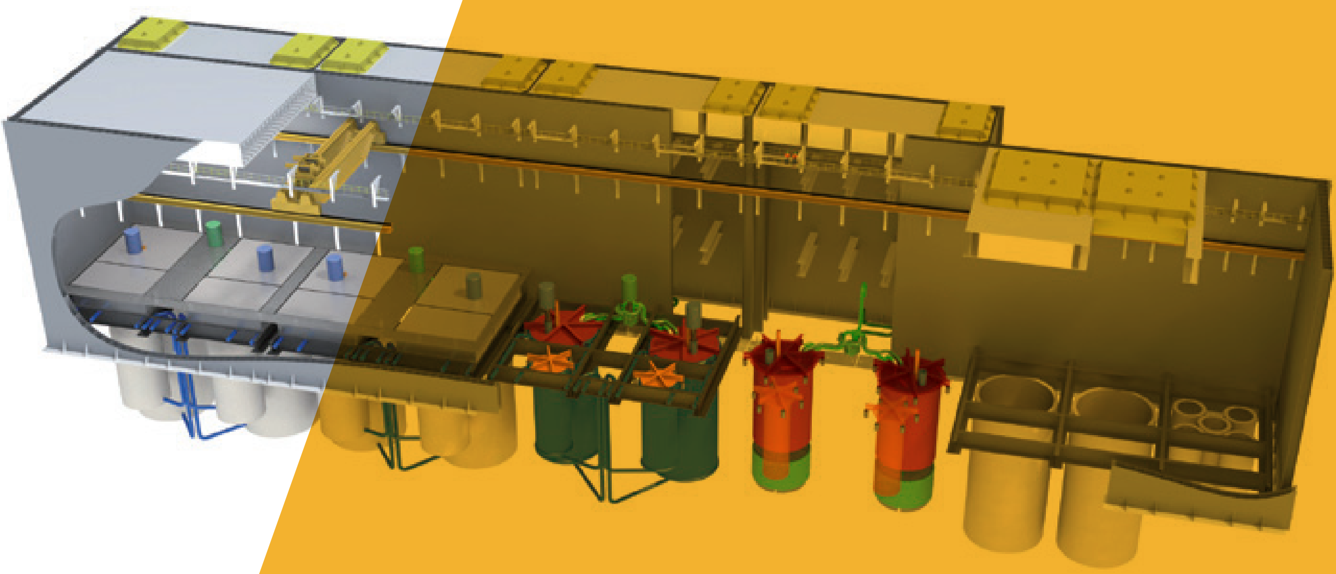

Facilitating International Licensing of Small Modular Reactors

Cooperation in Reactor Design Evaluation and Licensing (CORDEL) Working Group

Small Modular Reactors Ad-hoc Group

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Contents

Foreword

In January 2007 the World Nuclear Association established the Cooperation in Reactor Design Evaluation and Licensing (CORDEL) Working Group with the aim of stimulating a dialogue between the nuclear industry (including reactor vendors, operators and utilities) and nuclear regulators (national and international organizations) on the benefits and means of achieving a worldwide convergence of reactor safety standards for reactor designs. From the time of its inception to the present, CORDEL has evolved from a group of experts discussing how to achieve international standardization in nuclear safety design and standards to an established and recognized working group dedicated to conducting analysis and forging common industry understandings in key areas as input to major decisions on nuclear energy policy.

Over the past several years, Small Modular Reactors (SMRs) have been seen as a promising new option for the nuclear industry. Numerous workshops and conferences have looked at the development of various designs that could be introduced in emerging nuclear countries as well as in mature ones.

The Small Modular Reactor Ad-hoc Group (SMRAG) was created by CORDEL in September 2013 in order to establish a path towards harmonized and well-regulated global SMR deployment.

The objective of this report is to lay out the main issues facing the nuclear industry in the licensing of SMRs and potential approaches on how to facilitate a more efficient way forward. The detailed analysis of the issues involved in constructing and operating SMRs will be covered in subsequent reports by the group.

Members of SMRAG would further like to emphasize that safety levels, as prescribed by national laws, do not differ in relation to the size or type of a plant. As such, while this report looks at how design and licensing of SMRs can be processed in more efficient ways, it is not intended to question the safety levels of any licensed design.

This paper was initiated under the leadership of Danielle Goodman (former Chair of the SMRAG), and completed under the guidance of Kristiina Soderholm (Fortum, Finland) and Tom Bergman (Nuscale, United States), SMRAG Co-Chairs, based on discussions with and input provided by members of the Ad-Hoc Group.

The secretariat would also like to thank the following who contributed to the drafting of this report: Peter Storey, UCLan; Richard Swinburn, Rolls-Royce; Matt O'Connor, EPRI; Nawal Prinja, AMEC; and Simon Franklin, AMEC.

Executive Summary

The CORDEL Working Group established the Small Modular Reactor Ad-hoc Group (SMRAG) in 2013 to elaborate a path towards harmonized and well-regulated global SMR deployment. This group was directed to review the state of the art for this technology and its potential for standardization. Stemming from this review, this report looks at the various issues (positive and negative) that could arise in the licensing process for SMRs, applying the CORDEL concept of a standardized design approval process.

A major reference for SMRAG was the CORDEL report on *Licensing and Project Development of New Nuclear Plants* [1]. This report explores the general relationship between licensing and regulatory systems on the one hand and important commercial project decisions on the other and brings to light some issues affecting new build. SMRs face many of the same issues that any new build project would face. These issues could relate, for example, to: different types of country (large or small, mature or emerging); differences in licensing process (one- or two-step); and types of reactor ('first-of-a-kind', 'first-in-a-country' or 'n^{th}–of-a-kind').

Using the results of this report, the SMRAG has identified important factors concerning the overall approach needed to establish a more efficient and effective standardized methodology to license SMRs. This approach is based on a systematic look at the various requirements needed to obtain a construction and/or operating license.

This report starts by defining what an SMR is and what differentiates such designs from reactors currently being built and operated. Chapter 6 discusses the main concept of the report: what factors are associated with facilitating international licensing of SMRs. This chapter follows the standard licensing path from initial design concept to construction and operating license.

Based on their size, design and construction, licensing SMRs presents unique challenges to the nuclear industry and regulators. The report argues that new approaches are required taking into account that SMRs will employ different fabrication techniques and will enjoy unique construction and operating features.

The final part of the report concludes that the timing is right and there is a valid way forward, if there is willingness amongst the relevant parties to accept a new licensing process for SMRs.

An appendix has been included in the report, providing suggestions for an adaptable licensing process using Finland as a case study.

1 Introduction

The CORDEL Working Group sets up ad-hoc groups from time to time to look at the state of the art in a specific area including reactor design and to assess industry's views on the need to enhance harmonization. SMRs became a focus in early 2010, when a small CORDEL subgroup met to discuss recent developments. While no specific action was taken at that time, it was recognized that work was being undertaken to develop a number of designs for future deployment.

Approximately three years later in 2013, an ad-hoc group was set up based on a significant increase in interest and work on SMRs. The result was a large number of experts from various backgrounds –industry, academia, research – met and discussed the current status. Participants noted the need to contribute to establishing a path towards harmonized and well-regulated global SMR deployment through the issuance of industry position papers on key issues. This work should be coordinated with other CORDEL Task Forces and World Nuclear Association Working Groups and shared with relevant international agencies (International Atomic Energy Agency (IAEA), Nuclear Energy Agency (NEA), etc.). Over a longer term the group cited the need to identify 'commendable practices' and 'lessons learned' from SMR innovations relating to modular construction, licensing, operation and maintenance.

The enormous potential of SMRs rests on a number of factors:

- Because of their small size and modularity, SMRs could almost be completely built in a controlled factory setting and installed module by module, improving the level of construction quality and efficiency.
- Their small size and passive safety features lend them to countries with smaller grids and less experience of nuclear power.
- Size, construction efficiency and passive safety systems (requiring less redundancy) can lead to easier financing compared to that for larger plants. Moreover,
- Achieving 'economies of series production' for a specific SMR design will reduce costs further.

Future reports being developed by SMRAG along with those of international agencies will provide a fuller picture of the benefits.

Current regulatory environments found within established nuclear markets are designed for larger nuclear power plants, and could constrain potential deployment of SMRs. In particular, site-specific requirements may be challenging for repeat build of identical units based on a reference standard design. This report lays out the main issues facing the nuclear industry in the licensing of SMRs and potential approaches on how to facilitate a more efficient way forward.

2 Definition

The need to have a clear consensus on what defines an SMR was identified early on as essential. SMRAG looked at various definitions established by national and international organisations and agreed on the definition below. This definition is closely based on the IAEA and the Nuclear Energy Institute (NEI) definitions and has been fully considered and debated by the group.

Small Modular Reactors (SMRs) are defined as nuclear reactors generally 300MWe equivalent or less, designed with modular technology using module factory fabrication, pursuing economies of series production and short construction times.

At this point, most designs certified or under development are regarded as standardized, apt for series production in factories and more practical for deployment in a greater variety of locations and niche applications than large reactors.

3 Standardized and Internationally Standardized Designs

Since its conception, CORDEL has noted the benefits of having an international standardization of reactors designs. The recently issued CORDEL report on *Design Knowledge and Design Change Management in the Operation of Nuclear Fleets* [5] defines standardization as follows:

'The concept of standardized reactor designs does not require units to be completely identical. Rather all units that use the standardized 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.'

It is envisaged that the reactor modules and primary safety systems for an SMR design would meet this definition.

Whilst some progress in standardization of licensing and harmonization of regulatory requirements has been achieved, we are still far from an internationally standardized approach. This means that there are still significant changes required to designs deployed in different countries in other areas of the plant, even if the physical conditions (seismic risk, water access, etc.) are comparable.

International standardization of licensing as well as harmonization of regulatory requirements has been a goal of several programmes, including those of CORDEL, MDEP (Multinational Design Evaluation Programme) and ERDA (European Reactor Design Approval). CORDEL has looked at international aviation licensing [3] as a model from which good practices can be drawn.

International design certification is a long-term goal for large NPP designs, but this does not necessarily have to be the case for SMRs. Based on their size and design characteristics, SMRs can be seen as an early opportunity for seeking multi-lateral or international regulatory approvals.

4 Unique Features of a Small Modular Reactor

In order to facilitate changes in international licensing for SMRs, it is necessary to understand the features of an SMR design. Some of these features are not unique in themselves and it is only when considered collectively that they provide an understanding of this type of reactor. They include:

- Small power and compact architecture and usually (at least for NSSS[1] and associated safety systems) employment of passive concepts. Therefore there is less reliance on active safety systems and additional pumps, as well as AC[2] power for accident mitigation.
- The compact architecture enables modularity of fabrication (in-factory), which can also facilitate implementation of higher quality standards.
- Lower power leading to reduction of the source term as well as smaller radioactive inventory in a reactor (smaller reactors).
- Potential for sub-grade (underground or underwater) location of the reactor unit providing more protection from natural (*e.g.* seismic or tsunami according to the location) or man-made (*e.g.* aircraft impact) hazards.
- The modular design and small size lends itself to having multiple units on the same site.
- Lower requirement for access to cooling water – therefore suitable for remote regions and for specific applications such as mining, desalination.
- Ability to remove reactor module or in-situ decommissioning at the end of the lifetime.

Thanks to these features, SMRs can also be developed for niche applications including isolated electrical systems (islands, remote areas), district heating and chemical processes.

It is important to note that the term modular has also been applied to new large reactors. When applied to these types of reactors the reference is to modular construction of the entire power plant and not to the reactor and its integral components

These features also raise a number of questions including those related to operational staff requirements, emergency planning zone requirements (in light of reduced radioactive inventory) and other site related issues. These questions are not examined in this report.

[1] NSSS: Nuclear Steam Supply System

[2] AC: Alternating Current

5 Current Licensing Process for New Build

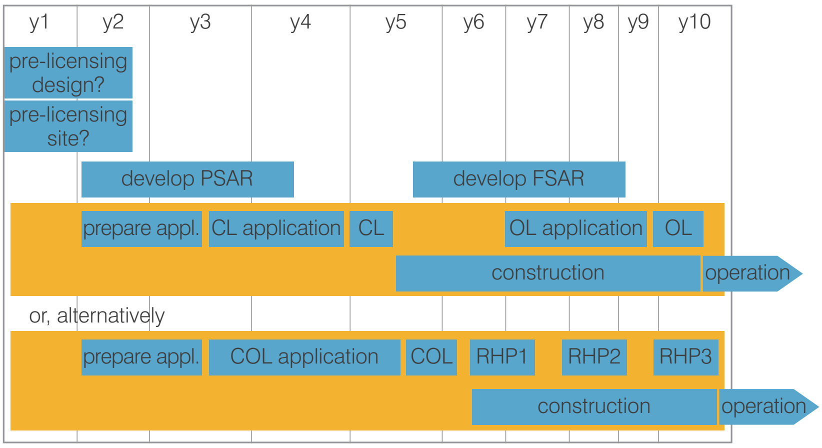
The regulations and requirements that set forth the licensing process for nuclear power plants are prescribed by the national authority and derived from national laws. As laws differ from country to country so do the nuclear regulations and requirements that are used for approving a license. Amending the laws or changing nuclear regulations and requirements is a time-consuming undertaking and therefore is not something that is routinely done.

The various national systems today follow similar paths in approving nuclear power plant construction and operation. The process generally includes the following elements:

- Taking the decision to build and operate a plant;
- Selecting and approving a site;
- Certifying a reactor design;
- Assessing and approving a construction license and an operating license.

As noted in World Nuclear Association/ CORDEL paper [2], 'a reactor vendor offers one or more standard designs. Experience to date has shown that, if a standard design is to be deployed in a country (or countries) other than where it originated, it normally has to be adapted to comply with the national safety standards.' Therefore, while the elements may be similar in nature, the differences in successfully accomplishing them in several countries require expenditure of considerable resources.

The first three elements (sometimes also called pre-licensing steps) may be performed at different intervals and orders, while the last bullet may be performed as separate steps or as one combined approval (see Figure 1). The main difference between the licensing process above and that needed for a Small Modular Reactor would be the design certification step, which for an SMR would be applied to the reactor module and primary safety system.



CL: construction licence
OL: operating licence
COL: combined construction and operating licence
RHP: regulatory hold point (consent, permit, ITAAC....)
PSAR: preliminary safety analysis report
FSAR: final safety analysis report

Figure 1: Major Licensing Steps for Nuclear Power Plants [1]

6 Optimizing the SMR Licensing Process

6.1. Optimization

The modular fabrication of reactor modules for SMRs, along with the fact that units will be identical in design and built in series enables the application of a more efficient licensing process. Accordingly, once the initial licensing process has been performed, the regulator could use the assessments to eliminate overlapping and repetition.

The process described in this report adapts suitable steps from different licensing processes, as well as using selected elements from other industry licensing processes (aviation and railway industries).

This type of process could be easily adopted in newcomer countries, however, a case-by-case study would be required to determine the feasibility of using it in existing nuclear countries.

Existing countries would also have to assess the suitability of current laws and changes required to the current regulatory framework. Major changes required for either of these could pose a significant challenge. A suggestion for such an adaptable schema, using Finland as a case study, can be found in Appendix 1.

The success of such an approach, *i.e.* achieving an internationally transferable reactor module design certification, would lead to the ability to simplify the construction and operation of multiple, identical SMRs on the same site by eliminating the need to review and approve each reactor module separately. However, it would still be necessary to assess other requirements such as multiple operation of reactors using common facilities, common-cause failure modes, site approval, emergency preparedness, security, etc./or revise the existing licenses (such as site approval).

6.2. SMR Licensing Process Step-by-Step

In order to determine the feasibility and applicability of implementing this new approach to SMR licensing, the following sections provide a closer look at each of the major steps:

Decision in Principle

Some countries require that an upfront 'political licence' or 'decision in principle' be made in order to proceed with a nuclear project. This decision is not a license to construct or operate, but is a governmental ruling which, in effect, allows work (non-safety related) to be started. This kind of decision was noted in the CORDEL Licensing Report [1].

While this requirement is not universal - in fact few countries formally implement it – it is seen as very beneficial especially in that it serves to reduce political risk during the later stages of a project. This approach would work the same way for SMRs as it does for current nuclear power plants.

Site Approval

The site approval process would be similar to that used for current nuclear power plants. For example, the Early Site Permit in the USA could also be well suited to SMR licensing. It can also be applied separately from other licensing steps.

More specific to the SMR case would be the need to consider how (or if) the unique features of an SMR would impact the site selection. For example would the smaller output, lower source material, sub-grade installation, etc., affect the size of the site, environmental impact or the emergency planning?

There could be a need for many new sites and some of these sites may be close to cities, thus the influence of public acceptance should not be underestimated.

The Module Design Certification

A Design Certificate in the SMR case would be the certification of the detailed design of the SMR reactor module, including the primary safety systems (Module Design Certification). Each module is assumed to have an independent safety system, in other words from a safety point of view it would not be dependent on the other parts of the plant. It should be noted that there are technical features to be discussed, such as common main control room for multiple reactor modules; however, it is assumed that these features do not affect the proposed licensing process. The module and its safety systems would be standardized during the design phase and the site envelope would be assumed to be suited to most sites. Once certified, the module's design, including the primary safety systems, would not need to be reviewed again as a single module during any specific NPP licensing process.

The Module Design Certification is the part of the licensing process that could be internationally valid or transferable from the country of origin to other countries if the licensing requirements of the module and its safety systems do not differ in practice from one country to another.

With this approach, a module would only need to be certified once. Based on the fabrication of identical modules, the same licence application would be reviewed to verify there are no changes in the design. Therefore, in the case of multiple modules, an SMR plant would only need to go through the module licensing process once.

One potential disadvantage in this approach is the management of design changes over the lifetime of the unit. These would need to be planned as part of the formal change management process. This especially would apply if an operator intended to build a series of reactors in the same plant over a period of time when the changes may occur.

The inherent advantage, especially for newcomer countries, is the separation of the site approval from the design certification. This approach would provide the operator with a less burdensome approval process before deciding on a final technology. Moreover, by obtaining a Module Design Certification that is transferrable to other countries, the approval process in the host country would already be optimized and, hopefully, provide a more cost-effective means of deployment.

Master Facility Licence

For the purposes of this report, a Master Facility License is defined as a legal document issued by the regulatory body granting authorization to perform specified activities related to a facility or activity. In this case facility refers to the complete nuclear power plant including one or any number of combined small modular reactors.

A Master Facility Licence would have a number of beneficial features specifically related to SMR licensing. Modifications that only relate to a reactor module, could be designated as such, and therefore could be reviewed as part of the design certification (or design change management programme). Changes under the Master Facility Licence would then concentrate on safety issues that are common to the whole project (*e.g*. external hazards and common cause failures).

This approach would lead to a more straightforward licensing process. Additionally the project-specific part (Master Facility Licence) would be minimized to reduce repetition in the licensing process. A Master Facility Licence would facilitate approval for operation when approved.

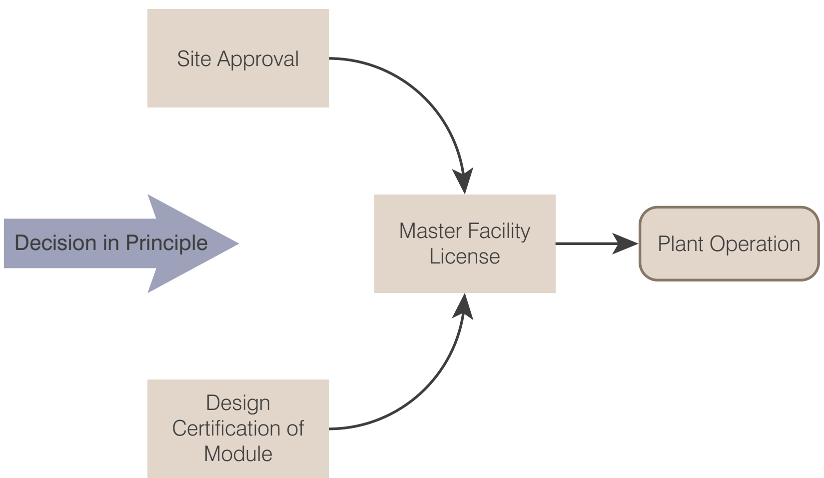


Figure 2: Possible Elements of a Modular Licensing Process for SMRs (Söderholm, K. 2013)

7 Associated Issues

7.1. Factory Fabrication

Series fabrication of (identical) reactor modules may be performed in different ways, including:

- At a factory location in one country for installation in that country or another country,
- At several factory locations in a country for installation in that country or another country,
- At several factory locations in a different country for installation in that country or another country,
- At several factory locations in different countries for installation in different countries

This could require establishing an in-factory certification process which would be recognized at an international level by national safety authorities without additional significant investigation (similar to the certification process of aircraft industry as of today).

7.2. Regulatory Philosophy

Nuclear licensing is a process that demonstrates compliance with applicable requirements, mainly including, but not limited to, nuclear safety and security. Licensing processes vary between different countries. As discussed in WNA Licensing Report [1], this is primarily based on the country's legislation.

There are two main approaches to licencing plants: prescriptive versus goal- setting/performance-based. The prescriptive approach sets very detailed regulatory requirements that a nuclear facility and operator must meet to be licensed. The goal-setting approach sets out a safety target usually in risk terms. In this approach, the licensee must show that the design and operation achieves the set target. The level of safety is reviewed and ensured via a safety analysis or safety case, which demonstrates the safety features in a limiting event.

As pointed out in a previous Report (Raetzke/Goodman 2013 – Reference 13-2-5) the goal-setting approach could make the licensing process more adjustable to take account of different SMR features, such as passive systems.

7.3. Compliance with Design Extension Conditions (DEC)

International nuclear organizations, such as the IAEA, have revised their safety standards and guides in response to the lessons learnt from the Fukushima Daiichi accident and other incidents reported throughout the history of nuclear power. Safety requirements have been updated considering *e.g.* multiple (internal and external) hazards, prolonged power blackouts, availability of cooling water, cooling of spent fuel and protection of sites with multiple reactors.

Design Extension Conditions (DEC) have also gained more focus after the Fukushima Daiichi accident. DECs are to be considered in design, site evaluation, operation, etc. to cater for multiple hazard and multiple failure conditions. This DEC evaluation is closely combined with the Defence in Depth approach. The overall safety evaluation for SMRs needs detailed study and discussion regarding how the current safety requirements are to be interpreted, or if new safety standards are needed.

7.4. Codes and Standards Convergence

Current differences in requirements include:

- Mechanical design codes
- Personnel and procedure qualification

- Materials & analysis requirements
- QA requirements

Manufacturers of large components for power plants throughout the world are used to meeting different regulatory regimes and code requirements. Manufacturers have developed a good understanding of the different codes in order to do so; their personnel are certified according to a range of certification schemes; and specific procedures are adapted for the intended regulatory regime. Similar approaches could be used in the factories manufacturing reactor core modules for SMRs although this would make the economics of implementing this technology challenging. In addition, designs should be able to meet a wide range of regulatory requirements.

7.5. Design Change Management

Since design change management (DCM) will be an important factor in SMR licensing, this should be planned in the early phase of the licensing preparation and handled according to a developed knowledge management process, using a systems engineering approach. It should be noted that if a number of reactors are planned to be built over a phased programme, this DCM provision should be included at the start of the process.

Vendors also have an important role in keeping their designs up to high standards of safety and security and therefore should act as advisors to operators. The type of fleet management as exercised in the aero-industry by companies such as Boeing and Airbus could provide a model. Further discussion is required in a number of areas relating to DCM of SMRs, notably:

- What should be the authority or responsibility of a vendor or manufacturer for managing the changes to a design brought about by technological improvements?
- Could a manufacturing site be licensed in order to exercise component control?

Regarding the change management process for the Module Design Certification itself, the introduction of a periodic review process (*e.g.* every five years) could ensure that operators have the knowledge to update existing plants and to be a knowledgeable customer for a new plant.

7.6. Intellectual Property and Technology Transfer

The adequate protection of vendor and supplier intellectual property would be challenging in the approach being proposed, since openness of the design information would be the cornerstone of international acceptability.

8 Key Challenges

Current licensing regimes do not allow for the cost-efficient deployment of SMRs. If international standardization could be achieved via the CORDEL stepwise integrated approach as described in the 2010 CORDEL report on International Standardization [2], deployment of SMRs would be greatly facilitated. Some of the main challenges to achieving this are outlined in the following subsections.

8.1. Large Versus Small

One of the key challenges mentioned in any debate is size. SMRs, as defined in this report, are 300MWe equivalent or less, while some of the new reactors being built today can produce over 1600 MWe (net).

The challenges for licensing of SMRs are not only confined to the difference in power, they involve some of the design features (modularity, reactor / safety system integration, sub-grade installation etc.). Moreover, whereas large reactors have been built in some multi-unit installations of 4 or 6 reactors, SMRs may be built in clusters of 10 or more.

The proposed approach in this report would minimize the licensing risk and allow SMRs to be licensed as standard designs in many countries. The proposed approach is centred on limiting the scope of the design certification, and separating it from site-specific approvals and operational requirements, thereby allowing for a feasible reduction in the existing differences between countries' licensing practices.

8.2. Regulatory Challenges

The CORDEL Licensing report [1] states, 'The main issue here, regardless of whether a project is in a mature or emergent market, is establishing an adequate regulatory infrastructure with a licensing process which is hoped to be less complicated than for larger reactors.' The report also provides the following broad categories for regulatory programmes:

- Countries with large mature nuclear programmes and market-driven projects.
- Countries with large (often emerging) nuclear programmes and state-driven projects.
- Countries with small mature nuclear programmes.
- Countries with emergent nuclear programmes.

The question emerges as to how countries at differing levels of nuclear regulatory infrastructure can benefit from SMR deployment. An effective international certification scheme should allow for newcomer countries to take effective steps towards building regulatory competence and capacity whilst allowing mature countries to improve their regulatory effectiveness. The CORDEL approach of sharing design assessments to international design certification supports the development of SMRs in newcomer countries by permitting regulators to utilize the state of the art in regulatory practice as well as benefitting from efficiencies. Accordingly, costs would be minimized and safety enhanced through sharing.

8.3. Other Challenges

While this report has focused on technical issues such as design and site selection, other challenges exist and will become prominent as discussions on application and deployment increase in the future. These include, but are not limited to, the following:

- Cross border co-operation: Do SMRs provide a better opportunity for cross-border cooperation by regulators?

- Nuclear Liability: Are the current liability regimes fit for purpose when considering factory production of modules?
- Export / Import Issues: Investigation of issues related to export controls, especially under a licensing regime where design and safety cases have to be exported.
- Implementing the lessons learned of Fukushima and other operating experience.
- Operators / Training: Discussions have noted the potential for reactor operators overseeing the operation of multiple units at the same time. This presents a new issue for licensing operators.

9 Summary

Small modular reactors represent the extension of early design knowledge of reactors into modern technology. In the early history of nuclear power, most reactors constructed were well under the size being looked at in today's SMRs. The introduction of modern technology and modular techniques has led to the potential for deployment of these new designs.

Following a brief overview, the report defines an SMR and then describes its attributes and unique features. This is followed by a discussion on the current licensing process and how a new approach could be implemented for SMRs. The report also provides a look at associated issues, and discusses some of the challenges that will be faced in constructing and operating these plants.

The main recommendation is that a new approach to licensing is justified given the design characteristics of an SMR. This would include adopting a pre-licensing step and then compartmentalizing the licensing process between the site approval, design certification of the reactor module and a master facility license. This 'breaking down' of the SMR licensing process into sufficiently independent 'modules' is a key factor in adapting the license assessment to the technology and would facilitate the deployment of SMRs.

Because of their technology features, it will be possible to have an equivalent standard design certificate that is replicable for standardized module designs. The application of an international standard certificate or at least European standard certificate has been mentioned in different studies over the years [1], and [5], but it has been found to be an almost impossible goal to achieve. Another approach, validating the design certificate from one country to another, has also been proposed by European Reactor Design Approval [6] considering licensing process development for large NPPs in Europe, but never taken forward to date.

This paper contends that, based on their size and design characteristics, SMRs can be seen as an early opportunity for seeking international regulatory approval, and if there is willingness amongst the relevant parties to accept a new process, there is a valid way forward.

An appendix has been included providing suggestions for an adaptable SMR licensing process using Finland as a case study.

As previously noted, it is not the intention of this report to provide detailed analysis of the issues involved in constructing and operating SMRs. Instead, the objective has been to lay out the main issues facing operators in the licensing of SMRs and some potential approaches for facilitating a more efficient way forward. The detailed analysis will be covered in subsequent tasks performed by the group.

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Appendix | Case study: Adaptation of SMR Model Licensing to the Finnish Regulatory Framework

The following is an adaptation of the proposed licensing process into the Finnish regulatory framework. The current Finnish licensing process is built to suit the current licensing framework for large NPP new build projects.

The Finnish licensing uses a two-step-licensing process with Construction Licence (CL), and Operating Licence (OL), with the unique political step in the beginning of the licensing (Decision in Principle) (STUK, 2010). The main modification to be brought in the current Finnish licensing regime would be the adoption of an additional step: *i.e*. the Design Certification of Module (DCM). Such an addition would introduce significant benefits with minimum modification to the entire process. This would change the content of the CL, which could then concentrate on safety issues that are common to the whole plant (*e.g*. external hazards and common cause failures). The idea of the proposed approach is to minimize repetition in the licensing process.

In the Finnish case, modular licensing could be adapted within the current nuclear legislation (Söderholm K., 2013).

With this approach the current licensing process would not necessarily change for large NPPs, but SMRs could use the new approach including DCM to replace part of the CL work.

As the modular licensing process is a general licensing model, it could be adapted in different regulatory frameworks as suitable. The presented modular licensing model could be directly adopted in new nuclear countries. For existing nuclear countries, a case-by-case study would be needed to ascertain whether the main benefits of modular licensing could be introduced without undue changes to the existing regulatory framework.

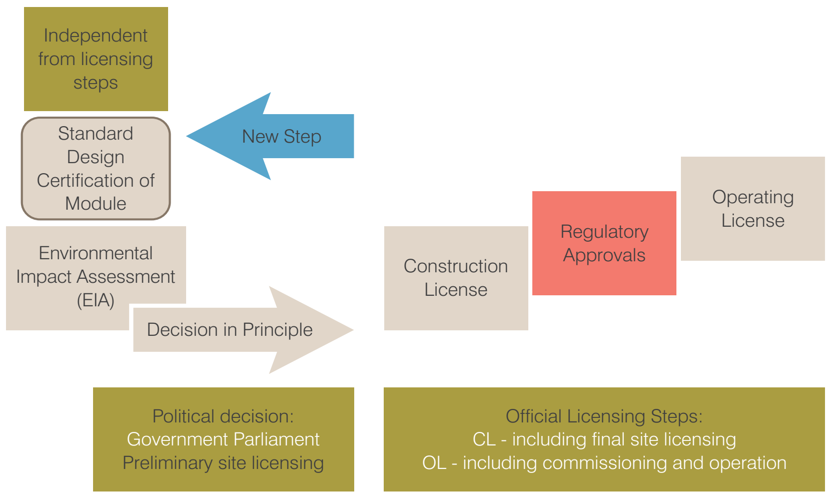

Figure 1: New, proposed licensing process for SMR licensing in Finland (Söderholm K., 2013)

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The Small Modular Reactor Ad-hoc Group (SMRAG) was created by CORDEL in September 2013 in order to establish a path towards harmonized and well-regulated global SMR deployment. The objective of this report is to lay out the main issues facing the nuclear industry in the licensing of SMRs and potential approaches on how to facilitate a more efficient way forward.