RESUMED **[9.32 am]**

COMMISSIONER: We reconvene at 9.30 and I welcome the representatives from Westinghouse Electric Company. Thank you very much; I think it is Rita and Michael, for joining us.

MR CORLETTI: Thank you.

COMMISSIONER: And Michael.

MS BOWSER: We are delighted to be here and support you. Thank you so much for inviting us.

COMMISSIONER: Thank you. Mr Jacobi.

MR JACOBI: Ms Rita Bowser is the vice president of New Plant Project advancement at Westinghouse Electric Company. In this role she leads new projects to expand the application of Westinghouse's AP1000 reactor to broader markets. Mr Corletti has over 30 years of experience in the nuclear industry, including senior roles in the design and licensing of the AP1000 of the United States and other international locations. Mr Corletti is the director of the AP1000 plant design integration for new plants and major projects at Westinghouse. He is responsible for establishing technical governance and oversight for the AP1000 plants under construction as well as new AP1000 projects. The AP1000s we will come to discuss is a pressurised water reactor which utilises passive systems supplemented by active systems and we will come in a minute to deal with the AP1000 project developments worldwide. We call Ms Rita Bowser and Mr Michael Corletti to the Commission.

COMMISSIONER: Thank you. We will go and explore the plant design but one of the distinguishing features is the passive safety system and I'd like to start there with just a broad overview of this particularly distinguishing feature and I think on slide 4 we have got a bit of a description.

MS BOWSER: We do Commissioner, and that is certainly an important feature of the AP1000 and one that is the most innovative in its design because the rest of the design is based upon components that have been in service in plants for a long time. The passive safety system represents an approach that is innovative, that similarly based on processes or components that are used in both a nuclear or in other industries. I will let Mike take us through the specifics on some of those features for you.

MR CORLETTI: So key to the passive safety systems is really the significantly reduced reliance on the need for operators to take action for any type of an event. One of the keys for this design, important features is that station blackout, which was experienced at the Fukushima event was really a design basis for the plant because the plant safety systems are designed to provide core cooling and containment cooling and cooling for all of the – for the core. In the unlikely event of a severe event such as a loss of OAC power, without reliance on operator actions, without reliance on (indistinct) related diesel generators or other safety systems that are common in the current fleet of generation II reactors.

MR JACOBI: Perhaps if I could pick up the question of passive safety and perhaps first turn to the physical characteristics of how the passive safety works within the particular reactor design and then we will come in a moment to deal with perhaps at a very high level, a broad overview of how we – how the plant will operate in the event of a blackout. So perhaps by reference to the diagram that we have got on slide 4, could you offer some explanation in terms of how the passive safety works within that plant?

MR CORLETTI: Sure. So the passive safety systems essentially rely on one time operation of valves to actuate. So for example if we – upon a station blackout, valves would open and a passive heat exchange would get through natural forces such as gravity will remove the core decay heat, essentially for an indefinite period of time following that loss of power. Because of the location of the decay heat removal system above the reactor core, through passive courses such as natural circulation we are able to provide core cooling indefinitely. In addition, another key barrier, or another key passive feature is the containment cooling. Similarly, through evaporation cooling, in the unlikely event of a situation that would cause a heat up of the containment, the passive systems remove decay heat through evaporation and through water that is located on top of the containment, pouring over top of the containment steel shelf and removing all of the energy that could be produced in the containment. So essentially with these one time operation of valves, the plant stays in a stable, safe condition following any type of postulated event.

MR JACOBI: All right.

MS BOWSER: What that also means is there is far less safety related mechanical equipment that might be needed and that equipment would need to be maintained over time and things. So the simplicity of this passive safety system eliminates a lot of those mechanical components that could indeed be problematic.

MR JACOBI: Perhaps if I could just come back to you Mike and separate out the issue of the core cooling and you talked about a one time alignment of the valves and I think that is picked up on the slide. Is that required to be activated by the operator, or are they valves that when the power drops out, they drop open or closed? How does that work?

MR CORLETTI: Yes. So they do not rely on operator action, so if power is lost to those valves they will move to their safe state, or if there is an indication of some event such as a loss of core cooling, they would also be activated by the instrumentation and control system to move them in to a safe state. So either they will be activated by our control system, or in case of an unlikely event of a loss of power, they would move to their safe state in that event.

MR JACOBI: Yes.

MS BOWSER: Without operator intervention.

MR CORLETTI: Yes, without operator intervention, that's correct.

MR JACOBI: And indeed, I wanted to pick up on, there is reference in the slide to a greatly reduced dependency on operator action and I am just interested to understand where would operator action be required, perhaps by reference to core cooling and then with respect to containment cooling.

MR CORLETTI: So actually within the first three days, after an event, the operators are not required to take any action at all. After three days, there would be some minor actions that they would take to realign water systems, to put water on to containment, or to essentially that is the main accidents to refill the water on the top of the containment tank, to provide longer containment cooling. Other than that, the operators are not required to take such action.

MR JACOBI: And in fact that is what I wanted to come to in terms of the tanks above the containment facility, I am just interested - - -

MR CORLETTI: Right.

MR JACOBI: - - - to understand what – perhaps you can explain in practical terms their purpose and then explain - - -

MR CORLETTI: Right.

MR JACOBI: - - - what is the reason for the three-day limit and what is required to be done?

MR CORLETTI: So the tanker type of containment are there in case you would have any kind of a release of energy into the containment. For nuclear power, we have three (indistinct) barriers to the release of radioactivity.

Of course, we have the fuel, we then have the reactor coolant pressure boundaries, and then we have the containment vessel. The containment vessel provides that line of defence for the release of radioactivity to the public. The tank of water on top of containment, in case the temperature in containment would be elevated, would actually open, the valves would open, and we'd pour water on the outside of the containment shell. That water then would preclude the pressure and temperature inside containment from getting above the design pressure of the containment vessel.

It is seised for three days, basically from a practical purpose; we decided to have three days of gravity feed onto the containment vessel. After three days, if the operator would do nothing, air cooling alone would be sufficient to maintain the containment below its ultimate pressure. So air cooling alone would satisfy the overall - the containment vessel would not fracture.

But in order to maintain it below its design limits, the operator would then take action to refill that tank with tanks of water that are located on site. So on site, we have additional tankages of water that the operator would refill that tank, and continue that process of cooling the containment with the water on the outside of the containment shell.

MR JACOBI: And in practical terms, what are the means for refilling? Does that come from a pipe network from those tanks, or is - - -?

MR CORLETTI: Yes, it's a very small pump, and powered by a very small diesel generator, the size of something that you could get at a local hardware store.

MR JACOBI: Now, there's also reference on slide 2 at defence in depth, and I'm just interested to understand the extent to which redundancy is built into the design, and perhaps you can explain the significance of that redundancy, in terms of the safety systems within the plant?

MR CORLETTI: I think you mean slide 4?

MR JACOBI: Yes, sorry, I apologise. I did mean slide 4?

MR CORLETTI: Sure. Yes. So in the nuclear industry, we have a defence in depth design strategy, so for all the safety systems, we have redundant components in case that any single component would fail, you will have a second component that would do the same thing, that would be available.

In the design of the safety systems, we have redundancies. In addition, what makes the AP1000 unique, and really one of the reasons why we have a very good safety margin and very good probabilistic risk assessment values is, we have diversity with defence in depth systems.

These defence in depth systems are systems that normally operate and are more like the system that are operated in a current Gen II plant. But the key to them is that they are not safety related, which means that they are a typical type of equipment, commercially available equipment, but they provide an added level of defence. Actually, they provide a diverse means of providing core cooling.

So this combination of diversity and redundancy provides for a very highly reliable and highly safe AP1000 design.

MR JACOBI: I think we've dipped in at the aspect of some of the passive safety systems, so I perhaps want to come back to the more general issue, and perhaps by reference to what's in the second slide. And I'm just interested in you addressing the rated capacity of the AP1000, in terms of output, and for you to offer us a broad description in terms of the plant layout?

MR CORLETTI: Sure. Let me take this. The nominal electrical output for the plant is 1117 megawatts electric. Of course, the actual net electric that's output is site dependent, depending on the ultimate heat sink. So it does vary from site to site, but that's a good value to use.

If you look on slide 2, you see the artist's depiction of the AP1000, and the building on the right, you see a cut away of what we call the turbine island, and this houses the turbine generator. AP1000 will utilise a Toshiba turbine generator design; it's a very proven design, it's in operation in plants today.

MS BOWSER: And the turbine generator system in a PWR plant is not so much different from that you would find in a coal or a gas plant, as well. It's a very traditional turbine generating system.

MR CORLETTI: That's right. And so the unique features then of a nuclear power station, and of AP1000, is you see the cylindrical building, which houses the reactor core, and what we call the "nuclear steam supply system" and that cut away is of the containment, and that consists of a free-standing steel containment vessel, which is essentially a pressure vessel that is designed to accommodate a pressure of over 60 pounds. So it is a very large pressure vessel.

On the outside of that is what we call our "shield building," it is a three foot thick steel composite shield building that protects the containment vessel from any external influences. In addition, we have what we call the "auxiliary building" which houses the equipment outside of the power station. Things like the spent fuel pool, things like the main control room; all of those items are located in the auxiliary building.

Unique for AP1000 is, essentially all of the safety systems are inside of the containment. In the Gen II plant, we have safety related equipment outside of the containment vessel, and in the yard. With the AP1000, with its very small footprint and the safety related systems inside containment, it allows for a very compact design and allows it to be sited on many sites, because of its fairly compact design when compared to generating stations of similar capacity.

MS BOWSER: And the point Mike mentioned about the fact that it was contained in the single building is important, because from a supply chain perspective, that means that there are more components that one can procure from people who do manufacturing, such as ship building or tank building, or other industries that might be available locally.

So the fact that you have the ability to just simply use high quality suppliers, but suppliers that might be engaged in industry already in a location, is a real advantage for us, in building the plant as well.

MR JACOBI: Can I just pick up on an answer you gave then Mike, in terms of the comparison of the - and I'm talking about the specific plant here. Can you offer a comparison in terms of its size, as compared to an existing Gen II plant?

MR CORLETTI: Comparison of the size?

Yes, that is, the footprint?

MR CORLETTI: Right. We've done many of these type of comparisons, but from a quantities comparison, the quantities of, for example, valves, we maybe would have approximately 50 per cent of the valves of a Gen II reactor, we require an AP1000 - - -

MR JACOBI: Sorry, I thought - - -

MR CORLETTI: - - - footprint. The amount of safety related concrete is significantly reduced, and the percentage is on the order of 40 to 50 per cent of the safety related concrete in an AP1000, compared to a Gen II plant of a similar power output.

MR JACOBI: Yes. I'm interested in the overall land use requirement of an AP1000, and I'm just wondering about whether you can give me some broad idea of the footprint that's required for one of these plants?

MR CORLETTI: (No audible response.)

MS BOWSER: So also, typically it's about, and I'm just going to give an approximate, about a third to a half the size footprint as well as the plants that are currently in service, because you don't have a lot of that mechanical equipment that goes out in the yards, and that kind of thing.

MR CORLETTI: Right. And that is right Rita, so we have been very successful, especially as we are deploying these plants in China where the sites are smaller. That smaller footprint we are able to place more plants on smaller sites and I think the term Rita used is probably a good rule of thumb. Of course if you come to the US where we have land is not such an issue, we are very – we still can have large sites but our plants do not require such a large site.

MS BOWSER: I will give you an example in the UK we have a project that is just under development in Moreside and we are fitting three of these units on a site where others had estimated they could only fit two of the more traditional plants. So again, you know it depends on the specific other boundaries but that is a pretty good rule of thumb.

MR JACOBI: Mike, in your answer you picked up the issue of the shield building and I am just interested to understand the – whether the plant has been licensed against external impact requirements both in the United States and in Europe?

MR CORLETTI: Yes. So as mentioned, the design of the shield building is a design that has been developed specifically for AP1000 and it has been designed to meet the latest standards with regards to aircraft impact. We have been licensed both in the United States where the United States subsequent to 9/11 passed new regulations regarding the ability for a nuclear structure to withstand an aircraft impact, an AP1000 meets all of those requirements - - -

MS BOWSER: And it is certified to do so by the US NRC.

MR CORLETTI: Yes, it has been reviewed and approved by the NRC. In addition, as part of our review of the design in Europe, in the UK, the UK regulator has reviewed and approved our aircraft impact studies as part of the design acceptance criteria that we are pursuing as part of the GDA process.

MS BOWSER: GDA licensing. So the ONR particularly has reviewed that aircraft impact.

MR JACOBI: I am also interested to understand, when these plants have been built around the world, are they being built to common standards and specifications such as with respect to shield buildings and so on or are there variations between the AP1000s that are being constructed?

MS BOWSER: I'll start, you - - -

MR CORLETTI: Sure.

MS BOWSER: So the nuclear island, we like to keep that as a standard plant and that is really important as we go forward because that allows several – us to share experiences between the plants both from construction and design and then it allows the operators to continue through the life of the plant to share those experiences. It depends again on a particular location but outside the nuclear island there are of course differences for 50 hertz and 60-hertz applications and also some local requirements. Similarly though, where we can, we try to even keep the non-nuclear island a balance of plant standard because again, there are efficiencies. If you imagine you are trying to line a supply chain up to be repetitive in how it would produce equipment and components and those sorts of things and have procedures and designs. So we do try. The nuclear island though, particularly is based upon the standard plan and we keep that much more standard, although there might be small regulatory differences that do occur through those approval processes, like GDA versus NRC, some small changes.

MR JACOBI: So am I right in understanding that - - -

MR CORLETTI: (indistinct) shield building - - -

MS BOWSER: Yes.

MR CORLETTI: - - - is (indistinct)

MS BOWSER: Yes.

MR CORLETTI: Okay. Yes, so and as Rita says, we have high (indistinct) standardisation across our units. For the specific question you asked regarding aircraft impact, the regulations in China are not – are different than the US, so the US – in China the plants have a more traditional reinforced concrete shield building but the plants in the US and all of the plants we are exporting subsequent to the China plants will have the hardened shield building design for aircraft impact.

MR JACOBI: Now can I just come to the question of capacity factor for the AP1000 and I am just interested to understand what your expectations are in terms of the capacity factor for this plant?

MS BOWSER: So plants today, nuclear plants today across the globe have been working very hard to improve their capacity factors and it is not uncommon for those plants to run as much as 90 or even 95 per cent, depending on their outage cycles. We have brought all of that experience over to the AP1000 particularly. Mike, you want to address the specifics of that?

MR CORLETTI: Yes. Well, so specifically while we have been talking about the novel features up to now about the passive safety system, it's really important that we understand that the power generation systems were really based on proven design. So with regards to the reactors, steam generator, the equipment that makes up the power generation system is proven and is very similar to what (indistinct) these high capacity factors of greater than 90 per cent in our operating fleet today.

MR JACOBI: Do you have an expectation about what the outages are for refuelling for this particular plant?

MS BOWSER: The outages for refuelling are measured in days. It is - our expectation is that we will have outages less than 20 days in duration and again, that is based on proven experience. We have taken some things like the refuelling equipment and included those automatic latching and unlatching features that make this go more quickly, so we have actually built in the experience of the past two decades or so to have confidence that we can routinely and systematically achieve those goals because we do that elsewhere today.

MR CORLETTI: One of the key set of requirements that the AP1000 designed to was the utilities that had been operating reactors in both Europe and the United States came up with a large set of requirements that all of the vendors, that the vendors should design their new plants to and Westinghouse used this set of requirements really as our specification for design on the AP1000 and these are included in what we call the ALWR utility requirement's document, advanced light water reactor utility requirements as well as the European utility requirements. And in there, the utility was very important that we design a new plant that had a very short refuelling schedule and so we have been able to – as part of the design up front, to design something on the order of 17 to 20 days as a design basis to demonstrate that we could have a 17 day refuelling outage. Of course every outage will be different depending on the amount of maintenance but from the nuclear (indistinct) side we have tried to shrink that as much as possible to minimise the outage time on the nuclear site.

MR JACOBI: And that is an outage as against what sort of cycle are we looking at? Every couple of years? Every 18 months? What is the cycle?

MR CORLETTI: So the base design is 18 months refuelling cycles, however we can also accommodate 24-month cycles. It gets to a utility preference because how they manage their fleet; different utilities would like either an 18-month or 24-month cycle depending on their other nuclear stations that they are managing.

MS BOWSER: Or perhaps other non-nuclear stations in the fleet as well, in peak hot and cold seasons.

MR JACOBI: So against that background what is the range of stated capacity factors for the AP1000?

MR CORLETTI: Our expectation is that we would have a range of – we would be expecting something on the order of 93 per cent capacity factor once the plant has been up and running. Of course in the first cycle that we will be experiencing in these new reactors, will be an opportunity for us to learn, so I wouldn't expect that the very first units would. However by the time we are building these plants in Australia, I would expect that we are having very good operating history and achieving those 93 per cent capacity factors.

MS BOWSER: And I think Mike also means on the first units for the first cycle or so.

MR CORLETTI: Yes.

MS BOWSER: Once we get beyond the first cycle there are even some special tests that one does on those first units but beyond that, over the life of those plants, we certainly expect that same sort of capacity factor.

MR JACOBI: Can I just come to the question of the plant technology, and I think we have got a slide that might pick this up, and I am particularly interested here in the nuclear aspects of the plant and I am just interested, we have got some key features and some of the things I think that we have picked up, but I am just interested to understand the extent to which the performance aspects of this plant might have been demonstrated in other operating Westinghouse plants, or the extent to which the technology that is within the plant might be described as novel?

MR CORLETTI: I believe you are on slide 3, is that what you said?

MR JACOBI: That is right, yes.

MR CORLETTI: Okay, sure. Do you want me to - - -

MS BOWSER: Yes.

MR CORLETTI: So let's start with the reactor vessel, which is at the centre of that picture. So the reactor vessel is what we call - is really based on reactor vessels that are operating today. This precise reactor vessel is in operation in some of our plants in Europe today. In addition, we have these two steam generators connected to the reactor vessel. You see those? And they are a large steam generator, approximately 125,000 square feet, but again, these steam generators are in operation in our PWR fleet today. We base the design of the reactor vessel on the steam generators, very much on our Gen 2 plants. We've obviously been making improvements to those, incremental improvements in our operatively - and that forms the basis for AP1000.

MS BOWSER: Well, the integrated head package is a good example of that. That was something that wasn't used in the olden days, but we learned that that made outages more efficient and it also keep the radiation dose for workers much lower by having a more automated system. So we put that in service in some plants and we brought that over to the AP1000 as something that would provide the same efficiencies going forward.

MR CORLETTI: That's right, Rita. Good point. That brings us to the reactor coolant pumps. In this AP1000 design we have four reactor coolant pumps. They're a different technology than what is used in our Gen 2 plants. We use what we call canned motor pumps. However, these pumps are actually - we're kind of going back to the future here. These pumps were actually in service in our very first nuclear plants and have extensive experience in our military program. They're used because of their high reliability and minimise the need for maintenance during operation.

Because they're a canned motor design, they do not require a seal injection. A seal injection is one of the features in the Gen 2 plants when we look at it from a safety system. It's an additional safety system that the Gen 2 plants have that we do not need with this reactor coolant pump design. So while the pump may be a less efficient machine, it's a higher reliable machine and it's really a safer machine than what we have in our Gen 2 reactor.

MS BOWSER: And we just finished some testing on those pumps and they're on the way to China, being packaged and shipped to China basically as we speak. So good progress has been made on those as we go forward.

MR JACOBI: We've heard some evidence and we've seen some material that suggests that there's been some simplification in terms of the design. I'm just interested to understand the extent to which you think that there has in fact been a simplification and what or if any expected benefits might be seen to flow from that.

MR CORLETTI: Right. So one of the simplifications from the picture that you're seeing there is the loop piping. So the loop piping is more compact and really were designed with a minimum number of welds and manufactured out of bent pipe to the extent possible. This reduced number of welds really reduces the amount of inspection that’s necessary throughout the life of the plant. So that's an example where by simplifying that piping arrangement that connects the loops reduces the overall cost to operate AP1000 during its life.

MS BOWSER: So the other features Mike already mentioned, without the seals there's less need for maintenance and inspection. Again, that reduces the duration of outages and it reduces the exposure to workers. The integrated head package, the same kind of thing, just allows things to go more quickly and smoother as we go forward. Again, going back to that request from current owners of plants to make those areas improved, I think, you know, we used that as the driver and that’s why you see some of these features.

MR CORLETTI: Another key point of simplification, because we've been able to go to passive safety systems there are largely these tanks of water inside containment, tanks of water that by gravity will refill the reactor core in case of any sort of potential loss of coolant. Those tanks of water replace a whole host of pumps and heat exchangers that are in the operating plant, those pumps in the heat exchangers so with essentially two tanks of water inside containment we've eliminated eight to 12 sets of pumps, six heat exchangers, all associated with core cooling in a standard plant.

MR JACOBI: Can I just come to the issue of cooling in the normal operation of the plant, and I'm just interested to understand the nature of the water requirements, either seawater or freshwater, with respect to the operation of such a plant.

MR CORLETTI: The normal cooling of the plant is through the steam generators, and we have very fewer feed water that feeds these steam generators. Essentially the water requirements are the same as what we have in our operating fleet of PWRs. So really we have proven components and proven water chemistry requirements that is really incremental or it builds on the experience that we have in our operating fleet with regards to pressurised water reactors.

MS BOWSER: One of the things that you'll see in nuclear plants in particular, it's actually expensive to make ultrapure water, and so the plants designed to recycle that water and reuse that ultrapure water as much as possible, and so that happens throughout the generation of the plant. That water gets re-cleaned and reused repeatedly. So you do have a third stream of water that's used for cooling and that's probably comparable to what you'd find in conventional plants as well. So if you have a plant (indistinct) today, you should be able to -

there's also a variety of cooling options available. You can use ocean or lake cooling. You can use cooling towers if you have a site that is not on a waterfront. So there are variety of cooling mechanisms that this plant is also designed to be compatible with.

MR JACOBI: The Commission has heard in the course of - particularly speaking to some vendors of SMRs - the ability to use methods of cooling other than what I might describe as wet cooling. It's been variously described as dry cooling or air cooling, and I'm just interested in the context to which the water requirements can be varied if one is minded to construct such a plant in more arid area.

MR CORLETTI: Right. So our standard plant, we have a standard cooling tower or a standard set of water requirements if we're going to use from a waterfront, as Rita mentioned. We have evaluated placing a reactor on a more arid site where we would maybe have a higher efficiency cooling tower that uses less water. So the plant can be adopted. That would take additional studies and that would get to be very site specific, but in general, the power block, there's nothing special about the power block that would prevent us from going to such a cooling arrangement if necessary.

MR JACOBI: Can I just come to the question of licencing, and I'm just interested to understand the nature of the approvals and licences that have been obtained for this design, and perhaps first of all, with respect to the United States and then perhaps we can move to other jurisdictions.

MS BOWSER: Yes, and that's fine. So the AP1000 was actually built off a design called the AP600, which was certified by the USNRC. The AP1000 has also been through that certification process and has actually had an amendment in that certification process. So nuclear plants have been built in the United States in the past and then there was a time frame where none were built. In about that time frame, the USNRC put forward some additional regulations that allowed a different sort of licencing process. All the licences in the prior construction period had been really site specific and each plant would licence the entire plant and perhaps even make some changes to it as they went along.

In the new regulations you can either certify the old way, site specific, which is fine, or you can go through and do what we did, which is put a standard plant through the process and then the site simply characterises itself to make sure that it's compatible with that plant. So we moved ahead, and the certified design, the AP1000, has been through and received that approval in December of 2011, and the four units that are under construction today are being built under those requirements.

We’ve also been through a licensing process in China, that has been comparably rigorous, there have been many questions that have been received and answered on the (indistinct) line, there has also been some regulatory reviews and questions. So the regulators today, you know, it really is a global world out there; there's a lot of sharing that goes on, of information. So the design is licensed, there is a permit in China.

We also have been through several of the phases of GDA licensing with the Office of Nuclear Regulation in the UK. We're in a final series of question and answering, ahead of construction on our application here, but we've been through several of the phases already, so the final questions - and we have a schedule and a time table that will take us through about the next year on those.

We've done some pre-licensing elsewhere, we also have a formal certification of compliance in Europe for the European design. Although not a regulator, also APRI has done a plant conformance review against those utility requirement documents that we talked about.

There have been other less formal reviews in markets considering the application of the AP1000 today, and there has been some regulatory sharing seminars on those, but those are, like I said, a less formal process: more like this, in preparation for future licensing than actual licensing.

I believe the AP1000, this is basically an opinion and perhaps not a fact, is one of the most licensed reactor designs out there, and certainly for the Generation III+, it is the most licensed plant out there.

MR JACOBI: Can I just pick up on - I'm just interested in the issue, I'm seeking Westinghouse's perspective on the significance of having obtained an approval within the United States under the generalised arrangements you're referring to, to obtaining licensing approvals in other jurisdictions.

MS BOWSER: It's an interesting process, because although there is the intention or desire on the part of many regulators to cooperate, typically the foundation of each regulatory entity (AUDIO MALFUNCTION) programs there is one called MDEP, where they're sharing of information and questions that goes on between regulators, and Westinghouse is very supportive of that process, and allows our information typically to be shared under appropriate conditions, in those circumstances.

But of course, for example, the basis of GDA licensing has a different, sort of a scientific basis than the NRC regulations, so each regulator, although they may trade information and they may rely on that, and it may certainly shorten the process or increase the confidence in that process, it looks to give it its own stamp.

There are some regulatory arenas where, especially people who are beginning to look at the nuclear process, have agreed to accept in part of their fulfilment of requirements, licensing by an entity such as the US NRC, as part of their approval process. But again, there is always that final look-see that would come by the local regulator.

MR CORLETTI: One thing to just add on: the generic design certification for AP1000 maybe to contrast that with the previous processes used in the United States, which is referred to as a two-step process. The standard plant design process required significant more detailed design to be complete at the time of the licence, because unlike in a two-step process where you get a licence to construct and then you get a later licence to operate, we essentially get a one-step licensing, where we get both a construction and an operating licence.

So at the time of design certification, you've taken it significantly further than where you would've taken it to get a construction licence in the previous process. What we've found is, our certified design with all of the detailed review that was done by the regulator provides a good foundation for any additional review of that standard design, in other countries.

MS BOWSER: Jurisdiction, sure.

MR JACOBI: I just wonder whether you can offer any insight in terms of the time frame it took Westinghouse to obtain its approval for a generic design. When did it start, and when did it ultimately obtain that certification in the United States?

MR CORLETTI: You want me to - - -

MS BOWSER: Yes, go ahead.

MR CORLETTI: For AP1000, we initially received approval of this in 2005, or approval of the plant design in 2005. So that was roughly from 2000 to 2005, a roughly four to five year time frame. And then, subsequently as Rita mentioned, in 2006 we actually provided an amendment to that, to actually expand the application of the AP1000 to a broader range of sites, and that licence, that separate licence approval took from around 2006 to about 2012.

Those were separate reviews, each of them took five to six years. But if you add that review on top of the AP600 review, which was another eight years, this plant has been under review by the US NRC for almost 18 years, if I'm doing the math right.

MS BOWSER: About one comment though I think might be important to Australia: one of the things on the AP1000, for example, is the fuel. And the fuel is quite similar to the fuel that would be in operating plants today. That becomes important because there are literally then a decade or decades of testing available in that fuel, including live dwell time in operating plants today.

Similarly, Mike talked about some of the components, the metallurgy, the performance of equipment and testing, and those kinds of things. If you were looking at technology and someone hasn't been through the process, to simply say it's a four or five year process, if it's you know, a start from scratch, is probably not entirely accurate. The reason that the AP1000 was able to go through the process in four to five years and then amend it in a similar time was because of the ability to rely on testing and equipment and component (AUDIO MALFUNCTION) in service for some period of time.

MR CORLETTI: That's right.

MS BOWSER: And I say that because I also am working on the Westinghouse SMR, and we're looking at similar synergies, as we take forward that design to rely on similar processes.

MR JACOBI: Can I just come to the question of costs, and I'm just interested to understand what Westinghouse's quoted American LCOE is for the AP1000.

MS BOWSER: An LCOE published by a public agency, the Energy Information Administration, quotes an estimate of about $5500 US per kilowatt electric. And Westinghouse finds that for initial assessment purposes, that value is a good and reasonable value to use.

Within that value, about 20 per cent of it, or should we say maybe about $1000 per kilowatt electric is owner's cost, and then about 80 per cent of that is plant construction cost. I can give you an idea, there is a slide 6, that gives you a little bit better idea of what that breakdown is.

As you can see on slide 6, the owner's cost particularly includes things like the switchyard and maybe some infrastructure upgrades in case the plant is somewhat larger, or you need water cooling systems. Administrative and office buildings, licensing, environmental impact assessments, which are done typically very, very early in the process, cyber security duties, et cetera, the land itself and the fuel supply.

On the other side, the part that makes up maybe 80 per cent comes from the standard plant we talked about, that standard plant and what that encompassed. And then things that are site specific, like, during the construction period, you likely will have a series of construction facilities for workers to both stay and perhaps a warehouse, special warehouses and those kinds of things. There'll be a site-specific simulator and the operator training. So all of those things that make the plant ready for operation are included in that cost.

MR JACOBI: We stated a figure of a bit over US$5,000 a kilowatt electric. Does that convert into a particular figure for an ultimate construction project for a Westinghouse AP1000?

MS BOWSER: Well, let me give it to you generically, and as you can imagine, yes, each side is different and commercially we provide very specific estimates for people, but again, I go back to what we believe is very good comparable data, that Energy Information Administration data, and if you look at about $55000 per kilowatt electronic of cost, that translates into about $12.5 billion for a twin-unit plant in the United States, which includes the owner's cost and the initial fuel load, and that's pretty consistent with the publicly available AP1000 data. So while it's not exactly our estimate, we think it's a very good basis for your assessment or comparison.

COMMISSIONER: Can I ask whether that's been mirrored in practice, in that as you built these new plants, your costs have been as expected?

MS BOWSER: So the first-of-a-kind plants always have some additional cost associated with those. Again, we try to look forward to the nth-of-a-kind plants and I can tell you that as we go forward, we're blending our lessons learned into our construction footprint and processes and design, and, for example, in the UK we're finding ourselves much closer to the nth-of-a-kind plant than we were perhaps on the first units elsewhere.

COMMISSIONER: In terms of nth-of-a-kind versus first-of-a-kind, what's the difference, broadly, that you would expect in terms of cost?

MS BOWSER: So you would expect to see both a decrease in the duration of the construction and you'd expect to see a duration in the cost and those reflected, along with the cost of the plant, is involved in the cost of money during that construction period. So your supply chain would also be more mature and so a lot of things we did to help our suppliers get stood up to get ready for nuclear construction were also involved in that initial time estimate. I'm probably not prepared to give you a direct comparison of what we're seeing today to what the nth-of-a-kind costs are, but what I can tell you is that we're counting on substantial reductions as we move forward.

COMMISSIONER: Do you have an estimate in terms of construction, or is that similarly wrapped up?

MS BOWSER: So the construction time frames, I can tell you that we're being pretty aggressive on our optimisation approach and we have special time frames in place. It doesn't answer your question, particularly on a dollar value comparison, but if time is money, shortening construction by a year or more can add significant value to the overall project cost.

COMMISSIONER: So do I take it then, that the goal is to strive to achieve a year decrease between first-of-a-kind and a nth-of-a-kind?

MS BOWSER: We'd actually expect to see more than that, and that's our target, our internal target, and we're working hard on that. I can tell you that although the eight plants under construction, we built them very close together. It's what they call a stagger, and we had a very tight stagger between essentially all eight units, and we're still seeing some efficiencies. The time to pour some particularly difficult-to-pour concrete and those kinds of things, we're seeing improvements as we go along, and so we have a systematic way that we're addressing, perhaps even more aggressive time frame improvements than what you mention.

MR JACOBI: Can I just pick up on that? I'm hoping for some insight in terms of how Westinghouse is managing, and this is by way of specific examples, the controlling time frames and how it's going to ensure that there are in fact the improvements in terms of the time frame for the delivery of projects.

MS BOWSER: Well - and I'll let Mike answer this - but we have a very systematic approach where, on a daily basis, on a living basis, we capture our specific activities. We have a lessons-learned process. We have an operating-experience process where we review events that happen in the industry. We review our own construction processes. Sometimes we bring in outside experts and look at those things, and we continuously cycle that back. Continuous improvement is one of the fundamental pillars of the nuclear industry, and in construction it's a very important part of that. I'll let Mike speak to that specifically.

MR CORLETTI: Yes. So one of the drivers, and probably the most important driver on the construction schedule for AP1000, is the use of modular construction, and as you may know - you may not know - the plant is designed to be built in modules. We include large structural modules, which essentially can be as big as a five-storey building. That gets designed in a fabrication shop and set all at once, our two very mechanical modules. So the key to improving our construction schedule is going to be the improvements we see in our construction of modules.

And, for example, in China where we're building four, we've seen significant improvement from that first module was delivered to the fourth one and to the north one where we're really seeing a shortened fabrication schedule and construction schedule due to that modularisation. There is where we see a key where we bring those lessons learned. We're bringing them into the US. We'll bring them into the future plants as really a key to reduce that overall construction schedule.

Another key is the mature supply chain as Rita mentioned, getting any of the first-of-a-kind issues with new pump owners we really - we've come through that now, and we're able to now rely with (indistinct) delivery schedule for all of the first-of-a-kind components that are no longer first-of-a-kind, and so I think the combination of coming through those first-of-a-kind issues and improvements in the modular construction techniques will enable us to see improvements in that overall construction schedule.

MS BOWSER: And we're actually committing to those today on those new projects.

MR CORLETTI: That's right.

MR JACOBI: With respect to modularisation, certainly in my reading I've understood that modularisation was something that's been talked about for a little while, and I'm just interested to understand how it is that - were benefits experienced with respect to modularisation in the early projects that you've done, and why is it expected now that there would be differences if they weren't?

MR CORLETTI: So the improvements that you see in modular construction really are improvements in quality where you're doing the manufacture in a much more controlled environment in the module fabrication shop. I think the improvement we are seeing is the learning of those manufacturers to improve their manufacturing technique. These were first-of-a-kind application of large structural modules in both China and the US and we're seeing from those lessons learned, and the follow-on unit, significant improvements there. Basically what differentiates AP1000 from maybe other designs is really the modules were designed into the plant upfront. You can't back fit modules into a design, and so the whole power block was really designed to be built in modules, and I think that - that's where, as we work through the first-of-a-kind issues, we'll be realising those benefits of the plant being designed to be built in modules.

MR JACOBI: I am just interested given that Westinghouse has been constructing plants both in China as well as the United States and I am just interested to the extent to which the benefits can be translated – could be expected to be translated in to other jurisdictions and the sorts of factors that would affect about whether those sorts of cost benefits can be translated in other countries?

MS BOWSER: Yes, and I think the answer for that is yes. There is the need in each jurisdiction and we look very hard at this. You know we look at the manufacturing capability. It's not uncommon for us even with the AP1000 capacity to procure as much as 60 per cent of the plants or sometimes more locally because if you look at the fact that you are going to have local materials, concrete, rebar metal, other some (indistinct) some (indistinct) if you are procuring those locally you want to make sure that those lessons learnt from elsewhere find their way in to the specifications for material and the qualifications. The more mature the supply chain, one of the things I did when I was in Australia is I came to Adelaide and I looked at some of the manufacturers there. I looked at some of the ship building facilities, I looked at some of the speciality defence and aerospace manufacturers and with that sort of a quality they are already have a lot of the capability. When I go in to some other places and look at manufacturers, they might not have that maturity and so the ability to capture as many of the lessons learned or as much of the programmatic improvement might be a little less.

So again, it depends on where you are deploying. In each case we expect to be – our designs reflect some of the enhancements that we made, our manufacturing techniques reflect those, the know how of a skilled workforce or leadership that would be there. We have aligned people from future projects to work on the current projects to get some of that experience. So by blending that in we would expect in all cases to see some improvements but more in the more mature markets than we would in some other places.

MR JACOBI: Just in terms of projected timeframe for the delivery of an AP1000, assuming that it were licensed in that jurisdiction, I think we have got a slide that might pick this up with number 8, I am just wondering whether you could talk us through what Westinghouse's view is in terms of the timeframe expected for construction?

MS BOWSER: Yes, I would be happy to do that. First thin I will do is I will call your attention to the little diamond kind of in the middle called "First nuclear concrete". That (indistinct) for a nuclear project. That is effectively the turning point where you have all of the controls and all of the regulatory requirements in place where the project changes from clearing land, or obtaining permits to a full nuclear construction project. So if we go from the diamond to the right, then the power block construction we are saying would be about four years or so, perhaps our aspiration might even be to be better than that; some fuel loading and then start up and commissioning. There is a very rigorous testing process that is ongoing for plant commissioning and although it varies according to jurisdiction, that testing is well worth it and quite rigorous. If you look at the green side of the arrow, there are several things that happen here. Often times, selecting a site and characterising the site and getting environmental or other permits for the site is what we call the long pole in the tent and so if people are looking to engage in nuclear industry, those environmental and other requirements are something worth looking at quite early in the process.

You might also consider sites that have already been evaluated for other energy forms and that could shorten that timeframe a little bit. The other thing that happens with modular construction is you also start to perhaps procure equipment and begin to establish your manufacturing facilities and start construction on some of those early components. So there again, when you start the first nuclear concrete on a modular construction site, you can actually put large components in place fairly rapidly. Again, that needs to be worked at very carefully with the utility owner because there is investment required at these different stages and different utilities want to phase out investment in different ways. Some will want to make the modules early and move to site, nuclear concrete quickly. Others will like to first characterise the site and then maybe step back and look at what those next steps will be. So we have a typical development model but it allows for the fact that different utility owners might have different requirements on project financing or project execution.

COMMISSIONER: I appreciate that this is an indicative schedule but can I take you to the plants that you have got under construction, and I appreciate to the left of the first nuclear concrete is variable because of the reasons you have used, but in terms of a power block construction, does your current achievement meet these timeframes?

MS BOWSER: The current first of a kind plants are in a different situation. We also had Fukushima occur in the middle of those constructions and virtually all of the plants took a step back to make sure that that had been appropriately considered in the design and licensing and manufacturing process. But as I said, on the ones that are in development today, we are committing to schedules like the ones that you see on the paper here. So we believe that we have captured that learning enough to commercially stand by these kinds of schedules.

COMMISSIONER: Thank you.

MR JACOBI: I am just interested in addressing, in terms of the overall design, the extent to which it has been designed, bearing in mind decommissioning and the need to decommission a plant of this sort. And I understand that that is a different feature of some new modern designs and I am just interested to the extent to which it’s a feature of this design?

MS BOWSER: In answer, that is a really important question. You know, I personally have been involved in plant decommissioning in my career and all plants consider decommissioning but the more modern plants, just as they consider design in a more sophisticated way, consider decommissioning. And the modularity also lends itself towards decommissioning. There are certain things that we did that would make large component removal easier et cetera in the large plant. It is a matter of fact in the US NRC licensing and I am not as clear on the GDA licensing but I expect there as well, you actually have to include your framework decommissioning plans as part of that licensing. So you must be able to effectively decommission the units upon end. And that's really important because of course, probably none of us will be at our career livelihood when these plants go out of service in 60, 80 or 100 years.

MR CORLETTI: The one thing we do see is the reduced amount of nuclear equipment. The reduced amount of equipment that is exposed to radiation, it does reduce that burden on decommissioning with regards to the total quantities.

MS BOWSER: Excellent point Mike, thank you.

MR JACOBI: So could I just pick up the answer with respect to expected lifetime and I understand that the plants typically expressed in terms of operation for a period of 60 years. I think you gave an answer with respect to 80 or 100. Is that with extended design licence approvals or what is the basis for a life beyond 60 years?

MS BOWSER: Yes. So the regulatory regimes today wouldn't licence a plant for 80 or 100 years to begin with but there is already experience even with the plants that are currently in operation, that have gone to 60 years and now are looking at life extension beyond that, of the kinds of things that – they are mechanical plants, there are things that will wear out in that time period, or need – certainly need inspected but there are just certain elements that you would want to upgrade in that timeframe. Imagine, you know looking – turning back the clock in that timeframe. And so it has been our intention to design and build with that thought in mind that these plants could indeed be extended and there would be a list of pretty standard things that would need to be looked at, or some items that would need to be replaced due to wear after that period of time.

MR CORLETTI: The current fleet of reactors were designed to a nominal design life of 40 years, they have been routinely been able to extend that to 60 years, as compared to AP1000, where we've done the nominal design to 60 years. We fully expect to have that built in margin to be able to extend that beyond 60, to that 80-100 year time frame.

Obviously the regulators don't provide that upfront, that's something over the life of the plant they would have those opportunities to extend them.

MS BOWSER: And the European requirements and deal in different increments, so each country has its own way to validate the continued operation is appropriate beyond the initial licensing period.

MR JACOBI: I was just hoping to pick up the issue about where Westinghouse sees the market for the AP1000, and I think we've got as slide that might pick up where the existing plants are. I was interested to understand where it is that Westinghouse sees that it will have a market and why it thinks it'll have it.

MS BOWSER: That's an excellent question, especially when you're looking at (indistinct) of a kind delivery on these units. As I mentioned, we have eight plants under construction today; four in China and four in the US. We have a development project underway in Moorside, and we're actively engaged in China wave II, we have some AP1000 plant orders received, we're continuing to engage.

And the AP1000 has been involved there as a standard that they'd like to rely upon going forward.

MR JACOBI: Sorry, can I just - - -

MS BOWSER: If you look at - - -

MR JACOBI: Can I interrupt there?

MS BOWSER: Sure.

MR JACOBI: I'm just interested in, what's the extent of the depth of the commitment, just in broad terms, with respect to the UK and Chinese projects? So how far are they along?

MS BOWSER: The way that these projects advance, the ones in Moorside is in a development stage, it's an early works stage, and they'll make continued decisions along the way on that particular project. Again, in China the owner would need to comment more specifically on its commercial arrangements with us, but we have firm agreements and are working closely with the Chinese on future waves of plants, rolling right from what we call Wave I into those future Waves II and III to come, so we're very active with them.

Much more I would call "marketing opportunities" although we have some early works in India, other countries where we're active and perhaps even have offices or have a presence (AUDIO MALFUNCTION) a large presence in

China, where we also did a fair amount of technology transfer, which is also one of the reasons that we're very confident about the Chinese market. You know, we have the ability and every time we've shared our technology with the French, with the Koreans, with the Chinese, and each of them now has a substantial market.

And then of course, early marketing opportunities: Mexico (indistinct) and Saudi Arabia, Czech Republic. Even more plants in the US, so the markets - we work on very long time scales, and we're in discussions for a long time with people, you know, as these projects develop. It's not uncommon that they do go in stages, like Moorside, where they continue to make assessment and commitments as the projects unfold.

MR JACOBI: Can I just pick up the issue of the United States, and that is we've read a little of the United States experience and that there was quite a lot of optimism, certainly in the early 2000s about the number of plants that might be developed and constructed in the United States at that time, and I'm just interested in your view about where you think that the United States nuclear industry, in terms of new construction, is likely to go over the next 10 or 15 years.

MS BOWSER: One of the things that's important about the US is that it's not a homogenous mixture; we have regulated, deregulated, partially deregulated markets, and you see different development in different areas. Clearly in the regulated markets, and also in the high growth areas, you see better conditions for large capital projects because that's what these are.

So we expect to continue to see the development of new nuclear projects in those areas. You find some other areas where the market conditions, you know, might not be as attractive for any generating source, and so you see challenges. Again, we are in very real discussions in the United States with people who are in those areas where we would expect to see market growth, and we want to keep them informed of our progress and our products, because we think that's worthwhile.

MR JACOBI: I'm just wondering also, we've heard quite a bit about small modular reactors, and in fact you mentioned Westinghouse's design, and I'm just interested for you to offer some insight, perhaps with respect to where you see the AP1000 as against some of those small modular designs.

MS BOWSER: That's a good question, the one thing that's important is the AP1000 is licensed and based on components that are in service today, and so we expect people who need the plant capacity will continue to build the large plants.

In the future, there will be room for SMRs, that's why Westinghouse has one, we're very active in the UK as you might've seen, with our SMR. But all of the SMR designs are - I mentioned the importance in the AP1000 licensing of the fact that there was a historical foundation behind that licensing, and so even the development of traditional light water SMRs, there is quite a road to go.

There are studies and information out there, and we're following those closely. Frankly, we're trying to leverage the real nature of our fuel and our components and our designs, to move our SMR ahead more quickly. You find others who are, I think, more aspirational about what they can do in the licensing process, and we'll see that as they go forward.

I think there's a niche for it, I think they'll be suitable for sites, but I think it's a future technology as compared to an AP1000 today technology.

COMMISSIONER: Rita and the team, thank you very much for your participation and for your evidence today, and the work that you've put into help us understand where the AP1000 is, and is going. Thank you.

MS BOWSER: Thank you all very much, we appreciate the time to speak to you.

COMMISSIONER: We'll adjourn now until this afternoon.

ADJOURNED **[10.47 am]**