Special Sizewell Stakeholder Group Meeting with Office for Nuclear Regulation held in public on 5th March 2014 to explain the technical review that was carried out by the Belgian nuclear regulator following the discovery of flaw indications in the reactor pressure vessels at Doel 3 and Tihange 2 and to explain how ONR used this international learning to assess if there were any implications for Sizewell

Contributors:
MF – Marianne Fellowes – Chair of the Sizewell Stakeholder Group
PW – Pete Wilkinson – co-opted member
GS – Gavin Smith – HM Principal Inspector of Health and Safety and ONR Inspector Sizewell B
GH – Dr Gareth Hopkin – HM Inspector of Health and Safety and ONR Specialist Inspector
CB – Charles Barnett – Shut Down Sizewell Campaign
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JG – Joan Girling – co-opted member and member of TASC (Together Against Sizewell C)
TH – Terry Hodgson – Suffolk Association of Local Councils
TB – Trevor Branton – co-opted member
MT – Mike Taylor – co-opted member and Suffolk Coastal Friends of the Earth
TG-J – Tom Griffith-Jones – Shut Down Sizewell Campaign
CT - Colin Tucker – member of the SSG and Sizewell B staff representative
MCl – Michael Clark – co-opted member

MF: Good evening ladies and gentlemen and thank you very much for your attendance this evening and to those who assisted with setting up the meeting and getting everyone to this place in time. My name is Marianne Fellowes and I'm the Chair of the Sizewell Stakeholder Group and this evening is a special meeting for the Sizewell Stakeholder Group to consider the one issue.

Our main meeting is tomorrow at the Stratford St Andrew Community Centre, starting at 10:00am (9.30am arrival with refreshments) – if anyone would like to attend our main meeting at any time, you are most welcome and we do encourage you to do so.

Can I thank you in advance for your respectful contribution to this evenings meeting and can I let you know that for Health & Safety, you have the exits behind you and the exit over to my right or in the far room out the doors if we go in that direction. There is no fire alarm. Ladies and gentleman's facilities are in the foyer, and if you do need to leave the room to grab a glass of water or coffee or anything like that please feel free to do so.

The objective this evening is to further our understanding of the issues regarding potential problems with the Reactor Pressure Vessel at Sizewell B Power Station and the ONR's report and the rationale which underpins their decision making.

Last week, the SSG sub-group met together and formulated some questions to assist the process and the team that's here this evening will do their very best to answer those questions and other questions that you may have this evening. They will give their presentation first and then we'll take additional questions after that. There'll be plenty of time to ask questions so I would like them to go through their full presentation first.

So the team that is here this evening, we have Gavin Smith who's the Principal Inspector of health and safety for the ONR Site inspector for Sizewell B and has been with us since May last year and he has a degree in mechanical engineering and Chartered Engineer and Dr Gareth Hopkin, who's again an inspector for the health and safety ONR but as a Specialist inspector, he specialises in structural integrity and is the lead for Sizewell B and as Chartered Engineer and a senior member of the Welding institute he has a degree and a PhD in Metallurgy from the

University of Cambridge – so as you can see we are very fortunate to have two members of staff from the ONR to address our questions this evening.

PW – can I make a statement please?

MF – you can ask me a question Pete, if you would like to

PW – I would like to make a statement that I think it's absolutely scandalous that the NDA doesn't feel able to finance a relatively small amount of money to get an independent expert here to debate with these two gentlemen.

MF – OK – this evening, let's take full opportunity to hear what they have to say with regards to their report and also the underpinning, the rationale for their decisions they have made – we can ask all the questions that we want following that.

I take a note of your question – can I let you know that for the minutes, we are recording the meeting this evening and Jane is going to be taking hand-written notes of all questions so that for anyone who's not present this evening, we're able to give them the questions and the answers that were given. So ladies and gentlemen, I'm going to hand the meeting over to Gavin and Gareth.

GS – Good evening – can you hear me OK on the mike? As Marianne said, my name's Gavin Smith and I'll just give you a brief overview – just give some time to get through the presentations and there will be ample time to ask questions in about half an hour, 40 minutes to go through our presentations to set the scene and give you background to what we are talking about tonight. I think we have covered the introductions – we can see that Gareth is better qualified than I am – but Gareth is typical of the sort of resources we have behind us in terms of specialists – for this particular topic we are talking about tonight, Gareth's our expert on structural integrity.

Just to set the scene a bit about what the ONR is – the Office of Nuclear Regulation – an independent regulator – (slide 3) that's the mission statement "to provide efficient and effective regulation of the nuclear industry, holding it to account on behalf of the public" – that is our mission statement and you will find that on our website.

(Slide 4) The legal framework in which we regulate:

- Health and Safety at Work Act 1974
- Nuclear Installation Act 1965 - and within the nuclear installations act, there are:
- 36 Site Licence Conditions - that any operator has to comply with to be able to legally operate a nuclear facility in the UK.

(Slide 5) How we regulate? The main elements are:

- Permissioning Inspection – where we give permission, for example, last June we gave Sizewell B permission to restart after re-fuelling.
- Compliance Inspection – is compliance against the Licence Conditions and the testing we oversee
- Enforcement – we have full set of tools for enforcement, prosecution, including notices, prohibition notices are our prime methods of enforcement
- Influencing – the main area of how we regulate the industry.

(Slide 6) Scope of Work for the UK:

- 40 licensed sites in the UK – and ONR covers:
- Nuclear safety
- Transport safety
- And Civil nuclear security

Like I said, I'm not going to talk too long, because I want to get Gareth on, but really what tonight is about, just to repeat what Marianne said, (slide 7) it's about explaining the basis of the technical review that was carried out by the Belgian nuclear regulator following the discovery of flaw indications in the reactor pressure vessels at their two sites. That's very important and Gareth will go through that and explain the technical side as well – in addition how we then use that learning and applied it to whether or not it was applicable to vessels within the UK – and there is only one steel vessel in operation now and that's at Sizewell B – that's the purpose of the meeting.

Just on a couple of other points – it's your meeting – it's not for us to talk to you and we will give you time to ask questions and it is important and we will try and answer best we can the questions you give us – if there is anything we can't answer, we will come back to you.

The other thing that we are particularly pleased with is the time you put into putting questions together for us and an advanced notice of those – it makes things a lot easier and we appreciate the time and effort that has gone into that.

So, I will hand over to Gareth now and he'll through some of the detail:

MF – While the gentlemen are setting up, can I say that later on when we go into the questions, if you have a question, if you could raise your hand, when the microphone comes to you if you can clearly state your name and then ask your question – thank you.

GH – OK – that's quite loud – my name is Gareth Hopkin – I'm a specialist structural integrity assessor with the Office of Nuclear Regulation – I'm based up in Bootle near Liverpool – I'm the site structural integrity lead for Sizewell B, so if there are any structural integrity questions that come for Sizewell B, they normally come across my desk. Structural integrity, in case you are wondering what the subject is, in layman's terms, it's the large bits of metal – its metallic components and how the stresses act from there.

(Slide 2) I've had quite a good introduction – I'm a Chartered Engineer, chartered with the Welding Institute which is based in Cambridge, senior member of the Welding Institute. I've got my degree and PhD in Metallurgy, or more strictly material science and metallurgy at Cambridge.

I've had 13 years' experience following my PhD – I started off in forensic metallurgy which is essentially looking at how defects form, how they grow and how things break – it was taking broken bits of metal that had failed in service, analysing that and working backwards to find how not to make it happen in future.

Prior to joining ONR, I spent six years working in the UK Naval Nuclear Programme – so that's submarine propulsion.

(Slide 3) This is probably known to everyone, so I'll skip over nice and quickly – (slide three shows a basic structure of a Pressurised Water Reactor) – over on the right, the blue section - that's essentially conventional plant – that's the normal part of the conventional steam generators invented by Charles Parsons, way back when, which haven't really changed – that's a conventional power station.

The bits I'm going to be talking about tonight are these yellow bits on the left of the slide – so it's the Reactor Pressure Vessel – if I slip and call it an RPV, I apologise – but that's the Reactor Pressure Vessel or the RPV …

(Slide 4) so there were two Belgian plants affected and the two are called Doel 3 and Tihange 2 – they were built to the same design – they are pretty much identical sister plants – they were built to a design code called the ASME code – that's the American Society for Mechanical Engineers – that's essentially a set of rules and instructions on how to design a Nuclear Power

Plant and within that it gives specifications on how you make the bits of metal, how you connect the metal bits together, the forgings, how you weld them together and how you inspect them afterwards – so that's the basic rule book that was used when building Doel 3 and Tihange 2 and for that matter also Sizewell. Both of the RPVs were built using forgings and they were made by the Rotterdam Drydock company (RDM) in Dutch. Castings were made by Krupp, which is the big German steel producer based in Essen and plate, there were two bits of plate – the very top and the very bottom are plate.

Now I'm going to be talking about the forgings primarily because this is where the defects, or the flaws, in Doel 3 and Tihange 2 were actually found, so the plate was actually French built, and then this was Rotterdam Drydock.

(Slide 5) So for those of you who are not familiar with the forging process, this is the larger of the two forges in Le Creusot – this is a lemon 11300 tonne forge and they are making a ring forge in here – rather similar to the ring forgings that would have gone into Doel 3 and ring forgings that are in Sizewell that I just pointed out in the previous slide.

So what's happening here, you have got a circular ring forging and this mandle here is supporting the weight, the press is coming down here and it is squeezing the metal – it's a fairly traditional and craft-like industry – it has a lot of skill involved. But essentially, the metal has been deformed, squeezed out to make the forging bigger, and bigger and bigger until you've got your final size – it's being expanded in that direction – so that's Le Creusot.

(Slide 6) Now, how are these flaws found? Every ten years, a plant built to the ASME design will undergo extensive, mandatory set of inspections – so like I said this is a set of rule books – ASME's set of rules for building a nuclear plant – it mandates ten yearly extensive inspections. This, in case of the RPV, the Reactor Pressure Vessel – it involves moving sections of the core and all the core internals, so you put people down and actually scan the inside of the pressure vessel, so you will actually send people into the pressure vessel to take out the internals – or in close proximity to the pressure vessel and not necessarily within it. The defects were found by the Electrabel (Doel 3 and Tihange 2 Licensee) and their sub-contractor were looking at the welds on that pressure vessel – because the ASME code does not specify that you look at the forgings, the ASME code specifies that you only look at the welds during this ten yearly outage. So they were looking at the welds – looking at a small section above and below as well – now as they looked at the small sections above and below, they found some indications, and moving on from that, they actually extended the inspections to cover the whole forgings and this is when they found the forgings were quite heavily full of flaws – that was at Doel 3 which was in June 2012. Shortly after, the sister plant Tihange 2, was taken off line for its ten yearly inspection, so it wasn't taken off line when they found the defects in Doel, it was taken off line about three months later for its planned inspection and in Tihange, they found a similar story that they found in Doel – they found defects in the pressure vessel. So we found out – we were told officially through our own internal communications with the Belgian regulator about this problem.

(Slide 7) Like I said, the flaws are only found in these forgings, so I'm not going to cover the top or the bottom of the Doel plant because they were plate, it was only covered in the forgings. These defects were easy to find with ultrasonic inspections – ultrasonic inspections is the standard technique that we use to look for flaws in a seal like this, and it is the same basic principle as – I'm a father, so you go to the maternity clinic and you scan for the baby, so it's the same basic principle – you send ultrasound waves and you are picking up reflections of what's inside. So the flaws are generally parallel to the surface of the forging, with negligible through-wall extent – (drawing on flip-chart to show RPV) so if you've got your forging, then, thick steel plates, slightly curved, the defects are in this direction – I've caveated it with 'generally' that means a couple of degrees either way – not necessarily bang on – but as near as makes very little odds – these things were parallel to the surface of the forgings. I'll put in that these are the least threatening orientation with respect to structural integrity – what we generally worry about in this field is through wall defects – so your pressure vessel – is pressurised up, big piece of

metal like that, it's going to be pulling apart – so as the through wall defect grows then the pressure would be to try and pull that apart. If you have got a laminate defect like this and I'll use the technical term, a lamination, a crinkly-shaped defect – it would be pulled like this and actually there would be no opening force – so in terms of threatening the structural integrity – these are the least threatening orientations. Now there were a large numbers of flaws in each cylindrical forging, 7205, so big numbers of flaws.

(Slide 8) Now, the defects have been characterised by the Belgian licensee as 'Hydrogen Bursts' – they call them Hydrogen Bursts, so I'm calling them Hydrogen Bursts for the purpose of this presentation – where you will probably find them 'Hydrogen Flakes' – I think I called them Hydrogen Flakes in the report there, but you also hear them called 'Hydrogen Induced Cracks', 'Hydrogen Cracking' – these things have got a million names – but I'm going to call them Hydrogen Bursts for the purposes of this presentation because that is what the Belgian regulator called them, so I'm just following up on their terminology.

So the characterisation has been accepted by the Belgian regulator and its technical advisors – characterisation has also accepted by the international regulatory group – so FANC, that's the Belgian regulator, called together a group of regulatory experts from around the world – initially they only extended invitation to regulators to countries with reactor pressure vessels built by Rotterdam Drydock, because it seemed that only those were at risk, but at our request, the ONR actually went onto that group, so we asked for an invitation to be on the group and we got one. All four ONR participants agreed with this characterisation, and again, there has been a recent forging used in Le Creusot forge (like the picture in slide 5) and Le Creusot forge have produced a forging for the French nuclear industry, so nothing to do with us. Again, we'd spoken to the French regulator, we've seen the pictures, and we've talked directly with the French regulator, so actually we were already aware of the problem before Doel happened.

(Slide 9) The Hydrogen Burst mechanism, it is a little bit of a peculiar mechanism – during casting, all steel will contain inclusions, so you have got a big piece of steel and if you're making hundreds of tonnes of steel, you will always get some particulate in there – so some of these particles would be harder than the surrounding steel and some of them would be softer, so for example, if you have a piece of silica, so sand which you can get, as you deform in the forge, the sand, the silica, is harder than the surrounding steel and the piece of silica will not deform and the steel will deform around it. Some inclusions are soft compared with steel and the classic example here is Manganese Sulphides (MnS), so if I start to call them Manganese Sulphides, forgive me – that's primarily what the soft inclusions are. If you've got a particle of Manganese Sulphide, you put it between a press and you push it flat, and instead of being a nice particle, it flattens out into a lamination – a pancake-shaped defect – so instead of a nice shape like silica and remain nice and round, instead it turns into a lamination.

(Slide 10) During manufacture, molten steel will pick up hydrogen from the air, the moisture in the air, so when you are casting steel, it will contain hydrogen – now hydrogen controls I will go into a little later – but as the steel solidifies and cools, the hydrogen is no longer stable within it and it tries to escape – and if it can, it will escape through the surfaces but it can also go and build up at these inclusions – so if the hydrogen starts to accumulate at the inclusion, it will get to a higher and higher and higher pressure until it will pop the inclusion apart. The pressure of hydrogen within that laminar defect will be enough to bend the steel and will pop the hydrogen apart. But without the laminations, we don't get Hydrogen Bursts – this is why it's called Bursts by the way, it pops it apart. Without hydrogen you don't get Hydrogen Bursts, without laminations you don't get Hydrogen Bursts – so this is a Hydrogen Burst mechanism. (The picture on Slide 10) that's not of Doel 3 or the French forging – that's actually hydrogen pressure induced cracking in an oil pipeline. The pictures have not been released, but that's fairly indicative, that's from my previous life working in forensic investigations – in fact, this was just testing material.

(Slide 11) So Hydrogen Bursts are flaws that are generally parallel to the surface of the forging – so they must form on these pancake laminations and so that matches exactly what we have

seen in Doel – the laminations act as the nucleation points without the hydrogen we don't see the flaws present. The flaws can be very easily found by ultrasonic inspection, so this is why we've come to the conclusion – or the Belgian regulator came to the conclusion – that the flaws in the forging are Hydrogen Bursts is because there's are lots and lots of them so we're talking about some gross mechanism which generally means gas and that generally means hydrogen – plus since they are all parallel to the surface give or take a degree or two – they must be related to the microstructure and not the stresses – like I've said before, if it is a stress related defect, the stress would react to force the cracks apart not to cause bursts. So that's why the Belgian regulator came to the conclusion that it was Hydrogen Bursts and not anything else – we do agree with their characterisation.

(Slide 12) So implications for Doel 3 and Tihange 3 – when they initially found them, they took off the plants and they left them depressurised – like I said before, they did not actually take Doel 3 off early – they waited for three months and took it off when it came to its ten yearly outage. Inspections were extended beyond the weld regions – so like I said, the ASME code – the design code and book of rules for making a nuclear pressure vessel only says you look at the welds – now they found defects or flaws rather, outside of the welds so they extended out and found all in all the worst affected was the one in Doel – 7205 flaws – so lots and lots of flaws, so a gross mechanism of flaw creation – gross by the way meaning very big.

(Slide 13) The Belgian regulator, what they did was they engaged directly with their licensee – so they went to speak to their licensee – and they have their own dedicated technical support organisation – they don't have technical people in actually their organisation as we do – so they went to their licensee to say what do you think this is? They went to their technical support organisation to say what do you think this is? Then they took all that information, all the data gathering had been done by those two organisations – they brought it to the international regulators, so that was all the regulators who have Rotterdam Drydock RPVs plus the UK and asked for our opinions and then they set up an independent working group of international experts – so this was a large group who we did interact with actually, there was at least one meeting where the regulatory group and the independent expert group sat together so they could hear each other's views – they were a group of largely retired experts from around the world all with expertise in seals for pressure vessels – now, if you'd like the independent expert group reports – it is available on the Belgian regulator website in English – so there is an independent report available commissioned by the Belgian regulator.

(Slide 14) The Belgian regulator, FANC, withheld restart – so they didn't want to let the reactor restart until they knew that they had a good understanding of what the flaws were, that they knew the characterisation of the flaws was complete, so they knew how many there were and where they were and there was a safety case in operation – so this is, have they done their analysis of the flaws properly? Have they actually done the stress analysis and know what stresses should be under normal and fault conditions? And were they content that not only could they withstand those conditions, but also any reasonable variations within those conditions. Obviously as a UK regulator, we did not assess the Belgian licensee's submissions because that is not for us to do. They also put in inspection plans for the next outage.

(Slide 15) Now, I'm going to read these verbatim – there are three additional measures placed by FANC on their licensee – so:

- For Doel 3 and Tihange 2, the licensee has reduced the authorised heat-up and cool-down rates to – I'll explain why – as you heat-up or cool-down the reactor, you are cooling down the reactor and the water inside the reactor is getting colder and colder and colder, there's thermal lag – so the outside, you're cooling the reactor down on the inside, so that's essentially contracting and contracting and the bit on the outside would suddenly be ever so slightly bigger than the bit on the inside – so the bit on the inside would go into tension, and if you start to heat it up, the opposite happens, the bit on the inside into compression and the outside in to tension – now the level of stress is directly dependant on the temperature – on how fast you heat it up and how fast you cool it down

– so if you cool it down slowly or heat it up slowly, less stress – that's why they put that in place.
- They put in a permanent preheat for the water injection system, so this is the emergency water supply, so if something has gone wrong, you pour water into the reactor, it's warmer, you'll have less stress and they also made training recommendations

(Slide 16) They also put in a couple of caveats on operation which was:
- Whenever a severe transient occurs during the future operation of Tihange 2 and Doel 3 (such as effective safety injection – so that's when you're pouring water in because something has very bad has happened), an additional in-service inspection of the reactor pressure vessel is required – so, if a severe transient, if something big happens, they will use that – again, I caveat with this – this is all Doel 3 and Tihange 2 – I've not gone onto the UK yet.
- Also after the first outage they're going to go back in and re-inspect the plant.

(Slide 17) So, it was June last year, FANC, that's the Belgian regulator, permissioned restart of these two plants – subject to the caveats I've given – I'd like to say that ONR – we do not have any role to play in whether Belgian reactors should or should not restart, that is a matter for the Belgians.

(Slide 18) OK – on to the implications for the UK – there is only one operating Civil Nuclear Power Plant in the UK which has a steel pressure vessel and that's Sizewell B – the other operating power plants are the AGR fleet and the single Magnox at Wylfa – and they all have reinforced concrete pressure vessels, so when it comes to the implications for the UK, we're only talking about Sizewell B. Although, that's current plant. EDF AREVA UK-EPR which has been proposed for Hinkley Point C also utilises a forged steel RPV. So when we are assessing, we actually assessed both the EDF nuclear generation and the Westinghouse designed plant – but I'll restrict myself to Sizewell B for this presentation.

(Slide 19) So, similar to Doel 3, Sizewell B is also a Pressurised Water Reactor (PWR), the same basic design, it has a forged steel pressure vessel – if you were drawing a basic diagram of Doel 3 and Sizewell B, that first diagram (Slide 3) that's applicable to both plants. The grade of steel used was nominally the same for Sizewell B and Doel 3, if you want to look it up, it's ASTM A508M Grade 3 and without going into too much technical detail, it is the standard grade of steel pressure vessel used around the world, so, anything built to the ASME design, which is most of the PWRs operating around the world is this material. They were both built to the ASME design code – so that's the book of rules for building nuclear power plants that I referred to earlier. Both plants undergo ten yearly inspections and Sizewell B's next ten yearly inspection is due 2016.

(Slide 20) There are significant differences also, so those were the similarities, there were also differences obviously:
- The forgings at Sizewell B were made by Japan Steelworks and Creusot Loire Industries, not Rotterdam Drydock – Creusot Loire Industries is now defunct and part of AREVA and Rotterdam Drydock is a completely different company now – there's no more forging activity going on that site.
- The steel used at Sizewell B, yes they were still the same nominal grade, however, during the build, there was recognition both within the NII (Nuclear Installations Inspectorate) – the predecessor organisation to ONR and within the CEGB at the time, that they should actually narrow down and go into the safer regions or the better controlled regions of this particular grade of steel – so for example, carbon levels within the Sizewell B Reactor Pressure Vessel are much more tightly controlled and are lower than the Doel 3 reactor – the more carbon you have, it makes the steel more hardenable and more susceptible to cracking, so that's why Sizewell B has the lower level, also, critically, Sizewell B underwent hydrogen control during its build, so not only were there controls on hydrogen in the steel melts, also, as appropriated, if there was an 'edging-up' of the hydrogen level within the steel, there would be dehydrogenation heat treatment –

all that is, is you get your forging, after you've forged it, before the cracks will happen, because these cracks generally happen cool – you put it in a furnace and you heat it in a dry atmosphere and the hydrogen will escape at high temperatures.

- Also critically, Sizewell B had extensive pre-service inspection of the RPV. So Doel 3, to all intents and purposes, the ASME minimum, what was specified in that design in that design code, just what was specified in that design code. Sizewell B is arguably the most heavily inspected RPV, I can't say that I've been through every RPV, certainly every RPV I have ever dealt with, excuse me, Reactor Pressure Vessel, it is the most heavily inspected and best characterised pressure vessel and that was due to the interactions of CEGB and NII at the time. We do have all of these manufacturing records – they still exist, they exist largely at Sizewell, I believe all the records are held at Sizewell – if ONR ask for access to this, we have never been refused access – and actually, if we were ever refused access, we have the power, the warranty power to walk in there, hopefully, I can't imagine ever coming to that – but we have access to these records.

(Slide 21) So we engage directly with EDF on this matter, on both technical and managerial level and through planned and reactive meetings – so all that means, is that we always have meetings – they're on-going, on a technical level.
The materials and production differences between Doel 3 and Sizewell B are where we get our confidence.

So we know that Sizewell B was not from the affected forgemaster (RDM) – we know and we have records of the chemical composition and the hydrogen content, so we know that everything was done to make sure that hydrogen bursts did not occur and we have been back through those records and there's the ONR report freely published on the web on the ONR website, I understand that the gentleman here had trouble finding it, if you go onto the ONR website and type in 'Doel' – it's either the first or second thing to pop up – full assessment, not redacted, the only thing redacted are the authors names.

So, we saw the records, we know the pedigree of the steel and we know, we have a good idea of what these defects are, we know the pedigree of the steel, we know that it was low hydrogen – we know that hydrogen was controlled, materials were controlled and we know that it is extremely well inspected, extremely well characterised. And subsequently we asked EDF to go back through their records and demonstrate that – but when we first heard about this, we didn't consider it appropriate to ask Sizewell to shut down because of that confidence – if you want to know where the confidence comes from, without blathering on too much, I hoping to get across just where we got that confidence from.

(Slide 22) So ONR requested that both EDF and NNB GenCo (for Hinkley Point) performed a review. The review included the manufacturing records, the inspection records and EDF proposed performing a full qualified inspection of the core region of the RPV in the ten yearly outage due for the Spring. As to whether or not EDF decide that they want to, that that's the primary reason for doing the inspections might not in their eyes be to look for these defects. But, from my point of view, these inspections will find these defects if they are there, and like I said, my view is that they are not there.

The safety case was received by the ONR on 17th January and it was assessed and put through all internal due process, so there are a number of authors of this safety case, all the authors spoke to one another, all the authors simply marked each other's work – it was then put through a second set of independent peer review, before going forward for its formal review and technical checking. So it's gone through our full extended due process and like I said, it is available – and actually this is the web address:
http://www.hse.gov.uk/nuclear/intervention-reports/2013/non-site-specific-13-009.pdf

(Slide 23) so, the views:

- The cracks in Doel 3 and Tihange 2 are most likely Hydrogen Bursts – through the reasons I've been into and I won't go over again – but that's the origin, so it's the microstructure, the orientation, and the number suggests that these are really hydrogen bursts – we don't think there is a credible alternative.
- Sizewell B contains no forgings by Rotterdam Drydock.
- The steel in the forgings was more tightly controlled than Doel 3 and Tihange 2 – in terms of impurity level and hydrogen control
- On this basis, we think that all practicable measures were taken to ensure the possible hydrogen bursts were minimised – what I mean by that is that we really don't think that these are there – we think that every possible precaution was taken to make sure they didn't get there in the first place and the thing was inspected and inspected. So it's inspected by not just one, but three different inspection agencies, who are all checking each other's work – it's not just one company looking, it's three companies – if you can catch the other ones out then that's a good thing isn't it? Because it shows how good you are in comparison with the others, so multiple and diverse inspections.

(Slide 24)

- These inspections were capable of finding the defects at Doel 3 and Tihange 2 and there is evidence at Sizewell B, flaws were observed and sentenced properly, so there were flaws at Sizewell which didn't need to be recorded – flaws of insignificant size – which didn't need to go on any records – but these have been recorded, so it's a good way of getting confidence that actually they are not only recording what they should be recording if anything is there, they have actually gone above and beyond – there is evidence of that.
- So on that basis, we'd say if there was hydrogen burst present, and for the reasons I've mentioned, we just don't think that these would have occurred, it would have been detected.

(Slide 25) so in terms of bringing the inspections forward:

- There has been an extensive and detailed review of the vessel manufacturing records done by EDF and also reviewed by ourselves and we're confident that the likelihood is minimal to negligible and if they had been there, they would have been found.
- To perform these inspections in 2014 would involve lifting of irradiated fuel, obviously, which we do for defuelling, but also a lot of the in-core equipment which is a big lift and does involve risk – now, these lifts will be performed anyway in the ten yearly outage to make the regions accessible, so in 2016, these inspections can be done at no additional risk.

So that's the end of my presentation – apologies that I have run over slightly, any questions?

MF – right, thank you for that – we'll take questions from the presentation and follow on matters from that question. If you want to raise question or comment on that question, keep your hand up. If it's a new question, I'll check before we move on if that's OK. So first question, if you can say your name before you start to speak.

CB – I think I can be heard without the gizmo, is that so, can you hear me? Well, I'm Charles Barnett, I'm a Chartered Civil Engineer (retired) and I'm the Chairman of the Sizewell Shutdown Campaign, and I am speaking on behalf of nearly 300 members who are very concerned about the safety of Sizewell B. We are not reassured by what we have learnt in the past and not altogether today, I can tell you – I have had over the last 18 months a protracted correspondence with Dr Mike Wakeman, who has now disappeared, Colin Patchett, who is the Chief Inspector, but is no longer the Chief Inspector and now, we find there is somebody else, Dr Andrew Hall has been appointed the Chief Nuclear Inspector and a Mr Mark Foy, his deputy – so it's been quite difficult to follow – now the latest communication I've had is from Mark Foy, the Deputy Engineer, in which he talks about the precautions taken during manufacture of

Sizewell B RPV and he says, 'I am confident that the precautions taken has minimised the likelihood of defects' – it doesn't say it precludes it – this is a different thing. Now we are talking about the safety of countless thousands of people here and I also have another letter from Mr Patchett, when he was Chief Inspector, saying: 'If there is a failure of the RPV, there is no safety case' – which means you all better get up and run. Now also, I've discovered in the course of my investigations, that the ultrasonic testing of the RPV vessel at manufacture was restricted to the area round the welds and this is true in your last ten year inspection, in 2005, just round the welds. Now, when I also learned that EDF in correspondence with the ONR has said that in future they think there should be, as another precaution and safety, there should be a complete testing of the whole RPV by ultrasonic as you, yourself have said, that would find any defects – this does not give us any confidence. Now, we have taken the position that we think that it is such a serious matter, that it ought to have been dealt with when it was discovered, 2012, June. We have been talking to the Sizewell Stakeholder Group at its quarterly meetings, ever since then and as I say, a very protracted correspondence, and we've never got a satisfactory answer and I, sorry, and all due deference to your expertise, that your response today has not in any way given us the confidence that it should be done now or as a matter of compromise, why isn't it going to be done in 2014? I mean, it's all very well talking about, you know, release and minimisation of radiation effects on the workers involved, but we're talking about the safety of thousands of people. Now, when I see you say there, there has been no other international response – how about the Shearon Harris Nuclear Plant shut down in America – that's in Carolina – it's the second plant, and they've found cracks there and this is, I believe, as a result of what they found in Belgium, so that's another reason for being uneasy about the whole thing. And finally, you know, the ONR maxim is: 'Safety is Paramount' – if it's paramount, you do the right thing, as a precautionary matter and test it now and certainly not later than 2014 – thank you Chairman.

MF – OK – right to summarise the three main points from that then is – the precautions taken during manufacture has minimised the likelihood of defects; the Carolina cracks and a response as to why we are not doing something more precautionary if safety is paramount.

GS – thank you Mr Barnett – I think it's important that you do make those points and express those views publicly – I don't propose to kind of to go through again

CB – Pardon?

GS – I don't propose, sorry … a bit better? I don't propose, it is … sorry, just to repeat, it's really important that you do make those points publicly and we are listening to you which is why I've brought Gareth down with me today to go through quite a bit of detail I think, in terms of metallurgy, the assessment that we made of another regulator had done in another country and I can assure you it was a very thorough assessment – it was subject to our Peer Review internally and that is actually quite important, we don't make decisions individually, we make them as an organisation – they are scrutinised and if there was any doubt, I can assure you, if there was any doubt, we would …

CB – But we've got the doubt

GS – No, let me finish … if we had any doubts, I assure you we would be asking EDF if they didn't want to do it, direct them to do it. We don't believe there is doubt, that is why there isn't a case to expose people to additional radiation to making nuclear lifts in advance of 2016 inspection – I can assure you if there was doubt, they wouldn't be operating now.

CB – But I hear you sir, but it doesn't in anyway give me any confidence of that decision when I tell you there's two American plants which have, since this happened, been stood down – with cracks in the RPV – what more do you need to know?

GS – I cannot comment on plants in America, I have no knowledge of that – but what I can do is, we can go through and Gareth has gone through radiologically what happened in Belgium

and quite a bit of detail on metallurgy and how the way the defects occur – how we assessed the documentation to give us assurance that the vessel at Sizewell has been made to the right standard and because we have gone through that process, there isn't a case to bring those inspections forward. I mean, I do recognise and see your point of view – but at the same time, we can't say to EDF: "shut down and do the inspection" – we have to have a reason for telling them to shut down and we haven't got that reason. I'll give you some examples of other sectors I've regulated in the UK, nuclear wise, where there has been doubt, and they haven't been able to make decisions and they've had to shut the facilities down. In this case, we haven't got a reasonable reason or any evidence to say you shouldn't be operating.

CB – I dispute that, when you didn't do an ultrasonic test in 2005 which is eight years ago, how do you know the state of play of the Reactor Pressure Vessel, it's all on the hypothesis of manufacture.

GS – I'll hand you back to Gareth – I don't want to try and repeat, there's obviously a lot of other questions we need to get through – I don't want to cut you off either, but it's important that we listen to you and respond to you. All I can say is that we have to have a reason.

CB - I've given it to you – I've told you about the two American ones.

GS – you haven't got the evidence … and the evidence, I leave it to Marianne.

MF – So the North Carolina example – what did the Rotterdam Dryrock company do wrong then that the forgemaster that made Sizewell didn't do, and is it the same as what the North Carolina forgemaster's did – what caused that?

CB – do you not know about these two failures?

GH – I'm not aware of these two failures – I'd just like to pick up on the terminology there – they are not failures because the Reactor Pressure Vessel has not failed.

CB – but it has cracks in it.

GH – there are cracks, there are flaws, but in terms of actual failure – I won't comment because I can't comment on these matters but they have not failed these Reactor Pressure Vessels

CB – because it has been detected in time, as a result of what happened in Belgium.

GH – because it has been detected, but again, in time – I'm not in a position to go any further forward on those, because I don't have that information – all I'd just like to go back to is that for Sizewell, we know that it is not one of the affected RPVs from Rotterdam Drydock and we do know that for hydrogen bursts, the hydrogen levels were controlled and the metallurgy was controlled, so the chances of hydrogen bursts being present is … I use the term 'minimised' in my presentation and … Mr Foy, was it in a letter from Mark Foy? He used the term 'minimised' and as I said during my presentation, what we mean by that, technically is, there is nothing, there is no further information that can convince us any further that these defects would be inside the Sizewell pressure vessel. Maybe it's scientific training of ONR – 100% negative answer is not something a scientist would normally make but every possible measure was taken in terms of making sure that there wasn't hydrogen in there and the material was not susceptible – so in terms of the Doel problem and wider world experience, we do not believe, and we've got evidence that I went through – we have evidence to say that it doesn't lie within that population, so Sizewell is not Doel in terms of making sure there's no hydrogen and there shouldn't be any cracks and if they were there, we would have found them.

CB – you see as I say Madam Chairman, because this is terribly important that … Madam Chairman, if you'll allow me, I don't want to hog the meeting, but I've recently learnt that the

metal, the steel which is used to attach the RPV to the brackets that hold them up is Inconel steel which is known to be liable to crack. That's what I have read.

GS – I don't know where that information came from Mr Barnett, we're kind of moving away from … I don't want to move from the original point actually, I don't mind addressing that, but you've drifted from the original argument … I know that you want to hog the meeting, and we do want to give you space to put your point across – I just want to make one point, then we'll come back to the 'Inconel' – if there was doubt and there was evidence, and we do need evidence as a regulator, we can't do things on 'gut-feel' – they would not be operating.

CB – if it does fail … it's on ONR's head

GS – I'll pass that to Mr Cubitt who is representing the power station this evening

MC – Good evening, so I'm Martin Cubitt, I'm the Technical and Safety Manager at Sizewell B – so just the …

CB – who is this gentleman?

MC – Martin Cubitt, Technical and Safety Manager at Sizewell B

CB – Oh, I see – you are part of the outfit, so to speak … yes

MC – I work for Sizewell B, EDF Energy, that is correct, yes. So I think, just to make one point, the whole of the RPV was inspected at manufacture … so, I think a point worth making.

CB – Well, that's not what I've got from the documentation, pages of it …

MC – OK, well, I can assure you that the whole of the RPV was inspected …

CB – Otherwise why is EDF saying now, and they have put it up as a suggestion, that at the next outage, as a matter of course, that the whole vessel is subject to ultraviolet, ultrasonic testing and the ONR have said that this is a good idea and they are making certain that if Hinkley C goes ahead, the RPV there must be ultrasonically tested … the whole of the metal.

MC – Yes, and that's what we did at Sizewell B during the …

CB – but if you are Sizewell A, how do you know that?

MC – Sizewell B …

CB – Sizewell B, I beg your pardon …

MC – Yes, so that's what was done at Sizewell B prior to construction.

MF – With ultrasonic technology?

MC – Not ultrasonic …

CB – when was that?

MC – during manufacture … post manufacture, prior to it being put in service

CB – was it done at the 2005 in-service test?

MC – No …

CB – as far as I know, it wasn't.

MC – so as was explained in the presentation, the routine testing is primarily focussed on the welds, but actually our inspection does do a band inside …

CB – well gentlemen, don't you think a bit of 'belt and braces' would be rather a good thing to happen here? As in fact is being suggested by EDF, but I don't know whether the ONR has made it a condition of the next outage, or the next test.

MF – thank you Mr Cubitt, if you would like to take a seat again

GS – Do we want to move on? We can come back to this

CB – it's a matter of confidence gentlemen – which we've lost …

MF – We've made a note of that question, we've heard a reply to that question. I think I asked what did the Rotterdam Drydock company do differently or do wrong then?

GH – In terms of the comparison with the Rotterdam Drydock with Creusot Loire Industries and Japan Steelworks who made Sizewell's RPV – there were a number of matters … I've talked about the chemical composition at Doel 3 is looser and so the Rotterdam Drydock control of chemistry was looser. Control of hydrogen, as I've also already said, the control of hydrogen at Rotterdam Drydock was looser – having spoken to the Belgian regulator, they told us that they found no evidence of a dehydrogenation heat treatment and this is … you take the forge, and you make it and you put it in a furnace and you leave it for a certain amount of time and the hydrogen escape, so the hydrogen is better at Japan Steelworks and Creusot forge and we've got documented evidence of that EDF produced for us. The other critical factor actually is the control of inclusions … now I was talking about the inclusions being the source of these bursts, so you flatten out the softer inclusions. Inclusions tend to form at … you're pouring an ingot (draws on flipchart) – when you pour an ingot – an ingot is just a big lump of metal – you pour from the top, chilled sides and chilled bottom … and as you pour off the ladle, you start to get the first piece of steel in … generally contains a lot of stuff … dross … which is actually a technical term, yes. And then, it solidifies outside to the inside and that solidification process sweeps in anything else, so you would get the odd 'dot' but as it sweeps in … anything else back in the steel ends up in the middle and then at the top you also get a lot of dross and we call it trunk elements; inclusions … there's lots of different terms, you can use 'dross' if you want to. At Rotterdam Drydocks – it wasn't at Rotterdam Drydocks, this was at Krupp which is now part of Thyssenkrupp in Essen in Germany, so a reputable supplier – but there, you actually cut off the bottom, cut off the top and to make a ring forging, you need to pierce down the middle, so you actually cut out the areas that are most affected by these inclusions. The level … now I'm working from memory here … but the level of discard, they call this discard because it will be thrown away – the level of discard at Creusot forge in Japan Steelworks was approximately 20%, and I am working from memory, so – but there was at least a factor of two between the level of discard at Thyssenkrupp and Japan Steelworks at Creusot forge – so the amount of steel thrown away, because it was not of the best quality, was much greater for Sizewell B, so that's another … it's a bit of technical detail – I do get a bit excited about metallurgy, because I'm a metallurgist – but that's another source of our confidence as an organisation – we know that the worst bits of the steel at Creusot forge and Japan Steelworks were thrown away, whereas not so much was thrown away by Thyssenkrupp who then supplied that to Rotterdam Drydock.

MF – OK – Mrs Girling

JG – I'd just like to ask a question – Sizewell B's RPV was performed quite a few years ago now – would the same system, if you like, to get the forging, take place now, or have we moved on?

GH – the same?

JG – the way the forging was done, that if it was done at Sizewell B's RPV was 30 – 40 years ago

GH – the forgings were produced in the late 80s for Sizewell B and were produced in the 70s, early 70s, I think, for Doel 3. The answer, and again, trying not to get too excited because I'm a metallurgist is 'yes' and 'no' – we have the same basic principles, so these ingots are generally made of melted scrap – so, that sounds to most people a bit scary – it's melted scrap – but what … you will have the top-end scrap, so this will be trimmings off bits from the steel mill, not old Morris Minors … this is …

JG – there's nothing wrong with Morris Minors …

GH – there's nothing wrong with Morris Minors, I'd love to own a Morris Minor … so this is what they call virgin scrap – so this has never been through reproduction – it's not reclaimed stuff … you then melt that and … for example in Thyssenkrupp, or just Krupp at the time, they would have melted it in open electric out furnace – I don't have too many details here – but it would be open, open to the atmosphere and they would have air – poured it down into the ingot … (draws on flipchart) now the Japan Steelworks, I know fair bit about, they will protect that and try and keep the atmosphere inert so the top as it melts … then actually they will actually pour off the bottom … well, there's a big bucket of steel up here and they'll be pouring down but they would actually have – as it's pouring down there, they have actually got an inert atmosphere over it – well it's not actually inert, it's called vacuum pouring, so they will pour in a vacuum and they also have a very fancy system of agitating the flow at the same time, so what you are actually doing is getting the flow of steel going in small beads and that agitates it and gets out as much gas as possible, so is it the same metallurgy? Yes, but it has moved on, so, would you be producing the same basic thing? Yes, but it has improved the process.

JG – so we will expect better things for Sizewell C – that's what I'm trying to say.

MF – OK – I am trying to keep a note of the questions that haven't been answered yet from the previous ones, but I'll take fresh questions now … Terry and then …

TH – Thank you, Terry Hodgson, member of the SSG, representing the Suffolk Association of Local Councils – you mentioned a couple of times in your talk that these defects should have been discovered when the original manufacture was made – why weren't they or can you explain why they weren't?

GH – I have used some very careful words – some very careful words were used in this assessment document here – saying we don't know why these were missed – why Rotterdam Drydock missed these flaws. Their techniques at the time should have been capable of detecting these flaws but there were no flaws recorded, so in terms of … this is one of the reasons I try to bring out my levels of confidence and diversity and redundancy that was used at Sizewell – so at Doel they had a limited, just the one inspectorate company, at Sizewell, there were three, all checking each other's work, I believe it was three, I could stand to be corrected – it was certainly more than one – whereas there was no, not anywhere close to the same level of government checking, so should have been found at Doel, they really should, but they weren't … and in terms, that … I'm going to stop there in terms of the Belgian … because reactors in Belgium are a matter for the Belgian regulators, so I'm not going to comment any further on Doel. On Sizewell, there is diversity and redundancy in the records – we've got it written down and we've had EDF go through it, so that's … I can't give you an answer for Doel 3, but for Sizewell, I can give you the answer that they should have been found and that they weren't and it really does give me confidence that they are not there.

TH – as a supplementary to that, if they did inspect and didn't find, is there any other way that these could have happened after … in the interim years, could these flaws have been developed?

GH – that's a good question … and it's one of the ones … you'll have to excuse me, picking up a piece of paper here … it was one of the ones that was written down had we known that where is the confidence that this is a hydrogen burst? The confidence is from … number one, the characterisation of the shape and the location of these defects or flaws in Doel 3 and Tihange 2 – they are pancaked-shaped, parallel to the surface … now the microstructure, which is basically the internal structure of the steel which is formed during the forging, partly during the casting, but mostly during the forging - that will follow … I'll draw another picture – I like pictures (draws on flip-chart) … so if that's a section through … you've worked it like this … your forge has come down like that … that'll squash out things like that … so, if you look at the … I call it … it's technically called the grains …the little bits of crystals of metal that make up a big bit of steel – they will all follow … they have been squashed out to look like that … and so have the soft inclusions, so we know that these defects were related to the microstructure and not the stresses, because when you stress something, you're putting on a stress like that … excuse …at this point, I've got GCSE Music, but I didn't get GCSE Art … you'd start a crack like that … so in terms of Doel 3, and this is Doel 3 again, I'm not talking about flaws in Sizewell, because I have gone through again and again, I just don't see that there is any reason to believe there are any. In Doel 3, if it was an in-service crack, you'd expect it to grow through the walls to follow the stress, because that is driving the crack – if it's following the microstructure, then it's due to the original manufacturer.

MF – OK – Pete and then Trevor

PW – Thank you – I'm a bit confused actually Chair – we spent a lot of time the other night going through a lot of questions – are they going to be answered this evening?

MF – Yes, I'm marking the ones off that have already been answered.

PW – We've got 40 minutes left … and other questions have come up as a result of the presentation and I haven't heard any answers to the questions we asked the other night.

MF – I'm marking off the questions that have already been answered during the presentation and I know the ones that still haven't – I'm letting the floor come up with other questions immediately in response to the presentation.

PW – OK – thank you – alright, well I have got a few questions that have come up from the presentation – I'd like to know firstly what the reasonably practicable measures that were taken – well I don't want to know what the measures were – would you agree that the phrase 'reasonably practicable' includes a consideration of the costs involved, so there were firm measures that you could take but price precluded them – that was the first thing. Secondly, you say in one of your slides that there is evidence that Sizewell B, any flaws observed were recorded and sentenced appropriately – is that evidence in the public domain please? You say also that to perform an inspection in 2014 would involve lifting the irradiated fuel and equipment which carries with it a nuclear risk – could you tell me, is it the same process as an outage and what is the nuclear risk that goes with it please because I thought outages were very very safe. And lastly, could you tell me, is your recommendation, ONR's recommendation, is it compliant with the WENRA (Western European Nuclear Regulators Association) recommendations, and if not, could you tell me how it differs? Thank you

MF – So was price something that controlled your practicable achievable …

GS – the answer is no – cost is not a consideration … sorry, I'll try get through the questions – but we do want to actually answer those list of questions … because we have failed if we

haven't … cost is not a consideration – as I've said before, if we felt it needed to be done, they either do it or we tell them to do it. Sorry, what was the second question?

MF – Evidence in the public domain?

GS – of … ?

PW – the evidence of the work was carried out – you say in one of your slides: multiple and diverse inspections were applied at Sizewell B at manufacture 30 years ago and there is evidence that at Sizewell B, any flaws observed were recorded and sentenced appropriately – is that evidence in the public domain and able to be scrutinised please?

MF – because my concern is that EDF is both the licensee of this site and now owns the forge works

GS – I think the quick answer is: No it isn't but it was part of the assessment that was done into this work – so we will use that information as part of the assessment – so indirectly, the judgement that we made having looked at those records as part of the assessment – in terms of the document being out there – the answer is: No

PW – so it can't be independently scrutinised?

GS – Quick answer is: No

PW – Why's that?

GS – sorry, can we get through these four questions …

PW – While we're on that point, is that because of commercial confidentiality?

GS – No, no – we're the independent regulator, we're the independent experts – the panel of experts from the ONR looked at the information records and came up with the assessment – that's the process – and you find that anywhere really …

PW – That doesn't tell me why people can't see it – it's a 'trust me, I know best' argument is it?

GS – It isn't no – it's we're the independent regulator, we are specialist inspectors that do specialist inspection work and that was information they used that belongs to EDF.

PW – so it is commercially confidential – commercially sensitive?

GS – I don't know what the document classification is

PW – So it's secret … whatever is, it's secret – we can't see it, we can't scrutinise it

GS – But you have our judgement in that report.

PW – I know you have, but we can't scrutinise it – that's the answer. It's not very transparent of you – which is one of your 'watch-words' by the way.

MF – I'll note that and we'll see if we can find that out

GS – The judgement is transparent and our opinion is transparent.

PW – you have an obligation in your written material to have a presumption of disclosure – unless you can tell us why, given the public interest test, it should be kept secret. You haven't

given me any indication that why it should be kept secret - you haven't even told me whether it is commercially confidential.

GS – I haven't said 'secret', I haven't said 'commercially confidential' – I don't know how the documents are marked – all I can say is … our independent assessment used those documents and the judgement that we made are recorded in the assessment report which you have got access to – and that's the process – that process is the way we do business across the UK

PW – OK – it's secret then?

GS – it's not secret

PW – well can we see it then please? Can we see the evidence?

MF – Excuse me, through the Chair please – OK – through the Chair if we may. I'll make a note of that and find out how the document is marked and see if we can find out why it is not in the public domain.

PW – Thank you

MF – But we can find that out. OK, then the next question was around lifting and the worker dose, is that similar to what happens during an outage? … Why can't you do an outage earlier?

GS – let's keep this very simple … during an outage, they remove fuel and certain in-core components – to do the inspection of the areas that Gareth was talking about involves removing lower components that are much deeper into the vessel – of significant size and when exposed, they are actually highly irradiated, so it's quite a dose to the worker and it is a big lift, so it's slightly different to a normal outage.

PW – OK – thank you – and the last question is, are your recommendations compliant with the WENRA recommendations?

GS – I'll hand that one to Gareth …

GH – Our recommendations are compliant with the WENRA recommendations is the short answer – and if you want to move on from there … we can ….

PW – Well, I mean … so … you are undertaking or recommending undertaking, additional non-destructive testing

GH – the decision, and WENRA says the decision to … as to whether or not to undertake tests rests with the National Nuclear Authorities – so the WENRA recommendation does not actually say … you will undertake tests. Now EDF have proposed for other reasons to actually inspect 100% of the forgings up and down the cylindrical ridge – so it doesn't actually really matter what you call those, they will inspect 100% of the cylindrical forgings – so, I don't know how to dress this up otherwise … the answer is: yes, it is compliant.

PW – because the final decision rests with the regulator?

GH – the final decision?

PW – about whether to carry out additional non-destructive tests rests with you?

GH – it does …

PW – but you are not actually recommending that EDF carry out additional non-destructive testing, you're saying, it's your decision and therefore you are complying with the recommendation.

GH – ONR could recommend … yes, it's with EDF – ONR could recommend but EDF are volunteering to do this.

GS – we're not having to tell them to do it, they are doing it, or will be doing it.

PW – Thank you

MF – OK – I can read it: "WENRA recommends performing additional non-destructive testing to reassess the quality of RPV forging base materials of the vessels. The decision as to whether this should be undertaken rests with the national nuclear safety authorities and will depend upon the strength of the information presented from the Step 1 review". So you are saying from the Step 1 review presentations, you don't think there is any need to do the additional?

GH – From the Step 1 review, we have confidence – and I have used that word and I know it's one of the … in your questions, it was one of 'where is your confidence?' – so I really do hope that I have put across where ONR's confidence comes from – from the Step 1 review, we have confidence that these hydrogen bursts – the chances of there being hydrogen bursts within the Sizewell RPV is negligible, everything is done … and if there were hydrogen bursts, they would have been found by the inspections, so EDF has actually made our decision as to whether or not to force them to do inspections, a moot decision – because they have volunteered to do inspections that would satisfy the WENRA conditions – now if they choose to change their minds, we would have to make that decision as per the WENRA recommendations, but they volunteered to do it, so we are not going to ask them to do less inspections than they want to, just to satisfy the WENRA recommendation – I think, the spirit, and pretty much the letter of that recommendation, we are compliant with.

PW – thank you very much, that's fine

MF – OK – I'll ask a quick question from the list that we haven't looked at yet. What would be the general implications if the generating life of Sizewell B was extended and what is the impact of heat and pressure during operation?

GH – Can you give me the numbers as well please?

MF – right, 12, what would be the general implications if the generating life of Sizewell B was extended if there are flaws – because you have said there are flaws – Sizewell B have recorded flaws – you've said that in your presentation.

GH – Yes, well there are – there is a Safety Case in place for Sizewell B RPV for 40 years

GS – so if they want to extend it and operate the reactor for longer, they'd have to make a Safety Case … end of.

MF – What is the extension of life actually on these faults that were found – you said they were recorded.

GS – there is no Safety Case beyond 40 years and if they want to work it longer than 40 years, they'd have to make a Safety Case – there are a lot of other factors that are considered in making that Safety Case – that's only one small part of it, and we haven't had those discussions with Sizewell B yet.

MF – would these hydrogen induced defects continue to propagate with time?

GH – the hydrogen bursts mechanism is, like I said, is related to the microstructure. So you've got these laminate defects, so when they burst apart, they will reach, at a maximum, the size of the lamination, the size of the inclusion. So, the theoretical maximum size of a laminar defect as was seen in Doel 3 is the size of the inclusion, so it's limited, so that mechanism is limited.

MF – Trevor was waiting, then Mike.

TB – Thank you, it's clarification resulting from the question, just asked – the hydrogen bursts defects are produced during the manufacture, the casting and forging process – would it be expected that there would further propagation of any defects, hydrogen bursts defects, with any operation at lower temperatures? Typical of RPV lifting operation? What is incorporated in the forging stage like that will probably rest at site unless it is elevated up to forging high temperatures again.

GH – I can answer that … but I'm going to get excited and metallurgical again – but first of all, I'll have to caveat that (makes reference to drawing on flip-chart) – that's the diagram – but I'll have to caveat that these are Doel 3 and Tihange 2 defects, so this answer is applicable to Doel 3 and Tihange 2 in the abstract, not Sizewell because we really have confidence that they are not in Sizewell.

TB – yes, I'm asking in respect of the Belgian reactors – but understanding that those defects have not been traced or have been halted by Sizewell B

GH – so you have given me an excuse to be an excitable metallurgist – thank you. (Reference to flip-chart drawing) The stress is, like I said here, the stress is on the RPV during operation at that direction – so if you've got a crack that's like that or a flaw that's like that – stresses are actually pulling on the end of the crack, they are not pulling in an 'opening it up' fashion – so, the stresses aren't acting to increase the length of the crack – so, again Doel 3, there is a safety case in place for operation, I've not reviewed it – that's with the prerogative Belgian operator – the stresses will not open the crack and I'll stop getting excited and metallurgical now.

MT – Mike Taylor, Sizewell Stakeholder Group – a couple of questions if I may – there was a hydrogen cracking incident at Le Creusot plant in your report, was there an explanation as to why that happened? Because presumably it is the same equipment that would be used on Hinkley C.

GH – yes, it is the same equipment as would be used on Hinkley C, and, if I can skip back a long way (through presentation) – it was the forge, is that forge (slide 5) – now, the incident was 2011 and it was not UK related – this was a French forging, made in France for the French fleet – it's not under my bailiwick – the French regulator has spoken to me about it because we speak as regulators – it was caught at the first possible moment they could possibly look for defects and the component was scrapped – has ONR interacted? This is a Sizewell B meeting – and I'm excitable and I'll put that on the table obviously.

MF – I think it is relevant.

GH – it is relevant – but it's not directly relevant to Sizewell B, but with Hinkley Point C, as you will see from the report, we have spoken with Le Creusot forge and there are numerous controls on hydrogen now in place making sure that this is properly controlled – so this occurred, completely separate to anything in the UK and we've taken the learning from it and we will be applying it to anything that happens in the future, and that's – I've strayed outside this meeting really, but we've learnt from it.

MT – Can I ask another couple of questions? One was just confirmation, on the WENRA recommendations, there were further measures up to ONR to decide upon, on the analysis of other equipment which would have been steam generators and pressurisers according to what I

am reading here – is that likely to form the basis of what EDF are proposing to do in 2016 as well? Presumably this fault could be on other forgings on other components – am I right?

GH – In terms of what EDF are planning to do – that's a question for EDF – in terms of the WENRA recommendations that you should think about forgings other than just the RPV – we have already asked EDF – but in terms of what they are planning to do – that's a matter for EDF …

MF – are you, no but, is the regulator, is ONR going to ask EDF to also include analysis to other primary equipment , Steam Generators, Pressurisers for example?

GH – we have already spoken and we have already started discourse with EDF on that matter.

MT – so it may form a request from you for EDF to do that.

GH – it's at a very preliminary stage.

MT – Right, OK – the only other question, and it's interesting because I did have a little bit of on-site testing on bearings very many years ago – but at the time, I seemed to recollect that there was any way of actually getting a trace of what the readings were – so they were basing on, I think it was a oscilloscope type thing – am I right in thinking that, maybe in modern times, we have a bit more way of actually detecting faults and proving that they actually recorded.

GH – you can have the long answer, or the short answer – the short answer is: yes – the long answer …

GS – Short answer Gareth, time

GH – Short answer is: yes, I'd just add to that the actually, the inspections on Sizewell were qualified – so the actual capability – what defects can see, what orientation those defects were in and how small the defect might be – those were qualified, so there were limits – we knew what each inspection could see, so: yes.

MF – Tim in the front row, then to you sir …

TG-J – I find myself still uneasy about what has happened at Doel and Tihange – it's quite clear that there was some serious failure at the point of manufacture – now you have not, you have chosen not to identify who is at fault but it appears to me that both the people who were forging that component and not just them, but the regulator were both at fault for not picking up these defects – now one of your reports, I think it was the expert report that I picked up that was organised by FANC mentions that the technology for checking for problems in the forging process was as good at the time they were forged as it is now in terms of picking up these defects and that they should have been picked up, clearly they were not, and yet another one of the reports states that new technology was used in 2012 in Doel and Tihange and it was that, that identified the faults – now, I don't quite understand how both statements can be correct – but, why did FANC not bother to monitor this while it was being constructed – now, ok, you might not be able to tell me, but it seems to me a key duty of the regulator to make sure when a key component like the RPV is being constructed, that it is constructed to the design that you wish it to be constructed to, with the materials that you wish it to be constructed to, in the way in which you wish it to be constructed to without the faults that you don't want – now for FANC to state in 2012./2013 that it was not aware of any evidence of dehydrogenation defects – hydrogenous defects, whatever they are – seems to me, working about 40 years too late – why did the hell did they not check it at the time? So, that's … are you saying that they were incompetent …

GS – I think the way you've put that is absolutely spot-on. A point very well made … we can't possibly comment on the another regulator …

MF – See, that's the problem, why there's still the unease

GS – You've made your point very well – your logic is correct – the defects, as Gareth said, should have, we believe, been found at that stage. Now, we can't say anymore on that really, I think that's a given, we can't comment on another regulator.

TG-J – OK, you can't comment – but if we move on then to try to decide what is best for Sizewell B, I don't quite see that your difficulties in moving forward the inspections from 2016 to 2014 are really significant – if you undertake, or should I say, EDF undertakes that inspection in 2014 then clearly it doesn't have to do it in 2016 – so all you've done is moved the time forward one outage. Also, if my mathematics is right, 2016 is more than ten years on from the last inspection in 2005 – so actually, 2014 would be a more appropriate time to do a ten year inspection …

GS – Points very well made there – just start by saying that EDF are responsible, they are ultimately responsible and we hold them to account, ensuring, given all the learning out there, given all the knowledge they have, they are doing the right thing and they have made a robust case not to bring the inspections forward – they are responsible, absolutely, it's very clearly in their court. Regarding, I think there's a bit the dates, I can't answer that, something about 2005 …

TG-J – 2005 was the last time the RPV was inspected.

GS – I can't answer that – again, some good questions.

MF – I mean, the worker dose is the same whether if it's in 2014 or 2016 – isn't it.

CT – Colin Tucker, member of the SSG and staff representative –so I'm one of the people that gets heavily involved when one of these outages happen – I was there for the 2005 outage. Two points, one is, that the, although we say a ten year frequency, they are done according to, again, the ASME code for inspections – that allows some flexibility – so it's possible to shift it by a few months either way to fit in with planned refuelling outages and that's why I think we've slipped into 2016 when the last one was at the end of 2005. So it's just a bit of flexibility in the code. The thing that strikes me, having been through the last one, is this is just one of thousands of inspections we do on a whole set of frequencies, all of them different. It's very very difficult to change those plans and move things around without having a big effect on the rest of the outage planning and causing a much much longer outage – that's not saying we wouldn't do it if we thought it was necessary – I'm not saying that, but that is why it is hard to just move one task – such a large task as this, and not have a very large effect overall on the outage plan, because those other inspections would still have to be done in 2016 would not save those. If that helps?

GS – Yes, that's fine – I think your points are very well made, I just want to go over this point about whether we … I think we covered it before, but it's important we go through it again while we are here about moving it forward. I haven't dealt with Sizewell B since May last year because I came from another sector, regulating a different part of the UK – Gareth has been a lot closer to it for a lot longer. So, in a sense, I'm kind of independent within our organisation and I've looked at the judgements that have been made and some of the decision making and how EDF have responded, so there's a bit of independence there. But going back to the point I've made before, I can't see any evidence, there's no evidence to say or for us to tell EDF to bring those inspections forward because of the points that Gareth has made through the presentation. There's nothing there, there's no doubt there – we have to have a case, we can't just say: bring your inspections two years forward without having evidence. We've got to use evidence – we've got to make evidence based decisions and the evidence isn't there.

TG-J – well we seem to have some evidence from North America, which, for some reason, you are not aware of …

GS – Yes, again evidence from North America …

TG-J - … but if it's the same kind of problem, then we really should be taking the precautionary measures …

GS - ... absolutely right, and the precautionary bit, is all the detailed assessment that we've done … I mean, if you think … just broaden this a little bit … there's things go on all over the world in Nuclear Power Plant – learning that we see, learning that EDF see – a whole range of different things … vessels to valves, sumps, pumps, motors, turbines, fires … and all operators are expected to look at international learning and say: oh yeah, do I have one of those, does that relate to my plant ? That's part of the industry, it's part of how we regulate – we look at things and say: is that relevant to the UK? Is it defence, is it power generation and this is just an example of that. We've looked at the learning, taken it very seriously, gone into a lot of detail and said: does that apply to the UK? And the answer is, in the big big picture, yes, it must do because it's material, and it's forged, and it's in a vessel … then we've gone right down into the detail, right down into all the manufacturing records, right down into all the inspections – and we have to make a judgement and there isn't sufficient evidence to bring that inspection forward.

MF – Can I ask, would …

GS – and I've kind of seen that as independent within ONR I guess, in the last 12 months – I haven't been involved in that decision making.

MF – would ONR take an action to find out what happened at the two plants San Onofre and Saint Lucie in America where there were plant component failures…

GS – No, I don't think … if the information is out there on the Internet, that's all we'll be doing – you can go on the NRC website, that'll be on there.

GH – I can comment on San Onofre coming off – it was not related to Doel 3 type defects … I don't know about the Saint Lucie plant, I apologise for not looking it up in advance … but …

GS – I mean, a good source of information if you want details, look on the Nuclear Regulation Commission website … that's the regulators view of things gone on in the states … nrc.gov – very informative … well worth looking at.

MF – and are there any other industries where hydrogen flakings have been found?

GS – well forging … and I'm not going into Gareth's area … forgings are used throughout our lives, if you think about aeroplanes, all the blades on the turbine are forgings, when you're up in the air, it's all materials, it's all defects, it's all hydrogen – there's forgings everywhere – certainly the airline industry, there's a lot of forgings in an engine, so again, it's much broader than nuclear.

MF – OK

MCl – Michael Clark – I am a co-opted member of the Sizewell Stakeholder Group – like many of us here, I am a Chartered Engineer with NGER and I used to study metallurgy strangely enough – grateful for being updated on many aspects of it. I wondered if anyone could tell me, what would have happened if the flaws in the Belgian reactors had been discovered at the appropriate time, would those forgings still have been used or would they have been rejected? I think that does bear on what I'd like to say next.

GH – I can answer that question, with a caveat, I don't think my answer will be applicable to Sizewell – because I do not believe that there are any flaws like this in Sizewell – ONR does not believe that there any flaws of this type in Sizewell. Do these forgings actually meet the ASME code? I'm wracking my brains back now, the lower shell forging, I think would have been rejected, but I think, one or two of the shell forgings would have been acceptable under the ASME code – although, you'd hope, if you've got any nous about you as an Engineer, you find 7,000 in your forging, you'd think that something had gone wrong and you'd hopefully reject it anyway – but, like I said, that doesn't apply to Sizewell because we have good evidence – again, confidence was one of those things that I've tried to present here, the source of ONR's confidence that these defects are not in the RPV at Sizewell.

MCI – my next point then, coming onto what Charles believes, as do so many others, perhaps 300 others believe, it appears to me from what has been said and from what I know, that there are no flaws in Sizewell station – we believe that to be true, you believe that to be true, you're confident, but you don't know – let me carry on because, FANC has placed three additional actions on top of the existing operating measures for the two Belgian reactors and some additional measures as well – perfectly sensible things, not things that cost a lot of money, but which do affect the operations – I wonder if, in the knowledge that you don't know whether there are flaws or not, whether such operational measures could be applied to Sizewell B?

GH – two sections to that one …

GS – … Gareth, I think we should hand that one to Martin …

GH – the first one is: do we know? And we've got every piece of evidence that was gathered and we have gone through them, so we are as close as knowing as possible. In terms of operations, that's a matter for EDF – I don't know if they want to comment?

MF – No, this meeting is to ask the ONR to address their report and underpin their decision making. The question was, FANC report has recommended three additional measures, does ONR think there is merit in looking at putting those to the operator?

GS – the operator has considered those additional measures – that's as far as we can go – it's with the operator – they are operational issues, it's not for us to answer those.

MF – that's fine

GS – It's up to you whether you want to invite EDF to …

MF – No … Ms Girling?

JG – It's slightly off where we're at Madame Chairman, I was always under the impression that the Office of Nuclear Regulation and before them, NII, had a lot bigger game to play in this than it appears they have – it seems that most of the onus is on ENR, sorry EDF, to identify and notify when there are problems – now I've always been under the impression that it would be the other way round and it would be the ONR and NII had greater feel of that … can I just carry on because I feel another question coming up … which is, Sizewell B have been in operation now for quite a long time, and the techniques that have been used since day one have changed and altered just as the metal forgings have changed and altered – my biggest concern of all is the aging process of the plant, particularly the pressure vessel, and it's not just on the forging, it's wear and tear if you like, and all of the other components and if the onus is actually on the operator, who is in it to make money, I would be expecting the ONR and in part, the Environment Agency as well, to have a lot greater say and play in what is happening and as I understand it, that is not what's happening.

GS – very good questions and I'll try and answer them briefly because it's getting on for 9 o'clock – the UK legal regime is non-prescriptive and places onus and responsibility of safety on

the operator and the duty holder, whether that's Halford's garage down the road or a nuclear power station. UK law is non-prescriptive, the operator or the duty holder, in this case you are talking about EDF, is responsible for safety, not the regulator – it is not the role of the regulator. What was the second question?

JG – the fact that the aging of the plant …

GS – Aging. Right. We expect EDF or let's talk about Sizewell B, to understand the condition of their facility for them to operate it safely – the inspection that I do, I look at … do you understand … now this is very broad now, I can't go into the detail here … you understand the condition of the plant, whether it's the tank, the pump, fuel, any part of the reactor, I expect them, and that's a very clear expectation, I expect them to understand the condition of the plant. When they find a defect, which is potentially safety significant, they have to fix it and get it to the standard where it should be – that's a very clear expectation … now, if I see or get evidence of them tolerating degraded plant, I've got sufficient power, we start with influence then we move into enforcement … first of the enforcement is a letter, the second of the enforcement is an improvement notice where I can make them fix things – if they don't fix things, I can prosecute them – we generally don't go beyond influence because they recognise if they have problems, they do fix things because they are the responsible duty holder. So I am aware and they do get challenged on asset condition and long term suitability for safe operation and that's part of my job, very clearly. Does that answer your question?

JG – More or less …but there's …

GS – I'm back tomorrow morning, we can do more tomorrow …

JG – the little sting in the tail is and I noticed as Pete did, that there is evidence at Sizewell B, any flaws observed were recorded and sentenced appropriately, so, sorry, if they record them, and you actually don't know exactly … or we don't know what they are … how do we hold you to account for them to be held to account?

GS – I'm not going to stray in Gareth's area, but no material is free from defects …

JG – Sorry …

GS – all materials, all materials whether it's man-made materials, do have defects in them – it's the level of defects isn't it that you need to make the judgement on.

JG – do you make that judgement? Or do they …

GS - … going back to what I've said before, the judgement has to be with the duty holder, but we will look at their decision making processes and sample the basis of their decisions. So primarily it is with the duty holder to make the judgement and what we do as part of routine work, Gareth, yeah …

GH – Yes – absolutely …

GS - … on structural integrity, control systems, civil engineering, ops studies, human integrity … a whole raft of things – we will sample and look at the quality of their decisions – if we feel that those decisions are less than adequate … and adequate actually means very good, by the way, in nuclear language, in legal terms, adequate means really good … we will challenge them, if they don't respond, we keep going until they do recognise that they are not where they should be – I'm talking very generally now, that applies to everything … primarily it sits with them and they're responsible – we hold them to account to ensure that plant is operated within the safety case limits and they understand the condition of it.

MF – OK – thank you … I'd like to go back to …

GS – Is that OK is it?

MF – I'd like to go through the roles and responsibilities type thing because I picked up two tonight, it might be the language you were using, but at one point you said that ONR has to evidence if you want the operator to do anything earlier or to do anything more – surely, it's the operator should be evidencing why they shouldn't do it earlier or why they shouldn't do more not you saying why they should.

GS – generally from my experience dealing with different parts of the UK and my experience with the operator – it's a fairly mature industry and mature operators want to do the right thing – they don't try and find ways of not doing things

MF – but in a commercial environment, we can't get away with the fact that outages cost money, and the government is striving to maintain power supplies, is also a driver …

GS – … yes, good challenge

MF - … so rather than you having to evidence why they should bring things forward, I think that operators should evidence on why they shouldn't bring things forward.

GS – all I can say from things I've seen in the last eight to twelve months having dealt with Sizewell, call it conservative decision making, they made a number of decisions where they didn't start up, they started up after the last outage late … it wasn't late, it wasn't on schedule – because they had things that weren't quite where they should be, they made those decisions on safety grounds. I've seen another forced outage in – I cannot remember where it was, there was a forced outage … was it …? August – they shut down, went in, fixed it, brought the reactor back up to power – no involvement from me, I monitor what they do and watch what they do – I've seen no evidence of commercial precedent over safety – all I've seen is evidence of stopping, thinking and taking measured approaches to safe related issues and that's based on evidence and that's not gut-feeling …

MF – Thank you

GS – Good question

MF – Right, other questions from the floor please … What I would ask is perhaps written answers to any other questions from this list that we haven't tackled this evening …

GS – What we'll do, I think there's a really good set of questions that you've put together, and it's a shame that we've almost run out of time …

MF – I think there are only two or three …

GS – what we'll do with the answers that … we can either try and cover it now, or we can give you a written response – so we can leave that with you …

GH – could you let us know which two or three, because if they're short questions …

MF – right well, I think we've talked about the operators going inside the RPV looking at the lower elements … what has been the regulators' (ONR's) input and overview of the inspections carried out to date? That's more of an in-depth question, historically, for you to provide … I think. OK – good one – at what point would the ONR evoke the precautionary principle? Tolerability of risk?

GS – I think we've covered that in that if we felt that it was necessary and there was evidence, please be assured, and I've certainly done it on other sites, where there is evidence that they shouldn't be operating and we've stopped it – that isn't the case here …

GH – it's the precautionary principle deals with risk – yeah…

GS - … well if there is evidence that they shouldn't be operating as a consequence of the work you've done, they wouldn't be operating.

MF – What is the maximum credible accident that could occur if the cracks in the RPV go undetected?

GS – I think that Gareth covered that in that the cracks are limited in to where the indications are …

MF – … they wouldn't open up … OK

GH – yeah, these cracks, you do actually, as a metallurgist, you might actually design a laminated crack stopping structure, I wouldn't recommend that for an RPV, but people do actually build laminations into cracks … I'm digressing …

MF – … and we had a question about MOX fuel, but in discussions with you both earlier, there's no current safety case because that has not been proposed. OK – final questions from the floor … yes, Tim …

TG-J – there is still one more issue that disturbed me when I was reading these papers about these two reactors and it was that there appears to be no research on the effect of radiation on the growth of defects within a pressure vessel … and that does seem to me a rather strange omission, because surely, one of the unknowns about nuclear is what the effect of radiation would be on all aspects of what it impinges upon, so … perhaps you can make a comment on that?

GH – in terms of the effects of radiation on material properties, there is an on-going and quite large set of research programmes which we sit, ONR, and we review the world's data on how radiation actually affects the material properties, why that's relevant to this is … a crack is obviously growing, or not growing – this is a theoretical crack growing through a material which is irradiated – the resistance of that material to that crack growth is something that is being studied around the world and the UK, both through us, a lot of the technical support organisations – that's people like NNL … and EDF, we're all plugged in to the research that's going on looking at that. In terms of how the cracks or a theoretical crack might grow under the influence of radiation, is something that's covered, because it's not something that we would expect to happen – it's how it's monitored is that these things are inspected and we know the material properties – so in terms of how the crack grows or how a theoretical crack would grow, world evidence would suggest that irradiation would not really affect crack growth, it's things like fatigue that would affect crack growth, but in terms of actually making sure that irradiation is accounted for in fracture mechanics, which is what this is, there is worldwide research going on into how these materials behave with radiation.

TG-J – it's going on now you said … but we've had a nuclear industry since the 50s, so it's a bit slow in happening isn't it?

GH – it's been going on since the start of the nuclear industry – and every nuclear power plant, to my knowledge, contains surveillance capsules – bits of metal that they put inside the core – that will be irradiated, and then they can point them out and then test them – that's going on at Sizewell, and ONR, we oversee that, in a regulatory manner, we oversee that – it's an on-going research – it's not something that's just started, it's been going on since the birth of the nuclear industry.

TG-J – that wasn't the purport of this comment that I found, and I'll have to go back into the reports and find out where I dug it out, but it was in one of the two reports, I looked at – either the experts report or FANC's final conclusions from whatever it was, 17th May 2013 – anyway, I can come back to you on that one …

GH - … I think I can caveat with that we have confidence … we have …you know …

TG-J – well you have the confidence, it's we that don't and I think that's where the difficulty is …

MT – Well, it's just a question, did the generic design assessment for the EPR actually look at the claim 60 year design life – because that is a key feature that the manufacturer makes about the life of the plant and what confidence has ONR got that will be reached, considering that there have been earlier failures of a number of plants particularly in America on the various for reasons including material failure

GH – I can't comment on Hinkley Point C, because obviously I'm here to talk about Sizewell B – and I've not come armed with GDA information …

GS – good question … for another day … not for tomorrow.

MF – OK – ladies and gentlemen, thank you for your attendance this evening. Gentlemen, thank you for your attendance and for answering the questions and for coming all this way to do so. Our main meeting, again, tomorrow morning 9:30am for 10:00am start at Stratford St Andrew and ladies and gentlemen, thank you very much.

JG – Marianne – I'd like to thank very much both the gentlemen coming from the ONR – I think they have been very helpful and can I also ask the Chair, if we are going to get written answers to the questions that were not actually posed tonight.

GS – yes – thank you