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SOTONSAFE

A BRIEF REVIEW OF THE

INFORMATION OBTAINED VIA FREEDOM OF INFORMATION ACT 2000 REQUESTS

RELATING TO

BERTHING ROYAL NAVY NUCLEAR POWERED SUBMARINES AT SOUTHAMPTON

CLIENT: SOLENT COALITION AGAINST NUCLEAR SHIPS (SCANS)

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OFF-SITE EMERGENCY PLANNING MEASURES FOR BERTHING NUCLEAR POWERED SUBMARINES AT SOUTHAMPTON

ABSTRACT

This review follows up a previous study identifying shortfalls in the joint Ministry of Defence (MoD) and Southampton City Council (SCC) collaboration to provide emergency planning arrangements in the event of an incident and radiation emergency arising at the nuclear powered submarine berth in Southampton Eastern Docks. At the public meeting in November 2009, the Ministry of Defence promised to answer all of the questions and matters raised by written communication so, taking this offer up and after almost a year of pursuing requests for information under the Freedom of Information Act 2001 (FOIA), I am now in a position to review the responses to my requests from the MoD, SCC and other principal parties involved in the Sotonsafe Off-Site Emergency Plan.

Considered overall, the information gained reveals an intriguing insight into the sometimes illogical reasoning behind key aspects of the emergency arrangements, that the MoD's contribution includes significant errors and unsubstantiated assumptions about the incident performance of its submarine nuclear plant, and it highlights shortcomings of the Sotonsafe emergency arrangements. For example:

- Publicly, the MoD persists with its claim that the worst possible incident that could beset the submarine nuclear power plant would not result in significant radiation exposure to any member of the public located beyond the Eastern Docks area. It claims this on the basis that its reactor plant and submarine design are sufficient to withstand and contain *all reasonably foreseeable* incidents, that the release of fission product aerosol from the submarine to atmosphere would be absolutely minimal, so much so that the only significant radiation emissions would be from gamma rays penetrating the intact submarine hull from the molten nuclear fuel contained within, and then dissipating to a tolerable level at about 900m distant from the stricken submarine. This is quite unlike the incident and release scenarios adopted for civil nuclear power stations where public dose exposure from aerosol release of fission product by far dominates over the direct gamma shine from the damaged nuclear plant.
- However, the classified documents received under the FOIA, show that MoD's definition of what is or what is not *'reasonably foreseeable'* is not only unreliable but that there is considerable confusion amongst and error by the various MoD divisions responsible for the Sotonsafe emergency plan of how *'reasonably foreseeable'* is defined: MoD's own nuclear safety regulator, DNSR, is scathingly critical of Navy Command's errors in presenting its interpretation of the incident frequency (ie the risk) in the classified Berth Safety Statement, and the publicly available REPPIR Report of Assessment has entirely different risk frequencies that are not at all sourced. The MoD's own consultants, SERCO, in a classified review of the REPPIR submissions, casts considerable doubt about the applicability of a single *Reference Accident* approach covering different reactors, fuel cores and boat hull designs, noting that even the somewhat contrived *Reference Accident* for REPPIR could, for the *Trafalgar* class boats, topple from a *'cliff edge'* situation to result in a considerable and unplanned for radioactive release.
- Several classified documents give hint of double standards when comparing the requirements of REPPIR *'as opposed to the* [DNSR] *safety case assessment standards'* and that, hidden from the REPPIR assessments, is the MoD recognition that incidents of greater severity of damage, and radiological consequence, are indeed recognised as being *reasonably foreseeable*. Astonishingly, terrorist and other malevolent acts are excluded from the REPPIR assessments because these, in themselves, are *not reasonably foreseeable*.
- In another classified document, the Health & Safety Executive which is responsible for the implementation of REPPIR overall, admits that it has been too busy to assess the MoD's Berth Safety Statement for Southampton leaving this crucial work to the MoD's own regulator. Even so, MoD finds the Southampton berth safety assessment to be *'trivial and unsourced'*, *'particularly weak'* and that, overall, the MoD's own safety submission does '*not fully provide the level of safety substantiation expected'* requiring a significantly improved safety assessment to be submitted by 2011 – to date (April 2010) this had not been completed.
- A great deal is to be learnt from REPPIR exercises conducted at other localities, again via the generally classified exercise wrap-up assessments. For example, at Barrow-in-Furness in 2010, exercise Indigo was allowed to run its course, warts and all, to the extent that individual local Cumbrian firefighters received a hypothetical 142mSv radiation dose exposure. If the same radiological environment occurred in a real incident at Southampton then the local Hampshire firefighters would have to withdraw from intervention duties very early on before their individual annual dose reached the limit of 20mSv, which is at one-seventh the projected exposure of the Indigo exercise. Other emergency personnel, particularly employees of the police, ambulance and Southampton Council itself, have no prior agreed emergency dose level and, hence, would have to retire from radiological areas very early as the incident aftermath developed.

In fact, early radiation exposure of personnel required for the effective deployment of countermeasures is the principal underlying weakness of Sotonsafe. This is because unless the incident radiological aftermath remains within the MoD nominated *Reference Accident*, which I consider to be unduly optimistic, then the numbers of intervention personnel available will rapidly shrink, leaving shortfalls in the skilled human resources available for the timely and effective implementation of countermeasures that will be necessary to protect the short, interim and longer term health and well-being of the public which is, after all, the overriding purpose of the REPPIR off-site emergency plan.

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OFF-SITE EMERGENCY PLANNING MEASURES
RELATING TO THE
BERTHING ROYAL NAVY NUCLEAR POWERED SUBMARINES AT SOUTHAMPTON
RADIATION (EMERGENCY PREPAREDNESS & PUBLIC INFORMATION) REGULATIONS 2001 - REPPIR

This brief review refers to the information released, via a series of *Freedom of Information Act 2000* (FOIA) requests, by the organisations involved in the Southampton Operational Berth off-site emergency plan, Sotonsafe - TABLE 1 lists these parties and the number of requests directed at and received from each. A full listing of the requests, the responses and related information may be accessed at the Large & Associates SCANS web page.

This review is presented in two parts: **PART I** provides a general summary and update of the November 2009 R3185-A2 report, which was prepared to analyse the information available to the public relating to the berthing of a Royal Navy nuclear powered submarine at the Southampton Eastern Docks, and **PART II** analyses the FOIA responses in greater detail.

PART I SUMMARY UPDATE OF R3185-A2

A) REPPIR PROCESS

The main aim of REPPIR is to establish a framework for the protection of the public through emergency preparedness for radiation incidents with the potential to expose members of the public to ionising radiations; and to ensure provision of adequate information to the public were a radiation emergency to arise; and in the event of any kind of radiation emergency, however it might arise.

Essentially, the mechanisms by which these statutory objectives are achieved require the operator, for the Southampton submarine *operational berth* the Ministry of Defence (MoD) - to prepare a *Report of Assessment* (Regulation 6, Schedule 5 - ROA) and submit this to the Health & Safety Executive (HSE) who determine if off-site emergency arrangements are justified and, if so, the extent to which they are to be coordinated and provided, in the form of an *Off-Site Emergency Plan*, by the public authority, in this case Southampton City Council (SCC - Regulation 9). Separately the MoD is required to prepare an *Operator's Emergency Plan* that will, so far as is reasonably practicable, prevent the exposure of persons to the reasonably foreseeable emergencies identified by the ROA (Regulation 7).

Both the operator (MoD) and the public authority (SCC) are required to provide the public with information: prior information from the MoD to ensure that individual members of the public have a sufficiently clear understanding of the actions that they might be required to take should a radiation emergency arise (Regulation 16 – Schedule 9) and, where a radiation emergency has occurred, SCC is required to inform those individual members of the public actually affected promptly of the facts and measures to be taken for their health protection (Regulation 17 – Schedule 10).

B) REPORT OF ASSESSMENT AND INCIDENT SEVERITY

The MoD approach to the ROA is via a generic *Hazard Identification and Risk Evaluation* (HIRE) centred on a single, nominated *Reference Accident* (RA) which is claimed to be representative of all incident conditions, covering all of the submarine classes and nuclear reactor fuel cores for the different reactor designs, reactor plant states, etc.. The berth-specific ROA submitted to HSE is the generic HIRE modified in account of factors that pertain to the specific operational berth (previously termed the *Z-Berth* – at Southampton Berth 38/39), for which MoD Navy Command prepares a Berth Safety Statement (BSS) to supplement the generic HIRE by providing local and berth-specific context.

The generic HIRE and BSS are both classified documents and there are two version of the ROA, one of which is classified and not available for public scrutiny. Because the nuclear power plants of Royal Navy submarines utilise design technology and nuclear fuel components acquired from the United States, it is most likely that the bilateral *1958 US–UK Mutual Defence Agreement* applies and, if so, this would prohibit disclosure of the generic HIRE, BSS and the classified ROA to SCC and the other civilian parties involved. Similar circulation restrictions are also likely to apply to any account and assessment of terrorist and other malevolent acts that might put the submarine at risk.

The FOIA requests and responses identified a number of shortcomings with the MoD's approach to REPPIR, generally including (see **PART II** for a detailed analyses):

i) The MoD nomination of the single and representative RA is not convincingly demonstrated in that both the MoD's own watchdog the Defence Nuclear Safety Regulator (DNSR) and, indeed, DNSR's consultants SERCO, both raise concerns about its applicability and reliability:

   a) SERCO considers that the adoption of the RA might result in a *'cliff edge'* situation whereby, in certain circumstances and for the *Trafalgar* class boats, a real incident may result in a very much larger release of reactor fuel fission product than that prescribed by the RA and that, relating to this, that there is *'limited consideration to the follow consequences of failures'*[23.4 page 4].

   b) SERCO note, however, that any cliff edge situation of the *Trafalgar* boats will ameliorate as this class of boats is progressively withdrawn from service in future years; and in general agreement with this:-

   c) DNSR recommend that the emergency plans should put in place some contingency to deal with larger consequences radioactive releases by extendibility of the off-site plan, going on to suggest that the assessment of the ROA carried out by SERCO was against the less demanding REPPIR *'as opposed to the* [DNSR] *safety case assessment standards'*, with SERCO raising the caveat that *'a clear distinction is drawn between the reasonably foreseeable, more qualitative approach of the REPPIR submission and the Reactor Plant and Site Safety Justifications'* [9 page 1].

ii) This apparent double-standard implies some careful if not contrived 'management' of the REPPIR requirement that the *Operator's Emergency Plan* (Regulation 7) should consider only *'reasonably foreseeable'* emergencies, because:

   a) REPPIR (Regulation 4) requires that *'all'* hazards with the potential to cause a radiation emergency be identified and only thereafter the test *'reasonably foreseeable'* be applied (at the subsequent stage of preparing the *Operator's Emergency Plan* - Regulation 7).

   b) However, the MoD presumption seems to be, for the REPPIR standard at least, that the *'reasonably foreseeable'* test be used to filter out hazards and, particularly, incident sequences and severities from the assessments of Regulation 4 and 6 - this results in all but *'reasonably foreseeable'* incidents being excluded from ROA.

   c) Interestingly, SERCO implies that the REPPIR submission is a special case, in that the Reference Accident *'approach does not imply that more serious accident scenarios cannot occur . . .'* but *'. . those accidents that are more likely should have largely been designed out and those that are still credible, but very unlikely, should be addressed via extendibility of the detailed emergency plans'* [8 page 2].

   d) This special or exclusive approach adopted for the REPPIR submission is referred to by SERCO to be *'the key to the REPPIR submission is identifying the range of accidents considered to be reasonably foreseeable from which the RA with bounding radiological consequences is selected . . the methodology uses a combination of semi-quantitative/qualitative arguments and expert judgement to 'strip away' the more unlikely/higher consequence accidents and designate these as NRF (not reasonably foreseeable)* [15-16 page 3].

   e) Unless rigorously and independently managed, this approach could result in the selection of an unrealistic RA suited only to the purpose of the REPPIR submission and, whatever, it results in a nominated RA of somewhat doubtful event frequency/probability that is, nevertheless, promoted in the HIRE/ROA in terms of its particular low probability of occurrence.

   f) Moreover, there is clearly confusion over the projected frequency of occurrence at which an incident becomes *'not reasonably foreseeable'* and, by virtue of this, excluded from the *Operator's Emergency Plan* and also from (at least) the unclassified version of the ROA – this is particularly apparent from DNSR's scathing criticism of the accident frequency (probability) errors included within the BSS prepared by Navy Command.

   g) The *'reasonably foreseeable'* test is also applied to acts of terrorism, etc., because malevolent actions are not considered to be *'reasonably foreseeable'* then such do not have to be taken into account in the operator's ROA and are thus excluded from further consideration for REPPIR

iii) The nominated RA, with its very small fission product release to atmosphere, irrespective of the *Trafalgar* class *'cliff edge'* uncertainties, is interpreted to justify a reduction of area over which emergency arrangements have to be in place, reducing the pre-planned countermeasure zone (PPCMZ) from 2 to 1.5 km radius from the berth location in the Eastern Docks of Southampton.

   a) Unlike the off-site REPPIR plans for the PWR plant of a civil nuclear power station, for example Sizewell B, where the short, interim and longer term dose from the fission product release to atmosphere by far dominates over the short-term exposure dose from the gamma shine radiation

component of the melted fuel remaining within the containment dome, the MoD claims quite the reverse situation with exposure from the fission product release being almost trivial in comparison to the hull gamma shine emanating from the molten fuel remaining in the intact submarine reactor compartment.

b) No substantiation and almost no technical justification are proffered by the MoD and its consultants for this claim which is, quite frankly, counter to engineering commonsense.

iv) The continuing refusal of the MoD [para 2 page 3] to make public its projected radiation dose rates, from hull gamma shine and, particularly, fission product release is justified on the basis that the *". . dose contour graphs contain classified information. . "* and, even more bizarrely, that it considers for a submarine afloat that there are *". . no reasonably foreseeable routes that will result in a release to the water surrounding the submarine"*

a) It is absolute nonsense to claim that release of the radiation dose rate contours, even for the unduly optimistic minimal RA release, would provide any meaningful insight into the performance of nuclear reactor (PWR) and the highly enriched uranium fuel technology deployed in the submarine propulsion plant.

v) Moreover, the refusal to release the predicted dose rates is likely result in degradation of the effectiveness of the emergency arrangements at Southampton if and when required to respond to a real radiation emergency, because:

a) The MoD admits that it has conducted radioactive release dispersion and deposition modelling analysis for each of the operational berths, including Southampton, so templates yielding the dose rate contours for a range of meteorological and atmospheric stability conditions are available and should be incorporated in the Sotonsafe plan.

b) Foreknowledge of the likely fission product release, particularly that of radio-iodine, and the associated radiation exposure rates, is crucial for determining the range and level of resources required to mitigate the radiological consequences of a real radiation emergency.

vi) Failure to incorporate the dose rate contours in advance of a real incident might result in greater detriment to the public, either directly or indirectly.

a) For example, at a recent REPPIR operational berth exercise (Indigo) at Barrow-in-Furness, the absence of any forward-looking consequence analysis (ie deriving from the dose rate contours) led to a complete lack of understanding by the civil authorities of the likely consequences, so much so that they over-reacted and implemented distribution of potassium iodide tablets (PITs)[1] and evacuation well beyond the 2km pre-planned countermeasure zone (PPCMZ), thereby squandering valuable resources needed for countermeasure effort in the automatic countermeasure zone (ACMZ).

b) Similarly, in the 2007 Devonport REPPIR exercise (Short Sermon 07) it was noted by the Cornwall County Council participant that the decision on school evacuations needed to *'be made earlier, based on potential dose rates rather than waiting for an assessment of actual dose rates'* and, separately, by the Health Protection Agency that facilities were inadequate, including the lack of *'meteorological and radiation data'*, thereby calling for advance publication of the dose rate contour templates.

C) RADIATION EXPOSURE - INTERVENTION PERSONNEL & MEMBERS OF PUBLIC

As discussed above, the MoD steadfastly continues to refuse to disclose any projected radiation exposure to members of the public in the radiation emergency zones, although it is established that modelling for the RA (and most probably more severe incidents) for each berth has been undertaken. However, FOIA requested information and data obtained indirectly via the NII demonstrated that radiation exposure during the course of an incident based on the RA can be very high, with exposures for submarine crew reaching 330mSv and for Cumbrian firefighters 142mSv during the recent REPPIR exercise to test the response to an incident on board an *Astute* class submarine at Barrow-in-Furness:

vii) Such high levels of exposure applied at Southampton would require the local Hampshire Fire and Rescue Service (HFRS) firefighting personnel to withdraw upon reaching their individual 20mSv annual limit; South Central Ambulance Service (SCAS), Hampshire Constabulary (HC) and SCC employees would effectively prohibited from entering any active radiological area because each of these

1 PITs (potassium iodate tablets) – a prophylactic measure to block the uptake of radio-i-131 by the human thyroid gland.

employers *'seeks to avoid exposure'* of its employees and so does not register any of its employees under REPPIR Regulation 14 which permits a prior agreed emergency exposure level.

viii) The radiological situation adopted for the Barrow-in-Furness exercise, if applied at Southampton, would project out to include the National Oceanographic Centre Southampton (NOCS) at about 900m distance from the submarine operational berth and would, therefore, place the 800 employees and users of NOCS at significant risk, particularly if what seems to be poorly planned and thought-through emergency arrangements (for PITs take-up and self-evacuation) log-jammed, leaving possibly hundreds of uninformed individuals in the open.

ix) Other employees (about 300 to 400 in addition) in the Eastern Dock area may also be at similar risk.

If a real radiation emergency at Southampton extended the active radiological environment much beyond the ACMZ, let alone out to the 1.5 km limit of the PPCMZ or, indeed, to within the extendibility zone out to 10km, then it is very doubtful that the REPPIR Regulation 14 personnel, comprising just military personnel and HFRS firefighters (the latter with their limited dose uptake maximum of 20mSv per annum), would be sufficient in numbers to cope:

x) There is doubt that the MoD's assessment of the military resources (services personnel, etc) required to manage and mitigate the consequences of even a limited radioactive release from the RA at Southampton will be sufficiently reliable – SCC is totally reliant upon this MoD resourcing to implement Sotonsafe – because of the inadequacies and shortfalls of the Southampton BSS:

   a) Prepared by Navy Command in 2008, the BSS was been shown to be hopelessly inadequate by the MoD itself in that *'the Berth Safety Statements [BSS], which include the site specific HIREs and ROAs, do not fully provide the level of safety substantiation expected'*.

   b) Even though the MoD radiological information and other resource demanding data has not been released into the public domain, the MoD's own nuclear safety regulator DNSR has been very critical of the incomplete and poor quality of the Southampton BSS noting, for example, that the all-important demographic data for the various emergency zones is hopelessly out of date in using the 1991 census data.

Of overriding concern is not just with the continuing failure of the MoD to rectify these declared shortfalls, that remain outstanding since 2008,[2] but that the HSE Nuclear Directorate, essentially responsible for REPPIR standards of reliability and probity, itself admitted that, because of other work priorities, it had *'not undertaken a detailed assessment of the site-specific Reports of Assessment'* leaving, it might well be argued, the effectiveness of Sotonsafe to the competence of the MoD.

PART II

I first reviewed the *Radiation (Emergency Preparedness and Public Information) Regulations 2001* (REPPIR) off-site emergency arrangements in 2001 following the introduction of REPPIR, and I reported later in May 2003 by which time Southampton City Council had established its first version of SotonSafe. Then in October 2009, I was once again instructed by SCANS to provide an update of the information available to the general public relating to the berthing of a Royal Navy nuclear powered submarine at Southampton Eastern Docks.

In 2001, I reported my overriding conclusion that because the MoD was not prepared to release crucial information for reasons of national security this, I considered, precluded Southampton City Council (SCC) being able to prepare a realistic and workable emergency plan. I concluded that SotonSafe would not achieve its purpose of practically mitigating the radiation exposure of members of public should a nuclear powered submarine incident occur at the Z-Berth, or while the vessel is in transit in the busy commercial shipping waters leading to and from the berth.

In 2003, at a time that SotonSafe had been bedded down for three years I found that a number of niggling wrinkles had been ironed-out and certain ambiguities addressed. However, overall, the fundamental problem of the MoD's reluctance to include a reasonable level of damage severity resulting in a realistic level of radioactive release, together with failure to publish meaningful radiation dose rate information, remained and continued to undermine the achievement of any significant improvement in effectiveness of the emergency plan.

2 Outstanding to the of my latest FOIA enquiry April 2010.

This latest SCANS instruction follows on from a further assessment of the Southampton emergency plans in 2009, particularly arising from the public meeting of 4 November 2009 during which the MoD steadfastly refused to provide any further information or, indeed, insight into its continuing claims that an incident involving the nuclear power plant could never be of such severity to result in a release of radioactivity (fission products) into the local environment.

SCANS agreed to the strategy to interrogate each of the parties involved in the REPPIR off-site emergency arrangements by requests made via the FOIA. In this respect, over fifty separate requests and clarifications have been made relating to the subject area to the following Public Authorities as defined by the FOIA:

TABLE 1 SUMMARY OF THE FOIA REQUESTS & RESPONSES[3]

PUBLIC AUTHORITY		REPPIR ROLE	INVOLVEMENT REPPIR REG N°	N° REQUESTS ETC	N° RESPONSES
Southampton City Council	SCC	Local Authority	2(1), 9, 10, 11, 17	5	2
Ministry of Defence	MoD	Operator	5,7, 18	25	34
Southampton University NOC	NOCS	Member of Public		4	1
South Central Ambulance Trust	SCAS	Emergency Services	2(1)	2	1
HSE	NII-HSE	Executive	2(1), 5	7	10
Emergency Preparedness Division Department of Health	EPD	Advisory		1	-
Hampshire Constabulary	HC	Emergency Services	2(1)	1	2
Hampshire Fire & Rescue Service	HFRS	Emergency Services	2(1)	1	1

GENERIC REFERENCE ACCIDENT APPROACH

Then as now, I found the MoD's nominated *Reference Accident* to be unrealistically moderate in damage severity and, particularly, in the amounts of radioactive release that, coupled with the MoD's refusal to release crucial projections of the radiation dose exposures to members of public in the residential and commercial areas nearby Southampton Docks, resulted in SotonSafe being then fundamentally flawed.

The most recent review of the REPPIR operational berth submissions, undertaken by SERCO on behalf of the DNSR, examined in some detail the 2008 REPPIR submission on the hazard and risk associated with the generic operational berths and, in certain instances, how these applied to specific berths. This review was necessary to satisfy the REPPIR requirement (Regulation 5.2) for a review to be undertaken of the compliance every three years. The main objective of the REPPIR review was to determine the area (and civilian population) affected by radiation hazards that can arise during a radiological incident and, hence, define the need for both on-site (operator) and/or off-site emergency arrangements, although SERCO made no recommendation in this respect.

REPPIR requires the operator to prepare and submit a Report of Assessment (ROA - Regulation 6.3) which, for the submarine operational berths is a combination of the generic hazard identification and risk evaluation (HIRE) taking into account berth specific factors identified and evaluated in the Berth Safety Statement (BSS). The ROA, in the form of a declassified[4] and publicly available document, is then considered by the Health and Safety Executive (HSE) to determine, amongst other things, the need for off-site emergency arrangements and, if so, the extent of the area over which these arrangements should be put in place.

The generic HIRE (in this case a classified and unavailable document) is provided by the operator for each of the four *Swiftsure*,[5] *Trafalgar*, *Astute* and *Vanguard*[6]classes of nuclear powered submarine presently in operation with the Royal Navy. The HIRE considers the relevant nuclear reactor plant and fuel core combinations and sets out *'bounding'* arguments enabling the risk assessment to be undertaken for the *generic* operational berth, and it does so by referring to a prescribed *Reference Accident* (RA) nominated to be representative in risk of occurrence, severity and radiological outcome of any incident involving a submarine (of whatever class, nuclear fuel inventory, etc).

3 It is not the purpose of this review to report in detail on how these various parties responded to the FOIA requests – some were very helpful and responsive, some simply did not understand their obligations under the Act, others were resistant to providing any meaningful information, and one particular party had rendered itself almost incapable of any action, delaying and rendering itself ineffective by the mire of its own bureaucracy – it is left to the reader to identify each of these.

4 That said, two versions of the ROA exist, one of which is classified containing submarine data – see DE&S [B)b].

5 The last of the *Swiftsure* class squadron (HMS *Sceptre*) is currently in 'extended readiness' and is scheduled to be withdrawn from service in December 2010.

6 The essential differences between these classes is that the *Astute* and *Vanguard* submarines have a larger PWR2 nuclear reactor plant compared to the earlier PWR1 plant of the *Swiftsure* and *Trafalgar* classes, and that HMS *Vanguard* and the other three submarines of this class are nuclear armed with Trident missiles.

Since the plant generic HIRE covers only those external factors present at the main home ports, HMNB Clyde and Devonport, it does not cover the occasional use *operational berths* (ie the previously termed Z-Berths) such as Southampton. Essentially, the main outcome of the generic HIRE assessment derives from hazards that are present from within the submarine and that relate to the nuclear plant itself (and the risks of malfunction thereof) together with the effectiveness of the submarine to contain the hazard. This generic-centred approach excludes external hazards, such as aircraft crash, the generation of other hazards embarked on the submarine, such as the inadvertent detonation of a weapon including nuclear weapons and missile propellant, fire, etc., and any other external event that is not reasonably foreseeable, such as terrorist attack, sabotage or other forms of malevolent action.[7]

The *Reference Accident* for the generic HIRE commences with a small unisolable breach in the reactor plant cooling circuit, loss of coolant (accident – LOCA) to the extent that the reactor fuel core is uncovered and a fuel melt occurs. The radionuclides released from the molten fuel migrate into the confines of the reactor compartment (RC), formed by the pressure hull and the fore-aft pressure sealed bulkheads, but remain contained within the confines of the RC, since containment bypass is considered (by the operator) to be *not reasonably foreseeable*. However, a nominal release of radioactive substances through the containment is assumed[8] to provide a basis for REPPIR off-site exercising, although because this a very small and some would opine a contrived release,[9] the resulting radiological consequences are dominated by gamma radiation emanating from the melted fuel remaining and contained within the submarine shining through the submarine hull.

The potential radiation dose uptake by individual members of the public comprises two components:

First and dominantly, the dose exposure from the gamma shine is confined to the locality (petering out at about 900m)[10] of the berthed submarine, but which may be attenuated by intervening buildings, structures, etc.. Receipt of this dose component is only when the individual is within the beam of shine, so moving out of the beam (rather like moving away from the radiant heat of an electric bar fire) stops accumulation of further dose.

The second component of dose uptake is exposure to particles and gases that have leaked from the submarine hull containment. This atmospheric release comprises radioactive fission products of the nuclear fuel that may have melted and part vaporised during and in the aftermath of the incident. These particles will loft and form an airborne plume that will disperse, being carried from the submarine to eventually settle (deposit) at some distance – the final dispersion and disposition pattern will be determined by the energy and vigour of the release, the local atmospheric conditions, and individual radionuclides themselves, their density and residual heat generation via radioactive decay (and hence buoyancy keeping the particles aloft). Unlike the hull gamma shine, if the particles are respirable-sized then the dose uptake and exposure is more complex, with countermeasures and restrictions possibly needing to be applied in the interim and longer terms.

The MoD nuclear safety regulator notes [section 5, Annex A] this apparent disparity *'DNSR is very aware that the nominated reference accident is divergent from . . the UK-wide practice, where fission product release dominates off site planning'* and, in account of this, suggests that the emergency plans should include some contingency to deal with larger consequence radioactive releases by extendibility of the off-site plans.

> **Application to Sotonsafe:** Other than the concept of extendibility that seems, at its most complex, simply to relate to extending the PPMZ out to a 10km radius, there is no suggestion that the

7 Navy Command [para 1, page 2] state *'that malicious action as a result of saboteur or terrorist attack lie outside the scope of submarine operations and as such are not considered in the plant HIRE, however, access control, security and prevention of malicious intent are included in the specific assessment of each berth. It is MOD policy not to publish precise security arrangements'.*

8 The assumption seems to be that fission products will migrate from the reactor compartment into the other manned compartments and then bypass the pressure hull via a hatch or similar opening – the RA does not seem to include for direct breach of the pressure hull, either by an internal event such as a flying fragment of the plant ejected by the reactor event or an overpressure relating to the molten fuel, or by an explosion somewhere within the submarine pressure hull, such as from the bow torpedo compartment, and/or from some external event, such as a terrorist attack.

9 During the Southampton Foxwater REPPIR exercise the MoD's own nuclear safety regulator, DNSR, [Annex A, para 2] reported that *'the radiological consequences of the release appeared to be somewhat greater than intended'* thereby confirming the somewhat contrived approach to emergency planning. This compares with the DNSR's estimate that the radiological consequences (an exposed individual remaining for 5 days) deriving from the limited fission product release alone would apply to a downwind area of less than 250m for the submarine. In fact, changes were then implemented to the Foxwater storyboard to render (in the opinion of the MoD the accident scenarios 'more realistic' [A)c page 2] which reduced the anticipated release, the emergency planning burden and, of course, the potential consequences.

10 Navy Command reckon [para 4 page 2] that *'it is not reasonably foreseeable that the lower ERL for evacuation would be exceeded in the downwind sector beyond 400m from the submarine'.*

> radiological levels in the ACMZ and beyond might be unmanageable and become established very soon following the initial event triggering the incident. In the words, the aftermath of the incident might skip *Categories 1* and *2* and move directly to a *Category 3* fission product release immediately.[11]

The weakness of the RA approach is that the LOCA leak rate and the progression of the damage severity and radiological consequences of the incident are determined by the size of the reactor circuit breach. The operator's generic HIRE argues that catastrophic sizes of circuit rupture can be prevented by good design, quality control and leak-before-break monitoring. However, the HIRE acknowledges that an intolerable size of rupture cannot be entirely dismissed but that these arguments are somewhat judgmental, particularly in that it has not happened before, and the event frequency and probability are deployed to dismiss more severely damaging scenarios into the not reasonably foreseeable category. Indeed, Navy Command [page 2, para 2] states *'that all information as required by REPPIR has been provided to the appropriate authorities, which includes a scenario of total failure of containment'*, although to the contrary, there is no mention of this catastrophic failure case in the comprehensive SERCO review of the REPPIR submissions.

The generic HIRE judges that for the majority of reactor circuit components, the failure rate is of the order 10^{-5} (E-5) per year of reactor operation, although it is acknowledged that for several components absolute compliance with this requirement is not met. Also, no account seems to have been given to knock-on failures occurring in other linked components and/or systems with, for example, the main steam pipework having a higher frequency (ie more often at risk) of failure and that its failure may precipitate more severe consequences in the reactor plant. Component non-compliance and knock-on or cascade failure introduce uncertainties in the probabilistic RA approach.

In the event of the RA progressing to fuel core melt then the molten core presents a challenge to the integrity of the final containment boundary, the submarine's pressure hull, and some doubt is expressed about the resilience of the hulls for *Swiftsure* and *Trafalgar* classes.[12] Similar doubts are also expressed about the containment integrity of these classes responding to an energetic event occurring within the RA sequence, so much so that the RA presents a 'cliff edge' situation leading to at least minor impairment (and release of fission product particulate) of the containment.

As well as the severity of the LOCA, continuing pressure hull containment integrity is much determined by operator intervention and the time periods required to implement mitigation measures to protect the nuclear plant and submarine and, importantly, whether this mitigation sufficiently slows the time to fuel core melt. In this respect it is claimed, although in the absence of any justification, that it is more likely that slow (ie >24 hours to core melt) events will occur at operational berths (ie Southampton) than at the home and repair and refit ports of Clyde and Devonport respectively. This is somewhat odd and largely unsubstantiated reasoning because the off-boat plant and human resources,[13] necessary to arrest the event (such as adequate supplies of make-up water and decay heat cooling), are unlikely to be fully deployable at the operational berths so there will be less, not greater, opportunity to damp down the incident progression.

For the pressurised water reactor (PWR) there is a whole class of incident sequences that occur rapidly, within minutes of the triggering LOCA, and that generate sufficient in-reactor compartment overpressure cycles sufficient to put the hull containment at risk. The nominated RA centres around a very limited LOCA and catastrophic events beyond this are reasoned, by the plant designers, not to be reasonably foreseeable.

The risk of hull containment failure is also determined by the thermal and physical state of the nuclear plant at the time of the incident. When the submarine is under nuclear propulsion the plant is at State B, operating at high temperature and pressure, but when berthed the nuclear plant will significantly reduce both pressure and temperature to virtually an idling condition of State A. The frequency of initiating events to the RA for State A from State B reduces by about x50, but a recently shut down plant (from State B to A) will have to manage a high residual heat load from the radioactive decay of the fuel core which, unless managed and effectively dissipated will lead to fuel core melt.

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11 This is the classification system for an unexpected event that is likely to lead to, or has resulted in, a release of fission products external to the fuel. Reactor accidents are sub-divided into three categories of accident: (1) *Category 1*. An event that is likely to lead to, or has resulted in, the release of fission products from the fuel. (2) *Category 2*. An event that has led to a radiation hazard as the result of the release of fission products from the fuel. (3) *Category 3*. An event that has led to the release of fission products from the fuel to the environment outside the pressure hull.

12 The HIRE/ROA [4.5 page 8] states that *'the containment arrangements for the UK submarine* [sic] *are common to all classes'* which is contrary to the SERCO assessment of each boat class.

13 Of course, there will be fewer human resources and the so-called Suitable Qualified and Experienced Persons (SQEPs) available at an operational berth and, indeed, a significant proportion of the crew may be incapacitated as a result of the triggering event.

In other words, there is considerable potential to incorrectly sentence incidents to the *not reasonably foreseeable* category and thereafter give these potentially catastrophic events little further consideration on the basis that the size of the LOCA breach will be containable; that incidents at operational berths will somehow, in both severity and timescale, not be so challenging as those at the Devonport and Clyde home ports; and that the containment of the submarine pressure hull should not be assumed to be assured at all times and in all nuclear plant state circumstances. Uncertainties arise because of the complexity of the submarine nuclear plant and range of operating conditions; from the largely judgmentally based approach depending upon somewhat semi-quantitative assessments of the probabilities and frequencies that claim orders of magnitude of credit; and, indeed, the imprecise definition of *reasonably foreseeable*.

The overall conclusion of the SERCO review is that a combined residual uncertainty remains in the generic HIRE assessment, that is changes in the primary containment from *nominal*[14] to *minor* will have a significant effect because of the fission product release to atmosphere, this being the dominant radiation dose contributor against limiting the dose burden to members of public to derive from hull shine alone.

Obviously, if the fission product release is absolutely minimised (as for the RA), then the emergency effort can be concentrated within the hull gamma shine shadow of up to about 900m – once members of the public and non-essential personnel have been moved away from shadow then the ongoing dose accumulation is largely cancelled. On the other hand, if there is a significant fission product release to atmosphere then the emergency area is at the dictate of wind and weather, potentially involving large numbers of public and requiring much larger intervention resources and containment measures.

In summary: The MoD's own consultants, SERCO, find the generic HIRE largely judgment based, involving many arguments that are not readily quantifiable and remain open to challenge. This means that there are uncertainties, in the absence of quantification and substantiation, over the dismissal of certain incidents of severity beyond the RA as being *not reasonably foreseeable.* The other largely unsubstantiated thesis running throughout the generic HIRE is that all classes of submarines, reactor plant design, and reactor fuel core types (including the extent of fuel irradiation or burn-up) will comply to a single RA determined by a contained LOCA via a prescribed size and rate of leak in the reactor primary circuit, resulting in, at the worst, a minor leakage via the containment of the submarine pressure hull and, moreover, that the fuel core melt down will be delayed by effective action of the submarine crew and local SQEP availability.

DNSR summed up the SERCO's approach in its assessment [3.a] of the REPPIR submissions in that *'SERCO conducted the bulk of the technical assessments . . against the requirements of REPPIR as opposed to safety case assessment standards'*, thereby implying a somewhat secondary and less demanding status of the REPPIR requirement.

> **Application to Sotonsafe:** Without revealing any substantiation whatsoever, Navy Command state [page 2 para 2] *'total failure of the containment system has been demonstrated to be not reasonably foreseeable in the HIRE'*, thereby stemming the progression of any real incident beyond a small and, so it is claimed, an entirely manageable, low consequence release.
>
> In contrast, DNSR's advice [section 5] is *'that the nominated reference accident (RA) already involves a localised release (very limited in nature through the containment boundary) but agrees that, although beyond the reasonably foreseeable criterion, operators should provide information to local authorities on this accident sequence as an illustration of the lower probability, but more severe, potential accidents that should be taken into account when developing the concept of extendibility*[15] *in emergency plans'*. In another document, DNSR [section 4.b page 2] when referring the RA approach states *'the approach does however mean that there are uncertainties associated with any quantification used to dismiss accidents that are not reasonably foreseeable'*.
>
> In other words, DNSR admits that the RA is not a truly representative reflection of the severity of a nuclear reactor plant incident on board a submarine although, that said, it might be argued that the 2008 REPPIR preparations had addressed the shortfalls adopted in 2005 [Section 3, a, b & c] which resulted in the issue of a *Safety Improvement Notice*.[16]

14 A containment state of *'nominal'* is where the containment remains intact and only gamma shine pervades through the hull plating but there is no fission product aerosol release into the atmosphere or marine environment.

15 Actually, the level of incident severity will also apply to the ACMZ and the pre-planned countermeasure zone (PPCMZ) with levels of radiation and the presence of airborne fission products be generally higher.

16 At the time of the *Safety Improvement Notice*, these included: *a) that the Trafalgar class bounding case had not been conclusively demonstrated; b) that the method of calculating the Detailed Emergency Planning Zone were not sufficiently conclusive;* and *c) that the evidence presented in ROA did not present a stand alone safety argument.*

In fact, the adoption of the RA, nominated on the basis of probability or projected frequency of occurrence is counter to the MoD's own guidelines, JSP 471 [ch 2, page 2 para 0210], which state that *'Where an off-site plan is required . . . MOD duty holders should have arrangements to advise local authorities on the possible consequences of **any** radiation emergency, so that they can plan for such and provide additional information relevant to the preparation of the off-site emergency plan'*.[17]

The outcome of this reasoning and reassessment of the generic HIRE, particularly in account of the claimed greater containment surety of the *Astute* class hull, is that the release of aerosol, particulate and gaseous fission products into the atmosphere will be smaller than that determined by the previous generic HIRE because this, so it is claimed, covered a range of accident severities and the less robust hull containment of the *Trafalgar* and *Swiftsure* classes. SERCO [para 37] confirm this to be the case in concluding that *'there will be an improvement* [reduction in the amount of fission product release] *in time* [as the *Swiftsure* and *Trafalgar* classes] *are withdrawn from service'*.

LOCAL BERTH ISSUES – BERTH SAFETY STATEMENTS & REPORTS OF ASSESSMENT

Berth specific issues and hazards are tacked on to the generic HIRE by consideration of the *Operational Berth HIRE* based on a *Berth Safety Statement* (BSS) for each operational berth. This combination, subject to changes to suit declassification, is then presented as the REPPIR Regulation 6(3) Report of Assessment (ROA) upon which the HSE draws its determination of the extent of the off-site emergency planning zones.

Application to Sotonsafe: The Southampton operational berth HIRE, which includes an account of local berth factors, claims that the RA being the '*accident sequence bounding in consequences'* has a *'probability of some one in 1,000,000 years of operations'* (1E-6 per year of plant operation) and, only then, does this RA lead to *'some damage'* to the reactor core *'but with only a very small release to atmosphere through intact containment'*.

However, the MoD's own nuclear safety regulator, DNSR, shows this projection to be incorrect and inconsistent with the generic HIRE. This and other numerous errors stem from the classified version of the Southampton (and other southern operational) berth safety statement (BSS) in DNSR's 2008 review. These errors include an incorrect frequency *'for Accident 63 as 5E-6'* being '*greater than 1E-5)'* and, significantly, DNSR also identify another error being carried through to the ROA in that the RA is stated to have a probability (frequency) of 1E-6, which is a factor of 10 too high[18] and that this will give rise to extending the radiological *'consequences to 1400m'* compared to the 500m automatic countermeasure zone (ACMZ) included in Sotonsafe.

In fact, the MoD itself introduces further confusion with Operator's Emergency Plan which is Appendix 1 of Sotonsafe. Contrary to nomination of a single RA for the purposes of emergency planning as endorsed by DNSR[19] and SERCO, the operator's emergency plan reckons that, based on the upper Emergency Reference Level (ERL) of dose exposure to any member of the public, the 500m radius ACMZ would need to be evacuated once every 50,000 (2E-5) year of continuous reactor operation; sheltering and potassium iodate (PITs) distribution would be required beyond the 2km (now 1.5km)[20] pre-planned countermeasure zone (PPCMZ) at a frequency of 2E-5, and for evacuation of the PPCMZ at 5E-6; and the frequency at which there is need for countermeasures in the 10km radius Extendibility Zone to be 5E-6.

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17 The FOIA responses from these two organisations are, in places, contradictory; DNSR is highly critical of Navy Command; and, on its part, Navy Command does not seem to fully understand its responsibilities under REPPIR and, indeed, the MoD's own *Defence Nuclear Accident Response* manual JSP 471, and in at least one instance ignores the role of DNSR to regulate nuclear safety of the nuclear powered submarines.

18 That is x10 overly pessimistic, or that it is reckoned to occur 10x more often in the BSS.

19 Here the operator of the submarine is MoD FLEET (also referred to here as Navy Command, formerly CINCFLEET) and the Operator's plan seems to totally disregard the role of the Defence Nuclear Safety Regulator (DNSR) with just two unrelated references to DNSR, even though DNSR (via its Nuclear Weapon Regulator) has been highly critical of FLEET noting in it 2004-5 Annual Report [para 28] that *'full engagement of and by FLEET in responding to regulation remains uncertain; a recent re-issue of a Safety Management Plan fails to acknowledge the introduction of regulation or the existence of the regulator'*.

20 This change from 2km to 1.5km relates to a reassessment undertaken by Navy Command notified on 28 May 2009 but, that said, it is made in advance of DNSR's requirement for the BSS to be significantly approved for the 2011 REPPIR submission – it is Navy Command that is responsible for the Berth Safety Statement (BSS).

The countermeasure zoning of and emergency resource allocation to Sotonsafe is based on an RA that does not result in a significant release of fission product aerosol (or particulate) beyond the submarine containment. Indeed, as the Royal Navy (Navy Command) claim in its letter of 30 October 2009 [para 5 page 2], that the need for evacuation of the downwind sector beyond 400m is not reasonably foreseeable, adding the patently absurd notion that there *'are no reasonably foreseeable routes that will result in a release into the water surrounding the submarine'*. However, this claim that the RA will not result in a release of radioactive matter beyond the submarine hull is clearly contradicted by the FLEET acknowledgement that the incident can (at a projected frequency of 2E-5) progress beyond *Category 2*, where the radiation exposure is solely via gamma shine through the submarine hull plating, to a *Category 3* release where radioactive fission products (aerosols, noble gases and gaseous iodine) are borne aloft to be carried windward to a wider population, and from which the exposure is much more complex, potentially involving respiratory uptake, ground, surfaces and food contamination over the interim and longer terms.

Other omissions and shortfalls considered by DNSR specifically applicable to the Southampton operational berth include, amongst others:

- There are difficulties [Section 2a] in the descriptions of the control of commercial shipping.
- The population data was out of date using the 1991 census data [B.c page 2].[21]
- Submarine movements to and from the operational berth are not deconflicted [section 2b] with cruise liner dockings and ferry movements.
- The discussion of fire hazards at Southampton are *'trivial and unsourced'* [section 9] and the conclusions presented in the Southampton Safety Statement is *'particularly weak'*.[22]

The DNSR 2008 review sums up the unsatisfactory BSS for the Southampton and Portland operational berths in that *'the Berth Safety Statements as submitted fulfil the REPPIR requirements but do not fully provide the level of safety substantiation expected'* and that it *'is a regulatory expectation that the 2011 REPPIR Submissions will be supported by a significantly improved BSS'*.

In other words, the operational berth at Southampton falls short of essential safety prerequisites of the MoD's own nuclear safety regulator, and will remain deficient until the BSSs are upgraded.[23]

In its role of examining the Southampton ROA, which incorporates the BSS, the HSE Nuclear Directorate admitted [Summary para 5] that because of other work priorities it had *'not undertaken a detailed assessment of the site-specific Reports of Assessment'*. With this admission, the HSE relinquished its REPPIR role to ensure protection of the public to another regulator, DNSR, being in the direct employ of and answerable only to the MoD.

Application to NOCS & Others in the Eastern Docks: DNSR's 2008 review reference to radiological *'consequences to 1400m'* could give rise to the potential of significant dose uptake at Southampton for those individual members of public employed within the Eastern Docks (about 1,200 in total).

The largest of these organisations is the National Oceanography Centre Southampton (NOCS), being about 900m from the operational berth, with the numbers of individuals in occupation (staff, students and researchers), being upwards of 800 during a typical term day. Essentially,[24] the NOCS evacuation plan comprises members of its security personnel positioning *'a table in the middle of the road entrance to the Centre'* with the *'pre-distributed PITS on top of it' and* in such a position as *'to allow vehicles leaving the Centre to collect PITS'.*

This evacuation and PITS collection procedure has not been practised to date. Managing the evacuation of such a large number of individual pedestrians and vehicles could result in vehicle jams and pedestrian queues at both the table collection point and the Eastern Dock Gate 4, with individuals remaining in the open, unprotected against radiation shine and respiratory uptake of airborne fission

21 This is subsequently misreported in the HIRE/ROA [para 2.6.3 page 4] that the population data derives from the *'latest National Census 2001'*.

22 The HIRE/ROA [section 3 page 5] states otherwise in that *' it has been established that no port activity would pose nay threat to the safety of the Nuclear Powered Warship'*.

23 As of 22 April 2010, this remains so as confirmed by Defence Equipment & Support [B)2, page 2].

24 NOCS have requested that the detailed duties of the NOCS Incident Control Officer not be made publicly available – see M3185-A40.

product. Moreover, it is not at all clear that potentially contaminated vehicles will be permitted to leave the Eastern Dock area[25] and, indeed, Dock Gate 4 might be exclusively reserved for access to the Eastern Dock by emergency services vehicles.

SotonSafe stipulates that the Automatic Evacuation Zone covers the whole of the Eastern Docks area, including that lying beyond the 500m ACMZ and that all individuals (non-essential personnel and members of public) are to be evacuated from the Eastern Docks at the declaration of a *Category 1* incident (ie from the onset). This inflexibility of approach rules out temporary sheltering in the NOCS and other workplace buildings which might be a preferable option in circumstances whereby an airborne radioactive plume (ie where the incident rapidly progresses to *Category 3*) drifts across the occupied areas of the Eastern Dock.

The numbers of individuals at potential risk because of the omission of this commonsense option could be very significant indeed, particularly, because there is no provision for monitoring and/or decontaminating individuals (and vehicles) prior to leaving the Eastern Dock area and, indeed, no arrangements whatsoever for transporting out evacuees, that is with individuals being left entirely to their own means.[26]

REFERENCE SUBMARINE INCIDENTS

Each operational berth provides much the same facilities for any Royal Navy submarine so, it follows, any of the exercises taken at any of the 36 operational berths around the British Isles and abroad will provide a useful insight into the abnormal operation and performance of the submarine's nuclear plant and the radiological situation in the immediate environment of the submarine berth (or site of the incident). What would be expected to vary from operational berth to berth would include, obviously, local factors such as, particularly, population density and demography, local arrangements with the emergency services, particularly on radiation dose limitation, and so on.

In other words, it is possible to pick through the publicly available information on various exercises, such as Short Sermon, Foxwater,[27] Indigo and Indian Footprint to isolate features not considered specifically for the Southampton operational berth,

The Indigo exercise ran on 13 July 2010 at the BAE Submarine Solutions construction yard at Barrow-in-Furness being part of the triennial proving trials for REPPIR, involving a reactor plant incident on board an *Astute* class submarine undergoing power range testing whilst tied up alongside the berth. The Nuclear Installations Inspectorate's assessment of the REPPIR emergency response to this incident has been recently released into the public domain.

For Indigo the assumption was that the incident would develop from a relatively small breach in the reactor primary water coolant circuit, being *Level 1* damage severity, to reactor core damage (fuel melt) and release of fuel debris into the reactor compartment (*Level 2*) which would remain sealed, thereafter there would be a small release of aerosol fission product bypassing the overall containment of the submarine pressure hull,

> **Application to Sotonsafe:** Should a real incident occur to a submarine (in this example an *Astute* class boat) at the Southampton operational berth then much the same sequences of events and radiological scenario would be expected to occur, other than those for better or worse factors determined by local Southampton conditions and circumstances.

The Indigo exercise ran into difficulties from its onset: time delays were experienced in accounting for the number of people in the automatic countermeasure zone (ACMZ), so much so that this became a distraction that stopped the command and control cell concentrating on the progression of the incident; there were delays while the paperwork routines were established and completed; casualty handling was poor; and there was a significant shortfall of meaningful advice to the Senior Coordination Group (SCG) on the likely radiological consequences with the result that actions taken to protect the public would not be well-informed and grossly over-pessimistic at the cost of resources needed elsewhere.

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25 At the public meeting of 4 November 2009, the Emergency Planning Officer suggested, in all seriousness, that the scheduled public bus service could be used by individuals for self-evacuation – see item vii) of M3185-A20 .

26 Interestingly, the DNSR wrap up (para 17) report on the Southampton Foxwater exercise completely redacts the section relating to the *'Provision of Transport for Evacuees'*, although it is not clear how this subject matter qualifies to engage any of the qualified exemptions of the FOIA.

27 The Foxwater exercise undertaken on 14 January 2009 at Southampton included a number of artificialities: PITs were not issued, the weather conditions were pre-planned, there was no evacuation of the ACMZ and the Southampton City Centre Evacuation Plan was not activated.

Application to Sotonsafe: In Indigo, the Command Cell was tasked with feeding across to the SCG information on how the radiological environment was developing. With this information, the SCG triggered the appropriate countermeasures to mitigate public dose uptake. Much the same demarcation of responsibility exist in the Sotonsafe framework and, like Barrow, the projected radiological circumstances (such as the dose rate contours, the inventory of the fission product release, critically in the immediate time aftermath the radio-iodine (I-131) presence, and so on) are not available in advance.

However, the generic HIRE and, it is to be assumed, the BSS but not the publicly available REPPIR ROA, include dose contour projections modelled[28] in advance of and in preparation for any real incident. However, such dose contour data and graphs, according to Navy Command, *'contain classified information and, as such, are not routinely released'*.[29]

The absence of this crucial information and data at the planning and implementation stages of Sotonsafe must influence the appropriateness of the resource allocations that have to be made in advance by the parties contributing to Sotonsafe, particularly the emergency services. This will be particularly so, if the incident involves a release of fission product aerosol etc., into the atmosphere.

The reluctance of the MoD to release information to the public authority and the general public highlighted by Navy Command is contrary to the requirement specified in Schedule 9 of REPPIR and, indeed, endorsed by the MoD's own accident response manual [Ch 2, Annex D, para 1, page 1] that states that *'MOD duty holders must ensure that any identifiable population group who are in an area in which, in the opinion of the Executive, they are likely to be affected by a radiation emergency, are supplied, in an appropriate manner, without them having to request it, the information specified in REPPIR, Schedule 9. This applies to all members of the public within the Detailed Emergency Planning Zones (DEPZ) at all NPW X and Z berths'*.

Application to NOCS & Other Employees within the ACMZ: Unlike Barrow where the ACMZ was confined to the BAE dockyard with relatively few non-essential personnel within the confines of the ACMZ, the Southampton ACMZ extends throughout the Eastern Dock area, in which scattered about are about 1,200 or more employees, students, etc.. The nature of the activities undertaken, particularly within NOCS, would render any audit of individuals who had not been evacuated very imprecise indeed.[30]

SCC assumes that all NOCS and other non-essential employees within the Eastern Dock area would commence self-evacuation at *Category 1* alert and, by implication of this, no audit would be required because SCC assumes that all evacuees would have left the Eastern Dock area in good time, certainly by the time that a *Category 3* alert had been declared. Of course, this SCC reasoning assumes, without any justification whatsoever, that the incident would progress through the various levels of severity (ie *Categories 1*, *2* and *3*) at a leisurely pace.[31]

For Indigo, when the accident severity moved to *Level 2* (ie *Category 2* fuel core damage), the forward control point was abandoned with little control of and guidance to the intervention teams being available, so much so that the intervention teams had little knowledge of where they were or what had found or had achieved; and from the onset of *Category 2* and any meaningful advice on the radiological consequences to the public was not transmitted to the off-site personnel, resulting in a complete lack of understanding by the

28 Methods of projecting radioactive, dispersion and deposition forecasts and consequently, the radiation dose uptake are included in the classified versions of the generic HIRE from mathematical modelling by POYRY and COSYMA. Subsequent analysis conducted by MOD was done using CONDOR, a bespoke computer model developed in conjunction with SERCO/RR and the NRPB (now HPA), although none of the results are publicly available (see Navy Command response – see Navy Command response of 30 October 2009 to FOIA request M3185-A2, A5, A9 and A15.

29 The MoD robustly refused to disclose any further information of radiation dose and its detailed assessment thereof, refusing three specifically cited documents relating to assessment of the radiation exposures of the REPPIR submissions, citing the FOIA qualified exemption s26(1) Defence as reason for non-disclosure – the reports requested but never obtained were 1) Defence College of Management Technology (HMS Sultan) - Nuclear Department Report NDTM 996 July 2008 - Analysis of Doses in the MoD REPPIR 2008 Submission, 2) Defence College of Management Technology (HMS Sultan) - Nuclear Department Review of MoD REPPIR Submissions 11 August 2008 and 3) Defence College of Management Technology (HMS Sultan) - Nuclear Department Report NDTM 994 July 2008 - Analysis of Hull Gamma Shine Data in the MoD REPPIR 2008 Submission.

30 During the Southampton Foxwater exercise a submarine crew EZRC evacuee remained unaccounted for 2 hours (actually and not a planned part of the exercise) in the EZRC.

31 In fact, there is nothing in the HIRE or ROA that defines any timescale for the RA to increase in severity, indeed the HIRE assiduously skirts around this important issue

civil authorities provoking them in ever more precautionary countermeasures, including large scale evacuation (~15,000 members of the public).[32]

The Indigo wrap-up report issued by the NII records that Royal Navy services personnel involved received (for exercises purposes) individual (assumed average and not the collective man-Sv dose) doses of 330mSv and the local authority fire and rescue emergency services personnel 142mSv, but there is no recorded assessment of the individual or collective dose receipt for members of the public.[33]

Application to Sotonsafe: The Hampshire Fire and Rescue Service (HFRS) have an agreed local radiation dose limitation system that constrains the maximum annual whole body dose equivalent to 20mSv in any one year for male firefighters dose and, thereafter, if that exposure limits has been reached, no further exposure is permitted for two years thereafter. Female HFRS firefighters are not permitted any radiation dose exposure.

Obviously, the Indigo firefighter exposures (142mSv) would have breached the HFRS local agreement (20mSv/annum), so for firefighters to remain in-limit, numerous separate watches would have to be deployed in sequence at an equivalent radiological severity incident at Southampton.

Of the other civilian authorities involved, the police, ambulance and para-medic workers, and employees of Southampton City Council, none of these have chosen to identify (ie register) those of their employees who may be subject to emergency exposures as specified by REPPIR Regulation 14.[34] For these 'unregistered' individuals the expectation is that they would be unable to participate and would have to be withdrawn if their individual dose, arising from their individual duties in the response, was projected to exceed that of any other member of the public subject to the emergency.

For example, the Hampshire Constabulary (HC) state that none of its employees have been registered under Regulation 14, although it acknowledges that *'individuals have been assigned to work in a potential radiological environment'*, but it refuses to provide any further details of this, claiming exemption under sections 24.1 (National Security), 31 (Law Enforcement) and 38 (Health and Safety) of the FOIA that the public interest favours non-disclosure.[35] All of which is somewhat 'academic' because there is nothing that permits exemption of any individual engaged in an emergency, even under a chemical, biological, radiological, and nuclear (CBRN) conditions, from the requirements of REPPIR.[36]

The South Central Ambulance Service (SCAS) is very much more open and forthcoming about the role and radiological limitations of its personnel. Although none of its employees are classed as IRR *'Radiation Workers'*, nevertheless being a radiation employer (because of the proximity to the movement of nuclear medicines, etc) about 10% of SCAS staff are trained for CBRN situations and equipped with personnel dosimeters. These CBRN trained and all other SCAS employers are not registered under REPPIR Regulation 14 and would be obliged to withdraw from their response duties should their individual exposure exceed that of any other member of the public.

Southampton City Council has concluded that *'it will seek to avoid any exposure of its staff'* and that any support function provided by SCC staff would be *'beyond the declared zones of critical risk'*,

32 In fact, so unsatisfactory was the outcome of Indigo 2010 that the HSE ordered the exercise be repeated within a period of six months.

33 There is a consistence absence of radiation dose assessment for members of public in the REPPIR exercises which is anomalous with the fundamental objective of REPPIR which is, after all, aimed at minimising the individual public dose receipt (to less than 5mSv in the year following the incident) – for examples see REPPIR exercises Short Sermon, Foxwater, Indigo and Indian Footprint.

34 REPPIR Reg 14 requires that all employees who individually may be subject to emergency exposure as a direct result of their involvement and prescribed duties in the implementation and management of the emergency countermeasures, etc., shall be identified in advance and be provided with adequate information, training, equipment, etc – Reg 14 is not concerned with doses received by employees who may be subject to exposure as a direct result of the radiation incident that leads to the emergency and only the doses received by employees involved in the response are subject to this regulation. All of the Royal Navy and MoD personnel likely to be involved in the REPPIR response are registered under Regulation 14, and emergency exposures have been established under Regulation 14(1) and these have been approved by the HSE in accord with Regulation 14(3) – see Navy Command, para 5, page 2. The HSE approved levels of individual maximum dose receipt are 1) Ship's Crew i) lifesaving 500mSv ii) all other 100mSv, 2) Emergency Zone Reception Centre 50mSv.

35 These individuals probably comprise the 10% or so required to be trained for CBRN duties although, even so, unless they are individual classified as a radiation Worker under the IRRs 99, then each would still have to register under REPPIR Regulation 14 to participate in the REPPIR radiation emergency zones.

36 The only exemption to REPPIR Reg 14 is if the individual is registered as a 'Radiation Worker' under the Ionising Radiations Regulations 1999 (IRR 99).

stating that the countermeasure functions of implementing and managing sheltering, evacuation, PITs distribution and radiation monitoring are the responsibilities of others.[37,38]

MoD personnel are to assume control of the entry points to the ACMZ with a Health Physics Adviser (HPA) assessing the radiological situation within the ACMZ. However, the HPA (who is part of the MoD's emergency response team) is required under the Operator's Emergency Plan [section 6.4] to meet the prevailing emergency dose levels for intervention personnel specified by MoD JSP 576, which remains a classified document. These JSP 576 dose levels, which have been agreed in advance with the HSE only for employees previously identified and trained under REPPIR Regulation 14, so all non-Regulation 14 employees (SCC, SCAS and HC) would be excluded from the ACMZ if, that is, the HPA's assessment identified any risk of any additional dose exposure during their individual response activities.

Early on in the Indigo exercise a *'significant amount of time was taken in dealing with briefing and the paperwork for the intervention teams'* – for an incident at Southampton because ACMZ entry for all of the SSC, SCAS and HC personnel would have to account for their zero-dose tolerance, delays from paperwork etc., might be expected to be exacerbated.

An obvious weakness in permitting non-Regulation 14 intervention teams to enter the ACMZ when the *Category 1* radiological situation is fluid is open to risk:

At Indigo [Objective D, Appendix A] the forward control point (FCP) was abandoned at the declaration of *Category 2* (ie radiation presence beyond the submarine) then monitoring and control of the intervention teams within the ACMZ was lost. At Southampton, this situation would leave SCC, SCAS and HC intervention teams within the ACMZ dependent upon the personal dosimeters included in the grab bag (NARO emergency pack) issued by the MoD at the ACMZ access point. Since, the universal setting preset (alarm) for each NARO dosimeter is 18mSv cumulative dose and the dose rate alarm setting is 18mSv/h,[39] the non-Regulation 14 SSC, SCAS [Part 6 page 10] and HC personnel [Part 6 page 5] relying upon these dosimeter alarm settings would run the risk of exceeding the IRR 99 public dose limit of 1mSv in any calendar year [Schedule 4, Part 1, s6].

There are also issues over the reliability and fit for purpose condition of the NARO dosimeter equipment issued in the grab bags, with the Indian Footprint exercise noting [para 18] that some of the equipment was *'out of calibration . . obsolete . . 4 Mk 10's . . did not work'*.

Intervention personnel can be drawn into a radiological situation over which they have no control. For example, during Foxwater [section 8 Appendix 1] an ambulance entered the ACMZ during a *Category 1* alert level but, then was held back, until subsequently being deployed when the radiological situation has degraded to *Category 2* putting the non-Regulation 14 SCAS crew at risk of additional dose uptake.

These weaknesses and shortfalls in controlling the presence of non-Regulation 14 personnel in radiation environments and, hence, their potential exposure to excessive levels of radiation could also arise under the Sotonsafe arrangements. This is because, in effect, the single radiological 'gatekeeper' directing teams of intervention personnel (which may include non-Regulation 14 SCC, SCAS and HC employees) is the health physicist employed by MoD,[40] via the Incident Officer (ABP), whose duties include providing radiation protection advice [Part 3 page 14/15] to those personnel requiring access to the ACMZ. That said, it is not made clear in Sotonsafe whether the ABP has advance information of who is, or is not, permitted to receive an emergency level of dose and, even if the ABP did know, whether this information could be put to use under the hustle and bustle of what may be a rapidly changing emergency situation.

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37 SCC considers that these functions to be wholly undertaken by the *'emergency services, Port Operator and Navy support teams'*.

38 In contrast to SCC, for the Portland Operational Berth (Section 6.6.5) off-site emergency plan Weymouth & Portland Borough Council acknowledge that certain of its employees will be required to achieve foreseeable actions and has, accordingly, provided the appropriate training, etc required by Regulation 14.

39 The presumption here is that the maximum dose level as 20mSv for Reg 14 registered personnel, so the 18mSv/h dose rate alarm leaves little time, that is [(1-18/20)*60=] 6 minutes for the intervention team to prepare for and leave the radiological area of the ACMZ.

40 Provided by the Defence, Scientific and Technology Laboratory