

**ON ASPECTS RELATING TO THE OPERATIONAL NUCLEAR SAFETY OF THE  
ŌMA NUCLEAR POWER PLANT, AOMORI**

**INSUFFICIENCIES AND INCOMPLETENESS OF THE DESIGN, CONSTRUCTION  
AND NUCLEAR SAFETY CASE SUBMISSIONS AVAILABLE IN THE PUBLIC  
DOMAIN**

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**3<sup>rd</sup> Opinion and Statement of JOHN H LARGE**

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REVISION	REVISION	THIRD EDITION
		<b>21 FEBRUARY 2017</b>

The authoritative version of this statement is the English language version.

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**3<sup>RD</sup> STATEMENT OF JOHN LARGE**

- 1 I am John H Large of the Gatehouse, 1 Repository Road, Ha Ha Road, London, United Kingdom SE18 4BQ.
- 2 I have stated my experience and professional qualifications in nuclear engineering and related matters in my 1<sup>st</sup> Statement to the Court of 29 December 2016.
- 3 I am familiar with the design and operation of light water moderated nuclear power plants (NPPs) such as the pressurised water reactor (PWR), the boiling water reactor (BWR) and its advanced variant the ABWR being the reactor type presently under construction at Ōma.
- 4 I am aware that construction of the Ōma NPP was first planned to commence commercial operation in or about 2008 but that this was subsequently delayed to enable design amendments in account of the national review of Japanese seismic standards. Then, following the catastrophic failure of the three operating BWR units at Fukushima Daiichi during the earthquake and associated tsunami of March 2011, further construction at Ōma was again suspended until around October 2012.
- 5 The Court will be aware of the upheaval to the Japanese nuclear safety regulatory framework following Fukushima Daiichi events of 2011 and, thereafter, the progressive introduction of the newly formed (September 2012) Nuclear Regulation Authority's (NRA) *Draft New Safety Standards for Nuclear Power Stations* (1) and, separately, the *Outline New Regulatory Requirements for the Design Basis* (2), *Severe Accident Measures* (3), and *Earthquakes and Tsunamis* (4) respectively, all introduced in outline or draft form in April 2013.
- 6 The latest position with the construction programme at Ōma is that '*safety upgrades*' to suit the NRA's *New Safety and Regulatory Standards and Requirements* (items 1, 2, 3 and 4 of paragraph 5) are not planned to commence until 2018 for completion in or about 2023.

- 7 According to this chronology, the basic design amendments (ie the *'safety upgrades'*) necessary to account for and satisfy the NRA's *New Safety and Regulatory Standards and Requirements* for the Ōma NPP could not have commenced in earnest until post April 2013.
- 8 In fact, in responding to the *New Regulatory Requirements*, the Ōma NPP operator J-Power submitted an *'Installation Change Review'* (ICR) to the NRA sometime in 2014, although I have not been able to discover details of this submission by searching the public records.
- 9 My experience is that for an established regulatory framework to consider and approve even the introduction (ie modification) of a single novel feature to a proven nuclear reactor design requires several, time-consuming rounds of interrogatory exchange between the regulator and the licensee to settle.
- 10 For the Ōma 2014 ICR much ratification of meaning and detailed interpretation would have been needed because of the outline and draft nature of items (1), (2), (3) and (4) of paragraph 5 and, in addition, further time and resources have to be spent in account of the partially constructed state of the Ōma NPP, particularly because of the i) advance stage of construction of the nuclear island and ii) the engineered complexity and magnitude of each of the *'safety upgrades'* necessary to bring the Ōma NPP into compliance with the post-Fukushima Daiichi *New Regulatory Requirements*.
- 11 For these reasons I consider that the J-Power's 2014 ICR must have been rudimentary and following its submission subject to much discussion and refinement.
- 12 To arrive at a sense of the time scales involved in meeting regulatory compliance, for similar modifications to an existing but unfinished NPP in the West, I could track progress of the particular issue, item, equipment, etc. For example, in the United Kingdom progress would be publicly announced via a series of Licence Amendments and Conditions, Regulatory Hold-Points, Design Acceptance Confirmation and, finally, the Site Nuclear Licence – all of these regulatory framework stages would have to comply with various international and national standards and codes of practice, including the Technical Assessment Guides, the Safety Assessment Principles for Nuclear Installations, Pre-Construction and Pre-Commissioning Safety Reports, and so on.
- 13 In fact, the ABWR type of NPP is presently under review by the United States Nuclear Regulatory Commission (NRC) and, separately, in the United Kingdom by the Office of Nuclear Regulation (ONR). Both of these are essentially paperwork projects with the generic and detailed design undergoing a regulatory approval process before construction is permitted to commence.

- 14 For example, the ONR's *Generic Design Assessment* (GDA) of the Hitachi-GE ABWR commenced in January 2013 and is not expected to gain *Design Acceptance* until, at the earliest, December 2017 (about 5 years in total). Even then the final licensing stage, which has to account for the NPP's site-specific features, is expected to take a further 18 months to 2 years or more.
- 15 What is of interest here is that the ABWR proposals submitted respectively to the NRC and ONR is that the pre-Fukushima Daiichi (2011) general and detailed designs have undergone substantial amendment in account of Fukushima Daiichi events – this is particularly apparent in the reinforced concrete containment barrier of the nuclear island; the arrangements for post fuel core melt management (ie the fuel corium catcher); and, beyond the NPP perimeter the safeguarding and securing of (by duplicating) off-site electrical supply lines and regional and national electricity supply grid infrastructure.
- 16 My point here is that the same process for the Ōma NPP has to be conducted with a fledgling nuclear regulatory agency (the NRA), via a series of outline, draft and largely unproven regulatory requirements (items 1, 2, 3 and 4 of paragraph 5), and for a NPP that has already been partially constructed with much of the nuclear island completed (ie the mass, reinforced concrete structure that houses the reactor and interim spent fuel pond, and provides the ultimate containment for both).
- 17 In paragraph 6, I noted that the Fukushima Daiichi safety upgrades for the Ōma NPP would not commence physical installation until 2018.
- 18 This suggests to me that the final design of these safety upgrades has yet to be finalized and approved by the NRA. This is very apparent from the written statement of Tetsuro Kobayashi, the Chief Engineer of J-Power, to the Court in which he claims (Part 2 Basic Approach to Safety Measures) that the third basic safety function, that of "*confinement of radioactive material*" for abnormalities or accidents, is achieved.
- 19 Because the final design, regulatory approval and construction of the nuclear island containment barrier for Ōma NPP has yet to be completed, I cannot share Mr Kobayashi's confidence in that this final, safety critical containment will be adequate for all credible, external and/or internal incident/accident scenarios. Indeed, the question that Mr Kobayashi has not addressed is whether the final containment design (that has yet to be made public according to my searches) has or will be compromised by the advanced and virtually unchangeable construction stage of the existing nuclear island at the Ōma NPP.

- 20 In my opinion, the advanced state of construction of the Ōma NPP nuclear island will hinder the optimal design and implementation of certain of the 'safety upgrades' – in this respect I disagree with Mr Kobayashi that *"Since Ohma nuclear power plant is currently under construction, it has the advantage of it being relatively simple to incorporate into the design new measures discussed"* because I strongly believe the exact opposite applies, particularly in that the existing structures and equipment are likely to preclude certain design options.
- 21 Referring to the regulatory approach to the ABWR in the West (paragraph 13), post-Fukushima Daiichi design appraisals pool information via *Multinational Design Evaluation Programme* (MDEP). This enables the sharing of technical information and technical assessment findings and opinions with the nuclear regulatory authorities of the United States NRC, Sweden SSM, Finland STUK and the United Kingdom ONR, the findings of which are relayed to Japan's NRA.
- 22 The MDEP has made substantial progress with the development of a generic ABWR addressing issues arising from the Fukushima Daiichi accident, particularly how the various operational ABWR NPPs tackle the key safety areas of i) evolutionary improvement in safety, ii) external hazards, iii) reliability of safety functions, iv) accidents with core melt, v) emergency preparedness in design, vi) spent fuel pools and, more generally, vii) safety analysis.
- 23 Even though commenced in 2014, the MDEP has yet to publish its final recommendations on the revisions required for the tolerably safe operation of existing ABWR NPPs and, importantly here, it is yet to specify revisions to the regulatory framework for ABWR projects presently undergoing regulatory assessment stages.
- 24 My point here is that a host of independent western nuclear safety regulators has yet, in 2017, to determine the final, acceptably safe form (both generically and site-specific) of the ABWR NPP.
- 25 To my assessment the Japanese regulator, the NRA, is in much the same position, as is the technical representative of J-Power Tetsuro Kobayashi.
- 26 This is because I find Mr Kobayashi's written statement and response to cross examination simply do not address the issues raised by past events at Fukushima Daiichi – I arrive at this conclusion with the greatest of respect for Tetsuro Kobayashi who has proven credentials of qualification and experience in the nuclear power generation and safety fields.

- 27 I suggest that the reason that Mr Kobayashi does not address in detail the safety issues raised by past events at Fukushima Daiichi and also, separately, from the root-and-branch reviews presently underway by MDEP, is that design amendments proposed for the Ōma NPP (see Section 6 of the Mr Kobayashi's written statement) have yet to be worked-up and finalised in detail.
- 28 For example, Section 6.2 of the written statement considers preventative measures against containment damage, including for management of the 100 tonnes or so of molten fuel corium as it drops from the melted-through reactor pressure vessel bottom head.
- 29 The original ABWR was not designed for this corium melt-through scenario so, somewhat improvised in my opinion, the Ōma NPP intends to cool the corium by water spray to confine it to within the reactor pressure vessel (RPV) – the risk here is, as acknowledged by Mr Kobayashi, that the molten corium will drop from the fuel thimble into water either in the bottom of the RPV or, as a follow on, from the bottom of the RPV to the 'dry well' into which the corium emergency cooling water has accumulated, with both scenarios at the risk of violent steam explosion as the molten corium plunges into the water.
- 30 This contrasts with the French European Pressurised Reactor (EPR) which is the first reactor to be designed to allow the corium to burn through the RPV to be then managed on the floor below.
- 31 Essentially, the EPR contrives this process to be entirely dry, thus eliminating so far as is practicable, a corium-water plunge steam explosion and, separately, the generation of hydrogen from the exothermic reaction of steam and the zirconium alloy fuel cladding. The EPR post-melt corium 'catching' pit is furnished with a specially developed ceramic surface to resist the intense corium heat and inhibit the generation of non-condensable gases if allowed direct contact with cementitious concrete; the flow of corium from the 'catching' pit is controlled via a series of erodible banks or dams that release the corium lava-like flow to disperse over a cooling floor that has banks of buried passive water cooling pipes linked to a dedicated remote reservoir.
- 32 The post-melt corium management system installed on the four EPR NPPs, each presently at advanced stages of construction, is a fully custom-engineered and developed system that has undergone large-scale demonstration trials with molten uranium as representative corium feedstock. Moreover, it is a safety feature that has been independently approved by five national nuclear safety regulators (France, United States, People's Republic China, Finland and the United Kingdom).

- 33 In the United Kingdom the ONR has also examined the post-melt corium management system proposed for GE-Hitachi ESBWR NPP (economic simplified BWR but now referred to as UK-ABWR) presently undergoing generic design assessment and, although acknowledging there to be merits in the claim that post-melt corium will be retained, it noted *“the arguments and evidence to support it will, in our view, be challenging to demonstrate with an appropriate degree of confidence”* (see ONR-HSE *Public Report on the Generic Design Assessment of New Nuclear Reactor Designs – GE-Hitachi Nuclear Energy International LLC ESBWR Nuclear Reactor – Step 2 Fundamental Safety Overview*). I have good reason to believe that the final decision on the post-melt corium management system for the UK ABWR will be delayed until the final report of the MDEP (see paragraph 22). The post-melt corium management system described by Mr Kobayashi is clearly only at the planning stage because he states *“there are plans to provide what is known as a corium shield . . . in the vicinity of the sump”* (see Section 6.4 and Figure 6-7 of the J-Power written statement); if developed it will have to be shoe-horned into the existing basement reactor pit or sump; its operation is accompanied by acknowledged risk of very violent steam explosion (see Section 6.iii of J-Power written statement) although the risk, claimed to be *“extremely small”*, it is not at all quantified; and, importantly, although now a prerequisite of the NRA’s *New Regulatory Requirements - Severe Accident Measures* that a post-melt corium management be in place, there is nothing in the public record to suggest that this outline scheme has already or is expected to meet regulatory approval.
- 34 My examination of the post-melt corium catcher *‘planned’* for the Ōma NPP has been limited by the very generalised nature of the J-Power written submission to the Court. Again with respect to Tetsuro Kobayashi, my conclusion is that there is insufficient detail and certainty about the proposed design presented by the J-Power written submission for a professional engineer, like myself, to arrive at a properly informed opinion on this vital safety feature proposed for the Ōma NPP.
- 35 Similarly, I have examined, so far as the details presented in J-Power submission permit, other key aspects of the design and construction modifications claimed by J-Power that will bring the pre-Fukushima Daiichi Ōma NPP design into compliance with the NRA’s post-Fukushima Daiichi *New Regulatory Requirements*. For this I have given particular regard to the measures (planned to be) provided against severed accidents, essentially the J-Powers planned *‘safety upgrades’* that I refer to in paragraph 6.

- 36 Included amongst these topics of my specific interest are the i) Release Fraction of the mixed oxide fuel (MOX) and the chemistry (volatility), particulate size (respiratory uptake) and dispersion/deposition behaviour of its transuranic products and actinide elements; ii) the resilience of the nuclear island reinforced concrete structure when subject to extreme external and internal events; iii) the over-dependency upon portable power units and the heightened vulnerability of such units to extreme external events; and iv) the effectiveness of J-Power's *Disaster Prevention Planning* (as required by the NRA's *Nuclear Emergency Response Guidelines*).
- 37 All of these topics from i) through to iv) depend in varying degrees on the final form and implementation of the 'safety upgrades' essential to convert the Ōma NPP from pre- to post-Fukushima Daiichi compliance with the *New Regulatory Requirements*.
- 38 However, all the evidence and information that I have reviewed strongly suggests these 'safety upgrades' have yet to be fully prepared for approval by NRA and installed at the Ōma NPP (planned for installation from 2018 through to 2023), so much so that analysis of the respective and combined effectiveness of the 'safety upgrades' can only be presented in the vaguest of terms.
- 39 In addition, I have searched the public records for detailed information on the Ōma 'safety upgrades' but nothing specific to Ōma NPP has been forthcoming – this included Japanese colleagues searching Japanese language sources and the archives of the NRA.
- 40 In other words, there is very little reliable, technical and sufficiently specific information about the Ōma 'safety upgrades' for me, or any other professional engineer, to arrive at an informed judgment about the compliance of the Ōma NPP with the NRA's *New Regulatory Requirements*.
- 41 With respect, might I suggest that this lack of detailed information also applies to the descriptive and technical information made available to the Court and may serve to impair its judgment on the engineering and technical aspects matter.
- 42 I have similar concerns and reservations about other aspects of how the existing pre-Fukushima Daiichi design is to be adapted to meet the safety prerequisites of the NRA's *New Safety and Regulatory Standards and Requirements* (items 1, 2, 3 and 4 of paragraph 5), particularly in that these safety modifications are not planned to commence until 2018 for completion in or about 2023.
- 43 In conclusion: At this point in time, I am unable to assess how the Ōma NPP will perform when subject to extreme external and/or internal event conditions at any time after its



scheduled commissioning in or around 2023 so, I add, it might be appropriate for the Court to defer its judgment until it receives a final and complete detailed demonstration of the post-Fukushima Daiichi safety case from J-Power that has been endorsed by the NRA.

44 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.



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