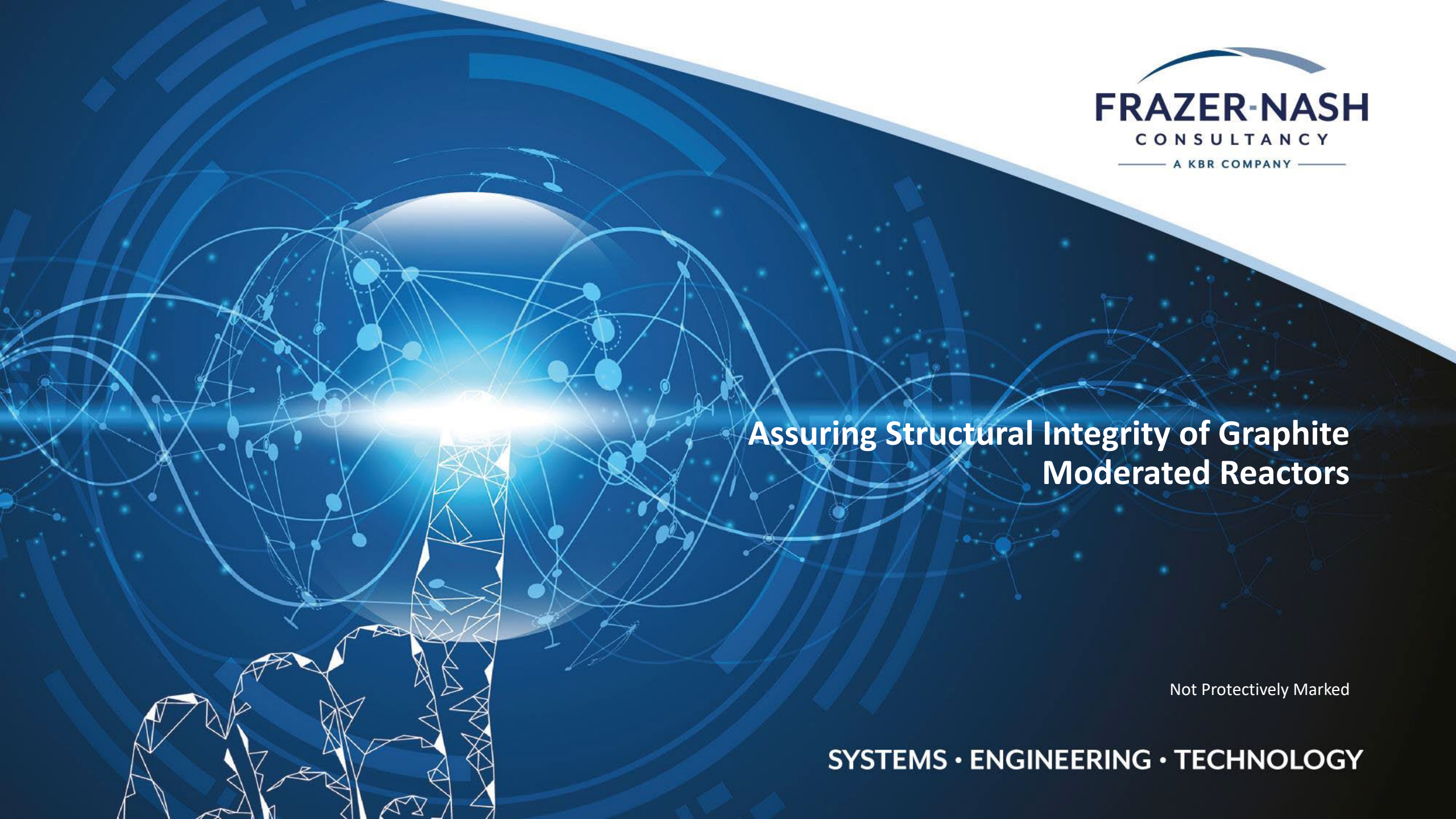

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Assuring Structural Integrity of Graphite Moderated Reactors

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Assuring Structural Integrity of Graphite Moderated Reactors

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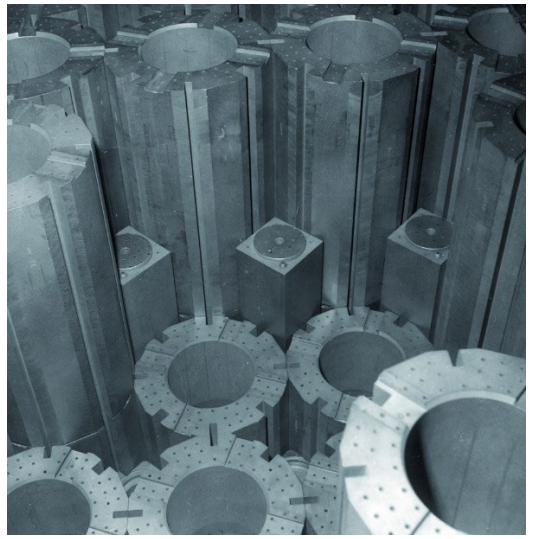
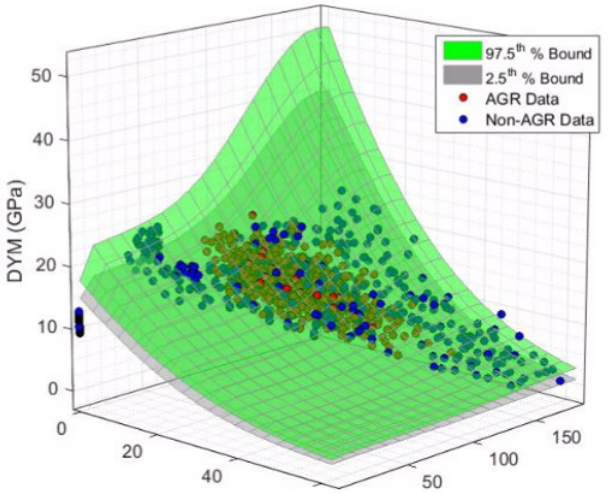
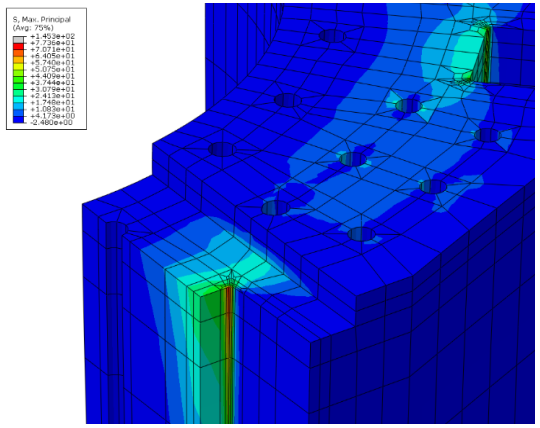
Context and Contents

- The understanding of graphite behaviour in reactors systems has increased rapidly in recent years
- Opportunity to take learning to Molten Salt systems
- Identify knowledge gaps ahead of need
- Provide robust evidence for long term safe reactor operation





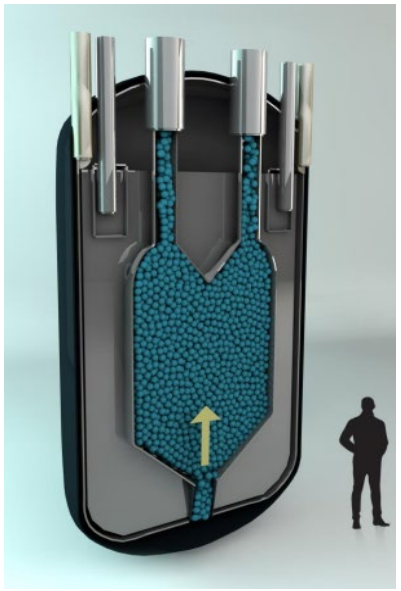


These opinions are those of the author and don't necessarily represent those of any client organisation

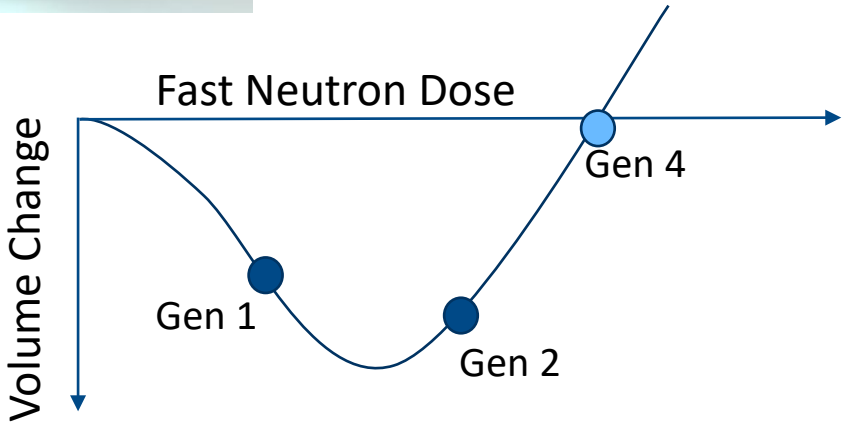
Graphite in Molten Salt Reactors

- In common with gas-cooled reactors, graphite components form large portions of the reactor core structure
- Defines the coolant flow paths
- Defines the entry channels for reactivity control elements
- The functions of these features likely to be significant safety claims
- Molten Salt Reactors may ‘work their graphite harder’ than current commercial plant experience

IMSR: terrestrialenergy.com



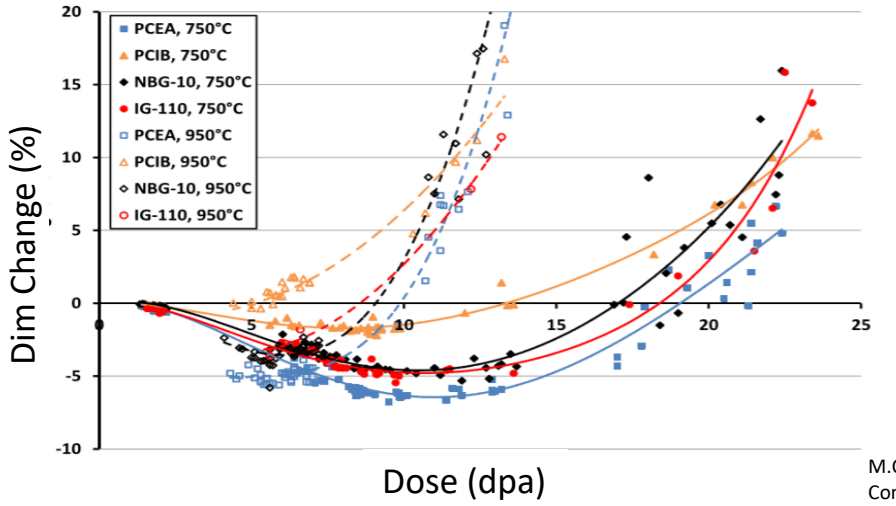
KP-FHR: Kairospower.com



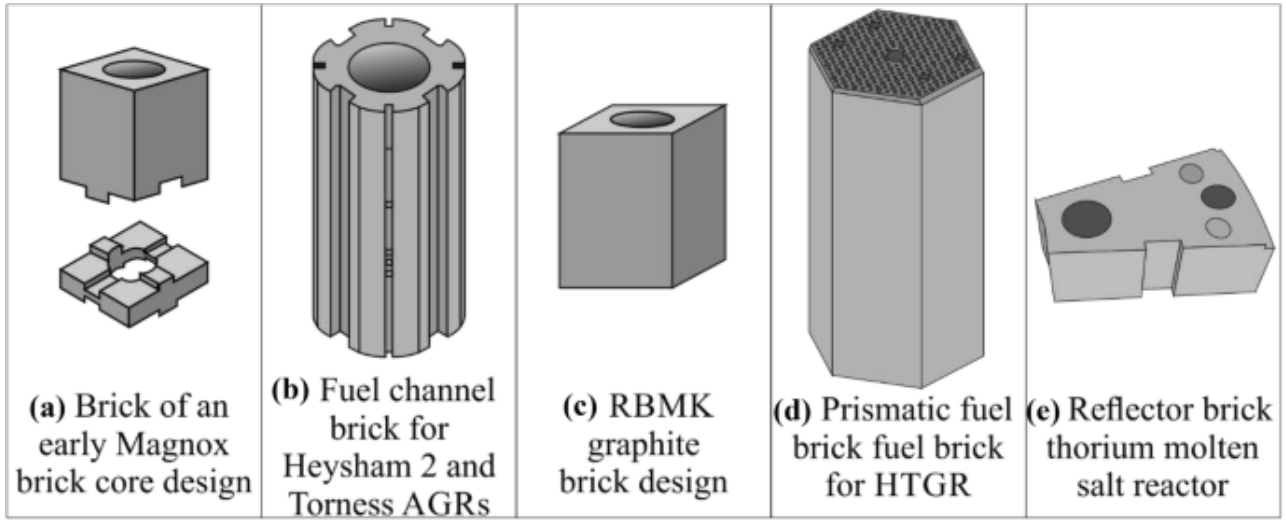
Challenges

- Dimensional change likely to cause some distortion of core components
- Thermal conductivity evolution may result in component temperature change through life
- Fluence or temperature gradients can lead to stress formation

- Fluid interactions, pressure, corrosion, erosion, etc
- Restraint issues

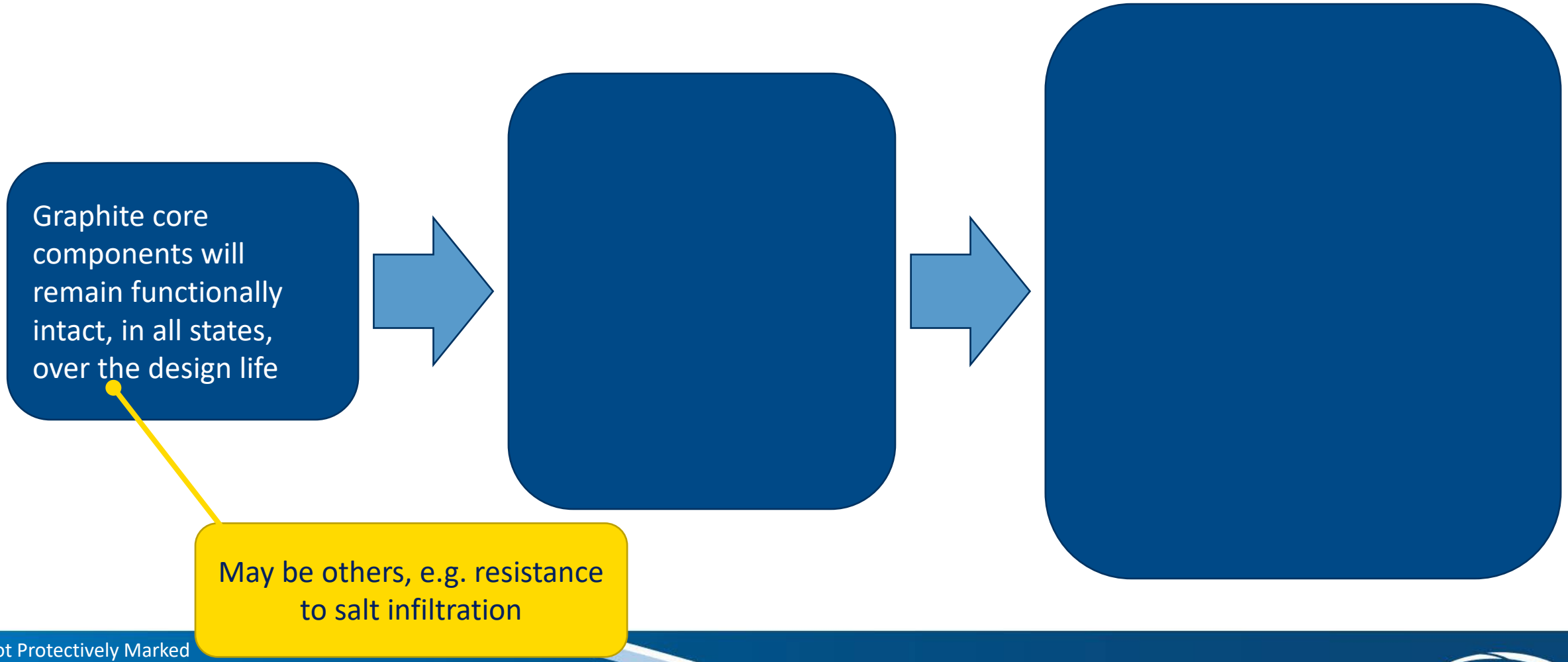


M.C.R. Heijna, S. de Groot, J.A. Vreeling,
Comparison of irradiation behaviour of HTR graphite grades,
Journal of Nuclear Materials, Volume 492, 2017



Arregui-Mena, J.D., Worth, R.N., Hall, G. *et al.* A Review of Finite Element Method Models for Nuclear Graphite Applications. *Arch Computat Methods Eng* **27,** 331–350 (2020). https://doi.org/10.1007/s11831-018-09310-y

Claims – Arguments - Evidence



Claims – Arguments - Evidence

Graphite core components will remain functionally intact, in all states, over the design life

1. Predictions of distortion, stress and strength throughout life
2. We have an assessment of variability
3. We understand where the limits are

Claims – Arguments - Evidence

Graphite core components will remain functionally intact, in all states, over the design life

1. Predictions of distortion, stress and strength throughout life
2. We have an assessment of variability
3. We understand where the limits are

1. An appropriate set of analysis tools and guidance
2. A model for material property evolution
3. Material properties data
4. A constitutive model
5. Creep data
6. Quantified uncertainty in combining grade datasets
7. Quantified uncertainty using data from inert experiments in salt applications

Distinguish between irradiation and measurement temperatures

Can we reduce the testing burden?

Summary

Understanding of graphite in gas-cooled reactor systems has increased significantly in recent years

Many of these approaches are likely to be transferable to the assurance of graphite in molten salt cooled systems

Future safe operation of new reactors requires an understanding of uncertainty

Potentially this could be efficiently reduced by identifying where existing evidence can be used to support assessments for MSRs

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