DEVELOPING A FIT-FOR-PURPOSE APPROACH TO THE REGULATION OF EXTERNAL HAZARDS IN THE UK FOR THE NEW NUCLEAR REACTOR BUILD PROGRAMME

P Ford

ABSTRACT

External hazards as a nuclear technical discipline has matured significantly since the last nuclear reactor build programme in the UK, in the 1980s and ‘90s. In part this is because of improved understanding of these hazards and their potential implications for nuclear safety, but it is also a response to a number of external hazards initiated nuclear safety challenges, most notably in March 2011 at Fukushima Dai-ichi in Japan. In addition, the UK Government recently made a policy decision to positively encourage the construction of new nuclear reactors.

New nuclear reactor projects in the UK accommodate consideration of external hazards as a mainstream part of the design process, so the advent of these projects has led to a substantial increase in the demand for external hazards Suitably Qualified and Experienced Person (SQEP) resource within Office for Nuclear Regulation (ONR) to assess the adequacy of safety submissions for new nuclear reactor sites. This has prompted a re-consideration of the most appropriate way for a modern nuclear regulator, such as the ONR in the UK, to regulate in the external hazards technical area.

This paper describes how the ONR now organises itself to assess external hazards safety submissions for new nuclear reactor build projects and describes the resource model currently being applied to the most advanced new build site in the UK at Hinkley Point C, which is owned and operated by EDF Energy Nuclear New Build Generation Company Ltd (NNB GenCo). The model provides the vehicle for applying ONR’s regulatory processes, including how various types of skilled resources are deployed and identifies the important interfaces with other technical disciplines. Finally, the paper describes how the model will be developed for use at other new build sites in the UK.

NUCLEAR SAFETY REGULATION IN THE UK

Nuclear Safety in the UK is the responsibility of the organisations that operate sites licensed under the Nuclear Installations Act 1965 (NIA65). These nuclear licensees set high standards for safety through their own nuclear safety principles and demonstrate these principles are met for plant operations on their sites by preparing documents called safety cases. The major safety case for a new nuclear reactor build site is the Pre-Construction Safety Report (PCSR); it comprehensively demonstrates in a single (very large) document why the licensee believes its reactors can be operated safely, in compliance with their own safety principles, various legal requirements and relevant good practice.

Licences, Licensing and the Permissioning Process

The Office for Nuclear Regulation (ONR) is responsible for issuing Nuclear Site Licences (NSLs) to organisations seeking to operate nuclear plant on a site and for granting permission to such licensees to build and operate this plant. The ONR is established as the nuclear safety regulator under the Energy Act 2013 (EA13), and has responsibility for licensing nuclear sites because those aspects of the NIA65 relevant to licensing of nuclear sites are Relevant Statutory Provisions of the EA13. Permissions are

---

1 A Relevant Statutory Provision occurs when an element of existing statutory law is brought within the interest of another Act of Parliament.
granted in response to requests from the Licensee to undertake specific nuclear significant operations. Typically for new reactor sites these will include permission to:

- Commence construction of nuclear safety structures.
- Commence nuclear commissioning of the reactors.
- Bring nuclear fuel on to the site.
- First criticality of the reactor core.

Such requirements are made under particular Licence Conditions attached to the NSL. There are 36 standard licence conditions (LCs) attached to every NSL in the UK, covering construction, operation, modification, maintenance and decommissioning of plant, safety cases and periodic safety reviews, emergency arrangements, the need for Suitably Qualified and Experienced Personnel (SQEPs) to operate plant and a number of other safety significant matters. The standard LCs are specified in ONR (2014a). Most of the LCs include provisions to enable ONR to grant permissions of one type or another; for example, clause 1 of LC19, allows ONR to issue a Consent to permit the Licensee to move from one stage of construction to the next. There are six types of permission that ONR can grant:

- **Consents** – A Consent is required before the licensee can carry out any activity which is specifically identified in the licence or for any other activities which ONR may Specify.
- **Approvals** – An Approval can be used to freeze a licensee’s arrangements (documented procedures) and key elements of its safety management system, such as safety committees and maintenance arrangements.
- **Directions** – A Direction is issued by ONR when it requires the licensee to take a particular action. For example, LC31(1) gives ONR the power to Direct a licensee to shut down any plant, operation or process. Such a Direction would relate to a matter of major or immediate safety importance.
- **Agreements** – An Agreement issued by ONR allows a licensee to proceed with an agreed course of action. For example, LC30(2) enables ONR to Agree the extension of a plant’s operating period.
- **Notification** – The NSLs give ONR powers to request the submission of information by Notifying the licensee. For example, in LC21(8) the licensee shall, if Notified by ONR, submit a safety case and shall not commence operation of the relevant plant or process without the Consent of ONR.
- **Specification** – The NSL gives ONR discretionary controls with regard to a licensee’s arrangements and these are implemented through Specifications. For example, in LC23(2), if ONR Specifies, the licensee is required to refer “Operating Rules” to their “Nuclear Safety Committee” for consideration.

In order to issue, for example, a Consent under LC19(1) to start construction of nuclear safety structures, the licensee must support its request with an adequate safety case, in this case a version of the PCSR current at the time of the request. The PCSR itself refers down to many lower tier supporting references and this entirety is known as the safety submission relating to that request.

ONR inspectors undertake an assessment of this safety submission to assure themselves that it meets the legal test of adequacy, using its own Safety Assessment Principles (SAPs), ONR (2014b), and lower level Technical Assessment Guides (TAGs), ONR (2015). ONR is a non-prescriptive regulator, meaning that it does not in general publish prescribed standards for plant design and operation that Licensees are mandated to meet; instead it looks to Licensees themselves to identify relevant codes and standards, to devise appropriate safety principles tailored to their particular nuclear activities, and demonstrate that

---

2 Operating Rules (LC23) are safety significant conditions and limits within which nuclear plant is operated to ensure it meets the claims made in its safety case(s). Each licensed site is required under LC13 to set up a competent Nuclear Safety Committee to provide independent and authoritative safety advice to the licensee regarding the operation of nuclear plant covered by the NSL.

3 The term adequate is the legal test under NIA65 that distinguishes, in this instance, a safety case that is fit for purpose and meets all necessary requirements arising from the licensee’s procedures and processes (arrangements), relevant legal requirements and relevant good practise. Safety cases covering significant nuclear activities are required under LC23(1) and, among other things, must define appropriate Operating Rules within which the plant or activity shall be conducted.
their plant design and operation meets these. There are some mandatory legal requirements relating for example to radiation doses from normal operations and accidents (IRRs, HSE (2002)), the development of emergency plans (REPPIR01), and a large number of mandatory requirements that derive from non-nuclear safety regulation. But for nuclear safety, the test of adequacy is met principally by the Licensee demonstrating, through its safety case, that the risk arising from activities relating to the permissioning request will be as low as reasonably practicable (ALARP), commonly referred to in the UK as the ALARP principle. This is the most important safety principle in UK nuclear safety and is linked to the overarching legal requirement relating to industrial safety generally, that duty holders shall ensure that the risks to employees and those not in their employment are low so far as is reasonably practicable (SFAIRP).

In practice, for a major permissioning request such as the ones discussed above, ONR will establish an assessment project team, in which all the relevant technical disciplines will be represented; the project will be managed by a project inspector. This paper is concerned with the External Hazards (EH) discipline, and how the required technical and managerial resources are brought to bear to facilitate a suitable and sufficient assessment of a major safety submission supporting a new reactor build permissioning request. This assessment must be sufficient to enable a judgement of adequacy to be formed by the external hazards inspector undertaking the assessment. This is then communicated to the project inspector as a recommendation to support (or not) the granting of permission to allow the requested activities to proceed. The project inspector will collate such advice from all technical disciplines and form a project wide (rather than discipline-specific) judgement to recommend to senior ONR management whether or not to support the granting of permission. Ultimately, it is up to senior management to decide whether to act on this advice since only they have the legal authority under NIA65 to do so. It is extremely unlikely that they would ignore it, but for a major permissioning decision such as those involved in a new nuclear reactor project, they may well choose to independently test the rigour of the assessment undertaken. If the decision is made to grant permission, this is implemented by means of a letter, written to a standard legal format and called a Licence Instrument (LI). This instrument has the force of law and is the vehicle containing the permission that the Licensee has requested.

**ONR’s Assessment of Safety Cases**

As discussed above, ONR inspectors assess safety cases to assure themselves that the activities for which the Licensee seeks permission are adequately safe, i.e. that they meet the intent of the Licensee’s own nuclear safety principles, our own SAPs and TAGs, and world-wide relevant good practice (RGP). Much of this work constitutes a review of the safety submission documentation and will include various types of formal and informal exchange with the Licensee to clarify points of concern. But ONR also has other approaches it can use to gain confidence in the Licensee’s safety claims and these are summarised below:

- Inspection of activities (construction, plant operation etc.) to which the request refers.
- Inspection of management processes, such as training arrangements, maintenance procedures, Intelligent Customer (IC) and contract procurement procedures etc.
- Inspection of work by contractors and the Licensee’s supply chain generally.

All these approaches are collectively called interventions.

**THE ONR EXTERNAL HAZARDS RESOURCE MODEL FOR NEW REACTOR BUILD PROJECTS**

The most developed new build project at the time of writing is at the Hinkley Point C (HPC) site in Somerset; the owner, operator and Licensee is NNB GenCo. The PCSR is now at an advanced stage of development and external hazards issues are covered in various parts of this document and in a large

---

4 The terms “duty holder” and “SFAIRP” are defined in HSWA74. For the purposes of this paper and in most issues of nuclear safety, the duty holder is the licensee, and the SFAIRP principle is entirely equivalent to ALARP principle.
number of supporting references. Around 30 separate external hazards have been identified that are considered credible at the HPC site, both naturally occurring and man-made. They vary enormously in their safety significance and this is reflected in the amount of analysis effort devoted to defining each hazard’s effect at the site, and on the plant design to control and mitigate it. Much of this work is presented in supporting documents – about 700 in the case of the HPC PCSR. The PCSR itself provides a consolidated summary of this work, setting down the arguments that take this supporting analysis and demonstrating that the safety claims made in the PCSR can be met by plant operations.

The EH discipline is a broad-based technical area, covering many different technology-specific disciplines, especially in relation to natural hazards such as seismicity, extreme flooding and extreme weather. Most external hazards attract deep specialists of their own. ONR at present employs six inspectors specialising in EH; between them they cover the entire portfolio of ONR regulatory work, including in addition to new reactor build projects, operating and decommissioning reactor sites, fuel manufacture and waste processing sites, civilian operated sites relevant to the UK’s nuclear deterrent programme, and various other sites that make use of nuclear materials, e.g. those involved in nuclear medicine.

At present four inspectors are involved in new reactor build projects, or about two Full Time Equivalents (FTEs). The HPC project itself is covered by two inspectors at about ½ FTE\(^5\). This is a meagre resource to dedicate to this task. Not only is this resource insufficient in terms of quantity, it is simply not possible for two individuals to have the necessary breadth of skills and experience to cover the myriad hazards and issues involved in a major project such as this. However, this is a common picture for ONR across most of its work. It suits its non-prescriptive regulatory style, but it calls for individuals who take on inspectorial duties to have a broad science/engineering background, or a specialism they can apply widely and expand to accommodate the application of their specialist area to complex plant. This is especially true for external hazards inspectors, who often come to the discipline from other related disciplines and have to expand their scientific/engineering skills into new areas. Inspectors are also called on to make regulatory judgments based on a sound knowledge of UK nuclear and general health and safety law. ONR’s EH inspectors have developed their nuclear specialist expertise in to a general knowledge base sufficient to be able to act as an intelligent customer for work across the entire portfolio of EHs.

The author has developed a resource model whose objective is to enable a comprehensive and technically sophisticated assessment of new reactor build PCSRs and supporting documents, to engage with the Licensee at regular intervals to provide timely advice and feedback, and to engage with other inspection activities from time to time to enable well-argued judgments of adequacy to be made to fully contribute to the permissioning process that is the heart of ONR’s regulatory function.

The EH resource model has four components:

- **Interfaces**: Recognising when EH issues are common across a number of nuclear discipline areas such that substantive interfaces exist. Advice and information can be exchanged across these interfaces to improve the regulatory decision making in each discipline. The following interfaces are generally recognised:
  - EH/Civil Engineering
  - EH/Mechanical Engineering
  - EH/Fault Studies & PSA
  - EH/Emergency Planning
  - EH/Human Factors

- **TSC support**: Provision of services by Technical Support Contractors (TSCs). Selecting high quality TSC support is critical to undertaking a comprehensive assessment of the PCSR by Suitably Qualified and Experienced Persons (SQEPs). TSCs typically provide
  - Substantial additional SQEP resource to augment the in-house inspector SQEPs.

---

\(^5\) This has increased lately to about one FTE as the first nuclear permissioning point is approached.
Significantly enhanced depth and breadth of expertise and experience that ONR can bring to bear in its EH assessment work.

In many ways good TSC support makes a major EH assessment project, such as the one for HPC, doable; without this support, ONR would be challenged to provide the quality of assessment needed to credibly support a regulatory judgment of adequacy of the PCSR.

- **Specialist Expertise**: It has already been noted that the EH discipline encompasses a number of large sub-discipline specialist areas, especially in relation to the analysis of natural hazards. In 2010, ONR determined that two such areas in particular deserved special attention:
  - Seismic hazard analysis
  - Climate change effects on extreme weather and flooding hazards

  The reasons for this are principally:
  - These hazards and effects have the potential for costly design provisions, are poorly understood with the current state-of-the-art and consequently can only be expressed with a large degree of uncertainty.
  - Earthquakes, and natural events linked to climate change, can attract a large amount of publicity. If they occurred in the UK, would very likely lead to ONR having to respond to requests for information and advice from Government and the general public.
  - Given the uncertainty surrounding these issues, there is a chance that ONR’s technical response to them, i.e. how it formulates its regulatory judgments of adequacy, may become subject to judicial review that might arise from the planning, nuclear site licensing, or permissioning processes.

For all these reasons, ONR judged that it needed specialist expertise in these areas especially to function as a credible regulator. And so the Expert Panel on Seismic Hazard and Climate Change was created. Its members are actively engaged in the HPC, Sizewell C (SZC) and Wylfa Newydd new build projects at this time.

- **Availability of sufficient inspectorial resource to act as**
  - Project managers for the each new build EH assessment project.
  - Intelligent Customers (ICs) for TSC and EP support.

With the expertise and TSC support listed above, it is judged that between ½ and one FTE inspectorial resource is appropriate for each new build site.

This is the current resource model used for EH assessment on the HPC project, and ONR expects to use this model for all future new build projects.

**THE RESOURCE MODEL APPLIED TO HINKLEY POINT C**

The NNB GenCo new build project at Hinkley Point C is the most advanced of the UK projects currently under way. At the time of writing, it has progressed to the stage where the first formal permitting point under LC19(1) for the first of two UK EPR reactors, known as First Nuclear Safety Concrete (FNSC), is within sight. The Licensee is preparing a version of the PCSR suitable to justify early nuclear construction work and ONR is assessing this safety case and supporting information to confirm it meets the test of adequacy under LC23(1).

For its external hazards assessment ONR has implemented the resource model as follows:

- **ONR staff resource**:
  - 1 FTE comprising a lead assessor and seismic specialist.

---

6 These areas are both well researched with many knowledgeable experts and practitioners. But the application of the broad technical understanding from both areas to nuclear plant safety involves a large degree of uncertainty, precisely because this broad understanding cannot easily be mapped on to the need for detailed knowledge at a site-specific scale.
• TSC resource:
  o Contractor covering the PCSR generally except seismic hazard, capable faulting and tsunami
  o Specialist contractor covering accidental aircraft crash hazard
  o Specialist contractor covering hydro-geology and groundwater flows
  o Specialist contractor with expertise in the application of statistical methods

• Expert Panel
  o Seismic and capable faulting hazards
  o Climate change effects and flood hazard support
  o Tsunami hazard support

These elements interact in terms of reporting as depicted in figure 1, and in terms of information flow as in figure 2.

Figure 1: Reporting arrangements for Hinkley Point C External Hazards Project

Note that Figure 2 includes the Environment Agency, since they are the other major nuclear regulator with a significant interest in flood hazard. The dotted line indicates that the information exchange is a by-product of the separate regulatory interests of both organisations. ONR is responsible for regulating nuclear safety under the EA13, NIA65 and HSW74. The Environment Agency is responsible for a number of regulatory areas including the disposal of radioactive waste under the Environmental Permitting Regulations 2010 (EPR10) from nuclear sites and for providing competent advice to the Planning Inspectorate as a statutory consultee (for major infrastructure projects like nuclear new build) and local planning authorities. The Environment Agency is also the principal flood risk management authority in England with a strategic overview role. The ONR and the Environment Agency work closely together under a Memorandum of Understanding. For further information on the relationship and shared interests of ONR and the Environment Agency, see EA/ONR (2013).

APPLICATION OF THE RESOURCE MODEL TO OTHER NEW REACTOR BUILD SITES

As noted above, it is anticipated that the same resource model will be used at other new reactor build sites in the UK. The only differences from the HPC model are expected to be with the range of specialist TSC
support. Specialist TSCs will be recruited to meet the technical needs of ONR’s external hazards assessment work at each site, and these may vary depending on the nature of the site and the demands of the reactor technology to be constructed there.

CONCLUSIONS

This paper has described ONR’s preferred resource model for undertaking external hazards assessment of Pre-Construction Safety Reports for new nuclear reactor sites in the UK. The paper also summarises the regulatory process applied to nuclear safety in the UK and describes how this is being applied to new nuclear reactor sites.

REFERENCES


HSWA74, Health and Safety at Work etc. Act 1974,

IRR99, The Ionising Radiations Regulations 1999,

REPP6R01, The Radiation (Emergency Preparedness and Public Information) Regulations 2001,