

SIZEWELL A – COOLING POND RECIRCULATION PIPE FAILURE INCIDENT OF 7 JANUARY 2007

ASSESSMENT OF THE NII DECISION MAKING PROCESS

CLIENT: SHUTDOWN SIZEWELL CAMPAIGN - REF N^o R3179-A1

SUMMARY

This is a review of the Nuclear Installations Inspectorate’s decision not to prosecute Magnox Electric Ltd over its involvement in the Sizewell A radioactive discharge incident of 7 January 2007. The radioactive release arose as a direct consequence of a breach in the pipework of the spent fuel pond water recirculation system resulting in uncontrolled spillage of 40,000 gallons (180m³) of (radio)active water over a period of about 45 minutes. About one-quarter of this spillage discharged completely untreated to the marine environment via the Sizewell A site storm drainage system.

Requesting further information on the incident from the Nuclear Installations Inspectorate, the *Shut Down Sizewell Campaign* received a response that comprised much jargon if not, some might opine, gobbledygook in respect of the Inspectorate’s explanation why it had not proceeded with a prosecution against Magnox Electric. The *Campaign* then instructed Large & Associates to independently assess the processes adopted by the Inspectorate in arriving at its decision not to prosecute Magnox Electric Ltd.

For its decision-making the NII adheres to the HSE *Enforcement Management Model* (EMM) framework in which, essentially, the actual risk of adverse consequences is compared to the benchmark of acceptable risk and tolerable consequences specified by the Nuclear Site Licence and its adjunct regulatory framework. This so-called Risk Gap is then resolved, with account being taken of Dutyholder’s (Magnox Electric) performance and with the decision overall being qualified by Strategic factors, to determine the appropriate regulatory action necessary to bring the nuclear activity into compliance with the Law which, itself, may involve prosecution. At the front end of the EMM process, the Inspectorate investigates the incident with its preliminary report serving to define the actual risk involved and the performance of the Dutyholder specifically leading up to and during the incident and, more generally, in its overall operation of the nuclear plant (Sizewell A). On the evidence made available to Large & Associates, we consider that the serious mistakes made by the Sizewell A operations and systems engineering staff, as identified in the Inspectorate’s Preliminary Report, by far outweigh the positive scoring assigned to Magnox Electric in the EMM Dutyholder performance assessment. In this respect it is difficult to fathom how the Inspectorate was able to convert a Risk Gap ranked at *substantial* to *extreme* that, by its own definition, required serving an Improvement Notice specifying mandatory changes to the plant and its management, and most likely proceeding with prosecution, to the much less punitive action of issuing a Directive whereupon Magnox Electric conducted its own review in the absence of prosecution.

Our findings are that the issues involved were quite unambiguous: Magnox Electric had failed to put in place proper inspection and appropriate maintenance regimes for the pond water recirculation and containment systems; its staff were poorly trained and ill-prepared; vital detection and alarm systems were either not fully commissioned and/or not working; lessons had not been learnt, particularly from a previous and almost identical failure of the recirculation pipework; and, generally, such was the significance of the mistakes made by Magnox Electric staff that their suitability to carry out their roles effectively must be at issue. In fact, if it had not been for the quite fortuitous presence of a contractor in an adjacent laundry area who reported flooding in that locality, then the leakage could have completely drained down the pond, uncovered the spent fuel and, in all probability, resulted in a fuel fire with an off-site airborne release of highly radioactive fission product – this scenario could have developed within 10 hours of the initial pipe failure, that is inside the 12 hours rota of the walk-through inspections of the fuel pond area in operation at the time of the incident.

On related issues: We find that Magnox Electric did not fully appraise the Sizewell Stakeholder Group of all of the facts and circumstances of the incident in that it implied that the spillage of 10,000 or so gallons of active water to the marine environment was an authorised discharge; it failed to give account of the many shortcomings in maintenance, inspection, commissioning and staff performance identified by the Inspectorate; and it made no reference whatsoever that within 10 hours the situation could have developed into a very significant off-site airborne release of fission product laden fuel oxides, with extreme if not dire health consequences to the public.

Finally, on information availability and transparency we have been disappointed by the response of the Inspectorate to our quite proper request for information on its decision-making over this incident which, we consider, has denied us access to what we assume to be a considerable amount of further information relating to this matter.

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ASSESSMENT OF THE NII DECISION MAKING PROCESS

BACKGROUND

This assessment relates to the Nuclear Installations Inspectorate's decision not to proceed with a criminal prosecution over the incident at Sizewell A nuclear power station on 7 January 2007.

In January 2009, the Chief Inspector of HM Nuclear Installations Inspectorate (NII - Inspectorate) responded^{1,i} to concerns raised by the *Shut Down Sizewell Campaign* (the Campaign) on the lack of enforcement action. In response, the Chief Inspector relayed¹ the NII's decision not to prosecute the operator (Licensee – then Magnox Electric Ltd) because

“ . . . a number of factors including the identification of the “risk Gap”, the “initial enforcement expectation” and the “stakeholder factors” . . . Given the efforts of the Licensee in the proactive approach to addressing the event . . . we judged that prosecution . . . was not in the public interest. . . .”¹

[my . . . truncation]

The Campaign then instructed (18 February 2009) Large & Associates to provide an assessment of the processes adopted by the Inspectorate in reaching its decision not to prosecute. For this, Large & Associates requested further information from the Inspectorate,^{2,3} receiving a response comprising 3 documents on 24 March 2009.^{4,5,6} For completeness, Large & Associates subsequently requested from the Inspectorate confirmation or otherwise that it considered the three documents provided to the earlier request^{2,3} to be a complete response to which we are awaiting a reply.

HSE ENFORCEMENT MANAGEMENT MODEL

For its decision-making processes the NII follows the framework detailed within the HSE *Enforcement Management Model* (EMM).^{7,ii} EMM defines the parameters and other factors required of inspectors when arriving at enforcement decisions in line with the Health and Safety Commission's (HSC) *Enforcement Policy Statement* (EPS).⁸ The EPS sets out the principles inspectors should apply when determining what enforcement action to take in response to breaches of health and safety legislation, here the *Nuclear Installations Act 1965* as applied specifically to the Sizewell A incident of 7 January 2007.

In effect the EMM procedure guides the Inspectorate in arriving at and demonstrating that the enforcement action is proportional to the health and safety risks, matched to the seriousness of the breach, and in the public interest. For this a pro-forma record, the *Enforcement Assessment Record*,⁶ summarising the decision process is completed and logged against the incident.

INCIDENT OF 7 JANUARY 2007

The incident is described in a number of sources, the most authoritative being the NII *Preliminary Assessment Report 2007/0011*:⁴

“ . . . At 11:30hrs on Sunday 7th January 2007 the main control room was notified by a contractor [. . . REDACTED . . .] . . . that a large volume of water was leaking onto the ground floor of the Effluent Treatment Plant. Investigation . . . found the source of the leak to be a vertical longitudinal split [15ft long] in a section of 8in (200mm) plastic pipe in the cooling pond recirculation system. The in-service pond water recirculation pump was manually shut down, stopping the leak. . . the pond water level had fallen below the normal working level, without any engineered alarms initiating, . . . approximately 40,000 gallons, or 180m³, of radioactive material had been released from the failed pipe. Most of this water was contained within the Effluent Treatment Plant Building, however, . . . some pond water had escaped from the building and entered the site's storm drain system which discharges directly to sea. . . .”

[my . . . truncation – [additional information]- HSE REDACTION]

- i The relevant documents are directly accessible from www.largeassociates.com, via the 'Client Zones' tab and input the secure pass code 'CZ3179'.
- ii See Appendix III for a schematic of the EMM process and related documents.

In reporting the incident to the Sizewell A & B Stakeholder Group (SSG),⁹ a staff member of Sizewell A noted that:

“... (iv) A decision was taken to use the site drainage system for the discharge of water from the pond. This was an authorised discharge route and the decision took account of the radioactivity contained within the water. This assessment had been based conservatively on the radioactivity contained in all of the water which had escaped although in fact some 30,000 gallons was recovered in sumps on the site. . . .”

The SSG record implies that the discharge was an ‘authorised’ discharge of 10,000 gallons (45m³) of contaminated water and, moreover, that a ‘decision’ was taken to route the contaminated water via the site storm drainage system. This differs from the Inspectorate’s findings in that some of the contaminated water had ‘escaped’ to the site’s storm drain system which would eventually discharge uncontrolled to the marine environment. So far as being ‘authorised’ this could not have been so because the Environment Agency had then (10 March 2007) still underway its own investigation into the incident.

Although not reported to the SSG, the level of radiocaesium (Cs-137) reckoned by Magnox Electric contained within the 180m³ pond water was about 3.6GBq (with additional radionuclides) which, in total, represents a uncontrolled potential discharge to sea of less than 1% (0.36%) of the 1TBq annual limit for radiocaesium or, on the basis that about 45m³ was lost to sea prior to any radioactivity abatement,ⁱⁱⁱ then about 0.1% of the radiocaesium annual limit was actually discharged.¹⁰ Setting aside the elevated levels of transport skip contamination,¹¹ typical annual discharges of Cs-137 from Sizewell A have been, on average, 0.07TBq/year, so the uncontrolled discharge during the day of 7 January represents approximately 5% of the actual annual (year-on-year) discharges of radiocaesium.

NII ENFORCEMENT DECISION

As previously noted, the NII Chief Inspector justified¹ the decision not to prosecute on a number of factors, including the ‘risk gap’, and the ‘initial enforcement expectation’ through the application of EMM.

The Inspectorate’s explanation relied upon much jargon, indeed some might opine gobbledygook, in setting out the decision-making process not to prosecute Magnox Electric. Moreover, the Inspector introduced other contributory elements that are not formally incorporated into the EMM process, such as ‘stakeholder factors’, the post-incident ‘proactive action’ taken by the Licensee to ensure that a recurrence of the event was ‘unlikely’, and the amount of ‘time and effort’ required of the Inspectorate in mounting a prosecution. In response to Large & Associates’s initial request and clarification for further information^{2,3} the NII provided a summary pro-forma (2 pages),⁶ a copy of its own preliminary report into the incident,⁴ and a copy of the letter notifying Magnox Electric that no further regulatory action was to be taken.^{attached to 4} In the absence of any further information, we have had to rely upon just the Preliminary Assessment Report and the EMM Enforcement Assessment Report pro-forma, noting that these most likely provide less than a comprehensive and entirely meaningful insight into the decision-making process determining the regulatory outcome of this incident.

The basis of EMM is Risk Gap analysis: The *Risk Gap* is the difference between the actual risk and that expected in compliance with the Nuclear Site Licence. The Risk Gap, with account of other factors, is deployed to assess what enforcement is necessary to secure compliance with the law and also to determine whether prosecution should be considered - a summary of this process (see schematic OF APPENDIX III) is recorded on the *EMM Enforcement Assessment Record*,⁶ colour-coded here for clarity:

iii The most radiologically significant radionuclides in liquid discharges from Magnox power stations in normal operation are caesium isotopes Cs-137 and there are smaller contributions from Cs-134 and tritium. The caesium arises mainly by leakage from fuel elements in the cooling ponds, where spent fuel is stored prior to being sent for reprocessing. Unusually, the spent fuel storage pond at Sizewell A may not be equipped with a submersible of caesium removal plant in the pond itself serving for first-stage caesium removal, so the processing by recirculation to the Effluent Treatment Building is the sole radiocaesium abatement facility serving the spent fuel pond water.

RISK OF SERIOUS INJURY □

Section 2 of the EMM considers the *imminent* risk of serious personal injury but it is not clear from this summarised pro-forma if the assessment has been modified in account of the stochastic effects of exposure to ionising radiations¹² of individual members of the workforce and/or a member of the public.

The Inspectorate’s assessment is that there was no imminent risk of serious personal injury and that, accordingly, Section 25 of the *Health and Safety at Work, etc Act 1974* need not apply.

RISK GAP □

Actual Risk: To arrive at the *Risk Gap*, first, the *Actual Risk* level is determined, that is where the situation actually is. For the 7 January incident this should include the numbers of people at risk of exposure, related aspects of the inspection, maintenance and supervision regimes applicable to the cooling pond pipework, staff training, design of the building bundage, availability to isolate and contain the site storm drainage system, etc., all of which should be considered in terms of the potential for harm (not what actually happened).

Benchmark: The next step is to establish a *Benchmark*, that is where the situation (according to the Site Licence etc.) ought to be. This will involve consideration of the expected standards against which the operator (here Magnox Electric) might be compared, including discharge limits with BPM and ALARP constraints,¹³ the installation and upkeep of alarms and transducing devices, adequate maintenance and local supervisory rules, etc., all of which might be combined to arrive at a qualitative judgement on the *Consequence* reasonably expected to occur, *Likelihood* of the event happening, and the *Extent* or number of people that could be affected.

Risk Gap: The *Risk Gap* is determined by resolving the intersection of the *Actual Risk* -v- *Benchmark Risk* in TABLES 2.1-2 (APPENDIX I) which relate to single and low, and large numbers of potential casualties respectively.

Referring to the EMM record (left) for the 7 January incident the *Actual Likelihood* is assessed to be in the range of *possible* to *remote* compared to the *Benchmark Likelihood* requiring a *nil* and/or *negligible* occurrence. On this basis of comparison the EMM assessment identifies the consequences for both individuals (Table 2.1 – APPENDIX I) and larger numbers of persons (Table 2.2) to be within the range of *extreme* and *substantial*.

Enforcement Management Model

Enforcement Assessment Record

Section 1

Duty holder Client No

Site/Premises Location No Event No

Brief description of circumstances

Loss of up to 40,000 gallons of pond water on 7th January 2007. Most of the water was retained within the Active Effluent Treatment Building but some escaped and went to the North Sea via the site's storm drain system. The event was detected by a contractor, the engineered alarm system/protection system did not work on the day, however, if it had done then control room staff would have been unaware due to standing alarms. Breached of various Licence Conditions identified, but primarily LC 34. Clearly a breach of Section 4.6 of the Nuclear Installations Act 1965. As there was no harm then it is less clear that there has been a breach of the Health and Safety at Work etc Act 1974.

Section 2 – Imminent risk of serious personal injury

Prohibition notice Yes No Section 25 powers Yes No

Section 3 – Risk gap (From Table 1 and Figures 2.1 or 2.2)

Actual risk	Consequence	Probable <input type="checkbox"/>	Possible <input checked="" type="checkbox"/>	Remote <input checked="" type="checkbox"/>	Nil / negligible <input type="checkbox"/>
	Likelihood	Probable <input type="checkbox"/>	Possible <input checked="" type="checkbox"/>	Remote <input type="checkbox"/>	Nil / negligible <input checked="" type="checkbox"/>
Benchmark	Consequence	Probable <input type="checkbox"/>	Possible <input type="checkbox"/>	Remote <input type="checkbox"/>	Nil / negligible <input checked="" type="checkbox"/>
	Likelihood	Probable <input type="checkbox"/>	Possible <input type="checkbox"/>	Remote <input type="checkbox"/>	Nil / negligible <input checked="" type="checkbox"/>
Risk gap (and table used)	Table 2.1	Extreme <input checked="" type="checkbox"/>	Substantial <input checked="" type="checkbox"/>	Moderate <input type="checkbox"/>	Nominal <input type="checkbox"/>
	Table 2.2	Extreme <input checked="" type="checkbox"/>	Substantial <input checked="" type="checkbox"/>	Moderate <input type="checkbox"/>	Nominal <input type="checkbox"/>

Section 4 – Initial Enforcement Expectation (Tables 5.1, 5.2 or 5.3)

Benchmark standard (Table 3)	Defined <input type="checkbox"/>	Established <input checked="" type="checkbox"/>	Interpretative <input type="checkbox"/>
Compliance / admin descriptor (Table 4)	Absent <input type="checkbox"/>	Inadequate <input type="checkbox"/>	Minor <input checked="" type="checkbox"/>
Compliance with permissioning document	Contravention <input type="checkbox"/>	Irregularities <input type="checkbox"/>	Compliance <input checked="" type="checkbox"/>
Initial Enforcement Expectation	Prosecution <input checked="" type="checkbox"/>	I / N <input checked="" type="checkbox"/>	Letter <input type="checkbox"/>
Permissioning document impact (table 5.3 only)	Revocation / refusal / direction <input type="checkbox"/>	Amendment / refusal / variation <input type="checkbox"/>	Amendment <input type="checkbox"/>

Section 5 – Dutyholder factors (all elements do not always apply)

Is there a record of previous relevant written enforcement action, such as notices, prosecutions, or letters requiring action?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	
Is there a history of related incidents, accidents, ill health, etc?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	One similar event noted
Is there a history of previous relevant verbal enforcement?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	
Did the dutyholder gain or deliberately seek economic advantage from non-compliance?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	
Level of actual harm arising from the matter under consideration?	Serious personal injury or serious health effect <input type="checkbox"/>	No serious harm <input checked="" type="checkbox"/>	
What is the standard of general conditions?	Poor <input type="checkbox"/>	Reasonable or N/A <input type="checkbox"/>	Good <input checked="" type="checkbox"/>
What is the inspection history of the dutyholder?	Poor <input type="checkbox"/>	Reasonable or N/A <input type="checkbox"/>	Good <input checked="" type="checkbox"/>
What is the attitude of the dutyholder to H&S issues?	Hostile / indifferent <input type="checkbox"/>	Reasonable <input type="checkbox"/>	Positive <input checked="" type="checkbox"/>

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Note: See page 8 for continuation of the EMM Summary

INITIAL ENFORCEMENT EXPECTATION □

Appropriate Standards: The proportionate level of enforcement, according to the EMM process, is geared to the level or stringency of the standards (ie regulatory framework) required in the undertaking of the function, here operating a nuclear installation safely. Obviously, the more defined or established the appropriate standard or standards, then the greater the seriousness the non-compliance. The appropriate standards are well defined being the *Nuclear Installations Act 1965* and its supporting regulatory framework, essentially the *Nuclear Site Licence*;¹⁴ the *Radioactive Substances Act 1960* and the *Ionising Radiations Regulations 1999* and the *Health and Safety at Work etc Act 1974*.

In terms of clarity and definition of what is expected of Magnox Electric in safely operating Sizewell A, the appropriate *standards* are authoritative, *defined* and *established*. The 7 January incident involved a number of individual and multiple issues which draw in different *standards* relevant to each (ie *Nuclear Site Licence* on safety issues, *Ionising Radiations Regulations* on potential exposure and health harm, *Radioactive Substances Act* on discharge authorisations and Source Constraint, etc).

Initial Enforcement Expectation: TABLE 5.1 (APPENDIX II) show the relationship between the *Risk Gap* and the *Appropriate Standard* for the 7 January incident. With the *Risk Gap* in the range of *extreme* and *substantial* and the *Standards* being *defined* and *established*, the *Enforcement Expectation* strongly points to a prosecution and, to secure compliance with the Law, the serving an *Improvement Notice*, *Direction* or similar.

DUTYHOLDER FACTORS □

In the Inspector's letter of explanation,¹ the Chief Inspector refers to '*Stakeholder Factors*' by which it is assumed he is referring to the quite specific party *Dutyholder* (here Magnox Electric Ltd).^{iv}

Dutyholder factors may influence the enforcement decision which, for this incident, seemed to have served to militate against the *Enforcement Expectation* of prosecution because all of the factors identified favour the performance of Magnox Electric. However, the Inspectorate's *Preliminary Report*⁴ strongly suggests otherwise, there being *Dutyholder* factors that directly contributed to the incident itself and that the *Dutyholder's* management of the plant included several serious shortfalls that, as it happened, were only negated by fortuitous circumstances.

Referring to the Inspectorate's *Preliminary Report*:^{4,v}

Incident Notification [para 5]

The leak of spent fuel pond water was first notified to the Main Control Room by a plant worker who was undertaking an entirely unrelated activity of sorting clothing in the Active Laundry area adjacent to the Effluent Treatment Plant area where the pipe split had occurred about 45 minutes earlier.

Detection of the leak was entirely dependent upon the quite fortuitous intervention of the laundry area operative because the pond water level instrumentation, although replaced in 2006, did not work on the day of the incident [para 17]. Not only was the Sizewell A Responsible Engineer unaware that the level instrumentation and alarm system did not work, control room operatives were oblivious to the fact that the water level signal was not being relayed to the Main Control Room [para 18]. In other words, although one alarm raised locally in the spent fuel pond area, since this area was normally unmanned, the failure of the alarm to repeat in the Main Control Room meant that until the reporting by the laundry worker those in control were totally unaware of the developing situation in the pond area.

Save the intervention of the laundry worker, if the situation had progressed unnoticed because, normally at weekends the pond area is unmanned and only subject to a patrol every 12 hours, then pond would have drained down in 10 hours and there would have arisen a very significant risk of

iv The term *Stakeholder* is not included in the EMM process.

v For fuller details refer to the paragraphs cited in the NII Preliminary Report of Ref 4.

the uncovered spent fuel igniting¹⁵ and, from this, an airborne off-site release of radioactive fission product [para 20].

The Inspectorate⁴ identifies [para 22] a number of possible breaches of the Licence Conditions¹⁴ relating to the failure of the alarm and systems, these being 17 (Quality Assurance), 19 (Construction or Installation of New Plant), 21 (Commissioning), 22 (Modification or Experiment on Existing Plant), 26 (Control and Supervision of Operations), 27 (Safety Mechanisms, Devices and Circuits), 28 (Examination, Inspection, Maintenance and Testing) and, probably, 34 (Failure of Inspection).

Previous Incidents [para 12]

Two previous events (and not one as recorded on the EMM Record)⁶ involving breaks and leaks in the pond recirculation pipework had occurred in 1994 (about 200 to 400 gallons) and, more recently, a split in pipework (of identical section to the 7 January incident) in 2006 resulting in a loss of about 6,000 gallons of active pond water. As a result of the 2006 event, Magnox Electric undertook to change sections [para 13] of the suspect piping (*Durapipe*) by August 2006 and, although apparently completed, this replacement work was never formally cleared by the time of the 7 January 2007 incident.

Adequacy of Inspections and Maintenance [para 13]

It is now obvious that the post-2006 event inspection and replacement works (by August 2006) failed to identify what must have been then the doubtful and vulnerable section of piping that was to fail 4 months later in January 2007. Moreover, the failed original pipework section was not compliant with the design and as installed the pipework never met the specification required [para 14-15], but this serious anomaly was not detected by the August 2006 review and replacement programme of sections and components of the pipework.

Indeed, there seems to have been throughout the operational life a clear failure of maintenance and inspections of the pond pipework [para 15], with wall thinning and embrittlement not recognised as means leading to a failure mode and, possibly, in breach of the Licence Conditions¹⁴ 19(10), 28(1) and 17(1). This has resulted, so finds the Inspectorate [under para 29, LC 28], that for the pond at least “ . . . *The [nuclear] safety case and MS [maintenance schedule] are not consistent. Either the arrangement or their implementation are not adequate. . .*”.

The Inspectorate⁴ noted [para 23] “. . . *the systems engineers had performed poorly with regard to the mismatch between MS and the Safety Case [the pipe should have been on the MS] and just about everything associated with the Effluent Treatment Plant refurbishment project. . .*”, concluding that “. . . *The only good action noted was that when a contractor raised the alarm the operators appeared to react very well and avoided a significant event from becoming a very serious off-site event. . .*”.

Training of Magnox Electric Staff [para 29]

The situation prior to the 7 January incident raised a number of inadequacies of the operations staff, including [under para LC10] failure to take corrective action on standing alarms,^{vi} with these alarms being permitted to continue to sound with defects being raised on them; on their part, the systems engineers appeared not to understand the need to control the activities of contractors replacing safety systems, such as the new alarm in the spent fuel pond which was not working unbeknown to the control room staff; and there was a lack of priority in commissioning new equipment at the earliest opportunity.

vi At the time of the incident both Sizewell A reactors were being closed down and cooled via the main boilers venting steam following cessation of generation in December 2006. As many of the systems were being taken out of service or were operating in an abnormal mode, a considerable number of alarms were either initiating or sounding in the Main Control Room and around the site. These sounding and visual alarms served to mask any other alarms that may have triggered for proper reasons.

Competent Persons in Place [para 29]

The Inspectorate found that [under para LC12] that operators and systems engineers “ . . . made significant mistakes which call into question their suitability to carry out their roles . . . ”.

Installation, Specification and Commissioning of New Plant [para 29]

Regarding the new pond alarm system, which failed to sound in the Main Control Room, the Inspectorate recorded [under para LC19] “ . . . it is clear that the control arrangements were inadequate, their implementation was inadequate, or both were inadequate . . . ”. This was because the contractor had removed an obsolete but fully functional alarm system, replacing it with one that did not work, passing this to Magnox Electric who did not check the functionality of the new system “ . . . for many months and although it was being used to [assumed to] protect against pond faults it had never been commissioned by the site’s responsible systems engineer. . . ”.

Indeed, the evidence is that the Magnox Electric “ . . . systems engineers have been allowing contractors to carry out significant plant modifications without taking control of the process . . . they failed to check the work and carry out timely commissioning of equipment . . . despite its track record for good safety standards, it fell well short of the mark on this occasion. . . ”.

Moreover, [under LC26] there is an overall safety culture problem on site, in that “ . . . Given the failure of the plant modification responsible engineer to control the contractor while modifying the pond alarm system, and the willingness of main control room staff to accept standing alarms without question, there is an issue regarding the suitability of people to control operations on site. . . ”. This situation of tolerating standing alarms in the Main Control Room (and elsewhere) persisted [para 32] “ . . . for at least several days without anyone doing anything about it. . . ”.

Radioactive Discharge of 7 January 2007 [para 32]

The Inspectorate’s investigation “ . . . found clear evidence that radioactive material (pond water) had been allowed to leak and escape out of control for 40 to 45 minutes without being detected by the engineered alarm system . . . ” and, in terms of the EMM Risk Gap that “ . . . During this event the control was lost and the risk of serious personal injury [ie pond fuel ignition and off-site airborne release consequences] fell into the remote or possible area, thus indicating a risk gap of substantial to extreme. . . ”.

In account of the Inspectorate’s highly critical findings and comments (précis above), it seems quite contrary for the *Dutyholder Factors* section of EMM *Enforcement Assessment Record*⁶ to summarize the categories of *general conditions, inspection history* and *attitude towards Health & Safety issues* to be ‘Good’ and ‘Positive’ in respect of the Magnox Electric actions that led and contributed to the 7 January incident. Note that it is important to consider the Dutyholder’s performance (here shortcomings and failings) in terms of the potential for harm and not of what actually happened (ie the chance intervention of the laundry contractor), nor in account of its record in other past or present activities within the plant (ie exemplary performance in one activity should not compensate for failings in another).

Returning to the EMM *Enforcement Assessment Record*⁶ for the incident of 7 January 2007:

INDICATED ENFORCEMENT ACTION □

Even though the Risk gap was identified to be in the range of *substantial to extreme*, warranting an *Initial Enforcement Expectation* of prosecution, at this stage the Inspectorate’s interpretation of the Dutyholder’s (Magnox Electric) performance is that it would be sufficient to issue an *Improvement Notice* for compliance with the Law.

However, it not absolutely clear which incident outcome the Inspectorate adopted when determining the *Actual Risk* of the Risk Gap analysis. The impression is that the Inspectorate has chosen the spillage of active pond water to be the outcome, whereas the true potential outcome is, surely, the situation whereby the pond drains down, the fuel is uncovered, the fuel ignites and a significant off-site release occurs. In other words, the spillage incident and discharge to the marine environment might be considered as the first step to a very much more

Indicated enforcement action (after considering local factors)			
Enforcement	Prosecution <input type="checkbox"/>	I / N <input checked="" type="checkbox"/>	Letter <input type="checkbox"/> Verbal warning <input type="checkbox"/>
Permitting	Revocation / refusal / direction <input type="checkbox"/>	Amendment / refusal / variation <input type="checkbox"/>	Amendment <input type="checkbox"/> Letter <input type="checkbox"/> Verbal warning <input type="checkbox"/>
Strategic factors			
Does action coincide with public interest?	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>	
Are vulnerable groups protected by the action?	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>	
What is the long-term impact of the action?	Sustained <input checked="" type="checkbox"/>	None <input type="checkbox"/>	
What is the effect of the action on other dutyholders?	Positive <input checked="" type="checkbox"/>	Negative <input type="checkbox"/>	
What is the initial effect of action on compliance with benchmark?	Achieved <input checked="" type="checkbox"/>	Incomplete <input type="checkbox"/>	
What is the functional impact of the action?	Acceptable <input checked="" type="checkbox"/>	Unacceptable <input type="checkbox"/>	
Have the principles and expectations of the Enforcement policy been met?	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>	
Outcomes of management review			
Regulatory action required – IN or LC Direction; some action would clearly be expected by a member of the public.			
Enforcement action plan (Priorities for action, and timescales)			
Issue an IN – but very difficult as the Licensee has now taken appropriate action and is almost certainly compliant with the LCs (27 and 34) where non-compliance may have existed.			
LC Direction – After considerable discussion it is felt that the best approach would be to issue a Direction under LC15(4) which states: "The licensee shall, if so directed by the Executive, carry out a review and reassessment of safety and submit a report of such review and assessment to the Executive at such intervals, within such a period and for such matters or operations as may be specified in the direction."			
MEL to review the event on 7 January 2007, the Cooling Pond Safety Case, the Maintenance Schedule and all operating instructions so as to determine what actions are required in the interest of safety in the SZA pond area.			
Name of inspector			Date completed 08/02/07
Line manager's assessment			
See Division 1 PAR 2007/0011			
Name of line manager			Date 09/02/07

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serious and higher consequence event. The cascade down to this event was only stopped by the chance presence of the laundry contractor so, left solely to the supervision and safety arrangements in place by Magnox Electric, save the contractor's timely intervention, the pool would have inevitably drained down to uncover the fuel.

Since the pond level alarm was not repeating in the Main Control Room, the next operating alarm to sound would have been the pool area gamma alarm (triggered by the lack of water shielding depth over the fuel) by which time it would have been, probably, too late to avert a fuel ignition situation.^{vii}

Referring back to the EMM summary for Risk Gap (EMM Section 3), the *Actual Risk Consequence* would increase from *Significant* to be definitely *Serious* and, in the absence of alarms and feedback to the Main Control Room of a developing situation, the *Likelihood* would be firmly *Probable*, that is greater in certainty than *Possible*.

STRATEGIC FACTORS □

Account of *Strategic Factors* serve to qualify the enforcement decision, they do not determine it.

Assessing the Strategic Factors for particular circumstances is a qualitative-based judgement involving consideration of the public interest, including the public's expectation.

Arguably, Strategic Factors should give regard to the public perception of any activity involving nuclear and radiological substances which, in itself, might require a greater rather than lesser punitive redress to be followed.

The tests applied to the qualification of Strategic Factors are: what would a reasonable person expect of the Inspectorate in the circumstances; and would the Inspectorate's action be justified in any public forum or inquiry?

OUTCOME - MANAGEMENT REVIEW □

However, even in account of much criticism of Magnox Electric's performance and failings, as highlighted in the Preliminary Investigation Report, the Inspectorate was able to conclude⁴ [para 35] ". . . that there is no obvious benefit to be gained from issuing an IN [Improvement Notice] as the licensee [Magnox Electric] has set about putting right all that was wrong in this case . . ." and, so far as proceeding with a prosecution, even though the Inspectorate considered there to be two prosecutable breaches of the Nuclear Safety Licence (Licence Conditions 27 and 34) the decision not to prosecute seems to have been swayed by an external factor ". . . this would require the commitment of a considerable resource . . . at a time when NII's resources are stretched . . .".

vii Obviously, with the recirculation pump operating at a constant flow rate as the pool drains, the volume of water markedly decreases with the bottom level being occupied by fuel, racking, skips and other equipment, so much so that the low levels of the pond would be drained more quickly.

ENFORCEMENT ACTION PLAN

At this stage of the EMM process the option to prosecute has been dropped and an Improvement Notice is considered and dismissed on the grounds that Magnox Electric had taken the appropriate action.

In view of the time scale involved here, that is just one month following the incident, it is somewhat doubtful that this included the retraining of staff, properly commissioning the alarm systems specifically serving the spent fuel pond and resetting all other alarms erroneously sounding throughout the site.

OBSERVATIONS

There are a number of areas of interest that arise from the Inspectorate's assessment of the incident of 7 January 2007:

1 EMM PROCESS & DECISION NOT TO PROSECUTE

Our assessment of the EMM decision-making process and the decision not to prosecute Magnox Electric is entirely reliant upon our interpretation of the summarised EMM Enforcement Assessment Record and the Inspectorate's Preliminary Investigation Report. Moreover, we acknowledge that the NII personnel involved in the decision-making process would have the benefit of first-hand knowledge of not just the 7 January incident but, comprehensively, of the Sizewell A plant, its management systems and its personnel.

That said, we are surprised at the clear dichotomy between the wholly positive scoring of the EMM Assessment's *Dutyholder Factors* and the highly critical Inspectorate's Preliminary Report. The fact that the NII inspection team believed it necessary to record their highly critical conclusion that operations and systems engineering personnel at Sizewell A "*. . . made significant mistakes which call into question their suitability to carry out their roles . . .*" is entirely at odds with the impression given by the overly optimistic scoring of the tick boxes of the *Dutyholder Factors* section of the EMM Assessment Record.

These mistakes, which accumulated over a considerable period, not only directly contributed to the uncontrolled release of (radio)active spent fuel pond water of 7 January, which was a significant radiological event in itself, but if it had not been for the "*. . . intervention of a contractor who just happened in the right plant area when things went wrong. . .*" then the 7 January incident would have run into a rapidly deteriorating situation that could have, within 10 hours of the pipe break, resulted in a irradiated fuel fire and "*. . . a very serious off-site event. . .*" giving rise to "*. . . a significant risk that operators, and even members of the public, could have been harmed. . .*"^{viii}

So, in account of the *mistakes* of the Sizewell A management systems and staff resulted in an *unauthorised* release of radioactivity into the marine environment, and wherein circumstances could have rapidly developed into a significant *off-site airborne release* of fission products, the Inspectorate determined to issue Magnox Electric with a Directive rather than an Improvement Notice or, indeed as open to it under the EMM assessment procedure, to proceed with a recommendation to prosecute. This Directive^{attached to 4} is confined to a review and investigation of the pond water leak event of 7 January 2007 and does not, surprisingly, require Magnox Electric to address and resolve the broader and systemic failings of its management and staff identified by the Inspectorate's Preliminary Report.

We are concerned that too much emphasis has been placed with Magnox Electric's general compliance in operating Sizewell A overall (ie "*. . . and taking into account your previous good compliance record . . .*").⁵ This we consider may have resulted in too great an offset being set against the Risk Gap level which, based on the potential harm (and not what actually occurred) could have, with the pool incident running to a complete drain down, resulted in very serious public health consequences.

viii At the time of the incident it is believed that about 5,000 Magnox spent fuel elements were under storage in the pond which is about one-fifth of a reactor core, or in total about 60 tonnes or irradiated uranium metal which presents a very substantial radioactive inventory. Self-ignition temperature for the fuel element Magnox cladding in air commences via exothermic corrosion reaction at about 600°C and for the uranium elemental metal fuel surfaces at around 212°C, or on exposure to small amounts of oxygen (at ambient temperature) if uranium hydride has formed on the fuel surface exposed by minor defects in the cladding (which in moist, steam conditions is likely). Products of uranium exothermic oxidation (ie fire) are particles, ranging down well into the respirable range, of oxide(s) which are available for windborne dispersion and eventual disposition depending on the plume lofting height (ie the energy of the fire) and the atmospheric stability conditions, with the principal dose uptake route being via respiration of airborne particles.

We have similar reservations about the Inspectorate introducing its own resource limitations (“ . . . *at a time when NII’s resources are stretched . . .*”^{4[para 36]}) in its decision not to pursue prosecution.

2 SIZEWELL A STAKEHOLDER MEETING OF 8 MARCH 2007

Once again we have to rely upon the interpretation of others, as expressed in the SSG minutes⁹ of the meeting of March 2007.

The Magnox Electric reporting of the incident to the SSG is, in a number of respects, at odds with the Inspectorate’s Preliminary Report, particularly that the discharge was claimed to be via an authorised route^{ix} and this was a decision of the station staff:

- a) Magnox Electric’s statement might be taken to imply that it was a controlled release of radioactivity to the marine environment with a decision made to intentionally divert to the storm drain {Minute, para 349, item iv}, whereas the NII state quite clearly that it was an uncontrolled off-site discharge via the storm drains, that is the spillage entered the storm drainage system because the leakage rate (about 1000 gallons per minute) was so great that the Effluent Treatment Building was inundated with the leaking pond water gushing out of the building into the storm drainage system – it was later discovered that some pond water was lost via the laundry room drain;
- b) details are not given how the leak was actually detected {i & vi}, whereas the actions to isolate the leak arose solely from the chance intervention of a laundry area contractor who just happened to be in the locality at the time, none of which was reported to the SSG;
- c) Magnox Electric states that the pipe had given no warning of failure {vii} whereas the NII identify the failure to have arisen because of the wholly inadequate inspection and maintenance regime and that forewarning of failure had been given by two previous incidents of pipe failure, particularly the then recent very similar pipe split failure of 2006;
- d) the suggestion that Magnox Electric itself had undertaken the reviews of its own volition {viii} is at the omission to mention that the NII had served a Direction, under the Site Nuclear Licence, requiring the Review under the terms of the Nuclear Site Licence;
- e) there is a complete absence of any reference to how the incident could have developed into a very significant off-site release with the public being subject to the risk of high levels of health harm; and under the following discussion items
- f) the recirculation pump sump alarms did not sound {para 350, i} because the pipe failure was in a different area so the pump sumps never filled, and the reason that the falling pond level was not detected and the alarm transmitted to the Main Control Room was because the pond level alarms had not been commissioned and/or were not properly working; and
- g) noting that the sump alarms did not operate but that the “ . . . *configuration and settings of those parts of the plant would be reviewed . . .*” {viii} is somewhat of an understatement in consideration that the pond water level did not sound in the Main Control Room and, indeed, even if they had they would have been masked by all of the standing alarms running at the time.

3 SHUT DOWN SIZEWELL CAMPAIGN

On its part, the *Campaign* is concerned that the Inspectorate did not properly account for the Strategic Factors in qualifying its decision not to prosecute.

The *Campaign*’s expectation is that the Inspectorate should have consulted with individual members and representative groups of the public and, for this, that these should have been informed about the potential seriousness of the incident (ie pond drain down, fuel fire, and off-site airborne release). However, the

ix For further discussion on this aspect of the discharge see the letter of the Environment Agency (EA) of 21 October, 2008 to the Chair of the SSG. The regulatory concern of the EA was that part of the pond treatment plant “ . . . *was not fit for purpose . . .*” and that this, in itself was a breach of the EA authorisation insofar as there is a standing requirement to “ . . . *maintain the discharge system . . .*”. However, legal advice was that the pond treatment plant was not part of the discharge system and that “ . . . *Magnox Electric had no duty under the Radioactive Substances Act 1960 to maintain it . . .*”. For this reason, the EA took no direct action with Magnox Electric under its regulatory powers.

Inspectorate did not consult with members of public nor, indeed, were the public informed about the incident at the time. Even when information on the incident subsequently became public knowledge (in or about March 2007), this was via the Sizewell A Stakeholder Group membership who may not have been fully apprised of all of the circumstances and the radiological significance of the potential outcome of the 7 January 2007 event (see SECTION 2 foregoing).^x

In other words, because of the gravity of the potential outcome of the incident, the *Campaign* is of the opinion that any reasonable and properly informed person would have expected the Inspectorate to have prosecuted in the circumstances.

4 NII RESPONSE TO LARGE & ASSOCIATES'S FREEDOM OF INFORMATION REQUEST

In responding to our request for further information,^{2,3} the Inspectorate provided 4 documents comprising a) its own Preliminary Investigation Report of 15 pages, b) the 2 page EMM Enforcement Assessment Report which is little more than a tick box check list, c) the single page Directive, and d) its single page letter of 18 June 2007 to Magnox Letter acknowledging receipt of the Review required under the Direction of item c) foregoing.

We consider this to be a very lean response to our quite reasonable request for further information. In our view the proper response should have included the following (see APPENDIX III):

- i) A full copy of the documentation and analysis prepared in conjunction with the EMM, including:
 - a) the supporting assessment of the potential radiological consequences of the unauthorised discharge undertaken by a *Specialist Inspector (Radiation)* or *Health Physics Assessor* as required of OC 130/11;
 - b) minutes and/or records of the internal meetings within the NII [see para 38] to determine the final decision to opt for a Directive rather than an Improvement Notice; and
 - c) the Line Manager's assessment of Division 1 PAR 2007/0011.
- ii) The Magnox Electric letter (SZA51689N) of 29 May 2007 and attached report '*A report on the Review and Reassessment of Safety matters referred in the Direction under Licence Instrument 510 Under Sizewell A Nuclear Site Licence No 51*', together with its supporting evidence.

RECOMMENDATIONS

The *Campaign* might consider:

1) NII Decision not to Prosecute

That, on the evidence available to Large & Associates, the serious mistakes made by the Sizewell A operations and systems engineering staff identified in the Inspectorate's Preliminary Report, by far outweigh the positive scoring assigned to Magnox Electric in the EMM Dutyholder Factors assessment. In this respect it is difficult to fathom how the Inspectorate was able to convert a Risk Gap ranked at *substantial* to *extreme*, by its own definition that requiring the serving of an Improvement Notice and most likely prosecution, to the much less punitive action of issuing a Directive in the absence of prosecution, that is simply requiring Magnox Electric itself to Review aspects of the spent fuel pond safety case.

x The constitution of the SSG is given on the SSG website (<http://www.onesuffolk.co.uk/SizewellStakeholderGroup/Constitution/>) being, essentially, i) to inform the public of activities on the Sizewell sites, ii) act as a conduit for two-way information flow, and iii) act as a 'clearing house' for community concerns and members representing an elected Council, and the like, shall form an important link with the public through whom concerns and specific questions shall be usually channelled. Although the SSG meeting minutes are available on its web site, there is no newsletter circulated to members of the public, nor are the mechanisms in place that guarantee the reporting of incidents directly to public by the elected Councils. For example, the *2006-07 Annual Report* of Leiston-cum-Sizewell Town Council, although there is mention of the Sizewell nuclear plants twice (on the evacuation plans and new build residential development and 'A' station decommissioning) there is nothing reported on the 7 January 2007 incident.

On this basis, the *Campaign* might wish to notify the Health & Safety Executive that it considers the enforcement action taken by the Inspectorate not to be commensurate with its own reporting of the inadequacies and culpability of Magnox Electric and, moreover, that the *Campaign* is not satisfied with the processes adopted by and accountability of the Inspectorate in reaching its determination not to prosecute Magnox Electric for its involvement and performance in the 7 January 2007 incident.

2) **Sizewell Stakeholder Group Minutes of March 2007 Meeting**

That, on the information and authoritative findings of the Inspectorate's Preliminary Report, the *Campaign* may wish correct the areas of possible misunderstanding represented by the minutes of the SSG March 2007 meeting. Referring the SSG members to the Inspectorate's Preliminary Report⁴ should be sufficient for this.

3) **NII Response to Large & Associates Freedom of Information Request**

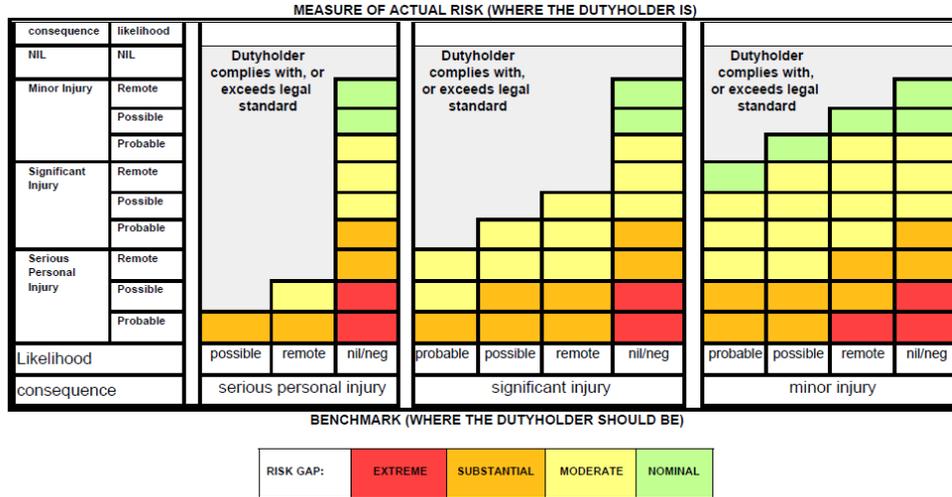
The *Campaign* might consider the very limited information response of the Inspectorate, and the fact that delivery of the response exceeded the 20 working days timeline set out by the FoI Act, not to comply with the Law.

Accordingly, the *Campaign* may wish to refer the matter to the Information Commissioner.

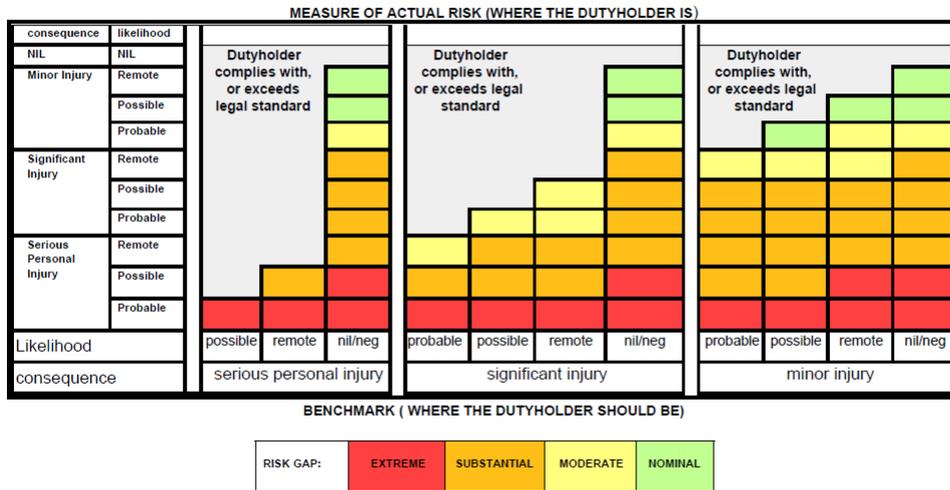
LARGE & ASSOCIATES
CONSULTING ENGINEERS, LONDON

APPENDIX I RISK GAP TABLES - EMM⁷

RISK GAP TABLE 2.1
Single and low casualties



RISK GAP TABLE 2.2
Multiple casualties

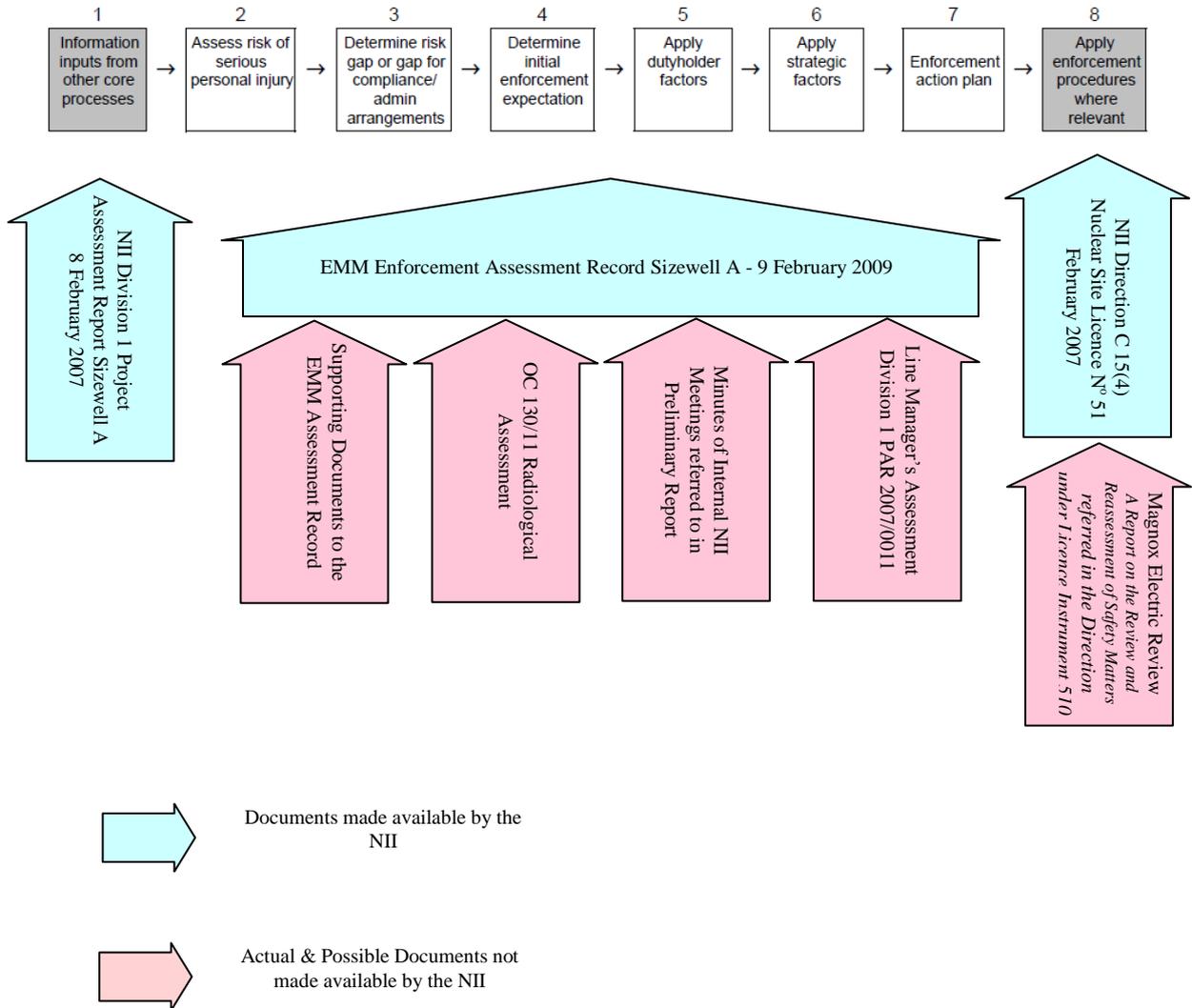


APPENDIX II INITIAL ENFORCEMENT TABLES - EMM⁷

Note: A slightly modified version of these tables applies to nuclear situations with the *Expectation* column modified to include *'Improvement Notice/Direction/Specification'*.

Table 5.1 Health and safety initial enforcement expectation			
Risk Gap	Standards	Initial Enforcement Expectation* (to secure compliance with the law)	Prosecution
Extreme	Defined	Improvement Notice	Yes
	Established	Improvement Notice	Yes
	Interpretative	Improvement Notice	
Substantial	Defined	Improvement Notice	
	Established	Improvement Notice	
	Interpretative	Letter/inspection form	
Moderate	Defined	Improvement Notice	
	Established	Letter/inspection form	
	Interpretative	Letter/inspection form	
Nominal	Defined	Letter/inspection form	
	Established	Letter/inspection form/Verbal warning	
	Interpretative	Verbal warning	
*Immediate risk of serious personal injury has already been considered and dealt with where appropriate			

APPENDIX III EMM PROCESS AND RELATED DOCUMENTS



REFERENCES AND NOTES

- 1 Letter of 9 January 2009 (Ref N^o 5.1.3.356 2009/2836) from HM Chief Inspector of Nuclear Installations in response to the earlier enquiry from Charles Barnett of the Campaign.
- 2 Large & Associates to M Weightman, NII, e-mail 18 February 2009 seeking clarification of the terms and reasoning presented in the NII letter to the Campaign of 9 January 2009 (Ref 1).
- 3 Large & Associates to M Jennions, NII e-mail providing clarification of request of Ref 2.
- 4 HSE, NII, Division 1 Project Assessment Report No: 2007/0011, Preliminary Investigation Report, Sizewell A, *Uncontrolled Partial Emptying of the Sizewell A Irradiated Fuel Cooling Pond on 7th January 2007*, 8 February 2007.
- 5 Letter from Nuclear Directorate to Site Director, Sizewell A, Ref SZA70930N, 18 June 2007
- 6 HSE, *Enforcement Assessment Record*, Sizewell A, completed 08 February 2007
- 7 HSE, *Enforcement Management Model*, Operational Version 3.0, 23 September 2005 – see also, HSE, *Guidance: The Use of the Enforcement Management Model in ND*, G/INS/030, 6 September 2007
- 8 HSE, *Enforcement Policy Statement*, February 2009
- 9 Minutes of the Meeting of the Sizewell A & B Stakeholder Group, Thursday 8 March 2007
- 10 Once that the reactors have closed down the total radionuclide activity discharged reduces significantly, although since most of the Cs-137 is sourced from the spent fuel pond its annual discharge level remains reasonably constant whilst spent fuel remains in the pond. The discharges should be considered in terms of the combined Sizewell A and B sites and, properly, in terms of the so-called *Source Constraint* of 300 $\mu\text{Sv/y}$ but this is exclusive of the Sizewell A worker dose burden from the clean up operations of the Effluent Plant building which is reckoned to be no more than 1mSv/person/day – see para 27, Ref 4. Of course, the estimate of the actual discharge is entirely dependent upon Magnox Electric's assessment of the radiocaesium present in the pond water for which no assayed record has been made available.
- 11 The Cs-137 discharge situation at Sizewell A during 2001 and 2002 (and possibly thereafter) is additionally complicated by the elevated Cs-137 discharges from the spent fuel transport skips returning from Sellafield and with the rapid blocking of filters of the submersible caesium removal units.
- 12 HSE, *Enforcement Management Model (EMM): Application to Ionising Radiation*, OC 130/11, 6 June 2008
- 13 If the stochastic effects of the potential radiation exposure have been taken into account, as given in OC 130/11 (Ref 12), then the EMM assessor for the 7 January incident may have considered the potential exposures to be at or below the determined ALARP level, thus giving the *likelihood* as negligible for the *Benchmark* and, arguably, the *Actual Risk* in the range of *possible* and *remote* suggesting that the assessor assumed, respectively, a potential actual dose between 1mSv and 10mSv greater than the ALARP level and a potential dose of between 100 μSv and 1mSv greater than ALARP. However, it is not clear if the OC 130/11 amended EMM Table 2.1 and 2.2 have been used, nor is it clear if the Benchmark ALARP level have been determined by a *Specialist Inspector (Radiation)* or *Health Physics Assessor* as suggested by OC 130/11.
- 14 Nuclear Site Licence N^o 51 applies to Sizewell A.
- 15 Large J H, *Corrosion of Magnox Cladding*, Evidence to House of Commons Environment Committee, 6th Report, *Radioactive Waste*, by Order of the Committee, January 1986