RESUMED **[3.00 PM]**

COMMISSIONER: We reconvene at 1500 and I welcome Dr Patrick Upson. Dr Upson, thank you for joining us.

MR HANDSHIN: The Urenco Group is a nuclear fuel company operating

uranium enrichment plants in Germany, The Netherlands, the United States and the United Kingdom. It was established in 1970 once the Treaty of Almelo signed by the German, Dutch and United Kingdom governments entered into force. A separate treaty, the Treaty of Washington, was subsequently executed between those governments to allow for the establishment of Urenco enrichment plants in the United States. Dr Upson was a senior executive in the International nuclear industry for many years up to 2010, serving in the Urenco Group for 25 years. He led the project to licence the technology for Urenco in the United States. He is now an independent nuclear consultant.

COMMISSIONER: Dr Upson, we've heard a lot about the theory of the front end of the nuclear fuel cycle. We're particularly interested in this Commission about whether there are commercial opportunities. So it would be very useful for us if you could give us a quick walk-through the sorts of issues that you think about when you're thinking about conversion and enrichment and fuel fabrication.

DR UPSON: You understand the technologies, obviously.

COMMISSIONER: We do.

DR UPSON: For conversion you've got to take the uranium oxide and treat in a kiln with hydrofluoric acid and then fluorine to get the uranium hexafluoride. From a theoretical point of view you need to use uranium hexafluoride if you're going to use either the old diffusion process or a centrifuge process because fluorine only has one isotope. So you really are then just trying to separate the two uranium isotopes, 235 and 238. You're working on the slight difference in weight between the two isotopes. So you have to have a conversion plant which I would wish to site near to the mine so you're not having to transfer the oxide and the ore large distances. That requires a feed of fluorine. I think what has been done in Europe and America is to have the fluorine production near to the conversion plant.

So if I were building such a process I'd be looking at somewhere near the uranium mine and (indistinct) build a fluorine plant and the conversion plant. That's fairly standard technology. It has been around for as long as I can remember. I started in 1973 and the fluorine plant on the site at British Nuclear Fuels (indistinct) was getting to be old by that stage and we were looking into the new one. So the technology is well understood.

An enrichment plant is something a little bit more special. The technology is well known. It started with the gas diffusion process where you take the uranium hexafluoride and you pump it through various porous barriers. It's very expensive, takes a huge amount of energy, probably about a hundred times the amount of energy per unit output that a centrifuge plant takes.

Nobody is now using it. All diffusion plants have shut down and the original diffusion plants were built for the nuclear weapons program and then only later this was converted to making low enriched material for the fuel cycle. Nobody would ever plan to build a diffusion plant. It would have to be built. It's very, very large, very expensive and could not compete in the world market for uranium enrichment.

I know you've heard from the SILEX people today or yesterday. I did a lot of work on laser enrichment in the 1980s and 1990s with Urenco. We came to the conclusion that, although it would work, it would be very difficult to scale up to thousands of tonnes a year. Had we not had the centrifuge process at the time, which was seen as very effective, very efficient and cost effective, we might have continued but we stopped and everybody else in Europe and America, apart from those now connected, GE with SILEX, stopped work on laser. So in my view your only uranium enrichment process that's credible from an economic and industrial point of view in the near future and maybe even in the far future would be a centrifuge enrichment plant.

Now, the centrifuge technology is classified because it can be used for non-civil purposes. So if you wanted to build the centrifuge enrichment plant you would have to either develop your own centrifuge technology, which I wouldn't recommend – that would take you many years – or do some sort of deal with the technology provider. There really are only two potentials. That's Russia or the Urenco Group under ETC, Enrichment Technology Company.

I would be looking to build a centrifuge enrichment plant close to the conversion plant so that you could optimise your use of materials. I think I've got in my note that fuel production and fuel purchasing from the reactor operators is a seasonal thing. It sounds crazy but it's true. People want to refuel their reactors in the summer when the demand is lower so they're not losing quite so much money in power supply. So people want to have their fuel made in the spring which means they want to have their uranium enrichment delivered around about the turn of the year. Enrichment plants, which have to work 24-7, really need to be operating in advance of some of the contracts and some of the demand. So you need to be running ahead of the orders and building up stock.

Now, the same applies obviously to the conversion plant and the fuel fabricators. So if you were running a conversion plant and an enrichment plant together on one site you can minimise the amount of additional material and the movement of material. I think that would be a far more economic way of proceeding. As I also put in my note, you would have to persuade the fuel purchasers that they want to buy enriched uranium. What they like to do is optimise each stage so that they can get a better price for the stages.

If I were starting at a new site I'd be looking to go right from mining through to uranium enrichment and that would require you to build an enrichment plant near the converter. With high-speed gas centrifuges you can't make them somewhere and ship them to the plant. They're very delicate instruments and if you try to transport them they wouldn't be in a state to work when you get them to the plant. So you can make the components, as Urenco do and as the Russian industry does. You can make the components at your existing manufacturing site, ship the sets of components out. Usually you would do that in several different sets so that if anybody were to access one of your shipments they wouldn't have a complete set of components to work from. You would have to then have an assembly facility at your enrichment site where the final assembly was carried out.

I mean, I used to think of it as a little bit like the NASA rocket production. You build your NASA space rocket in the construction facility and then you trundle it along to the site where you're going to launch it at very slow speed and very carefully. With centrifuges you build your centrifuges in the enrichment assembly facility and take them on very slowly around on a specially prepared path in to the enrichment plant and install them. So that that gives you firstly the best chance of your machines working when you try and start them up, it also gives you a lot more security because your final assembly is there on the site, where your enrichment plant is going to be and you can be covered by the same security arrangements. You are not shipping complete centrifuges, where somebody – if somebody was to divert one of the shipments and reverse engineer you could find out how exactly to make and assemble a centrifuge. So from a non-proliferation point of view, I am sure Mr von Hippel this morning, or when you spoke to him, was talking about those aspects. I think building an enrichment plant on the site, so that you can have one complete set of security would be the way forward. Now in the last 10 years, I did a lot of work with the World Nuclear Association where we looked at security of supply and we looked at the longer-term need for fuel – regional fuel cycle centres, where we recommended that one should go ahead with a regional fuel cycle centre. We did exactly what I've just described. Went from the mine right through to enriched uranium and was then supplying that region.

I mean one of the reasons that we went ahead in Urenco and built the plant in New Mexico, North America was that the Americans felt that the supply of enriched uranium was too strategic to rely on it being shipped in from the over the Atlantic; were very keen to have a regional centre in America, supplying the American reactors. Now I think there is room for a regional fuel cycle centre somewhere in the Pacific Rim supplying the requirements in the Pacific area because you have got a big demand in South Korea, you have got the demand in Japan. A lot of other countries now, Vietnam, Indonesia, Philippines are talking about the potential for nuclear power and I think there is room for a regional fuel cycle centre. As an enrichment technology man,

knowing all the issues about transfer of the technology in to a new plant, I would think Australia is one of the few areas where it would be relatively simple to come up with an intergovernmental agreement to transfer the technology and keep it protected from a safeguard point of view. There are other countries in the Pacific Rim area which it would be more difficult to transfer that technology and get an intergovernmental agreement.

So that is really my thoughts. I've rambled a little bit there but that's really my thoughts on the requirements for building a mining to enrichment plant. I would be very – a bit more cautious about the fuel fabrication facility because fuel fabricators tend to own the design of the fuel. So unless you had a regional need for one type of fuel only, let's say Westinghouse were the only reactor supplier in your region, then fuel fabrication you would have to buy the licence to build all sorts of different designs of fuel. A) that would be expensive; b) you would have to have additional technology in your fuel fabrication plant, so that you could make – manufacture the different types of fuel. So I would be recommending going as far as the enriched uranium but perhaps relying on being able to deliver that to a large number of different fuel fabricators.

COMMISSIONER: Dr Upson, thank you very much for that. Can I just take you to the current market position?

DR UPSON: Yes.

COMMISSIONER: And get an assessment from you about the likelihood of such a facility being competitive in this particular market we are in now and perhaps where you see the market going in the future?

DR UPSON: Yes. the market now is probably not relevant because it would take you 10 years, I would say to get to the point where you had such a regional fuel cycle centre. It could take longer depending on the intergovernmental agreements that you need to put in place. So I think you are in – you need to be thinking about and looking at what is the market going to be in 10 years time. Well, there are 60 reactors currently under construction worldwide. I mean a lot of those are in China but if you had a regional fuel cycle centre in Australia, I think the Chinese market might open up to that centre. China are trying to build their own front end facilities but really it will take a long, long time to catch up with the demand that they are going to have for fuel in China. So I think in the longer term, China will probably become a bit more independent but for in 10 years time, I think it will still be a demand from them.

But if you're looking at other parts of the Pacific Rim area, South Korea are likely to have an increased demand, both from the potential for building new

reactors and from making their existing reactors work harder. Upgrading plant ad improving the efficiency of existing plant will require more fuel to make that happen. Japan, I think in August restarted the Sendai 1 reactor. They are talking about restarting Sendai 2 this month and I think by this time next year; you will see a lot more of the Japanese reactors running and it is my personal view that within 10 years time, you may even be getting Japanese ordering new reactors to replace some of the ones that they won't restart. I mean politically that is going to take some time in Japan to establish but they still do not have many other options for power supply in that country. You are getting other Pacific Rim countries talking about the potential for nuclear power, maybe not quite so loudly now as they were before the Fukishima accident. But I see the world demand for nuclear power and for fuel, even to supply the existing reactors, will continue to increase and I think there is room for further plants to be built.

MR HANDSHIN: Thank you. Dr Upson, can I just pick up on a couple of things that you have mentioned and perhaps - - -

DR UPSON: Yes.

MR HANDSHIN: - - - try and explore in a little bit more detail. The first concern is China and you have made reference to a potential opening in the Chinese market, at least in the short to mid-term. Otherwise, does it appear as though the Chinese market will head towards vertical integration?

DR UPSON: Well, that is certainly their plan. I know on the enrichment side, the Chinese purchased the technology from Russia but I understand that the Russian technology they purchased was not even the most up to date Russian technology, so it's not the most efficient enrichment process. I think there is potential if the price is right for the Chinese to – a) with such a huge programme, they would - strategically they would not want to rely too heavily on outside supplies of fuel. But I would see them potentially, if the price for the fuel was right, and I think it could be if you built a reasonably sized fuel cycle centre, in that region, I could see a significant proportion, say up to 25 per cent of the Chinese demand, even in the long term, being supplied from outside of China. Makes sense, firstly for the economics, but also from security of supply. If you have got one national facility and something goes wrong, you have an incident at that facility, you can lose centrifuge capacity, you would really want to have an alternative somewhere, so you are not just relying on the one plant that you have got. So I think there is a potential there that there will be vertical integration in China but I think the potential is there for other suppliers to take a reasonable proportion of that demand.

MR HANDSHIN: Yes. So diversity of supply remains important?

DR UPSON: Sure. I mean, if your reactor is down for a day you're losing $1 million a day, to say nothing about what that's going to do to other industries where you can't supply power. So it's really worth having security of supply. The price of the fuel, the price of enrichment, is not your biggest worry and the strategic issue is one that if - that's why you want to have a regional centre so you're not relying on it being shipped in from all over the world from different suppliers. Also, it gives you that flexibility in the long term. If your plant goes down you've got another alternative.

MR HANDSHIN: Some material that's been received by the Commission suggests that over the coming years there's going to be a substantial decommissioning of existing nuclear power facilities. I'm just wondering how that might reconcile with what you suggested is going to be a continuing increasing trend for the use of nuclear power.

DR UPSON: Well, I mean, take the UK, for example. We retired and we're decommissioning a significant number of the old reactors, but we're now planning to replace them. I think, again, security of supply from an electricity point of view, in the UK we need something for a steady baseload. We're not happy to be relying on gas coming in from other countries, some of which we're not too sure about the security of that supply for the long term, and wind power, solar power, is still not the most economic way forward, and we don't necessarily have the greatest amount of sunshine here in the UK, and my view, from a UK point of view, is we need to be building more nuclear power to provide a steady baseload, but the government needs to be putting money into research into energy so that these alternatives in 40 years' time are there and economic, otherwise in 40 years' time we'll be standing here saying, "Well, it'd be nice if we had more wind power, but we've got to rely on nuclear again. Let's build some nuclear reactors."

So I think we need to have a balanced supply, nuclear power for the baseload, improving the technology for other longer term demands, as such that we've got a good balanced supply for the next generation, and I think, yes, they're looking at that in many other countries. In America they almost fooled themselves recently with the fracking which has brought in a lot more gas and oil at low prices, but they are now building - they have started building a couple of new reactors on the east coast and in the longer term I think they will come to the same conclusion that fracking is only going to work for a while. We've got to have a baseload, and as their reactors come offline new reactors will be ordered and built.

The one exception is Germany, who for, I think, political reasons, will retire all their nuclear reactors and probably will never build any more, but that's a political decision rather than a sensible energy policy, I think, but I am, yes, very fond of the nuclear industry, so maybe I would think that.

MR HANDSHIN: Just one final question on the topic of market forecasts. Do you see India as having a role in the future demand for enrichment services?

DR UPSON: Sure. There's a big demand in India for nuclear power, but again, like China, I think they will be looking to supply most of their own demand for fuel. I mean, I don't know much about the Indian program, but I understood that they were basing it on a fast breeder reactor and maybe even thorium fuel. So it could be that their demand doesn't have a big impact on what I see as the uranium front-end of the fuel cycle, but I think, like China, in 20 years' time India will be moving forward with a nuclear power program. There will be a demand and once they're building up their own facilities there could be a demand from outside India that in the longer term maybe won't be quite so interesting but would provide a reason for putting new enrichment capacity and new conversion capacity in.

MR HANDSHIN: One matter that you touched on a moment ago was technology, and in particular laser enrichment.

DR UPSON: Yes.

MR HANDSHIN: Do you have any views on whether laser enrichment is likely to become a viable enrichment process in the short to mid term?

DR UPSON: Yes. I've given this view many times in different venues at conferences. We stopped laser enrichment because it just wasn't going to compete with our gas centrifuges when I was with Urenco. We made it work on a small scale, a very small scale, laboratory-type scale. When you come to scaling up it becomes very difficult and you end up with a plant that was very (indistinct) we had a small facility actually based at the UK Atomic Energy Authority in Harwell and that was still working. It becomes (indistinct) with slightly enriched uranium metal flaking out on the inside of some of your facilities.

When we looked at the future cost of decommissioning such a plant, we looked at the costs of scaling it up. For anything that would be a thousand tonnes a year, we came to the conclusion it would never compete economically. Now, there are other issues. The process we were looking at produced enriched uranium metal which is not uranium hexafluoride. So you've then got another completely new process for making new fuel. So now you've got to persuade your safety authorities that the fuel made by a new route is actually going to be as good and safe as the fuel that we've been used to (indistinct) so again, there would be a significant cost of getting that to market.

Now, unless you came along with a laser process which was, say, 50% of the

price of uranium enrichment by gas centrifuges, I can't see anybody getting to the point where they're going to develop and use it. Now, Silex may well disagree with me, but we looked at the Silex process. USEC in America worked with Silex for a while and then stopped because they chose instead to try and develop the American centrifuge. GE are working on the Silex process, but their demonstration plant is still some way from having demonstrated the process. Technically it could work, but I don't see it being introduced in the short, medium, probably even long term. The problem I would also have is I'm a bit nervous about the proliferation issues with a laser process. I think it will be less easy to control the use of the technology.

MR HANDSHIN: We heard some evidence a little while ago from Dr Goldsworthy about some suggested limitations in the centrifuge process, namely, that once they're started they need to operate on a continuous basis and that this leads to underfeeding and therefore stockpiling of uranium inventories and tails assays. Do you see those as limitations with the centrifuge process, and if so, are there any technological developments in the pipeline that might ameliorate those problems?

DR UPSON: They're not a problem, so there aren't any technologies that will ameliorate because there isn't a problem. You're right, and the Silex team are right: you have to operate your machines 24/7. I mean, the problem with a centrifuge is you put it under huge stresses when you run it up to speed. It has to go through several critical speeds and at critical speeds you're in danger of breaking the machine into pieces, of crashing the machine. So you're very careful about how you run it up to speed, but I think you'll find that Urenco and Tenex in Russia have quite a lot of experience doing that and don't lose machines these days when they're commissioning the plants.

So if you ever come to stop a machine, firstly, you're running the risk next time you try and run it up of machines crashing because you put additional stress on them. Also, when you're running a machine you'll get very small deposits of material on the inside of the machine. I mean, it's spinning like a spin dryer at very, very high speeds. If you stop the machine and even a small piece of the deposit falls out your machine will be unbalanced. So that when you come to start it up it's getting like a spin dryer when you've got a whole load of clothes in and they're not very well balanced, it will start to shake and your machines will crash. So you do not want to strap down your machines.

Now, that's not to say you can't do it. I mean, within the Urenco Group we did that on many occasions but you have to do it very carefully. You lose a lot of output while you're carefully running up and starting the feed again. So you're better off keeping the machines running. Rather than shut them down, I would rather them empty. Just take the feed off and leave them spinning on the vacuum, but that again is expensive. You're taking power and you're not

getting any output for it, but it's not a problem. I mean, you do have to judge your manufacturing program or your enrichment programs, such that to deliver – say you're delivering something like 40 or 50 per cent of your demand in November, December every year and the customer may well not have delivered his uranium hexafluoride to be enriched until a few weeks before he's due to have the fuel delivered.

So you're ending up buying material early to enrich early. I mean, the only risk you have there is have I enriched it to the right level? If the customer wanted 4.53 and you guessed he wanted 4.45 you might have to do a bit of blending afterwards, which is an added expense. The way things are working these days is the enrichment requirementss are pretty well known. The enrichment plants are tending to work at standard enrichment levels. If you had a good agreement with a fuel fabricator, again, some of the blending can be done by the fuel fabricator.

So I think working alongside the converters so that you're sharing some of the additional material you need to buy early, working alongside the fuel fabricators so that you are actually producing standard enrichments and the fuel fabricator isn't having to worry about where the enriched level is – you can do some blending at the fuel fabrication, at the conversion to the oxide for fuel. The process can manage the seasonal nature and the 24-7 operation of the centrifuges. If you have a regional fuel cycle centre, that's even better because you can be looking at the whole demand for that region and not just if you were running a small plant with lots of different customers worldwide.

So I don't see it's a problem. I mean, it has been running like that – you've only got to look at the Urenco operations. I have no idea what the figures are but let's say they've got between 25 and 30 per cent of the enrichment demand in the world market. They're running extremely well with plants that run 24-7 and they're profitability is very good. So I can't see that that is giving either a technical or an economic problem.

MR HANDSHIN: Another very closely allied question – and it might be that a lot of what you've just told us stands in answer to this question too. We've heard that centrifuge enrichment facilities are quite energy intensive. Is that a significant factor so far as their economic viability to operate goes?

DR UPSON: You say they use a lot of energy?

MR HANDSHIN: Yes.

DR UPSON: Absolutely not. That's absolutely not the case. A diffusion plants uses a lot of energy. The latest centrifuges – I can't speak for the Russians but I'm sure they're pretty efficient too – almost use no energy once

you've got them up to speed. I don't think this is classified but at one point in Urenco at Capenhurst – I'm talking 25, 30 years ago when I was in charge of the plant there – we switched off the centrifuges because there was a strike in the workforce and we weren't allowed to keep the plant running. So we switched off the power and they coasted and when we came back 24 hours later they were still spinning. They don't need a lot of energy once you've got them up and running. So absolutely the energy costs as part of the enrichment costs is very small.

MR HANDSHIN: I think you've probably touched on a number of these matters as well in the course of our initial discussion but I wonder if you might be able to step through and collate for us what you think would be necessary at a practical level to establish an enrichment facility in South Australia.

DR UPSON: Assuming you're not going to start from scratch and try and develop your own centrifuges, because that wouldn't make sense, you would need to approach one of the technology suppliers. Assuming that was Urenco, you would need to establish with the British, Dutch, German and French governments who currently safeguard the technology for use in America and Europe, you would need to approach them and agree an intergovernmental agreement. Now, I've perhaps missed a step. You'd have to get agreement with the technology supplier if they were amenable to some sort of economic deal to supply technology if the governments would approve it, and I'm sure they would be.

The governments' only interest is the safeguard of the technology, such that they would want to be sure that the information and the technology, the different components for a centrifuge, were safeguarded to the same level, the same understanding, as happening in the existing plants in Europe and America. So you would have to develop an intergovernmental agreement which said, "This is how we are going to protect the information in the plant," and that would then have to be ratified in the Australian, the British, Dutch, German, French governments. So it would be an intergovernmental agreement.

Now, when we did the Washington agreement to transfer the technology to America, that took four or five years. When we did the Cardiff agreement, which was for transferring the technology from Urenco for use in France, that took five or six years. So I don't see a period significantly less than that. Maybe one could do it in two or three years but I would be looking at getting a governmental agreement for the transfer of the technology to a new venue. So that would be a real necessity.

You would have to find the site. It may be that the site near the uranium mines is not the best site. Centrifuges don't like being shaken. So you need a fairly

low seismic activity level in the site that you choose. I was responsible for Urenco's American plant, getting the licence and choosing the site for the plant, back around about the year 2000. We found lots of good sites but found the seismic activity was just inappropriate. Now, you can cover that by putting in a seismic floor which, if there was seismic activity, would reduce the risk to your plant but I would be looking for a fairly seismically stable location. It may be that that's not right next door to the mine, but during the time you were looking at your intergovernmental agreement you would have to establish the best site for such a facility.

Now, I'm talking here about a seismic event that would cause the plant to crash. That isn't a safety issue. That's an economic issue. If your centrifuge crashes you don't get large amounts of uranium hexafluoride coming out of the plant because the plant is under vacuum. All you get, if a plant crashes you would get air rushing in. I couldn't guarantee but I'd be pretty sure that you'll get almost nothing coming out of the plant. So you've lost your economic capacity and you had a plant there that you were relying on to deliver to customers but you don't have a safety risk on the site. That is not one of the big issues.

COMMISSIONER: Dr Upson that leads me in to the question about safety which was - - -

DR UPSON: Yes.

COMMISSIONER: - - - the next on my list. You have had lots of experience, what are the sorts of challenges, safety issues that you have had during your life running these plants?

DR UPSON: Well, centrifuge enrichment plant is very safe. I mean the biggest concern about radiation levels are on your tails storage yard. So the tails which are about a .1, .2 per cent u-235 will be stored. I mean in Urenco at the moment they are just building a tails management facility which is going to take the historic tails from 40 years of operation and turn them in to uranium oxide where they can be more safely stored. But at the moment they are stored as uranium hexafluoride and you will have several thousand tonnes of uranium hexafluoride sitting on your tails facility, tails raft. You have to be concerned about the radiation levels but that's not a high risk. You just need to make sure that there is some – maybe an earth wall around the facility, maybe a building with some shielding around it and you don't spend lots of time occupying it but you don't anyway. It's a sewerage facility, you have to go in occasionally and monitor and check that the stainless steel containers are in a good condition. Ultimately you would have to build a deconversion plant where you turn the material back in to uranium oxide. The biggest safety risk in the plant would be reuse of uranium hexafluoride.

To be honest, the biggest risk in that is the fluorine. If you had a release of uranium hexafluoride, as soon as it comes in to contact with moisture in the air, you will get hydrochloric acid and uranium oxide dropping out. So any uranium would be fairly local on your plant but you might have a cloud of hydrochloric acid gas which is not something you want to be breathing in. So I mean my view was that provided your requirements for safety covered you for the chemical risk, the atomic nuclear risk was more than covered. Now in the 25 years of working for the Urenco group, we never had in my time a major safety hazard. We had several occasions where we lost some plant capacity because machines crashed and we had a significant time where we were decommissioning some of the old plants which had finished their lifetime service and we cleaned them up. But again, that has a low risk of radiation because you are cleaning small amounts of uranium under the plants. But they are very safe. So the worst that can happen is a machine will crash. If it's a single machine, it just sits there dead in your cascade of machines. If the whole plant were to crash, you will get air rushing in and you've got an economic problem because you can't supply from that cascade but you haven't got any reuse of radioactive material.

We always have some difficulty coming up with a scenario when we were doing safety planning. We always had exercises and the usual scenario was a forklift truck had driven in to the tails yard and pierced one of the tails containers and material had come out. We did even look at a small aircraft crashing on to the tails raft and releasing uranium hexafluoride but actually the safety risk, even of that, was pretty low. So there are small chemical plants - I am not sure I should say this but when I go to the Capenhurst site, the Urenco plant was much safer than the chlorine plant run by ICI about five miles away. And the chemical hazard from the chlorine plant that has releases of material which shut the motorway driving past on at least three occasions that I can remember. We never had incident on the uranium enrichment plant, nor would I expect to have one. Absolutely one of the safest processes in the nuclear business.

COMMISSIONER: Thank you. The final question we have for you, Dr Upson is to get a sense of the number of people and the sorts of skills that might be involved in a regional fuel cycle centre.

DR UPSON: Okay.

COMMISSIONER: Just to give us a broad idea?

DR UPSON: Well, I really can't speak about the conversion plant but I can't – I don't think that requires huge numbers of people. It is just a small chemical plant.

COMMISSIONER: Yes.

DR UPSON: Now you are not talking about hundreds of thousands of tonnes of material going through each year, you are talking about tens of thousands of tonnes of material. So it's a small chemical plant and you would need chemist, engineers - uranium enrichment plant the big demand is when you are building it. You would need to have some skilled people for assembly. What Urenco did in both France and the USA is send a small team of experts, who then trained up the local people for the assembly but that is assembly of some delicate material. It's a bit like aerospace. If you are thinking about somebody who is assembling aerospace jet engines for aircraft, it's the same sort of skills. You need to be able to control and position items very carefully; you need to have a clean room technology. So while you are building the plant, you would need those sorts of skills. Running the plant itself, you need some process operators. Again, it's really like a small chemical plant. But at the Urenco sites the numbers of people running it are pretty small. You would be looking at maybe between 100 and 200 people running the plant. Some process operator skills, some maintenance skills. You don't maintain the centrifuges but you have got various pumps and feed systems around that that need to be maintained.

So I would be looking at a series of mechanical, maybe one or two chemical engineers but it is not something where you need some highly specialised nuclear skills. It is just basic chemical engineering and mechanical engineering. For the plant that Urenco built in New Mexico, again we took some Europeans over for the first part of the operation, to train up the locals but we brought in the locals from around the Hobbs County where the plant is situated and there was people skilled in the oil industry. So again, engineering, mechanical engineering, bit of chemical technology. So those will be the sort of skills. But if – I am sure you would have those skills in the Australian region where you are. It's not a huge number of high technology people with nuclear background. You don't need that. You will need some from the point of view of the safety and the environmental team but it is nothing that you couldn't easily cope with.

COMMISSIONER: And the capital cost of such a facility?

DR UPSON: Yes. Depends what size you are – I couldn't tell you for a conversion plant.

COMMISSIONER: No.

DR UPSON: Although a centrifuge enrichment plant – and I have built many, you would be looking at maybe I think two or three billion Euros. I don't

know what that works out in Australian dollars. Say two billion pounds.

COMMISSIONER: Okay. Dr Upson, I thank you very much for very practical advice. We appreciate you spending the time with us.

DR UPSON: That's okay. And if there is anything else I can do to help you with your decisions, you only have to call on me.

COMMISSIONER: Thank you very much.

DR UPSON: Not necessarily at 5.30 am every time but - - -

COMMISSIONER: We promise we won't.

DR UPSON: That's okay. Thanks very much.

COMMISSIONER: Thank you. We will adjourn until Wednesday, the 14 - - -

MR HANDSHIN: Twenty-first.

MATTER ADJOURNED AT 3.50 PM UNTIL WEDNESDAY, 21 OCTOBER 2015