HUNTERSTON REACTOR 3

GRAPHITE INSPECTIONS UPDATE

BACKGROUND

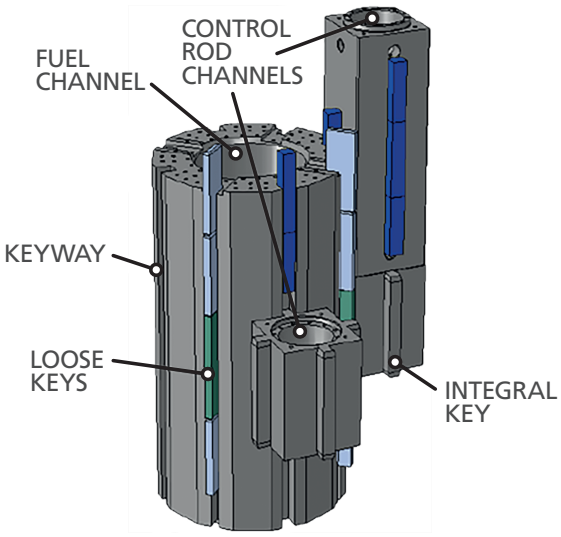
In March this year Hunterston B reactor 3 was taken offline to carry out planned, routine inspections of the graphite core. As part of the normal ageing process we expect to see cracks occurring in some of the graphite bricks that make up the reactor core, something that is well understood and is recognised in our operational safety cases which are agreed with the ONR. The inspections confirmed the expected presence of new keyway root cracks in the reactor core and also identified these happening at a slightly higher rate than modelled.

On 2nd May we decided that, while Hunterston Reactor 3 could return to operation from the current outage, it would remain offline to enable us to work with the regulator to ensure that the longer term safety case reflects the findings of the recent inspections and includes the results obtained from other analysis and modelling.

This decision underlines our commitment to nuclear safety and Hunterston B is, and will continue to be, operated with very large safety margins. The longer term safety case will build on existing analysis and will demonstrate that these margins will be maintained both now and for the projected reactor lifetime.

The Role of Graphite **in our Reactors**

- The graphite bricks act as a moderator, reducing the speed of neutrons and allowing a nuclear reaction to be sustained. They also perform an important safety function by providing the structure through which CO2 gas flows to remove heat from the nuclear fuel and include the channels for the control rods which are used to shutdown the reactor. Uranium fuel is inserted into the reactor in a fuel assembly through channels in the graphite core. Control rods, containing boron, are also inserted through other channels in the core to control the reaction and also used to shut down the reactor.
- Each reactor core is made up of around 3,000 graphite fuel bricks measuring 825mm high and 460mm diameter. Each one is 10 metres high, has a diameter of 10 metres and weighs 1400 tonnes. The bricks are all connected together, bound by a steel restraint and contained within a concrete pressure vessel over three metres thick.
- The bricks are each linked by graphite 'keys', with eight keys (and keyways) in each brick. The whole structure is aligned and locked in place by the keying system.



Graphite **Cracking**

- The stresses inside graphite bricks change over time. This is a well-known phenomenon and we have been working over many years to fully understand and prepare for these late life changes to the reactor core and regular inspections at all our plants have provided a clear understanding of how the reactor cores age. Our graphite research programme benefits from the expertise of our specialists, along with expert academics at many leading UK universities and companies.
- Over the last five years we have invested more than £100million and 1,000-person years into research, the results of which give us great confidence that by building on the work already completed the longer term safety case will demonstrate that there are large safety margins both now and for the projected reactor lifetime.
- Through all of this work nuclear safety will remain our overriding priority.

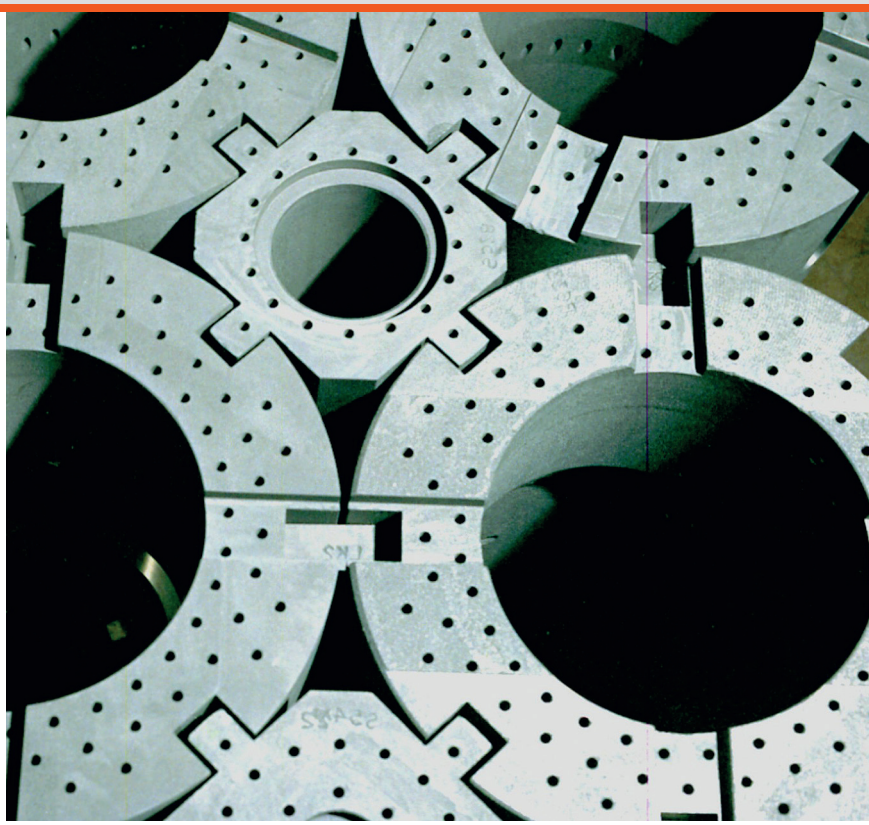
Graphite Inspection **at Hunterston Reactor 3**

- We closely monitor the condition of the graphite in our reactors. Graphite inspections are normally carried out during a station's statutory outage, which takes place every three years. Inspections are held more frequently at our longest-operating stations; Hunterston B and Hinkley Point B.
- Reactor 3 at Hunterston is the oldest core in our fleet so it's what we call our "lead reactor", where we perform inspections every 12 months. While Hinkley Point B station is of a similar age, there are material differences in the graphite that puts it a couple of years behind Hunterston in terms of how the core has aged.
- We are, of course, regularly inspecting the Hinkley Point B reactors too – along with all the other gas cooled reactors in our fleet.

Inspection work taking place at Hunterston B

Regulatory **Assessment**

- We welcome the robust regulatory environment in which we operate; we work very closely with the ONR to achieve our shared objective of ensuring nuclear safety
- Donald Urquhart, Deputy Chief Nuclear Inspector and Director of ONR's Operating Facilities Division said: "We welcome the decision by EDF Energy to delay the return to service of Reactor 3 at Hunterston B pending further assessment of the significance of the most recent identified keyway root cracks. I view EDF's decision as responsible, conservative, and made in the best interest of public safety."
- By working closely with the ONR and presenting robust evidence of safety margins we can ensure that Hunterston B Reactor 3 will operate for as long as it is safe to do so.



Upgraded Hunterston B Nitrogen Plant

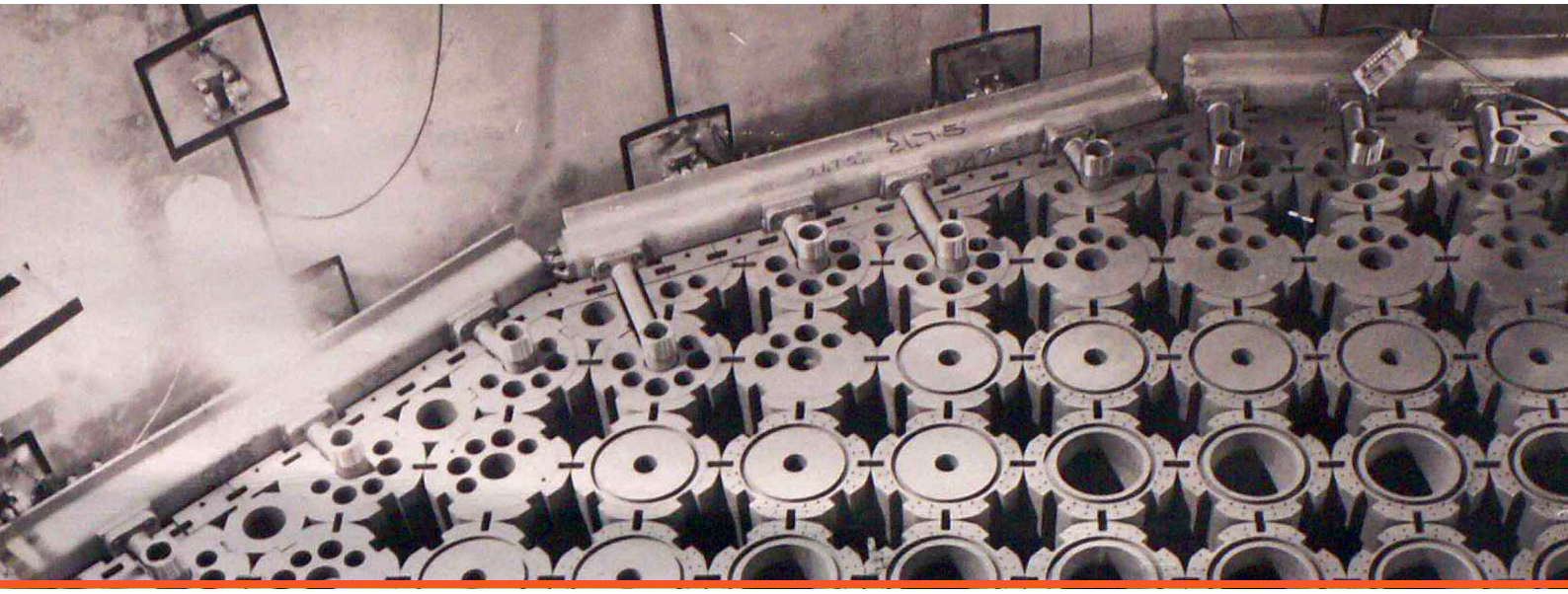
Nuclear **Safety**

- Maintaining nuclear safety as our overriding priority, we build strength in depth into our operations, providing back-up systems that ensure operational safety is never compromised.
- The principle nuclear safety issue presented by graphite cracking is associated with seismic (earthquake) scenarios and the potential for a core with more cracks to distort during a seismic event; there is no impact on our normal operations. In an extreme seismic incident we must be sure that any distortion in the reactor core could not hamper the insertion of control rods necessary to shut down the reactor.
- Our assessments are designed to demonstrate large margins in tolerable core distortions which could challenge control rod entry, giving us considerable safety margins in the overall primary shutdown system (control rods).
- Each reactor has around 80 control rods that are used to manage the power in the reactor. Half of them are used to control the temperature and day to day operation of the reactor, the others would be used if we needed to shut the reactor down.
- We actually only need 12 to shut down the reactor, the others provide strength in depth. 12 control rods with double the level of articulation have been installed in the reactors at Hinkley Point B and Hunterston B – these effectively guarantee shutdown.
- In the highly unlikely event that the number of rods inserted into the reactor was unable to control the nuclear reaction during a major seismic event our stations have a back-up system that would quickly inject nitrogen gas into the core and stop the nuclear reaction.

Next **Steps**

A specialist team has been set up to support the established graphite programme. The programme strategy will:

- Perform additional inspections to further support safety case judgements and reduce uncertainties. These would start following planned maintenance which is currently being performed on the refuelling machine.
- Produce a safety case which sets the principles associated with long term graphite core operation and will be used to define the overall safe and operational envelope for the graphite core. This has been in production over 2017 and 2018 and will shortly be submitted to the external regulator for their assessment. These principles take account, for instance, of the plant modifications performed at Hunterston to provide additional defence in depth for reactor shutdown.
- Extend the agreed safety case to demonstrate safe operation for a next period of six months starting when it returns to service after the current outage.
- Provide further evidence to demonstrate confidence in the seismic models and assessments and the understanding of graphite core degradation.



Impact on the Lifetime Assessment **for Hunterston B**

- Our current view remains that the best lifetime judgement for Hunterston B Reactor 3 (2023) continues to be supported, given the large nuclear safety margins.

Impact on our **Advanced Gas Cooled Reactor Fleet**

- The stresses inside graphite bricks change over time and as a result we expect cracking to occur in some bricks as they age. While we expect to see this in our other gas cooled reactors as they approach the end of their lives, they are some way behind so there is no immediate impact on the operations at our other AGR stations.
- The inspections taking place at Hunterston B are providing us with a wealth of knowledge and experience that will help us with other reactors in our fleet when they reach the later stages of their operational lives.

Further Information

There will be regular proactive communications on this issue with our own people and with key stakeholders within the local community and beyond:
https://www.edfenergy.com/energy/nuclear-lifetime-management