Small Modular Reactors Regulators’ Forum

Licensing Issues Working Group

Report on Key Regulatory Interventions during a Small Modular Reactor Lifecycle

INTERIM REPORT

15 December 2019

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Executive Summary

There is a sustained global interest in small modular reactors (SMRs), which have the potential to play an important role in globally sustainable energy development as part of an optimal energy mix. Such reactors have the potential to enhance energy availability and security of supply in both countries expanding their nuclear energy programs and those embarking on a nuclear energy program for the first time.

The SMR Regulators Forum was formed in 2014 to identify, enhance understanding of and address key regulatory challenges that may emerge in future SMR regulatory discussions. This is expected to help enhance safety, efficiency in SMR regulation, including licensing, and to enable regulators to inform changes, if necessary, to their requirements and regulatory practices.

The Forum entered its second phase in 2017, following up on the work carried out in previous years. The following three topics are being covered in the second phase:

- licensing issues
- design and safety analysis
- manufacturing, commissioning and operations

This document is the interim report of the second topic covered by the Licensing Issues Working Group. It concerns the key regulatory interventions during an SMR lifecycle.

This interim report aims to:

- identify the potential stages unique to the lifecycle of an SMR
- describe the considerations that support the choice of key regulatory interventions (KRIs)
- suggest KRIs that should be considered by regulators in the licensing of SMRs.

Licensees should have the capabilities to work with the vendors to understand where KRIs may emerge. From the beginning the applicant should provide a description of the different phases of the project and the proposed potential KRIs. The regulator should evaluate the KRIs to determine whether they are appropriate.

This report was developed based on information, insights, and experience gained from the regulatory activities of the SMR Regulators' Forum members. It is considered to be generally consistent with existing IAEA documents but may deviate in some cases. This report is intended to provide useful information to regulators and industry in the development, deployment and oversight of SMRs.

Introduction

Context

For the most part, traditional nuclear power plant lifecycles have been fairly consistent, with a site generally going through the following high-level stages of activities, as defined in IAEA SSG-12.

Lifecycle stage per IAEA SSG-12, *Licensing Process for Nuclear Installations*	Typical activities conducted during lifecycle stage
Siting and site evaluation	Site characterization and comparison of generic design(s) to the site characteristics
Design	Site-specific reconciliation against a chosen specific design
Construction	Construction that could include cold (fuel-out) commissioning activities
Commissioning	Fuel-in commissioning with a critical reactor
Operation	Commercial operation and maintenance evolutions – includes ongoing radiological and hazardous waste management
Decommissioning	Facility disassembly and site remediation
Release from regulatory control	Site hazards below threshold that merit control by the licensee – transfer to long-term monitoring under institutional control

International regulators strive to implement licensing processes that are clearly defined and communicated, systematically performed, transparent and traceable through proper records management. The licensing process should be established to facilitate efficient validation of safety, which in turn facilitates efficient progression of regulatory activities. The steps of the licensing process should be discrete and follow a logical order.

Figure 1 shows the main stages dealt with in the licensing process for traditional nuclear power plants according to IAEA SSG-12, *Licensing Process for Nuclear Installations*. Experience has shown that stages may overlap; i.e., one stage may start before the previous one is fully completed. The blue arrows represent potential key regulatory interventions (KRIs) along the process, for illustrative purposes only.

The above approach has been proven for traditional nuclear power plant licensing. SMR proponents are proposing some different and unique approaches to plant lifecycles, and this may pose challenges to the traditional view of the licensing approach.

The modularity inherent to SMRs introduces new challenges to the SMR lifecycle, mainly associated with the construction, commissioning and decommissioning stages.

Figure 1: Lifecycle steps for a traditional reactor (new build) – Taken from SSG12

Siting and site evaluation

- Audit of applicant's site characterization program

Design

- Audit of design organization and management system
- Review of engineering change control
- Control of procurement (services and goods)
- Use of R&D and operating experience

Construction

- Audit of construction oversight by licensee, including receipt inspections of goods
- Completion assurance and turnover to operations

Commissioning

- Audit of commissioning program oversight by licensee including conduct of commissioning activities
- Conduct of turn-over to operations

Operation

Acceptance of final safety analysis report, restart from outages, major equipment replacements, periodic safety review etc.

Decommissioning

Release from regulatory control

Objectives

This interim report aims to:

- identify the potential stages unique to the lifecycle of an SMR
- describe the considerations that support the choice of key regulatory interventions (KRIs)
- propose KRIs in the lifecycle of an SMR

Key regulatory interventions

For the purpose of this document, the Licensing Issues WG proposes introducing the term “key regulatory intervention” (KRI) to describe a strategic regulatory point of interest during the lifecycle of an SMR. A KRI could range from a higher level of regulatory involvement or scrutiny to pauses in the licensee’s activities until the regulatory authority has issued an authorization to continue work.

The WG initially considered using the term “hold point” since the IAEA also uses it. However, since this term is not defined in the IAEA’s Safety Glossary, not all countries use it during the licensing process of a reactor and its meaning could vary from one country to another. Therefore, the WG decided to use the term “key regulatory intervention”, as it is more generally applicable than “hold point”.

In a given lifecycle stage, there may be several KRIs set by national legislation and regulatory requirements. These KRIs give the regulatory body the power, aside from the typical oversight program, to ensure that risks to the health and safety of people and to the environment from nuclear installations and their activities are properly controlled by the persons or organizations responsible for the nuclear installations and their activities. The arrows in figure 1 represent points in the licensing process where a regulator may choose to have or impose KRIs. The arrows are for illustrative purposes only and do not necessarily represent recommended KRIs. KRIs can be intrinsically built into a licensing process, by way of distinct licensing stages or regulatory process steps. KRIs may also be included within a licence and managed under compliance for that licence.

A KRI can originate from 2 different places, the first is KRI presented by the licence applicants’ future conduct of activities that the licensees will have control over (for example requesting authorisation for specific commissioning activities).

The second ones are issues presented by the vendors design activities. There may be outstanding issues from the design which would result in KRIs. For example, - evidence around FOAK design issues may need to be substantiated. In this case it is the responsibility of the applicant/licensee to identify those areas and address the potential risk to their specific new built project.

An optional design review certification process, which is normally conducted with a vendor, may not be able to predict all of the specific KRIs that a licensee would encounter in a new build project.

Applicants/licensees should have the capabilities to work with vendors to understand where KRIs may emerge. From the beginning the applicant should provide a description of the different phases of the project and the proposed potential KRIs. The regulator should evaluate the KRIs to determine whether they are appropriate.

Methodology for determining KRIs

It is not feasible to define specific KRIs that would apply to all types of SMR facilities. However, some generic considerations may be useful in determining KRIs, such as:

- the level of risk or the safety significance of the lifecycle step being considered
- the level of complexity of the design or part of design subject of a potential KRI (e.g. integrated designs)
- the novelty or lack of proven-ness of the design or part of design subject to a potential KRI, in recognition of the need for operating experience to inform decision making
- design constraints (e.g., access limitations after a certain stage of construction)
- other constraints (e.g., impossibility or difficulty to repeat the activity if not successful at first attempt)
- stage of lifecycle (e.g., manufacturing, fabrication, transportation, offsite commissioning)

In some cases, potential KRIs may coincide with significant licensee project milestones, such as:

- turnovers of major project activities from one organization to another
- completion of excavation prior to first pour of nuclear concrete
- substantive completion of a portion of the project prior to onset of a major evolution for the next portion
- initiation of major commissioning milestones (particularly for a first plant)
- fuel receipt onsite
- loading of fuel into the reactor core

In other cases, KRIs may be at points where the regulator is seeking to confirm that sufficient confidence is demonstrated by the licensee (including licensee contractors and subcontractors) so that activities may proceed based on work-as-done. These areas of interest may be focused on:

- the need to confirm completion of activities important to the successful completion of future activities (e.g., specific studies, safety analyses or designs)
- verifying that quality requirements have been met for work as-done (e.g., rebar position or quality of cured concrete)
- the licensee’s program and process readiness for the activities to come

The common element of these considerations is that they are known to be areas of higher risk. That is, if not completed properly by the licensee, they could present as safety issues or latent flaws that could challenge operational safety. For example, if concrete was not cured properly, this could reduce the capacity of the concrete to perform its function, and additional analysis and/or testing would be required to verify the concrete’s ability to perform its intended function.

Chapter 1: Potential stages for the lifecycle of an SMR

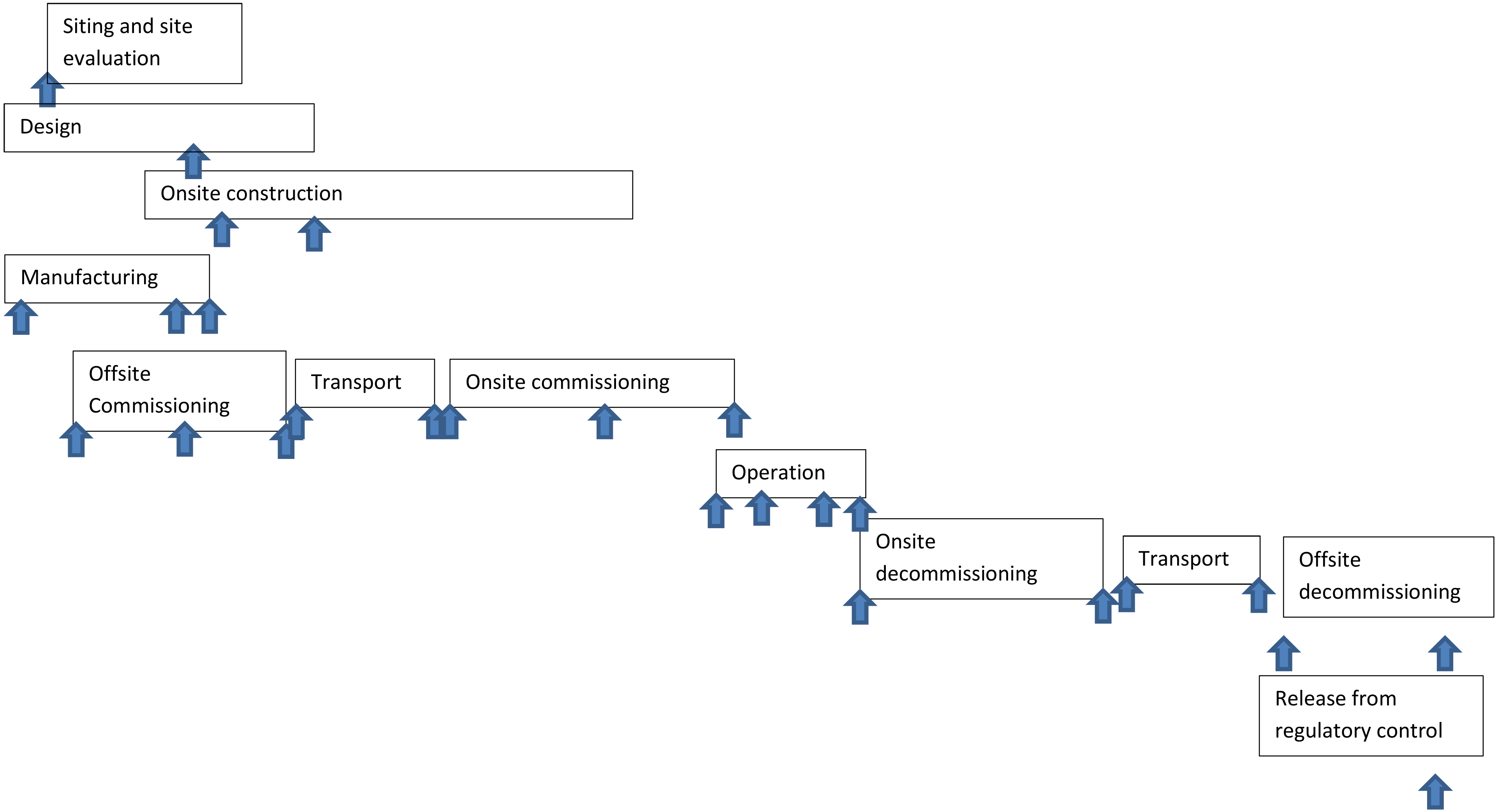
In addition to novel design features and approaches, SMR projects may introduce a number of differences to a new-build project – ranging from factory manufacturing and testing, to new construction and commissioning methods, to new programs for long-term operation and maintenance. These, in turn, may impact potential stages (as defined in IAEA SSG-12) for SMR licensing process and where KRIs might be based on the levels of risk introduced. For a first plant project, this may mean additional KRIs as operating experience is generated.

The following are potential stages in the lifecycle of a SMR:

- siting and site evaluation
- design
- construction
- manufacturing
- offsite commissioning
- transportation (both to and from facility)
- onsite commissioning
- operation
- onsite decommissioning
- offsite decommissioning
- release from regulatory control

These stages are illustrated in figure 2. It is worth noting that each of these stages, which are further detailed in chapter 2 of this document, may not be needed for all SMR designs. It is also worth noting that the regulatory body would seek assurances on the licensee's organizational capability to effectively oversee safety considerations at all stages of the lifecycle. This will be a subject of a dedicated report.

Figure 2: Sample SMR licensing process



Chapter 2: Key regulatory interventions expected for each stage of the SMR lifecycle

Each potential licensing stage is discussed in this chapter in view of how KRIs might be introduced due to the unique licensing features of some SMR designs. This discussion is summarized in the table in Appendix A, O*verview of the licensing stages of an SMR lifecycle and proposed KRIs*.

Siting and site evaluation

All activities associated with the proposal, including the impact of construction and operation of multiple modules (or units) on a single site, should to be considered in the licence application.

Where multiple modules are considered for a single site, the planned activities (i.e., construction, operation, maintenance and decommissioning) should be considered during site evaluation to ensure that it is possible to implement them on the site. This could include, for example, a preliminary aging management program for common services shared among modules – including civil structures, electrical systems, compressed air systems, pools, security, and emergency arrangements. This would be particularly important for cases such as:

- multiple-module SMRs where a licensee proposes to put only a few modules into service at the onset, with an option to install and operate more units in the future
- spent modules that may be removed and replaced with newer modules, which could differ technically from the original unit

The impact of adjacent units planned on a site, along with the proximity to population, also should be considered. In some cases, more than one licensee may be present on a site – and any possible interactions would need to be considered by all potential or current licensees.

Note: Similar considerations should be applied for floating reactors (for the facility where the reactor is fuelled).

KRIs for siting and site evaluation

Potential KRIs for siting and site evaluation could include:

- overall approval of plans for activities on the site
- environmental impact assessment results

Design

There is no fundamental change in the design review process for an SMR vs. a large-scale design. However, due consideration should be given to first-of-a-kind (FOAK) designs, since these will differ in the type of evidence and operating experience available to support their safety cases.

In addition, regulatory agencies may need to adopt new guidelines/approaches adapted to SMRs in order to meet the underlying requirements or regulations.

Another challenge that arises with SMRs is the level of maturity of design organizations, some of them being industry newcomers with little to no experience in nuclear safety.

Regulators also should ensure that processes are in place to ensure efficient and effective knowledge transfer from the designer to the licence applicant.

Finally, the design of onsite supporting systems should be evaluated in terms of overall plant safety.

KRIs for design

Potential KRIs for design include:

- approval that the reactor design is capable of meeting safety requirements
- approval that the balance of site would not negatively impact the safety of a facility

Manufacturing

There may be many different manufacturing models for SMRs. While these models vary widely, the goal of many SMR designs is to manufacture SMR modules offsite and then transport them to a site for installation and use. The engineered modules could be manufactured serially in a controlled factory environment. The premise is that factory manufacturing results in high-quality construction, short manufacturing times, and economies of scale. These engineered modules would be delivered from production factories to be assembled on the plant site, with the assumption that construction time would be significantly reduced. It is also claimed that some of the commissioning work could be done during manufacturing, reducing the onsite time to bring the plant to commercial operation. This concept has been proven in the shipbuilding and aerospace industries. Traditional reactor construction has also utilized this approach; however, some proposed SMR designs would use it on a wider scale – with some proposing to build, fuel and commission reactors before delivering them to site.

With the manufacturing model described above, there are two major differences compared to traditional reactors in that:

- assembly is mostly performed at the factory
- manufacturing and assembly may take place before the future licensee has decided to build the facility; i.e., prior to the beginning of any licensing process (reactor modules could be built and be available for immediate sale/use as part of manufacturing inventory)

There is a need to establish regulatory oversight for safety-related systems that are built and assembled in a factory. The level of regulatory oversight should be proportionate to the safety significance of the systems being assembled at the factory, and it should also consider the availability of onsite system inspection. The scope of regulatory oversight may be limited to the licensee's procurement process for systems that are easily verified after onsite installation.

Additional consideration should be given to a manufacturing facility involved in fuel loading; these considerations should recognize safety, security and safeguards aspects.

For factory sites that are not licensed, or even for factory sites outside of the regulator's control, regulatory oversight should still be maintained through the availability of regulatory inspections. The type and depth of regulatory inspections should be commensurate with the importance of the components being assembled, as well as the ability to inspect them once installed at a site.

Another option for regulatory oversight might also include the qualification or certification of a manufacturer. This can be especially beneficial if reactor modules are manufactured by different manufacturers at different facilities, or if modules are held in inventory for long periods of time. As previously mentioned, it is conceivable that some modules may be manufactured before a site is chosen or prepared.

Finally, an additional challenge arises for components or modules that have been manufactured abroad. Regulators may consider developing processes for approval of components whose manufacturing they (or the licence applicant) have not been able to oversee. It may be worthwhile to consider exchanging knowledge with counterparts and applying the experience of other regulators, if available, to support the review.

KRIs for manufacturing

Potential KRIs for manufacturing include:

- licence or QA approval for manufacturers
- inspections of items before a point at which they cannot be further inspected (for example, after assembly)
- approval of modules before they are shipped to site (for modules manufactured before the current licensee and regulator were involved).

Construction

Construction time is expected to be shorter for SMRs than for traditional nuclear power plants. This is due to their smaller footprint, and the possibility that many key components might be manufactured offsite and then transported to the site for final inspection and installation (greater use of modularization).

For sites with multiple modules, the simultaneous construction of modules in parallel with operation of other modules should be considered. Any construction activity could pose an additional hazard to existing units.

KRIs for construction

Potential KRIs for construction include:

- issuing a construction licence
- key construction activities (e.g., pouring of first concrete)
- modification to the design of functionally safety-significant equipment or components during the construction phase

Offsite commissioning

Commissioning tests should be performed to confirm that design requirements have been achieved. The design should include the acceptance criteria of commissioning activities that are necessary and sufficient to provide reasonable assurance that, if these commissioning activities are performed and the acceptance criteria met, the as-built components will conform to the approved plant design and applicable regulations.

For some SMRs, offsite commissioning consists of the commissioning tests that are performed on a module (or other equipment) before it leaves the offsite assembly facility. Offsite commissioning activities are especially important when inspection of modules or parts of modules is not possible due to some components not being accessible. Some offsite commissioning might also represent the last opportunity a regulator has to inspect some portions of a module. Offsite commissioning can replace some onsite commissioning tests.

It may be easier to perform some commissioning offsite versus onsite – especially if the commissioning equipment needed to perform certain tests is not portable. The commissioning equipment can stay at the assembly facility, where it can be used for multiple reactor modules.

Offsite commissioning plans should also take into consideration possible damage during transportation – and also should consider the time between testing and module use; if there is a prolonged period between a piece of equipment or module is tested and its use, an appropriate asset care program should be set in place.

Regulatory agencies may expect the licensee's personnel to conduct or supervise offsite commissioning to ensure that appropriate commissioning standards are being adhered to, hence ensuring proper transfer of knowledge and responsibility to the licensee.

As for manufacturing, additional challenges may arise when offsite commissioning has been completed earlier, meaning that the regulator and the licence applicant would not have had the opportunity to observe the tests. A thorough and transparent documentation of the test performance (not only the results, but also test conditions, possible modifications to testing procedures, etc.) is crucial in these cases (for additional information, see MDEP Common Position addressing First-Plant-Only-Tests (FPOT) - MDEP Common Position CP-STC-01).

KRIs for offsite commissioning

Potential KRIs for offsite commissioning include:

- testing of items before they cannot be tested any more (for example, after assembly)
- the possible need for design-specific KRIs (tests performed to demonstrate design requirements or commitments)
- fuel loading
- transportation (both to and from facility)

Transportation

Transportation of modules that are fuelled onsite is not expected to differ from transportation for large-scale reactors. However, additional checks may be expected once the module arrives at the designated location to ensure that no damage has been incurred during transportation.

For modules that are fuelled offsite, transportation introduces additional challenges, especially with respect to safety, security and safeguards.

The traditional model of reactor refuelling currently used at nuclear power plants around the world is to perform individual fuel element replacements at the facility site. Fresh fuel is delivered to the site in suitable packaging, and spent fuel is kept onsite in safe storage following removal from the reactor.

A number of SMR concepts consider using a compact nuclear core vessel that would either be entirely replaceable or that would have its entire fuel inventory replaced in a manner similar to a fuel cartridge. Using this approach, operators intend to reduce or even eliminate lengthy refuelling operations at the deployment site and possibly facilitate quicker removal from the deployment site. The spent fuel inventory might then either be stored onsite or shipped to another location for refurbishment or disposal. Transporting reactor vessels is especially challenging, as there is no certified packaging that is large enough for most (or all) reactor cores. Proposals exist for shipping reactor cores that:

- are always defuelled (for delivery to site, or removal from a site),
- are fuelled with fresh fuel (for delivery to a site)
- contain spent fuel (when removed from a site)

For regulating the transport of reactor modules that contain fuel, it is recognized that many safety, security and legal challenges arise, both on nationally and internationally. These challenges should be addressed separately.

KRIs for transportation

Potential KRIs for transportation include:

- licence/authorization for transportation
- module completion – before packaging for shipment
- after packaging for shipment
- before transport if the module is fuelled
    - safe and stable configuration
    - package certification
- acceptance at final destination

Onsite commissioning

Onsite commissioning consists of the commissioning tests performed on a module after it arrives from the assembly facility. There may be onsite commissioning both before and after the module is installed in its facility location.

Onsite commissioning plans should also take into consideration possible damage during transportation – and also should consider the time between any offsite commissioning testing and module use. KRIs might be transferred from the site to offsite – or from offsite to the site itself.

Continuity from offsite commission to onsite commissioning should be ensured.

Onsite commissioning should consider difficulties that may be introduced as new modules are added. Integration testing of all modules and systems also should to be considered.

KRIs for onsite commissioning

Potential KRIs for onsite commissioning include:

- commissioning without nuclear fuel
- fuel loading
- start of active commissioning (for each module or only first one)

Operation

Some SMR designs propose to have multiple smaller reactors operating on a single site.
The multiple reactor modules may have common services that are shared between modules, such as common electrical systems, compressed air systems or civil structures.

For facilities with multiple modules, additional consideration should be given to the impact of activities involving some modules on the operation of the other modules. Such activities may include:

- bringing new modules onsite or installing a new module in the facility
- refuelling operations
- maintenance (which may include replacing a module)

When licensing an SMR site or facility, regulators should also consider:

- that some novel designs may need additional regulatory controls for operation
- that many operating concepts can be different from traditional reactors:
    - remotely operated facilities, no operators onsite
    - multiple modules operated from common control room by same operators
    - different companies for different actions (refuelling, maintenance.)
- security arrangements of remote sites
- accident response of remote sites
- multiple operators on one site
- length of the operating licence, interval of periodic safety reviews

KRIs for operation

Potential KRIs for operation include:

- first criticality / power ascension (several KRIs corresponding to ramp-up thresholds for the first module, as needed for subsequent modules, including shared systems)
- first-of-a-kind activities (e.g. refuelling, maintenance)
- possible regulatory controls during early operation
- major component replacements

Onsite decommissioning

Regulators should ensure that SMRs have credible decommissioning plans and that they consider any novel technologies in use. Some SMR facilities could have sequenced decommissioning; i.e., some modules may still be operating while some are decommissioned. This could lead to decommissioning personnel working close to operating modules. Security and safety issues should consider these cases.

KRIs for onsite decommissioning

Potential KRIs for onsite decommissioning include:

- permit/licence to start decommissioning activities
- establishment of fuel disposal plans

Offsite decommissioning

Offsite decommissioning of SMRs can include defuelling, decontamination and disassembly of components. The licensee of an offsite decommissioning facility may be different than the licensee that operated the reactor, with a transfer of ownership and liability from the operator to the decommissioning facility.

Unique regulatory perspectives for offsite commissioning can include disposal considerations for unconventional fuels, and various reuse or refurbishment possibilities for modules. For example, a reactor module may just need to be refuelled and key components inspected before redeploying at the same or different site where it came from. Decommissioning in an offsite facility would likely be more controlled than traditional onsite decommissioning activities.

KRIs for offsite decommissioning

Potential KRIs for offsite decommissioning include:

- the issuing of a licence for an offsite decommissioning facility
- before departure from the operating site
- on arrival at the offsite decommissioning facility
- in case of refurbishment, before departure from the decommissioning facility
- establishment and approval of waste disposal routes

Release from regulatory control

This stage is unlikely to present any significant difference from traditional reactors.

APPENDIX A: Overview of the licensing stages of an SMR lifecycle and proposed KRIs

The table below summarizes how KRIs might be introduced due to the unique licensing features of some SMR designs. Some sample questions are included in the table below.

Licensing stage	Questions to consider for development of KRIs for SMRs	Potential KRIs
Siting and site evaluation	• What is the maximum number of units proposed for the site? • Would there be any adjacent units? • Are there any shared facilities (pools, electricity, emergency arrangements)? • What is the proximity to population? • What is the size of the EPZ? • Will there be several licensee's to one site?	• overall approval of plans to do activities on the site • Environmental impact assessment results
Design	• What additional regulatory oversight should there be due to the novelty of the design? • How confident is the regulator with the transfer of knowledge from the designer to the operator?	• Approval that the reactor design meets safety requirements • Approval that the balance of site does not negatively impact the safety of a facility
Manufacturing	• How much factory testing and regulatory involvement is needed at the factory? • Is fuel loading taking place at a factory? If so a license is likely to be needed (who would be the licensee in this case?) • Are more inspections at the manufacturer's premises needed? ○ What if the Manufacturing of modules is done overseas? • What is the maturity of the manufacturer. Is additional oversight necessary? • Will modules be held in inventory for a long time? What would be the impact? • Have modules been manufactured by different suppliers at different facilities?	• license or QA approval for manufacturers • Inspections of items before they cannot be inspected any more (after assembly…) • approval of modules before they are shipped to site (for modules manufactured before the current licensee and regulator were involved).

Construction	• What if construction of modules happens simultaneously with operation? • Is construction an external hazard to existing units?	• Issuing a construction licence • Key construction activities (e.g. pouring of first concrete) • modification to the design of functionally safety significant equipment or components during the construction phase
Off-site commissioning	• Are Inspections possible after assembly and commissioning? Are all components accessible? • Are any on site commissioning tests being replaced by offsite work? • Are tests being performed in a controlled environment (positive aspect)? • Are any outstanding KRIs being transferred to later in the build schedule? • Can some KRIs be conducted during on-site versus off-site commissioning?	• Testing of items before they cannot be tested any more (after assembly…) • Design specific KRIs might be needed (tests performed to demonstrate design requirements or commitments) • Fuel loading

Transportation	• Who is responsible during transport?
	• Are the modules fuelled?
	• What are the recovery scenarios for unplanned events during transport of fuelled modules?
	• What are the transfer routes and methods?
	• Are there any transborder (national or international) transfers?
	• What security arrangements need to be implemented?
	• What is the inspection routine?
		• Licence / authorization for transportation
		• Module completion – before packaging for shipment
		• After packaging for shipment
		• Before transport if the module is fuelled
		    ○ safe and stable configuration
		    ○ package certification
		• Acceptance at final destination

On-site commissioning	• What is the impact of reduced on-site commissioning due to modularization and off site commissioning? ○ E.g., for battery type reactors only minimum on site testing may be proposed • Are the impacts of possible transportation damage being considered? • What is the impact of serial commissioning as new modules are added?	• Commissioning without nuclear fuel • Fuel loading • Start of active commissioning (for each module or only first one)

Operation	• What are the multi-module considerations? E.g., in the same building, can there be modules in different phases
	• Should there be any KRIs due to novel designs?
	• Should there be any KRIs based on different operating concept? E.g.,
	  ○ remote control, no operators on site
	  ○ multiple modules operated from common control room by same operators
	  ○ different companies for different actions (refuelling, maintenance.)
	• Should there be any KRIs as a result of the site being remote – particularly related to security arrangements and/or emergency response?
	• Are there multiple licensees on one site?
	• What is the length of the operating license? Interval of periodic safety reviews?
		• First criticality / power ascension (several KRIs corresponding to ramp-up thresholds for the first module, as needed for subsequent modules - including shared systems)
		• First of a kind activities (e.g. refuelling, maintenance)
		• Possible regulatory controls during early operation
		• Major component replacements

On-site decommissioning	• Is there sequenced decommissioning? i.e., some modules may still be operating while some are decommissioned ○ Are decommissioning personnel working close to operating modules? Does this introduce security issues etc. • Is there a credible decommissioning plan considering novel technologies?	• Permit/license to start decommissioning activities • Establishment of fuel disposal plans
Off-site decommissioning	• Would there be a different licensee for off-site decommissioning? • Are there considerations needed for the disposal of unconventional fuels? • Are there any refurbishment intentions for components or modules?	• Issuing a license for an off-site decommissioning facility • Before leaving the operating site • On arrival at the off-site decommissioning facility • In case of refurbishment, before leaving the decommissioning facility • Establishment and approval of waste disposal routes

Release from regulatory control	N/A	N/A

APPENDIX B: Representatives of the Licensing Working Group

Country	Institution
Canada	Canadian Nuclear Safety Commission (CNSC)
China	Nuclear and Radiation Safety Center (NRSC)
Finland	Radiation and Nuclear Safety Authority (STUK)
France	Institut de Radioprotection et de Sûreté Nucléaire (IRSN)
UK	Office for Nuclear Regulation (ONR)
USA	U.S. Nuclear Regulatory Commission (NRC)
Republic of Korea	Korea Institute of Nuclear Safety (KINS)
Saudi Arabia	NRRC