IN THE HIGH COURT OF JUSTICE
QUEEN'S BENCH DIVISION
ADMINISTRATIVE COURT

BETWEEN:

THE QUEEN (on the application of AN TAISCE)

Claimant

-and-

SECRETARY OF STATE FOR ENERGY AND CLIMATE CHANGE

Defendant

-and-

NNB GENERATION COMPANY LIMITED

Interested Party

Witness Statement of JOHN H LARGE

	REVISION N^O	APPROVED	CURRENT ISSUE DATE
			12 NOVEMBER 2013

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ON THE APPLICATION OF AN TAISCE *v* SECRETARY OF STATE FOR ENERGY AND CLIMATE CHANGE

WITNESS STATEMENT OF JOHN LARGE

1 I am John H Large of the Gatehouse, 1 Repository Road, Ha Ha Road, London SE18 4BQ.

2 I am a Consulting Engineer, Chartered Engineer, Fellow of the Institution of Mechanical Engineers, Learned Member of the Nuclear Institute, Graduate Member of the Institution Civil Engineers, a Fellow of the Royal Society of Arts, and a Member of Federation of American Scientists.

3 From the mid 1960s I undertook postgraduate research in the United States, thereafter from the late 1960s through to the early 1990s I was a full-time member of the academic research and teaching staff in the School of Engineering at Brunel University, undertaking applications research in the nuclear area on behalf of the United Kingdom Atomic Energy Authority (UKAEA) and other government agencies. As part of my academic teaching and tutoring duties, during my university career I organised and taught a number of engineering study courses at both undergraduate and postgraduate level, I served as an elected member of the Senate of Brunel University, and over the years I have presented and continue to present lectures and short courses at a number of UK universities.

4 In the late 1980s I established the firm of Consulting Engineers Large & Associates specialising in, along with other disciplines, analysis and advice in nuclear related activities, including assessment of the response of nuclear plants during abnormal operation and when confronted with internal and external challenges. In this role[1] I have provided evidence to the European Court of Human Rights in Strasbourg; advised and/or provided evidence to a number of governments; acted as Expert Witness at a number of Public Planning Inquiries; in the UK, presented to parliamentary Select Committees and, amongst other things, I headed up the expert team that evaluated the radiological hazards arising from the nuclear propulsion reactors and nuclear weaponry on board the sunken Russian Federation submarine K141 *Kursk* throughout the World-first successful salvage of a nuclear powered submarine during 2001.[2]

5 In recent years, I have undertaken a number of projects and assessments of the EPR and PWR NPPs[3] that form some part of the basis of my understanding and experience of the topics relevant to this matter.

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1 For a full bibliography see http://www.largeassociates.com

2 *Risks and Hazards in Recovering the Nuclear Submarine Kursk*, Royal Inst Naval Architects, 2005

3 Note that the European Pressurized Reactor (EPR) proposed for Hinkley Point C is a development (mostly in size and the degree of automation) of the earlier Generation I and II pressurized water reactors (PWR) that are the dominant form of nuclear power plants (NPPs) worldwide.

6 These projects include the provision of evidence on the safe operation of two PWR nuclear power plants at San Onofre in Southern California;[4] two reviews into the advance nuclear safety regulation of the EPR, the first being an assessment of the Finnish regulator's assessment of the Olkiluoto 3 NPP currently under construction;[5] more recently, an assessment of the UK Office for Nuclear Regulation (ONR) Generic Design Assessment (GDA) being directly applicable to the proposed Hinkley Point C (HPC) NPP;[6] and I have modelled and analysed in detail the dispersion, deposition and radiological consequences arising in the aftermath of a credible (ie reasonably foreseeable) radioactive release event at the EPR NPP presently under construction at Flamanville, France.[7]

7 I shall refer to and rely upon these and other pertinent work throughout the course of this Witness Statement.

8 I consider myself to be sufficiently qualified, experienced and practised in the topics relating to this matter.

9 **INSTRUCTIONS**

10 On 31 November 2013, Ms Rosa Curling of Leigh Day, acting on behalf of An Taisce, asked me to examine the Secretary of State's (SoS) decision to make a development consent order to permit the construction of a nuclear power plant (NPP) at Hinkley Point C (HPC). In particular, Ms Curling asked that, referring to Euratom Treaty Article 37 submission (A37)[8] and other assessments, etc., I evaluate and give opinion, so far as I am able to determine, on the following:

11 a) the basis for and the assumptions underpinning, the Defendant's conclusions as to the potential impacts for the Republic of Ireland of a nuclear accident/incident arising at the proposed HPC NPP;

12 b) similarly, the extent to which the Court will be able to evaluate the processes by which Defendant made the assessments, etc., and conclusions on which the Defendant relies; and

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4 a) John H Large 1st Affidavit *Response to ASLB Factual Issues*, United States Of America Nuclear Regulatory Commission, Before The Atomic Safety And Licensing Board, In the Matter of Southern California Edison Company (San Onofre Nuclear Generating Station, Units 2 and 3), 22 January 2013, b) John H Large Declaration *Comments on the NRC and SCE Responses of January 30, 2013* Before The Atomic Safety And Licensing Board, In the Matter of Southern California Edison Company (San Onofre Nuclear Generating Station, Units 2 and 3), 14 February 2013, and c) John H Large *Declaration In Support of the 2.206 Petition by Friends of the Earth*, March 27 2013.

5 *European Pressurised Reactor at Olkiluoto 3, Inland Review of the Finnish Radiation & Nuclear Safety Authority (Säteilyturvakeskus - (STUK), Assessment of STUK Ol3 Inspection Report*, R3132-A2, September 2005.

6 a) *1st Interim Review of the Generic Design Assessment Outstanding Issues*, R3206-I1, June 2012 b) *2nd Interim Review of the Generic Design Assessment Outstanding Issues*, R3206-I2, September 2012, and c) *Final Report on the Generic Design Assessment* , R3206-I3, June 2013.

7 *Assessments of the Radiological Consequences of Releases from Existing and Proposed EPR/PWR Nuclear Power Plants In France*, R3150-5. March 2007

13 c) the extent to which those conclusions and assessments, particularly as they relate to nuclear safety considerations, can be said to be complete, precise, and provide definitive findings and conclusions capable of removing all reasonable scientific doubt as to the potential for significant impact for the people of the Republic of Ireland arising from the proposal.

14 In forming my opinion I have referred to the A37[8] submission and a number of other documents available to the Court.[9]

15 Also, I have read the Witness Statements of Paul Dorfman and John Sweeney. I agree with the facts and opinion expressed in each of these witness statements.

16 **SoS's Adoption of the 'Worst Case' Accident/Incident**

17 SoS states that in reaching decision that trans-boundary consultation (with the Republic of Ireland) was unnecessary [¶5(a),(b)][9i)] because he had taken into account the

> *" . . . (a) . . . arrangements regulating the likelihood of accidents and of the risk of operational accidents and other serious incidents . . . (b) the prior assessment of the likelihood of accidents . . ."*
>
> my truncation . . .

18 SoS identifies [¶5(a),(b),(c),(d)][9i)] the sources of information that he relied upon for his decision to be (a) the developer's Environmental Statement,[10,11] (b) the Regulatory Justification process[12] that concluded in 2010, (c) the [future] role of the Office for Nuclear Regulation (ONR), and (d) the Euratom Treaty A37 submission.[8]

19 Each of the documents that the SoS claims to have relied upon considers accidents/incidents triggered by an external and/or internal event that is then, somehow, controlled and brought to a halt in such a prescribed way that the accident/incident is mitigated in outcome and radiological consequences. I can simply illustrate this logic and give a practical example of a loss of off-site power (LOOP) event as follows:

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8 UK EPR Hinkley Point C Site, Submission of General Data as Applicable under Article 37 of the Euratom Treaty, Secretary of State for Department of Energy and Climate Change, 2011

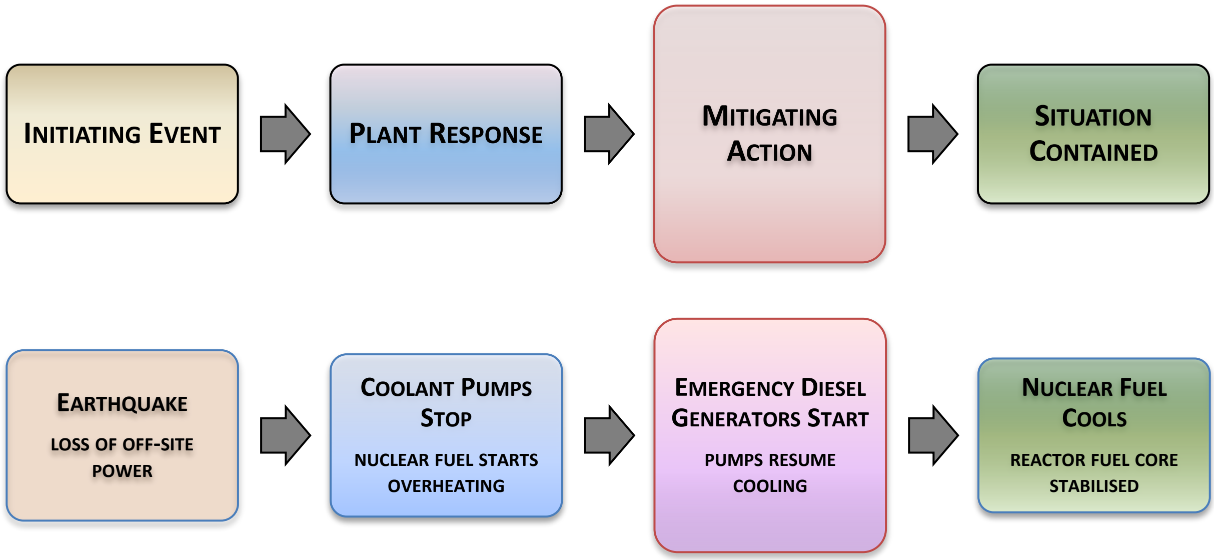
9 i) *Summary of Grounds of Defence of Secretary of State* (DECC);
ii) witness statement of *Giles Scott* dated 25 September 2013;
iii) second witness statement of the Interested Party *Richard Torquill Heriot Mayson* dated 12 September 2013
iv) HPC *Submission of General Data under Article 37* of the EURATOM Treaty; and, generally,
v) Tab 11 of the Secretary of State's bundle of documents for the Court.

10 *Radioactive Substances Regulation Environmental Permit Application*, NNB Generation Company Limited, UK EPR, Hinkley Point C, 2011

11 *Hinkley Point C, Development Consent Order Application, Environmental Statement, Non-Technical Summary*, EDF October 2011

12 *Justification of Practices Involving Ionising Radiation Regulations 2004, Secretary of State's Decision*, October 2010 [¶1.61]

20 **SCHEMATIC 1 LOOP FAULT EVENT SUCCESSFUL MITIGATION SEQUENCE**



21 Normally, the NPP exports its generated electricity to the transmission network to supply the national grid but at the same time the NPP uses the transmission lines as a two-way system importing electrical power to operate auxiliary and essential safety equipment, such as the reactor coolant pumps. If the transmission lines are interrupted then the import of vital electricity supplies to the safety equipment is also lost.

22 In the lower row of the **SCHEMATIC 1** example, an earthquake or some other off-site event interrupts the electricity power supply lines to the NPP. This requires the NPP to cease generating electricity and immediately SCRAM (shut down) the nuclear reactor but, even when shut down, the nuclear fuel in the reactor core (typically about 120 tonnes) continues to generate heat via the process of radioactive decay alone (immediately about 10 to 15% of the full thermal power rating, thereafter decaying over the following hours, days and weeks).[13] To safely manage this fuel residual decay heat, the fuel core has to be forced-cooled in the absence of incoming power supplies so, for this, on-site emergency diesel generators immediately start-up to power the reactor circuit coolant pumps, thus enabling the steam generators to dissipate the fuel decay heat via a number of diverse residual heat removal systems.

23 Of course, if the mitigation action fails to successfully engage then the scenario of the example given in **SCHEMATIC 1** could continue unabated, particularly if another adverse event intervenes, developing the LOOP into a station black out (SBO) event, for example:

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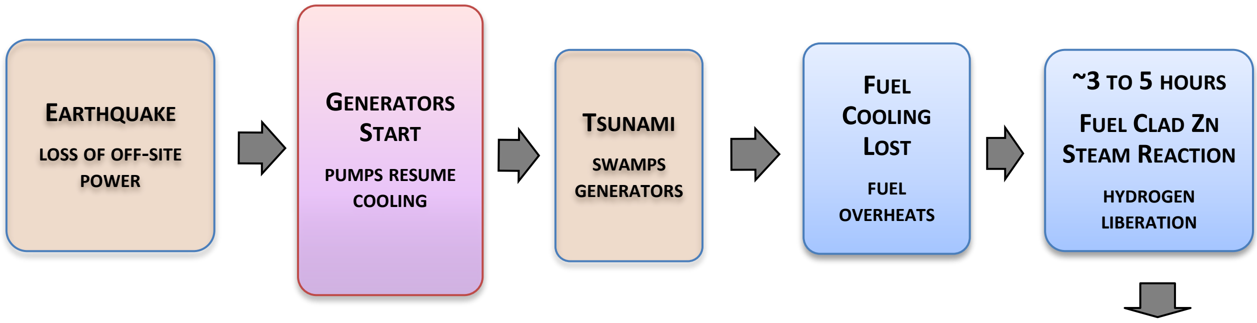
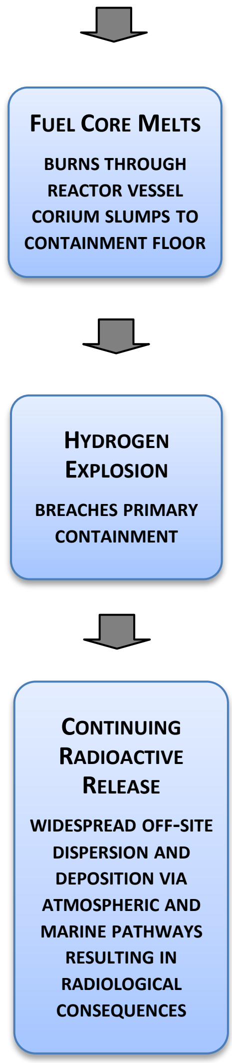
13 The full thermal rated power is typically about 3,500MW_t so immediately following reactor shut down from full power, about 400MWt heat has to be dissipated by forced cooling – 400MWt is equivalent to the heat given off by about 400,000 single element electric bar fires. Depending on the irradiation or burn-up history of the reactor core fuel, this residual heat decay and need for forced cooling continues for about 6 to 8 weeks by which time natural circulation of the water in the reactor circuit is sufficient to cool the fuel core, this being termed the 'thermal rollover' time.

24 **SCHEMATIC 2 SBO EVENT WITHOUT MITIGATION ENGAGEMENT**





25 In this scenario a second adverse event, say for illustrative purposes a tsunami, swamps the NPP site and cuts out the emergency diesel generators so that all off- and on-site power is lost. The pumps circulating the reactor cooling water stop, the reactor fuel core overheats and a steam void forms within the reactor pressure vessel (RPV). Within about three to five hours the interface between fuel element cladding (an alloy of zirconium – Zircaloy) and steam is raised to sufficient temperature to violently and exothermically react, liberating free hydrogen within the reactor primary cooling circuit.

26 With continued loss of cooling under SBO conditions, the fuel core completely melts in about 16 hours and the corium mass slumps to the bottom of the RPV, thereafter burning through the RPV steel shell to fall and slump onto the primary containment floor. At this point in time, the hydrogen gas in the RPV circuit is released into the primary containment whereupon it reacts with the air in the containment, deflagrating and exploding with sufficient might to breach the containment surety and, with this, the first phase release of radioactivity to the atmosphere for dispersion and deposition further afield commences.

27 Thereafter, the molten fuel corium reacts with the concrete floor (and RPV pedestal) surfaces and in doing so continuously generates a non-condensable carbon-monoxide gas that serves to transport radioactive release of hot and highly buoyant fuel oxide particles, along with fission product gases such as iodine-131, to the atmosphere again for dispersion and deposition further afield.

28 As it happens, the example that I have modelled for **SCHEMATIC 2** assumes the events and sequencing of the very real incident at the Japanese Fukushima Daiichi NPP following the earthquake-tsunami external incident of 11 March 2013.

29 At Fukushima Daiichi the external challenges to the NPP comprised, first, the earthquake which isolated the NPP's from grid power supplies (LOOP) and, second, the arrival of the tsunami wave which shut down the vital internal emergency supply of power (the diesel generators) resulting in a total station blackout (SBO).

30 Of course, there are other external threats and challenges that could occur with much the same result. For example, the Dungeness B NPP (Kent) was forced to SCRAM its two operating reactors during the recent October (2013) St Jude storm putting the NPP into a LOOP event.[14] In this Dungeness incident the emergency generators started and remained operational acting as, effectively, the last line of its *defence in depth*. However, if prior to or following the LOOP another incident had disabled the emergency generators (for example, an unpredictable storm surge that inundates the site), then forced into SBO mode both reactors of Dungeness B would have encountered problems in maintaining cooling of the nuclear fuel cores.

31 My point here is that NPPs are engineered to withstand external (and internal) challenges that are prescribed in terms of frequency of occurrence, nature and severity – in meeting <u>prescribed</u> challenges the NPP satisfactorily performs because it is acting within its *design basis*. However, if the severity of the external challenge is too great, or the combination of challenges overwhelming or, indeed, if the nature of the challenge has not been prior forecast then the plant has to respond to a hazard that is <u>*beyond*</u> the *design basis*.

32 At Fukushima Daiichi, the earthquake and tsunami overcome the defence systems because in combination they were a *beyond design basis* challenge. In this incident the fuel core of each of three operating NPPs melted and each containment was severely damaged and breached (see left); radioactive release to the atmosphere continued throughout two weeks, and intermittently thereafter, and the radioactive release via a second pathway to the marine environment continues to this day (November 2013).

FIGURE 1 HULK OF THE CONTAINMENT OF UNIT 3 [centre]

14 This LOOP (loss of off-site power) incident occurred at the Dungeness B NPP when the electricity grid connection was lost during the St Jude storm of 28 October 2013, causing both reactors to SCRAM and requiring emergency generator operation in support of fuel cooling – see EDF Background Note.

33 I have read through representative sections of the documents that SoS relied upon for his decision [¶5(a),(b),(d)],[9i)] noting that all of the various *design basis*[15] and *risk reduction*[16] accidents nominated in these documents generally adhere to my **SCHEMATIC 1** sequence.[17]

34 This **SCHEMATIC 1** sequence assumes that (compared to what actually occurred at the Fukushima Daiichi NPP):

35 1) the intended mitigation action(s) successfully engages, intervenes, arrests and stabilises the accident sequence(s);

36 At Fukushima Daiichi, even though the emergency diesel generators engaged but were subsequently swamped by the tsunami,[18] there were two further systems held in reserve for the fuel core residual heat cooling (the steam-turbo driven high pressure make-up water pumps and the isolation condenser) which, although of limited capacity and availability duration, these systems would have eased the early demand to cool the nuclear fuel. However, both of these systems failed to engage and/or function correctly.

37 2) the HPC EPR assumes that, for all *design-basis* initiating events, the nuclear island primary containment (essentially, the dome-like structure that characterises NPP architecture) remains intact with the volumetric leak rate not exceeding 0.3% per day,[19] although arising from its GDA assessment of the EPR design ONR requires further heat removal and pressure reduction diversity to counter excessive containment internal

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15 The approach to nuclear safety is, generally, to nominate a series of accidents/incidents that are considered representative of <u>all</u> internal situations that could arise within the plant. The *design basis* accidents are grouped into four Plant Condition Categories (PCCs) which are ranked in frequency of occurrence – for example PCC4 fault conditions includes design basis accidents within the frequency of occurrence range of 10^{-6} to 10^{-4} per reactor year (ie a chance of 1 in a million to 1 in ten thousand).

16 The second group or category of accidents/incidents are where multiple failure where the probability of occurrence is shared and which primarily relate to the situation where the reactor is operating at full power (State A) – this group is referred to as Risk Reduction Category A (RCC-A). A further RCC relates to the immediate aftermath of a PCC4 where the reactor has shut down at low pressure but fuel core degrade is (or could be) underway to develop into a full fuel core melt – this is referred to as RCC-B.

17 Generally, the UK ONR adopts and incorporates into its Safety Assessment Principles (SAPs) the International Atomic Energy Agency's definition of *'design basis'*, being *"the range of conditions and events that should be explicitly taken into account in the design of the facility, according to established criteria, such that the facility can withstand them without exceeding authorised limits by the planned operation of safety systems"* – the emphasis being on the mitigation achieved by the *'planned operation of safety systems'.*

18 The tsunami swamping the Fukushima Daiichi site is available on <u>video</u>.

19 In the aftermath of a loss of coolant (LOCA) incident, the hitherto high pressure primary circuit water expands and steams into the larger containment dome volume, taking with it any radioactive fission product that has released from the fuel. Correspondingly, the venting of steam into the primary containment is accompanied by an increase in pressure and temperature so, if the containment shell is undamaged, the rate of bypassing the primary containment determines the potential off-site radiological detriment. In the EPR design, the maximum 0.3% vol/day relates leakage from the primary containment pressurised at 5.5 bar (atmospheres) into inter-space or annulus of the containment domed structure where it is dealt with by the annulus ventilation system (AVS) before discharge to atmosphere – 0.3% vol/day is the rate that the AVS is design to process for a *'within limits'* discharge to atmosphere. The US NRC sets down the maximum containment leakage or bypass rate applicable to *design basis* accident - See 10 CFR §50, <u>Appendix J to Part 50,Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors</u>, NRC – for 3 types of in-situ test to a prescribed limit of leakage – there is no prescriptive equivalent in the ONR SAPs.

pressure/temperature during and in the aftermath of severe, *beyond design basis* events.[20]

38 At Fukushima Daiichi, the primary containment of all three reactors failed. Units 1 and 3 (**FIGURE 1**) containments failed at the superstructure levels and Unit 2 at subterranean level(s), opening radioactive release pathways to both atmospheric and marine environments. Since all containment barriers (fuel cladding, reactor vessel and primary) were lost the equivalent volumetric leakage, compared to the HPC EPR at 0.3% vol/day, was immediate and total at 100%.[21]

39 3) with the nuclear island primary containment remaining sensibly intact for the design basis and RRC-B accidents project for HPC, the predicted amounts of two significant radionuclides released via the 0.3% vol/day containment bypass to the atmospheric environment are summarised in A37 [p176, Table 6.9]:[9iv)]

	SOURCE TERM RELEASED TO ENVIRONMENT (Bq)[22]		
RADIONUCLIDE	**STEAM GENERATOR TUBE RUPTURE**	**LOSS OF COOLANT ACCIDENT (LOCA)**	**RRC-B (FUEL MELT)**
IODINE-131	1.86E+11[23]	3.78E+10	2.92E+12
CAESIUM-137	4.24E+10	6.15E+09	4.47E+10
TOTAL	2.28E+11	4.47E+10	2.96E+12

40 For comparison, in the aftermath of the Fukushima Daiichi accident the atmospheric release estimates from the authoritative Japan Nuclear Energy Safety (JNES) organisation up to and including core degradation for the Units 1, 2 and 3 NPPs was:

	SOURCE TERM RELEASED TO ENVIRONMENT (Bq)
RADIONUCLIDE	**ALL 3 UNITS**
IODINE-131	1 to 2E+17
CAESIUM-137	1 to 2E+16
TOTAL	1.1 to 2.2E+17

41 The general consensus is that Unit 3 made up the by far greater part of the atmospheric release so, with its primary containment utterly destroyed (ie its bypass rate was 100% compared to

20 Other than by cooling the inner dome volume to reduce pressure and temperature, the EPR does not offer a diverse means of reducing pressure by filtered discharged other than via the very limited AVS. This lack of diversity resulted in the ONR raising the GDA *Assessment Finding* AF-UKEPR-CSA-25 requiring AREVA-EDF to provide available measures to limit the containment pressure in the event of a severe accident (*beyond design basis*) – see Generic Design Assessment – New Civil Reactor Build GDA Close-out for the EDF and AREVA UK EPR Reactor GDA Issue GI-UKEPR-CC-03 Revision 3 – *Fukushima lessons learnt impact on UK EPR*, March 2013 – to my knowledge AF-UKEPR-CSA-25 remains outstanding.

21 The volumetric leakage at Chernobyl during and in the immediate aftermath of the Chernobyl accident in 1986 was also 100%.

22 Bq – Becquerel – a unit of energy via a disintegration in the decay of a radionuclide, ie the single tick of a Geiger counter.

23 1.86E+11Bq is the scientific notation for $1.86.10^{11Bq}$ or 186GBq or 186,000,000,000Bq.

the 0.3% envisaged or the HPC EPR), a rough-and-ready comparison shows the actual radioactive release at Fukushima Daiichi from Unit 3 alone was about {1.1E+17/2.96E+12=} 37E+3 or at least 37,000 times larger than the release predicted for the A37 RRC-B accident at HPC.

42 Moreover, if I take account of the relative sizes of the Fukushima and HPC reactor fuel cores and, particularly, the greater levels of fuel irradiation (burn-up)[24] then, again as a rough and ready pointer, all other things being equal the equivalent Fukushima Daiichi accident applied the proposed HPC EPR NPP would be at least 64,000 times greater than the release assumed in the A37 RRC-B accident at HPC.

43 This leads me to my opinion that SoS did not nominate the **worse case** accident in the A37 submission because the ultimate severity of each of his accident scenarios [p176, Table 6.9]:[9iv)] was assumed to be moderated by the successful intervention of a mitigating action. If the mitigating action(s) had failed to successfully engage, then the accident cascade would have stepped along a notch and, as at Fukushima Daiichi, yielded greater and intolerable radiological consequences.

44 At Fukushima Daiichi the pre-accident assumption was that the final element of the *defence in depth*, ie the generators starting up and maintaining emergency power supplies, was overridden by the severity of the tsunami – the Japanese assumed that this last line of defence would stand thereby keeping the accident in the realms of the *design basis*.

45 Essentially, SoS's assumption that the mitigating action will always successfully engage and terminate the fault and/or stabilise the fault sequence, keeps the accident/incident within the *'design basis'* - failure to engage takes the accident/incident into the <u>*beyond*</u> *design basis* regime,

46 Moreover, in his final report assessing the implications of Fukushima and the UK nuclear industry[25] (published after the A37 submission), the Chief Inspector[26] of Nuclear Installations recommended [p144, ¶786]:[25]

24 The greater the fuel irradiation (burn-up) then the larger the amount of fission product held within the fuel matrix and, the fuel core of the HPC is of greater rating than the Fukushima boiling water reactors – 1,600MW_e compared to 794MW_e. The design maximum burn-up for the EPR NPP is 65GW_ed/tU and, generally, the average fuel core burn-up would be about 48GW_ed/tU compared, compared to the Fukushima Daiichi average core burn-up of about 36GW_ed/tU, and at higher burn-p levels the release faction (of the total fission product content) under certain accident conditions increases from, typically 2-4% to 8% and above. In account of all of these factors, so roughly a factor of x2 to x4 fission product would be available for release in an EPR compared to the Fukushima-Daiichi Unit 3 NPP.

25 *Japanese earthquake and tsunami: Implications for the UK nuclear industry*, Final Report HM Chief Inspector of Nuclear Installations, September 2011 – see also *Japanese earthquake and tsunami: Implications for the UK nuclear industry*, Interim Report HM Chief Inspector of Nuclear Installations, May 2011

47 *“ . . .* ***Recommendation FR-4:*** *The nuclear industry should ensure that adequate Level 2 Probabilistic Safety Analyses (PSA) are provided for all nuclear facilities that could have accidents with significant off-site consequences and use the results to inform further consideration of severe accident management measures. The PSAs* ***should consider a full range of external events including “beyond design basis” events*** *and extended mission times.”*

my ***emphasis*** and ***underlining***

48 Adding that for the EPR NPP design [p144, ¶456]:[25]

49 “. . . *Any future operators of either design will need to have in place adequate Severe Accident Management Guidelines (SAMG).”*

50 Noting that [p90, ¶504]:[25]

51 *“. . . it is clear from the Fukushima event that the accident was* ***significantly outside*** *of what is covered by the [UK] SAMGs, and that the guidance was not adequate to cope with multiple plant failures. . .”*

my ***emphasis*** and added *[explanation]*

52 The ONR’s post-Fukushima recommendation FR-4 [§47], that the accident/incident to be taken as a benchmark should be a *‘beyond design basis’* event, endorses my opinion that SoS did not adopt the **worst case** accident/incident for the A37 submission. As I have explained earlier [§39 and f20], the 0.3% vol/day containment bypass leakage rate, relied upon in A37 [¶843, p172][8] to limit the off-site radiological consequences, would be invalid in the circumstances of a *beyond design basis* accident/incident so, it follows, with this limit lifted the radioactive release and radiological consequences would be significantly greater.

53 In related Fukushima Daiichi reviews, the European Commission directed the ONR (as it did with all other Member State nuclear safety regulators) to undertake a series of *‘stress tests’*,[27] reporting its findings in a National Report for peer review by the European Nuclear Safety Regulators Group (ENSREG). A number of the findings of the ONR’s National Report[28] are of interest here because of the greater emphasis placed on *beyond design basis* events, for example:

54 “. . . *STF-3 Licensees should undertake* ***a further review of the totality of the required actions*** *from operators when they are* ***claimed in mitigation*** *within*

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26 HM Chief Inspector of Nuclear Installations and Director of the Health and Safety Executive (HSE) Nuclear Safety Directorate, at the time being Mike Weightman. Dr Weightman headed up the International Atomic Energy Agency (IAEA) Mission team to Fukushima Daiichi in May-June 2011; a few days following the Fukushima Daiichi accident, in March 2011, he was asked by and reported directly to the Secretary of State (DECC) on the implications of the unprecedented events in Japan and the lessons to be learned for the UK Nuclear Industry.

27 In the UK, the European Commission directed ONR to evaluate and report to European Nuclear Safety Regulators Group (ENSREG) for peer review, producing its *National Final Report* in December 2011 – the stress test evaluations applied to existing and projected NPPs (such as HPC) and other nuclear facilities. The ONR’s National Report is a general compilation of the stress tests evaluations prepared by the individual operators (for UK NPPs EdF and the Nuclear Decommissioning Authority - NDA), although these NPP-specific evaluations have not been made publicly available.

28 *European Council “Stress Tests” for UK nuclear power plants*, National Final Report, ONR, December 2011

*external hazards safety cases. This should **also extend** into **__beyond__ design basis events** as appropriate. . . .*

*STF-5 Licensees should further review the margins for all safety-significant structures, . . . to understand the **__beyond__ design basis sequence of failure and any cliff-edges that apply for all external hazards.***

*STF-8 Licensees should **further investigate** the provision of suitable event-qualified connection points to facilitate the reconnection of supplies to essential equipment for **__beyond__ design basis** events.*

*STF-15 Licensees should complete the various reviews . . . These reviews should look in detail at on-site emergency facilities and arrangements, off-site facilities, facilities for remote indication of plant status, communication systems, contents and location of **__beyond__ design basis** containers and the adequacy of any arrangements necessary to get people and equipment on to and around site under **severe accident conditions**. . . .“*

my ***emphasis*** and underlining ***__throughout__***

55 These STF and FR-4 findings and recommendation were incorporated into an *Outstanding Issue* late in the Generic Design Assessment (GDA) – I have given an example of an awaited modification to the containment design that arose from these STF and FR-4 findings [§37 and f20]. In this particular respect, SoS's conclusion that the EPR containment system was sufficiently robust, which he made at the time of the Screening Decision, was made in advance of the modifications required to the primary containment that have still yet to be designed, approved and implemented.

56 The STFs and FR-4 herald significant changes to the UK regulatory approach that have necessitated a fundamental rethink and changes to the overly probabilistic approach[49,29] of defining the chance occurrence of any damaging event or threat to the NPP, either external or internal, or a combination of both, that has the potential to give rise to a significant release of radioactivity to near off-site and beyond.

57 In my recent work relating to the San Onofre NPP (Southern California) steam generator tube accelerated degradation,[30] it became very clear to me that the Nuclear Regulatory Commission (NRC) was now (mid 2012) placing a much greater emphasis on the *'beyond design basis'* external and plant sourced fault conditions than hitherto.

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29 In fact some of the Fukushima Daiichi provoked safety modifications are already underway (or planned) for the HPC EPR. As reported in the ONR *Assessment of an Application submitted by NNB GenCo for a Nuclear Site Licence*, REV A 31 October 2012 notes *'120 The severe accident analysis assessment which contributed to the assessment report noted that the NNB GenCo severe accident lead engineer is actively engaged with the proposed design changes arising from lessons learned from the Fukushima incident'* and *'122 The effects of the earthquake and tsunami event at Fukushima have been considered both by NNB GenCo and by the reactor vendor. As a result, a number of modifications to the basic design are being proposed, including some changes to the conventional island building location'*.

30 *Response to Atomic Safety and Licensing Board's Factual Issues 1st Affidavit of John H Large*, United States of America Nuclear Regulatory Commission, Before the Atomic Safety and Licensing Board, in the Matter of Southern California Edison Company, San Onofre Nuclear Generating Station, Units 2 and 3, 22 January 2013

58 In other words and importantly, because of the experience of Fukushima Daiichi the approach to assessing the risk to and response of the NPP has become more *risk informed*[31] than *risk based.*[32] This means that in account of our post-Fukushima knowledge in March 2013, the A37 submission[9i)] is inappropriate and incomplete in its approach, being outdated and redundant – I consider these aspects in a later section of this Witness Statement.

59 **LIKELIHOOD & CAPABILITY OF 'WORST CASE' ACCIDENT TO CAUSE SIGNIFICANT DETRIMENT**

60 FIGURE 2 shows the extent and severity of radioactive contamination striking to the north-west and south-west from the Fukushima Daiichi NPP (mid-frame on east coast).

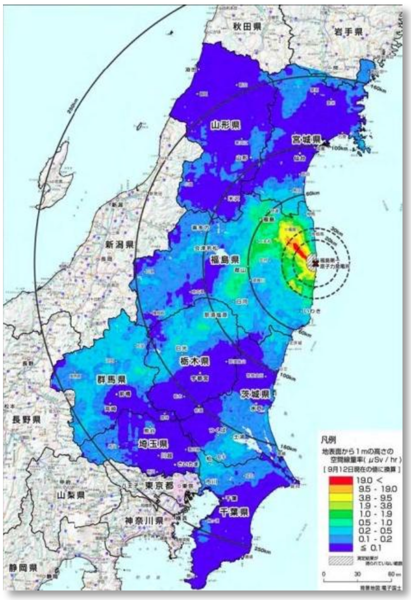


FIGURE 2 CONTAMINATION AT FUKUSHIMA

61 The legend box (lower right) shows the contamination levels expressed in external radiation dose received by a typical human receptor in residence in any particular area, with the dose units in µSv per hour.[33] The dominant radionuclide deposited downwind of the Fukushima Daiichi NPP was Caesium-137 (Cs-137) with a radioactive decay half-life of approximately 30 years so, as a rule of thumb, its albeit decaying (radio)activity will persist for 300 years or thereabouts.

62 The superimposed circular lines represent radial distances from the Fukushima Daiichi NPP with the outermost band at 250 kilometres from the NPP – coincidentally, this is about the distance from Hinkley Point to the nearest landfall in the Republic of Ireland at Rosslare.

63 Referring to **FIGURE 2**, at around 250km some areas are subject to radiation levels in the 0.2 to 0.5 µSv/hr range (■) so, crudely, an individual remaining in the area will be exposed externally via the radiation shine pathway[34] to an additional dose increment of (24*364*0.2 to 0.5=) 1,750 to 4,370µSv over a 12 month period.

64 In the Republic of Ireland the permissible dose limit for a member of public from artificially introduced radionuclides (excepting dose from medical treatment, diagnostics, etc) is limited

31 *Risk Informed* - an approach to regulatory decision making, in which insights from probabilistic risk assessment are considered **together** with other engineering insights.

32 *Risk Based* - An approach to regulatory decision making that considers **only** the results of a probabilistic risk assessment.

33 µSv per hour – 1E-06Sv/hr – one millionth of a Sievert per hour – 1mSv=1,000µSv

34 The radiation shine pathway is the dose exposure from the radioactive emissions from deposited radioactive particles on the ground and surfaces, etc.. This pathway excludes other dose uptake routes and pathways, for example resuspension of the deposited particles available for respiration to internal (within body) uptake thereafter generating an internal organ dose exposure, and/or the dose received from the inhalation of the passing gases, aerosols and particulate matter during the first and early phases of the release.

to 1,000 μSv in any period of 12 months.[35] Again, this rough and ready comparison suggests that should a similar radioactive release occur from the HPC EPR, then residents in south-east area of the Republic of Ireland could, depending on wind and weather, be subject to an additional external annual dose of up to 4+ times the national limits applied in both the Republic of Ireland and, separately, the United Kingdom.

65 My drawing of such a comparison between the very real accident and radioactive release at Fukushima Daiichi and a similarly severe event occurring at HPC has to be considered with some caution because, obviously, no two accidents are identical and local and regional differences will contribute strongly to differences in outcome. Nevertheless, for the HPC-Ireland situation, I would expect an increase in the potential consequences, particularly in that:

66 a) My reckoning of the dose received by residents in the proximity of Rosslare takes no account of the inhaled or organ dose uptake, especially during the first and early phases of the release sequence.

67 In my opinion, inhalation of radio-iodine and other volatile radionuclides during the early phases of the release would likely and markedly increase the overall or effective dose of those individuals exposed.

68 b) The Fukushima Daiichi release sequences for Units 1 and 3 each comprised an energetic puff release followed by a longer period of low energy, low altitude release with, for the first two to three days, the release being driven out to the Pacific to return sweeping overland – see CEREA[36] video reconstruction of plume timing and trajectories. It follows, because the first and early phases of the Fukushima Daiichi plume were out over the Pacific Ocean, the two to three days delay until the plume swept back over the land mass meant that, with the prior dispersion and deposition over the sea, the land contamination was considerably weakened. Also, the primary sources of the radioactive release (the crippled reactor plants) were weakening as the (thermal) energy within the fuel cores eked away and, particularly, due to the often ad hoc actions being undertaken by the Japanese to bring the situation under control, primarily by flooding the reactors and spent fuel ponds.

69 Between HPC and Rosslare, the open fetch of sea lends itself to a more stable easterly airflow, resulting in less dispersion and weakening of the plume during its transit which, in my opinion, provides conditions more conducive to the land mass of south-east Ireland being delivered an

35 Radiological Protection Institute of Ireland – A similar public dose regime applies in the UK, see Schedule 4, Dose Limits, *The Ionising Radiations Regulations 1999* being 1mSv in any calendar year – both states adopt the recommendations on the International Committee on Radiological Protection (ICRP)

36 CEREA, joint laboratory École des Ponts ParisTech and EdF R&D – scroll down to 3rd block on CEREA web page – of interest here is the explosion and containment failure of Unit 3 on 14-15 March 2011.

undispersed (ie undiluted) radioactive plume and, hence, higher concentrations of land contamination.

70 c) As I have previously noted [§42, f24] because of the comparative sizes and fuel burn-up of the NPPs at Fukushima Daiichi and that proposed for HPC, then the release mass would be expected to be correspondingly larger.

71 Setting aside the dose exposure of employees engaged at the Fukushima Daiichi NPP site (about 170 employees received more than 100mSv over the first few days of the accident), the World Health Organisation (WHO)[37] reckons that most of the 140,000 members of the public evacuated received an effective individual dose below 10mSv, with exception of residents of Namie town and Litate village who received dose between 10 to 50mSv and there is concern about infants in Namie town who received an estimated iodine-131 thyroid organ dose of between 100-200mSv.

72 So if an accident/incident occurred at HPC of about the same severity as the Fukushima Daiichi accident, then the arrival and deposition of a radioactive plume emanating from HPC, under certain meteorological and atmospheric stability conditions, would result in intolerable economic,[38] environmental[39] and health[40] detriments to the people of the Republic of Ireland. Extrapolating the Fukushima Daiichi, albeit crudely, yields and expectation that a number of individuals in the Rosslare region, if not beyond, would be subject effective doses at least in the range of 10 to 50mSv.

73 However, the accident/incident scenario adopted for the A37 submission, as endorsed by SoS, is not the **worst case** because the magnitude of the radioactive release is limited by the assumption that, whatever the circumstances, the accident will be within the *design basis* and primary containment surety guaranteed, hence, the radioactive release limited (to 0.3% vol/day bypass).

74 In the event of a worst case accident/incident as I have defined [§16 to 58], the radioactive release would be likely to be capable of, and would have the **potential** to cause unacceptable levels of economic, environmental and health detriments to the people of the Republic of Ireland.

37 *Nature*, V485, Iss 7399, 23 May 2012.

38 Economic detriment because contamination of the land would involve the cost of decontamination, where practicable; changes in use of the land; loss of tourism revenues, and so on.

39 Environmental detriment because contamination would blight the land, and require immediate and interim changes is the use of the land which is likely to render changes in eco-systems, etc – for example, hill farming in the Republic of Ireland, and in Wales, Cumbria and Scotland had in place strict management regimes controlling the radio-Caesium uptake of grazing sheep, particularly lambs, under the so called *'mark and release'* restrictions as a direct result of the Chernobyl nuclear accident in 1986 – the last of these restrictions, originally applied to 9,800 farms in the UK, remaining on 8 and 327 farms in Cumbria and Wales respectively, were removed in June 2012, that is some 26 years following the Chernobyl radioactive release.

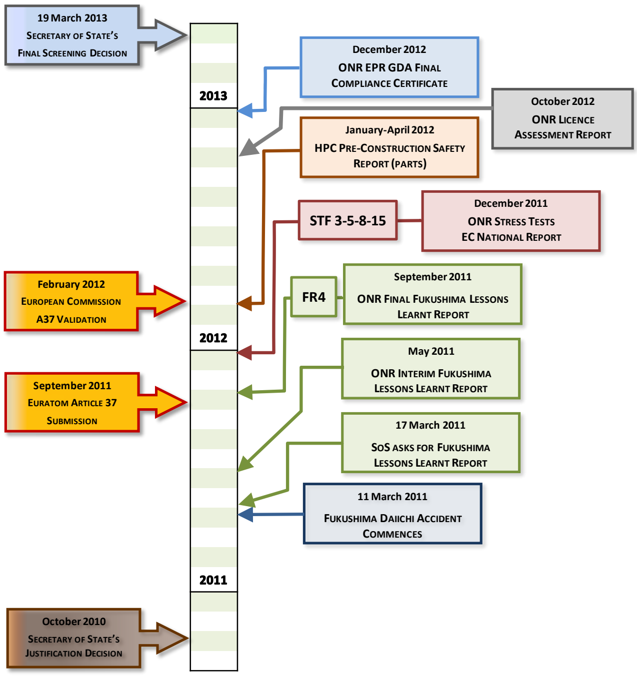
40 Health detriment in accord with the established and internationally accepted recommendations of the ICRP setting out the causal relationships between radiation exposure and health impact.

75 In other words, the A37[9iv)] submission does not demonstrate that there was **no likely** significant trans-boundary effect of the HPC development as claimed by the SoS [¶16][9i)] and on which SoS relied for his Screening Decision.

76 **a) Basis of SoS's Assumptions and Conclusions**

77 I shall set out the first part of my response to Ms Curling's instructions in the context of the information and assessments, etc., that would have been available in the public domain up to but not beyond the date of SoS's Screening Decision letter for HPC,[41] that is 19 March 2013.

78 **Appendix 1** [right - **App 1**] lays out the relative position in time of SOS's lead-in to the Screening Decision (LH side) and the associated information, such as the GDA and PCSR and, following the Fukushima Daiichi accident, reports and recommendations arising from ONR's investigation (RH side).



Appendix 1 Time Lines of Information Availability

79 For clarity, I have the omitted the IAEA fact-finding mission report of June 2011 that was led by the ONR Chief Inspector and the European Commission specification[42] for the *'stress tests'* to the various Member State national nuclear safety regulatory bodies of April 2011.

80 **The Fukushima Daiichi Consideration:** Note that the A37 submission of September 2011 predates the publication of the PCSR of January-April 2012 and the completion of the ONR GDA in December 2012, but that all of this information, together with the important FR4 recommendation [§47] and STF findings [§54] would have been available to SoS in good time for his deliberation leading up to the Screening Decision of 19 March 2013.

81 As I have demonstrated in earlier sections, all of the Fukushima Daiichi reporting strongly suggests that a worst case accident goes beyond the limits of my **Schematic I** model whereby a mitigation action successfully engages to arrest and stabilise the accident/incident sequence.

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41 Letter, Secretary of State, Department of Energy and Climate Change, *Application for the Proposed Hinkley Point C (Nuclear Generating Station) Order*, 19 March 2013

42 *'Stress Tests' Specification*, Proposal by the WENRA Task Force, 21 April 2011.

82 The Fukushima Daiichi accident shows that the reliably of predicting the frequency of occurrence of the external hazard (the tsunami, storm surge, or whatever) to be fundamentally flawed and, moreover, that severe accidents/incidents that result in primary containment failure can and have resulted in wide-scale and far-flung radiological contamination and radiation dose uptake.

83 More surprising therefore, that although SoS himself asked the ONR Chief Inspector to report on the implications for the UK nuclear industry[25] he seems not to have taken account of its findings and recommendations in his Screening Decision.

84 **Objectivity -*v*- Subjectivity of the A37 Submission:** I note that on 7 October 2013 Leigh Day requested from the Treasury Solicitor a further 24 points of information and/or clarification relating to the A37 submission. In response to this request, the Treasury Solicitor replied on 18 October 2013:

85 *". . . My client does not hold, and* ***has never held,*** *any of the documents or information you have requested in the numbered paragraphs 1-24 of your letter. . . The [A37] submission was subsequently seen by relevant UK regulators [ONR and Environment Agency(?)] before being provided by the UK Government to the Commission.. . ."*

my. [added explanation], truncation . . . and ***emphasis***

86 Since DECC only had access to the A37, which it admits *'was compiled by, NNB Genco, as the competent persons'*, and not to any other source and/or supporting documents, it seems to me that for his Screening Decision SoS relied on the A37 content alone.

87 Moreover, the basis of SoS's Screening Decision seems to rely, according to Giles Scott, on qualitative measures such as *'the risk of accidents involving* ***significant*** *radioactive releases will be* ***very low*** *indeed'*, along with other equally ambiguous descriptions.

88 As one progressively reads through the A37 it soon becomes abundantly clear just why Giles Scott has adopted such qualitative terms. This being simply because the A37 provides very little in the way of a statistical framework or benchmark upon which to define Scott's terminology of *'very low'*, *highly unlikely'*, *'practically eliminated'* and so on - for further examples see Paul Dorfman's witness statement [¶2.1].

89 In other words Giles Scott's *'highly unlikely'* could mean a chance in 1 in 10, 1 in 100, 1 in 1,000, 1 in 10,000 and so on – with the greatest of respect to Giles Scott and the authors of the A37, this usage is meaningless in statistical terms, if not defying commonsense.

90 SoS also relies heavily on the chance of events occurring, such as [¶2(7), p23-4][9i)]

91 *“. . . the law is clear that the expression includes effects of which there is a “real risk”, but not events of which there is only a bare possibility. . . “*

92 However, he does so in terms of a legal definition of risk and probability, whereas he is referring to *‘events’* as these are defined in the nuclear safety case, being set down in clear numerical rankings in the ONR’s Safety Assessment Principles (SAPs).[43]

93 The SAPs specify targets and risks, usually expressed as a range of *Basic Safety Level* (BSL) and *Basic Safety Objective* (BSO), together with an overarching requirement for the NPP licensee to control the radiological hazard as *‘low as reasonably practicable’* (ALARP).[44]

94 SAPs *Target 8* [¶617, p102][43] is set in terms of the frequency of accidents that could give rise to specified levels of dose to an individual off the site, for example the frequency of event giving rise to an effective dose of between 10 to 100mSv is BSL 1 in 100 and BSO 1 in 10,000 per annum where the BSO would be considered near-ALARP.

95 The societal risk limits arising from a severe accident is set by *Target 9* [¶623, p103][43] in terms of the total risk of 100 fatalities arising (in short and longer terms) as a result ionising radiation exposure is specified as BSL 1 in 100,000 and BSO 1 in 10,000,000 per annum.

96 The SAPs are quite clear that account of severe accidents by severe accident analysis (SAA) should be considered [¶597, p98][43]

97 “*. . . particularly important in assessing the overall impact of the site in terms of the risks of major accidents that could lead to significant off-site consequences . . .”*

98 and that [¶622, p102][43]

99 “*. . . SAA will be important in assessing the overall impact of the site in terms of the risks of major accidents that could lead to significant off-site consequences. . .”*

100 These examples of the statistical interpretation of risk and the importance of taking into account severe accidents, as set down by the nuclear safety regulator, provide the targets, limits (BSL to BSO) and thresholds for nuclear safety and, therefore, should have featured in SoS’s reasoning in the Screening Decision.

101 **In summary**: The statements of Giles Scott and SoS strongly suggest to me that the basis for and the assumptions underpinning SoS’s conclusions that there would be no significant radiological impact on the Republic of Ireland from a nuclear accident at HPC NPP was flawed. This is because, amongst other things, SoS’s decision making process

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43 HSE, *Safety Assessment Principles for Nuclear Facilities*, 2006.

44 In meeting the BSL the risks may not necessarily be ALARP and the application of ALARP serves to drive the risks lower.

102 i) placed too much reliance upon on the A37 submission instead of probing into and benefitting from other established assessments and reports – in this respect it was not a rigorous exercise, it was incomplete and it was not sufficiently broad-based;

103 ii) it did not consider the worst case accident/incident, both in terms of severity and likelihood of occurrence, and it failed to properly quantify these determinant factors, instead relying on qualitative and at times the subjective reasoning of the A37 submission, nor did it adopt the precautionary principle to include the worst case – in these respects the worst case accident/incident chosen was inappropriate; and

104 iii) it failed to explore the effects of future design and development changes and additions, research and the quite specific requirements made of the licensee that were outstanding at the time of the Screening Decision (March 2013) – in these respects there were gaps in the process and uncertainty about the future fault condition performance of the proposed HPC EPR NPP.

105 **b) THE COURT'S EVALUATION OF SOS'S ASSUMPTIONS AND CONCLUSIONS**

106 For this I shall consider the extent to which the Court will be able to evaluate the processes by which Defendant made the assessments, etc., and conclusions on which the Defendant.

107 I have read through the respective witness statements of Paul Dorfman and John Sweeney, each of whom has independently identified many of the shortfalls that have contributed to SoS's Screening Decision, so here I shall just example what I consider to be more major deficiencies in SoS's provision of technical grounds to the Court:

108 **Worst Case Accident/Incident**: As I have previously explained the March 2011 event at Fukushima Daiichi demonstrates that SoS's hypothetical worst case has been overturned by the real events at the Fukushima Daiichi NPP.

109 SoS's stance on this is given in his views in the Screening Decision at S6.6.2 [3/B995-996], in that:

110 *". . . 6.6.2(iii) The Austrian expert contends that in assessing the likely environmental effects of the HPC project, I should take into account the effects of **very low probability**, extreme (or severe) accidents, Effectively, the report says that unless it can be demonstrated that a severe accident (involving significant radiological release) cannot occur, then no matter how unlikely it is, I must consider its consequences as part of the development consent process, having regard in particular, to the possible deleterious effects on Austria. However, in my view **such accidents are <u>so unlikely</u> that it would not be reasonable to "scope in" such an issue for environmental impact assessment purposes.**"*

my ***emphasis*** and ***<u>underlining</u>***

111 This is the Black Swan conundrum:[45] The Austrian expert believes that since the existence of Black Swans is established fact, then account must be taken of their existence but, to the contrary although acknowledging the Back Swans exist, SoS argues that they are only to be found on the other side of the World, so he is never likely see one.

112 Much the same argument is proffered by A37 on the Fukushima Daiichi incident, that is tacitly implying that it was a Black Swan event that could not possibly happen here, being an accident that occurred on the far side of the World and, moreover, that it was triggered by external challenges (the earthquake and tsunami) that we do not encounter on our shores [¶789, p161].[8]

113 My point here is that facts, opinions and times have changed between the date that the A37 was submitted (September 2011) and the Screening Decision (March 2013). By March 2013, we (nuclear industry and particularly the nuclear safety regulator) had developed a much deeper understanding of the underlying and fundamental root causes of the Fukushima Daiichi event and how this might apply to other existing and proposed NPP designs – APPENDIX 1.

114 This deeper understanding is reflected by the ONR Chief Inspector's FR-4 Recommendation [§47] of September 2011 that a *'full range of external events including "beyond design basis" events'* be taken into account and, quite separately, by the ONR *stress tests* National Report[28] of December 2011. With this recommendation the Chief Inspector strengthened the established SAPs requirement that severe accident analysis (SAA) should be undertaken in assessing the overall impact of the NPP site [§96].

115 Put simply, prior to 11 March 2011 events at Fukushima Daiichi would *not* have been considered *reasonably foreseeable* or *credible*.

116 However, now that it has happened it, and accidents of similar severity that were previously considered to be incredible and, hence, discountable it is, I suggest, not a complete answer for

45 The *Black Swan* theory was developed by Taleb, Nassim Nicholas (2007), *The Black Swan: The Impact of the Highly Improbable*, Random House.

SoS (and any of the documents and assessments that he purportedly relied upon)[46] to dismiss a similar accident at HPC solely on the basis that *'it could not happen here'* (ie it would be a Black Swan event).[47,48,49]

117 The present information and documentation relied upon and presented to the Court by SoS does not provide a realistic and representative range and severity of worst case accident/incident scenarios.

118 Such a representative range of accidents/incidents should also have included a radiological release sourced from i) a spent fuel pond incident occurring at a time when several refuelling cycles had been undertaken;[50] ii) a terrorist or other malevolent act whereby the nuclear island containment is deliberately targeted and breached; iii) a scenario where there is a strong leakage pathway to the marine environment; and iv) a SBO situation where the centralised control and instrumentation dual computer platforms (TXS and SPPA) fail and control of the plant is not recovered by the hard core NCSS stand-alone system [¶3, p14].[6c)] Importantly, these accident/incident scenarios should have included some degree of failure of the primary containment and, hence, a more realistic radioactive release.

119 **Inaccessibility of Information:** Information that is vital for assessing certain of the external hazards has been withdrawn (redacted) from the Pre-Construction Safety Report (PCSR)[50] on the basis that it is *'AREVA or EDF Commercially Confidential Information {CCI}'*.

120 For example, in Sub-Chapter 2 the aircraft crash frequency for the generic case (and from which the HPC site risk would be determined) has been redacted thus [¶3.1, p16]:[51]

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46 This point is also discussed by Paul Dorfman in his witness statement [¶6.6, p4] whereby SoS admits that he does not have, and never has had, copies of the documents that he relies upon to a greater part for his Screening Decision.

47 Actually, my Black Swan metaphor has a major shortcoming: this is that although, like the New Zealand Back Swans, Fukushima Daiichi was on the far side of the World the engineered structures were designed, constructed and operated to common, universal standards,[48] and the regulatory framework will have been with the over-arching standards set out by the International Atomic Energy Agency.[49]

48 At Fukushima Daiichi Units all six units were of a US General Electric design, likes nuclear reactor installations world-wide all of the steel pressure vessels conformed to the America Society of Mechanical Engineers (AMSE) Code of Practice BPVB III, and the reinforced concrete structures making up the primary containment would have compliant with similar common standards and codes of practice.

49 Similarly, the nuclear safety regulatory framework in Japan is not that different to the international model of nuclear safety regulation adopting, as it does, a risk-informed approach[31] which underlies the *'acceptable risk and tolerable consequences'* composite assumed almost universally. In this respect I disagree with the ONR's conclusion that there is a disparity between the Japanese deterministic methodologies and the UK probabilistic approach as stated in A37 [¶789, p161].[8]

50 The A37 does not include a safety case assessment for a spent fuel pond incident and, similarly, its source document the *Pre-Construction Safety Case, Chapter 16, Risk Reduction Analysis*, 31 March 2011 has yet to fully develop the spent fuel safety case - intensely radioactive spent fuel is expected to stay on site for 100 years post NPP commissioning [¶740, p152].[8]

51 Hinkley Point Pre Construction Safety Report *Sub Chapter 2.2 Verification of Bounding Character of GDA Site Envelope Part of Chapter 2, Site Data And Bounding Character of GDA Site Envelope*, NNB Generation Company, 3 January 2012 – this is the basis data set for a generically sited EPR and from which site-specific hazards are further quantified,

121 *"... *

The aircraft crash frequency from the GDA is calculated to be {CCI removed}."

122 Previously, I gave example of a loss of off-site power (LOOP) triggered incident [§20] but, like aircraft crash, the frequency of LOOP events is also suppressed [¶Table 15, p33]:[51]

123 "...

Table 15: LOOP Results from National Grid Study

LOOP Timescales Indicative	LOOP Frequency (y-1)
< 1 minute	{ CCI Removed }
> 1 minute < 1 hour	{ CCI Removed }
> 1 hour < 2 hours	{ CCI Removed }
> 2 hours < 24 hours	{ CCI Removed }
> 24 hours	{ CCI Removed }

..."

124 In total, 17 similar redactions of data and information have been rendered in PCSR Sub-Chapter 2 thereby denying any quantitative assessment of the bounding parameters of a number of external hazards to the generically sited EPR NPP.

125 The extent of redaction throughout the PCSR is extensive. For example, in Chapters 15 and 16 which deal with the Probabilistic Safety Assessment (ie the expected frequency of occurrence) and the risk reduction assessment, including internal and external hazards and plant response to these, have the following rates of redaction, including entire tables, diagrams, etc:

126 **TABLE A EXAMPLE RATES OF REDACTION IN CHAPTER 15 & 16 PCSR**

SUB-CHAPTER	N° OF REDACTIONS
15.1 Level 1 PSA	280
15.2 Internal/External Hazards	39
15.3 Spent Fuel Pond	45
15.4 Level 2 PSA	257
15.5 Level 3 PSA	3
15.6 Seismic Margin Assessment	16
15.7 Discussion and Conclusions	263
16,1 Risk Reduction Analysis	0
16.2 Severe Accident Analysis	7
16.3 Practically Eliminated Situations	0
16.4 Specific Studies	2
16.5 UK EPR Functional Diversity	31

127 The incompleteness of information and data vital to the understanding of the assessments and conclusions of the Defendant is not available in the public domain. Where this relates to the probability or (actual) frequency of occurrence, as with the redacted National Grid LOOP data [§123].

128 What is important here is that although much of the risk (probability and actual frequency) data has been redacted to the likes of me and other independent experts, it exists in the proprietary version of the PCSR to which SoS would have had, surely, open access. If he had accessed the proprietary version of the PCSR then he would have been more informed about the risk of occurrence of severe accidents.

129 **In summary**: Although it is difficult to track the stage-by-stage processes taken by SoS in reaching his Screening Decision, it is clear to me that he did not:

130 i) undertake a systematic and ordered process when defining and applying the range of worst case accident/incident scenarios, accepting as he did the A37 that was compiled by the future operator/licensee of the HPC NPP *NNB Genco* – in this respect the A37 upon which SoS relied could not be considered to be wholly independent;

131 ii) to have made a informed judgment of the risk of severe accident SoS should have consulted the proprietary version of the PCSR, it is obvious to me that he did not – in this respect SoS had no benchmarks to value and justify his Screening Decision which, being so critically dependent upon the risk of severe accident being acceptable, must have deficit in objectivity and justification. and

132 iii) when compiling the A37 *NNB Genco* must have referred to the PCSR, yet the publicly available version of the PCSR is heavily redacted in those chapters dealing with the bounding parameters, hazards and response (both within and beyond the *design basis*) and, furthermore there is no source referencing substantiating the claims contained within the A37 – this these respects the A37 and SoS's processes reliant upon it were secretive.

133 **c) COMPLETENESS, PRECISION, ETC OF SOS'S FINDINGS AND CONCLUSIONS**

134 I have previously given examples of the incompleteness, etc., of SoS's findings and conclusions so, I suggest, suffice to examine a few principled points.

135 **My Own Assessment:** First, I note that if I personally had been required to arrive at a decision on whether the Republic of Ireland should be involved in the consultation process then, on technical grounds, I would have concluded that an EPR NPP sited at HPC could, in

the event of a severely damaging accident, present an intolerable radiological threat to the Republic of Ireland.

136 To arrive at this decision I would have needed to have looked beyond the limited information and data provided by the A37 submission; I would have had to plug the gaps in lack of specific risk-informed data resulting from the somewhat heavy-handed redactions in the PCSR; and I would have taken on board the lessons learnt from previous severe nuclear accidents, such as Chernobyl and Fukushima Daiichi.

137 Also, I would have been aware that the design of modifications to the all-important primary containment was underway [§56, f29], as a result of Fukushima Daiichi and that these might take some years to fully develop and practicably implement. Even so, as an engineer I would have to accept that there is a limit to the amount of *belt-and-braces* that can be practicably added to a developed design, so that the risk of failure of the primary containment (and other key-safety systems) can never be completely eliminated.

138 I am confident that as a professional engineer, experienced in such matters, my assessments and the conclusions that I would have reached would not be those reached by SoS and, moreover, I could have arrived at my conclusions in good time before the Screening Decision date of March 2013**.**

139 **Broad-Based and Effectiveness of SoS's Decision**: Since SoS's Screening Decision excludes the potential radiological effects on the Republic of Ireland, his assessment cannot be considered to be broad-based nor effective. Similarly, because the range (diversity and severity) of accidents/incidents considered by SoS is both curtailed and suppressed, I consider the Screening Decision also not to be broad-based nor effective in this regard.

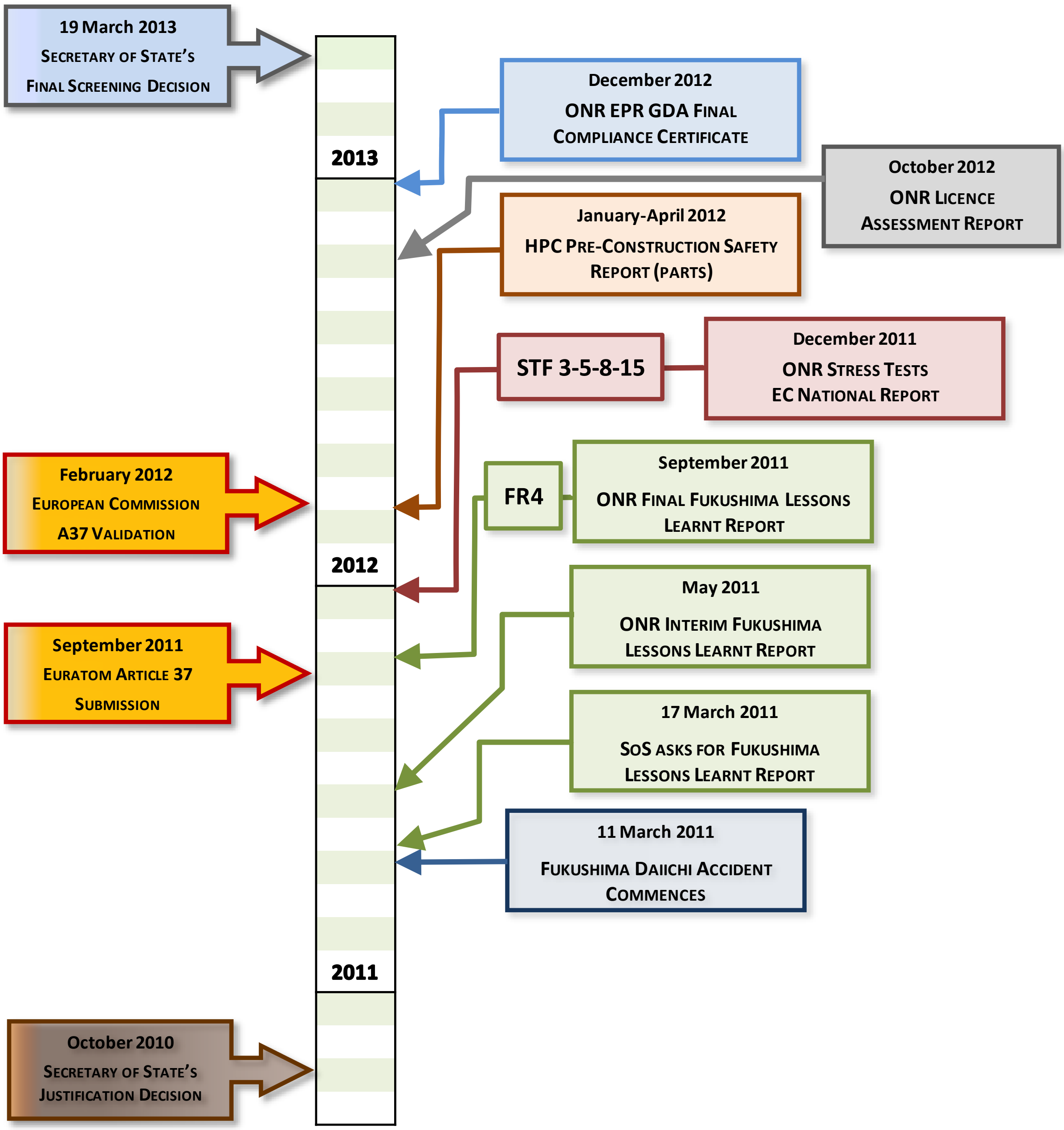
140 **Rigorousness**, **Comprehensiveness** and **Completeness of SoS's Submissions:** I consider the submissions made to the Court by SoS in support of and to justify his Screening Decision to be wanting on a number of important technical grounds and in incomplete in the process stages undertaken.

141 I have referred to certain of these shortfalls and omissions earlier in my witness statement so suffice to note here that I consider the submissions made by the SoS do not, in my opinion and specifically on technical grounds, provide a sufficiently robust and complete argument that the Republic of Ireland should have been excluded from the trans-boundary consultation.

142 In other words, the evidential base provided by A37 and the process(es) that seems to have been followed through by SoS was insufficient and unreliable for the decision to which it pertains.

143 I state here that I confirm that I have made clear which facts and matters referred to in this Statement that are within my own knowledge and those which are not. Those that are within my own knowledge I confirm to be true. The opinions I have expressed represent my true and complete professional opinions on the matters to which they refer.

JOHN H LARGE
LARGE & ASSOCIATES
CONSULTING ENGINEERS, LONDON



Appendix I Time Lines relating to the Secretary of State's Screening Decision