modes and effect analysis, operating experience, the development of fault trees, so essentially you can unpack for a particular set of events, what are the key initiating events that could lead to a particular outcome.

The evaluation of those fault sequences to look at how they would progress from an initiating event to a defined consequence, the evaluation of the consequence both to operating staff and to members of the public over defined time periods, so for members of the public, the resulting exposure could be evaluated over a period of, for example, 70 years in terms of certain long-lived isotopes. That really will then define what the - initially through the design phase, what the number and types of safety systems that will be required, and through the evaluation of the development of the design through to the final design, how robust those safety systems actually are.

In terms of the initiating events, they would be assessed through, for example, reliability data for particular components that have been utilised. But we will also look at external events, and for that conservative assumptions are made on the events that would be selected. So there is some judgment made on the credibility of certain events but, for example, a standard would be to select a one in 10,000 year return frequency event for something like an earthquake or a tsunami. So we're really trying to select very challenging events that are then grouped within what's called the design basis. So you then work out what it is that that design is protected against.

MR DOYLE: So the basic philosophy is to start with the events that can present a hazard.

MR GRIFFITHS: Yes.

MR DOYLE: Trace through the causal pathway and ensure that the safety system has multiple controls against it.

MR GRIFFITHS: Absolutely. I mean, as I said, defensive depth is the key so that we have multiple barriers between an initiating event and a consequence. We're not reliant on one single barrier in any one case to keep us from safe and unsafe conditions.

MR DOYLE: So contrast that with the probabilistic approach, and I think we've got a slide that shows the model that is in operation with the OPAL reactor. I'll just see if I can step through it with you. I think it makes most sense, doesn't it, to begin with the step lines on the right-hand side of the graph. Could you tell the Commission what those lines represent?

MR GRIFFITHS: These lines are taken from the ARPANSA guidance but I think they're largely mirrored in the safety assessment principles that were developed by the UK Nuclear Installations Inspectorate. They relate in many ways back to earlier work that was undertaken by the Health and Safety Commission and the Health and Safety Executive while they were looking at the planning approval for the Sizewell B nuclear reactor. So they started looking at the tolerability of risk. So essentially trying to ensure that the nuclear industry would be comparable with other similar industries both in terms of the actual risk that was presented, but also society's acceptance of that level of risk.

MR DOYLE: Can I just pause there just to make sure it's clear. On this particular graph you have got the gravity of the risk represented by a dosage rate - - -

MR GRIFFITHS: Yes.

MR DOYLE: - - - of millisieverts and the frequency probability of the event occurring on the Y axis, but the line that's represented by the safety limit reflects an underlying level of tolerable risk to society that could easily be translated in a different industry to something other than dose rates.

MR GRIFFITHS: Yes. You're right. Essentially the safety limit represents the limit of tolerability. If you are to the right-hand side or above that, then the residual risk is intolerable. The safety objective can be likened to an acceptable level of risk. If you're in between the safety objective and the safety limit, you're in what we have referred to as the polar region where you would have to demonstrate that the control measures that have been put in place will maintain the risk as low as what is reasonably achievable, social and economic factors been taken into account.

MR DOYLE: Now, with that background, if we pick one of the vertical lines on the chart which I think represent fault sequences that could occur at the OPAL reactor, I think perhaps focusing on the line RCG2FRPS, I wonder if you could try and explain in as simple terms as possible what's involved in a fault sequence and how you can go about plotting that to determine whether it's within a safe range.

MR GRIFFITHS: Yes. The simple answer is no. To start with I'll pass over to Mark to talk through the reactor based parts of that and then I'll come in with the consequence assessment.

MR SUMMERFIELD: What we did is as part of our safety analysis report which this actually - the graph comes from, we analysed a number of what we considered were beyond design basis events. This RCG2FRPS is one of those. We have in our reflective vessel 12 radiation facilities where we radiate targets for – as part of our molybdenum deduction process. These are effectively mini fuel plates. There’s actually four plates per target, three targets per rig and 12 rigs in total. So we had one of the full sequences we (indistinct) events we identified was what happens if we lose the full cooling to these. So it’s effectively they're mini fuel plates that would get hot. Especially with the FRPS is our first reactor protection system. If that fails to identify the fault and fails to trip the reactor, all these targets would melt. They would melt in the reflector vessel; the reactor core would be okay. This is where it's a bit different from a power reactor because they wouldn't have this situation but we would have effectively mini-fuel plates melting, releasing their fission products. That would be released at the bottom of the core and go up.

The probabilistic safety assessment, level one of that is determining the likelihood of that and so the likelihood of that, as you can see from the vertical line up and down from that, ranges from in the region of five times to the minus three per annum, which is about once every 5,000 years, all the way down to nearly 10 to the minus six which is nearly once every million years. So the error band on the frequency is very broad and that's partly as a result of being a research reactor because unlike power reactors, we simply don't have the breadth of background of data or reliability of systems and every research reactor being unique. However, then as part of this being one of the faults we want to look, we then did the consequence assessment and looked at what would be the consequence for the most individual effective dose, which is to the individual standing on a buffer zone boundary, which is 1.6 kilometres, for 24 hours, eating any food locally, breathing the local air, just standing there getting the maximum dose they could. And as you see, the dose then comes up with slightly below point one of a millisievert, is what that person would receive, which considering that the average annual dose in the Sydney region is 1.8 to 1.9 millisievert per annum is less than five per cent of his annual dose he's going to receive anyway.

MR GRIFFITHS: So I think the key things that as you develop this, you make conservative assumptions both in terms of the initiating event, the performance of the mitigating systems that are in place, the release fraction from the target plate itself. The performance of the containment boundary, the dispersion in the atmosphere, the exposure of the person that is potentially receiving this dose and consideration of all potential exposure pathways to come up with a dose which can then be converted in to a risk by the application of the standard dose risk factors that are developed by the International Commission on Radiological Protection. But again, the key thing through this is to show how far away we are from the safety objective. That in essence, is where we want to be. Whenever you're developing a safety assessment, you want to be able to demonstrate that there is a clear safety margin between certainly where the worst-case accidents could be and the safety limit. But in this case, we're below the safety objective which gives us an ever-greater margin. Once you've developed these deterministic assessments, they will then feed in to the operating model for the reactor and form the basis of the safety case. So you set the site operators again below based on the deterministic assessments and then ensure that your actual operating below and the limiting conditions of that have a significant safety margin between where you would be in the worst case operation and the boundary which you were challenging the safety case.

MR DOYLE: Is one of the advantages of this approach, as a complement to the deterministic method, it enables you to pick which fault mechanisms pose the greatest risk relative to the tolerable risk and - - -

MR GRIFFITHS: Yes.

MR DOYLE: - - - therefore enables you to focus your energies?

MR SUMMERFIELD: Definitely. In that respect, the probabilistic safety assessment is very much used as a design tool. It's not the ultimate reliance for safety cases, it's very much identifying where is a vulnerable part, where could the most effort simple addition of a valve, or change of a minor thing can make dramatic difference overall. If you look to get – you want to have an even balance design. If you find you're risking one area that is normally about - - -

MR GRIFFITHS: And again, getting back to safety culture, again that would feed back in to things like operator training, the development of operating instructions and on the job safety assessments, so that people know where the highest potential risks are in terms of potential fault sequences and they can ensure that the work practices adequately reflect that.

MR DOYLE: To what extent are these probabilistic assessments required by regulatory regimes around the world? And if they're not required, are they routinely used nevertheless?

MR GRIFFITHS: I think for power reactors in general they are but as I say, the key aspect of safety demonstration is again – is using the deterministic method. Essentially, where you look at the worst case and ensure that you have suitable barriers embedded within that. PSA is useful I think for looking at the cumulative residual risk and as Mark said, looking at both the initial design and the design modifications that would come in the future as to where you're going to put your efforts.

MR DOYLE: All right. Well, we might leave that topic and move to the issue of emergency planning and preparedness. I wonder if you could outline what you consider to be the key phases and – that form part of emergency planning - - -

MR GRIFFITHS: Yes.

MR DOYLE: - - - and preparedness?

MR GRIFFITHS: I think essentially the starting point follows on from the previous discussion and the starting point for emergency preparedness and response is that safety assessment. So the emergency preparedness and response procedures essentially are in place to look at beyond design basis accidents but also to support within design basis accidents to ensure that any potential exposures are as low as reasonably achievable. So the first action is the planning, which is heavily based on what the potential full sequence is and what the potential exposure pathways to either operational staff or members of the public would be. Once you've developed that emergency plan, which for nuclear organisations is not something that you do as a standalone. We would develop onsite emergency plans which would be largely under our control, but even so for significant events, we would call on support from combat agencies, such as the local fire brigade, ambulance or police. So it's vital to ensure that there's a multiagency approach to the planning to ensure that the expectations of each party is completely understood and also what the authorities and the overall command and control are going to be.

Once the plan has been prepared, approved in our case through regulatory body, ARPANSA and endorsed by all the other agencies that are called upon within the plan, preparedness is essentially the purpose of not just exercising that plan as a regulator in the UK, it should be a test. You should be testing the plan to try and find out what the weak points are. Does it rely on just having the AT? What happens if people are on holiday? What happens if a critical piece of equipment are not available? How do you work your plan to develop the – to identify the weak points and then mitigate them? If in the worst case, we have to implement the emergency plan, the key aspect is to regain control of the situations and bring the situation back into a safe state while mitigating the consequences both to staff on site, to first responders both from within the operating organisation and from outside, and to members of the public, to be aware of a transition to recovery. The phase of an event would go through an early phase where your (indistinct) would be in control.

Once you're in control, then it would tend to transition to another organisation to try and look at the transition to recovery, not just on the operating site but in any potentially affected area outside, and particularly that applies to nuclear power plants, and then the implementation of recovery, which could involve the transition of evacuated populations back into the area, the decontamination processes that would possibly have to be applied in order to make that area habitable again afterwards.

MR DOYLE: Just wanted to focus on one element of that, which was the mitigation of consequences, and this is with particular regard to lessons learned from accidents in the past and most obviously among them Fukushima. What's meant in this context by the concept of justification in relation to intervention measures, and what observations would you make about it?

MR GRIFFITHS: I think that follows on really from the basic principles of radiation protection is that any action that's undertaken that could lead to a potential exposure should be justified. In this case the actions or the interventions previously referred to as counter-measures are designed to avert radiation exposure to individuals or to population groups. Those sort of interventions include sheltering, evacuation, issuing of stable iodine tablets to saturate the thyroid to prevent further uptake of radioiodine, or the implementation of food bans, each of those actions has a detriment associated with it, whether that's a potential increase in non-radiological health and safety risks, or to risks from - to a breakdown of societal bonds.

MR DOYLE: Perhaps could we just deal with the three intervention measures you mentioned?

MR GRIFFITHS: Yes.

MR DOYLE: Sheltering. What are the sorts of previously perhaps unforeseen but now foreseeable risks involved in that?

MR GRIFFITHS: Yes. I think sheltering is probably one of the lowest risk interventions. It essentially involves going into the nearest building or going into your home, closing doors and windows, turning off airconditioning, turning on the radio or the television and looking for public information broadcasts. But there is a school of thought that if a population are advised to shelter, that a certain proportion will decide to self-evacuate, so you're having an uncontrolled evacuation which could then lead to exposure of people if they're, for example, driving into a potential radioactive plume. It can also block up escape routes that emergency services would want to use in time, or block routes that emergency services would want to use to actually get to the site.

In terms of individuals, you could have vulnerable members of society, the old and infirm, people who require access to special medicines, infants that require baby formula, for example, and even down to many locations particularly within the UK where nuclear power plants are stationed in remote and rural areas, the fact that local farmers would still feel the need to have to go out and tend to their livestock.

COMMISSIONER: So could I just interrupt for a minute?

MR GRIFFITHS: Yes.

COMMISSIONER: How do you engage the local community in your area for instance about these issues? Do you give them briefings? How do you communicate the sort of safety aspects of living close to a nuclear site?

MR GRIFFITHS: We are very open with our site. We hold many, many public tours. We have approximately 10,000 people a year come through our site from not just the local community but schools throughout New South Wales and local Probus groups, et cetera. We advertise those extensively through the local community. We engage in sponsorship at local events. Everything we can do really to try and reach out to the community and to engage with them that they can come and (a) learn more about the work that we do that we believe has a significant benefit for Australia, but also to try and allay any fears that they may have of living in proximity to Australia's only nuclear site.

MR DOYLE: Just following up that topic of making sure there's an appropriate realisation of the risks of radiation, and not an over reaction, I wonder if you might touch on what might be some of the dangers associated with evacuation where it might not be appropriate or necessary.

MR GRIFFITHS: Yes. I think we saw through the response to the Fukushima accident that evacuation was implemented fairly early in the piece which essentially it has to be done fairly early, once an accident such as that progresses then you lose your window for evacuation. I think it was a very brave decision to make that, particularly with the damage the local infrastructure caused, both by the earthquake and the tsunami, and it will undoubtedly have averted a significant collective dose to the population.

Unfortunately through the evacuation, as I was reading in a news article today I think, the cumulative total number of deaths from the evacuation has now exceeded the number of deaths that occurred in the tsunami itself, and I think that really goes to the complexity of implementing an evacuation, that there were a number of particularly vulnerable people, particularly aged residents within care facilities that unfortunately died during the evacuation, and then following on from that, as has been seen with populations that have been relocated in the Marshall Islands and following Chernobyl, there are a number of psychosocial issues that then develop associated with depression, alcoholism, with increased number of suicides, just because of, I guess, the trauma associated with being relocated from your land and the uncertainty as to when you will be allowed to return to a normal life.

I think as part of the justification process, recognises the difference between the benefits and the risks associated with each of these interventions and there are a number of guidance levels that are recommended by IAEA that are adopted by most countries. These really provide a guidance level at which you may start thinking about certain of these interventions. Obviously the greater the detriment associated with that intervention, the higher the averted dose needs to be before that becomes justified.

They are essentially guidance levels, they're not prescriptive, because it will be down to the command and control structure of that particular incident to judge whether the particular circumstances merit the imposition of a particular countermeasure, even though the averted dose may make it worthy of consideration.

COMMISSIONER: I don't think we have any more questions for you, gentlemen. Thank you very much for attending.

MR GRIFFITHS: Our pleasure.

COMMISSIONER: It has been very useful for us to put this into context, particularly with the local flavour to it.

MR GRIFFITHS: Right.

COMMISSIONER: We'll adjourn till 1600 when Mr Peter Wilkinson will provide evidence.

MR GRIFFITHS: Thank you, Commissioner.

COMMISSIONER: Thank you very much.

ADJOURNED **[3.20 pm]**