HITACHI

Generic Design Assessment of the UK ABWR
Comments Process - Public Digest

A significant aspect of Generic Design Assessment has been Hitachi-GE's formal "GDA comments process”.

Alongside publication of major regulatory submissions, public documents and lay summaries; the comments process provided the highest possible level of transparency around assessment of the UK ABWR - inviting comments and questions relating to the technology and its assessment for use in the UK.

Implemented in line with the regulators' guidance, the process received 83 meaningful inputs between 6th January 2014 and 15th August 2017. Each of these was reviewed by Hitachi-GE, before both the question and our response were shared with the regulators.

Below is a summary of major themes raised through the process (and via associated engagements), and our responses thereto.

Note: this publication is not part of the GDA process, but is a voluntary publication made by Hitachi-GE – in agreement with the regulators – to further support GDA transparency.

Use of ‘Single circuit’ reactor designs, and a concern this could lead to contamination of the turbine.

BWRs are the second most common reactor type globally, so there is nothing unusual about this.

All nuclear plants have elements of radiation somewhere in the system, the key is to ensure suitable shielding between that radiation and workers. In the case of BWRs, this applies to the steam system. Materials which come into contact with steam are also carefully selected, to minimise contamination.

Despite this, there is some minor transfer of radiation from the reactor to the turbine - primarily via Nitrogen-16 in the steam, or trace particles of activated corrosion products which are carried in the steam. These decay very quickly after shut down however, so the turbine does not remain contaminated after the end of operations and is not a decommissioning concern.

The implications if a fuel rod were to leak into the water / steam system

Fuel failure is a very rare – on average, minor failures occur in a couple of pins per year over the ABWR fleet.

When this does happen fission products can cause a very small amount of deposition on turbine blades – though the primary outcome of fuel failure is increased presence of noble gasses, which are removed by the Off Gas System. This is considered within the GDA discharge assessment for normal operations, and the relevant systems are designed to manage such an incidence. There is no notable impact on workers, emissions, or the outside environment.

Whether the ABWR is a similar design to that used at Fukushima
The reactors at Fukushima were of a far older generation and very different design to those proposed in the UK. The Fukushima Dai’ichi site comprised four “BWR 4”, one “BWR 3” (both designs from the

1960s & 70s) one "BWR 5". These designs were later superseded by BWR 6, ABWR, and now UK ABWR.
Improvements in the ABWR compared to Fukushima include modified containment structures, improved reactor protection system, enhanced Emergency Core Cooling Systems, and improved measures for managing excess pressure in containment.

The UK ABWR will also contain full Fukushima countermeasures, and a range of UK-specific modifications agreed with the regulators.

The ABWR's record of operational availability, and outages in Japan

BWR plant availability is competitive with other designs, though in some cases Japanese ABWR plant availability has been mixed. One factor is national differences in operating cycles and scope of inspections between operating cycles – the Japanese system entails shorter cycles leading to lower availability figures.

Seismic issues are also a consideration – for example, in 2007 local seismic activity entailed a lengthy shutdown to considerations unrelated to the nuclear plant itself. There have also been some challenges with non-nuclear aspects of the plant, including turbines – and suitable countermeasures are in place to prevent any recurrence.

Why core-melt management systems differs from those on ABWR promoted elsewhere in the global market

It's normal to see some differences in the detail of design from plan to plant. These are based on a wide range of considerations. To progress through regulation, what matters is the level of safety achieved – not the technical means by which it is reached.

The ABWR proposed for the UK would manage any potential core melt via a number of systems, such as:

- *A large spreading area for melt debris in the lower drywell*
- *Water injection in lower drywell*
- *A flooder system via fusible plugs to lower drywell from suppression pool by gravity*
- *A sacrificial layer of basaltic concrete to minimise non-condensable gases*
- *A Corium shield to protect the sump region.*

What prevents fission products in the steam from entering the condenser, then cooling water and the environment

There is no pathway for fission products to get to the condenser cooling water, and the off gas system removes gasses from the condenser.

Where power goes in the event of a turbine trip

Power is safely discharged to the condenser (via turbine bypass valves) and the suppression pool, via safety relief valves.

Whether large BWRs are prone to instability

BWR operators ensure suitable stability during operations through a power versus core flow map to define acceptable operating regions, and a minimum 'reactor internal pump' speed is set.

Why Control Rods are inserted from below the reactor, not gravity powered from above

Control Rods are inserted via a ‘fail-safe’ system, with automatic insertion if power is lost. This achieves comparable reliability and speed to gravity driven systems. Insertion on BWRs is from the bottom, because reactor components mean top-insertion is not possible.

A hydraulic system (high-pressure water stored in nitrogen charged accumulators) inserts the control rods in just a few seconds. Nonetheless, several back-up systems are in place – such as electric motors to insert control rods, and borated water injection

What is the steam turbine output / plant output?

Nominally 1,350MW, with exact output depending on site and operational conditions.

What is the reactor steam pressure?

The reactor pressure is 7.17 MPa[abs].

What is the steam operating temperature?

Steam temperature is approximately 284 deg. C.

What is the steam flow rate?

7642 tonnes per hour.