PLANNING APPLICATIONS Y06/1647/SH AND Y06/1648/SH

PROPOSALS FOR

NEW TERMINAL AND RUNWAY EXTENSION

AT

LONDON ASHFORD AIRPORT AT LYDD, KENT

NUCLEAR SAFETY OF THE NUCLEAR POWER PLANTS AT DUNGENESS

AS DETERMINED BY THE

PROPOSED DEVELOPMENT OF LONDON ASHFORD AIRPORT

CLIENT: LYDD AIRPORT ACTION GROUP

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SAFETY OF THE EXISTING AND FUTURE NUCLEAR POWER PLANTS AT DUNGENESS

SUMMARY

I am John Large, a Chartered, Consulting Engineer with considerable experience in nuclear matters.

I have been instructed by the *Lydd Airport Action Group* to provide opinion on if and how the proposed development of the London Ashford Airport (LAA) at Lydd might impinge on nuclear safety of the Dungeness nuclear power plants.

I have considered this matter in terms of any change to the risk of aircraft crash onto the Dungeness nuclear power plants (NPPs); the severity of damage to the NPPs that that could arise from aircraft crash; the radiological hazards at those plants; and if and how these hazards might result in radiological consequences to the public communities nearby and afar from Dungeness.

In these respects:

i) I am of the opinion that the proposed development of the airfield at Lydd would introduce an increased level risk of accidental aircraft crash onto the existing Dungeness NPPs.

For the expansion to 500,000 passengers per annum (ppa) I predict that the overall risk of a commercial airliner accidentally crashing onto the Dungeness NPP site to be 1.4507E-06 per year, that is odds of 1 in 689,229 in each year. Should LAA expand to 2,000,000 ppa then the risk of aircraft crash increases to 2.9099E-06 per year or the odds of 1 in 409,691 in each year.

Both of these risk levels are substantially higher (ie more frequent) than the 1 in 10 million level of acceptable odds or risk of accidental aircraft crash imposed by the Nuclear Installations Inspectorate (NII) in order to maintain the nuclear safety case. In this respect, the LAA generated risk would be unacceptable in terms of the potential radiological consequences to individual members of the public and, in societal terms, generally as a whole.

I refer to and agree with the previous statement of the NII (see para 53 of main text) that any development in air traffic at Lydd airport beyond its last periodic safety review of 1995/97 will require reconsideration of the nuclear safety case. The present proposals to redevelopment LAA are substantially and materially different from 1995/97, involving both increased numbers of air traffic movements and larger aircraft, so much so that it would be prudent for the nuclear safety cases for both Dungeness B (operational) and Dungeness A (decommissioning) to be comprehensively re-evaluated and published prior to the present planning application moving forward to the final decision stage.

Put simply, past and present air traffic operations at LAA have comprised mainly light aircraft which do not pose, in terms of damage potential, a crash threat on the Dungeness NPPs, and the movements of heavier commercial aircraft to and from the airport are presently so infrequent so as not to represent a threat to the NPPs. In contrast, the proposed expansion of LAA introduces commercial airliners, the majority of which are over 20 tonnes take-off weight, so the threat to the Dungeness NPPs is rendered *credible* in terms of damage severity and frequency of occurrence. In other words, the expansion of LAA introduces credible and novel accident scenarios that were not included in the original engineering designs and safety cases of the Dungeness A and B NPPs.

ii) I show that the legislation and regulatory framework determining an acceptable level of nuclear safety to be complex, extending beyond the engineering systems and on-site management of the NPPs alone.

For example, given that is it not possible to proof the existing Dungeness NPPs against aircraft crash by back-fitting, then it has to be acknowledged that a severely damaging *credible* aircraft crash accident could progress to an off-site radiological incident that can only be countered in the emergency response domain. The introduction of the new aircraft crash accident scenario and its novel radiological outcome would require substantial re-evaluation of the state of preparedness and resources allocated by the local authority in its off-site emergency planning; the pre-prepared countermeasures emergency zone might require expansion and redefinition, public evacuation and sheltering distances might have to be redefined,; and so on.

These and other changes in the decommissioning procedures for currently Dungeness A and later Dungeness B, together with justification of the nuclear and radiological process underway at the Dungeness site will also need to be reviewed for amendment should the proposed LAA development proceed.

iii) I have similar reservations about the risks and potential radiological consequences relating to aircraft crash on the completely unprotected railhead for loading irradiated fuel flasks and for the rail dispatch of these flasks over a track that passes close by the southern end of the LAA runway. Again, I consider it prudent for the railhead and transportation safety cases be reviewed. Included in these reviews should be consideration of the very large volumes of radioactive wastes that will arise during decommissioning of, first, Dungeness A and then Dungeness B.

iv) I have briefly considered the influence that commercial operations at LAA may have on future development of nuclear power generation on the Dungeness site. Since it is most unlikely that the NII will make an exception of the Dungeness site and relax the 1 in 10,000,000 per year screening limit of aircraft crash frequency, any new NPP will have to demonstrate absolute surety of its containment and reliability of its nuclear and safety systems when subject by the very high forces of the impact, fire and possible aviation fuel deflagration brought about by the crashing of a commercial airliner.

In my judgement it is not possible to proof a NPP against aircraft crash so the event must be ruled out by other means by, first, limiting the gross size (weight and fuel capacity) of the aircraft and, second, by setting a limit to the predicted frequency of crash. The proposed development at Lydd does neither: it raises the size of the aircraft using the airport and it increases the number of air traffic movements. Thus, granting the LAA development would place a prohibition on any future development of the Dungeness nuclear site with it losing favour as the leading candidate site for future nuclear generation capacity in the South-East.

My understanding is that in considering the LAA development application, the planning authority has a duty to identify and take into account all material considerations, including public health and safety. Since the airport site, air traffic approaches and departures are within close proximity to the Dungeness A and B nuclear power plants, any potential change in the nuclear safety of these plants will be a material consideration. I am of the opinion that the planning authority should give full consideration of development of LAA resulting in a reduction in the nuclear safety of the Dungeness nuclear plants, thereby placing the public at greater risk of being subject to intolerable levels of radiological consequence.

Accordingly, I am of the opinion that the Application to develop LAA should not be granted.

Finally, I have refrained from commenting in detail on the potential opportunities that further development of LAA would provide for terrorist and other malevolent acts that might be targeted at the Dungeness NPP site. That said, I have no doubt in my mind that commercial operations at LAA would provide openings for such acts to be perpetrated.

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PLANNING APPLICATIONS Y06/1647/SH AND Y06/1648/SH

SAFETY OF THE EXISTING AND FUTURE NUCLEAR POWER PLANTS AT DUNGENESS

1 **QUALIFICATIONS AND EXPERIENCE**

2 I am John H Large of the Gatehouse, 1 & 2 Repository Road, Ha Ha Road, Woolwich, London SEI8.

3 I am a Consulting Engineer, Chartered Engineer, Fellow of the Institution of Mechanical Engineers, Graduate Member of the Institution Civil Engineers, Member of the British Nuclear Society and a Fellow of the Royal Society of Arts.

4 From the mid 1960s I was engaged as a research fellow working on defence related work in the United States, thereafter from 1970 through to the early 1990s I was a full-time member of the academic research and teaching staff at Brunel University, undertaking applications research in the nuclear area on behalf of the United Kingdom Atomic Energy Authority (UKAEA) and other government agencies. In the early 1990s I established the firm of Consulting Engineers Large & Associates which provides specialist analysis and advice in nuclear related activities, including the development, deployment, transportation and storage of nuclear warheads and weapons systems.

5 I have undertaken a number of projects and assessments that form the basis of my understanding and experience of the topics relevant to the application. I have referred to these and other pertinent work throughout the course of this submission.[1]

6 Specifically and recently, I have reported on the risks and hazards of transporting irradiated (spent) fuel by rail, including for transits from Dungeness,[2] for the Mayor of London I analysed the risks associated with possible new nuclear power plants constructed nearby London, including at Dungeness;[3] on the weaknesses of nuclear plants to aircraft crash;[4] and I have published on the vulnerability of nuclear facilities to terrorist attack,[5] including closed down nuclear power plants undergoing decommissioning.[6]

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1 For a bibliography go to http://www.largeassociates.com/PapersReports.htm

2 Risks and Hazards arising the Transportation of Irradiated Fuel and Nuclear Materials in the United Kingdom, R3144-A1, March 2006 - http://www.largeassociates.com/3144%20Spent%20Fuel/R3144-A2%20FINAL.pdf

3 *HM Government Energy Review and its Influence on London,* Greater London Authority, Mayor of London, R3155-2, August 2006 - http://www.largeassociates.com/clientzone/CZ3156/R3156-2%20final.pdf

4 Large J H, *Brief Review of Edf Document Demarche de Dimensionnement des Ouvrages EPR Vis-À-Vis Du Risque Lie Aux Chutes D'avions Civils (Assessment of the Operational Risks and Hazards of the EPR when subject to Aircraft Crash)*, May 2006 - http://www.largeassociates.com/3150%20Flamanville/R3150-aircraft%20impact%20-%20FINAL.pdf

5 Additional Analysis and Comments on the Threat of Terrorist Attack to the Proposed 3rd Nuclear Power Plant at Flamanville, France, States of Jersey, R3155-3, August 2006 - http://www.largeassociates.com/3155%20Jersey/R3155-3.pdf, *The Implications of 11 September for the Nuclear Industry*, J H Large, United Nations for Disarmament Research, Disarmament Forum, 2003 No 2 - http://www.largeassociates.com/terrorismUNDisarmament.pdf

6 *Decommissioning Nuclear Plants - Openings for the Terrorist Threat*, 10th Global Conference & Exhibition on Decommissioning Nuclear - Taking Experience Forward, London 20-22 November 2006 - http://www.largeassociates .com/ibc%20decommr/IBCpaperFINAL%2014%2011%2006.pdf

7 **INSTRUCTIONS**

8 I have been instructed by Ms Louise Barton who is a member of the *Lydd Airport Action Group* (LAAG).

11 My instructions are to specifically address the assertion that in considering the planning applications (Y06/1647/SH AND Y06/1648/SH) to develop the London Ashford Airport (Lydd – LAA) that Shepway District Council planning authority:

12 *is bound to identify and take into account all material considerations, including public health and safety; and that moreover,*

13 *since the airport site, air traffic approaches and departures are within close proximity to the Dungeness A and B nuclear power plants, public safety would be a material consideration.*

14 I am also instructed to provide an opinion whether the development of commercial airline activities at LAA will have any bearing on the opportunity to construct, commission and operate a new, *Generation III* nuclear power plant on or nearby the present Dungeness power station site.

15 I address these instructions in five parts of this submission:

16 **PART I** demonstrates that the Dungeness nuclear power plants and the transportation of radioactive materials therefrom are hazards that have the potential for serious radiological consequences in the public domain;

17 **PART II** identifies the heightened risk of accident and incident arising from the increased numbers (air traffic movements) and types (aircraft size) projected to operate from a developed LAA;

18 **PART III** examines the vulnerability the Dungeness NPPs to aircraft crash, identifying in outline those parts and aspects of the plants that could result in a significant radioactive release in the aftermath of an aircraft crash; and

19 **PART IV** outlines the nuclear safety and other statutory regulations that specifically require a reassessment and review of the existing nuclear safety cases and licensing for the Dungeness A and B nuclear power plants.

20 **PART V** assesses how the presence of a commercial airport at Lydd would influence any assessment of the suitability of the Dungeness site for a new, Generation III nuclear power plant.

21 **PART I HAZARDS ARISING FROM THE NUCLEAR ACTIVITIES AT DUNGENESS**

22 Dungeness A and Dungeness B nuclear power plants comprise 4 graphite moderated, gas cooled nuclear reactors.

23 Essentially, to generate electricity uranium fuel is irradiated or fissioned in the reactor core during which the fissile uranium isotope fissions producing fragmented fission products and heat that is channelled to heat exchangers or boilers to raise steam driving alternators that generate electricity.

24 As an outcome of the nuclear processes there occurs a build up of fission products, many of which are long-lived and intensely radioactive. When the fuel is spent in the reactor core it is transferred to storage under water at the station for three or more years before dispatch to Sellafield in Cumbria.

25 It is the nuclear fuel, both in the cores of the reactors and in the spent fuel ponds, that is the dominant hazard at a nuclear power plant. If, somehow, the fuel is disrupted and the fission product contents released to the environment, then there is a potential for radiological consequences via uptake of and exposure to radiation dose by members of the public. This exposure or radiation dose will occur in the immediate aftermath of the radioactive release, it will contaminate land and foodstuffs with the dose uptake pathways changing and acting over the interim and longer terms, and it may result in genetic damage being transferred from one human generation to the next.

26 **Dungeness A Magnox Station:** The earlier Dungeness A station comprises 2 Magnox reactors each containing approximately 300 tonnes of natural uranium fuel. When in operation, each reactor holds about 22,000 or so rods of uranium metal encased in a magnesium alloy cladding and spent fuel discharged from the reactors accumulates in storage ponds for a period of at least 90 days to enable further natural radioactive decay[7] prior to dispatch of the fuel to Sellafield. Spent fuel held in the storage ponds can, depending on the recent generation output history of the station, reach several hundreds of tonnes.

27 In addition to the fission products mostly contained within the spent fuel, the irradiation process also renders radioactive components of the reactor (the graphite moderator, reactor steelwork, and concrete biological shield), and there are a number of radioactive wastes streams that have arisen over the operating lifetime of the station. These radioactive wastes, both retained operational and decommissioning arisings totalling about 24,000m^3 packaged volume, will require eventual transportation off-site and thereafter long-term (tens, hundreds and thousands of years) management under storage and eventually throughout disposal.

28 Although both reactors of Dungeness A shut down in late-2006, the nuclear plant remains subject to a *Nuclear Site Licence* as required by the *Nuclear Installations Act 1965*. This licensing and nuclear safety requirement will remain in place until the *Nuclear Installations Inspectorate* (NII, a division of the Health & Safety Executive) is satisfied that the radiological risk and hazard are tolerable, a state that is defined by the *Ionising Radiations Regulations 1999.*

29 A full nuclear site licence would be expected to remain in place so long as there remains fuel in the core of either reactor so, since it takes about 2 to 3 years to entirely defuel the reactors over which time Dungeness A will remain a fully licensed site. Once the reactors have been defuelled the nuclear safety case is determined by the risks and hazards associated with the fuel storage ponds,[8] radioactive wastes that have been stored on the site, and by the (radio)activated and contaminated components and structures of the reactors, the shielding, storage and process treatment plants.

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7 Storage enables the decay particularly of the volatile but short-lived iodine-131 radionuclide prior to transportation through the public domain by rail.

8 Large J H, *Corrosion of Magnox Cladding* - Evidence to House of Commons Environment Committee, November 1985; by order of the H of C Environment Committee – essentially, uranium forms pyrophoric oxides and hydrides. Both react violently with water and are best stored in their oxide form in dry, inert atmospheres. Under pond storage conditions, the chemistry and quality of the pond water is key to the prevention of hydrides on the surface of the elemental metal uranium rod if the magnesium cladding is damaged and the hydrides exposed to moist air

30 Even when all of the spent fuel has been removed from the Dungeness A reactors and on-site storage ponds, there remains a sufficiently large amount of radioactivated and radioactively contaminated materials for regulatory controls to stay in place for so long as the nuclear island, or its remnants, are in situ. The time scale for full decommissioning, that is complete dismantling of the nuclear island and removal of all radioactive waste, has yet to be finalised although the *Nuclear Decommissioning Authority* (NDA) has identified a 25 year to site clearance target, with this superseding previous time scales of 100 and 150 years.[9]

31 The very large quantity of graphite bricks that form the moderator core of each reactor (about 1,800 tonnes) requires careful management through both the decommissioning dwell and dismantling processes. This is because, first, the graphite will exothermically react in air (ie it will burn) at a relatively low temperature with this reaction temperature being lowered further by the ingress of sodium from ventilation of the graphite cores with salt laden air that will occur over the long decommissioning dwell periods presently envisaged.[10]

32 Second, arising from the nuclear processes whilst the reactors were in operation, energy is accumulated in the interstitial lattices of the graphite cores. This energy, known as *Wigner Energy*, is the result of atoms of the graphite being individually displaced during the neutron slowing (moderation) process, from the millions of trillions of collisions with neutrons that have occurred during the 30 or so year operating life of each reactor. Essentially, Wigner energy remains captive within the graphite lattice unless there occurs a temperature rise in the graphite that is 50^{o}C or more above the irradiated temperature at which the Wigner energy was first captured.

33 Accordingly, even with the reactor defuelled, any untoward event that results in a local rise in temperature is at risk of triggering a very significant release of Wigner energy, first locally but subsequently spreading throughout the entire core that has the potential for a significant release of off-site radioactivity.[11]

34 Cross channels are incorporated into the moderator core to enable lateral flow cooling and pressure equalisation across the core whilst the reactor is in operation. However, within these narrow 'interbrick' passages carbonaceous dust accumulates

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when, for example, when there is an unintentional drain down of the storage pond water. Uranium metal (U) releases hydrogen gas when allowed to react with water. The hydrogen may then react with the metal to form uranium hydride which may in turn react with oxygen in the air to form stable uranium oxide and hydrogen gas. This sequence of events is given by the equations

U + 2H{sub 2}O {yields} UO{sub 2} + 2H{sub 2} + {Delta}Q

U + 3/2H{sub 2} {yields} UH{sub 3} + {Delta}Q

4UH{sub 3} + 7O{sub 2} {yields} 4UO{sub 2} + 6H{sub 2}O {Delta}Q.

In all instances, heat ({Delta}Q) is liberated, which increases the rates of reaction.

9 Although 25 years has now been identified by the NDA to return the existing Magnox sites to the so-called 'green field' condition, it is not a certainty that complete decommissioning will not be delayed further into the future. Largely, the decommissioning timescale is determining by the availability of a radioactive waste management strategy and, of course, by physical facilities for the long term storage and/or disposal of the very large volumes of radioactive waste arisings that derive from the UK's early development into nuclear power, industrial and pharmaceutical isotopes and, of course, the development and maintenance of its nuclear weapons arsenal.

10 The moderator cores of the closed down and defuelled reactors will have to be naturally ventilated to remove any accumulation of hydrogen liberated during the slow corrosion processes of the pressure vessel and core support structural steelwork. The presence of chloride acts as a catalyst lowering the air reactivity temperature of the graphite – see Large J H, *Decommissioning of Nuclear Reactor Systems*, Proc IMechE, PT A, J Power & Energy, V206, 1993.

11 This is how events unfurled in the Windscale fire of 1957 when an attempt to anneal out the Wigner energy from the No 1 Plutonium Production Pile ran out of control and the graphite core and the fuel within caught fire and burnt for over two days – see *Decommissioning of Nuclear Reactor Systems*, Proc IMechE, PT A, J Power & Energy, V206, 1993.

which is available for explosive-fire when the core is immersed in air which might be triggered by, say, a corroded steel component collapsing with a spark generated at impact.[12]

35 During the extended decommissioning period (para 30), especially when dismantling of the reactor cores is underway, the containment systems (ie the reactor pressure vessel and the concrete biological shield) will themselves have to be dismantled thus exposing the remaining radioactive contents of the reactors (the graphite cores and supporting steelwork structures – about 3,500 tonnes in total for each reactor) to risk of dispersion by an external event such as, as considered here, aircraft crash.

36 **Summary - Dungeness A Hazards:** Even though the two Magnox reactors of Dungeness A have closed down and all of the fuel is likely to have been removed from the reactor cores by the time any effective redevelopment of the LAA could take place, there will remain several significant sources of radioactivity on the Dungeness A station part of the site.

37 During dismantling operations, particularly when the reactor pressure vessel and graphite core are being removed, the containment buildings and concrete shields themselves will have to be partially dismantled thereby removing the main defence against radioactive release when subject to an energetic external event such as aircraft crash. An aircraft crashing onto a partially dismantled reactor, spillage of aviation fuel into the graphite core, and ignition thereafter could result in a significant release of radioactivity.

38 Movement of the radioactive waste, both accumulated operational arisings and dismantling will require a total of 34,700m^3 of low level waste (about 2,000 individual transport packages) and 4,110m^3 of intermediate level waste (583 packages) spread over the decommissioning period.[13]

39 The most obvious route for dispatch of these wastes from the NPP is via the existing railway line that runs across the southern end of the LAA runway. At present there is an agreement that airport take-off and landing operations are suspended whilst spent fuel is in transit from the loading gantry, although this arrangement may not be practicable to guarantee for so many package movements during periods of high commercial flight air traffic.

40 **Dungeness B AGR Station:** The later Dungeness B station comprises 2 Advanced *Gas-Cooled Reactors* (AGRs) each containing approximately 120 tonnes of low enriched uranium fuel.[14] The fuel system comprise around 330 stringers each comprising 8 fuel modules holding 36 stainless steel clad pins, with a total of about 96,000 pins across each reactor core. Like in the Magnox plant, the spent fuel is transferred and stored in water filled ponds but for a longer period of 2 to 5 years in account of the higher levels of fuel burn-up (fissioning) and radioactivity.

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12 The formation of nitrogenous polymer dust arises from the effective binding of nitrogen and the trace amounts (>1%) of carbon monoxide present in the carbon dioxide coolant gas when subject to irradiation.

13 Large J H, *Brief Report On The Potential Implications For Nuclear Material Transportation Issues Across London In Account Of HM Government's 2006 Energy Review*, Mayor of London, September 2006

14 Natural uranium contains 0.7% of the fissile uranium isotope U-235 and this fuel is used in the Magnox reactors. For the AGR reactor the U-235 content is enriched to between 2 to 4% which increases the amount of (thermal) energy that can be extracted from the fuel but which, it follows, increases the amount of fission product retained in the fuel, rendering it more radioactive than its Magnox counterpart and, in the event of a release from an operating reactor, potentially greater radiological consequences.

41 Dungeness B is expected to operate until 2018, thereafter it will proceed along the then determined decommissioning measures and timescales.

42 Each graphite reactor core is enclosed within a massive, reinforced concrete pressure vessel and, like the Magnox nuclear plant, there is no secondary containment.

43 Reactor components are irradiated during service operation, although Wigner energy accumulation is not considered significant in the AGR core because of the higher core operating temperatures. Accumulation of carbonaceous dust is at a higher rate than that in the Magnox moderator core. Reactor core, steelwork structures and the reinforced steel concrete pressure vessels are also activated radioactive during the course of the lifetime of the reactor.

44 Over the remaining lifetime of Dungeness B there will be approximately 500 flask dispatching rail movements of spent fuel and, during decommissioning and dismantling following shut down in 2018, there will be at least 12,900m^3 (734 packages) low level and 3,900m^3 (371 packages) intermediate level radioactive wastes to be managed on site for eventual dispatch to an offsite radioactive waste repository.

45 **Summary - Dungeness B Hazards:** With Dungeness B reactors remaining in operation, the by far the most significant radiological hazard is the irradiated fuel in the reactor core and, quite separately and depending on how many spent fuel rods are in storage, the spent fuel storage ponds,

46 There has never been published an assessment of the radiological consequences of a severely damaging accident/incident for the Dungeness B NPP (or any other AGR NPP). However, an indication of the potential radiological consequences might be taken from a recent study of severely damaging incidents at French nuclear plants for which the pressurised water reactor (PWR) at Fessenheim (Eastern France, near to the German-Swiss-French border) yielded the following probabilistically-based prediction :[15,16]

		NUMBER OF HEALTH EFFECTS FRACTILE		
NPP SITE	HEALTH EFFECT/COUNTERMEASURES	MAXIMUM	MEAN	50th
Fessenheim EXISTING 880MWe PWR 100% LEU core	EARLY Death	194	26	10
	LATE Fatal Cancer	36,010	10,340	8,913
	Thyroid Cancer DEATHS	2,599	492	479
	LAND Area (ideally) Evacuated km^2	6,188	2,206	1,950
	Area (ideally) Iodine Prophylaxis km^2	1,268	273	200
	NUMBERS Persons (ideally) evacuated	2,960,000	563,300	331,100
	Persons (ideally) I-131 Prophylaxis	502,900	90,180	31,150

47 Similarly, assessment of the consequences of a radioactive release from a *Type B* irradiated fuel transportation flask (or flasks) has never been published, although assessments have been made for urban situations.[17]

15 Large J H, Assessments *of the Radiological Consequences of Releases from Existing and Proposed French EPR/PWR Nuclear Power Plants,* February 2007 - http://www.largeassociates.com/3150%20Flamanville/Flamanville%20Final.pdf (in French http://www.largeassociates.com/3150%20Flamanville/r3150-final-FR.pdf).

16 The comparison should be considered with great caution because the Fessenheim reactor at 880MWe output is larger than the 600MWe Dungeness B reactor and its fuel is burnt-up to a higher degree which means a greater amount of radioactivity being released at the French location. Other factors included different population distributions, emergency planning measures and countermeasures, etc.. The MEAN column on the right side of the table is the *Expectation Value*, ie that most probably to result if the accident took place.

17 Shaw K, The Radiological Impact of Postulated Accidental Releases during the Transportation of Irradiated PWR Fuel through Greater London, NRPB-R147, 1983 and Large J H, Risks and Hazards arising the Transportation of Irradiated Fuel and Nuclear Materials in the United Kingdom, R3144-A1, March 2006

48 **PART II ASSESSING THE HEIGHTENED RISK FROM INCREASED AIR TRAFFIC MOVEMENTS**

49 Romney Marsh generally and Dungeness specifically are within the Worthing Control Area which extends in altitude from 5,500 to 24,500ft. The airspace is dissected by airways (flight path corridors) that extend above the Control Area with a large number of commercial airliners transiting daily, together with a smaller number of light aircraft operating at lower altitude.

50 The LAA (Lydd) airport is the nearest airfield, located about 5km from the Dungeness NPPs and there are no other airfields within 20km.

51 The overall risk of aircraft crash onto the Dungeness NPP site is determined by account and summing of the i) *background* level of aviation risk; aircraft transiting the area at high altitude termed ii) *airways* risk; iii) the risk arising from *military combat aircraft* (MCA); and, as in this case, iv) the low altitude air traffic movements at airports such as at Lydd.

52 The last publicly available assessment of the risk of accidental aircraft crash for the Dungeness NPPs was undertaken in or about 1995 for air traffic movements projected for 1997,[18,19] although for this the detailed analysis is not publicly available so it is not possible to isolate the risk deriving from landing and take-off movements at LAA alone from the UK background, MCA and the airways traffic risk. The NII analysis predicts a total impact frequency on the NPP site at Dungeness of $1.4\text{x}10^{-6}$ per year (a chance of about 1 in 715,000 years) for all categories of aircraft and helicopters. Since that time (1997) there has been a general increase in aviation air movements[20] (*background* and *airways*) so the overall aircraft crash risk would now be higher.[20] The *MCA* risk contribution may have also increased with changes of military activity, particularly helicopters, on the Ministry of Defence ranges nearby the Dungeness NPP site.[21]

53 The 1997 risk level clearly falls short of *Principle 119* of the NII's[22] then *Safety Assessment Principles* (SAPs – but see later)[23] which requires a screening frequency of 1 in 10 million (ie $1\text{x}10^{-7}$ per year) with the predicted impact frequency of

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18 Aircraft Impact Dungeness B – Topic Report 2.4 – Dungeness A-PSR – *C2 Assessment Report on Dungeness A External Hazards Aircraft Crash*, ARF No 15 NUC 305/67/4/3 P1 E3, Nuclear Installations Inspectorate, September 1995. In fact, Lydd Airport operations have never, to date, reached the levels projected in 1995 which then predicted a total of 56,398 air movements per annum (including 600 pa helicopter) but the actual air movements reported to the CAA (*Annual Airport Statistics*, 2006) are as follows:

1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
22,000	27,000	33,000	34,000	25,000	27,000	22,000	26,000	24,000	22,000	20,000

19 It seems, although it is not certain, that the NII's Dungeness A analysis of 1995 was based on the information provided by the then airport operator *Lydd Airport Group* in its 1998 application (SH/88/230) for a runway extension. This was the subject of Local Public Inquiry inspector's report of September 1992. The air traffic data is used for the *NII Case* of TABLE 1 (see later) are taken from the 1992 Inspector's report although it is understood that these projected levels of air traffic have never been achieved at Lydd.

The NII also reviewed its 1995 assessment in 1997, adopting this for Dungeness B.

20 The increase in commercial aircraft activity (mainly C4 aircraft) over the period from 1996 through to 2006 for the London area airports has been about 31% with the total for all UK reporting airports being about 18% - *CAA Airport Statistics*, 2006 – airways movements increased from 2M in 2000 to 2.3M in 2006 or about a 15% increase during the last 5 years see www.nats.co.uk/text/47/operational_and_safety.html

21 There are helicopter movements to the MoD ranges in the area but detailed information is not publicly available.

22 The NII have an interest in any development in the area because of its licensing function for the Dungeness NPPs under the *Nuclear Installations Act 1965*, and there is an arrangement dating from 1961 between the Department of Environment and Shepway District Council that it (but now the NII) would be consulted over any development.

23 *Safety Assessment Principles for Nuclear Plants*, NII, Health & Safety Executive, May 2000 first introduced for nuclear reactors in 1979 and for nuclear chemical plants in 1983.

$1.4x10^{-6}$ being more frequent. However, the NII then found that although the level of risk did not satisfy the *P119* screening level it was, nevertheless, infrequent when compared to other hazards and risks to the Dungeness NPPs. However, in arriving at this relaxation of the nuclear safety case, the NII then noted that the risk calculation was '*. . . only valid for the present aircraft environment and, should substantial changes take place e.g. extension of the runway at Lydd Airport, the Safety Case would require revision.'*

54 Because the 1995 PSR aircraft crash analysis is not available in detail it is not possible to update this prediction in account of the generally increased air movements over the UK and, specifically, the introduction of greater air traffic movements of heavier, commercially-sized aircraft operating from LAA.

55 As previously noted, the comprehensive calculation of aircraft crash risk usually entails a composite of the background, airfields, and airways rates. However, for the proposed development at LAA the change of risk entirely derives from changes in the air traffic movements of commercially-sized *Category 4* (*C4*)[24] aircraft taking off and landing at Lydd so, accordingly, it is only necessary to compare changes of air operations and aircraft types (ie *Category*) proposed by the development of LAA.

56 The predicted frequency of crash (excluding malicious and terrorist acts) is given by:

57 $$g = NR\,f(r,\emptyset)$$

58 in which *R* is the probability per air movement *N* of a landing or take-off accident and $f(r,\emptyset)$ relates the ground location being considered in respect of the airfield runway (ie, here Dungeness NPPs). Other than for light *C1* aircraft, the probability expression has been empirically derived in Cartesian form for both landing and take-off operations.[25]

59 The site under consideration, here the two Dungeness NPPs, is represented as a single block (overall height, width and length) with respect to the angle at which the aircraft approaches. For fixed wing incidents originating during the approach and take-off phases at LAA a ceiling of 2,000ft is applied.

60 For the nuclear safety case of each of the Dungeness NPPs, including the outgoing spent fuel rail transits, the principal concern is that of the chance of an aircraft crashing onto one of the NPPs (or on a spent fuel train or the off-site railhead)[26] and causing an unacceptable release of radioactivity. Like all other external hazards, the NII considers aircraft crash in terms of its *acceptable risk and tolerable consequences* of outcome criterion (see later).

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24 The 5 categories of aircraft are *C1* light fixed wing of <2.3t, *C2* helicopters, *C3* fixed wing of >2.3<20t, *C4* any >20t fixed wing aircraft, *C5* military fighter aircraft.

25 For a runway projection distance x of 2.91km and its ordinate *y* of 3.96km to the Dungeness NPP site, the landing and take-off impact probabilities are:

$$g_L = (x + 3.275)/3.24.e^{-(x+3.275)}/1.8[(56.25/S2\pi).e^{-0.5(125y)^{\wedge}2} + 0.625e^{-y/0.4} + 0.005e^{-y/5}]$$
$$g_T = (x + 0.6)/1.44.e^{-(x+0.65)/1.2}[(56.25/S2\pi).e^{-0.5(125y)^{\wedge}2} + 0.9635e^{-4.1y} + 0.08e^{-y}]$$

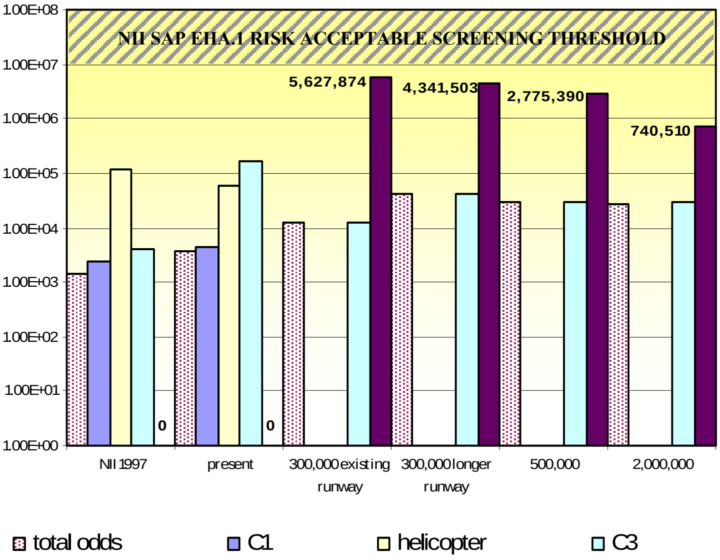
The incident resulting in the crash is assumed to occur at an altitude of around 1,000ft.

26 The risk of aircraft crash onto the railhead or rail track are not calculated here.

61 The previous NII assessment assumed that aircraft taking off would be able to over-fly the Ministry of Defence (MoD) range for 50% of the time that it was not in military use but this is no longer an option and no over-flying of the range will be permitted. The take-off flight path for *C1* and *C2* aircraft may turn south-east towards the NPPs but the heavier *C3* and *C4* aircraft will be required to immediately turn west to avoid the MoD range.

62 Considering *C1* and *C2* (light fixed wing aircraft and helicopters) separately from the commercially-sized *C3* (>2.3t <20t weight) and *C4* fixed wing aircraft (>20t weight), the projected crash rates for the present air traffic operations, and the projected 300,000 (with and without runway extension), 500,000 and 2 million[27] passenger per annum developments identified by the Applicant are shown in TABLE 1 and compared in the accompanying graph (right).

63 Note that the vertical *RISK* axis of the graph is expressed in logarithmic values with each major unit representing a change of magnitude over its immediate predecessor, ie 10, 100, 1,000, 10,000, 100,000 and so on,



ANNUAL AIRCRAFT CRASH RISK – AIRPORT OPERATIONS ONLY

64 Again with caution in making a direct comparison with the 1997 NII risk forecast, LAA airfield operations risks are all above (ie more frequent than) the once in ten million years (1E-07) screening value specified by *SAP Principle EHA.1/2* (previously *P119*) and which should properly include *background*, *airways* and *MCA* risks elements. Thus, properly, all sources of hazards of the projected operations at LAA cannot be excluded from the nuclear safety case as required by *SAP EHA.8*.

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27 Projection of the 2 million air traffic and passengers movements provided by LAAG is:

AIRCRAFT TYPE	CATEGORY	PASSENGER CAPACITY	ACTUAL PASSENGERS PER AIRCRAFT	DAILY MOVEMENTS	DAILY PASSENGERS	ANNUAL MOVEMENTS L	ANNUAL PASSENGERS
B737	C4	160	136	19	2517	6754	918605
A319	C4	140	112	23	2517	8202	918605
BAE146	C4	100	78	2	156	730	56940
Dash 8	C4	50	40	2	80	730	29200
ATR42 -500	C3	48	40	4	160	1460	58400
SAAB 340	C3	33	25	2	50	730	18250
			Total C3	**6**	**210**	**2190**	**76650**
			Total C4	**46**	**5269**	**16416**	**1923350**
			TOTAL	**52**	**5479**	**18606**	**2,000,000**

For the increase in air traffic movements over 500,000ppa, LAAG assume all additional movements up to 2M ppa to be C4 aircraft..

65 **TABLE 1 – COMPARATIVE AIRCRAFT CRASH RISKS DUNGENESS A + B SITE - LAA INITIATED ONLY**

PASSENGERS PER ANNUM	AIRCRAFT CAT	SCENARIO	RELIABILITY	ANNUAL MOVEMENTS	CRASH RATE	DUNGENESS TARGET IMPACT[28]	ODDS PER YEAR
PRESENT[29]	C1	PRIVATE	1.20E-06	22,035	2.7952E-04	2.3447E-04	4,265
	C2	HELICOPTERS	2.30E-06	1,200	3.2566E-05	1.6835E-05	59,400
	C3	BUSINESS JETS	1.80E-6	365	6.9454E-06	5.8258E-06	171,650
	C4	NO AIRLINERS	5.90E-07	0	0		-
300,000[30] PRESENT RUNWAY	C3	SAAB 340/ATR 43	1.80E-06	5,110	9.7236E-05	8.1561E-05	12,261
	C4	ALL OTHER TYPES	5.90E-07	2,160	2.1183E-07	1.7769E-07	5,627,874
300,000[31] EXTENDED RUNWAY	C3	SAAB 340/ATR 43	1.80E-06	1,460	2.7782E-05	2.3303E-05	42,913
	C4	ALL OTHER TYPES	5.90E-07	2,800	2.7460E-07	2.3033E-07	4,341,503
500,000[32]	C3	SAAB 340/ATR 43	1.80E-06	2,190	4.1672E-05	3.4955E-05	28,317
	C4	ALL OTHER TYPES	5.90E-07	4,380	4.2955E-07	2.2206E-07	2,775,400
2,000,000[33]	C3	SAAB 340/ATR 43	1.80E-06	2,190	4.1672E-05	3.4955E-05	28,608
	C4	ALL OTHER TYPES	5.90E-07	16,416	1.6099E-06	1.3504E-06	740,510

NII[18]	C1	PRIVATE	1.20E-06	40,000	5.0743E-04	4.2563E-04	2,349
	C2	HELICOPTERS	2.30E-06	600	1.6283E-05	8.4176E-06	1:118,800
	C3	BUSINESS JETS	1.80E-6	17,618	1.9028E-04	2.5215E-04	3,966
	C4	ALL OTHER TYPES[34]					

66 However, it is important to note that it is the combination of *frequency* of crash and *consequences* that is important in setting the potential of the radioactive release, primarily because the heavier and greater fuel capacity of *C4* aircraft has the potential to severely damage the NPP plant equipment and containment systems. On first inspection of TABLE 1 and the accompanying graph it might appear that the use of the larger *C4* aircraft reduces the risk over the present level of operations. This apparent 'improvement' arises because of the larger passenger carrying capacity of the *C4* aircraft (hence fewer aircraft movements) and because the greater reliability (number of crashes, pilot training, etc – 4th column) which is about x 30 smaller than the *C3* and *C1* aircraft types.

67 Although, strictly, the SAPs require the crash frequency for *all* categories of aircraft to be evaluated, it is accepted that impact of aircraft under 2.3 tonnes, mainly privately owned 'flying club' activity aircraft, would not pose a significant threat to the Dungeness NPPs. Similarly, the *C3* category of up to 20t aircraft is dominated by executive jet type aircraft[35] of around or less than 10t with many of aircraft in this category not presenting that much a threat to the NPPs. In fact, the previous NII assessment of aircraft crash (para 53) was statistically dominated by *C1* aircraft under 2.3t that pose little physical threat to the NPPs at Dungeness (overleaf right).

28 Assumes that the accidents are initiated below 2000ft and that the target is represented by a cube of 80m height, 750m length and 600m depth.

29 LAA Application Report 3850883 – Chapter 3, Table 3.1 – present operations

30 LAA Application Report 3850883 – Chapter 3, Table 3.3 - 300,000 passengers per annum with no runway extension

31 LAA Application Report 3850883 – Chapter 4, Table 4.2 - 300,000 passengers per annum with runway extension – this table seems to include an error in the total annual air movements

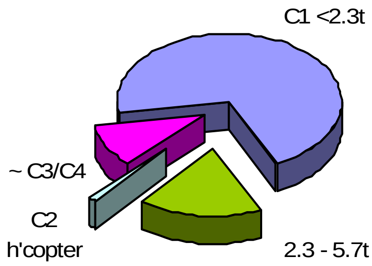
32 LAA Application Report 3850872 – Chapter 3, Table 4.2 - 500,000 passengers per annum with runway extension

33 Derived by LAAG and comprising mostly *C4* aircraft on the basis that airline operators are unlikely to operate the smaller *C3* aircraft for reasons of economies of scale.

34 The NII assessment (with little detail) adopts >5.7t and not the >20t distinction between smaller and larger commercial aircraft.

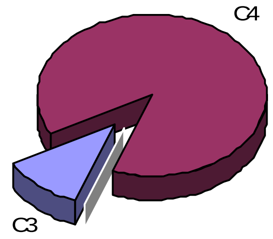
35 For example the Raytheon Hawker 800 at about 12t MTWA (maximum take-off weight authorised), Hawker 4000 Horizon 17t, Jetcruzer 450 3t, Beechcraft E50 3.4t

68 On this basis it seems that the NII was relaxed about permitting the 1995 aircraft crash frequency of $1.4.10^{-6}$ per year even though it was more frequent than the screening frequency of 1.10^{-7} per year, although it expressed that any change in air traffic operations would require reassessment of the nuclear safety case (para 52).



1995-97 Aircraft Types

69 In contrast the present development comprises air traffic movements that introduce a mix of *C3* and *C4* aircraft (right), particularly the heavier than 20t *C4* numbers which are acknowledged to present a serious threat to the existing Dungeness NPPs.



2007 2,000,000 ppa LAAG

70 In ether words, the combination of frequency and aircraft weight of the LAA proposal represents a much greater threat to the Dungeness NPPs than the 1995 assessment.

71 The risk analysis included here is confined to the air movements at the airfield and excludes background, airways, and MCA contributions to the overall risk. If these additional elements of risk are taken into account then there will arise an increase in the projected frequency of aircraft crash at Dungeness.

72 For example,[36] for the 2,000,000 ppa case and *C4* aircraft, taking a *background* rate[37] of $0.12.10^{-5}$ $km^{-2}yr^{-1}$ and an *airways* contribution of $0.01.10^{-5}$ $km^{-2}yr^{-1}$ the overall risk (excluding MCA) is 2.4409E-06 (1 in 409,691 per year). Similarly, for the 500,000 ppa case specifically cited in the LAA application, but for *C4* aircraft only the overall crash risk and odds of an aircraft accidentally crashing onto the Dungeness NPP site are 1.4507E-06 and 1 in 689,299 per year, being more frequent (ie failing) the NII *SAP Principle EHA.1.*

36 The crash rates are calculated for the combined Dungeness A and B sites. If the A and B sites are considered separately the risks and odd for each separate NPP are for the 500,000 ppa expansion 8.7481.E-07 or odds of 1 in 1,143,108 and for the 2M ppa case 1.4718E-06 or odds of 1 in 670,417, all for *C4* aircraft alone.

37 The 50% confidence level UK mainland background crash rate at May 2002, from Kingscott C, *Background Aircraft Crash Rates for the United Kingdom, 1991-2000*, IMC EE/GNSR/5044, May 2002.

73 **PART III THE VULNERABILITY OF THE DUNGENESS NPPS TO AIRCRAFT CRASH**

74 Obviously, the effect and outcome of an aircraft crash and fuel explosion/burning on any one of the active plant building or processing/storage area would be subject to how each of the individual target buildings perform under the impact and fire conditions.

75 As a result of impact (kinetic) energy is transferred from the aircraft to the building.[38,39] The energy transferred is absorbed by the building components in the form of strain energy whilst each component is deforming elastically and beyond up to the point of permanent yielding.

76 The impact can be segregated into two regimes: First, at the moment of impact the aircraft can be considered to be a very large but relatively 'soft' projectile which, by self-deformation' will dissipate some fraction of the total kinetic energy being transferred during the impact event. Second, some components of the aircraft will be sufficiently tough to form rigid projectiles that will strike and commence to penetrate, again by kinetic energy, components of the building fabric and structure.

77 The first of these damage regimes involves quasi-impulsive loading, so the response of the structure is obtained by equating the work done by the impacting load to the strain energy produced in the structures. Setting aside localised damage in which individual structural components are removed (blasted away), the most probable failure mode of the structure overall is that of buckling and collapse in response to the impact. The types of building structure featured at nuclear power plants, for example the radioactive waste and spent fuel buildings, would not withstand the impulse magnitude delivered by a crashing commercial aircraft.[40]

78 For the impact damage case the aircraft, more particularly parts and components of it, have to be considered as inert projectiles. The energy transfer upon impact relates to the kinetic energy (KE) and the key parameter in determining the target (building component) response is the kinetic energy density which relates the KE and the projected area of the projectile.

79 In terms of projectile velocity and for the LAA situation,[41] a diving civilian aircraft is unlikely to exceed 250 knots so the damage mechanism falls below the so-called hydrodynamic regime where the intensity of the projectile-target interaction is so high that a fluid-to-fluid damage mechanism prevails (as utilised by tungsten tipped and depleted uranium sarab or

38 Just on the basis of kinetic energy alone the three levels of aircraft crash *C1*, *C3* and *C4* increase from in the ratio 1 to 50 to 1500 or that the energy available from a crashing commercial airline (impact alone) is 1500 times that of a light aircraft.

39 Large J H, *Brief Review of Edf Document Demarche de Dimensionnement des Ouvrages EPR Vis-À-Vis Du Risque Lie Aux Chutes D'avions Civils (Assessment of the Operational Risks and Hazards of the EPR when subject to Aircraft Crash)*, May 2006 - http://www.largeassociates.com/3150%20Flamanville/R3150-aircraft%20impact%20-%20FINAL.pdf

40 The maximum impact before yielding commences is given by

$$ir = [2Lim/En]0.5\ \partial y/Ah$$

which (adopting conventional notation) for a typical rc construction, with a roof slab load per column assumed at 35t, the structure yields at about 1,750 Pa-s. The impulse force arising from a crashing aircraft of, say 200 tonnes all-up weight considered impacting over its projected front end fuselage area (about 30m2) with the event lasting over the entire collapse of the fuselage length, gives an impulse force of about 20,000 Pa-s or about x10 the yield strength of the typical rc structure described above.

41 See later, but the situations that are assumed to initiate the aircraft crash are assumed to occur as the aircraft is in its landing or take off mode, say at 1,000ft altitude at 160knots or thereabouts – impact velocity and skew approach are reckoned to be 200 to 250knots and 30 to 60^{o}.

long rod penetrator armour piercing rounds).[42] In the sub-hydrodynamic regime more conventional strength of materials characteristics (ie strength, stiffness, hardness and toughness) will determine the penetration mechanism.

80 For uniform, elastic materials, such as low carbon steel used in steel-frame construction such as diesel generator sheds, radioactive waste stores and the irradiated fuel storage buildings, a good first estimate of the penetrating power of a projectile can be obtained from the *Recht* equation which, for certain hard components of the aircraft engines, could be as high as 200mm.[43] For a steel framed industrial building structure, web and flange thicknesses of the steel section girders and beams is typically about 20 to 40mm so, even with penetrator break up, this and other projectiles would be more than sufficient to structurally damage, if not catastrophically collapse the building steel frame.

81 The failure of reinforced concrete (rc) to ballistic loading applies to the different ways in which this common building structural material is used: For very thick walled structures the concrete is considered to be a semi-infinite mass, for concrete walling and flooring (and roof) slabs the account has to be taken of the flexure of the slab, and to prevent scabbing (where the back face of the concrete surface detaches) the reflective characteristics have to be modelled. The first two of these applications are important in respect to the whole structure remaining intact, and the last that in even where complete penetration is not achieved, the detached scab can form a missile in itself damaging and/or disabling safety critical plant within the concrete containment. The derivation of the ballistic loading of ferro-concrete (steel reinforced concrete - rc) structures is a little more empirically derived,[44] although even with broad brush assumptions about the detailed design of rc structures the hardened projectile striking most of the concrete structures of a nuclear power plant would achieve full penetration. For example, a glancing impact on a typical rc framed building would be sufficient to possibly penetrate the rc roof slabs which are not practicably greater than 250mm thickness, (because of selfweight loading considerations over the 4m spans).

82 The point here is that the building structures of the Dungeness nuclear plants require to maintain complete containment during an aircraft crash because even relatively small penetrations will permit the inflow of aviation fuel with the almost certain fire aftermath which would, in itself heighten the release and dispersal of any radioactive materials held within the building structure.

83 For the purposes of this submission, it is quite reasonable to assume that the building containment would be breached – this is likely to be a justified assumption because of the absence of any extraordinary civil engineering features visibly

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42 At projectile impact velocities below 1000m/s all impacts are sub-hydrodynamic – at 500 knots the closing velocity at impact would be approximately 260m/s.

43 After R F Recht, *Ballistic Perforation Dynamics of Armor-Piercing Projectiles*, NWC TP4532, 1967. which, for a blunt nose ogive, is

$$x = 1.61M/(bA)[V - a/b\ln([a+bV]/a)]$$

where a and b relate to the material properties of the target, M is the mass of the projectile and V the projectile closing velocity. For an aircraft impact, if it is assumed that a sufficiently robust penetrator will present itself in the form of a main turbine shaft of an aero engine which, with its blades and other attachments, might represent a mass of 0.25 tonnes of 150mm projected diameter (stub end of shaft), typical strength of materials properties give a = 2.109 and b = 10.106, so that the final penetration thickness into a steel element (ie a building stanchion) is about 200mm.

44 *MOD Assessment, Strengthening, Hardening, Repair and Demolition of Existing Structures*, Army Code No 71523, MoD 1992 which, for the same missile adopted for *Footnote 43* the slab penetration is about 1,100mm.

incorporated into the building design. On this assumption, once that the building is breached it may be that the particular process and/or substances stored within will add to the damage, by explosion, and ferocity of the fire (flammables).

84 For the Dungeness NPPs, the following outline scenarios might arise: -

85 **Irradiated Fuel Storage:** Of the covered fuel ponds, if the roof structure was penetrated and the pond wall structure breached, then loss of pond water and aviation fuel fire could lead to a breakdown of the fuel cladding and fuel itself, resulting in a high release fraction of fission products, possibly mixed with emulsions of the aviation fuel. The fuel pond radioactive inventory depends on the degree of irradiation of the fuel (the burn-up) and the post in-core period, although the quantity of spent fuel accumulated in the storage ponds might represent (in mass) several times, or more, the reactor core load.

86 If irradiated fuel remains in the Magnox A station, then both the magnesium alloy cladding and the base elemental metal fuel rods provide opportunity for an exothermic and self-sustaining steam or air reaction at elevated temperatures that will result in, obviously, failure of the fuel cladding and increased oxidation of the exposed fuel rod surfaces., with the accompanying radioactive release of spent fuel fission products potentially very significant.[45]

87 A crashing airliner, displacement of the fuel pond water and introduction of burning aviation fuel could result in a very significant radioactive release from the irradiated fuel pond. The subsequent dispersion range of the airborne carried radioactivity could be much enhanced by the high thermal energy involved (plume height) and combination of fission products with emulsions of the aviation fuel and its products of combustion.

88 **Intermediate Radioactive Wastes and Decommissioning:** The radioactive inventories and chemical make-up of the stored radioactive wastes at nuclear plants sites is known and the inventory for Dungeness is regularly published.[46] Also, because of the dilemma over failure to find a national radioactive waste repository for high and intermediate level categories of radioactive waste such wastes will accumulate at the individual nuclear sites for the immediate and interim futures.

89 Aircraft crash onto a radioactive waste storage building could result in a significant release of radioactivity.

90 Whilst in the dismantling process, which is likely to occupy five to ten years at least, the reactor hulks will have some part of the primary containment removed for access and thus are likely to be more vulnerable to aircraft crash during this phase of decommissioning.

91 **Operational Nuclear Reactors:** The range of potential outcomes for operational reactors subject to aircraft crash is large.

92 Obviously, a direct impact on the reactor locality, breaching the reactor pressure vessel and/or the primary coolant circuit would most probably result in a radioactive release into and through the secondary containment systems that would have also been breached by the impacting airframe. Other safety-critical equipment of operational nuclear power plants include

45 *Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants*, NRC October 2000, but note this is for zirconium alloy clad fuels.

46 *2004 United Kingdom Radioactive Waste Inventory*, DEFRA-NIREX, Electrowatt-Ekono, 2005.

the electricity supply grid connections and the emergency diesel electricity generators, both of which provide essential electrical suppliers for safety systems, reactor cooling and heat sinks, loss of which, particularly effective core cooling, could result in containment challenging events developing within the reactor core.

93 The main conclusions that can be drawn from these outlined scenarios are that:-

94 a) Neither of the Dungeness NPPs have reactor primary containments that were specifically designed to resist *C3* and *C4* category aircraft impact. Even though the Dungeness B AGR reactors, by virtue of the massive, reinforced concrete construction of the pressure vessels would likely resist a direct impact, there are many feedwater, steam and services penetrations that could be damaged and breached during the impact or subsequent fuel fire/explosion.;

95 b) none of the radioactive waste and spent fuel facilities, at Dungeness A and B NPPs have been specifically designed to resist the direct impact of a fully loaded commercial airliner; and

96 c) the highly probable aviation fuel fire/explosion in the immediate aftermath of the impact could, of course, incapacitate some, if not all, of the NPP operating staff leaving the 2 reactors unattended possibly for hours before emergency and replacement staff could attend.

97 **Overall:** I am of the opinion that the development of air traffic operations at LAA, both the numbers of air movements and the use of larger commercial aircraft, would introduce risks and hazards that were not catered for in the original NPP plant designs at Dungeness; that the present nuclear safety case does not include account of these risks and hazards; and that, moreover, the Dungeness NPPs could not be physically adapted (ie strengthened, shielded, explosion proofed, etc) to provide a complaint nuclear safety case in future should the LAA development proceed.

98 **PART IV THE REGULATORY FRAMEWORK & APPROACH**

99 **Nuclear Safety Case and Nuclear Site Licence:** The *Nuclear Installations Act 1965* (NIA) requires that nuclear activities at any nuclear site or nuclear power plant (NPP) are licensed in terms of safety of operation and the potential health harm to members of the public. There are similar provisions to protect the health of employees and other persons via the *Health and Safety at Work, Etc. 1974.*

100 Application of the NIA is via the regulatory body the *Nuclear Installations Inspectorate* (NII - a division of the Health & Safety Executive) requiring the operator to present justification (the *Nuclear Safety Case*) that the nuclear activities undertaken on a particular site will not result in intolerable health harm to the public during both normal and abnormal operation. Satisfaction of this fundamental requirement qualifies the NPP for operation via the *Nuclear Site Licence* issued under the NIA.

101 In preparing the Nuclear Safety Case the operator is required to give account to internal and external events. Aircraft crash is considered to be an *External Hazard.*

102 Nowadays in the face of the threat of terrorist attack, the Nuclear Site Licence must also give account to matters of security and the physical protection of the security of the NPP. This is achieved via a *Memorandum of Understanding* between the *Office of Civil Nuclear Security* (OCNS) and the operators at Dungeness and, as required by the *Nuclear Industries Security Regulations 2003*, there is a formal relationship between the NII and OCNS.

103 **Regulatory Approach:** For much of its regulatory account of incidents the NII adopts a proposition of *a priori* in that there is a sufficient pool of past incidents to draw upon to determine the risk of the same or a similar incident recurring. This gives rise to the compact of *Acceptable Risk and Tolerable Consequences* and, importantly, requires a *Probabilistic Risk Analysis* (PRA) basis to be adopted for determining much of the nuclear safety case.

104 To determine the tolerable consequences in terms of health harm the NII refers to the *Ionising Radiations Regulations 1999* (IRRs) for normal operation of the licensed facility. Essentially, the IRRs prescribe a series of limits of radiation exposure (dose) for individual organs and the whole body (the whole body equivalent) for members of the public and two categories of persons employed at nuclear facilities. These dose limits are generally in accord with the *International Commission on Radiological Protection* (ICRP) recommendations that are accepted into UK statute.[47] The present whole body equivalent dose upper limit for a member of public is 1mSv[48] in any calendar year.

105 The regulatory route arriving at the basically probabilistic approach to setting a nuclear safety case is via the *Safety Assessment Principles* (SAPs)[49] and a series of *Technical Assessment Guides* (TAGs), notably in this application those referring to *External Hazards*,[50] the *Management of Radioactive Materials and Waste*,[51] and *Decommissioning*.[52] This approach requires nuclear facility designer/operator to identify the hazards and quantify the frequency of risk for which those hazards that are frequent the consequences have to be tolerable but, where the hazard is acceptably infrequent (ie is never likely to occur), it is accepted that the consequences could be intolerable.

106 Typically, the frequency targets adopted by the regulator are of the order of one in million for each year of reactor operation with, generally, more frequent risks being defined *credible* incidents where the consequences have to be *tolerable* and less frequent or *incredible* incidents.

107 Even though the general approach is to minimise the risk of occurrence of hazards in the form of internal faults (by sound and proven engineering design) and external events (mainly site location), nevertheless unforeseen faults may still occur so a NPP must be tolerant of and/or resilient against a range of sometimes unspecified fault conditions originating from internal (engineered component failure, human error, etc) and external (seismic, flooding, aircraft crash etc) events.

108 This uncertainty is covered by, so the nuclear industry claims, a *Design Basis* approach that requires the NPP to cope with or withstand a wide range of faults and external hazards, including extremely events, by virtue of what is claimed to be the

47 International Committee on Radiological Protection, *Recommendations of the ICRP 1990* (ICRP60)

48 1 mSv or 1 milli Sievert or 0.001 Sv being the measure of energy absorbed by tissue.

49 *Safety Assessment Principles for Nuclear Facilities, 2006*, Nuclear Safety Directorate 2006.

50 T/AST/013 *External Hazards*, January 2005

51 T/AST/024 *Management of Radioactive Materials and Radioactive Waste on Nuclear Licensed Sites* January 2005

52 T/AST/026 *Decommissioning on Nuclear Licensed Sites* September 2002

plant's inherent characteristics or safety measures. The design basis is the second strand deployed to determine the robustness of the nuclear safety case being undertaken by *design basis analysis* (DBA) in assessing the fault tolerance of the NPP. DBA endeavours to determine the effectiveness of the plant's safety measures and the limits of safe operation when subject to all reasonably foreseeable faults (including categories of extreme incidents that PRA would dismiss as *incredible*).

109 Unlike PRA, DBA is a deterministic approach with the risk not being quantified, instead the adequacy of the design and the suitability and sufficiency of the deterministically defined safety measures are defined in terms of margins of strength, robustness, safety, etc..

110 *Principle EHA.1* of that SAPs requires that all *external* and *internal* hazards that could affect the safety of the facility should be identified and treated as events that can give rise to possible initiating faults. As note previously, aircraft crash onto the plant is considered to be an external hazard and unless this is demonstrably below once in ten million years it may not be excluded from the nuclear safety justification.[53] The 1:10,000,000 years is referred to as the *Screening Frequency*.

111 If the aircraft crash event cannot be excluded (either on the basis of low frequency and/or insignificant consequence) then a *design basis event* associated with it has to be derived. In effect, this means the nuclear plant and its containments have to be shown to be sufficiently robust against the forces (impact, shock, etc) and circumstances (fuel burn temperature, explosion, incapacitation of on site key staff, etc).

112 Aircraft crash and impact is specifically considered by *Principle EHA.8* requires that the total predicted frequency of aircraft crash, including helicopters and other airborne vehicles, on or near any facility housing structures, systems and components important to safety has to be determined from the most recent data on aircraft crash, flight paths, aircraft type, etc..

113 **Nuclear Safety Objectives & Limits:** Both PRA and DBA are applied against performance (resilience) targets and legal limits referred to as *Basic Safety Objectives* (BSO) and *Basic Safety Limits* (BSL). For example, the targets for the effective dose received by any person located off-site during a design basis fault sequence might be expressed as a deterministically-defined dose based on a probability of occurrence basis. For this the BSL might stipulate that the target dose of, say, 1mSv should not occur at a frequency greater than 1 in a 1000 per reactor year of operation, 10mSv at a 1 in 10,000, and so on with the objective or BSO to achieve, say, a dose of 0.01mSv[54] per annum. Similarly, BSL and BSO

53 However, the NII might argue that even though the risk deriving from activities at LAA may not satisfy the screening frequency of one in ten million if it is infrequent compared to other comparable consequence hazards then the higher level of risk from aircraft crash might be accepted. Fixed wing aircraft under 2.3t gross weight and helicopters (ie *Categories 1* and *2*) are considered to be too light to cause severe damage to the NPP containment and so are generally ruled out of the design basis event requirement.

54 The BSL/BSO system adopted in the UK is as follows:

OFF-SITE MEMBERS OF PUBLIC – EFFECTIVE DOSE		
TARGET	TARGET DOSE	FAULT FREQUENCY PER ANNUM
BSL	1mSv 10mSv 100mSv	greater than 1.10^{-3} between 1.10^{-3} and 1.10^{-4} less than 1.10^{-4}
BSO	0.01mSv per annum	

targets might be defined in terms of the individual risk to any off-site person with, for example, the target dose of 1 to 10mSv not occurring at a BSL of 1 in 100 and with the objective of reaching a BSO of 1 in 1000 per reactor year of operation.

114 In other words, a NPP is considered acceptably safe if its operation presents a risk of unplanned radiation dose exposure that is acceptable to *individual* members of the public. The acceptability or tolerability of the individual is defined by the maintenance of prescribed limits relating the degree of exposure and the frequency at which this is predicted to occur.

115 **Beyond the Design Basis Events:** It is not practicably possible to include all *credible* faults in the DB analysis the full range of identified faults, so confidence of the adequacy or comprehensiveness of the DBA is taken on the basis of the overly-conservative approach presumed to be an integral element of the design approach to hazardous facilities such as NPPs. Albeit that the design of nuclear plants endeavours to take account of all foreseeable incidents, it is acknowledged that there remains the possibility of an incident occurring that is beyond the design basis.

116 Crash of a commercially-sized aircraft, at the time of the NPP design and for subsequent *Periodic Safety Reviews*[55, 56] for both Dungeness A and B stations, would have been considered to have been a *beyond design basis* event.[57,58] Now, in compliance with the latest issue of SAPs, aircraft crash at a rate below the screening frequency (1:10,000,000) has to be addressed in terms of a design basis event (para 111).

117 The detailed assessment of aircraft crash risk for both Dungeness A and B NPPs has never been made available, other than the overall assessment completed by the NII that has been previously referred to.[18]

OFF-SITE MEMBERS OF PUBLIC – EFFECTIVE DOSE		
TARGET DOSE	FREQUENCY PER ANNUM	
mSv	BSL	BSO
0.1 – 1	1	1.10^{-2}
1 – 10	1.10^{-1}	1.10^{-3}
10 – 100	1.10^{-2}	1.10^{-4}
100 – 1000	1.10^{-3}	1.10^{-5}
> 1000	1.10^{-4}	1.10^{-6}

55 Technical Assessment Guide T/AST/050, *Periodic Safety Reviews (PSRs)*, Nuclear Safety Directorate, April 2004

56 PSRs are required to be carried out at least every 10 years and should take into account ageing and other time related phenomena and unforeseen circumstances, including external hazards such as aircraft crash, that may render the NPP unsafe

57 The first edition of the *Safety Assessment Principles* (SAPs) was introduced in 1979 which is predated by both Magnox and AGR design and construction at Dungeness. For the last *Periodic Safety Review* (PSR) undertaken for the A and B plants a Dungeness May 2000 SAPs edition applies.

58 Of the May 2000 SAPs, *Principles 126* and *127* of the licensing body's (NII) SAPs refer to aircraft impact in the following way:

" . . (P126) The predicted frequency of [accidental] aircraft and helicopter crash on or near safety-related plant at the nuclear site should be determined. The risk associated with the impacts. Including the possibility of aircraft fuel ignition, should be determined to establish whether Principle P119 is satisfied.

(P127) The calculation of crash frequency should include the most recent crash statistics, flight paths and flight movements for all types of aircraft and take into account forecast changes in these factors if they affect the risk. Relevant bodies should be consulted by the licensee with the object of minimising the risk from aircraft approaching or over-flying the plant. . . ."

Principle 119 relates to the anticipated frequency of the hazard, in this case an aircraft crash:-

" . . .(P119) It should be shown for all hazards that the design basis analysis principles and the PSA principles are satisfied as appropriate, unless it can be demonstrated that the frequency of an event being exceeded is less than once in 10 million years, or if the source of the hazard is sufficiently distant that it cannot be expected to affect the plant. . . ."

118 **Societal Risk:** Generally, very severely damaging faults and incidents are assessed on a best-estimate basis which applies to incidents that are considered to be very infrequent where it may not be considered practicable (ie cost effective) to include design provision against the outcome. Severe incidents are usually defined as those fault sequences that lead either to consequences exceeding the highest radiological doses (ie the maximum BSL), or to a substantial unintended relocation of radioactive material within the facility placing a demand on the integrity of the remaining physical barriers. A *substantial* quantity of radioactive material is usually defined to be the nature and amount which, if released, could result in unacceptable *societal* risk.

119 Obviously, in severe incidents involving substantial quantity of radioactive release doses to members of the public increase. As dose increases above 1000mSv then deterministic health effects including the possibility of prompt death become more important, if not dominant, so that the effects are likely to apply wider than to a particular individual, giving rise to significant off-site consequences. This is because with increasing levels of dose a greater number of individuals will suffer in both short and longer terms, so much so that in this eventuality the consequences might also have to be considered in societal terms.

120 BSL and BSO targets and objectives can also be applied to societal risk and are taken from an incident situation where immediate or eventual 100 or more fatalities are expected to occur,[59] even though the greater number of such fatalities would arise as a result of low dose to very large populations leading to stochastic deaths. BSL and BSO societal values determining acceptable rates of incidents resulting fatalities of 100 or more are 1.10^{-5} and 1.10^{-7} per annum respectively.[60]

121 **Emergency Planning:** In the UK there is a requirement for local authorities to provide emergency planning aimed at mitigating the consequences of nuclear incidents resulting in a radioactive release into the public domain. This requirement is set out in the *Radiation (Emergency Preparedness & Public Information) Regulations 2001* (REPPIR).[61]

122 So that local authorities may prepare adequate off-site emergency plans, the nuclear plant operator at each nuclear site has a statutory obligation to provide a *Report of Assessment*[62] that will enable the Health & Safety Executive (HSE) to determine if off-site emergency plans are necessary and, if so, the geographical area over which these are to be implemented by the local authority. The local authority receives notification from the HSE, thereafter having six months to prepare and fully implement the off-site emergency plan. REPPIR will supersede the operator's obligations of *Regulations 26* and *27* of the *IRRs* under which it provides and maintains the existing emergency planning schemes.

123 In or about 2001, both operators at Dungeness NPP, then Magnox Electric and British Energy, submitted Reports of Assessment from which the HSE determined that pre-prepared emergency planning was required out to a radial distance

59 Hughes D, *The Revision of Dose Limits For Exposure to Ionizing Radiation*, Ann of Occ Hygiene, V34 No 5, 1990

60 This involves interpretation of the public perception of risk and the complex differentiation in valuing the detriment of, say, a single accident involving a road bus accident involving a few deaths in a single accident which will cause great public concern, concern to the almost unnoticed passing of many more deaths daily from many roads accidents.

61 *The Radiation (Emergency Preparedness and Public Information) Regulations* (REPPIR) are intended to implement articles 48 to 52 on intervention in cases of radiation emergency in an European Council Directive on the basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation (Euratom BSS96 Directive).

62 The operator's report of Assessment has to provide sufficient information on all reasonably foreseeable radiological incidents, including for the nature, rapidity and magnitude of any projected radioactive release.

of 2.4km from the plants – this requirement was implemented in May 2002. However, there is a requirement that the risk and hazard assessment be regularly reviewed. *Regulation 5* of REPPIR requires that where a material change occurs the assessment should be reviewed to ensure that the hazard identification and the risk and hazard evaluation remain valid, inasmuch that *'. . . (a) the operator shall make further assessments to take account of these changes . . .'*

124 Accordingly, the should the LAA development proceed then the REPPIR Report of Assessment will need to be revised to include account of the increased air traffic movement and, particularly, the impact and consequences of the larger *C4* aircraft taken into account.

125 **Decommissioning:** There is a requirement under the *Nuclear Reactors. (Environmental Impact Assessment for Decommissioning) Regulations 1999* to minimise the environmental impact of the overall decommissioning process.

126 Specifically, *Part II (9)* requires consideration of the measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects with Schedule *2 (f)* the risk of accidents, having regard in particular to substances or technologies used. Even though Dungeness A has now entered the decommissioning process the conditions and circumstances relating to the reactor hulks and radioactive wastes remaining on site will continue to be subject of the NIA and these regulations until the Dungeness site is cleared of radiological hazard (from 25 to 100 or more years into the future in accord with NDA policy).

127 **Justification of Nuclear Practices:** Under the J*ustification of Practices Involving Ionising Radiation Regulations 2004* an existing practice (such as the continuing operation of Dungeness B NPP and/or the decommissioning processes of Dungeness A) may be reviewed by the *Justifying Authority* if it is demonstrated that *'. . . new and important evidence about is efficacy or consequences is acquired . . .'*[63]

128 Thus the existing and projected schemes of decommissioning will need to be reviewed if the higher risk of aircraft crash, and its radiological consequences, is introduced.

129 **Transportation of Spent Fuel & Radioactive Wastes:** A nuclear safety case is also required for the present transportation of irradiated fuel from both Dungeness A and B NPPs.[64]

63 *Justification of Practices Involving Ionising Radiation Regulations 2004, SI 1769 Part 3, S10(4(a)* - The justification process is an initial regulatory step, which applies to all new classes or type of nuclear practice Justification is not about approving a particular design of reactor on safety, security and other grounds, rather it is a higher level assessment of these issues, to confirm whether the benefits outweigh the potential detriments. - European Union Member States are required under the Basic Safety Standards Directive to ensure that all new classes or type of practice resulting in exposure to ionising radiation are justified in advance of being first adopted or first approved by their economic, social or other benefits in relation to the health detriment they may cause. Existing classes or types of practice may be reviewed whenever new and important evidence about their efficacy or consequences is acquired. In the UK the Secretary of State for Trade and Industry is the "Justifying Authority" for civil nuclear power.

64 There is a plethora of regulations and statutes relating to the transportation of *Category II* materials in addition to the IAEA regulations (ST 1, TS-R-1 and INFCIRC/225) for the safe transport and physical protection of radioactive materials. Referring to the IAEA 1996 Regulations approvals and compliance is required for Multilateral Shipment Approval (IAEA 820) and fissile packages (IAEA 566), special use vessels (IAEA 566), details of the proposed route, controls and shipment period (IAEA 822), flooding (IAEA 671), etc. In the UK the Competent Authority that approves radioactive material in transit is the *Radioactive Materials Transport Division* (RMTD) of the Department for Transport. More specifically, the RMTD generally Reviews the nuclear safety arrangements, although matters relating to security are undertaken by arrangement with the Department of Trade and Industry's Office of Civil Nuclear Security (OCNS). OCNS regulates the security aspects of movement of all civil nuclear material by road and rail, classifying carriers so that IAEA Category.

130 The existing spent fuel flask loading railhead is located within 1km of the LAA runway and the rail track runs across the end of the LAA runway. There is a standing arrangement whereby airport operations cease while spent fuel is in close proximity to the airport.

131 Once that decommissioning of Dungeness A is underway considerable volumes of radioactive waste will be dispatched from the site – see para 38 - although it has yet to be determined if the existing rail link will be utilised for this.

132 **PART V SITING OF A NEW NPP AT DUNGENESS**

133 A not unreasonable interpretation of the Government's recently published Energy Review[65] is that an expansion of nuclear power in the UK is to be encouraged. The government argues that nuclear power has a role to play in the future UK energy producing mix alongside other low carbon and carbon-free means of generation. [66]

134 Siting factors for new-build NPPs include consideration of the connection to and capacity of the electricity supply and distribution grid and, of course, matching the local and regional demands, are important factors in any electricity generating siting process.

135 NPPs are typically large capacity units (Generation III EPR at 1,600MW_e)[67] so copious quantities of cooling water in the environment favours seaside siting; and, of course, population density and dispersion routes and directions in the event of an untoward release of radioactivity have to be considered in the nuclear safety case. The policy of the Scottish Parliament may well preclude new-build NPPs in Scotland, or it may choose only to permit a new generating capacity proportionate to its electricity consumption demand which, as previously discussed, will be more than met by the renewable sector development.[68] Such a prohibition by Scotland's parliament, unless overruled not to be in the national interest, would place more emphasis on the remaining English and Welsh NPP sites.

136 Limiting the new-build NPP to existing licensed sites could be attractive to government because, given modification to the planning legislation, the process and public inquiry process could be shortened by limiting inquiry to local topics by dealing with principled issues via the justification process.[63] Also, certain existing NPP sites may require upgrading by additional grid connection for which, both overhead transmission lines and grid connection equipment siting, are likely to require scrutiny via the planning process. Government has indicated that grid upgrades specifically relating to a new-build generating plant (NPP or otherwise), should considered an intrinsic part of the planning process for the generating plant, being considered under a single planning inquiry.

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65 *Energy Review*, HM Department of Trade and Industry, July 2006

66 House of Commons, Trade and Industry Committee, *New Nuclear? Examining the Issues*, July 2006

67 It is more than likely any future NPP to be built in the UK will be either a Westinghouse AP 1000 or larger pressurised water reactor (PWR) or an EPR (European Pressurised Reactor) also a PWR designed by the ARIVA-Siemens consortium.

68 The justification process is an initial regulatory step, which applies to all new classes or type of nuclear practice Justification is not about approving a particular design of reactor on safety, security and other grounds, rather it is a higher level assessment of these issues, to confirm whether the benefits outweigh the potential detriments. - European Union Member States are required under the Basic Safety Standards Directive to ensure that all new classes or type of practice resulting in exposure to ionising radiation are justified in advance of being first adopted or first approved by their economic, social or other benefits in relation to the health detriment they may cause. Existing classes or types of practice may be reviewed whenever new and important evidence about their efficacy or consequences is acquired. In the UK the Secretary of State for Trade and Industry is the "Justifying Authority" for civil nuclear power.

137 There is high growth of electricity demand in the South-East and installation of the first new-build NPPs might assume priority at one or more of the existing NPP sites at Dungeness, Sizewell and/or Bradwell. Electricity distribution grid and other infrastructure costs generally support increased generating capacity at Dungeness. Also, on the assumption that no new *'green field'* sites will be considered seriously, the existing NPP site at Dungeness is the most likely existing site to be nominated for early development in the new-build NPP programme.[69]

138 However, any NPP new-build at Dungeness would need to fully satisfy the aircraft impact requirement of the SAPs and it is unlikely that the present relaxation of the once in ten million years requirement (*Principle EHA.1/2)* would be permitted.

139 To overcome the higher levels of risk of aircraft crash onto the Dungeness site any new NPP, either the EPR or AP series, would require considerable modification, both in structural and building layout designs, with resulting in increased costs and considerable delays . If so the very close proximity of the LAA to the Dungeness NPP site is likely to act as a strong impediment to any future NPP new build at Dungeness.

140 In my judgement it is not possible to proof a NPP against aircraft crash so the event must be ruled out by other means by, first, limiting the gross size (weight and fuel capacity) of the aircraft and, second, by setting a limit to the predicted frequency of crash. The proposed development at Lydd does neither: it raises the size of the aircraft using the airport it increases the number of air traffic movements. Thus, permitting the LAA development to proceed places a prohibition on any future development of the Dungeness nuclear site with it losing favour as the leading candidate site for future nuclear generation capacity in the South-East.

141 **IN CONCLUSION**

142 I am of the opinion that the proposed development of the airfield at Lydd would introduce an increased level of risk of aircraft crash onto the existing Dungeness NPPs.

143 I consider that this increased level of risk would exceed the present screening limit imposed by the NII to maintain the nuclear safety case. In this respect, the risk would be unacceptable in terms of the potential radiological consequences to individual members of the public and, in societal terms, generally as a whole.

144 I refer to and agree the previous statement by the NII (see para 53) that any development beyond the LAA plans of 1995/97 will require reconsideration of the Nuclear Safety Case. The present proposals to redevelopment LAA are substantially and materially different from 1995/97, involving both increased numbers of air traffic movements and larger aircraft, so much so that it would be prudent for the Nuclear Safety Cases for both Dungeness B (operational) and Dungeness A (decommissioning) to be undertaken and published prior to the present planning application moving forward to Planning Committee stage.

69 As part of setting the strategic context for new-build, the Government will be undertaking a further assessment of the suitability of sites for new nuclear build. This assessment is to involve a full assessment of the strategic and high level environmental impacts of new nuclear build and will identify the criteria for locations where the Government would support proposals for new nuclear power stations. It will also indicate how potential sites meet these criteria. Industry has indicated that the most viable sites for new-build are likely to be adjacent to existing nuclear generating plant, although there might be other attractive sites, for example other nuclear installations and sites with retiring fossil fuel generating stations. The Government will begin this strategic siting assessment in early 2007.

145 I have shown that the legislation and regulatory framework of nuclear safety is complex. In my opinion, as well as the nuclear safety case having to be reassessed, other requirements relating to decommissioning, emergency planning, and justification would also need to be reviewed for amendment should the proposed LAA development proceed.

146 I have similar reservations about the risks and potential radiological consequences relating to aircraft crash on the completely unprotected railhead for loading irradiated fuel flasks and for the rail dispatch of these flasks over a track that passes along the southern end of the LAA runway. Again, I consider it prudent for the railhead and transportation safety cases be reviewed and included in this review should be consideration of the very large volumes of radioactive wastes that will arise during decommissioning of, first, Dungeness A and then Dungeness B.

147 I have briefly considered the influence that commercial operations at LAA may have on future development of nuclear power generation on the Dungeness site. The increased risk of aircraft crash on the site would, in my opinion, require any new build Generation III NPP to be substantially enhanced and modified, so much so that this would lengthen the development and build time and, with this, increased capital and operating costs.

148 Thus, the close proximity of LAA would necessitate the construction, commissioning and operation of a unique version NPP at Dungeness, being different to the series of identical NPPs likely to be built elsewhere in the UK. Such a requirement is unlikely to favour Dungeness as a candidate site for future nuclear generation capacity.

149 As I have opined earlier, I do not believe it possible to proof the existing Dungeness A and B NPPs, or a future Generation III NPP that might be built on the Dungeness site, against aircraft crash, particularly that of a fully fuelled, commercial airliner of the types proposed for the LAA development. This being so, the reasonable possibility of aircraft crash must be ruled out by other means by, first, limiting the gross size (weight and fuel capacity) of the aircraft and, second, by setting a limit to the predicted frequency of crash. The proposed development at Lydd does neither: it raises the size of the aircraft using the airport and it increases the number of air traffic movements.

150 Finally, I have refrained from commenting in detail on the potential opportunities that further development of LAA would provide for terrorist and other malevolent acts that might be targeted at the Dungeness site. That said, I have no doubt in my mind that commercial operations at LAA would provide openings for such acts to be perpetrated.

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