RESUMED **[1.30 pm]**

COMMISSIONER: Welcome back. We are on the subject of low and intermediate level waste storage management and disposal and from Finland I welcome Dr Sami Hautakangas from Fortum.

DR HAUTAKANGAS: Thank you.

COMMISSIONER: Thank you very much for joining us. Welcome to sunny Australia.

DR HAUTAKANGAS: Thank you.

MR JACOBI: Fortum is a Finnish company which was founded in 1998. Its operations include hydroelectric, nuclear and solar power generation and is one of the largest producers of heat in the world. Fortum's main areas of operations are the Nordic and the Baltic countries, Russia and Poland. Dr Sami Hautakangas is a product manager in the nuclear expert services at Fortum. Having commenced work at Fortum in 2007 he's held several roles including the manager of nuclear waste research and development and the department head of nuclear waste and technology. Dr Hautakangas obtained his doctorate in engineering physics from the Helsinki University of Technology in 2005 and the Commission calls Dr Sami Hautakangas.

COMMISSIONER: Dr Hautakangas, can we start with understanding the nature of what it is in terms of medium and low level waste that this Finnish experience was trying to grapple with. What were you trying to store and just a bit of background on the extent of the storage that might be required?

DR HAUTAKANGAS: Yes, in principle these wastes are produced by the nuclear power plant and from the spent fuel. Many other wastes are produced and these are just normal wastes which are produced during the normal operation of the power plant and they can be divided in low and intermediate level wastes and we in Finland doesn't make any distinction between long or short living lower level waste, so whenever we talk about low or intermediate level waste we mean those as a whole.

MR JACOBI: In terms of the waste streams that are being dealt with at two facilities, one which we'll refer to as VLJ and the other one at Loviisa, are the waste streams only from nuclear power plants?

DR HAUTAKANGAS: Mostly, yes, in this which is seen in the slide. This is a block from the nuclear power plant and at this facility it will be stored only wastes from the nuclear power plant, from the Loviisa nuclear power plant. There are some discussions going on regarding the waste from the research

reactor which is now being decommissioned in Finland and it also needs to be disposal site somewhere, but that's not clear yet which place it will be.

MR JACOBI: Yes, but that could be at either VLJ or Loviisa. Is that right?

DR HAUTAKANGAS: Yes.

MR JACOBI: Going to the VLJ is the VLJ likely to receive other waste streams as well? Is it expected it might take waste streams from other industries?

DR HAUTAKANGAS: Well, I suppose the VLG you mean the repository in Olkiluoto?

MR JACOBI: Yes.

DR HAUTAKANGAS: Yes, Olkiluoto is designed to have also waste from the industry and medicine and also our radiation safety authority has laboratory activities which will be – and those wastes will be also disposed of in the Olkiluoto repository.

COMMISSIONER: Could you just walk us through what this diagram is actually showing us, the nature of the facility and how it operates?

MR HAUTAKANGAS: Yes. This is the plot for the repository. It's located at Loviisa power plant site, 110 metres below sea level and the basic idea is to dispose of all the maintenance and operational waste there and also decommissioning waste once the power plant will be decommissioned and from the right side of the plot you see the tunnels and caverns are already build it and they are already in use, but the other - - -

COMMISSIONER: Is that a vertical shaft or is that just a - - -

MR HAUTAKANGAS: Yes. Yes, it's a vertical shaft you can go, well, directly with the lift down, down to the repository level, but there is also a driving tunnel where you can then bring the big components and all the waste is brought by car or truck to the repository.

COMMISSIONER: Then underground that's a conditioning area, is it, what we're seeing there at the bottom levels?

DR HAUTAKANGAS: There is a shaft – as a matter of fact there are two shafts, one is for the people, transportation, another is for ventilation.

COMMISSIONER: On the ground level though as we see it there, just above

the sign that says Decommissioning Waste, what are we seeing there?

DR HAUTAKANGAS: These are plans, so there is nothing yet - - -

COMMISSIONER: No, I understand that, but what's the plan?

DR HAUTAKANGAS: Yes, the plan is to have all the – the plan is to decommission the power plant and to dispose of all our active components there. Decommissioning means that you have to (indistinct) into pieces all the concrete structures from the power plant - - -

COMMISSIONER: Right, so they're the vaults.

DR HAUTAKANGAS: - - - and that they are in the vaults, yes, and also the reactor pressure vessel will be installed there and turbines as well. All the components which are active.

MR JACOBI: Drawing the distinction I think between the decommissioning and the maintenance site as I understand it some of the operational site has been constructed.

DR HAUTAKANGAS: Yes.

MR JACOBI: I think we've got a slide that picks that up. If we can go to the next image. Could you explain what we're looking at in the left and the right-hand images?

DR HAUTAKANGAS: On the left-hand side there is a low level waste tunnel and you can see there's steel drums over there, so all the dry low level waste are disposed in this way so that they are put in the steel drums, compacted and then transported for disposal to this tunnel and from the right side there is an intermediate level waste cavern. This is a concrete structure where you – or pool, concrete pool where you then displace all the concrete barrels where all the liquid type of waste have been cementised.

MR JACOBI: Yes, I'm going to come to the waste treatment in a moment. I think the next image that comes up is the low level cavern and I gather that's what we would otherwise see on the left-hand side without the internal form work. Is that right?

DR HAUTAKANGAS: Yes. This will be served – at the end this will be serving as the decommissioned waste repository. At the moment there is kept low level waste in order to coordinate all the waste streams inside the repository, but it will serve as a decommissioned waste repository.

MR JACOBI: In terms of the sort of volumes of waste that perhaps the low level facility first can address is that designed to be able to deal with all of the low level waste associated with the plant itself through to the point of decommissioning?

DR HAUTAKANGAS: Yes.

MR JACOBI: We're looking at a single tunnel here. Are there a number of tunnels in the structure?

DR HAUTAKANGAS: Yes. I think this is the third tunnel which is constructed there, but there will be constructed more of them especially – there will be a specified silo for the reactor pressure vessel which will be disposed in the silos, so not yet everything is constructed.

MR JACOBI: Yes, so in terms of the overall plan approximately how many tunnels are we looking at overall in terms of the structure that's being built?

DR HAUTAKANGAS: There will be five, six tunnels overall. As I say, if you take a slide back, you can see the whole – yes, I think this is the whole volume of the repository, plant (indistinct)

MR JACOBI: I think if we could perhaps come back to the next slide and deal with the cavern on the right-hand side. I think we're looking at some blue light, I gather that's simply the rock face that's above that's illuminated in blue?

DR HAUTAKANGAS: Yes.

MR JACOBI: In terms of the number of intermediate level waste caverns is there more than one of those?

DR HAUTAKANGAS: This is meant for the immobilised waste, so we have a cementation station where all the liquid waste will be cemented inside a cement matrix and that waste will be disposed of in these pools.

MR JACOBI: I want to pick up the question of the waste forms that you're dealing with. What is the range of waste forms that the overall VLJ needs to be able to address?

DR HAUTAKANGAS: Waste forms: the low-level waste is mainly kind of an organic type of waste where you have normal - - -

MR JACOBI: Contaminated clothing - - -

DR HAUTAKANGAS: Contaminated clothes, for example, et cetera, et cetera - everything which can be compressed. Then there is waste for metal waste. This is one form which will be also formed during the operation of the power plant. Then there is the liquid waste which will be cemented, like already discussed, and that's - - -

MR JACOBI: Just in terms of the liquid waste treatment, is that conducted within the facility at that depth or is there a packaging plant that's associated with the storage and disposal facility?

DR HAUTAKANGAS: All these actions are done at the nuclear power plant site. So once the liquid waste is generated at the power plant site, we will treat them at the site and we will cement them at the site and then it will be transported. So the whole process is happening inside the power plant.

MR JACOBI: In terms of the overall development, we've talked about the fact that part of the facility has been constructed to this point. How long is the overall development expected to take in terms of the need for its use?

DR HAUTAKANGAS: That's a good question. Of course the actions are started in order to have these repositories in order to reduce and take care of the wastes which are generated all the time when the power plant is running. The construction of this facility was started somewhere in the 90s and it will continue operation until the last spent fuel is transported out from the site. It will take somewhere in 2065, so around 60, 70 years this will operate.

MR JACOBI: Is it then expected to operate during the period of the decommissioning of the plants themselves and actually accommodate those plants?

DR HAUTAKANGAS: Yes.

MR JACOBI: And I'm right in understanding, aren't I, that the spent fuel is otherwise not going to be disposed of in this facility? That's the facility I think we're going to be addressing when you give evidence on Monday.

DR HAUTAKANGAS: Yes.

MR JACOBI: I'm just wondering if perhaps we can come to deal with the time line for the development of the facility and perhaps if we can come to when the first planning commenced with respect to the development of the Loviisa storage plant. We understand that that commenced in about the late 1970s. I'm just wondering if perhaps whether you can give an explanation of what was conceived of at that time as to what the need would be and then how the work commenced.

DR HAUTAKANGAS: In principle the repositories are - the best design is relying on many analyses. One of the important analyses is long-term safety, which then affects the design of the repository and the facility itself. One of the aspects to bring effects to the long-term safety is this: is to understand what kind of waste there will be, the form and the amount and most important of all would be the nuclide inventory. So this has been the design basis, but when it comes to the process itself for siting this place, it started during the 70s and the site itself was selected to be at the nuclear power plant site. The reason for that is that it was seen as the most visible solution to have this low and intermediate level waste repository at the site.

MR JACOBI: Did that have advantages in terms of the economics of disposal?

DR HAUTAKANGAS: Economics is one thing but also the local acceptance is the other issue because during those days we didn't find it quite possible to have any other place for disposal because since the power plant itself has been located at that place, the local people have accepted to have the facility, nuclear facility, in the neighbourhood. So they were more likely to accept also the repository to be replaced at the site.

MR JACOBI: Perhaps if we can take Loviisa first. In terms of explaining where that is in relation to other population centres within Finland, are you able to give us a bit of an idea about what sort of communities it's nearby and - - -

DR HAUTAKANGAS: Loviisa is located something like 100 kilometres due east from Helsinki capital and it's a small town. The inhabitants are around 10,000, if I remember correctly. The power plant itself, it's about 10 kilometres from the town centre and in coastal area.

COMMISSIONER: Can I go back to the original slide. There's an awful lot of water around the site - clearly not at that level though, the sort of hundred metres. There's no issue in terms of potential contamination of the water sources from this particular site?

DR HAUTAKANGAS: Of course sea level has an impact to the long-term safety analysis and this has been taken into account when doing this analysis, but basically the design is done so that all the radioactive substance is sealed inside blocks so that the water wouldn't be intact to, for example, the sea. So the basic issue of course in long-term safety analysis is the presence of water, how to prevent those negative effects coming from the flowing ground water, and this has been taken into account in this design.

MR JACOBI: I just want to pick up the studies in terms of the process that

was gone through in terms of the development of the safety case associated with this project and I understand that the investigation into the geology commenced in the late 1970s. I'm just wondering whether perhaps you can explain what those analyses involved in terms of the analysis of the geology at that particular site.

DR HAUTAKANGAS: The long-term safety analysis is done basically to understand better how to seal all the radioactive nuclides inside repository. So this is the simple task of the safety analysis. For doing that, we have incorporated barriers. Those barriers can be natural barriers or they can be technical barriers, man-made barriers. In principle, a technical barrier is something which is made by man. A natural barrier is something which is naturally existing in the repository. It could be, for example, rock itself. It's a natural barrier. But then a natural barrier could be also ground water flow rate or another example for the natural barrier is, for example, how the rock itself could absorb nuclides, preventing them to be released into the biosphere.

MR JACOBI: I'm interested in the studies that underpins the application that went to the Finnish regulator, STUK, in terms of satisfying the regulator that indeed those objectives of isolation and containment could be met. I'm just interested to know the sort of time period that those studies of the geology and other characteristics were undertaken.

DR HAUTAKANGAS: This is studies which we are doing all the time. So geological surveys are being doing - and other information has been collecting also in this repository but also the other repository in Olkiluoto in order to have a better understanding about the rock characterisation and also about the ground water flows, et cetera, et cetera - fracture zones, et cetera - so that we can really make an overall picture about the initial state of the repository, because after that we need to first understand the initial state first, in order to make any prediction about the future, and this prediction is done by a different kind of scenario analysis.

What comes to the STUK itself, we, of course provide information regarding this development work, to STUK and for approval.

COMMISSIONER: I should mention that STUK is the regulator.

DR HAUTAKANGAS: Yes, nuclear safety regulator.

COMMISSIONER: Yes.

MR JACOBI: I understand that the project commenced operation in the mid-1990s and I think you've mentioned that there is ongoing analysis, and I'm just interested in the extent to which there's ongoing monitoring at the site, to

validate the studies that were undertaken in the early period, to the extent to which you could be satisfied that what predictions were made then, are, in fact, demonstrated by what's occurred later.

DR HAUTAKANGAS: There is many different kind of monitor programs going on at the site. Of course, the nuclear power plant has to monitor its environment regularly to the radiation safety authority, but then there is also what comes to the repository itself. There is a monitoring program in order to make and planning about the maintenance work regarding the repository, and they could be many kind of, for example, measurements to understand how the concrete structures are developing during the time: is there any movements, et cetera, et cetera.

COMMISSIONER: Can I just pick up the time frame? Starting in 1978 and the first disposal tunnel operation in 1998, and three years' construction, is that timing dictated by the length of time that you had prior to needing to store low level waste? I guess what I'm getting at, is that time frame of 20 years what you would expect in terms of developing a facility such as this?

DR HAUTAKANGAS: Yes, if you will start from the scratch, as we have. So without any previous knowledge, we have developed all this. Of course, now once we know we could also, or any other organisation could do that little bit faster. But I think that this has been an enormous development work, so that we have lived, and we learned and developed many aspects regarding the repository activities.

COMMISSIONER: The figure I see of three years' construction for the facility or the first tunnel is right?

DR HAUTAKANGAS: Yes, yes. Yes.

COMMISSIONER: So that's a small fraction of the total time for development?

DR HAUTAKANGAS: Yes, exactly.

COMMISSIONER: Okay.

MR JACOBI: I'm interested to understand the interactions with the regulator. To what extent did the regulator already have - I'm interested in the development of the concept of this particular disposal. We heard in evidence earlier today, with respect to the Belgian example that there had been much interaction with the regulator during the process of developing the safety case. I'm just interested, is that similar to the process that was followed in Finland?

DR HAUTAKANGAS: Yes, I could split this question into two lines. One is that how the overall licensing process will evolve, and the other is that how the regulator will monitor our program. What comes to this letter, I think that at the power plant we have constantly, personal from the regulator to - monitoring the activities which we are doing there.

This is also the case for the construction of the repository, so that we can - this is, I think - in Finland we have this advantage, to have a constant low level discussion channel with the regulator. In our case, once we are interested in energy production it's extremely important for us to have reaction from the authority, as fast as possible. In our case, it's been really advantage to have a regulator present at the site, all the time.

Then the other path is that how the regulator or STUK influences to the work, is the licensing process itself. In Finland we have nuclear energy legislation, we have three-phased approach to license nuclear installations. The first one we call this is "in-principle process", where the political decision making has great importance. This will be approved by the parliament. And the basic idea in this, this is in-principle, is that we need to, or the applicant needs to show that this facility will be overall good for the society.

Finally, when the approval is given, first approval technically speaking is given by the government and then it's ratified by the parliament; once the DIP process is approved by the political process, then the process goes on and start the construction licence, going to watch construction licence application. So the construction licence is second phase.

MR JACOBI: At the stage of the decision in-principle, is a concept of a sub-surface facility like this already a contemplation with a proponent that wants to build it, or how far along the, I guess the conceptualisation process, are you?

DR HAUTAKANGAS: That's good question, because now this is not completely clear yet regarding the disposal activities. Now the government and state officials haven't yet made a decision whether or not the decommissioning process itself needs a decision in-principle.

MR JACOBI: Yes.

DR HAUTAKANGAS: So this is an example how the licensing process, it's not ready yet and it's developing all the time, even in these kind of long time frames.

MR JACOBI: But I gather a decision in-principle was made, with respect to the disposal of the operational waste?

DR HAUTAKANGAS: Well, exactly this operational waste disposal is based on our operational licence of the power plant.

MR JACOBI: Right.

DR HAUTAKANGAS: So there is not any specific decision in-principle made for this operational waste.

COMMISSIONER: You talked about two phases, I don't think you had an opportunity to go to the final one.

DR HAUTAKANGAS: Yes, well I think that the second phase was exactly this, this three phase process, which I tried to familiarise. The second phase indeed is the construction licence phase, and the third one is the operational licence, which we are having for the power plant, right now.

COMMISSIONER: Can I go back to the first phase? You've got a location in mind at that first phase, and there has been discussion with the community in terms of community acceptance of that location? That's required before parliament gives the first phase approval?

DR HAUTAKANGAS: Exactly, yes. That's correct. This is an in-principle licence, there is maybe a couple of things which need to be phrased out. One is exactly the statement from the local municipality. This is needed in order to process, to go on. Municipality have veto right in these kind of activities, so if they don't like to have these kind of facilities to be constructed, then it will not be constructed at the site.

Second important aspect is, of course, the favourable resolution from STUK.

COMMISSIONER: Yes.

DR HAUTAKANGAS: So I think these are the main important issues. And the third one is the environmental impact assessment. So there is I think three elements in the DIP process to be completed in order to go forward.

MR JACOBI: Is the municipality's consent and its exercise of making a statement before the DIP, does that come after the regulator gives its okay or when is it expected to express a view?

DR HAUTAKANGAS: In principle, the applicant makes the submission for the nuclear installation to the government and then the government start the process by collecting this information from municipality and STUK, et cetera, et cetera. So everything comes in at the same time.

MR JACOBI: I'm interested to understand when the decision was made with respect to this particular facility, how the community were engaged during that process before ultimately the municipality came to express a view one way or the other. How did the proponent manage that particular process?

DR HAUTAKANGAS: You're speaking now about the repository or the nuclear power plant itself?

MR JACOBI: No, I'm talking about the repository.

DR HAUTAKANGAS: Since the repository itself is running under the operational licence, there hasn't been made this kind of DIP process. So in this respect it hasn't gone through all the required actions that are required by the DIP process, but of course there has been interactions with the local people in many other ways. For example, the nuclear power plant has constant discussion going on with the local people but that's mainly based on the operational issues.

MR JACOBI: Was the fact that, as I understand it, the facility is integrally related with the nuclear power plant, was that something that was addressed with the community at the time that the plant itself was sited there?

DR HAUTAKANGAS: It wasn't clear in the early 70s when the decision was made regarding the power plant itself about how spent fuel or how the low and intermediate level waste will be disposed of. So the community were not aware that they will have also to have this kind of repository in the site.

MR JACOBI: Though there was not a DIP, I'm just interested the extent to which the community has been involved in the process over all of the - you described the process that's gone on over some 15 years of studies and other analyses and EIAs and so on - how the community has been involved in respect to that process and the information that's been provided to it.

DR HAUTAKANGAS: I think the most important aspect is this EIA process because it's done for the repository itself, although it hasn't been a part of the DIP process. There is constant discussion and interaction with the local people in order to give them the possibility to express themselves. This wasn't exactly the case when the power plant itself was constructed because during those days it wasn't fully clear how the waste management will be done.

MR JACOBI: Is the position different at the VLJ in the sense - was there a DIP process for VLJ?

DR HAUTAKANGAS: It was more or less the same kind of process for Olkiluoto repository because it was also constructed during more or less the

same time. I mean the whole power plant was constructed about the same time as Loviisa power plant.

MR JACOBI: I'm just also interested in - we've heard about packages of benefits to communities associated with waste facilities, particularly in the Belgian context. I'm just interested to understand the extent to which there might be a community benefit that might arise from these particular facilities.

DR HAUTAKANGAS: Excuse me, "modernise"? What do you mean?

MR JACOBI: We heard with respect to the Belgian facility that at the time that it was sited a package of benefits had been negotiated and, as I understand it, agreed to with the community. Has there been something similar with respect to either VLJ or the Loviisa facilities?

DR HAUTAKANGAS: Of course the important factor for the local people is the right to collect taxes and this is one benefit that they are having in local decision-making, that they can collect - - -

MR JACOBI: The municipality actually has a right to collect taxes associated with the power plant being located there.

DR HAUTAKANGAS: Yes.

MR JACOBI: So there's a revenue stream to the community that's associated with the plant.

DR HAUTAKANGAS: Yes.

MR JACOBI: Can I come to the question of the - - -

COMMISSIONER: Can I just dig a bit deeper. Knowing that this plant is going to be there for hundreds of years and potentially could be there when there is no power plant, there's no community benefit for having the waste repository on their site?

DR HAUTAKANGAS: Yes, that's true. But the basic idea is that once the repository will be closed then there would be no harm at all for the community from the repository.

COMMISSIONER: So therefore no reason to recompense.

DR HAUTAKANGAS: Yes, that's the basic idea.

MR JACOBI: That might be an appropriate time for me to ask, we saw some

images before - perhaps we can come back to the caverns that are located - what's the process ultimately expected to be in terms of sealing or closing the facility? Is this a facility where there's going to be - we've heard with other facilities that they will be packed with concrete themselves in order to be shut. What is the overall closure process envisaged to be with respect to the Loviisa facility?

DR HAUTAKANGAS: For example, for the low-level waste tunnel the whole tunnel will be - there will be a block.

MR JACOBI: So it will be plugged.

DR HAUTAKANGAS: It will be blocked. So for the low-level tunnel the idea is that the block will have this kind of major effect on the long-term safety analysis in respect that the block itself will prevent the water flow - in and out flow - from the repository, whereas the intermediate-level waste there is a different kind of method to seal the isotopes. Once this will be full of these concrete barrels, they will be pouring cement on that so that the whole pool will be one piece of cement. Then there will be of course plugging of the tunnel as well.

MR JACOBI: I think we've dealt with the safety case early on and I'm just interested - we talked about rock characterisation and I think we've also talked about ground water flow. I'm just interested to the extent to which - and I think the commissioner has raised it - there was an analysis of sea water and sea water related effects with the repository. Has that been addressed with respect to this particular facility?

DR HAUTAKANGAS: Yes, the sea level has been taken into account in the long-term safety analysis. That's one of the parameters in the modelling.

MR JACOBI: Again, I'm also interested in things like fracture rates and the extent to which that's also been analysed and considered, given the sort of time scale that we're talking about here.

DR HAUTAKANGAS: With fracture rates you mean the rock fractures?

MR JACOBI: Yes.

DR HAUTAKANGAS: Yes, of course we have made drillings in order to understand the network of factors in the rock so that we can make a model and we understand how the ground water flow will behave in these fractures.

COMMISSIONER: When we were talking about Belgium, the point was made that there is no perfect site; that each site has it's positive and negative

connotations and therefore the barriers that you put in are very specific to the site. Was that the case here, noting that there was really no intent to put a repository in when you built the power plant? Were there elements of the site that perhaps weren't perfect? If there were, what additional steps in terms of barriers did you put in to take cognisance of the characteristics of the site you've got?

DR HAUTAKANGAS: I agree with that aspect that there is no need to find the perfect place for the waste. I already describe that we have a big variety of different kinds of barriers to be used, and one of those barriers is engineered barriers which can be developed in whatever place. We, in Finland, think that it is even unnecessary to speak anything about the perfect place, because what is a perfect place? What are the characteristics of a perfect place? We have adopted our mind thinking to designs that will fulfill the requirements, so that's the difference. We are not seeking for perfect place, we are just defining the design so that it will fulfill the requirements.

COMMISSIONER: If I was to look at what you're doing here and VLJ, there are obviously different site characteristics. In terms of planning the barriers, are there any major differences between the two? I understand that they're going to serve different needs, but in terms of preparing the engineered barriers, is there much difference between the two sites?

DR HAUTAKANGAS: Between which sites?

COMMISSIONER: Between this and Olkiluoto.

DR HAUTAKANGAS: Basically, the bedrock itself is the same all over Finland. The concept itself might be different in Olkiluoto related to Loviisa site. Of course one aspect is also that inventory will be different because the power plant, they are not alike, so once again because the starting parameters are a bit different so the design would be also different only so that the requirements are fulfilled so that there will be no release during certain time period to the life-sphere, so this is the most important aspect.

COMMISSIONER: So you're designing your barriers based upon the location - - -

DR HAUTAKANGAS: Yes.

COMMISSIONER: - - - and the characterisation of the rock and the environment?

DR HAUTAKANGAS: Yes, and also waste. The barriers itself could have influence to the ground waterflow, for example, et cetera. It's a continuous and

quite big design work which needs to be done in order to have a good design for the waste.

MR JACOBI: We spoke a little bit with respect to the immobilisation and ultimate closure of the ILW facility, or the caverns, and I think you referred to cement. We've heard in some concepts that it's possible to use bentonite clay as a barrier. Is that a contemplated concept for this particular facility or - - -

DR HAUTAKANGAS: Yes, bentonite will be used also for this facility, but it will be used for the decommissioned waste mostly, so it is not present at the moment. Bentonite clay is of course an important barrier in the spent fuel repository.

MR JACOBI: We can see the low level waste there being stored in drums. We heard in evidence, and particularly from Mr Mallants earlier, that they were securing the waste also in what they called a monolith, which was, in essence, a highly specialised high-performance concrete case. Is a similar concept to that being used for the intermediate waste casks to provide a further barrier, or how is that working with respect to the waste that is stored that is going to be intermediate level waste?

DR HAUTAKANGAS: Yes, this is more or less the same concept here. We have this kind of concrete barrels where we pour cement and waste itself and then it becomes one monolith.

MR JACOBI: Just to step through that, what I understand is that any liquid radioactive waste is reduced in volume first. Is that right?

DR HAUTAKANGAS: Yes.

MR JACOBI: It is then, essentially, mixed into the concrete mixture, and so ultimately transformed into a solid form, so there's not ultimately any liquid waste stored on - - -

DR HAUTAKANGAS: No, it's not a liquid. Once the concrete will be solid, then they have sealed all the substance inside the concrete block.

MR JACOBI: Those cylinders, or whatever they are, of solidified liquid waste, are they then encased in a monolith structure to be placed into the caverns?

DR HAUTAKANGAS: Yes.

MR JACOBI: In terms of them being brought in, is there potential for retrievability of those particular canisters or the monoliths?

DR HAUTAKANGAS: That's true, once this is finalised it will be a quite big monolith in the repository. Retrievability, it's possible, yes, and this is also put in our long-term safety analysis that will be done if it's needed.

MR JACOBI: I gather with respect to the low level waste, in addition to the plug is there to be filling around the barrels, or are they otherwise expected to be retrievable if the plug is removed?

DR HAUTAKANGAS: The main barrier is the plug itself. There might be some kind of sand around the barrels, but the main barrier is the plug itself.

MR JACOBI: We described it as a plug or a block, but what in real terms are we talking about being stored into the tunnel?

DR HAUTAKANGAS: The plug?

MR JACOBI: Yes, in terms of dimensions or size.

DR HAUTAKANGAS: Maintenance waste is also - well, these two are maintenance waste which you have in front of - - -

COMMISSIONER: Is it a concrete block?

Mr JACOBI: At the point of closure, when the tunnel is closed, in terms of the seal, what are we looking at?

DR HAUTAKANGAS: It's concrete, yes.

MR JACOBI: And in terms of size?

DR HAUTAKANGAS: It depends on, once again, about how long it should last. For example, in this case I'm not completely sure how thick it will be, but it should be somewhere around a metre or two thick block in order to prevent the water flow, and also to take the compression which comes once the place is saturated.

MR JACOBI: We've spoken a bit about a multi-barrier system, and I'm just interested in terms of the longevity of the time that's associated with some of those barriers. We're talking about storing, as I understand it, low level waste for periods of hundreds of years, and the intermediate level waste for periods much greater than that. I'm just interested in the significance of the certain of the barriers to the time scale that can provide for containment and isolation.

DR HAUTAKANGAS: Yes, of course. The fundamental purpose of the

barriers is that they last the time which it's designed for the barriers to last, and different barriers have different kinds of ability in this respect. There is one (indistinct) barrier, for example, could be - once we are having this kind of metal contaminated or activated metal waste at the repository, we think that the metal itself it is first engineered barrier, and the metal itself, it takes some time to corrode and so the metal too radioactivity to be released out from the metal piece.

Then there is the de-bedding on the selected concrete there could be around that metal. The metal itself could be, for example, inside concrete. So the concrete will provide a second barrier for the radioactive to be released. Then there could be, for example, even further barriers between the rock and the metal piece, but the final barrier is, of course, the natural barriers which already described that could either be the rock itself or the characteristics of the natural environment.

MR JACOBI: I'm just interested, we heard a bit from Mr Mallants when he gave evidence of the importance of waste acceptance criteria, that is, controlling the waste that's inserted into the facility, bearing in mind the nature of the barriers that are in place, and I'm just interested to understand what are the waste acceptance criteria that apply to this particular facility, in broad terms?

DR HAUTAKANGAS: I would say that this kind of work starts from understanding about the inventory, what kind of elements, what kind of nuclides we have in waste. This is one aspect. The second aspect that what kind of chemical form they have, so how they would release, how they would behave with the environment during the time. So this is second topic to be considered.

Then the one natural bath for the nuclides is the run water, well, flow to the surface. Or then there is, of course, another option is to unintentional wells, so people could make wells to these kind of facilities somewhere in the future, unintentionally.

MR JACOBI: Yes. In terms of, I think Mr Mallants indicated that if waste doesn't meet the waste acceptance criteria, it would simply need to go a different kind of facility.

DR HAUTAKANGAS: Yes, that's true.

MR JACOBI: And I'm just interested to the extent to which there are limits that are applied to the sort of facility we're dealing with here. Obviously it can't deal with spent fuel, but I'm interested in the controls that are put in place, with respect to the waste that can in fact be input into this facility.

DR HAUTAKANGAS: In this facility, it's designed to take all the waste which are produced during the operation of the power plant, except the spent nuclear fuel. The reason is that spent nuclear fuel has a totally different kind of inventory, in itself, and in this respect also, the long term safety analysis is different regarding spent fuel and maintenance waste.

So it really is, to understand how the radioactivity will behave during the certain period of time. Radioactivity itself, it will naturally decay during the time, so the design has to be done so that the barriers will last until they have decayed under the natural radiation level.

MR JACOBI: That brings me to the design parameter I guess, in terms of the low level waste facility. I think Mr Mallants was talking about, for the facility that he was talking about in Belgium, the need for it to operate for a period of three to four hundred, I think several hundred years, to store it.

DR HAUTAKANGAS: Yes, that's correct.

MR JACOBI: Is that the sort of design characteristic for the low level waste facility, or is it expected because of its particular fact that it's deep down in a rock formation that it could, in fact, isolate and contain waste for a much longer period?

DR HAUTAKANGAS: Well, in this case for example, this low level waste inside that, it's designed to last that couple of hundred kind of, years up, maximum 500 years. So it's completely what you said, this is exactly the same kind of analysis is behind this.

MR JACOBI: And in terms of the design for the intermediate level waste cavern, are we talking about a period of many thousands of years?

DR HAUTAKANGAS: Yes, correct.

MR JACOBI: When we spoke to Mr Mallants, we talked about things in terms of how you could be satisfied that you could predict the future to such a period of time in advance, and I'm just interested to understand how it was that you, as the proponent, satisfied yourself first that it would, in fact, last that period of time, and then satisfy the regulator that it was capable of doing so.

DR HAUTAKANGAS: Well, that's again good question. We have to do - the analysis is based on the long term development of the work, and one of the important aspects in this demonstration is to find the natural, analogues from environment. For example, copper, we are adapting spent - this is related to the spent nuclear fuel, but related to that, we are adapted to have a copper layer

on that capsule, and the strongest reason to use copper around that is that we have found an analogues from the nature, so that fuel copper can last millions of years, and it's quite - people and scientists, they agree quite broadly, this approach.

And it is also the case for the other aspects coming through the low and intermediate level waste design. The basic philosophy is that we have open discussion along all the scientific disciplines, in order to find the most sustainable solution, and open and transparency here are the words in order to have this dialogue with people.

MR JACOBI: I'm interested to understand the extent to which the scientific studies upon which the conclusion was based, that were made available to the regulator, were they made available to the community?

DR HAUTAKANGAS: In Finland, the community and public itself - - -

MR JACOBI: Sorry, I should perhaps have asked, were they made available to the scientific community for comment and criticism?

DR HAUTAKANGAS: Okay, you mean scientific, okay, yes, fine. This is based on the fact that the scientific community is in relation with the STUK processes, so that the STUK gets always independent review on the work, what they have received from the utilities. So independent review is the tool for STUK to operate and approve these kind of issues.

MR JACOBI: In terms of the key conclusions of the scientific analyses, for example, that underpinned the satisfaction that an intermediate level waste facility could be operated and constructed over those periods, was that information, you know, the key conclusions to that science, was that communicated to the community? Not necessarily at the level of detail as between scientists, but was the underlying information communicated to the community?

DR HAUTAKANGAS: Scientific community?

MR JACOBI: No, no, was there - - -

DR HAUTAKANGAS: (indistinct)

MR JACOBI: - - - an attempt to distil the key scientific conclusions and make that available to the community so it could understand how those conclusions had been reached?

DR HAUTAKANGAS: Of course the intention has been to go through these

aspects with the scientific community, and to find the discussion and argumentation from the design also, from scientific point of view. So I would say that to get an acceptance is more related to the discussions, so that everybody agrees on the selected design.

COMMISSIONER: One of the challenges we face is the presentation of scientific knowledge in an understandable form, so that the community can follow the discussion. Is that something that you faced in Finland?

DR HAUTAKANGAS: Yes, that's - I agree, it's a big challenge to convert this information in understandable form, and I also say that it should be the purpose of the waste management work and all those people who were working in this waste management is to try to convert these kind of quite complex multidisciplinary system inside an understandable form so that people really understand. This is I think a really key element in discussions with the public.

Maybe we haven't succeeded that well in Finland either because we mostly have discussions inside the industry, inside the experts, inside the STUK, inside the independent reviewers, et cetera, et cetera, but not with the people and public itself. We would like to have discussion and we have even made that possible for the public to come to us and discuss but for some reason we haven't succeeded to have that kind of lively discussions about this in Finland.

COMMISSIONER: But clearly you've succeeded in convincing the local community to accept your plans.

DR HAUTAKANGAS: Yes, that's true, and we also succeeded to convince the regulator.

MR JACOBI: In terms of communicating information to the public, in terms of - I don't expect that people can necessarily access a low-level waste facility - but in terms of there being a demonstration tunnel or such other information, has that been a process that's been trialled either at VLJ or at Loviisa?

DR HAUTAKANGAS: Yes, as a matter of fact this facility is also in some extent possible to show for the public people - not for the big groups of course but it's possible to see especially the VLJ and the Olkiluoto. It's constructed for the purpose to be shown also to public people so that they can get really some kind of understanding of what we are talking about.

MR JACOBI: I just want to deal very quickly with the transportation. I think I raised before the question of the economics of the idea of taking decommissioned waste to a facility that's nearby. Is that one of the underlying reasons why a site was selected that was nearby the plants?

DR HAUTAKANGAS: The economical feasibility itself is of course one aspect which was considered during the siting decision but it turned out to be that it's not that big an element between the different concepts. But I think that the most important fact was the acceptability of the repository site itself; that we thought that during those days that it's much more easier to build a local nuclear site instead of starting to find a new repository somewhere inside Finland.

MR JACOBI: I just want to come to perhaps what you've - given the experience that Finland has had in constructing these facilities, what it thinks the key lessons are that might be drawn from the process that it undertook and that it might want to share with other countries that need to contemplate such facilities.

DR HAUTAKANGAS: When it comes to the low and intermediate level waste repositories those are already quite broadly implemented in other countries. This is not the only example. There are many, many examples around the world regarding low-level and intermediate-level waste facilities and repositories. Our concept is based on the fact that we don't have centralised facility in the country for the low and intermediate level waste, meaning that Loviisa having one repository and then Olkiluoto is having another repository and the reasons behind that is mainly the fact that the regulator and legislation allows us also to act separately in Finland. It doesn't force you to make any centralised solutions. So our legislation gives us possibilities to act as we will but we have the responsibility to take care in technological and economical point of view all the actions what are needed to have safe disposal.

MR JACOBI: I was just also interested whether it's a lesson from the experience in terms of the significance of the research and development that was undertaken in order to achieve a successful outcome? That was something we discussed with Mr Mallants earlier.

DR HAUTAKANGAS: Of course it's really important have a research and development program and as a matter of fact in Finland regarding low and intermediate level waste this started already in early 70s. So we have collected more than 40 years of research results from the institute and universities and so it's an important factor.

MR JACOBI: I just want to just deal with - and perhaps if we can just break from dealing with the low and intermediate level waste - I just want perhaps if we can for five minutes just briefly deal with the wastes that are actually generated by the two plants. In terms of the sorts of wastes that we're dealing with, what are the key wastes that are in fact generated by the nuclear power plants that are ultimately going to need treatment - this is other than spent fuel -

that are going to need treatment and ultimate storage and disposal within these facilities?

DR HAUTAKANGAS: One of the biggest in volume is the liquid waste because the power plant is running with the water or the heat transfer is handled with water so it means that we need to have a lot of water. So consequently the water itself will be contaminated and without any treatments this amount of water would be really, really huge, causing us quite big economical impacts to make a repository for this kind of volume. So we use different kind of treatment methods in order to decrease the number in volumes of this liquid waste. One form is already mentioned, is this organic waste coming from the contaminated clothes, et cetera, et cetera. The third form is this metal type of waste, inorganic material which comes also from the operations from the power plant. I think these are the main components in the waste forms.

MR JACOBI: I just want to deal with - because I understand that part of the facility has been built in mind with decommissioning waste. What are we looking at in terms of the expected decommissioning waste?

DR HAUTAKANGAS: In volume you mean?

MR JACOBI: Perhaps by comparison to the others but the main components of such decommissioning wastes.

DR HAUTAKANGAS: Decommissioning waste is a big part of the total volume of the repository. It depends on what kind of parameter we are looking at. The volume itself is the biggest problem with decommissioning waste but then we can also speak that where the - because the amount of activity is located and that's of course located in the intermediate-level waste and exactly this kind of waste cavern which is shown in what would have the biggest activity content of the repository. Also, the reactor pressure vessel and the internals will have really big activity. So reactor pressure vessel and its internals, plus this intermediate-level waste cavern will have the biggest amount of activity in the repository.

MR JACOBI: I think we discussed before the processing facilities for wastes other than decommissioning waste are already on site in the plant. I'm just wondering whether you can identify just what are the key processing activities that need to be conducted. I think we've already talked about liquid waste reduction and then ultimately solidification but are there other dry solid processing activities that are also needed to be undertaken at the site of the plant?

DR HAUTAKANGAS: One of the liquid waste treatment methods is based

on the ion exchange for reasons which is developed by our company and it's turned out to be a really, really effective way to reduce the activity from the contaminated water. One good reference of that is that this product is used also in Fukushima at the moment in order to purify one or two elements from their reactor.

MR JACOBI: This in fact removes certain radioactive elements from the water.

DR HAUTAKANGAS: Yes, in Fukushima as well. As product-wise, it has been really important for us because we have succeeded to have this kind of place to purify the water. But also the compression system for the low-level waste, we need to somehow to be feasible and to produce all the time the level of the waste and - so compression has been introduced to the waste which can be compressed. So this is one way of treating the waste.

COMMISSIONER: I think that completes our examination, Dr Hautakangas. Thank you very much for your evidence. We will now adjourn until 1615 and we'll talk with Mr Neri from ENRESA.

ADJOURNED **[2.42 pm]**