RESUMED **[9.30 am]**

COMMISSIONER: We will reconvene now at 9.30 and I well Mr Ross Miller from ANSTO.

MR JACOBI: Mr Ross Miller is currently working with ANSTO's nuclear operations division. He has worked in the nuclear industry since 1973, mainly for ANSTO and it's precursor the Australian Atomic Energy Commission. He has also worked at the Oak Ridge National Laboratory in Tennessee in the United States and at the Canadian Nuclear Laboratories in Ontario. His experience is primarily with nuclear research reactors. He was ANSTO's engineering manager and assistant project manager for the project which delivered Australia's new nuclear research reactor, OPAL, which currently operates at Lucas Heights. The Commission calls Ross Miller.

COMMISSIONER: Mr Miller, thanks very much for joining us. With your knowledge and design delivery construction and the operation of new ANSTO OPAL reactor, I wonder whether you could walk through with us about what skills were most important to you in the delivery of this brand new capability to the nation?

MR MILLER: In my view there are three key roles which need to be sorted at the beginning of a research reactor project. You need a project manager capable of delivering a project of this sort of size in the country in which the reactor is being built. That person doesn't necessarily have to have any background in nuclear, they must be able to work as a project manager and have a background in projects that employ a fairly large amount of technology. For example, we have two project managers staying with the project, the first one had a background before he came to us, he was the project manager for the contract of building the Anzac frigates for the navy, and the other one came from the electricity supply industry whose previous project was to build, was to supply electricity to all Olympic Games venues in Sydney.

ANSTO did not at the time of the reactor project have those sort of management skills in-house. You simply need to be a project manager managing a similar size of project and ANSTO hadn't been running projects of that size up to that point in time.

MR JACOBI: Sorry, can I just interrupt there, Mr Miller, and just to get a bit of an idea of the size of the project. What was the size of the project that you were managing perhaps in terms of workforce or in terms of total budget and longevity?

MR MILLER: When we started it was 286.4 million Aussie dollars, 1987 dollars. By the time we had finished it, with escalation and other such things, there was about $400 million spent. In terms of workforce it varied dramatically. Our project team, our in-house project team was always fairly small apart from during the tender evaluation period. In the tender evaluation period it went from seven full-time staff up to 60, and back down again

(indistinct) about three months because we had a very tight time constraint to be doing the tender evaluation, but the skill that we needed on the project varied as time went on.

Once you get towards the role and construction side of things you need a lot of what I will call normal engineering skills you would acquire in Australia, mechanical engineers, electrical engineers, instrumentation and controllers, civil engineers, those sorts of things. You need some that are specialists, but many of the people we had came from either ANSTO's existing workforce or from outside. People were either brought in as employees or people we had under contract.

MR JACOBI: Sorry, Mr Miller, I have taken you away. I think you identified the key role of the project manager. Could you come back and deal with the other two key roles you were - - -

MR MILLER: Yes, gladly. The second key roles is you need someone with skills and experience of the thing you are trying to build. In our case, we were building a research reactor. We had two such people, myself and Ken Hallock. When we started the contract between us we had between 60 and 70 years experience in the nuclear industry, almost exclusively with nuclear reactors. So the pair of us covered that. The third person you need is somebody to manage your licensing process.

COMMISSIONER: Can I just interrupt there, Mr Miller. In terms of the reactor engineer, then critically research reactor knowledge is an absolute essential quality that you're looking for in this particular position.

MR MILLER: Correct. If you're building a research reactor, you want somebody that knows - at least one person that knows research reactors from design, construction, operation, maintenance, modification, all the things you need to know walking into a process to build something new that we're going to operate and maintain for at least the next 40 years.

So in the case of a research reactor construction project, you need to have people with experience of research reactors. If it was a power reactor, likewise you need people with power reactor, if it was an enrichment plant, you need people skilled with that. So you need somebody with the technical expertise. They're not the only people you need with technical expertise, but if you get at least one person with a broad-ranging knowledge, they will be able to identify what other skills you need to bring on board.

The third position is a licensing manager. Licensing in the nuclear industry is a very important part of any process. There are safety assessment processes which the operator does firstly for his own benefit, and secondly they have to

demonstrate publicly with your regulator, that what they're doing is appropriate and safe. To be able to guide a project through that process you need a licensing manager with the background in the nuclear industry working on a similar sized facility, in my view.

These three key positions that I have put forward there are ones that I've participated on a number of international atomic energy agency missions to countries that are getting (indistinct) into nuclear research reactors and have put it forward that they're the three key things you need to look for when setting up a research reactor project in another country - sorry, not in another country, when you're setting up a research reactor project in a country that does not have a background in research reactors.

Likewise here, in my view, if you were setting up a project to build a power reactor, you would be looking for a skilled project manager in construction of a technology project of around the same size. You would need to find somebody, at least one person, very skilled in all facets of a power plant reactor and you would need your licensing manager from the nuclear industry capable of managing the licensing of such a facility, and that those three people between them would be able to identify all the other skills you needed to bring on board.

MR JACOBI: Do you have other areas that you consider might be supplementary to those three skills that you think are also important in terms of delivering a project successfully of the kind that you were involved in?

MR MILLER: Certainly. When we started making approaches to government for approval to build a research reactor, the organisation started building up its analytical expertise in reactor physics and in thermal hydraulics. There's two reasons we had to do that. One is performance, and the other is safety. If I just address the performance area to start with. Whereas a power reactor in all probability you would be buying existing design from some company that's built one or more of those receivers elsewhere, whereas a research reactor tends to be a one of a kind, they're almost always one of a kind, unless you're going very low end facility.

So you're hiring somebody to design a one of a kind facility for you, and you're not going to know that it will perform until many years later when you have done the first fuel load, you have taken it up to power and you measure the performance of the facility. So therefore it's important to have the analytical team on our side as well as on the contractor's side so that we can get an early assurance through analysis that what the contractor was proposing would deliver what they were required to deliver. Because while they're still bound by the contract, if it failed to deliver you don't want to run for six years and only then find out it can only deliver half the performance that was requested.

The second part is with regard to safety, the contractor again as required to deliver us a safe facility and to demonstrate that it is safe. Our in-house people though did - repeated all the analysis the contractor did, often using different analysis codes to be certain of the safety characteristics of the reactor. It is not just safe when operating normally; a reactor has to cope with many disturbances to normal operation. For example, loss of offsite power being one of them. And you have to be able to analyse for each of the possible starting points or for each of the situations the reactor might be in with regard to its operation at the time that some disturbance occurred, how the reactor would respond and be assured that it will be safe through that disturbance. So these analytical people that we had, (indistinct) with not quite (indistinct) in-house but we took people who were basic (indistinct) or the starting point they had degrees in physics or similar and were brought up to – by people have that been through that process before (indistinct) to being able to do analysis of reactors.

MR JACOBI: The Commission has heard in its submissions that it would be very, very difficult to find a skilled workforce that might be capable of delivering a nuclear facility such as a nuclear power plant and I am just interested to pick up where you drew your skill base from in terms of what I might describe as the technical trades for the delivery of the Opal project?

MR MILLER: Are you talking professionally, or are you talking at the trade level?

MR JACOBI: I am talking about both the engineering but also the trade delivery, the – but including speciality trades?

MR MILLER: At the engineering level, many of the people you need, as I said, the sorts of engineers you might find at a coal fired power station, or an oil refinery. We have a lot of piping, we have several hundred kilometres of cabling that was part of the facility from instrumentation and control mainly. So there are a lot of engineers in Australia with capabilities in those areas. It doesn't cover the full spectrum of what you need but you can get a lot of the (indistinct) from people that have those sorts of knowledge. In the trade area, the contractor a project was required to deliver at least 60 per cent – sorry, at least 50 per cent Australian content by value. And they achieved something around the 60 per cent, might've been 61, 62 per cent, something like that. That is because a lot of the skills that you need are actually (indistinct) skills. You are not going to import a workforce from overseas to pour concrete, reinforced concrete for example and there is a lot of value in reinforced concrete in a large reactor project. Same with electricians and welders, because most of the welding is on fairly normal materials, carbon steel, stainless steel, these are things that Australia has the competence of welding, as

do any developed country. There is some specialist welding that was done in a material called zircon which was done in-house by a contractor in Argentina. Not that they had the skills to start with but they went through a process and developed the skills to weld those materials and they did that themselves because they saw that as a useful thing for the future of their business, because they didn't expect that ours would be the last of that sort of welding (indistinct) would be doing.

MR JACOBI: We have heard a little bit about the need to nuclearise existing trades and that is to lift them to these standards that are to be expected of nuclear, and I am just interested to understand any perspective you had on the challenges that you faced in ensuring that the local trades were able to meet the requirements that are required in nuclear.

MR MILLER: Our prime contractor was not (indistinct) company called (indistinct) they had a major subcontractor, John Holland Evans Deakin Industries joint venture, otherwise known as JHEDI. They or the instrument or the interface with most of Australian industry and staring from the top level and working down, we and (indistinct) sat with JHEDI and explained at the beginning the extent to which quality assurance was going to need to be not only applied but applied rigorously to tasks that were being undertaken. And speaking with the project manager of JHEDI towards the end of the project, they admitted that no matter what we told them up front, the amount of documentation and demonstration and proof that things had been done as required by the design shocked them. They weren't ready for that level of effort on their part, (indistinct) on their part to demonstrate quality. It's one thing to deliver quality, it's another thing to demonstrate quality and in the nuclear industry you have to be able to demonstrate quality.

As you go down the chain, one of the more regrettable things to the project was one of the sub-subcontractors made a mistake. That happens but then he tried using his best practices, to recover from that without ever putting his hand up and saying I made a mistake. That is not something that is acceptable to the nuclear industry and I don't believe there was any ill intent on the part of the sub-subcontractor involved, it's just he did what he would normally do, which is not the right thing in the nuclear industry.

MR JACOBI: I understand that the Opal reactor was though (indistinct) had built a reactor as I understood it in a research reactor in Egypt prior to building one - - -

MR MILLER: Yes.

MR JACOBI: - - - in Australia. But I understand that the Australian design was first of a kind design and I am just interested to understand how you went

about thinking about managing risk in that scenario?

MR MILLER: The issue with risk that we took on well before we went in to contract was the assessment of who was best to manage risk and we put in place a contract that gave the organisation the best chance of managing the risk, we assigned the risk to them. For example, ANSTO has a lot of experience at operation, modification, utilisation of a research reactor. Far more than the contractor ever had. We don't have experience at design of a research reactor; we don't have experience at construction of a research reactor, so the contract made the Argentinean contractor the design authority. In other words, we could not question his design other than would the design deliver the performance that the contractor required them to deliver. If you said they've got to do it this way with two pumps instead of three pumps, that's his choice because he has far more experience (indistinct) than we did and it's one of those things that we found out towards the back end of he project, that this was fairly normal for the nuclear world certainly for research reactors, not normal for power reactors but for research reactors, many organisations, like ANSTO would take responsibility for the nuclear design at least, of the reactor. We considered having assessed that people were inviting to tender were the potential contractors who are far better at managing that risk than we were and so the contractor sold that risk to them.

MR JACOBI: And I am just interested perhaps in that context, what risks did ANSTO pick up or accept in terms of where it considered that it had the – an obligation both to verify for itself or perhaps it was in a better position to evaluate some matters than others?

MR MILLER: Siting is something we took on ourselves while I don't think either side had particular experience at siting studies. We certainly understood the Australian context for siting of nuclear facilities and we managed that through the process, through the (indistinct) process because one of the first regulatory stages you go through is getting a site authorisation. So before we have a reactor designed or even chosen a contractor, we had approval of the site on which to build the reactor. And we have been through that process with ARPANSA and I think the regulator. Certainly, once we got on to the back end of things, the exact operating procedures of instructions were drafted to a large extent by the ANSTO people, partly because - was the Argentinians use of English was widely acceptable. It was quite good. But in an operating instruction you want it written by somebody for whom English is the first language, and so even with the back end of things there was a lot of effort put in by ANSTO on the operating and maintenance preparations, certainly with very significant input from the Argentinians as to how it should be operated.

MR JACOBI: I wanted to pick up the areas where it was thought that it would be better for certain tasks to be performed overseas, and that is that not only - I

understand INVAP is an Argentinian operator, but whether there were particular tasks that it was thought would fundamentally need to be performed overseas because the skill base didn't exist in Australia.

MR MILLER: That would've been a decision by the Argentinian contractor. We had a turnkey contract. We only engaged one contractor throughout the project, which was the Argentinian contractor. He made decisions based upon his own business assessments as to where things should be made. The only thing we did, because the Australian government naturally had an interest in maximising how much money would be spent in Australia, we had a fairly simple theme that a certain percentage of the value had to be delivered in Australia at the time of tender. We put out to the tenders they had to nominate how much they would achieve, minimum. So it was one of the assessments criteria.

COMMISSIONER: Mr Miller, can I just interrupt there? Was the Australian content, in your view, onerous? Did it add costs to the program? Did it add a schedule delay? Did you get a sense of whether this was a forced process or whether it was quite easy to achieve?

MR MILLER: I think it was quite easy to achieve. It certainly didn't create schedule delays. The reality is the bigger and bulkier the item, the more the contractor would wish to have it manufactured near where you were going to deliver the final outcome. There's lot of piping and large piping and things like that involved in the reactor. Much of that was made within New South Wales. The contractor up Newcastle way did a lot of the stainless steel piping. There was some stuff down in western Sydney. It varied around the place, but I didn't get the feel that it was in any way onerous in terms of the target that had been agreed.

Much of the stuff that was done overseas came from Argentinian, but again, it was very much a world project. The cold neutron source that we have, which is typical of a research reactor, not a nuclear power reactor, is a cryogenic system that puts liquid hydrogen near the core of the reactor, about 30 litres, and the (indistinct) process was controlled by the Argentinians. The design of the moderator vessel which contains the liquid hydrogen came from Russia, the cryogenic plant came from France, and the compressors that drove the cryogenic plant came from Germany. I think communications in the Internet era make many of these things relatively easy to put together a package that meets the need.

I mentioned before some (indistinct) welding. That was something that did run (indistinct) it's a specialist skill we didn't have. We didn't seek to get it because we're not planning on building more reactors. It's not a skill that we needed to build. The Argentinians took it on. They ran significantly later than their

schedule on that to the point where the vessel had to be brought to Australia in an Argentinian Airforce Hercules to maintain the construction program (indistinct) come by ship. There was no time for that. It was all up to them.

MR JACOBI: I just want to pick up on a question of the Commissioner. I understand that there was piping made here, and I understand from your earlier answer that obviously the concrete and all the site works were done. Were there other key aspects of activities that were carried out that were identified as better to be carried out in Australia, and what were they?

MR MILLER: All the installation work was done locally using local tradespeople. When you've got a few kilometres of electric cable that's a major piece of work for an electrical contracting organisation. Steelwork manufacture, there were a lot of pressure vessels that were made in Australia, plus all the building trades: carpenters and concreters and painters and - they're all the low tech end, but the good technical work, I think, was done by the metal fabricators that were engaged and some of the electrical work was done as well.

MR JACOBI: In terms of skills, was it necessary, for the purpose of ANSTO being able to deliver on what it needed to, for it to recruit from overseas to pick up any particular skill areas that were recognised that it had a particular need?

MR MILLER: For the project, we did recruit from overseas. No, that's incorrect. They did recruit for a short period there the - it would've been the general manager, nuclear operations. He was recruited from (indistinct) with a background in the power reactor industry. He stayed with us for a few years and then left again and was replaced by an Australian who had developed more of his skills, most of his skills here, had spent a couple of years at Idaho National Laboratory in the US. During his (indistinct) career stage to develop some skills.

We did have a few people who had come from overseas but not specifically for the project. Our licencing manager, he came from Australia very early on to work in one of our reliability analysis groups on site. He wasn't recruited specifically for the project, but he's the fellow that eventually became our licencing manager. We had an instrumentation and control engineer who had background in power reactors in Canada and the United States, but he was recruited back in 1993, 94, well before government approval, but he was recruited to work on our former reactor HIFAR. These are the people that we have with overseas experience. I have some overseas experience, as did Ken Horlock.

COMMISSIONER: Mr Miller, I think you've answered very clearly our questions. I find that evidence very useful for us to think about to the work

that we're undertaking at the moment. I thank you for the preparation for this and for your appearance this morning.

MR MILLER: Thank you very much. It was a pleasure.

COMMISSIONER: We'll reconvene at 11.30.

ADJOURNED **[9.58 am]**