Office for Nuclear Regulation

**Emergency Arrangements Strategy**

# Review of ONR's Regulation of Emergency Arrangements at Magnox Reactor Sites – a New Strategy

Project Assessment Report ONR-DFW-PAR-15-004
Revision 0
June 2015

Published 04/16

# EXECUTIVE SUMMARY

## Review of ONR's Regulation of Emergency Arrangements at Magnox Reactor Sites – New Strategy

This report proposes a new strategy for the regulation of shutdown magnox reactor site emergency arrangements.

## Action Requested

A new strategy is required for regulation of emergency arrangements at shutdown magnox sites that are defueling, defuelled, undergoing decommissioning and entering care and maintenance.

## Background

At present, magnox sites are effectively regulated regarding emergency arrangements as though the hazard and risk is that posed by an at-power reactor site. However, only 1 site has an operating reactor, 1 site is approaching the latter stages of defueling and 8 sites are decommissioning. In the case of these last 9 magnox sites the hazards and risks are considerable less than those of an at-power site and regulatory expectations are appearing disproportionate. It is time for ONR to review and develop a more targeted and proportionate approach regarding emergency arrangements expectations. This report proposes a new regulatory strategy.

## Assessment

The reduced hazard associated with a shutdown magnox site post electricity generation is reviewed, the Magnox Limited specialists' views are considered and a more proportionate regulatory expectation regarding evolution of emergency arrangements during decommissioning is proposed. Key transition points post-shutdown of the last reactor on a magnox site are as follows:

- 90 days after shutdown (iodine decay such that KIO3 tablets not required);
- About 2 years after shutdown (No $CO_2$ required on site and oil stocks significantly reduced; establishment of passive core cooling means that event response times extend noticeably);
- No irradiated fuel on site (most of the original hazard no longer exists);
- No reasonably foreseeable radiation emergency, no radiation emergency in terms of REPPIR, no dose > 5mSv and no requirement for a REPPIR off-site plan; and
- Site is cold, dark and secure; in care and maintenance and under CCTV surveillance.

At each of the above transition points the licensee should be capable of making a safety case to reduce its emergency response capability and at some of the points the changes will justify a new emergency plan that requires ONR approval under licence condition 11. Once there is no foreseeable off-site release then off site facilities such as strategic coordination centres and the central emergency support centre will no longer be required. When the site is in care and maintenance and has passive waste in secure stores, then immediate response to an event could be left to the emergency services and, if required, longer term recovery provided by licensee specialists.

At all times there is a requirement that the licensee's emergency responders are trained and exercised regarding the site's emergency arrangements, and that periodically ONR will witness a 'demonstration' exercise. This review concludes that the annual demonstration exercise should continue until the site no longer requires an off-site plan under REPPIR. At this point the demonstration exercise frequency should reduce to the order of one every three

years. In the latter stages of care and maintenance the licensee should be capable of making a case to reduce this frequency further.

## Conclusions

A new strategy has been developed that allows the licensee of a shutdown magnox reactor site to steadily reduce emergency arrangement requirements as the site transitions to the end of care and maintenance. This strategy also covers the frequency of 'demonstration' exercises.

## Recommendation

The ONR Decommissioning, Fuel and Waste programme should adopt this new strategy for regulating emergency arrangements at shutdown magnox sites.

## LIST OF ABBREVIATIONS

| | |
|---|---|
| ALARP | As low as reasonably practicable |
| BSL | Basic Safety level (in SAPs) |
| BSO | Basic Safety Objective (in SAPs) |
| CNS | Civil Nuclear Security (ONR) |
| HOW2 | (Office for Nuclear Regulation) Business Management System |
| HSE | The Health and Safety Executive |
| IAEA | The International Atomic Energy Agency |
| NDA | Nuclear Decommissioning Authority |
| ONR | Office for Nuclear Regulation |
| PCER | Pre-construction Environment Report |
| PCSR | Pre-construction Safety Report |
| PSA | Probabilistic Safety Assessment |
| PSR | Preliminary Safety Report |
| RGP | Relevant Good Practice |
| SAP | Safety Assessment Principle(s) |
| SFAIRP | So far as is reasonably practicable |
| SSC | Structure, System and Component |
| TAG | Technical Assessment Guide (ONR) |

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## 1 PROPOSAL TO AMEND REGULATORY STRATEGY

1. The Magnox and Restoration (MAG&R) sub-programme within the Decommissioning, Fuel and Waste (DFW) programme of ONR has decided to review its strategy regarding emergency arrangements and demonstration exercise requirements for the Magnox reactor sites. Currently there are the same expectations at a number of sites despite their being a single generating site with one at-power reactor, a single defueling site and eight other sites that are at various stages of decommissioning. This is not consistent with the ONR view that levels of emergency provision should be proportionate to the nuclear safety hazard.

2. This report gives details of the review, discusses ways forward and suggests an amended ONR strategy.

## 2 BACKGROUND

3. Magnox Limited has ten twin-magnox reactor sites that are either still generating electricity (Wylfa), are in the process of defueling (Oldbury) or decommissioning (the other 8 magnox reactor sites). A shutdown and defuelled magnox reactor site represents a considerably reduced hazard compared with an at-power reactor site but at present ONR effectively regulates compliance with LC 11 (Emergency Arrangements) in the same way across all the Magnox reactor sites. This does not appear to be consistent with ONR's principles of targeted and proportionate regulation. Clearly it is time for a regulatory review and development of a new strategy. This report gives details of the review, discusses the outcome and puts forward a new strategy for future LC 11 compliance inspection.

## 3 CHANGING HAZARDS DURING A MAGNOX SITE LIFECYCLE

HAZARDS WHILE OPERATING

4. When operating at power, Magnox reactor cores are cooled by pumped, pressurised carbon dioxide ($CO_2$) gas. The reactor pressure vessels were designed, built and operated in a manner to ensure that a serious breach was unlikely. However, it was recognised by the designers that in the event of a breach to the coolant pressure circuit $CO_2$ along with radioactive gases and particulates would be released to the environment resulting in large areas of site, including the insides of buildings, becoming untenable because of the heat hazard, asphyxiation hazard and/or radiological hazard associated with escaping $CO_2$. Such a "hot gas release" could cause considerable secondary damage and noise which is itself a significant risk to workers.

5. In addition to the pressurised cooling circuit, there are pressurised steam pipes and water pipes, together with moving equipment such as steam turbines, gas circulators and many pumps. Consequences of failure of these can include missile damage from the significant energy and momentum and/or thermal damage of nearby equipment and damage in other parts of the circuit due to pressure transients. In the event of reactor damage, there is an urgent requirement to ensure that the reactor is shutdown and to re-establish and maintain cooling, as, immediately following shutdown, there remains significant generation of decay heat in the reactor core. The essentials are to maintain cooling, to prevent the fuel and the fuel cladding from over heat damage; to maintain the composition of the coolant, to prevent more rapid fuel and cladding degradation; and to maintain containment, to prevent the spread of contamination to the environment. Thus there are a class of potential faults on operating reactors that could lead to significant secondary damage, a wide spread hazard (radiation, heat and

carbon dioxide), and a number of casualties while endangering the integrity of the reactor core. Bounding design faults, including hot gas release, were used to define the requirements of both the on-site and off-site plans for operating Magnox sites.

6. It was generally accepted that if the licensee's emergency organisation could cope with a hot gas release then it could cope with any other fault that was reasonably foreseeable. The plans to cope with a hot gas release also made a sound foundation from which to mount a response to a more severe accident (extendibility fault).

EMERGENCY PROVISIONS WHILE OPERATING

7. The needs to undertake prompt repair to the reactor and associated equipment coupled with the potential for a site wide radiological and $CO_2$ hazard produces a requirement for:

- Damage assessment and damage repair teams to be available at very short notice, trained and equipped to use breathing apparatus (BA).
- Fully trained, Fire Service standards Fire Teams to enter burning buildings in heat and smoke to ensure access to essential plant and equipment.
- An understanding of temperatures, radiation levels and $CO_2$ levels across the site, requiring:
    I. Prompt on-site survey able to monitor radiation levels, $CO_2$ levels, and temperature in $CO_2$ environments.
    II. Health physicists to interpret temperature, $CO_2$ levels and radiation levels and give advice on stay times, PPE and other mitigating actions.
- Reactor physicists who can interpret the symptoms and determine the nature of reactor damage and the required mitigation actions.
- A command and control system capable of analysing issues of building tenability and the need for prompt reactor repair and of making appropriate decisions.

8. To respond to these requirements, an emergency structure consisting of three levels of control; strategic at the Emergency Control Centre (ECC), tactical at the Access Control Point (ACP) and operational through individual Team Control, has evolved. For example, the emergency scheme at Oldbury during the operational phase had 18 people on shift and a further 13 on standby.

9. The ECC's role in this structure is to collect information on the event and to set priorities for public protection and rapidly deliver casualty search and rescue, damage assessment and damage control/repair against a background of uncertainty and rapid change. Information may come from the Control Room (CCR), as it attempts to understand the alarms and other parameters available to it; eye witness reports about injuries, damage and fires on site; muster systems identifying people at muster points (by elimination, people unaccounted for); on-site survey teams reporting $CO_2$, temperature and radiation levels; and response teams sent to investigate. The ECC also has a role in co-ordinating and briefing the local Emergency Services Liaison Officers on site. It also acts as the communications hub that briefs all external support facilities that are set up to reduce the impact of an accident on members of the public.

10. The Access Control Point (ACP) exists to provide a barrier between the safe parts of the site and the affected zone to ensure that people in the affected zone are there for a

well understood purpose and that every effort has been made to ensure their safety. It is at the ACP that casualty search and rescue, damage assessment, fire fighting and damage repair teams are briefed, dispatched and their presence in the affected zone recorded and monitored. With the potential for widespread hazard associated with operating reactors, and the numbers of responders expected to pass through the facility, the Access Control Points are fixed permanent structures some distance from the reactors. This helps to reduce the potential for an ACP to become untenable due to a hot gas release or any other site wide hazard.

11. The teams dispatching from the ACP will have Team Leaders who are suitably qualified and trained to lead teams into the affected zone for the purposes of casualty search and rescue, Fire Fighting, damage assessment and/or repair as required. The teams are formulated with skills suitable for the task and can be made up from Site staff and Emergency Service Personnel.

12. Off-site survey is provided by two suitably equipped vehicles manned by personnel on a 24 hour standby rota. On declaration the teams dispatch from site and take a number of samples at prefixed locations dependant on wind direction. The Site also provides an automatic On-site survey capability to monitor continuously around the site for signs of $CO_2$ and high radiation levels; this is in response to a hot gas release across the site.

CHANGES AT REACTOR SHUTDOWN – Radiation Emergencies Reasonably Foreseeable

13. When reactors are shut down for the last time a number of important changes occur which reduce the risk profiles posed by the sites. These changes allow for a revision (simplification) of the site's Minimum Safety-Related Plant (MSRP) and Maintenance Schedule (MS) as the site becomes more inherently safe.

14. Iodine fission products can harm people because our bodies accumulate the iodine in the thyroid, consequently, following a reactor event potassium iodate tablets are taken so that the thyroid is saturated with stable (non-radioactive) iodine. An important change after shutdown is that all of the major isotopes of iodine have half-lives measured in days or shorter and, as a result, the iodine hazard reduces rapidly post-shutdown. Licensee fault study calculations indicate that 90 days post-shutdown less than four thousandths of the original harmful iodine inventory will still exist on site. Therefore the requirement for potassium iodate tablets can be removed as a countermeasure 90 days after final shutdown.

15. Early in the shutdown process the reactors are depressurised and stocks of bulk $CO_2$ are removed from site, this removes the possibility of depressurisation faults and the possibility of the CCR being filled with hot $CO_2$ so there is no continuing need for the CCR staff to be on a piped air system. This makes it a more comfortable and safer environment to work in and removes a number of self-protection actions.

16. The cessation of steam turbine operation greatly reduces the extent of steam leaks and high-energy and high-momentum hazards possible from plant operations. The removal of circulator and other oil intensive systems later in the process reduces the potential for severe fires.

17. A review of hazards and credible accidents at Magnox reactors undergoing defueling and decommissioning identified the following faults:

- Core cooling faults
- Water ingress faults
- Breach of containment faults

- Fuelling machine and pile cap faults
- Fuel handling faults in the discharge route
- Irradiated fuel storage faults
- Flask handing faults
- Fuel cooling pond faults
- Faults in waste stores.

18. In addition, potential harm could be caused by unauthorised activity or by external events such as severe weather or seismic activity.

19. As the shutdown reactor core begins to cool and the decay heat reduces, the requirement for core cooling also progressively reduces with time. Site specific analyses have defined three states of post-shutdown core cooling:

- Forced Circulation State/Forced Circulation Phase

This requires the availability of:

I. forced air circulation through the reactor core,

II. feed to two boiler circuits (Oldbury) or at least one boiler (Wylfa)

III. and, if reasonably practicable, the Pressure Vessel Cooling System (PVCS).

- Natural Circulation State/Natural Circulation Phase

This requires the availability of:

I. feed to two boiler circuits (Oldbury) or at least one boiler (Wylfa)

II. and, if reasonably practicable, the PVCS; but does not require gas circulators to provide forced air circulation through the reactor core. Entry into this cooling state requires a declaration from the Station Physicist (endorsed by the Engineering Manager and authorised by the Operations Manager) that adequate reactor cooling will be provided by the reduced cooling plant. This is conservatively expected about one year after shutdown.

- Passive Cooling State/Passive Cooling Phase.

  For Oldbury, this requires that an adequate number of reactor boiler circuits remain open, but does not require any active cooling to be available. It does not require the availability of gas circulators, boiler feed or the PVCS. For Oldbury, it is expected that passive cooling may be reached a further year after the Natural Circulation State is entered, that is, two years after cessation of generation.

20. The licensee's fault study calculations showed that, for Oldbury, the complete loss of cooling 100 days after shutdown and restoration of boiler feed 4 days later would result in peak fuel temperatures remaining below the 250$^{o}$C temperature limit that prevents fission product release from pre-damaged fuel (Ref 7). If restoration of feed is delayed to seven days then the peak fuel temperatures remain below the 500$^{o}$C limit for normal or slightly damaged fuel and will not threaten the structural integrity of the reactor or its internals and, given the conservatisms in the calculations, should not lead to a significant radionuclide release. Similarly, for Wylfa, transient analyses show that providing boiler feed is re-established in 48 hours there will be no fuel damage in the reactors. It also shows the absence of cliff-edges out to 7 days.

21. Thus, the licensee has assumed that beyond 100 days after shutdown, there would be at least two days to react to loss of coolant faults before fuel reaches temperatures sufficient to cause significant damage and possible fission product release.

22. Similarly, for water ingress faults there is a period of several days before pressure vessel Safety Relief Valves would lift and the risk of radiological release increase (Ref 7). Since the cooling circuits are not greatly pressurised a circuit breach would not be expected to lead to further damage and the consequences are both localised and slight.

23. When defueling, during the three cooling phases mentioned above, there is still the potential for an accident in the fuel route leading to dropped and damaged fuel elements. However all such events would be contained in a declared fuel route with no serious radiological consequences external to the fuel route or buildings. Recovery operations are formulated for these eventualities and time is not a determining factor for these operations. Bounding calculations based on elements that shear across the fuel porous region give only minor off-site releases; even if it takes 30 days to complete the recovery (Ref 7). None of these reactor or defueling faults would cause an immediate site-wide hazard of the scale postulated for operating reactors and, in particular, none of them would involve the release of a large quantity of hot, radioactive $CO_2$.

CHANGES AT REACTOR SHUTDOWN – Radiation Emergencies Not Reasonably Foreseeable

24. The decommissioning work being undertaken by Magnox is producing a continuing reduction in the hazards and risks on their sites. While Magnox has irradiated fuel on any of its sites it must be able to give advice to protect the public and workers from accidents in which it is involved. This advice can come from site or central expertise. Given the reduced decay heat in sites that have been shut down for over 90 days any advice, beyond "*retreat to a safe distance*", is not urgent. The completion of defueling and the transportation of irradiated fuel off site will remove heat generating material from the site and therefore marks a major step towards passive safety. At this stage all of the faults affecting reactor cooling cease to be a concern. Similarly fuel route faults cease to feature on the fault schedule and ponds fault consequences are limited to the impact of contaminated water, structures and sludges rather than used fuel.

25. Where irradiated fuel element debris (FED) and intermediate level waste (ILW) recovery is undertaken there may be an increase in both the likelihood and consequence of a fault as the contents of vaults or bunkers are worked on and disturbed and as the containment is breached to allow access. However, as the project progresses the inventory and hazard will be reducing resulting in a progressive reduction of the worst case consequences of a fault. The completion of FED and ILW recovery will represent the point at which a radiation emergency in terms of REPPIR is not reasonably foreseeable. Magnox is working on Accident Management Guidelines (AMGs) for FED fires. Completion of this project will codify the licensee's expertise, reducing the pressure on on-call expertise. Depending on the process chosen pond decommissioning and other decommissioning work may produce ILW but this will be packaged as it is produced so the inventory at risk should not be sufficient to cause a serious reasonably foreseeable radiation emergency.

26. Work undertaken to process the waste streams in preparation for the Care and Maintenance phase of the lifecycle, greatly reduces the radiological hazard on site and will result in a small number of stores containing well characterised and packaged materials in modern containment facilities. Thus the amount of information needed to characterise the site and understand the potential implications of faults is greatly

reduced during Care and Maintenance. Therefore, as the decommissioning work and preparation for C&M progresses, there will be a reduction in the urgency and complexity of faults that might be considered as reasonably foreseeable in the context of a nuclear emergency. This allows the emergency response to be simplified.

27. With a depressurised, defuelled and cold reactor, and no irradiated fuel left on site, the probability of an event with site-wide dangers is clearly greatly reduced. The only faults possible are those associated with waste stores where waste handling projects may continue. Routine REPPIR hazard identification and risk evaluation (HIRE) analyses do not predict reasonably foreseeable radiation emergencies and there is no longer a requirement for an off-site plan. Should there be a radiological event, the need to confirm the safety of all personnel on site, and the need to provide safe routes and safe internal muster points all diminish. After this stage most faults will lead to a small area or facility-wide hazards requiring a more local emergency response to ensure the safety of people in a more restricted area. There are no reactor faults that would require urgent damage assessment, full site monitoring and repair in hostile conditions. A retreat from the affected area where a project has suffered an unanticipated event becomes a more appropriate response.

REQUIRED SCOPE OF ON-SITE PLAN POST SHUTDOWN

(i) Radiation Emergencies Reasonably Foreseeable

28. Once the reactors are shut down and have response times measured in days, the most onerous set of circumstances that are reasonably foreseeable would be a fire in a contaminated area or radioactive waste store with injured or missing members of staff. The quantities of flammable material (lubrication oils, fuel oils and process gases) and the number of ignition sources reduce significantly throughout defueling and decommissioning so the probability of a major fire reduces compared to that on an operating site. There remains the potential for a fire and, in some facilities, the potential for a hydrogen explosion cannot be disregarded. This requires health physics capability, casualty rescue/first aid capability and the ability to manage the event. There is less need for the site to be able to rapidly deploy sophisticated emergency teams as the timescales and fault magnitudes are more comfortably within the capabilities of the local emergency services.

29. The licensee claims (Ref 7) that fires in waste vaults are considered to be unlikely but it is recognised that they could have consequences off-site if they did occur. The emergency response on-site would be to retreat from the area to a place of safety and then take steps to protect the public and workforce. These steps may include shutting off ventilation to starve the fire of oxidant, placing improvised sand filters over release points and the introduction of fire suppression agents such as argon or Graphex. With no faults that could become progressively worse if not dealt with quickly the response times could be increased. Thus on-site shift staff can, in many instances, be replaced by teams called in as needed. As stated before, the emphasis for urgent actions moves from damage repair in hostile conditions to an expectation that the emergency scheme will mainly be used to provide Emergency Service Liaison and first aid and continuing casualty care in more slow developing, relatively benign and localised events.

30. Another key change is that the management of activity on site changes from a 24/7 focus towards day operations particularly during decommissioning. Consequently, most faults would be expected to occur during day operations when site occupancy and work levels are higher and more personnel are available to manage the response.

(ii) Radiation Emergencies Not Reasonably Foreseeable

31. Under REPPIR there is a requirement to carry out HIREs; during the site decommissioning phase these will eventually predict that a radiation emergency in terms of REPPIR is not reasonably foreseeable. It is most probable that a site event will now be associated with a waste processing project where an accident has occurred. The main requirement will now be for assistance in the project area that may involve casualty handling and longer term post event clean-up of an area. Emergency services can deal with casualties and the clean-up could be over an extended time frame.

CHANGES TO ON-SITE PROVISIONS POST SHUTDOWN

Manning levels and Command and Control

32. Emergency Scheme manning levels and command and control structures at operating sites are intended to provide the ability to cope with an urgent, complex, widespread and dangerous situation. Multiple trained teams are required for damage assessment and repair because of the difficult working conditions expected which could reduce the stay time in critical areas to a matter of minutes per person. A structured command and control system is required: to ensure that strategy is considered on a site-wide basis, deploying and coordinating resources; to ensure the safety of the general public and those on site; to urgently assess and repair damage; to search for and rescue casualties; and. to fight fire and to undertake urgent decontamination of multiple casualties and responders.

33. Once the situation is reached that a site-wide event is unlikely, consideration can be given to reducing the numbers and composition of response teams. With less site-wide dangers, longer stay times and less urgency of repair means that the damage assessment and response teams can be merged, creating fewer but more flexible teams. Team posts can be covered by on-call arrangements.

34. With strategic issues becoming less challenging there is scope to consider the overheads associated with multiple layers of Command and Control (ECC, CCR and ACP) and to refocus effort into fewer levels with less communications overheads. Clearly, once the shutdown, depressurised reactors have response time measured in days the control room (CCR) can be removed from the chain of command. The need for reactor physics knowledge in the ECC is also reduced; and eventually it will not be required.

Implications for on-site survey

35. On a generating site, because of the risk of widespread damage and spread of hot, radioactive $CO_2$, the on-site survey is undertaken by a two man team in BA and is an urgent action. With the reactors depressurized the scope for widespread damage and danger is reduced and on-site monitoring can be reduced to the scene of the incident with reassurance monitoring carried out further afield and on return from the scene. Urgent on-site survey of radiation levels would no longer be required when all reasonably foreseeable faults have either long reaction times or will not cause a site-wide hazard.

36. There may still be a need for radiation measurements but these would be focused at the scene and surrounding area of the incident. This would be undertaken by the Initial Response Team for their own safety and if required, can be performed by one person without the need for BA (but wearing a respirator if necessary) for reassurance monitoring in the surrounding areas. This is a requested on-call resource rather than on-shift post. During and after the event there may be a need for on-site survey as a

component of contamination control but it would not be of the importance, urgency or scope of the on-site survey required in the event of a hot-gas release on a pressurised, operating reactor.

37. A corollary of this is that in the event of an incident on site it is far less likely that large sections of the site or building interiors will be untenable and that control of response teams can move closer to the scene if that were advantageous. This can enable a rapid and flexible response to any given situation.

38. Thus on-site survey teams equipped to survey for hot $CO_2$ and available as an urgent response are not needed on sites without pressurized reactors or bulk $CO_2$.

Breathing apparatus

39. Breathing apparatus is mainly used as a protection from the inhalation of hot, radioactive $CO_2$ although it also offers the highest level of protection from the inhalation of any radioactive material. BA was widely used in the emergency response at operating sites but is less appropriate for use at defueling and decommissioning sites.

40. Once the site has depressurised the use of respirators can be used as a default respiratory protection measure to carry out damage assessment, damage repair and casualty rescue operations that the initial response team may be required to undertake. This offers more rapid deployment, more comfortable working conditions and longer duration without a significant reduction in protection.

41. BA capability would have to be retained for confined space rescue and possibly emergency services escort. However, it is inevitable that there will be fewer responders trained in the use of BA.

Use of fixed facilities

42. Given the potential for wide spread hazards on an operating site and a complex response the licensee has developed a system of fixed Access Control Points (ACPs) which provide tactical and operational level command and control facilities, contamination control and dose control.

43. For operating sites there has been as assumption that there would be an urgent need to remove casualties some significant distance from the scene of an accident in order to protect them from radiation, heat and $CO_2$ hazards. While it is still true that there may be a need to remove casualties from contamination and smoke inhalation hazards, it is also true that the sites as a whole are less likely to be untenable and the option to treat casualties at the scene or closer to the scene becomes more credible and offers improved casualty care and contamination control.

44. It was recognised that a hot gas release could compromise large areas of site and render fixed facilities untenable; this led to the development of capable alternative facilities. With the removal of this possibility the need for alternative facilities is reduced.

45. These factors lead to a reassessment of the role of fixed facilities and the potential development of more flexible response options, placing more of the command and control, first aid and contamination control nearer the scene of the event. This better aligns with standard Fire and Rescue Service responses.

46. Once a site is depressurised and has no bulk $CO_2$ stocks it is unlikely that an off-site nuclear emergency or site incident requiring urgent use of the ECC or ACP would also

render these facilities unusable. Thus, as far as the nuclear emergency plans are concerned the fixed alternative facilities are no longer needed. These can be replaced by contingency plans, listed in the Emergency Handbook, that detail how the site would respond to an event which also compromised one or more of the principal facilities. Security events that lead to significant areas being cordoned off are the most likely reason to implement these contingency plans.

Muster and roll call

47. On operating sites it has been general practice to require all staff to muster in safe areas such as the canteen on declaration of an off-site nuclear emergency. This has many advantages:

- It removes staff from areas potentially affected by a release of hot $CO_2$.
- It allows staff to be counted and identified to see if anyone is missing.
- It allows $KIO_3$ to be distributed in a controlled manner to counteract the dose implications of radio-iodine.

48. Once sites have depressurised reactors that have been shutdown for a period of 90 days or more, the threats of hot $CO_2$ and radio-iodine no longer exist. There is still a need to account for all staff to confirm their safety.

49. On shut-down sites the requirement to muster can be reconsidered and possibly replaced with a more dispersed roll-call process. This can allow people to remain in or near their offices or place of work and confirm their safety by an electronic or manual roll-call process. A dispersed roll-call process needs to have communication channels established to ensure that these dispersed groups can be informed of events and provided with advice about how to protect themselves should the need arise.

LONG TERM CARE AND MAINTENANCE PROVISIONS

50. Eventually each Magnox reactor site will have no routine work taking place on it as all waste will have been processed and stored in a passive condition and the reactor buildings secured. Each site may still have security guards that patrol the facility, however, security may be by means of remote monitoring using CCTV surveillance. Occasionally, maintenance work will be required on the site but this is similar in nature to other non-nuclear industrial facilities. General health and safety provisions will be applicable but there will be no need for any additional nuclear safety provisions, not even under LC 11, as the radiological hazards will be very low.

## 4 RELEVANT UK LAW

CONDITIONS ATTACHED TO THE NUCLEAR SITE LICENCE

51. All UK licensed nuclear installations have a Nuclear Site Licence; each one has a standard set of Licence Conditions attached to it. Licence Condition 11 (LC 11) states:

**Emergency arrangements**

1 Without prejudice to any other requirements of the conditions attached to this licence the licensee shall make and implement adequate arrangement for dealing with any accident or emergency arising on the site and their effects.
2 The licensee shall submit to ONR for approval such part or parts of the aforesaid arrangements as ONR may specify.

3 The licensee shall ensure that once approved no alteration or amendment is made to the approved arrangements unless ONR has approved such alteration or amendment.

4 Where any such arrangements require the assistance or co-operation of, or render it necessary or expedient to make use of the services of any person, local authority or other body the licensee shall ensure that each person, local authority or other body is consulted in the making of such arrangements.

5 The licensee shall ensure that such arrangements are rehearsed at such intervals and at such times and to such extent as ONR may specify or, where ONR has not so specified, as the licensee considers necessary.

6 The licensee shall ensure that such arrangements include procedures to ensure that all persons in his employ who have duties in connection with such arrangements are properly instructed in the performance of the same, in the use of the equipment required and the precautions to be observed in connection therewith.

52. Clearly LC11(1) requires adequate arrangements for dealing with any accident or emergency at that site for the whole of the period that it is licenced. All of the Magnox site emergency plans have been approved by ONR under LC11(2) so that regulatory control is maintained since they cannot be altered or amended by the licensee without ONR issuing further approvals under LC11(3).

RADIATION (Emergency Preparedness and Public Information) REGULATIONS 2001 (REPPIR)

53. The REPPIR regulations were made under the Health and Safety at Work etc Act 1974 with the aim to:

"(a) establish a framework for the protection of the public through emergency preparedness for radiation accidents with the potential to affect members of the public, from premises and specified transport operations; and

(b) ensure the provision of information to the public:
(i) in advance in situations where a (REPPIR) radiation emergency might arise; and
(ii) in the event of any kind of radiation emergency (however it may arise)."

The regulations define a Radiation Emergency as "any event (other than a pre-existing situation) which is likely to result in any member of the public being exposed to ionising radiation arising from that event in excess of any of the doses set out in Schedule 1 [5 mSv in the period of one year immediately following the radiation emergency] and for this purpose any health protection measure to be taken during the 24 hours immediately following the event shall be disregarded". This should not be confused with the lower consequence Radiation Accident which is defined in the Ionising Radiations Regulations (1999) as "An accident where immediate action would be required to prevent or reduce the exposure to ionising radiation of employees or any other persons".

54. The REPPIR regulations apply to premises or transport operations where the quantities of radionuclides used or transported exceeds values given in Schedules to the regulations (Regulation 3). These quantities are such that all Magnox sites, including those in Care and Maintenance, are subject to the regulations.

55. Regulation 4 requires that sites undertake a hazard identification and risk evaluation (HIRE) process before work is undertaken to demonstrate that "all hazards arising from that work with the potential to cause a radiation accident have been identified; and the

nature and magnitude of the risks to employees and other persons arising from those hazards have been evaluated". This must be reviewed on material changes or every three years (Regulation 5) and reported to the Health &Safety Executive (HSE) [now ONR] (Regulation 6). These regulations remain applicable to all Magnox licensed sites and the HIREs have to be maintained, reviewed and reported.

56. Regulation 7 requires an Operator's emergency plan "where the assessment made by the operator …. shows that is reasonably foreseeable that a radiation emergency might arise". Guidance is given about the contents of a plan (Schedule 7). This regulation is no longer applicable to sites for which the ONR have agreed with Magnox's submission that a radiation emergency is not reasonably foreseeable.

57. Regulation 8 refers to Carrier's emergency plans and is not relevant to Magnox.

58. Regulation 9 requires a local authority off-site plan where the HIRE Report of Assessment (RoA) has identified a reasonably foreseeable radiation emergency and requires the HSE to determine the size of the Detailed Emergency Planning Zone (DEPZ). This regulation is no longer applicable to sites for which the ONR have agreed with Magnox's submission that a radiation emergency is not reasonably foreseeable.

59. Regulation 10 requires that plans (where they are required) are reviewed and tested.

60. Regulation 11 requires the operator (Magnox) to consult with any other employer who carries out work with ionising radiation on the premises and that they cooperate with compliance. This regulation remains in force when preparing HIREs and RoAs even for sites for which a radiation emergency is not reasonably foreseeable.

61. Regulation 12 allows local authorities to charge the operator for work undertaken on a Regulation 9 plan. This ceases to apply when regulations 7 and 9 cease to apply.

62. Regulation 13 requires the duty holder to initiate the plans prepared under regulations 7 and 9 when appropriate and to inform the executive without delay. This ceases to apply when regulations 7 and 9 cease to apply.

63. Regulation 14 provides a mechanism to approve emergency exposures.

64. Regulation 15 provides for the disapplication of IRR 99 dose limits in the event of a radiation emergency. These cease to apply when regulations 7 and 9 cease to apply.

65. Regulation 16 requires prior information to be given to members of the public within an area where they are likely to be affected by a radiation emergency arising from the undertaking of the operator (usually taken to be the DEPZ). Magnox satisfies this requirement by circulation of calendars and posters with the relevant information. These cease to apply when regulations 7 and 9 cease to apply.

66. Regulation 17 places a duty on the local authority to provide information in the event of a radiation emergency and ceases to be a concern of Magnox's when regulations 7 and 9 cease to apply.

67. The remaining REPPIR regulations are not relevant to Magnox.

68. HSE guidance on REPPIR states that "If the assessment shows that it is not reasonably foreseeable for a radiation emergency to occur at the premises, then the operator will not have to prepare an operator's emergency plan under REPPIR. The operator will still have to prepare a contingency plan under the IRR99 Regulations to deal with radiation accidents which may occur."

IONISING RADIATIONS REGULATIONS (IRR99)

69. IRR99 Regulation 7 requires a risk assessment of work with radioactive material with Regulation 7(3) stating that:

> "Where the assessment made for the purposes of this regulation shows that a radiation risk to employees or other persons exists from an identifiable radiation accident, the radiation employer shall take all reasonably practicable steps to:
> (a) prevent any such accident;
> (b) limit the consequences of any such accident which does occur; and
> (c) provide employees with the information, instruction and training, and with the equipment necessary, to restrict their exposure to ionising radiation".

70. A Radiation Accident is defined as "An accident where immediate action would be required to prevent or reduce the exposure to ionising radiation of employees or any other persons".

71. Radiation Accidents would generally be airborne activity excursions, spills of radioactive material, the loss of shielding around sources, with or without actual contamination or exposure of people or contaminated injuries sustained on site. These types of event are generally localised and have consequences well below a Radiation Emergency.

72. Potentially more serious, but less likely, are events such as fire, storm, earthquake or flood damage to containment structures leading to releases of radioactivity or diminution of shielding.

73. It should be noted that the IRRs do not explicitly define upper or lower limits to the definition of Radiation Accidents. The upper bound could be considered to be where Radiation Emergency starts, at 5mSv dose to the public but it is not necessary to define that limit. The lower bound would be where the process or operator does not recognise the need to "take immediate action to prevent or reduce the exposure to ionising radiation of employees or any other persons". That is the job is completed within the dose tariff determined by the Health Physics planning and is as low as reasonably practical. This leads to the conclusion that a Radiation Accident is any event recognised as such by the operators.

74. All projects, processes and facilities would be subject to local rules under IRR Regulation 17 which would include the Regulation 12 contingency plan if it were shown to be reasonably foreseeable that a Radiation Accident could occur. The level of detail in each contingency plan will need to reflect the circumstances anticipated. The expected content of the plan as detailed in the Ionising Radiations Regulations Approved Code of Practice is:

In particular, the plan should normally identify:

(a) which postholders are responsible for putting the plan into effect;

(b) what immediate actions for assessing the seriousness of the situation will be necessary, for example the use of suitable radiation and contamination monitors;

(c) what immediate mitigating actions need to be taken, for instance in clearing the accident area and establishing temporary means of preventing access to that area;

(d) what personal protective equipment will be needed and where it may be found;

(e) what personal dosimetry requirements there are for people involved in controlling the accident;

(f) what training of personnel is required;

(g) how to obtain radiation protection expertise so that proper judgements can be made about the seriousness of the situation and the measures necessary to recover from it;

(h) under what circumstances to summon the emergency services; and

(i) what dosimetry follow-up is needed so that all the people affected by the accident are identified and provision is made for their dose assessment.

[and] the radiation employer shall ensure that –

(a) condition where local rules are required for the purposes of regulation 17, a copy of the contingency plan made in pursuance of paragraph (1) is identified in those rules and incorporated into them by way of summary or reference;

(b) any employee under his control who may be involved with or may be affected by arrangements in the plan has been given suitable and sufficient instructions and where appropriate issued with suitable dosemeters or other devices obtained in either case from the approved dosimetry service with which the radiation employer has entered into an arrangement under regulation 21; and where appropriate, rehearsals of the arrangements in the plan are carried out at suitable intervals.

SUMMARY

75. This review of the regulations has shown that if the REPPIR "test" of having a reasonably foreseeable radiation emergency is not passed then the Local Authority need not prepare an off-site plan (REPPIR Regulation 9) and the duty holder need not prepare and demonstrate its REPPIR plan (Regulation 7).

76. Guidance to REPPIR Regulation 7 is very clear that if the regulation does not apply then the sites should consider if contingency plans are required under the Ionising Radiations Regulations (1999) to respond to reasonably foreseeable Radiation Accidents. The IRRs and associated guidance define the minimum contents of a contingency plan.

77. Until a site is delicensed, Licence Condition 11 remains in force requiring "adequate arrangements for dealing with any accident or emergency arising on the site and their effects".

## 5 EXISTING GUIDANCE

UK GUIDANCE (NEAF AND ONR PRINCIPLES/GUIDES)

78. In 2004 the UK nuclear industry stakeholders produced a paper under the Nuclear Emergency Arrangements Forum (NEAF) umbrella which considered emergency arrangement requirements for a generic nuclear facility lifecycle (Ref 13). It is not clear whether this document was finalised, however, all of the key licensees, and the regulator, were involved in drafting it. For the post-shutdown condition the NEAF document has the following statements:

- This paper [Ref 13] sets out the elements recognised as forming the basis of the Emergency Plan over the last 30-40 years of the nuclear industry and considers how these should evolve during the life of the site.

- Consultation with appropriate stakeholders is axiomatic for all elements of the emergency arrangements and across all of the lifecycle. Industry best practice suggests that these consultation bodies should meet approximately six monthly [when operational]. The REPPIR requirement to consult is removed when a reasonably foreseeable emergency no longer exists (after immobilisation of ILW/passive safe-store). At this time the need for an offsite plan under REPPIR is also removed. However, the site licence requirement to consult is not removed. Pragmatism suggests that a smaller consultation body, meeting less frequently (approximately yearly during preparation for care and maintenance and five yearly during care and maintenance) adequately fulfils this requirement.

- The requirement to provide [public] information disappears when there are no longer any reasonably foreseeable radiation emergencies. This occurs after the immobilisation of ILW onsite.

- Following the immobilisation of intermediate level waste it is not reasonably foreseeable to have a radiation emergency, hence the need for dedicated Offsite Facilities will no longer be required.

- Following the immobilisation of intermediate level waste a radiation emergency is not reasonably foreseeable but radiation accidents and conventional events could occur. The operator's staff may not be required on site 24 hours a day at this point in the life cycle. Therefore notifications and warning on site would become automated on detection of hazards. Auto-notification systems should allow the alert to be transmitted direct to the Emergency Services to respond and activating the owner/operator support for longer-term remediation activities.

- Together with Licence Condition 11, REPPIR requires off site emergency arrangements to be in place if a radiation emergency is reasonably foreseeable. REPPIR requires the Off Site Emergency Plans to be tested on a three yearly basis. Whilst the risks and hazards associated with the site's operational status deem it necessary for on and off site emergency arrangements, these should be regularly tested. The frequency and extent of the testing should be reviewed and agreed as the operational status changes with five yearly frequency of exercising being appropriate post the passive safe storage of ILW on the site.

- During the operational phase there will be the need for the command and control facilities onsite to be redundant and diverse to guard against the possibility of a facility becoming untenable. These facilities will need to be established, exercised and tested before first criticality. During defuel the significant reduction in radioactive inventory together with the removal of asphyxiant hazard removes the need for duplicate facilities. During preparation for the care and maintenance period the need for a range of command and control facilities on site could be reduced. Facilities could be amalgamated. During care and maintenance a dormant facility for access control could be established. Alternatively a mobile facility that could be deployed to the site could be established.

79. At the time that Ref 13 was produced NEAF did provide guidance for the UK nuclear industry, however, it is not clear that Ref 13 was formally published and therefore the status of it is unclear. That said, a group of knowledgeable stakeholders had at the very least produced some quality guidance for post-shutdown nuclear facilities.

80. The 2014 ONR safety assessment principles for nuclear facilities (SAPs) (Ref 1) document contains a section on "accident management and emergency preparedness" that contains one principle: **AM.1 – Strategies and plans should be in place to**

**prepare for and manage accidents at the facility and/or site**. Paragraphs 768 to 787 of Ref 1 give additional guidance to ONR assessors; key points include:

- The objective of accident management and emergency preparedness is to take all reasonably practicable measures to prepare for possible accidents at nuclear facilities, and to mitigate their consequences should they occur.

- REPPIR and its supporting guidance establish a framework for the protection of workers and the public through emergency preparedness for radiation emergencies. This framework is intended to provide an integrated approach so, for instance, the dutyholder's emergency plan should be developed in liaison with the emergency services.

- The emergency operating procedures and accident management guidelines should be tested during emergency exercises to confirm their accuracy and effectiveness and should also form part of operator training.

- An on-site emergency control room should be provided from which an emergency response can be suitably and safely directed. This should be located such that the likelihood of its non-availability due to the emergency itself is minimised.

- Facilities should also be provided for managing the deployment and return of emergency response teams, including briefing and rest/recuperation areas. Where reasonably practicable, such facilities should be of a robust design and suitably protected from radiation and other hazards potentially present in accident scenarios. These facilities should be designed to operate independently, without any need for off-site support.

- Provisions should be made for training personnel (including the local emergency services) in accident management procedures and implementing the accident management strategies. The training should include periodic exercising of the site's emergency arrangements, including multi-facility exercises where relevant. The exercises should be chosen so that in total they test the full scope of the site's arrangements and activities within the plans, eg the deployment of mobile equipment such as pumps and generators.

81. These principles are clearly aimed at facilities where there are still at-power reactors (or facilities where similar hazards exist). They do not mention post-shutdown requirements when the hazard will have reduced considerably.

82. ONR has one other guide that relates to LC11 (Ref 14). The LC 11 guide discusses licensee's arrangements for dealing with accidents and emergencies; it describes the approved emergency plan and lower tier detailed arrangements that are included in the 'Emergency Handbook'. Regulatory expectations are outlined and it does indicate that there is an expectation that emergency schemes will evolve as site hazards change during the lifecycle of a facility. Reference 14 also sets expectations for the annual 'demonstration' exercise. The guide is clearly aimed primarily at operational reactor sites and not those that are defuelled and decommissioning.

83. There does not appear to be any formalised, relevant UK guidance that deals in any detail with emergency arrangements requirements for shutdown, defuelled and decommissioning power reactors.

<u>International guidance (IAEA and WENRA)</u>

84. The International Atomic Energy Agency (IAEA) has issued a number of documents relating to emergency preparedness (Ref 2 - 4) and a number of documents related to

decommissioning of nuclear facilities (Refs. 5 - 6). These are not very useful as they deal with worst case scenarios with at-power reactors (Refs 2 and 3) or they do not address emergency arrangements during decommissioning (Refs 5 and 6).

85. WENRA (Western European Nuclear Regulators Association) Safety Reference Levels for Existing Reactors contains Issue R: On-Site Emergency Preparedness. Unfortunately the guidance clearly states that it is only applicable to any reasonably foreseeable event and therefore it is not relevant to a Magnox site in care and maintenance with no requirement for a REPPIR off-site plan.

86. WENRA has published a set of Decommissioning Safety Reference Levels (Ref 15) and these contain the following (extracted directly from Ref 15):

Safety issue: On-site emergency preparedness

If for the set of foreseeable accidents considered in the safety case, events requiring protective measures cannot be excluded, planned emergency arrangements will be required. These emergency plans should be proportionate taking account of the magnitude of the accident consequence. For some facilities (such as with low radioactive inventory) an off-site emergency plan may not be required, which must be justified and the off-site aspects of this safety issue will not apply. This site emergency plan can be based on the operational one but modified according to changed hazards during the decommissioning actions. The following SRLs therefore need to be applied in a proportionate manner.

D-31: The licensee shall provide arrangements for responding effectively to reasonably foreseeable events requiring measures at the scene for:

(a) regaining control of any emergency arising at the site, including events related to combinations of non-nuclear and nuclear hazards;
(b) preventing or mitigating the consequences at the scene of any such emergency and
(c) co-operating with external emergency response organizations in preventing adverse health effects in workers and the public.

D-32: The licensee shall

- prepare an on-site emergency plan as the basis for preparation and conduct of emergency measures,
- establish the necessary organizational structure for clear allocation of responsibilities, authorities and arrangements for coordinating on-site activities and cooperating with external response agencies throughout all phases of an emergency and
- ensure that, based on the on-site emergency plan trained and qualified personnel, facilities and equipment needed to control an emergency are appropriate, reliable and available at the time.

D-33: During decommissioning, the licensee shall review and update as necessary the existing on-site emergency plan, so that it stays appropriate for current and future states of the facility. Experience from recent emergency exercises and reports on real emergency occurrences shall be taken into account.

D-34: The licensee shall perform at regular intervals on-site emergency exercises, the results of which shall be reported to the regulatory body. Some of these exercises shall

include the participation to the extent possible of external organizations concerned with on-site emergency.

87. These safety reference levels are still focussed on foreseeable accidents but they do acknowledge that arrangements should be proportionate. They also require a licensee to have an on-site emergency plan, have an emergency response structure filled by trained and qualified personnel and facilities and equipment necessary to deal with an emergency. There is also a requirement that emergency exercises are performed at regular intervals

88. In conclusion, there is very little relevant international guidance. The WENRA guidance (Reference 15) is the best available but it is limited. Effectively it says that on-site emergency arrangements should be retained and they should be exercised, however, it does not attempt to define in any detail what arrangements a regulator should expect to find on a decommissioning power reactor site.

## 6 THE LICENSEES VIEW

89. Magnox have produced a series of generic papers that explain how they think emergency arrangements should evolve as their magnox power reactors shutdown and transition through defueling, decommissioning and enter into long term 'care and maintenance' (Refs 7 to 12). At an ONR/Magnox Level 4 meeting in March 2015, the licensee informed the regulator that References 9 and 10 had effectively been superseded by Reference 12. However, these papers do set out the Magnox strategy regarding changes they wish to make to site emergency arrangements as they progressed from at-power operation to defueling and then care and maintenance.

90. The transition from at-power operation through to the end of defueling is now a "well-trodden path" and therefore plans at Wylfa and Oldbury will follow a proven route, albeit with some acceleration of emergency arrangement changes. In 2015 the licensee wants to make changes to its central facilities as discussed in Reference 11.

Proposed On-Site and Central Support Emergency Arrangements when No Off-Site Release is predicted

91. The following paragraphs reflect the Magnox proposal that is outlined primarily in Ref 12; it covers the end of site life when no off-site plan is required.

MAGNOX'S REVISED EMERGENCY PREPAREDNESS AND RESPONSE PROPOSAL

Introduction

92. This section reviews the components of the current emergency arrangements and discusses the need, or otherwise, for them to continue (when no off-site release is believed to be possible).

The role of the Emergency Control Centre

93. Up until now the Emergency Control Centre (ECC) has been a dedicated fixed facility. It was fixed mainly because it contains some fixed systems (NIAS, EPGMS for example) and additional communications facilities (Tiims, phones, PA microphone etc). It was dedicated because it was known that at-power reactor faults such as a burst duct could be initiated without warning and required a very prompt response. Because of the importance of the facility dedicated alternative facilities were provided at generating sites and contingency plans for moving the functionality at short notice

available at defueling sites. The role of the Emergency Control Centre (ECC) is described in Section 4.2.1 of the Handbook as:

a. To be the centre of co-ordination, command and control for the Site Emergency response to an event.
b. To be the hub of all event information and event strategy.
c. To act as the conduit of information to the CESC and external agencies.

94. It also houses the NIAS radio used to control the off-site survey and the EPGMS terminal that reports the gamma dose-rate at the site boundary. Both of these pieces of equipment are decommissioned once the Local Authority off-site plan is removed.

95. Because of the reduced likelihood of requiring the facility and the reduced urgency of initiation there is no continuing need for a dedicated ECC. The function can be carried out in a shared facility, for example a meeting room. Experience of this has been gained in the Event Management Centre at the Berkeley Site. This is a meeting room with additional White Boards and phones and a lockable cupboard containing additional equipment such as manuals, log books, stationery and maps. People using the facility can be removed and the room configured as a Command and Control Centre in only a few minutes. The ability to relocate the Command and Control Centre with ease is useful for sites with buildings being taken out of use.

96. With the arrangements being reduced, the control of the site remaining with the Shift Leader and the ECC team being reduced (see below) the role of the facility is dramatically reduced. It is therefore proposed to remove the “ECC” title. Post-REPPIR planning sites will be expected to identify locations/rooms that the Event Management Process or Operational Decision Making Process can be carried out. These locations/rooms should be equipped with white boards, telephones and the other basic tools for effective Command and Control. This facility would not necessarily be a dedicated facility and while outside the remit of the approved emergency scheme would be available for use in a severe or prolonged event and for managing recovery should it be needed.

97. A Magnox Limited review has confirmed that the Company Standard on Business Continuity makes no explicit claim on the ECC or its personnel.

The role of the Duty Emergency Controller

98. According to the Emergency Handbook “The Duty Emergency Controller has the responsibility to:

a. Diagnose and declare the state of emergency appropriate to the conditions prevailing in consultation with the Initial Emergency Controller.
b. Ensure that all functions of the Emergency Plan and Handbook are being effectively carried out.
c. After relieving the [initial emergency controller] IEC, decide on and establish the relevant actions required to protect the public and on-site personnel, mitigate plant damage and retain subsequent control of all affected plant, maintain security of the site and protect the environment.
d. To liaise with the off-site organisations and emergency centres, to provide them with information on the course and status of the emergency, and to provide them with early advice on implementation of countermeasures to protect the public.

99. In the revised arrangements for post-REPPIR sites the declaration state “Off-site Nuclear Emergency” which was the sole responsibility of the Emergency Controller (Duty Emergency Controller or Initial Emergency Controller) no longer exists so clause

(a) above is largely redundant. The role of diagnosing the situation now lies with the Shift Leader/DAP for external and site events and with the project to diagnose and report radiation accidents. The declaration state “Site Incident” will be retained to allow the Shift Leader to gain undisputed authority over the site and any activities taking place on the site should the occasion demand. It will not trigger any default actions such as site muster.

100. The Shift Leader/DAP and the project have the responsibility to ensure the safety of persons on site and protect the environment and to ensure that appropriate contingency plans are initiated as required.

101. Clause (c) is still important but, with a significantly reduced scope of events, devolves to the Shift Leader and the project.

102. Clause (d) above is largely redundant because there is no need to provide off-site organisations with early countermeasure advice and there will be no off-site emergency centres operational. The Company Duty Officers (EHSS&Q Duty Officer, Assistant CESC Controller and Duty Press Officer) are available to provide support if and when required.

103. At this stage of the life cycle the role of Duty Emergency Controller can be removed. The residual responsibility of the DEC to ensure that responses to events are appropriate and to oversee any response, if required, would devolve to the Shift Leader/DAP with support, if required, from the Duty Manager.

Duty Manager (New Role)

104. The site management may wish to introduce a Duty Manager rota when the Duty Emergency Controller rota is withdrawn. This is because the DEC is often referred to for non-emergency matters.

105. The DM role would be to provide permanent availability of a delegate of the Site Director to manage the site in all circumstances. In an event the Duty Manager would, if required, be managing stakeholders (Media, Company Management and Regulators), providing senior management support to the response/recovery and considering business continuity matters not taking control of the situation unless it was necessary to do so.

106. The training of a Duty Manager would be significantly less onerous than that for a Duty Emergency Controller recognising the significant difference in the role and the range of events likely to be experienced. This would be a business process (Delegation of Authority) rather than an emergency preparedness process.

The role of the Emergency Health Physicist

107. The Emergency Health Physicist’s role is defined in Section 2.2c of the Emergency Handbook as:

> (a) To advise the Emergency Controller on associated radiological impacts to the public, staff and the environment.
> (b) To provide countermeasure advice to the Police.
> (c) To provide dose advice for on and off site activities.
> (d) To direct Emergency Health Physics staff in assessing and gathering radiological information and monitoring data.
> (e) To assist in the formulation of clean up, recovery and mitigation plans.

108. The scope of faults expected at this stage of the life-cycle is of significantly lower consequence and spread when compared to those envisaged when this role description was written.

109. It is not reasonably foreseeable that an event on site could have significant radiological consequences for the public. Mechanisms will be in place at project and shift level to ensure that workers accidentally exposed in the cause of their work will be removed from harm's way and decontaminated under the care of Occupational First Aiders and an Accredited Health Physicists. Recovery operations will ensure environment protection is given a suitably high priority. Contingency plans would also exist to cover spills of radioactive material or exposed sources leading to elevated doserates off-site.

110. Management of these would ensure suitably qualified and equipped personnel are available when projects are "at risk". Clause (a) remains important but, with reduced consequences, can be devolved to project Health Physicists and monitors supported by appropriate contingency plans advising the project and shift leader.

111. There will be no need to provide urgent countermeasure advice to the police; they are very unlikely to be alerted unless there is reason to suspect a crime has occurred, and it is not reasonably foreseeable that the public would be significantly affected. Clause (b) is redundant.

112. There will be no need to provide dose advice for off-site activities and the project will provide Health Physics advice and control for on-site activities. This provision will be managed by the contingency planning and setting to work process. Clause (c) is of reduced importance and devolved to the project and shift leader.

113. There will be no automatic off-site survey. Any radiological monitoring, either on-site or off-site, required will be carried out locally as identified in the Project Risk Assessment and the situation experienced and is expected to be more for reassurance purposes and thus will be less urgent. Clause (d) is of reduced importance and devolved to the project health physicists and shift leader.

114. A recovery plan would be formulated with advice from the project Health Physics capability. This would not be an urgent activity as initial response actions would make the area safe before withdrawing to consider clean-up and recovery. This would be delivered by the project and site as required. Clause (e) is of reduced importance and devolved to the project and shift leader.

115. The role of Emergency Health Physicist can be removed from the emergency scheme at post-REPPIR planning sites providing the site is confident that proportionate and appropriate Health Physics advice will be available to responders.

The role of the Emergency Technical Advisor

116. The role of the Emergency Technical Advisor is given in Section 2.2 (d) of the Handbook as: "To advise the Emergency Controller on the technical implications, effects of an incident and to assist in formulating mitigating actions required".

117. With the complexity and urgency of the accident responses expected to be much reduced this role is redundant. Suitable technical advice about the processes that were underway, the faults experienced, the ramifications and appropriate recovery activities can be provided by the project under their contingency plans. Where necessary, any required site resource could be called to provide support. The role of the Emergency Technical Advisor can be removed from the emergency scheme at post-REPPIR sites.

The role of the Emergency Services Liaison Officer

118. The Emergency Handbook defines the role of Emergency Services Liaison Officer (ESLO) as "On arrival at Site the Emergency Services will be met by the Emergency Services Liaison Officer (ESLO), who will arrange escort or direct them to the pre-arranged locations". This is an important role given that deploying the Emergency Services promptly is fundamental to the scheme philosophy. A suitably trained person will remain available to act as Emergency Services Liaison Officer (ESLO).

The role of the ACP

119. It is envisaged that an Access Control Point (ACP) will be retained as a place for responders to congregate and for the DAP to brief and coordinate responders. However, as it no longer strictly controls access and egress to the affected area its name is now a misnomer. The specification of the facility and the equipment available can be expected to be reviewed as the nature of the projects on site changes. At some point, it will be possible for a site to justify discontinuing the facility.

The role of the Gatehouse

120. The role of the gatehouse is to control the security of the site by controlling access and egress and by monitoring the perimeter. The gatehouse is usually the location for the ESLO (Section 6.7). The role of the gatehouse will be unchanged for the foreseeable future.

Entry Control Point (future new facility)

121. Sites in Care and Maintenance are expected to have an "Entry Control Point" which will provide some shelter for responders coming from off-site and may contain some equipment and site drawings. This will be the base location for any required security presence on site.

The role of security staff

122. The role of security staff is to control the security of the site at all times. This is unchanged.

Emergency Handbook

123. The Emergency Handbook is currently a key document in the Company's and the sites' emergency arrangements. Together with the approved plan it constitutes the onsite plan as required by REPPIR.

124. The Handbook explains in some detail the individual roles of responders and the tools they use. Post REPPIR Regulation 7, with a drastic reduction in the on-site plan, the Handbook is no longer needed. Key roles within the Sites arrangements will be identified within a proposed Contingency Overview Document.

125. The Emergency Handbook is mentioned in a number of Company documents which will require updating for sites that do not have a Handbook.

Muster, Roll Call and Lock-down

126. Following the process applied at many office, shopping centre and industrial sites, and subject to a site by site risk assessment, the need for mustering the whole site indoors may be withdrawn. One clear exception to this is at sites adjacent to an operating nuclear power station where there is a need to retain the ability to shelter all staff and provide stable iodine tablets.

127. Local evacuation plans will remain where appropriate. These consist of alarms such as bells, sirens, air-horns or whistles that tell people to make safe their work and leave by the safest exit. Proportionate systems that may include Fire/Area Marshals, local registers or tag systems and agreed muster points will be used to determine if people are left at risk.

128. The ability to lock-down the site will be retained at the level of performance required by the security regulations and local risk/needs assessment.

The Role of the Emergency Administration Officer

129. The role of the Emergency Administration Officer as defined in Emergency Handbook section 2.2 is "To ensure successful completion of Muster and Roll-call procedures and to assist the Emergency Controller in organising and controlling all administration duties for the ECC"

130. Sites will be required to have some muster and roll-call arrangements but they may be simple more localised systems that do not require a person on standby to assist. Responders to events at sites preparing for Care and Maintenance may still prefer to have administrative support but it is not an urgent requirement and need not be provided on a duty rota but provided as required on an ad hoc basis. The role of Emergency Administrative Officer can be withdrawn.

Command and Control

131. As discussed above, the role of the Shift Leader (or equivalent) and the Duty Emergency Controller would be fundamentally altered at this stage.

132. The key role for the shift personnel in response to a reported incident within a project's capability to respond, would be to ensure that, if required, the Emergency Services were summoned and deployed without undue delay; other personnel on site were both safe and out of the way of responders; initial mitigating actions had been initiated or completed and controlled access to the incident area had been established. Thereafter they would continue to control the site and to provide support for the response and recovery including the permissioning of the non-urgent remedial actions. Contingency arrangements will initiate initial mitigation actions such as barrier off affected areas (expected to be relatively small), turn off pumps, bund drains, close doors and the initial responders will work within the boundaries of the risk assessment and the contingency plan.

133. Sites will be expected to have an Event Management Process (EMP) or Operational Decision Making (ODM) Process outside the emergency arrangements to manage events on-site. This will identify a suitable location from which to manage any business continuity or recovery issues in result to any such event. It is also expected that, outside the emergency arrangements, any Magnox Site would have a "Duty Manager" or equivalent available for consultation (in person or by phone) to make any required management decisions regarding work underway on site. This person would have the responsibility to communicate with the Site's and Company's senior management and, in consultation with the Duty Press Officer, the local and national media if required.

Declaration states

134. The declaration state "Off-site Nuclear Emergency" will be withdrawn with the Local Authority off-site plan.

135. "Site Incident" will be retained as it provides for the rapid mobilisation of the site and Company resources; promulgates an alert and triggers the emergency response

including the Authorisation of the Shift Leader/DAP and the permitting of the judicious temporary setting aside of the Radiological Safety Rules.

RADSAFE and NAIR

136. Where a site has decommissioned the ECC and removed the emergency rota as suggested in this report (Ref 12), they will be less capable of supporting Radsafe or NAIR alerts as described in the Emergency Handbook Section 6. This will not be a barrier to the revision of the emergency scheme nor the site's ability to dispatch packages under RADSAFE as the terms of Magnox's membership of Radsafe is being managed to remove sites from the list of responding sites in anticipation of the their emergency provisions being reduced. NAIR is a voluntary scheme and Magnox involvement is in managed decline as for Radsafe.

Central support

137. The future provision of central support was discussed in Reference 11 and then summarised in Reference 12 as indicated in the following paragraphs.

138. The Central Emergency Support Centre (CESC) was intended to relieve an affected site of all aspects of off-site radiological protection, external advice and communications and to provide a single source of technical support to assist them in bringing the situation under control. It is currently set up for an Off-site Nuclear Emergency, Site Incident, Major Security Incident or Radsafe Incident. It is only fully set up for an Off-site Nuclear Emergency as its capabilities are designed to be able to cope with an Off-site Nuclear Emergency involving an operating reactor, and are arguably over specified for other events.

139. An operational difficultly associated with the CESC supporting multiple sites in different stages of the lifecycle has long been recognised. This is the requirement to specify the facility and its urgent response for the worst case and accept that the system may over react to events at the low risk sites. This presents no insurmountable issues; those called in but not needed would be sent home or deployed in some useful task. This issue becomes more pronounced for sites without an off-site plan but, again does not pose an insurmountable operational issue.

140. Although not an operational issue, the use of the full CESC response for decommissioning sites has removed the opportunity to learn how to manage appropriate arrangements for the low risk sites and so no lower tier arrangements are in place for when the CESC is no longer needed.

141. The CESC Health Physics resource in support of the site can be relaxed when the offsite plan is no longer required. There will be no occasion to give countermeasure advice to protect the public, no radioactive plume to measure or model, no off-site survey vehicles to command and significantly fewer external bodies to liaise with. As a result of this the Assistant Health Physicist, Radio operator and EDAS team can be removed.

142. The need for urgent technical support is greatly reduced as the scope for accidents and the threat of escalating situations is now recognised as being below reasonably foreseeable. As a result of this the need for the Engineering Support Team and some Technical Support Team members is reduced.

143. There would be no Strategic Coordination Centre (SCC) or Company SCC Team to support and a reduced number of external organisations interested so the time pressures on the CESC are reduced and its role as a communications hub reduced.

144. Initial central support can be reduced to an on-call team consisting of the EHSS&Q Duty Officer to make any external notifications required (as currently), a Company senior responder (Currently this would the Duty Assistant CESC Controller) and the Duty Press Officer.

145. The Assistant CESC controller may wish to contact further support by phone and initiate an Event Management Process but it is unlikely that the CESC would be required.

146. If the site did find it wanted more support or advice for its Health Physics efforts it could co-opt help from one or more of the other Magnox sites. This could utilise the Assistant CESC Controller or be managed directly as appropriate.

Warning and Informing the public

147. For sites within the REPPIR planning regime Magnox maintains mechanisms to warn and inform the public around its sites. Prior information is provided to homes and businesses within the Public Information Zone (PIZ) which for all Magnox sites is coincident with the Detailed Emergency Planning Zone (DEPZ). This information is designed to cover the requirements as defined in schedule 9 of REPPIR and is provided in the form of a calendar and some leaflets distributed annually.

148. With the legal requirement removed Magnox can reconsider this provision. It may choose to continue the provision in the current form, adapt the calendars and supporting leaflets to the post-REPPIR situation, or to discontinue the distribution. This would be a Magnox decision taken by Emergency Planning Services and the Communications team in consultation with the Local Authority and Regulators.

149. A telephone Warning and Informing system is maintained around some sites. This is able to transmit a pre-recorded or a bespoke message to all registered households and businesses within the DEPZ in the event that they are advised to take some countermeasure. Maintenance of this system is considered to be disproportionate to the potential requirements of a post-REPPIR planning site and it will be withdrawn.

150. Magnox will continue to be able to monitor the area beyond the site fence and will have proportionate measures in place to alert members of the public who may be subject to elevated risks at the site fence as a result of operations or events on-site.

Consultation with the Local Authority and Emergency Services

151. Magnox will continue to offer Emergency Planning Consultative Committee (EPCC) meetings, although at a reduced cycle (except at joint sites) as a mechanism to consult with the Local Authority and Emergency Services on matters pertaining to contingency planning.

152. The Emergency Services will continue to be invited to participate in contingency plan training.

SUMMARY OF REVISED ARRANGEMENTS

153. This section summarises the proposed arrangements both for managing work to minimise the possibility of an accident and ensuring adequate contingency arrangements and for responding to events should they occur.

Work planning and permissioning

154. Sites will be required to develop a “Contingency Folder” which collates a contingency overview of the site informed by the Site HIRE and Safety Case as well as the

Standards on contingency planning and training. This process would identify the generic contingency plans that would be appropriate and these will be adopted with adaption as required. Site, Area and project risk assessments would identify further contingency arrangements that would be needed for work to progress. These become a component of the Contingency Folder. Finally, the Contingency Folder will contain background information such as Site Maps and Equipment lists, Project recovery guidelines and details of the site's Event Management Process.

155. This Contingency Folder will be maintained and will be available to the Shift Leader/DAP with the relevant components also available more locally to the relevant areas and projects.

Setting to work and event response phase

156. The setting to work process, supervised by the Shift Leader/DAP, confirms that the work proposed for that period does not compromise the safety of other personnel or projects and that appropriate contingency plans are in place and adequately resourced. Should an accident happen the Shift Leader/DAP is informed and the project initiate the relevant contingency plan initially utilising the resources identified in the plan but ultimately being able to call on site resources through the Shift Leader/DAP and Company resources through the Company Duty Officers and the site's Duty Manager.

157. If faults need the attendance of the Emergency Services they will be summoned and briefed using the 999 system and then briefed and directed by the Emergency Services Liaison Officer.

158. The Site Director remains responsible for the safety of the public, the people on site and the environment at all times.

159. There is no ECC or ECC Team but a facility in which to manage a Command and Control response would be provided.

160. The ACP would continue to exist, at least in the short term, but the role, specification and level of equipment and readiness could be reviewed and changes made.

Documents

161. A number of Company documents refer to the Emergency Plan and Emergency Handbook (Appendix 6 & 7). These will have to be revised if the proposed changes are made.

## 7 DISCUSSION

ONR EXPECTATIONS FOR EMERGENGY ARRANGEMENTS

162. Licence Condition 23 requires an adequate safety case in respect of any operation that may affect safety. This requires development of appropriate safety standards. The implementation, and maintenance, of these safety standards reduces to a very low probability the chances of an accidental event which might lead to the event of uncontrolled release of even small amounts of radioactivity. Nevertheless it is a condition of each Nuclear Site Licence that there shall be arrangements, approved by ONR (if specified), for dealing with an accident or emergency.

163. Emergency arrangements at operational at-power reactor sites have been in place for many decades and they are well understood and agreed by both licensees and the regulator. However, during the lifecycle of a nuclear site, the potential for an

occurrence that would lead to a radiation release, and the characteristics of the release, will change. It is therefore logical to expect the requirements for emergency preparedness to protect the public, site staff, plant and the environment to also change.

164. This ONR review concludes that the first opportunity to consider changes to the generic at-power emergency arrangements will occur approximately 100 days post-shutdown due to the decay of radioactive iodine. Not only will this significant radiological hazard have decreased but core decay heat will have reduced by several orders of magnitude, reactor temperatures will be considerably lower and many energetic plant systems will have shutdown thus giving a reduced hazard. The need for an immediate on-site survey will have reduced and, provided there has been a considerable reduction in $CO_2$ stocks, response staff will no longer require BA in order to carry out their nuclear emergency role (although BA may be still required for conventional safety reasons).

165. As decay heat continues to fall further, $CO_2$ will be removed from the site and oil systems will be drained thus reducing risks further. Calculations show that it will take approximately two years before a shutdown magnox reactor no longer requires forced cooling by means of gas circulators and/or boiler pumps. During this period there will always be the possibility that an event will occur that requires a response team to be available to reconfigure plant and maintain cooling to prevent, stop, or reduce the risk of, fuel overheating. As long as irradiated fuel remains in the reactor there will remain a need for the CCR to be manned so that temperatures and pressures can be monitored on the site. No significant changes to a site's emergency arrangements would be anticipated during this phase.

166. As fuel route problems are still possible during defueling of the reactors and removal of irradiated fuel from the ponds the alternative ACP and ECC should be maintained. The main reason being that under REPPIR the licensee must keep the ability to reduce the exposure to ionising radiations of employees, or any other persons, resulting from a radiation accident. When defueling is almost complete, and large radiological releases are highly unlikely, the need for alternative facilities such as the alternative ACP and ECC will diminish.

167. While the site has an off-site plan (as defined by REPPIR) the licensee must maintain its on-site command and control capability, response team capability and off-site survey. This is vital if the duty holder is to fulfil its obligation to minimise exposure following a radiation emergency. However, as response timescales extend during defueling the licensee may make a case for many of the responders to be available under on-call arrangements. Roles such as ECC Reactor Physicist could be removed from the arrangements. This then gives the licensee the opportunity to reduce the number of people having to be on site for emergency scheme reasons during silent hours.

168. The licensee will produce regular REPPIR HIRES and these will eventually show that the shutdown, defuelled and decommissioning reactor site can no longer give rise to a foreseeable off-site release greater than 5 mSv and therefore there is no longer a legal requirement for an off-site plan. At this stage the off-site survey capability may be removed from the site's emergency arrangements. Response teams can be reduced in size as the events that may now occur should be localised in nature. It is anticipated that the CCR, alternative ACP and alternative ECC will no longer be part of the arrangements and that most of the limited number of responders will be called to site when required.

169. At this stage the licensee may be able to justify a site base emergency control facility that is more mobile and less complex than the currently accepted ECC. This will be the base for the person in charge of an emergency response. A case could also be made for no longer requiring off-site support facilities like the strategic coordination centre (SCC) and central emergency support centre (CESC) as any site based event should be nothing beyond a site incident that will not require immediate support from the licensee's corporate centre or government agencies in order to deal with it.

170. As already noted, some waste retrieval, handling and repackaging projects may increase site risk for a short period. These projects will require a safety case justification and ONR will have the opportunity to introduce appropriate regulatory controls via Licence Instruments if necessary. Such controls may include a requirement for short-term enhancement of aspects of the site's emergency arrangements during certain risk increased phases of a given project.

171. Once the site has immobilised its waste it will enter long term care and maintenance and the only people on site are likely to be security guards. When this stage is reached the emergency arrangements are going to be akin to any other industrial facility with initial response to an event being by means of the emergency services. If radioactive material is somehow involved then the licensee will have lots of time to get clean-up specialists to the site. Contingency arrangements (required by the IRRs) are likely to be immediate support by the emergency services followed up by longer term support for localised, on-site clean-up from within the licensee's wider organisation.

EXERCISING/DEMONSTRATING ARRANGEMENTS

172. The ONR SAPs (Ref 1) require periodic testing of a site's emergency arrangements and REPPIR (Regulation 10) also requires testing of plans. Consequently, at at-power reactor sites the normal practice has been that each shift carries out an annual shift based exercise for training purposes and one demonstration exercise that is witnessed by ONR. The off-site plan is tested on a three yearly basis. This review has concluded that these arrangements should remain in place until the REPPIR HIRE that removes the need for an off-site plan is accepted by ONR.

173. Once an off-site plan is not required there is likely to be a significant change in the site's emergency response capability. ONR would expect the licensee to continue to train its response staff and to occasionally demonstrate its arrangements to the regulator. From the nuclear safety point of view, the frequency of demonstration exercises, witnessed by ONR, could be reduced to the order of one every three years once no reasonably foreseeable radiation emergency is predicted. When site activity reduces to the latter stages of care and maintenance then this frequency could be reviewed and probably reduced further, eventually not being required when no work activities are taking place on the site.

## 8 CONCLUSIONS

174. This ONR review has found that very little guidance is available regarding emergency arrangements requirements at shutdown, defuelled reactor sites. Due to the lack of formal national, and limited international, guidance, Magnox Limited has been developing its own emergency arrangements strategy for its fleet of magnox reactor sites (Refs 7 to 12). ONR recognises that shutdown, defuelled magnox reactor sites represent a considerably reduced hazard when compared with an at-power reactor site and consequently the regulator should agree to the licensee gradually reducing its emergency response capability as a site transitions towards care and maintenance.

175. Key transition points post-shutdown are as follows:

- 90 days after shutdown (iodine decay such that $KIO_3$ tablets not required);
- About 12 to 18 months after shutdown the conventional safety hazard should have reduced as chemical hazards such as $CO_2$, hydrogen, acids and alkalis should have been removed from site;
- About 2 years after shutdown (establishment of passive cooling means that response times extend noticeably);
- No irradiated fuel on site (most of the original hazard no longer exists);
- No reasonably foreseeable radiation emergency in terms of REPPIR, no dose > 5mSv; no requirement for a REPPIR off-site plan;
- Site is cold, dark and secure; in care and maintenance and under CCTV surveillance.

At each of the above transition points the licensee should be capable of making a safety case to reduce its emergency response capability and at some of the points the changes will justify a new emergency plan that requires ONR approval. Justification for removal of off-site support facilities is probable once an off-site plan is no longer required.

176. While the site has LC 11 emergency arrangements it has a duty to train and exercise people in those arrangements. ONR would expect annual demonstrations of those arrangements to it as long as a radiation emergency in terms of REPPIR is reasonably foreseeable. Once this is not the case, and a REPPIR off-site plan is no longer required, the demonstration exercise to ONR may reduce to once every three years. Once all waste has been placed in a passive state and site work activity has declined then a further reduction in demonstration exercise frequency to ONR could be proposed and justified by the licensee. Eventually, once the site is fully into care and maintenance, the emergency arrangements will rely upon emergency services and no demonstration exercises to ONR will be necessary.

177. To conclude, this report has outlined an ONR strategy for evolution of emergency arrangements requirements at shutdown Magnox reactor sites that are transitioning into long term care and maintenance.

## 9 RECOMMENDATION

178. This project assessment report recommends that the strategy outlined above regarding emergency arrangements requirements at shutdown Magnox sites is adopted by DFW MAG&R.

## 10 REFERENCES

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