COMMISSIONER: Good morning. Welcome back to topic 8, Adding Value to South Australian Radioactive Minerals. This morning we'll hear from Professor Von Hippel from Princeton University, Mr James Voss from the University of London and Dr Michael Goldsworthy from Silex, and this afternoon Dr Patrick Upson from Urenco.

MR HANDSHIN: Today's public session is concerned with gaining an understanding of the feasibility of expanding South Australia's role into the so-called front end of the nuclear fuel cycle beyond the mining of uranium and, in particular, into the enrichment of that uranium so as to add value prior to its export. This requires the Commission to understand the nature and extent of current enrichment operations and their by-products and the development of new technology in uranium enrichment with a view to ascertaining whether it would be realistic and potentially beneficial for South Australia to become a participant in these activities.

The Commission will also seek to explore the risks attributed to enrichment activities, including the potential for any new enrichment facilities to contribute to the proliferation of nuclear weapons and the regulatory safeguards which are required to ensure against nuclear proliferation. This will be an introduction to a later public session dealing in detail with the topic of safeguards and nonproliferation.

The commercial enrichment of uranium which involves increasing the concentration of the main fissile isotope of uranium, U235, using centrifugal processes is currently undertaken by a handful of large and experienced organisations. These organisations currently meet most of the global demand for enrichment services which is presently exceeded by global supply. However, given the likely lead times to establish new enrichment facilities, the Commission needs to understand the potential commercial viability of additional enrichment services in the medium term. Given this future focus, the Commission intends to investigate not only current commercial enrichment technologies but also those in the later stages of development. Third generation laser enrichment technology invented by an Australian company, Silex Systems Ltd, has been under development for some time now and is argued by its proponents to be a potentially disruptive technology for the global enrichment services market.

Beyond enrichment, some written submissions to the Commission have urged its consideration of fuel leasing as a mechanism by which significant value might be added to South Australian uranium. Fuel leasing refers broadly to an arrangement whereby uranium is leased to a nuclear power facility or utility for use as nuclear fuel and then returned to the lessor as spent fuel for its storage and disposal. While the potential risks and opportunities presented by spent nuclear fuel storage will be examined in detail in later public sessions, the

Commission will today consider the topic of nuclear fuel leasing in the context of considering potential opportunities to add value to South Australian uranium.

The Commission's first witness this morning will be Professor Frank Von Hippel of Princeton University. Professor Frank Von Hippel is a theoretical physicist and Emeritus Professor of Public and International Affairs at Princeton University. He has worked on nuclear policy issues for over 40 years. From 1993 to 1994 he was the assistant director for National Security in the Whitehouse Office of Science and Technology Policy. He holds a DPhil in theoretical physics from Oxford 1962 and a BS from MIT in 1959. He was a founding co-chair of the International Panel on Fissile Materials and has written extensively on the technical basis for nuclear nonproliferation and disarmament initiatives and the future of nuclear energy.

COMMISSIONER: Professor, thank you very much for joining us this morning, this afternoon for you. Can I start with the broader question of your view of the nuclear industry at the moment?

PROFESSOR VON HIPPEL: At the moment – before I get into the substance, you're breaking up a little bit. So at some point it might help if we go off camera just for the audio. Let's see how it works, where we have it, but we may have some problems. I may ask you to repeat yourself or you may ask me to repeat myself. I think at the moment the future of nuclear power is very uncertain. It has been on a plateau, really, since Chernobyl. There was an anticipation in the middle of the 2000 to 2010 period of a nuclear renaissance but there was not that much of one and then Fukushima came.

So at the moment this plateau of global nuclear capacity appears to be continuing and it's possible that it even could decline in the future if the retirements outpace the construction of new capacity. In Europe and the US and Japan, the leading nuclear countries historically, the fleet of reactors is aging and there's a question of whether they'll be relicensed. In the US they have been largely relicensed to go 60 years and there's even some talk of relicensing them again to 80 years but that's very uncertain. So I think the one bright spot is really in China where about half of the nuclear power plants that are under construction are located but it's still a very small fraction of the global capacity that China is building. The IEA's expectation ranges from a plateau to maybe a doubling in global capacity by 2050 but because the rest of the non-nuclear capacity will be growing, at most maintaining the percentage of global electricity production which is about 11 per cent now.

COMMISSIONER: Professor, it might be a good time – in some of the submissions the Commission has received it has been put to us that the need to reduce greenhouse gas emissions from power generation might be a reason for a renaissance again for the nuclear industry. Do you have a particular view on that?

PROFESSOR VON HIPPEL: I think that's true but in the US and Europe it appears that wind and renewables are outcompeting nuclear. Nuclear has become so expensive. Japan, it's in an earlier stage, I think. I personally don't think we should turn our back on any non-greenhouse emitted energy technology but so far, of course, the global climate change policies is at an early stage and it might be that if it strengthens then it will lift all boats, including nuclear.

COMMISSIONER: Thank you. If we can now move on to the specific area that we're focusing on today, which is enrichment, conversion, fuel fabrication. Can you give us a sense of your view of each of those particular areas and where you see demand and supply at the moment?

PROFESSOR VON HIPPEL: This is more in the area of expertise of some of your later witnesses from Silex and Pat Upson. It really does again depend on global nuclear capacity growth. At the moment my simple way to orient myself is to look at the price of uranium and the price of enrichment work. They both plunged in the last few years, in the case of enrichment work by more than half, and so that suggests that there's an overcapacity at the moment, and I think the fact that GE Hitachi, which is going to build a laser enrichment plant (indistinct) laser enrichment plant in the US, that they postponed their plans similar to (indistinct) which is going to build an enrichment plant in United States, a centrifuge enrichment plant has postponed this, it was on the (indistinct) because that at the moment - you know, and I don't know how long this will last, you know, the conditions aren't good for a new entrance. We've come to fabrication. I don't know. That's a smaller part of the fuel circuit.

MR HANDSHIN: Professor, could I just pick up on one matter that you raised in your opening remarks, and in particular your reference to China. Is there any indication of whether China is predisposed to vertical integration of its nuclear industry?

PROFESSOR VON HIPPEL: Yes. China is building a lot of immersion capacity and it looks like it wants to be self-sufficient in that area. They are expanding their uranium mining, but I think quite aggressively taking positions outside China and trying to acquire long-term contracts, I think, including Australia, probably South Australia. So would the country be processing? I don't know whether that's on our agenda today or not. You know, I think there's a debate in China about whether to reprocess, but if they do, then I think they will - they won't ship their fuel elsewhere. They would build it domestically.

MR HANDSHIN: What kind of enrichment capacity does China currently have?

PROFESSOR VON HIPPEL: That's a mystery, because, you know, I have a colleague who's been trying to pull that together, a Chinese colleague, and he has found many more enrichments plants then we were in China. So I guess I could try to pull something together and send it to you by email, but I don’t have (indistinct) you know, it's been around two main sorts. It may be double that at this point.

MR HANDSHIN: Does China currently provide enrichment services outside of their own domestic market?

PROFESSOR VON HIPPEL: They don’t, but I think they're in a renaissance stage. I think the Chinese are looking to become an exporter of nuclear reactors, at least, and if they model themselves on the Russians in that regard, I mean, they'll try to provide all the services for those reactors that they export, but, you know, they're not as well positioned as the Russians are. It's only in the enrichment area the Russians have about half the global enrichment capacity.

MR HANDSHIN: Do you see any potential issues with respect to the degree to which Russia is involved in the enrichment market and how that might be affected by geopolitical issues?

PROFESSOR VON HIPPEL: Well, I think the Russians - you know, trying to explain the huge amount of enrichment capacity that they built, partly it was initially for weapons, as it was in the US. The US built actually, and has retired, a lot of enrichment capacity, maybe comparable to what Russia is. We kept going with gaseous diffusion which became less and less economic in competition with centrifuge enrichment. That's why our system capacity has been retired. Russia doesn't have that many exports and so I think nuclear - exporting nuclear reactors and services is one of the few areas where they are competitive, besides oil and gas, and so, yes, I suspect that they're happy and they might even, if they could, increase their share.

MR HANDSHIN: If there were an unavailability of access to Russia's enrichment services would that create a gap in the enrichment market?

PROFESSOR VON HIPPEL: I think it would, yes. I mean, certain countries of course are trying to do as little business with Russia as they can right now and that's a good point, and if there were really long-term sanctions on Russia, by their nature, you know, by Europe, by the US, in that area - you know, I actually don’t know what it is. I mean, we know we have some sanctions. I don't know whether there are some in the nuclear area as well. You know, that would certainly have a major impact.

MR HANDSHIN: You referred a moment ago, professor, to a SWU, a separative work - - -

PROFESSOR VON HIPPEL: (indistinct)

MR HANDSHIN: Could you give us an idea of where that concept sits in the context of enrichment and what it measures?

PROFESSOR VON HIPPEL: Yes. It is what the - a separative work unit, a SWU, and it is the - what the enrichment services providers sell, and for non-enriched uranium the - roughly speaking, to produce the four to 5% enriched uranium that one or two reactors use, it takes approximately 1 SWU per kilogram of uranium, 1 kilogram SWU. Sometimes people talk about tonne SWUs, but I think it's almost always kilogram SWUs in common usage.

And so to give you an idea, to translate that into centrifuge units, your really primitive centrifuges that Iran has built produce about 1 SWU per year, whereas Urenco enrichment - well, Russia's centrifuge produce around 10 SWUs a year and the Urenco, the most recent generation, around 100 SWUs per year. The Russians have a different philosophy where they stack up actually vertically. They stack up these relatively small centrifuges and it's different from Urenco which has gone to larger and larger centrifuges.

MR HANDSHIN: So is that SWU measurement that you gave us in relation to Russia and Urenco a measurement that relates to each individual centrifuge?

PROFESSOR VON HIPPEL: Yes.

MR HANDSHIN: Right. So then you add of those - - -

PROFESSOR VON HIPPEL: Yes, per centrifuge.

MR HANDSHIN: Yes.

PROFESSOR VON HIPPEL: So one for the Iranians, 10 for the Russians and 100 for Urenco. These are ballpark numbers.

MR HANDSHIN: Yes, sure. And in order to determine the overall capacity of an enrichment facility, do you add together, effectively, the capacity produced by each individual centrifuge?

PROFESSOR VON HIPPEL: Yes, to a (indistinct) approximation. You may lose some enrichment capacity if the - cascade, they're called. They're arranged in cascades where one centrifuge feeds into another centrifuge which enriches a little bit further. If there is no optimal design, you can lose some of the output in that way, reduce the overall output from what you could get by simple addition.

MR HANDSHIN: Perhaps given that we got into the topic of the enrichment process, could you provide us with a little more detail on how it works and the process of centrifuge?

PROFESSOR VON HIPPEL: Yes. The way that centrifusion works is you convert uranium oxide which is the form that you mine in Australia in to uranium hexafluoride, uranium with six fluorine atoms which is a gas. And so then you feed in to these cylinders which are spinning very rapidly, I like the analogy to cream separator, centrifugal cream separator and the gases is pressed against the outer – outside of the cylinder and the – we have two isotopes in uranium, u-235 and u-238. U-238 is about one per cent more heavier than u-235 and therefore pressed a little bit harder against the wall and as with cream, you get a slightly enriched of the layer toward the centre is slightly enriched in u-235. And so maybe if you put it in at seven tenths of – for a uranium centrifuge, if you put it in in seven tenths of a per cent, that's natural uranium has seven tenths of a per cent u-235. Maybe comes down to .8 per cent. And then you feed it in to the next layer of the cascade.

COMMISSIONER: Okay. Could I perhaps move on to the topic that I know you're interested in, reprocessing and to have - - -

PROFESSOR VON HIPPEL: Yes.

COMMISSIONER: - - - your views? Perhaps start with just a brief explanation professor on what reprocessing is and then perhaps tease out the issues that I know you are particularly concerned with?

PROFESSOR VON HIPPEL: Yes, thank you. Well, when you put nuclear fuel in to a reactor it contains maybe about four to five per cent u-235. When you take it out, so it's – at that point it's called spent fuel, it – most of that u-235 is inefficient and about one per cent of the uranium-238 that is the other 95, 96 per cent of the uranium you put in, about one per cent of that is converted to plutonium. And the other per cent actually has been converted to plutonium but efficient fuel was in the reactor. The plutonium, is like u-235 chain reactive and originally the rationale for reprocessing was to separate the plutonium out to start a new type of reactor which could actually be fuelled by u-238. It would be fuelled by – immediately by plutonium but it then would convert more u-238 in to plutonium with the extra neutrons it produced, than it used. And so these were called plutonium breeder reactors and the idea was that you would be able to get a 100 times – roughly a 100 times as much energy out of a kilogram of uranium. Now the type of breeder reactor that was developed was cooled not by water but by liquid sodium and that turned out to be trouble, sodium if it comes in contact with other air or water burns. And so most of the cost of nuclear power is the cost – the capital cost of the power plants and these liquid sodium cooled power plants turned out to be much more expensive than water cooling and so despite about 100 billion dollars of effort and 50 years, these – and even those – two countries, in particular Russia and India are still trying to commercialise these reactors. They haven't been commercialised.

So then the question – but in the meantime, in a few countries, notably France and the UK, those are countries which built new processing industries were built to separate out that one per cent plutonium and spent fuel, for start up fuel for the breeder reactors that didn't come. So then the question was what to do with that plutonium. France has pioneered in the idea of recycled – using that plutonium in – to fuel the water-cooled reactors, to recycle and to fuel their water-cooled reactors. That promotes (indistinct) That can has reduced France's uranium consumption by about 12 per cent, not very much. Much less dramatic than the effect that breeders would have had. And it's been very costly. Reprocessing, the cost of reprocessing were grossly underestimated originally. They increased about tenfold and France has found, and Japan which has been less successful than France, they found that the cost of the so-called mixed oxide fuel which is a mixture of a few per cent plutonium with depleted uranium. This fuel has been used to recycle the plutonium. It costs about ten times as much as the enriched uranium that it displaces.

In France and Japan, it has been found to be very difficult to change (indistinct) and the utilities are being made to eat that extra cost by their governments. My concern, of course the reason I am interested in this is plutonium is a weapons material and separating it from - and (indistinct) makes it much more accessible. In fact, for a while the US forgot this in the sixties and was promoting reprocessing and breeder reactors as the energy technology of the future and then one of the countries we were promoting it to was India and India had - we were in fact (indistinct) for peace programmes supporting India's development of reprocessing and breeder reactors and then India used the first plutonium that it separated in 1974 for a nuclear explosion and that caused the United States a very dramatic rethinking. You know I became involved at that point. I was much younger and the – I was part of the Carter administration's review and the question was do we need to do this? And we concluded that what in fact just turned out to be the case, that breeder reactors would not be economic. Reprocessing would not be economic and US abandoned its efforts in those areas and tried to persuade other countries to do so too.

Countries that were pretty far down the road, namely France, Britain, Japan, Russia were not willing to be persuaded to stop. But the effort has been successful in preventing new countries from getting in to this business. Basically we have taken the position that we don't do it, you don't need to do it either.

MR HANDSHIN: Professor what level of global demand is there at the moment for reprocessing?

PROFESSOR VON HIPPEL: Well, at the moment the countries which have been reprocessing for other countries are France, UK and Russia. And in the case of – in all of those cases, the demand has essentially evaporated. In the case of the UK, because of the economics and because the exporting your fuel to France or the UK was not a solution to your radioactive waste problems because part of the contract was that they were going to ship the high-level waste from reprocessing back to you, and it turned out to be that it's politically no easier to deal with, that high-level waste, than the original spent fuel. But in the case of the UK even its own utility which, interestingly enough, is Électricité de France – Électricité de France did buy all the UK nuclear power plants – has refused to renew their contracts. So the UK's plan is to finish up the current contracts and, if the plant works reasonably well, it expects to be done by 2018.

In the case of France one country did renew its contract, the Netherlands. The Netherlands only has one very old nuclear power reactor. So that more than 99 per cent of the reprocessing in France is of its domestic Électricité de France's fuel because of the insistence of the government which – I think their reprocessing plant employs thousands of people in a rural area and I think that's sort of an industrial policy to keep them going.

Also, France has been trying to sell reprocessing plants. It's not clear whether it's succeeding with China. The price that was being cited for China was 20 billion Euros. So that's quite a bit of money for French exports and I think that might be another reason in addition to the employment for France to keep its own reprocessing business going, because even if it can't sell the services, maybe it can sell plants. It also has been lobbying very hard in the US to sell the US reprocessing plant. The Bush administration almost bought it. The Obama administration hasn't been interested.

So we come to Russia. It's a little more confusing. It may be that Hungary is renewed. It may be that Armenia – it's not clear what the situation is for those countries. Otherwise, though, there have not been renewals. The Eastern European countries which joined the EU have not renewed.

MR HANDSHIN: Professor, you mentioned a moment ago a number of the disadvantages, in your view, with reprocessing facilities and I think you mentioned proliferation risks and the costs involved in the operation of these facilities. Do you see any other downsides to them, perhaps environmental, radiation-related issues?

PROFESSOR VON HIPPEL: Well, I think in my own view the environmental issues of deep burial of spent fuel are not very large. One of the arguments used to promote reprocessing has been that you would then not bury plutonium and that plutonium is very long-lifed and who knows what kind of leakage on that time scale might have. That argument is stronger if you have bigger reactors where you really do fission all the plutonium or almost all of the plutonium eventually. In the case of light-water reactors the current plan is only to send the plutonium around once and then that would only reduce the amount of plutonium by about half which doesn't change the situation qualitatively. At the same time, of course, you take one radioactive waste form, spent fuel, and turn it into multiple waste streams, including the plutonium-contaminated waste streams from MOX fuel fabrication.

So it's not clear if there's an environmental advantage. Certainly in the US in the 1990s that was one argument that was being made and the National Academy of Sciences was asked to review that and they concluded that there was a very moderate, if any, environmental benefit at a huge cost.

COMMISSIONER: Could I just pick up on one of your points, Professor, about sodium-cooled reactors and how far they are away from commercial development. Are there any other reactors that are capable of burning spent fuel that you think are closer to commercialisation?

PROFESSOR VON HIPPEL: In terms of multiple recycles, I guess, you're asking. I don't think so. There is one reactor type which has sort of been also at the threshold and never quite got across the threshold, which is called a high temperature gas-cooled reactor. Its proponents say that one of its advantages, even on a once-through basis, is that it can burn a larger fraction of the plutonium than the water-cooled reactors. It also has been attractive to some of us because of its safety advantages but it's a perennial – there has been interest in South Africa. Now currently the Chinese are interested at a prototype level. The US built a couple in the 70s. They didn't work very well but not for fundamental reasons. Somebody else might make them work better.

There are advocates, of course, for many different types of reactors. There's a group that's promoting a molten salt reactor where the fuel is more – but it's quite complicated in the sense that it's a reactor and a chemical plant combined. I'm pretty sceptical myself. The other boomlet in the United States has been with regard to smaller reactors, small modular reactors, which some people argue that if you could get them into mass production they could be less costly than the permitted capacity, than the large reactors that dominate the market today, but they wouldn’t be different as far – qualitatively different. They would be water cooled.

Recently I looked at the design of the shipping port reactor which was the first light-water cooled reactor. I think it came online in the United States – it was built by the navy, the navy reactor people. It came online back in 1960 and it's amazing how little change there has been in reactor technology since then. The industry doesn't seem to pursue novelty, new reactor types.

COMMISSIONER: Professor, I think you were leading into the potential for spent fuel repositories being a better means of managing waste. Can you just tell to us about where you see spent fuel repositories going, what you've seen in the world, what you think has worked and what you think might work in the future?

PROFESSOR VON HIPPEL: I'll explain my hierarchy of concerns about nuclear power. I put proliferation at the top, reactors accidents in the middle, and radioactive waste repositories at the bottom. The public hierarchy is reversed, I think, and so if there was a rational country out there, you know, which didn't have - well, let me just explain why the evidence - that in fact in - in some situations, you know, that perception is shared by others.

The repositories that are furthest down the track are in Sweden and Finland and the sites of those repositories are adjacent to nuclear power plants, and I think that those communities do understand that spent fuel above ground - spent fuel in reactors is the most hazardous. Storage spent fuel and dry casks (indistinct) maybe is the next. The least hazardous is the spent fuel 500 metres underground. I mean, it could be that in a community like that, maybe one which becomes more sophisticated about the risks because they do host a reactor, you know, could actually make a lot of money by saying, "We'll take other countries' spent fuel."

I think that a well-designed repository 500 metres underground, when people do calculations, simulations, of over thousands of years, tens of thousands of years, very little material gets to the surface even in worst case analogies, and the material that does get to the surface tends not to include plutonium because plutonium is not - in most groundwater, plutonium is not very soluble. Other elements are more soluble. You might get a more sophisticated (indistinct) in this area (indistinct) you might get a more sophisticated perspective by somebody who has really gotten into that more deeply. I could suggest a couple of names to you if you decide to pursue that.

MR HANDSHIN: Thank you. Have you heard of the concept of fuel leasing, professor?

PROFESSOR VON HIPPEL: Yes, and that's basically what Russia does, and basically - and that's one of the appeals to countries, you know, that Russia sells reactors to, that they included in the service that they will take the spent fuel back. Russia at one point was considering taking other countries' spent fuel back, spent fuel from reactor power plants that they had not sold, and that was just too much for the Russian public even, you know, with the control that the central government has, but they - they argue because they're still imagining that their future source of nuclear power be (indistinct) reactors that spent fuel is not a waste. It's a resource, and therefore, you know, they ultimately will need that plutonium to start up an expanding fleet of plutonium (indistinct) reactors.

I don't know of any other country which has done that, but I think it is interesting, you know, because my perspective on that actually - the public is not objective about the risks of spent fuel. I think, in fact, if a country wanted to make fresh fuel, sell it and take it back, put it into a repository, you know, that could be quite a profitable business.

MR HANDSHIN: And how would you see Australia's appeal as part of involvement in a fuel leasing arrangement?

PROFESSOR VON HIPPEL: Well, I mean, the appeal of Australia to be also as a potential host for an enrichment plant if the situation opens up again. Its non-proliferation credentials - you know, there just hasn't been any indication. I don't know. Maybe in the 60s there might have been some interest in nuclear weapons in Australia, as there were in many other countries, but certainly not in recent times, and so, you know, I would be much more comfortable with an enrichment plant in Australia than I would be in Japan or South Korea, you know, where there are security threats and want to preserve a nuclear weapons option.

With regard to spent fuel, you know, I also - I mean, in some countries we're not comfortable with spent accumulating. That's certainly been the case with Iran where part of the deal with Iran is that its spent fuel will be exported just because plutonium contains - which with time, becomes more accessible as sufficient (indistinct) decay, and I think in that case it's Russia that will be taking Iran's spent fuel. So I think there is some appeal from a non-proliferation ground. I wasn't being that encouraging in terms of the commercial prospects in the near term with regard to enrichment but from non-proliferation grounds, I'd be happy to have South Australia explore the opportunities in the long term for a fuel leasing arrangement.

COMMISSIONER: If I could just finish with that sort of question, professor. A multinational enrichment facility, do you think that would have greater appeal to the international community?

PROFESSOR VON HIPPEL: Well, thank you very much for bringing that up, because that was - I forgot to include that. Right now I'm on a campaign arguing that there should be no more national enrichment plants and that - you know, because with an enrichment plant does come breakout potential, as we've seen, you know, with this crisis over at Iran's enrichment plant. You know, normally that enrichment plant is designed to produce three and a half per cent enriched uranium for the Boucher nuclear power plant, but it could - the cascades could be fairly quickly reconnected to proceed weapons grade uranium.

That's been the concern, and the concern is if Iran goes down the road and succeeded and just by persistence, is willing to - willingness to absorb the huge costs that it's incurred and has a national enrichment plant, then other countries, you know, Saudi Arabia, Turkey, Egypt, in the region, may say, "Well" - you know, in fact a senior Saudi official has said, "Whatever Iran has, we'll have too." And so you get a proliferation of nuclear weapons threshold States. So, you know, what I'm promoting is say, "Let's just get out of the national enrichment business and all future, and hopefully some existing, enrichment plants should be multinationalised.

Now, the situation is with Urenco, it's going to be multinational. Germany, The Netherlands and the UK own it. It accounts for about a third of the global enrichment capacity. So as an existence (indistinct) I don't know, I think it's optimally designed with non-proliferation in mind in terms - but whether it is an existence (indistinct) that is economically viable, and similarly, you know, I've been thinking that, you know, a multinational arrangement starting with Australia, Japan and South Korea, for example, could keep the pressure off us from South Korea, at least, to have its own enrichment plant, and maybe persuade the Japanese to retire their enrichment plant which has not been economically competitive. So thank you for asking the question.

COMMISSIONER: Professor, I think we asked all the questions that we sought from you. I thank you very much for your time late at night, and I wish you the best for the future.

PROFESSOR VON HIPPEL: Thank you. I enjoyed it. Bye-bye.

COMMISSIONER: We'll reconvene at 1000 with Mr James Voss from the University of London.

ADJOURNED **[9.21 AM]**