Facilitating International Licensing of Small Modular Reactors

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Map of global deployment
SMR standardisation

The WNA CORDEL Group’s concept of standardisation

• **The ideal:** A standard design that:
  - can be ordered by a utility in any country
  - will meet national regulations without significant adaptation
  - is changed only to adapt to site characteristics

• **Pragmatic definition:**

  ‘*Standardisation does not require units to be completely identical. Rather all units that use the standardised design technology should at least share the same global architecture and the same specifications for the nuclear steam supply system design and components, and associated safety systems.*’
Benefits of standardisation

**Benefits for Safety**
- Wider opportunities for shared experience, best practice and benchmarking
- Lessons learned from global operating fleets can benefit both new designs, and new construction projects
- Operation of a fleet of standard plants may improve operational excellence, availability and capacity factors, and maintenance efficiency
- Reduced customisation means wider deployment of proven technology

**Benefits for Regulators**
- Increased effectiveness and efficiency, through sharing of methods and data from safety evaluations
- Easier knowledge transfer to emerging countries
- More efficient oversight of manufacturers supplying components globally
- Better regulations from shared insights and comparisons
- Increased public acceptance

**Benefits for Industry**
- Increased predictability and stability in licensing
- Less customisation can reduce engineering and construction time and cost
- Leverage of resources across fleets during construction, operation and decommissioning (components, spare parts, tooling, SQEP, fuel etc)
- Enhanced credibility with investors

*Freshfields Bruckhaus Deringer*
Why are SMRs different?

Small
- Smaller radioactive inventory
- Reduced source term

Modular and scalable
- Agile and responsive site capacity
- Smoother financial resource demands

Factory fabrication
- Potential separation of construction/operator responsibility
- Potential to centralise experience; consistency

Passive safety systems
- Improved accident protection
- Lower barriers to entry for new, inexperienced operators

Siting
- Undergrounding potentially reduces for seismic and security risks
- Less cooling water demand

Remote decommissioning
- Quicker remediation of sites by removal of plant
- More predictable outcomes: safety and cost

Novel
- Most designs still unproven
Objective: to identify the industry’s main issues in SMR licensing and potential approaches to facilitating a more efficient way forward

Focused on the processing of licence for designs and projects, taking as read that safety standards are universal

Built on Licensing and Project Development of New Nuclear Plants, exploring the relationship between licensing systems and commercial project timelines, noting SMRs face many of the same issues:

- **Licensing system**: One-step v multi-step
- **Reactor type**: FOAK v NthOAK
- **Size and maturity** of nuclear regime

Identified addition, SMR-specific characteristics posing unique challenges and opportunities for international standardisation
Licensing SMRs: A new opportunity for standardisation

**Traditional nuclear plants**
- Traditional licensing frameworks and standards have been grown organically by national regulators alongside traditional, large-scale nuclear programmes for decades.
- They present a status quo that forms a significant barrier to international standardisation of licensing requirements for nuclear new build, at anything more than an incremental level.

**SMRs**
- Most existing legal frameworks allow for the deployment of using existing requirements and standards.
- But these frameworks will be deployed in a new way, and in some cases require the development of new standards.
- This provides a real opportunity for standardisation for SMRs.
SMR characteristics and standardisation

Efficiency in licensing

- A more efficient licensing process is possible for SMRs because:
  - they involve modular fabrication of reactor modules
  - units will be identical in design and built in series
- Regulator collaboration
  - Once the initial licensing process has been performed, the regulator could use the assessments previously performed by other regulators
  - Potential to eliminate overlap and repetition

Working towards international certification

- Based on their size and design characteristics, SMRs provide an early opportunity for exploring international regulatory approval, if there is willingness amongst the relevant parties to accept a new process
- Ultimately, it may be possible to have an equivalent standard design certificate that is replicable for standardised module designs
The WNA CORDEL Proposal

A novel approach

- A novel licensing approach applicable to series of standardised reactor components, and specifically applicable to Small Modular Reactors
- This would involve:
  - compartmentalizing the licensing process between sufficiently independent ‘modules’
  - adopting a pre-licensing step specific to the reactor module design
  - promoting standardisation of the licensing standards applicable to this design-focussed pre-licensing step

Diagram:

- Design Certification of the reactor module
- Master Facility Licence for operation of the site
- Site Approval

<table>
<thead>
<tr>
<th>Module 1</th>
<th>Module 2</th>
<th>Module 3</th>
<th>Module 4</th>
<th>Module 5</th>
<th>Module 6</th>
<th>Site Approval</th>
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Adapting phases to facilitate standardised SMR licensing

<table>
<thead>
<tr>
<th>Phases</th>
<th>Decision-in-principle</th>
<th>Construction</th>
<th>Commissioning and operation</th>
<th>Decommission</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 phases</td>
<td><strong>In principle decision</strong></td>
<td><strong>Siting</strong></td>
<td><strong>Reactor design approval</strong></td>
<td><strong>Construction</strong></td>
</tr>
<tr>
<td>5 phases</td>
<td><strong>Prepare site</strong></td>
<td><strong>Construction</strong></td>
<td><strong>Operation</strong></td>
<td><strong>Decommission</strong></td>
</tr>
<tr>
<td>1 Phase*</td>
<td><strong>Justification</strong></td>
<td><strong>Generic Design Assessment</strong></td>
<td><strong>Single site licence</strong> (includes decommissioning)</td>
<td><strong>Abandon</strong></td>
</tr>
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* with pre-requisites

- **Would work in the same way as large plants**
- **Separation from other steps would assist (eg, US)**
- **Unique features of SMRs present opportunity for new, harmonised standards**

- **Module and primary safety systems standardised in design phase**
- **No new review during plant licensing process**

- **Master Facility Licence for complete plant using any no of modules**
- **Standardised**
- **Concentrate on site-wide issues**
- **Facilitate approval for operation**

- **Limited changes needed**
- **Design change management for modular deployment could pose challenges**

- **Potential for remote de-fuelling allows ongoing decommissioning of different modules**
- **New technical standards needed**

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Other licensing adaptations for standardised SMRs

**Factory fabrication**
- In-factory certification (beyond existing manufacturer quality oversight) needed?
- Standardisation improves ability for cross-border manufacture and deployment

**Regulatory philosophy**
- Prescriptive regimes require deliberate adoption of international standards, and potential change of laws and regulations
- Goal-based regimes may adopt standardised designs more readily, but provide less stability and predictability
- Need to accommodate both?

**Codes and standards convergence**
- Existing sets of national standards differ on many issues, and manufacturers used to certifying to multiple standards could apply that to standard SMRs:
  - Mechanical design codes
  - Personnel and procedure qualification
  - Materials and analysis requirements
  - QA requirements

**Design Change Management**
- Fleet management needed to deliver improvements in technology
- Potential use of periodic review process
Key opportunities and challenges

Cost efficiency
• Current licensing regimes pose a genuine barrier to SMR deployment
• Greater numbers of units deployed will multiply standardisation benefits when compared to large plants, posing a real opportunity to reduce this barrier

Regulator expertise
• SMRs are new for all regulators: novel designs require increased resources
• Standardisation promotes cooperation, therefore reducing resource demand

“Prime Responsibility” principle and liability channelling
• Factory production reduces operator’s ability to take prime responsibility
• Opportunity for hard delineation of manufacturer/operator responsibility?
• Existing operator liability channelling regimes arguably not fit for purpose

Export control
• Export of design and safety cases is challenging under some regimes
• Could new, bespoke legal architecture better facilitate regulatory collaboration?

Operator experience and training
• Developing systems of oversight of multiple small reactors may be challenging
• New standards needed?