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# Licensing of UK ABWR in an international environment

**12<sup>th</sup> September 2017**

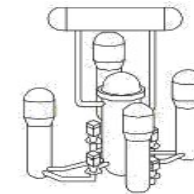
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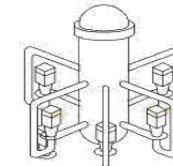
# Introduction



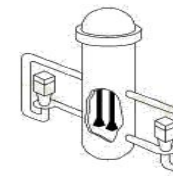
- Hitachi introduced Boiling Water Reactor (BWR) technology to Japan, building on US experience, in the 1950s.
- BWR technology has since been developed through successive generations of design – with construction more-or-less continual from 1970s to now.
- Design evolution during this time has culminated in the Advanced Boiling Water Reactor (ABWR).
- The UK Advanced Boiling Water Reactor (UK ABWR) is proposed for deployment in the UK, and Hitachi-GE is seeking regulatory design approval – a Design Acceptance Confirmation (DAC) and Statement of Design Acceptability (SoDA) for the design.



BWR1



BWR2



BWR3



BWR4

BWR5

BWR6



ABWR

# ABWR Overview

- Benefits from proven construction and operating experience – safe, reliable and cost competitive
- Proven design: 4 operational, 4 under construction
- 4 units constructed on time and on budget in Japan
- Simplified systems with high operability
- UK ABWR design includes latest international developments, as well as refinements to meet specific UK conditions – but remains an ABWR.
- World-class safety features



# Safety features of the UK ABWR



- Defence in depth design– multiple safety trains and back-ups
  - Core cooling: diverse methods of cooling water supply
  - Containment: multiple layers – fuel cladding, RPV and RCCV
  - Control: control rods fast acting to shut down the reactor plus back-up liquid control system
- Enhanced C&I system & HWBS
- Aircraft impact protection
- Extreme hazard protection from independent Back-up Building

<p>Introduction to ABWR</p> <p>Key Facts</p> <p>Environmental performance and waste management</p> <p>Site Buildings</p> <p>Reactor Building</p> <p>Reactor Pressure Vessel</p> <p>Reactor Internal Pump</p> <p>Safety</p> <p>History and Experience</p> <p>More Detailed Information (PDF)</p>	<p>The safety features of the UK ABWR are based on a Defence in Depth or 'redundant measures' approach. This ensures that there are multiple layers of protection with all layers designed to ensure safety independently of each other.</p> <p>There are three main steps which are necessary to achieve and maintain a safe state of shutdown during and following an emergency:</p> <ol style="list-style-type: none"><li>1. To effectively shut down the operating reactors and end the nuclear reaction.</li><li>2. To cool the reactors (which reach high temperatures during operation), and maintain cooling for the fuel which will continue to produce heat at a lower rate after shutdown because of the high levels of radioactivity present in the fuel.</li><li>3. To ensure continued containment of radioactivity.</li></ol>  <p>ABWR Safety Information Video, based on a generic approach – individual site developments will be subject to site specific design.</p> <p>Further improvements were made to the reactor design incorporating lessons learned from the Fukushima accident of March 2011, with a particular focus on prevention of a complete loss of power on site (known as a Station Black Out) and loss of all cooling options (known as the loss of Ultimate Heat Sink).</p> <p><b>To shut down operating reactors</b></p> <p>In the event that an emergency shutdown is needed, Control Rods are immediately driven hydraulically into the reactor by high-pressure nitrogen, shutting it down. As a back-up system, water (infused with boric/borated water) can also be injected directly onto the reactor core by</p>
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Visit our website and view the UK ABWR safety video:  
<http://www.hitachi-hgne-uk-abwr.co.uk/reactor-safety.html>

# Fukushima Countermeasures

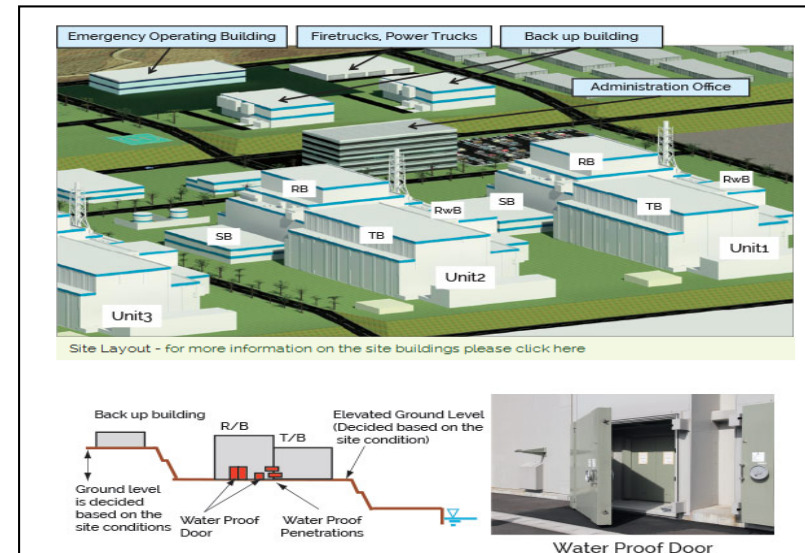
Lessons learnt from Fukushima include:

**Earthquake Protection:** Seismically qualified buildings

**Site layout:** Elevated site plus option to site backup buildings on raised ground

**Protection of core facilities:** watertight buildings and doors around backup features

**Loss of cooling and loss of off-site power:** additional diverse and independent methods of power supply and core cooling



Visit website for further information on Fukushima learnings:  
<http://www.hitachi-hgne-uk-abwr.co.uk/reactor-safety.html>

# UK ABWR Update - GDA



- Generic Design Assessment (GDA) is a challenging review by UK nuclear regulators
- Examines safety, environmental protection, security
- Takes significant effort



- Transparent process – reports published plus a public comments process
- Aim is to complete assessment while design is still ‘on paper’
- A number of design changes have been made to meet UK regulatory expectations

# UK ABWR Update – site deployment



- GDA target completion is end of 2017
- Horizon Nuclear Power (a 100% Hitachi subsidiary) has plans to deploy the UK ABWR at Wylfa Newydd and Oldbury-on-Severn.
- Will be twin units at each site
- Nuclear Site Licence application made
- Working to build UK domestic expertise – University seminars and support for BWR research hub





# Influences of International Licensing



- BWRs are deployed in many countries world-wide.
- Licensing by different regulatory regimes has undoubtedly contributed to design development and safety improvement.
- ABWR has undergone regulatory assessment in 4 countries.

<p>Introduction to ABWR Key Facts Environmental performance and waste management Site Buildings Reactor Building Reactor Pressure Vessel Reactor Internal Pump Safety History and Experience More Detailed Information (PDF)</p>	<p>The safety features of the UK ABWR are based on a Defence in Depth or 'redundant measures' approach. This ensures that there are multiple layers of protection with all layers designed to ensure safety independently of each other.</p> <p>There are three main steps which are necessary to achieve and maintain a safe state of shutdown during and following an emergency:</p> <ol style="list-style-type: none"><li>1. To effectively shut down the operating reactors and end the nuclear reaction.</li><li>2. To cool the reactors (which reach high temperatures during operation), and maintain cooling for the fuel which will continue to produce heat at a lower rate after shutdown because of the high levels of radioactivity present in the fuel.</li><li>3. To ensure continued containment of radioactivity.</li></ol>  <p>ABWR Safety Information Video, based on a generic approach - individual site developments will be subject to site specific design</p> <p>Further improvements were made to the reactor design incorporating lessons learned from the Fukushima accident of March 2011, with a particular focus on prevention of a complete loss of power on site (known as a Station Black Out) and loss of all cooling options (known as the loss of Ultimate Heat Sink).</p> <p><b>To shut down operating reactors</b></p> <p>In the event that an emergency shutdown is needed, Control Rods are immediately driven hydraulically into the reactor by high-pressure nitrogen, shutting it down. As a back-up system, water (infused with boron/borated water) can also be injected directly into the reactor core by</p>
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# Influences of MDEP



- MDEP has existed for around 10 years
- There is a design specific ABWR working group – this helps the regulators share information and learn from each other
- We believe MDEP does influence the UK regulator – and in turn that has an influence on their assessment as we progress through GDA
- No doubt that MDEP is positive for getting international regulators to work more closely together
- This is helping encourage common approaches (eg MDEP Common Positions) which will ultimately encourage international harmonisation of approaches for new reactor assessment.
- Hitachi-GE support further work to harmonise international regulation of new reactors.



- BWR technology has been developed through successive generations of design – with construction more-or-less continual from 1970s to now
- Design evolution during this time has resulted in the proven Advanced Boiling Water Reactor (ABWR)
- Generic Design Assessment for UK ABWR target is to complete end 2017
- ABWR design has been influenced by international developments e.g. introduction of Fukushima learning and aircraft impact protection
- Hitachi-GE believes international cooperation via MDEP benefits regulation of new nuclear power plants
- Hitachi-GE supports the MDEP initiative and encourages continued progress on international harmonisation of approaches to regulation

**HITACHI**

