

**Regulation of the Shutdown Defueling and Decommissioning Reactors in the United Kingdom – 16576**

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**ABSTRACT**

Nuclear policy, including for decommissioning, in the United Kingdom is set by the UK Government. The Nuclear Decommissioning Authority, NDA, is responsible for managing the clean-up of the UK's nuclear legacy which includes the first generation of Magnox power stations.

Magnox Ltd (MXL), owned by Cavendish Fluor Partnership, is the licensee and the management and operations contractor responsible for ten Magnox reactor sites and two restoration sites in the UK, working for the sites' owner, NDA. The work of the company is diverse covering electricity generation at Wylfa (until December 2015), defueling, and preparation for an interim end state, known as Care and Maintenance (C&M) which will precede the final site clearance. The C&M phase is expected to last over 75 years during which the sites are maintained in a passively safe and secure state while radiation levels are left to decay naturally. Preparations for this phase include removing fuel from the reactors and storage ponds; retrieving intermediate level waste from current stores and treating it or converting it to forms suitable for long-term storage or disposal and making sure of the integrity of critical safety systems of the defuelled reactors.

The Decommissioning, Fuel and Waste programme within the Office for Nuclear Regulation, ONR, regulates nuclear safety in the 12 Magnox nuclear licensed sites. ONR works with the environmental regulators who are responsible for environmental protection on nuclear sites.

The focus of this paper is the regulation of nuclear safety by ONR across the Magnox sites and the interactions with nuclear security and the environmental aspects required to achieve effective, proportionate and efficient regulation of these sites in the UK.

ONR's strategy for regulating the Magnox defueling and decommissioning sites is focused on enabling the licensee to complete the initial stages of decommissioning and reduce the nuclear and radioactive hazards on its sites. To this effect, ONR's revised inspection guidance is centred on inspecting the (remaining) important systems for safety identified in the safety cases. Other interventions focus on engaging with the licensee on safety significant decommissioning projects to gain

evidence of the licensee's readiness prior to and during these activities rather than formal assessment of the associated safety cases. In light of reduced hazards and risks across the defueled and decommissioning Magnox reactors, ONR's revised regulatory expectation regarding evolution of emergency arrangements during decommissioning is based on key transition points that follow electricity generation.

Implementation of these revised strategies as well as organisational restructuring within the team responsible for regulation of the Magnox fleet has resulted in improved efficiency and consistency in regulatory approach whilst securing the required safety standards in managing decommissioning activities.

## **INTRODUCTION**

In pursuit of its Strategy, ONR has identified six broad objectives for the organisation, these are to:

- Inspect and evaluate the safety & security performance and culture of its duty holders, ensuring risks are well controlled
- Enforce the law, in accordance with its Enforcement Management Policy
- Deliver a permissioning regime, ensuring that duty holder activities of principal significance to nuclear safety and security achieve UK legal standards
- Continually improve the regulatory framework, maintain ONR's management system and sustain its regulatory capability
- Engage, inform, advise and consult with duty holders, international bodies and other stakeholders
- Influence its duty holders to develop though-life strategies, achieving sustained delivery of good practice in safety and security.

ONR's Decommissioning, Fuel and Waste (DFW) Programme covers regulation of the defuelling and decommissioning nuclear power reactors, fuel cycle and waste, and restoration sites; 20 sites in total. The Programme leads on nuclear liability policy matters on behalf of ONR. It engages with stakeholders including the UK Government, Scottish Government and the Nuclear Decommissioning Authority (NDA), to influence national strategies and policy relating to dealing with the nuclear legacy; such as decommissioning, plutonium disposition, spent fuel, radioactive waste, sites' end-state definition and consolidation of nuclear material.

In line with the organisational mission, the overall aim of the ONR's DFW Programme is to ensure that the operators of the sites within this sector have demonstrated adequate control of the nuclear and radiological hazards; met the required safety standards; made satisfactory progress towards their decommissioning objectives; and reduced the nuclear risk and hazard on their sites.

Over the past year the DFW Programme has reviewed and revised its strategy, associated plans and guidance which it implemented in order to remain proportionate in regulating the decommissioning estate, in particular the Magnox defueling and decommissioning reactor and restoration sites. This included:

- inspection planning (based on the standard licence conditions)
- emergency preparedness and response based on key transition points during the life cycle of a reactor post generation
- permissioning nuclear safety significance activities
- conducting annual reviews of safety and security
- introducing criteria for Magnox reactors entering Care and Maintenance phase of decommissioning and guidance for the regulation of this phase by ONR

Each of these aspects are covered in more detail in the following section.

## **DISCUSSION**

This section covers the main aspects of ONR's DFW Programme revised strategy for regulating decommissioning sites, focusing on the shutdown Magnox reactor sites.

Following a review of the Programme structure, the DFW Programme management concluded that a re-organisation within the Programme is needed to make more effective use of the resources available and to better align these to the structure of the licensee organisations it regulates. For the Magnox sites, this meant mirroring the licensee's plans for regional management of its sites; for example, Scottish sites, Welsh sites, South west sites, etc. ONR's regional inspectors were appointed for regulation of the sites within a region. Further, in order to strengthen the corporate function, a Corporate Inspector was appointed to ensure consistency in regulation of the fleet as well as providing a single point of contact for engaging with the licensee's corporate function. This approach has proved very effective in consistent and proportionate regulation of the Magnox sites.

For other sites regulated by the DFW Programme, factors such as licensees' operations as well as the level of hazard posed by the installations were considered in determining the resource needs.

### **Inspection Planning**

All ONR's inspection plans and other planned interventions should derive from the associated Programme Strategy and be subject to oversight by the Programme's governance.

ONR conducts inspections in order to verify compliance with the law, to assure itself as an independent regulator that the duty-holders have adequate arrangements for compliance with the relevant statutory provisions and implement these to the high standards expected of nuclear installations. An important part of ONR's planned inspection is System Based Inspections (SBI). These are intended to establish that the basic elements of a site/ facility safety case as implemented in the Safety Systems and Structures (SSS) are fit-for-purpose and that they will fulfil their safety functional requirements. The SBI programme for each site/ facility is such that all the key elements implementing the safety case are inspected by ONR every 5 years. The overarching aim is to ensure that identified Safety Systems and Structure on a site will be inspected twice during the nominal ten year timescale associated with a Periodic Safety review. To carry-out a SBI, it is important to check the Safety Systems and Structures against six Licence Condition (LC) arrangements. The detailed description and guidance for conducting SBIs are provided in (Ref. 1).

As an example, an operating advanced gas-cooled Reactor (AGR) has approximately 30 SSS. The planned intervention programme therefore for an operating reactor site is approximately one week per month.

In light of the reduced hazards and risks on the decommissioning (Magnox) sites, ONR's DFW Programme reviewed its inspection planning guidance for defuelling and decommissioning reactors and the restorations sites (Ref. 2). The review resulted in identification of ten SSS for the defueling and five SSS for the decommissioning Magnox reactors aimed mainly at containment and fuel route systems for the former and focusing at the containment for the latter sites. The planned intervention programme for shutdown reactors (defueling and decommissioning Magnox sites) therefore amounts to 4 to 6 visits per year, each lasting between 3 to 4 days.

In addition to the shut-down Magnox reactors, fuel manufacturing and radioactive waste management sites, ONR's DFW Programme regulates the restoration sites; these are the Dounreay Site Restoration Limited (DSRL) and the restoration sites at Harwell and Winfrith operated by Magnox Limited. These are multi-facility sites, some with a wider range of operations (e.g. Dounreay) and as a result, a larger number of identified SSS. ONR's DFW Programme therefore has a more comprehensive programme of planned interventions at these sites.

For the shutdown reactors at advanced stages of preparation for entry to Care and Maintenance phase of decommissioning, such as Bradwell, from a safety perspective, inspections are limited to one SBI per year and a few compliance inspections. These inspections are complemented by inspections carried out by ONR's Conventional Health and Safety specialist to ensure the licensees adopt appropriate standards when dealing with conventional hazards.

## **Emergency Preparedness and Response**

ONR's generic guidance on Emergency Arrangements is provided in Ref 3. The guidance is intended to promote a consistent approach to the inspection of emergency arrangements and the evaluation of exercises by ONR inspectors.

Licence Condition 11 (Emergency Arrangements) is aimed at ensuring a licensee has adequate arrangements in place to be able to respond effectively to any incident in order to ensure the protection of both site personnel and the public so far as is reasonably practicable, thereby ensuring that the licensee, while responding to such an incident, fulfils the general duties imposed upon them by sections 2 and 3 of the Health and Safety at Work etc. Act 1974 (HSW Act).

With the reactor shuts down, the number of situations that could result in an emergency; either an off-site release of radioactivity or a major release within the site boundary reduce progressively and significantly as the spent fuel is removed from site. ONR's DFW Programme reviewed and developed a more targeted and proportionate approach for regulating emergency arrangements at shutdown Magnox reactor sites (Ref. 4). The revised approach focuses on key transition points post-shutdown. These are:

- 90 days after shutdown (iodine decay such that  $KIO_3$  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, no dose > 5mSv and no requirement for an 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 of radioactivity, off-site facilities such as 'site co-ordination centres' and the 'central emergency support centre' will no longer be required. When the site enters the Care and Maintenance phase of decommissioning 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 participate in rehearsals of the site's emergency arrangements, and that periodically ONR will witness a 'demonstration' exercise. ONR expects that the annual demonstration exercise should continue until the site no longer requires an off-site plan under Radiation Protection and Public Information Regulation 2001 (REPIIR 2001). At this point the demonstration exercise frequency should reduce to the order of one every three years. During the latter stages of decommissioning or when the facility(ies) is in Care and Maintenance, the licensee should be capable of making a case to reduce this frequency further, for example to once every five years.

### **Permissioning**

The site licence and attached licence conditions (LCs) provide the principal legal basis for regulation by ONR of nuclear safety on licensed sites. The LCs include various powers which are used by inspectors in ONR with 'delegated authority', to control specific activities proposed by the licensee for the licensed site. These are known as "primary" powers. The primary powers are the means provided for ONR to control specific aspects of the licensees' arrangements for managing their facilities and site activities safely. There are cases where it is not considered proportionate to use primary powers to effect regulatory control, but nevertheless it remains desirable in the interests of safety that ONR maintains a degree of control and oversight of a licensee's activities or proposals. In these cases appropriate regulatory control and oversight may be achieved through a process termed 'flexible permissioning'. This is either through powers "derived" from a licensee's arrangements to permission activities on a licensed site or through enhanced implementation monitoring and control. The latter is to ensure, by sampling, that activities and projects are being carried out safely, in accordance with the licensee's arrangements under the LCs, and any additional relevant legal requirements. Ref 5 provides detailed guidance on ONR's flexible permissioning.

Given the reduced hazard following the completion of defueling, ONR's DFW Programme considered that flexible permissioning mostly through enhanced implementation monitoring and control is a proportionate mechanism to permission a range of activities on site. In addition to reduced hazard, this mechanism allows the licensee and ONR to focus on human factors and capability aspects that is most relevant in dynamic situations such as decommissioning and where activities become less routine or are conducted on a one-off basis. Matters arising from ONR's assessment as part of this process are recorded and managed to conclusion. Where activities are of a higher safety significance, ONR may require the licensees to produce a 'hold-point' control plan to facilitate formal regulatory engagements. Where ONR identifies a significant issue an external regulator hold-point may be raised to add

further regulatory control.

Adoption of flexible permissioning through enhanced implementation monitoring and control has enabled ONR to have appropriate oversight of the licensees' decommissioning activities and make more effective use of its resources. It has also enabled the licensees to expedite decommissioning activities.

### **Conducting annual reviews of safety and security**

Site annual review meetings should be seen as one of the elements supporting continuous improvement at a nuclear licensed site. Other elements include both the major Periodic Safety Reviews (PSRs) undertaken at least every ten years and also interim reviews on a shorter term basis. The Purpose and scope of review meetings is described in detail in ONR's guidance on Site Annual Review Meetings (Ref. 6).

In order to conduct these reviews in a more effective and efficient manner, ONR's DFW programme proposed that these are conducted based on the regional structure that Magnox limited is adopting. This means that instead of 12 reviews per year, annual safety and security performance of sites under a common regional management are reviewed together – e.g. one review for the southwest west sites covering Berkeley, Oldbury and Hinkley Point A site. This change will be implemented in 2016. To ensure strategic alignment with the Environmental regulators, as well as safety and security regulated by ONR, the annual reviews also cover the environmental performance of the licensees.

### **Criteria for Magnox reactors entering Care and Maintenance phase of decommissioning**

Magnox Ltd's current decommissioning strategy is based on the IAEA concept of deferred dismantling (Ref. 7). Each power station site will be progressively decommissioned through the following life time phases:

- Defuelling;
- Initial Decommissioning;
- A quiescent period known as Care and Maintenance
- Final Decommissioning; and
- Delicensing.

The DFW Programme has developed guidance setting-out ONR's expectations for the sites entering Care and Maintenance (C&M) phase of its decommissioning. ONR intends to grant permission for the first Magnox reactor site progressing from initial decommissioning into C&M phase by granting a Consent under LC35 (Decommissioning). In order to grant the Consent, ONR needs to be satisfied that:

- The site is in a suitable condition to enter a period of C&M;

- Suitable management arrangements exist for entering the C&M phase.

The C&M phase could last for up to 75 years before final site clearance is attempted or the site is delicensed. The licensee's safety case for this state should define and demonstrate that the remaining radiological and conventional risks on the site have been reduced ALARP and that the site is appropriately secure.

Before permissioning any site's transition into C&M ONR would expect the licensee to demonstrate as a minimum that:

- All intact fuel and significant fuel fragments have been removed from site;
- Contaminated facilities that will be left in C&M, e.g. the reactor building and the fuel pond, have been decommissioned to an appropriate level such that the remaining risks at the point of entry into C&M are reduced ALARP;
- Other facilities containing radioactivity, that would not benefit from a period of decay storage, have been decommissioned to an appropriate point and the residual radioactivity has been characterised;
- Intermediate Level Waste (ILW) is being stored in a passively safe state;
- Nuclear Material and Other Radioactive Material (ORM) has appropriate security protection against theft and sabotage.
- Radiologically contaminated liquids are not present;
- Bulk chemicals are removed from the site;
- Appropriate arrangements exist to manage the site throughout the whole C&M phase.

During the decommissioning phase, hazards have been progressively reduced but not eliminated. Licensees may argue that less work be done to reach the C&M phase. ONR anticipates that reduced initial decommissioning will result in increased remaining hazard, more buildings and more plant remaining on site during the C&M period. ONR expects this will increase the resource and the extent of arrangements required to manage the remaining risk and hazards and the plans necessary for containment, inspection, maintenance of the remaining plants and structures on site.

### **Future Work**

In order to ensure that the overall framework and criteria for the latter phases of decommissioning remains proportionate, the DFW programme is developing guidance on key licence conditions required for regulating each major transition point during this phase. Having learnt the lessons from implementing previous guidance, this work will set-out ONR's strategy for regulation of the Magnox fleet and future reactors



post-generation through proportionate application of the licence conditions. Once established, the licensees undertaking decommissioning work are expected to make an appropriate case to demonstrate to ONR that they no longer require to have arrangements for compliance with certain licence conditions.

The DFW Programme has also made a significant contribution to a steering group to propose a new route for delicensing.

## **CONCLUSIONS**

Over the past year ONR's DFW Programme developed guidance which it implemented in order to remain proportionate in regulating the decommissioning estate, in particular the Magnox defueling and decommissioning reactor and restoration sites. The programme also revised its structure to make more effective use of the resources available and to better align these to the structure/ operations of the licensee organisations it regulates. Adopting these steps have improved regulatory effectiveness and provided a robust underpinning for current and future regulation of the decommissioning sites.

## **REFERENCES**

- 1- ONR Guidance for Intervention planning and reporting – ONR- INSP- GD- 059 Rev 2
- 2- ONR Internal Guidance - Framework & Guidance for Inspection Planning 2015/16 – Magnox and restoration sites.
- 3- ONR Internal Guidance- Licence Condition 11 Emergency Arrangements, NS-INSP-GD-011 Revision 3
- 4- ONR Internal Guidance- Regulation of Emergency Arrangements at Magnox Reactor Sites – A New Strategy
- 5- ONR Internal Guidance - Flexible Permissioning Including The Use Of Derived Powers, NS-PER-GD-001 Revision 0
- 6- ONR Internal Guidance - Site Annual review meetings, NS-INSP-GD-058 Revision 2.
- 7- IAEA Safety Standards Series, Decommissioning of Nuclear Power Plants and Research Reactors, WS- G-2.1.