

20 **RESUMED**

[4.30 pm]

COMMISSIONER: We reconvene at 16.30 and we welcome Dr Michael Weightman from the UK. Thanks for joining us Dr Weightman.

25 DR WEIGHTMAN: My pleasure.

MR DOYLE: Dr Weightman led the IEA's official fact-finding mission to Fukushima Daiichi in May 2011. He served as Her Majesty's Chief Inspector of Nuclear Installations and CEO of the Office for Nuclear Regulation in the United Kingdom before retiring from those roles in 2013. Dr Weightman is currently a member of the IAEA's international nuclear safety advisory group INSAG, a non-executive director for the National Nuclear Laboratory United Kingdom and a visiting professor in the Nuclear Engineering Department at the University of Cambridge.

35

COMMISSIONER: Dr Weightman, today we've been concentrating on nuclear accidents and their implications and the changes that have been caused around the world because of these accidents. So I'm going to open with a couple of questions along those sorts of lines. We've heard evidence today from UNSCEAR about radiation exposure resulting from the Fukushima Daiichi accident. Based upon your experience, including your part in the IAEA fact-finding mission, what was some of the other social and economic impacts of the accident?

45 DR WEIGHTMAN: Well, if I take it from the direct impacts in Japan,

predominantly those come from the release of contamination from the site and that led to evaporation shelter, in fact around about 160 people 150,000 people were evacuated and just a little over 100,000 are still evacuated. And that can obviously causes great social disruption there, both on an individual level and also on a more wider social level. Indeed, some of the work has indicated that health effects coming from the accident and sometimes it's difficult to discern whether it comes from the accident or from the tsunami, or the earthquake damage as well, are more to do with stress and distress that's caused to people, rather than any direct impacts or discernible impacts from the radiation impact effects. So the sort of stress and anguish causes health problems. It also causes social disruption to people's lives obviously there over a wide timescale and indeed, some of the aspects about temporary accommodation and splitting up of communities adds to that as well.

One of the perhaps lessons there might be that if you do have to evacuate people then you try and keep them within their community group, so they can have mutual support for example. So on a people level it can create a great social disruption and personal anguish and health impacts from the evacuation and also the fact that sometimes you have to evacuate frail people from hospitals or old age people as well. There are of course economic implications as well. Fukushima is an agricultural province, it provides food, other commodities in to the wider population and that's disruptive and people's livelihoods are disrupted from that. The restrictions on food consumption, fishery also caused disruption to there. There's a wider economic impact as well because of the response coming from the Japanese people and Japanese government where they shut down the rest of the reactors there until they could be shown to be adequately safe against enhanced standards from a new Japanese regulator there.

Indeed, that led to importation of gas and oil which led to higher energy prices but also increased fuel costs and some work has been shown and I'm not completely up to date with this but in 2013, there was about 35 billion US dollars fuel costs from importing gas and oil. That also led to – with the restriction on exports because there was less – the market responded to that on a global scale, there was a reverse of balance of payments in Japan. That's sort of large-scale impacts as well. And of course because you're burning fossil fuels, it can lead to greater CO2 emissions which has affected the Japanese people there and there's some statistics show that perhaps a 20 per cent increase in CO2 emissions from electricity generation has occurred. And those impacts can then reach internationally, as I said, it reaches in to global markets but also to – it changes policy. So we did see the German government decided to phase out nuclear; there was impacts in Switzerland as well. Other countries have taken a different route to that. There were quite wide social and economic impacts both locally, nationally and internationally I would suggest.

COMMISSIONER: Dr Weightman, if I might go from outcomes to causes, we've heard in evidence and then the IAEA report that there was some work done prior to March 2011 on modelling the outcome of seismic activity in that  
5 a larger tsunami than the one they'd planned for could in fact eventuate. We are going to get to cultural and institutional issues later on in our discussion but in your opinion, was it possible at that stage to make a change from the Japanese institutions based upon this modelling, or was the culture so ingrained that they were safe that it was never going to change?

10

DR WEIGHTMAN: I mean my opinion would be that there were cultural aspects to this and I'm not an expert, not a social scientist, I'm not an expert on cultural matters but I would suggest that there was perhaps reluctance to challenge the norm. Not to challenge either from – or to take heed of the  
15 voices that perhaps were a minority and sit back and say, well actually we ought to take a conservative attitude – approach here because the outcome, if we have got it wrong is so immense. And I think you have to take a conservative approach. Some of the aspects are cultural and institutional, I would have said and perhaps also – that's not to say the – it's an ingrained  
20 approach in any particular society but it's just an approach where the general belief was that these plans were very well engineered and therefore were absolutely safe. And there is no such thing as absolutely safe. The real end of the line philosophy, I would suggest for a nuclear – use of nuclear power in a safe way, is that you're never satisfied. You always seek to – ways in which  
25 you can improve, you welcome challenge and you listen to the minority voices as well and address it in a rational and objective way.

COMMISSIONER: If I might move on then to the international response. We've heard that following Fukushima there were a series of stress tests  
30 around the world. Is it your view that the physical plant layout has changed because of those stress tests in the broad?

DR WEIGHTMAN: There have been additional measures taken in various countries; depends on the design of the reactor and the extant systems in place.  
35 In the UK for example, we have ingrained in law, this is a philosophy of continuous improvement through – the basic requirement is to reduce risk so far as is reasonably practical. That is an ongoing legal requirement. On top of that we have 10-year periodic safety reviews. We require the licensee, the operator, to re-examine safety against the latest scientific knowledge, the  
40 experience of the plant and any extra tactical aspects that can put in place. So in some areas there is a continuous approach to try and improve safety and therefore the need for extra safety requirements on the plant is less. Perhaps in Japan, this was the case where the periodic safety reviews weren't really up with international standards. So there will be a variety across there. The stress  
45 test were informative and the peer review was useful and has led to increased

attention to some aspects of safety, including remote – more remote control systems, more remote final ability to cool or provide electricity supplies. So it's part of a continuing approach to improving safety as far as reasonably practically you can.

5

MR DOYLE: Dr Weightman, we know that there were design failures which contributed to the Fukushima accident but I wonder whether you could explain, in your view, what the lessons were for institutions arising out of the Fukushima accident?

10

DR WEIGHTMAN: Yes, I think for me, if you perhaps take an analysis of what you might say are the root causes of the accident and try and learn the lessons where it's not necessarily just the particular technical aspects related to this accident. You're going to have to ask why about four or five times in any investigation, if you want to get to the basic cause. You're going to have to ask why about four or five times. And if you go down that chain, there clearly was (indistinct) design basis for external events there. The challenge within TEPCO did not appear to be adequate to address that issue. There was inadequate peer challenge from the nuclear industry in Japan or from international peers, it appears there. And then you say, well what was the regulator doing? Well, perhaps again there was inadequate challenge from Japanese regulator and then you go back and say well there's inadequate challenge from stakeholders, the wider public, the (indistinct) and that led me to think, well actually one of the prime – the root cause is that institutional and cultural failures and that is supported to a degree by the IAEA's recent authorities report there and also by – especially by the Japanese diet's report that was produced fairly soon after the accident.

25

So what it led me to think about, well how do we look at institutions? And institutional failure if we can address those issues, then we can then get something that might be a more basic lesson learnt across the world and especially perhaps for newcomers when they're thinking about building their infrastructure, their institutions so that they can have a nuclear power programme. And I think that's a very worthwhile lesson to think about and something that deserves greater attention and that's what I've been trying to do with some people at Cambridge University and elsewhere and through INSAG, International Nuclear Safety Advisory Group. So what I mean in relation to the TEPCO Fukushima Daiichi accident, well it meant that, as I said, internally within TEPCO there was insufficient challenge, was not sufficient challenge from peer groups there and internationally. But also the regulator was not sufficiently independent of the industry there. They were too close and there is a general cultural, as we said earlier, attitude that these are highly technical people, they have applied their attention to these plants and therefore they are safe, rather than a challenging attitude. And part of that comes from perhaps a lack of openness of the industry and the regulator to stakeholders.

45

Stakeholders can't challenge if they don't know the information.

Therefore, you have to have openness from both the industry and the regulator, so that you can – the stakeholder can provide those challenges and there has to be a culture of welcoming challenge as well, rather than just say, trust us. We are experts, we know what we're doing, you don't have to worry about it. And some of that comes from this idea that it's absolutely safe to reassure people, I think people are more intelligent and astute than that, you have to explain to them why it is adequately safe, rather than why you tell them it's absolutely safe. So there are aspects that relate to cultural aspects but also institutionally you need to put robustness in to the system. For me, that lack of robustness is important. And so one of the things we've been thinking about is how you apply some of the basic principles of nuclear safety and I think in previous parts of this Commission. You've heard evidence about the technical use of defence in depth.

MR DOYLE: Yes.

DR WEIGHTMAN: And what we've been trying to do is look at those principles and apply them to institutions and looking to use a model institution but you can then test using such defence in depth principles.

MR DOYLE: I wonder Dr Weightman whether you might briefly outline your thinking on that topic and perhaps start by identifying what you have in mind when you refer to institutions?

DR WEIGHTMAN: Yes. And forgive me, the word is not quite right in terms of stakeholders, it's really – and I don't know the collective noun for a group of institutions but to my mind, if I think of it as barriers and one of the principles of defence in depth is multiple independent barriers. It really comes from military strategy actually defence in depth, from Roman times, perhaps even before that. But it means it's how you build castles. If you imagine a castle, you have several walls which are independent as defence. And in a technical sense, you do that through different independent safety systems. So what I'm looking for in institutions is barriers, independent barriers. The first barrier to me is – and this is a very simple model but the first barrier to me is the industry itself. The industry barrier must be strong and it has several sub-barriers within that. And then the next barrier, which should be independent of that first barrier, is the regulator and the regulatory system there. And again, there are sub-barriers within that. And the third barrier are stakeholders, who hold both the industry and the regulator to account in a variety of ways and the stakeholder barriers multi-faceted. It can – it goes from government, the public, NGOs, media, a whole range of welfare organisations. So it's a multi-faceted barrier there. But again, it needs to be independent.

Now for that model to work, apart from an independency barrier, you have to have a cultural latch to both within the industry and within the regulator about being accountable to the stakeholders. And they, therefore, both the industry and the regulator has to be open and transparent in relation to the stakeholders.  
5 So they can act on information, they could assimilate information, test arguments and make sure both industry and the regulator are doing their job appropriately. And some of those will be in formal institutions. They may be parliamentary committees that from time to time hold the regulator to account, or there may be aspects of other parts of government as well, but also they'll be  
10 under any local and national public groupings as well.

MR DOYLE: All right. Dr Weightman, I wonder whether we could try and give some practical illustrations of that concept, particularly at an industry level. How do you build layers of defence into the industry level of your  
15 institutional model?

DR WEIGHTMAN: Well, within the licencing or operating organisation what you would do is (1) you have to have a basic tactical capability within that organisation. So they have to be competent and suitably quantified in  
20 experience in that sense. But within the licensee's organisation, structurally the organisation's structure should be that you have an independent group outside of the executive line of control that challenges and reviews that executive line of control, and that reaches right up to the board to expect through one of the non-executives in the UK corporate system to be looking at making sure that is  
25 operating.

And indeed, in the UK nuclear regulatory system that's one of the things we would look for and challenge the licensee to provide. Indeed, we look to see that the board operates within that sort of system. Now, as well as that we  
30 would look to have a nuclear safety committee within that licensee's organisation, and that committee would be composed of expert to advise the executive chain or the site director or the chief exec on nuclear safety issues. So if they wanted to change a plant, they would have to go to the nuclear safety committee to get advice and that committee would not be solely internal  
35 experts. It would also include external independent experts on it, and indeed, in the UK system that's a legal requirement through licence conditions to have such a committee and approach. So that's one barrier, the licensee's barrier.

But there again, you need another sub-barrier within that industry barrier,  
40 would be peer review, perhaps on a national scale. In some countries like the USA, after Three-Mile Island they introduced INPO there, which has a strong voice in holding individual utilities and their CEOs to account. So there they have an annual meeting where the worst performing plants in the US are held to account by their other chief execs who run other utilities there. So it's a self-  
45 regulatory-like holding-to-account system within the nuclear industry on that

national scale, and we in the UK have a safety director's forum, and I know the Japanese are seeking to do something else there. And other countries will have that internally there where they have large nuclear power plants. It's more difficult if you only have one utility and perhaps a couple of nuclear power plants there.

But also there are international, so there are world associated nuclear operators as independent review missions there, and that has been strengthened since Fukushima. So they now not only look at operational aspects but also look at some of the design aspects that were fundamental to some issues at Fukushima. There are also groups of multilateral international organisations of operated groups like CANDU reactor system, the Canadian system there, so we use owners' groups there. And perhaps I would also see a change as part of the industrial barrier some of IA review missions, the (indistinct) missions there, that look at operations of a nuclear power plant.

So in a way, you can see that the industry barrier has sub-barriers, which you would expect it to be, and that (indistinct) robustness. Some of the issues at Fukushima was that whilst they had some international missions, they were not as frequent as in other countries. So there was reluctance to accept international missions and that's one of the symptoms perhaps of a lack of robustness in the institutions in the country there. If I then went on to a regulatory system, there would be a similar approach there. So the regulatory barrier, first of all we have very competent people as part of the regulatory system there.

So you need world-class tactical regulatory capability. You need an organisation structure where you have individual standards that you use to operate against. But also you need to have organisational systems where there is peer review of the decisions that the regulator may be making, and that can be done through a hierarchal system where you will - it depends on the significance of the decision, it goes higher up in the organisation. So in the UK system if we were consenting to a reactor start up after an outage, then that would be done at the deputy chief inspector level. Normally you have inspectors, principal inspectors, superintendent inspectors, deputy chief inspectors and chief inspector.

If it was for a new licence for a site it would be done at the chief inspector level, and there would be a challenge function. There would be a need to produce a report to say why it is appropriate to get permission for this activity and that would be peer reviewed, but also then it would be challenged, and if you're putting your name to a legal document that you have to in these circumstances, you make very sure that your technical content with what's being put out for the arguments that are put forward are accepted, and again (indistinct)

MR DOYLE: Dr Weightman, could I just ask you a question at this point?

DR WEIGHTMAN: Yes.

5

MR DOYLE: I think you're about to come to some of the other layers that might be inserted in the regulatory barrier, and we've heard some evidence earlier in the Commission's hearings about the potential for a complex regulatory structure to cause confusion, and it would seem that in the Japanese context, the regulatory structure that existed before Fukushima was relatively complex. Is there a risk that in adding layers of oversight within the regulatory regime one can result in a situation where the regulator loses sight of their primary responsibility?

15 DR WEIGHTMAN: Well, I mean, there are risks in any structures of computing. I think the issue is you have to have clarity on roles and responsibilities in any system you put in place. There were issues in Japan about the regulatory system where there wasn't the clarity of roles and responsibilities. It was diffused later and it's perhaps not as clear as it should be in terms of what was under the Cabinet Office and what was under METI and actually was under other ministries as well.

25 So one of the issues how do you get clarity on roles and responsibilities, but also how you make sure you don't get conflict between different regulatory requirements. So, for example, you can imagine circumstances where regulatory nuclear safety may have some conflicts in regulating nuclear security. So a simple example will be doors. To have an escape from a nuclear incident in the facility, particularly (indistinct) you want people to be able to get out of that facility very quickly. But if you want nuclear security you don't want them to get in.

30 So how do you control that test there? And one of the ways in which you can address some of those complexities is by bringing together the regulatory functions of nuclear security and nuclear safety, and that's what we did in the UK. We - to avoid conflict, to make clear that these things were taking duly in to account; we simplify the system by bringing together different parts of the regulatory system and having a sole responsibility. So - but I understand the question, I think you can organisationally address those issues. What really matters about this clarity, roles and responsibility of that.

40

MR DOYLE: Well, I wonder whether you could just - because I think I cut you off in relation to the other barriers of the regulatory regime, but I wonder if you could give us some sort of practical insight in to how for example, an IAEA, IRRS mission might assist a local regulator in avoiding a common-mode failure.

45

DR WEIGHTMAN: Yes. Well, I think they – I mean we've had them several times in the UK, we invited them in when we were looking at how we would regulate a nuclear new build, if it occurred in the UK. And by looking at  
5 international standards as the basis of their regulatory reviews, which are a consensus of good practice internationally from right across the globe and then said how do you match up to those? And what really matters when you do that is that you have a culture of saying actually we welcome this. We welcome this challenge from our peers; we welcome the fact that they may have  
10 different thoughts of what we're doing. And so some of the issues will be where they identify further good practice in a regulator but in other cases, they will say well perhaps we will recommend that actually you adhere to the international standards more. That means that you can take benefit from that approach.

15 What really matters, because these aren't enforceable reviews, is that the culture there is you welcome that and you seek to improve it. One of the interesting aspects in relation to Japanese regulatory system was that whilst they did have an international regulatory review service mission, a couple of  
20 years before Fukushima it took them several years, I believe, to agree on the final report. In the UK, what we did, we said we're not going to argue about the content of this report really, we agree it straight away. And we accept it warts and all, where it says perhaps you're not doing things as well as you could do here because we want to learn from it. And it's – that's a real cultural  
25 message that we give, not only to stakeholders but importantly to people within side the regulatory body. That you have to learn from these experiences and that's part of that international engagement that you have a degree of humility that you can indeed learn from others. And if that is not part of the culture then it's difficult to see how you can take full advantage of these things.

30 And perhaps one of the issues really that internationally struggle with it, is – that it's quite right that national governments are responsible for their regulatory systems and their – international regulation on nuclear safety because the prime duty of a government is to protect its citizens, I would  
35 suggest. But how do you make it more open? How do you make its substance more effective? It's a prime aspect of trying to improve nuclear safety and nuclear - regulation of nuclear safety on a global scale.

MR DOYLE: All right. Well, finally on that topic Dr Weightman, can you  
40 give us some sense of what the importance of the stakeholder institution is and perhaps if you can relate it back to Fukushima, how did the stakeholder barrier, if I could put it that way, fail the nuclear safety system?

DR WEIGHTMAN: Well, I think because it didn't operate. It was  
45 non-existent, I think, as far as I can tell. In Japan there's a general sense that

the industry and the government will look after us, we don't have to challenge and there wasn't the degree of openness and transparency that other stakeholder barriers operate fully there. And if it can't operate then – well, if it doesn't have knowledge, it can't operate. If it doesn't have information about the operation of the plant that they – the way in which things are addressed, then it can't operate effectively. So for me, one of the issues was there was no real stakeholder barrier there and also as I said earlier, the industry and the regulator were perhaps too close. They're basically both under (indistinct) such that there wasn't that independence and that separation that you would have anticipated. And therefore, the stakeholders didn't look at that and say, hang on a minute, these should be separate entities here, they should be under separate government sponsorship departments, they should be more effective and so without that openness and transparency and without that approach where challenge is welcome and encouraged, from all types of stakeholders, then that system can't operate. And to me that's a lack of robustness in the system, it's fundamental that we must make institutions robust and that we must make them independent of each other, the barriers.

MR DOYLE: All right. Well, Dr Weightman, can I just move briefly to the topic of emergency response and the allied question of public education in advance of a nuclear emergency. What do you think the lessons from Fukushima were in that respect, and what would be the particular learnings for a potential new entrant in to nuclear power generation?

DR WEIGHTMAN: Well, I think the first lesson is that no matter how much effort you put in to the technical aspect and the design of the reactor, the operation of reactor systems, you must also have effective emergency responses because as I said, nothing is absolutely safe. Whilst we have enhanced the various aspects of the technical basis, the nuclear reactor safety doesn't mean to say you can do away with, or (indistinct) response capability less. And so you have to have the effective emergency response capability and some of the lessons was that they can be effective in terms of health impacts, directly from the radiation. Despite everything and the complication, perhaps not being sufficiently prepared for such an emergency – I mean the circumstances were very demanding. The earthquake itself disrupted the infrastructure and the tsunami had done even more damage across there. So despite everything, it was effective, emergency arrangements can be effective. Whether it was optimum is a different question and it's very easy to say so in hindsight because as I said earlier, there is other health impacts of the evacuation perhaps can be learnt about. So some issues about preparing properly for an emergency and having the infrastructure capability to address the issues about what you do with evacuees? What you do with people who need special care to evacuate? Are there some priorities there and indeed, how do you support them when they are evacuated? And do you evacuate them in to communities, or do you help in that way?

One of the interesting aspects, as you go further in to the emergency response is that you must involve people who may be affected, in understanding and developing those emergency arrangements, I would suggest. Part of the issue is about the fear that can be engendered in people who perhaps not having sufficient information prior to any accident, and perhaps not being sufficiently capable or having the information available to understand the impact of radiation. And the fact that it is around us all the time and that we're exposed to it as part of our living, from natural sources and putting it in to context. And indeed, whilst the Japanese school system for example, has got very effective educational programmes about what to do with - in an earthquake, it's not so pronounced in terms of tsunami I don't believe, but also local (indistinct) power plants perhaps more can be done in terms of (indistinct) as part of the education system going forward so that people can put some of these issues into context and perhaps the anguish would then be properly controlled in a more rational way than might otherwise be the case. So I think the preparation is need, but also it needs to have part of an information system and involvement system of the public in developing such arrangements.

MR DOYLE: Dr Weightman, standing back from all that's been said and done in relation to Fukushima, there would be those who would put the argument that if an experienced participant such as Japan could suffer failings at various design and institutional levels, aren't the risks all the greater for a potential new entrant. I wonder if you could comment on that issue and perhaps address whether some of the particular concerns that manifested in Japan are more readily dealt with if one is, in effect, starting from scratch in relation to design and the setting up of the relevant institutions.

DR WEIGHTMAN: Yes. I think it's an interesting point, isn't it. Will the capability be less, but the opportunity to start from scratch, as you say, will be greater. You can learn the lessons when you're starting to put the institution together rather than perhaps saying, "All these institutions have served us well for 20 years," but these are rare events. What we're talking about here are events that don't happen every year. I think there's 400 reactors operated - or 400 reactors operating worldwide and one in 25 years we're getting an event, it seems up to date. Hopefully they're getting more remote now, but you want to expect that that learning should go further forward, and indeed, that's why the IA missions for new entrants are really vitally important, as part of the roadmap to how you get your nuclear program is to take advantage of the IA support to do that.

So I think it's probably easier to start from scratch rather than amend a system that's embedded in the legal system embedded in the cultural system there, and it - what it will need is a degree of leadership from the top from within government to understand that building institutions is part of the nuclear

program, and building them in a way that adds robustness to the system is important as we go forward into (indistinct) it's not just saying, "Well, okay. We're buying this reactor system from abroad and they've got a nuclear power program." It's much more fundamental that build an infrastructure and building institutions around it as well.

COMMISSIONER: Dr Weightman, can I finish with a question? It seems to be there was certainly a lack of confidence following Fukushima. Do you think that confidence is now rebuilt, particularly looking at Hinkley Point for the UK, but do you sense that around the world?

DR WEIGHTMAN: I mean, in the UK you're right that the recent announcements on investment, which - it's not a question of public confidence. It's a question of finance, it appears at the presentation time, at least in the UK, and there will be differences in different size. That's what I said earlier. In Germany and Switzerland they moved away from nuclear power programs or are moving in that direction. In the UK the confidence returned fairly quickly, I would've said. Indeed, shortly afterwards there was a vote in parliament about nuclear-related issues which had some of the high support there has been in parliament for any issue, and whilst some of the surveys showed a dip in public support, immediately after Fukushima it grew to be greater than it was before.

So in the UK that confidence has returned. I think it's been there. I think on a global scale, yes, it has, I would suggest. The number of newcomer nations who are looking at nuclear power programs - understanding the lessons learned and understanding how to address those lessons is important. That's why the work of the IA, I would suggest, is important, why the authority report just recently issued is important as part of that ability to say, "Yes, we have learnt the lessons here." But at the end of the day, it will be a decision in democracies for the local people to decide. It's right that local people decide what they should do and that is the - and confidence has to earned, I would suggest, as well, and the industry has to earn that confidence by being open and transparent, just as regulators have to be open and transparent and, as we would anticipate, politicians ought to be open as well.

COMMISSIONER: On that point, it might be a good time to conclude. Dr Weightman, thank you very much for joining us so early in the morning, and I hope you get your first cup of coffee.

DR WEIGHTMAN: Yes. Well, actually I'll have some breakfast tea now.

COMMISSIONER: We'll conclude and we'll hear tomorrow morning, I think, at 900 from Professor Wigley.

DR WEIGHTMAN: Okay. Many thanks.

COMMISSIONER: Okay. Thank you.

**5 MATTER ADJOURNED AT 5.16 PM UNTIL  
FRIDAY, 23 OCTOBER 2015**