

**HEALTH & SAFETY EXECUTIVE
NUCLEAR DIRECTORATE
ASSESSMENT REPORT**

New Reactor Build

GDA Step 2 Summary of Overseas Regulatory Assessments

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1. INTRODUCTION

The HSE Guidance for Generic Design Acceptance (GDA) states that:

- for Step 2 Requesting Parties should provide a Preliminary Safety Report with information about all the assessments completed by overseas regulators,
- in Step 3 HSE will review what overseas regulators have done and review how HSE can make use of it,
- in Step 4 HSE will review overseas progress and issues raised by overseas regulators.

This assessment report summarises:

- the safety reviews of the designs undergoing Generic Design Assessment that have been carried out or are being carried out by nuclear safety regulatory authorities in other countries.
- the means by which HSE can obtain access to this information
- how we can collaborate with the other regulators in the future.

2. REPORT

2.1 **ACR 1000**

Canadian Nuclear Safety Commission (CNSC) review

CNSC has carried out some pre-licensing review work on both the ACR-700 and ACR-1000 designs. This began with the ACR-700 design in May 2003, with the goal of establishing whether, in the opinion of CNSC staff, there were fundamental barriers that would prevent licensing the plant in Canada.

In May 2005, AECL re-directed its efforts to the development of the ACR-1000 and requested the CNSC to wrap-up the pre-licensing review of the ACR-700. A report was issued in April 2006, capturing the CNSC view at that time.

CNSC staff then started to consider the ACR-1000, beginning in May 2005, but dealt largely with generic aspects of the design. CNSC decided to terminate the pre-licensing review in December 2006, due to resource limitations. CNSC staff issued the Project Close-out Report in January 2007. As a result of this early closure, CNSC staff did not review any submissions specific to the ACR-1000 design, although a large amount of work had been done by both AECL and CNSC staff on the generic design process and the safety analysis methodology.

CNSC are currently considering recommencing design reviews of new reactors that are under consideration for development in Canada, starting with the ACR-1000.

US Nuclear Regulatory Commission (USNRC) review

The USNRC has carried out a pre-application review (an initial review before a full Design Certification review) of the ACR-700, beginning December 2002 and continuing until early 2005. In October 2004, NRC staff prepared and issued the Pre-Application Safety Assessment Report (PASAR, Ref 1) related to the Advanced CANDU Reactor 700 MWe. US NRC stated that 'based on the information provided, the staff believes at this time that AECL will ultimately be able to satisfactorily address these potential policy, regulatory, and technical issues during the design certification review'.

Due to the fact that US regulations have been developed and written almost exclusively for PWRs and BWRs, the potential policy and regulatory issues identified by NRC staff are mostly related to the differences in the ACR-700 design (e.g. issues related to use of pressure tubes and pressure tube materials, use of on-power fuelling and thus of the fuelling machines' opening of the fuel

channels during reactor operation). This type of issue may be less problematic in the UK because HSE has a less prescriptive approach; the SAPs are written on a technology-neutral basis, and we have experience of licensing pressure tube reactors and on-load refuelling.

With respect to the potential technical issues identified, a number of them are related specifically to the ACR-700 design and not to the ACR-1000. Where they were relevant to ACR-1000, some have been already taken into account and addressed as the ACR-1000 design has been developed since 2004. During GDA Step 3 and Step 4 we will seek assurance that relevant issues from the US NRC review have been appropriately addressed.

2.2 AP1000

USNRC review

The USNRC is the only other regulatory authority that has undertaken a formal review of the AP1000 design, although the Chinese regulatory authority (National Nuclear Safety Administration) is or will soon be doing this. The AP1000 was one of the first plants to use the new licensing process in the US, Title 10 of the US Code of Federal Regulations, Section 52 (10 CFR 52). In addition, the AP1000 standard plant design is based closely on the AP600 design that US NRC certified in December 1999.

Following some initial USNRC pre-application review work, Westinghouse Electric Company (WEC) submitted an application for standard design certification for the AP1000 in March 2002. USNRC's final design approval was based on Revision 14 of WEC's Design Control Document (DCD) and was issued in September 2004. This was subsequently amended to take account of Revision 15 to the AP1000 DCD. The final AP1000 design certification was completed in January 2006.

Revision 16 to the AP1000 DCD is the version that formed the basis for the UK AP1000 Safety, Security and Environmental Report (Ref 2). It includes a number of substantial design changes compared to Revision 15. Revision 16 has not received final design approval from USNRC as it is currently being evaluated as described below.

It should also be noted that USNRC design certification does not mean that the reactor design is complete. For the AP1000, at Revision 15 of the DCD, a number of technical areas remain outstanding. In addition, formal licence applications have to be made and assessed before any construction will be permitted. Several such applications for AP1000 are currently under USNRC review.

By letter dated May 26, 2007, Westinghouse submitted an application to amend the AP1000 Design Certification Rule and submitted Revision 16 to the AP1000 Design Control Document (DCD). Revision 16 contains changes proposed in technical reports, some of which have not yet been reviewed by the NRC staff.

In a letter dated January 18, 2008, the NRC documented the completion of its acceptance review and stated that the application was being docketed. Subsequently, on February 15, 2008, the NRC issued a letter to Westinghouse establishing its review schedule. The schedule supports issuance of a final Safety Evaluation Report for the amendment in March 2010.

To date, Westinghouse has submitted more than 100 technical reports for staff review. These reports provide information on design changes and proposed resolution of certain combined license information items. The staff has held numerous meetings with Westinghouse, sent requests for additional information and has performed audits of documentation related to leak-before-break analyses, instrumentation and control, human factors engineering, and seismic analyses.

2.3 UK EPR

The EPR has been subject to review by several overseas nuclear regulators. However, it should be noted that there are a number of variations between the UK EPR and the EPR designs being assessed in other countries, and these are indicated in broad terms below, where relevant.

Franco–German review

- Starting in 1989, the French and Germans collaborated in the initial EPR Basic Design Phase. This included collaboration between the French and German safety authorities (ASN, BMU), their technical support organisations and their advisory committees and led to the publication of general design objectives in 1993. After completion of the Basic Design Phase the German nuclear safety authority withdrew from the EPR project, but German experts continued to participate in the French nuclear safety advisory committee as invited members.
- Based on the assessment performed on the basic design of the EPR, Technical Guidelines for the design and construction of new PWRs (Ref 3) were adopted in 2000 by the French nuclear safety advisory committee and German invited experts. Subsequent French assessments of EPR have used these as reference guidelines.

French review

- The first French EPR authorisation application was submitted by EDF for the third unit of Flamanville nuclear power plant. ASN has assessed the Flamanville 3 Preliminary Safety Analysis Report and in 2007, ASN concluded that:
 - The 1993 general design objectives were met.
 - Current operating experience had been taken into account satisfactorily.
 - The changes introduced for operational or economic reasons were acceptable from a safety viewpoint.
 - There was no reason to question the design choices for the large primary and secondary components.
 - No significant non-radiological industrial risk for the population or environment had been identified.
 - Additional assessment is required before operation is permitted.
- Based on the ASN's conclusion, the Authorisation decree of Flamanville 3 was signed by the Government in 2007. The construction is now in progress.
- ASN is currently carrying out inspection of the construction and an early review of the operating licence application file. This assessment will need to be complete before loading of the fuel will be permitted.
- EdF have stated that any design changes resulting from ASN's assessment of Flamanville 3 will be copied into the UK EPR submission and subject to review and endorsement by the UK EPR Design Change Committee.

Finnish review

The first EPR is being constructed as the third unit at Olkiluoto (OL3).

- The first stages of the pre-licensing process were an Environmental Impact Assessment, a political approval process and a feasibility study of all candidate designs.
- Following these, the construction licence application was made in January 2004. The Finnish nuclear safety authority (STUK) assessed this and reported its findings in January 2005, following which the Finnish government granted a construction licence in February 2005.
- Assessment of the design against Finish requirements (and differing operator requirements etc) resulted in a small number of major design modifications (in comparison with the UK EPR), including containment venting, fuel pool design, C&I, and pipe whip restraints. There were some reservations and restrictions as a result of the assessment. These addressed:
 - the fuel burn-up limit;
 - submission of more detailed design of the systems and structures;
 - consideration of OL3 waste management and suitability for disposal;
 - submission of the manufacturing schedule for safety components, structures and systems to enable regulatory oversight by STUK.
- Additional assessment and authorisation is required before operation is permitted.

USNRC review

- Areva submitted the US EPR for USNRC pre-application review in February 2005. This was in preparation for the design certification application that Areva submitted in December 2007. This is currently under review by USNRC with an expected completion date of 2011.
- As well as design certification, a separate construction and operation licence application would have to be made and assessed by USNRC before any construction could begin.
- In comparison with the UK EPR, there are modifications to the design and safety case for the US climate, grid frequency and USNRC Regulations.

2.4 ESBWR

US Nuclear Regulatory Commission (US NRC) review

The USNRC is the only other regulatory authority undertaking a formal review of the ESBWR design. The forerunner to the ESBWR was the Advanced Boiling Water Reactor which was the first plant to use the new licensing process in the US, Title 10 of the US Code of Federal Regulations, Section 52, *Licenses, certifications, and approvals for nuclear power plants*. The Advanced Boiling Water Reactor design was certified in 1997.

Following some initial USNRC pre-application review work, General Electric Hitachi (GEH) submitted an application for standard design certification for the ESBWR in August 2005. The application was accepted for assessment in December 2005. Assessment is ongoing and, as of February 2008, USNRC had raised approximately 4000 requests for additional information (RAIs) and reported that around 75% had been resolved.

In November 2007 USNRC indicated that, contingent on timely submissions from GEH and satisfactory resolution of requests for additional information, they anticipate issuing the Final Design Approval in June 2009, approximately two years ahead of the completion date for GDA Step 4. The USNRC is re-evaluating that schedule, in the light of the current status of the review and timing of GEH deliverables to support its completion.

The DCD is a formal regulatory submission in the USA. For the GDA process it is a reference to the main safety report. The version of the DCD referenced by GEH's Step 2 submission is Revision 3. The current version that is being reviewed by USNRC is Revision 4. This will be supplied to HSE in April 2008, together with an indication of those areas of the DCD which are likely to change as a result of interaction with USNRC. Revision 5 of the DCD, which is to incorporate USNRC comments, is expected to be issued to HSE in June or July 2008. GEH has taken account of all the RAIs on Revision 4 and these will be taken into account on Revision 5.

USNRC has been issuing the safety evaluation report with open items (SER/OI) on a chapter basis to facilitate issue resolution and to support meetings with the Advisory Committee for Reactor Safeguards (ACRS). To date, USNRC has issued SER/OIs for Chapters 2, 4, 5, 6, 8, 9, 10, 11, 12, 13, 15, 16, 17, and 21. USNRC has also issued open item letters for most of these chapters (all except for Chapter 4 which is currently in process). USNRC is in the process of re-evaluating the schedule for the design certification in light of the current status of the review and timing of GEH deliverables to support completion of the review.

The Finnish regulator, STUK, is carrying out a preliminary safety assessment of ESBWR as part of the process for possibly constructing the country's sixth nuclear power plant.

2.5 HSE USNRC RELATIONS

The Information Exchange Arrangement between USNRC and HSE is in the process of being renewed. HSE staff have made several visits to US NRC, discussing NRC Design Certification and collaboration with UK GDA. A USNRC inspector took part in the UK quality system inspections of GE and WEC in the US in 2007.

The NRC has established a broad collaborative program with regulatory agencies in other countries. This Multinational Design Evaluation Program (MDEP) provides for the exchange of technical assessments of issues of common interest between regulators. Each regulator can then use the technical evaluation in making its own regulatory decisions on the issues, consistent with its nation's policies. There is a need to coordinate future MDEP activities with the activities of the new CNRA WG on the Regulation of New Reactors, but this should be facilitated by NEA providing the secretariat for both MDEP and CNRA.

In addition to a standard Information Exchange Arrangement with USNRC (currently under renewal), HSE has an umbrella research exchange arrangement with USNRC, with subsidiary agreements in place or being negotiated on thermal hydraulics codes (CAMP) and severe accident research (CSARP).

2.6 HSE CNSC RELATIONS

There is an Information Exchange Arrangement between CNSC and HSE. HSE staff have made several visits to CNSC, discussing their design review processes and collaboration between

CNSC and the UK GDA process. A CNSC inspector took part in the quality system inspection of AECL in 2007.

If the ACR-1000 makes it through to Phase 3 of the CNSC review process, CNSC have expressed their openness to closer co-operation and collaboration.

2.7 HSE ASN RELATIONS

HSE is renewing its Information Exchange Agreements with ASN, and has had bilateral meetings to discuss new-build assessment collaboration and transfer of information. A bilateral cooperation process has been set up with ASN and its technical support organisation IRSN with the aim of having technical meetings to share the results of the safety assessments already performed on Flamanville 3. An ASN inspector took part in the quality system inspection of EDF and AREVA in 2007.

In addition, HSE has had meetings with the French technical support organisation (IRSN) that provides expert advice to ASN and STUK. In addition to the above mentioned discussions on access to existing review reports for EPR, they discussed the possibility of IRSN undertaking assessment work specifically for HSE. A formal agreement to facilitate this has been set up with IRSN.

For the last 10 years, there has been a programme of secondees in both directions between ASN and HSE-NII to improve the mutual collaboration.

2.8 HSE STUK RELATIONS

HSE has an Information Exchange Arrangement with STUK and has had bilateral meetings to discuss new-build assessment collaboration and transfer of information. A STUK inspector took part in the quality system inspection of AREVA in 2007.

In addition, HSE has had meetings with the main Finnish technical support organisation (VTT) that provide expert advice to STUK. These discussed access to existing review reports for EPR and the possibility of VTT undertaking assessment work specifically for HSE. A formal agreement to facilitate this is being negotiated with the VTT.

2.9 HSE MULTILATERAL COLLABORATION

The Multi-national Design Evaluation Programme was set up to share the resources and knowledge accumulated by national nuclear regulatory authorities during their assessment of new reactor designs, with the aim of improving both the efficiency and the effectiveness of the process.

ASN, STUK and USNRC already participate trilaterally in MDEP Stage 1 which has been set-up to share information on EPR assessments between regulators. HSE attended the January 2008 MDEP Stage 1 meeting as an observer with the intention of signing an appropriate agreement to join fully in future.

HSE is a member of MDEP Stage 2, as are ASN, CNSC, STUK and USNRC. The main objective of Stage 2 is to identify common regulatory practices and regulations that enhance the safety of new nuclear reactor designs. Ultimately this is expected to lead to a convergence of codes, standards and safety goals in the participating countries. To this end, two pilot projects have been launched. The first will investigate the licensing basis for new nuclear reactor designs, the scope of design safety reviews and overall safety goals. The second will examine regulatory oversight of components manufactured for new nuclear reactors. Stage 2 has the goal to provide initial results within a year on sectors such as digital instrumentation and control, severe accident requirements and emergency core cooling system requirements.

HSE also intends to participate in the new NEA CNRA WG on Regulation of New Reactors. The terms of reference of these various groups will need to be drawn up to avoid duplication.

2.10 USE OF OVERSEAS REGULATORS INFORMATION BY HSE

HSE sees great value in being able to share information with other regulators who have carried out relevant assessments, and we have published our views on how this information can be used in our GDA guidance. However, because the UK legal and regulatory framework is UK specific, design approval by other regulators cannot be transferred automatically to the UK. Also under international conventions nuclear safety is a national responsibility and therefore UK specific assessment by HSE is required. However this has not, and in future GDA steps will not, prevent HSE from making arrangements where appropriate to make use of overseas regulators assessments. HSE is considering how the efficiency of the regulatory process can be improved, and this will include consideration of options for further use of overseas regulators' assessments.

3. CONCLUSIONS

1. HSE's Generic Design Assessment guidance states that Requesting Parties should submit information on existing regulatory assessments of the design for GDA Step 2, and this has been done.
2. The state of assessments of the four designs undergoing GDA carried out by the Canadian, Finnish, French and US regulators has been summarised. These regulators are in many cases in advance of the UK with respect to assessment and HSE can benefit from taking cognisance of what has already been done.
3. Although assessments are ongoing in other countries, none of these four designs has yet received a licence to operate in any country.
4. HSE has formal bilateral agreements (or is in the process of renewing / creating them) with all these regulators and their relevant TSOs, facilitating collaboration.
5. We also collaborate over new build review with these regulators in the MDEP framework.
6. HSE's Generic Design Assessment guidance states that HSE will review these assessments and the issues raised. General recommendations are made below about how this should be pursued.

4. RECOMMENDATIONS

- R1. HSE should continue to pursue collaboration with ASN/IRSN, CNSC, STUK/VTT and USNRC both bilaterally and multilaterally (through MDEP and/or through the new CNRA WG on Regulation of New Reactors), in order to have access to all available information, to make the best use of resources and to demonstrate this to the public and government.
- R2. HSE should use this information to understand the practices of other regulators when they perform an assessment and make decisions on the submissions. This should include the depth and details of the submission requirements and the degree of independent analysis by the other regulators.
- R3. HSE should use this understanding to help avoid unnecessary independent analyses, to indicate areas of potential concern and to focus and potentially reduce our sampling for assessment purposes.

However, HSE's regulatory decisions will be based on UK requirements and not on those of other regulators.

5. REFERENCES

1. Pre-Application Safety Assessment Report related to the Advanced CANDU Reactor 700 MWe, USNRC, October 2004
2. UK AP1000 Safety, Security and Environmental Report, 2007,
<https://www.ukap1000application.com/AP1000Documentation.aspx>
3. Technical Guidelines for the Design and Construction of the next generation of NPPs with PWRs, adopted by the GPR/German experts plenary meeting held on October 19-20th 2000.