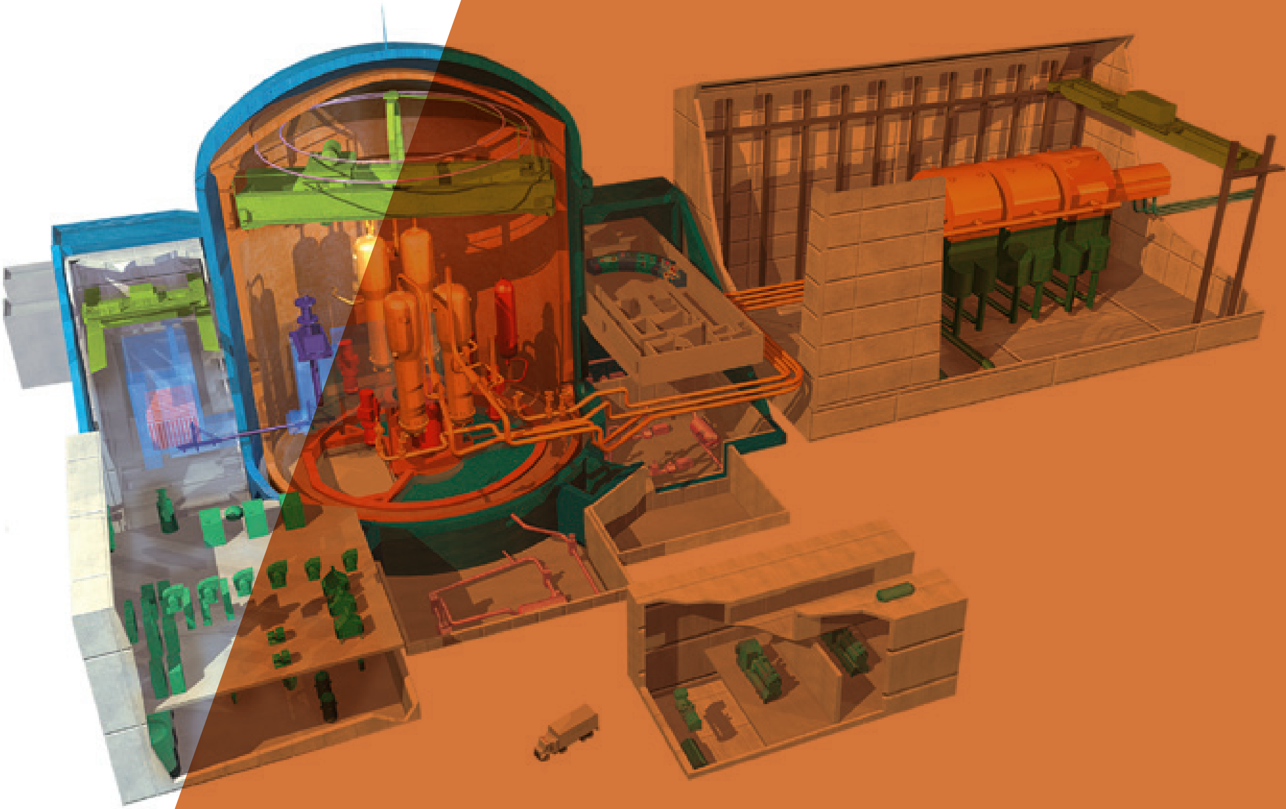

Licensing and Project Development of New Nuclear Plants

Licensing & Permitting Task Force

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Executive Summary

This report is based on the results of a survey of World Nuclear Association (WNA) members. It explores the relationship between licensing and regulatory systems on the one hand and important commercial project decisions on the other. While many documents on licensing procedures exist, the report brings some new aspects into the international discussion on new nuclear build.

In the introduction, the report identifies different categories of new build countries and gives an overview of the main commercial project decisions, such as technology selection, financial investment decision, and contracting or procurement. These project milestones then constitute the chapters of the report.

The results of the survey and the subsequent discussions among WNA members give a comprehensive picture of the relationship between licensing processes and commercial project decisions. This picture is full of variety as members' views and experience depend on the regulatory system as well as the commercial and political environment into which each project is set. For example, in countries with a competitive market and private project developers, there is a strong tendency to reduce risk as far as possible before entering into irreversible commitments. This leads to taking the financial investment decision (FID) and concluding binding full-scope contracts as late as possible in the project timeline. Other countries, with state-owned industries and government-led projects, put less emphasis on these issues.

It is interesting to note that respondents generally felt that predictability and stability of a regulatory system are more critical to making commercial decisions than the adherence to any specific regulatory system. Respondents generally preferred the regulatory system with which they were familiar, and no consensus emerged on any one system.

Nevertheless, some key conclusions and recommendations can be drawn out of the survey results. The most important are:

- The licensing system must be predictable and stable. Pre-licensing of a design or a site is seen as an important feature of a regulatory system, reducing the risk of licensing and making the outcome of a licensing process more predictable. The adherence, as far as possible, of all parties to a pre-agreed timescale is crucial.
- Vendor selection (if applicable) should occur as early in the process as possible, ideally before the construction licence application.
- Particularly in a market-driven environment, contracting consists of a series of steps in which the partners gradually enter commitments. Increased commitment is dependent on the progressive reduction of licensing risk as the licensing procedure goes forward. In less market-driven environments, the survey shows that the 'classic' approach of concluding an early engineering-procurement-construction (EPC) contract covering licensing and construction is still in use. In any case, regulators need to be aware of these circumstances.
- A reasonable level of design maturity should be reached before applying for a licence for a first-of-a-kind (FOAK) project – and, by the time of first concrete, a high proportion of the detailed design should have been completed. The same goes for first-in-a-country (FIAC) projects – a notion introduced in this report.

- A clear and predictable licensing regime makes financing for nuclear power plants easier.
- A formally binding positive decision about a nuclear plant project taken by the government (and possibly parliament) at the outset would remove political considerations from the licensing process, which could then focus on safety issues.
- Design documentation and manufacturing documentation needs to be efficiently and effectively reviewed between all parties involved. Enhanced international standardization and greater cooperation of regulators may be a means to reduce some of the difficulties and to make component manufacturing more predictable.
- On a more general level, international harmonization of safety requirements and standardization of reactor designs could greatly facilitate licensing. Particularly in the case of a FIAC project, implementing a standardized design and using licensing results already obtained in another country would be much easier than starting from scratch. However, there is still a great deal of work to do before this can be achieved.

1 Introduction

Methodology

This report analyzes the results of a survey issued by the World Nuclear Association's (WNA's) Licensing & Permitting Task Force, which is jointly sponsored by the WNA's Cooperation in Reactor Design Evaluation and Licensing (CORDEL) Working Group and the Nuclear Law and Contracting Working Group.

The survey was sent to WNA members in December 2011 and the results were discussed in April 2012 at a Task Force meeting in Helsinki. The Task Force received 15 sets of responses: ten from utilities, four from vendors and one from an architect engineer. In terms of geographical coverage, eight responses came from Europe, four from North America, two from Asia and one from Africa. The regulatory systems of 10 countries were covered by the respondents: Canada, Czech Republic, France, Germany, Japan, Korea, South Africa, Ukraine, UK and USA. Some respondents made occasional remarks on other countries as well.

The report covers the relationship between licensing and commercial issues of new nuclear power plant projects. Recommendations are drawn from the survey responses given by individual WNA members as well as the analysis carried out by the Task Force members. It is anticipated that the Task Force will continue its analysis on some of the topics in this report.

Scope of the survey

As governments develop and implement or update nuclear regulatory programs in response to new nuclear projects, their primary focus is appropriately on safety and security requirements. Developers of new nuclear projects must meet these requirements whilst making important commercial decisions.

Ideally, governments would impose regulatory requirements with a full appreciation of the timing and nature of commercial decisions; and commercial decisions could be made with a complete appreciation of the timing and nature of regulatory requirements.

International bodies such as the International Atomic Energy Agency (IAEA) and the Organisation for Economic Co-operation and Development's (OECD's) Nuclear Energy Agency (NEA) produce standards, guides and reports on recommended nuclear regulatory systems and processes. The main purpose of the WNA's Licensing & Permitting Task Force survey was to collect the views of the nuclear industry on the relationship between nuclear licensing processes and commercial activities (such as scheduling, procurement, contracting, and finance) which need to be carried out during the development of new nuclear projects. The results of the survey presented in this report aim to better define the gap between these two processes.

Licensing processes around the world – managing variety

The survey answers showed that there is great variety in the regulatory structures and the general project environment in countries with new nuclear projects, and commercial considerations need to be tailored to those differences. Two main factors have been identified. The first is the project framework and the regulatory and business model adopted in the country where licensing takes place, for example whether the new build project is driven by the state itself and implemented by state-owned companies or whether the project is conceived and implemented by private industry in a competitive environment. The second factor is whether the reactor is the first-of-a-kind (FOAK) to be built anywhere or the first-in-a-country (FIAC), or neither. Both factors are addressed in the following two sections.

Different types of new build countries

There are many different regulatory and business models but most of these fit into the following broad categories:

1. Countries with large mature nuclear programs and market-driven projects (US, UK, Canada). The main concern in this category is achieving predictability and certainty so that investors and financers can make an investment decision. As the licensing system is already established in these countries, the focus is on identifying elements of the system that either hinder or foster predictability and certainty.
2. Countries with large nuclear programs and state-driven projects (China, Russia, Korea, India). These countries constitute the majority of today's nuclear new build projects. Here, licensing procedure and risk are not as big an issue as in the first category. It is less clear how licensing and permitting regimes can be improved to reduce risk in these countries, but it does seem likely that they would benefit from some improvements in licensing, for example a higher degree of international design standardization or of international cooperation in licensing and oversight.
3. Countries with small mature nuclear programs (Czech Republic, Slovakia, Bulgaria). These programs place a greater reliance on external support, given the limitation of national resources. As for the countries in category 1, predictability and stability is important for countries in this category, as well as for the foreign investors who are invited to participate.
4. Countries with emerging nuclear programs (United Arab Emirates, Turkey, Poland, Indonesia, Vietnam). The main concern in this category – which in itself is very wide-ranging – appears to be an adequate regulatory infrastructure. Within this group, there may be significant differences in approach, for example the extent to which the regulatory system is 'imported' from the vendor country.
5. Regulatory and commercial aspects of small modular reactors (SMRs). The main issue here, regardless of whether a project is in a mature or emerging market, is establishing an adequate regulatory infrastructure with a licensing process that is hoped to be less complicated than for larger reactors. The unique aspects of SMRs in licensing are currently under discussion.

Many of the issues covered in the survey have different relevance for different types of new build countries. For example, in countries with market-driven development (category 1) some commercial decisions are taken only after a thorough assessment of the financial risks involved, including the regulatory and licensing risk. In these circumstances, timing is extremely important. Some financial decisions may be taken only after the licensing process has reached a sufficiently developed status. In countries with state-driven programmes (category 2), commercial decisions tend to be taken right at the outset and financial risk considerations do not seem to play such an important role.

The Table in the Appendix indicates the relevance of the survey items (and chapters of this report) to the different types of new build countries.

First-of-a-kind, n^{th}-of-a-kind, first-in-a-country

The survey responses and Task Force discussion revealed that a major factor for both regulators and new project developers is whether the project under consideration involves a first-of-a-kind (FOAK) or an n^{th}-of-a-kind (NOAK) reactor design. This choice makes a huge difference for both regulatory and commercial decision-making. For example, the question of the degree of design maturity and design completion necessary for making both regulatory and commercial decisions is a primary issue for a FOAK. On the other hand, only site-specific aspects of a design or enhancements over previous projects need to be considered in adopting a NOAK.

A further factor to be taken into account is whether the design is constructed for the first time in a given country. Such a first-in-a-country (FIAC) project may be a FOAK or – more frequently – a NOAK. However, many of the advantages of a NOAK may be weakened if the design is being built for the first time in a particular country – in this case, if the earlier licensing processes in the country (or countries) where the design has already been built are not taken into account, the project may be closer to a FOAK, at least for the licensing processes.

The final chapter of the report deals with international harmonization and cooperation, which would greatly help to maintain the benefits of a NOAK project, even if the design is implemented in other countries. While most respondents are in favour of harmonization of the numerous regulatory schemes around the world in order to help with making commercial decisions, the same respondents said this should not be at the expense of a predictable and stable regulatory regime.

Risk management and timeline

There is a logical progression of necessary commercial decisions that correlate to project implementation. Evaluating commercial considerations of a project against the impact of licensing processes can be accomplished by analyzing the sequence of commercial decisions as steps designed to adapt to progressively reduced regulatory risk and to advance project goals. Licensing processes in their turn can be evaluated according to their ability to support the commercial decisions and to afford certainty and predictability to developers.

As the survey focuses on the interaction between regulatory processes and the industry's commercial activities, the topics in the report are arranged according to this progression of commercial decisions.

The first milestone is the decision to develop a new nuclear project within a specific legal and regulatory framework. A political decision may have been taken, or there may be an incentive provided by the government, to start a particular project.

Next, the project owner will have to select a site and choose a design. Depending on the particular circumstances, one or both of these may be pre-defined so a selection process might not take place. For example, in some countries state-owned utilities might work together with the national vendor; or sites might be selected by the government, rather than by the project developer.

Following site selection and choice of technology, the contractual arrangements must be negotiated. These are closely linked to financing issues and there can be some remarkable differences. In some projects where there is high certainty (for example because the project is defined by government plans and executed by state-owned entities), full-scope contracts will be concluded right at the start. In other instances, especially in market-driven scenarios with private-owned utilities, contracting will be more complicated as the project owners would want to avoid being fully committed to the project from the outset. In these cases, contracting will be an on-going process with levels of commitment increasing as the licensing process develops and the certainty that the project can be delivered on time and on budget increases.

For similar reasons, the financial investment decision (FID) could be taken any time from the very start of the process up to when the construction licence has been granted. Obviously there is a strong link between contracting and the FID: the final contract, involving full commitment, can only be made effective after the FID.

In case of FOAK or FIAC projects, the design development is also an issue. In FOAK cases, the design has to be created before and – to a certain extent which sometimes is not clear – during and even after licensing. In FIAC cases, the existing design may have to be adapted to national regulations, which may involve considerable redesign. In both cases, major parts of the detailed design may have to be carried out after the construction licence has been issued. The requirements of the regulatory authorities in terms of delivery of the design documentation and its approval process may significantly influence the project time schedule – and a precise licensing plan shared by all stakeholders is necessary to achieve predictability. Besides, the ongoing design development will have to be covered in the contractual arrangements with the vendor.

In cases where the FID is taken late, after major stages of design development have been carried out, an elaborate system of preliminary contracts and limited scope agreements will be needed to support design development in earlier stages. This is a good example of the intricate relationship between the different aspects of project development and their interaction with the licensing procedure.

During the construction stage (and sometimes before), components need to be manufactured. This involves complicated systems of quality certification and control and the creation, endorsement and review of documents, with several parties involved (applicant, manufacturer, subcontractors, regulator, technical support organizations). This needs to be managed by the project organization and reflected in the contractual arrangements.

In all stages of the licensing and implementation process, stakeholder involvement is essential, particularly the participation of the public. There needs to be a strong framework for this, ensuring that participation is meaningful but at the same time that issues resolved in an early phase of the regulatory process are not re-opened later on.

Furthermore, enhanced standardization of reactor designs and close collaboration of regulators would help to save time and resources, reduce risk and enhance stability and predictability. Newcomer regulators will learn from their peers, and international fleets of standardized designs will be a better basis for operation experience feedback and for implementation of design improvements.

The structure of this report follows this sequence of project decisions:

- The commercial decision to start within a specific licensing and permitting system.
- Site selection and choice of technology.
- Contractual arrangements.
- Design development – level of detail and extent of completion.
- Financing.
- Involvement of stakeholders.
- Procurement, supply chain, documentation.
- Manufacturing of components.
- International standardization.

2 Structures of Licensing and Permitting Systems

The main structures of any given licensing and permitting system will be taken into account prior to any commercial decision to start a new nuclear project.

With regard to the relative merits of one-step, two-step or multi-step licensing, the survey indicated that commercial developers value predictability and certainty in any system over a preference for a particular system. One-step licensing may offer somewhat more certainty while two-step licensing is seen to allow for more flexibility. In any case, it is essential that the process and decision criteria are well-defined and understood, and that the process offers enough stability so that business decisions are valid for the entire life of the plant.

Accordingly, this chapter gives details on the licensing systems that the survey respondents are familiar with. These systems are evaluated and their advantages and drawbacks analyzed with regard to scheduling, project development and commercial decisions.

Pre-licensing of a design or a site is seen as an important feature of a regulatory system, reducing the risk of licensing and making the outcome of a licensing process more predictable. The adherence, as far as possible, of all stakeholders, including the regulator, to a pre-agreed timescale is another crucial element.

Non-nuclear permitting and licensing adds complexity to the regulatory process and thus may affect commercial decisions. However, it does not appear to conflict with nuclear regulatory milestones. A possible exception is the environmental review, which under some systems appears to partly overlap with nuclear reviews (particularly concerning radiation protection) and could be better coordinated with such reviews.

Figure 1 shows the major licensing steps for a new nuclear plant. A one-step licensing process (such as the combined construction and operating licence in the US) and multi-step process (here depicted as a two-step process with separate licences for construction and operation) are given as alternatives. The timeline is given for illustrative purposes and does not reflect the survey results.

General overview

In the countries covered by survey responses, there are big differences in the regulatory systems including the number of licensing steps and the possibility of pre-licensing.

Looking at the licensing process for a particular nuclear power plant, in seven of the ten countries addressed in the survey there are at least two licensing steps (*e.g.* construction licence and operating licence), and sometimes up to four (*e.g.* a siting licence or a commissioning licence in addition). One country (UK) has a one-step licensing process and two other countries (US and South Africa) offer both options.

There can also be pre-licensing steps, where the regulatory authority gives generic approval for a design or a site, independently of a particular nuclear power plant project. These steps might be referred to as certifications, acceptance confirmations or other terms. The important aspect is that in a subsequent licensing process for a particular nuclear power plant, such approvals can be referenced so that the assessment and evaluation does not have to be done again. There is a range of pre-licensing systems in the countries covered in the survey. Some countries have a strong, legally defined pre-licensing process (such as the US with the design certification and early site permit processes), others do not have one at all, and some have pre-licensing options that do not have the scope or importance they have in the US.

One-step and multi-step Licensing – the differences

The answers show that the number of steps in any licensing process may be less crucial than expected. One respondent stated: “We consider that these two alternatives are not necessarily antagonistic: for example the construction licence (authorization decree) in France signed by the government represents a major step which gives also a good degree of confidence regarding the granting of the operating licence later on.” Another respondent seconded: “It is certainly not a ‘black and white’ situation and the actual difference is probably much less important than what was sometimes said by the promoters of the one-step licensing.”

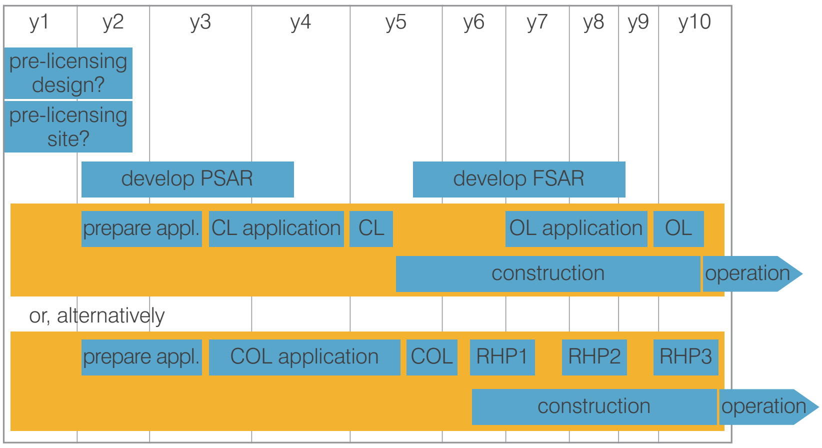
One-step licensing obviously does not mean that the regulatory authority ceases its approval activities after having given the comprehensive licence. There will be a number of regulatory hold points, formally below the level of licences, which in practice are very important milestones. In the UK, for example, there is only one licence – the nuclear site licence – but this is rather formal and sets the framework for a system of regulatory consents at pre-defined milestones. The overall requirement is for “adequate arrangements” to control work related to the construction and operation of nuclear plant. In the case of the US combined construction and operating licence (COL), the licensee must complete inspections, tests, analysis and acceptance criteria (ITAAC) that are specified in the licence and report completion to the Nuclear Regulatory Commission (NRC); this is a major regulatory hold point. In addition, each licence contains “licence conditions” which must be achieved prior to stated milestones as well as programs which must be established and implemented prior to operation.

Generally, there seems to be a distinction between ‘hard’ hold points, pre-defined in regulations and involving formal consent by the regulator, and ‘control points’ which are not contained in regulations, but proposed by the applicant. If the regulatory authority agrees with these control points, it makes them mandatory by including them in the licence. In some countries (*e.g.* UK), the emphasis is on the latter approach, with the applicant/licensee controlling activities at agreed hold points and the regulator only ‘controlling the controller’.

The same goes in multi-step licensing – for example the construction licence may contain regulatory hold points established for critical construction or manufacturing items and incorporated into the project schedule (Canada).

Altogether, it seems that the number and sequence of regulatory hold points is more or less independent of the number of formal licensing steps. And, as a vendor noted: “The number of hold points in the procurement and manufacturing process has the tendency to increase in all countries.”

In some countries, there is a choice depending on whether the applicant wants to submit a safety case for the entire life cycle of the installation or whether it prefers to submit safety cases with limited scope (South Africa). Similarly, the US offers the choice of the COL process (10 CFR part 52) or the traditional two-step process with a separate construction licence and operating licence (part 50).



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 a Nuclear Power Plant

Table 1: Pre-licensing and licensing steps in different countries

	Pre-licensing	Licensing steps
Canada	(Licence to prepare site) Pre-Licensing Vendor Design Review: an optional service provided by the CNSC (Canadian Nuclear Safety Commission) when requested by a vendor	1. Licence to prepare site 2. Licence to construct 3. Licence to operate
Czech Republic		1. Site licence 2. Construction licence 3. A number of 'small' licences for particular commissioning stages 4. Operating licence
France	ASN (Autorité de sûreté nucléaire) opinion on safety options (review of safety options)	1. Authorization decree for the creation of a basic nuclear installation 2. Licence for the commissioning of the installation
Germany	'Pre-statement' on project aspects (*e.g.* design) in the Nuclear Energy Act but never used	1. Construction licence in several steps (the first one being a type of design approval) 2. Operating licence in several steps
Japan		1. Site selection phase: environmental review 2. Preparation phase for construction: reactor installation licence, safety examination, construction plan 3. Construction phase: pre-service inspection, operational safety program 4. Operation phase: periodical inspection, safety inspection
Korea	Standard design approval for new design	1. Construction licence 2. Operating licence
South Africa		Both options (one-step or multi-step) are available. Depending on the application, the NNR (National Nuclear Regulator) could issue the following types of authorizations for nuclear installations: a) Nuclear installation licence (NIL) to site, construct and or operate or decontaminate or decommission the installation b) Nuclear installation site licence (NISL) for new installations c) Nuclear authorization to design a nuclear installation d) Nuclear authorization to manufacture components/parts
Ukraine	Operator can ask authority to do a safety review of a design Feasible sites are on a list to be established by government	1. Construction licence (including commissioning) with afterwards a number of regulatory hold points (*e.g.* first delivery of nuclear fuel, first criticality, commissioning, experimental operation phase) 2. Operating licence
UK	GDA (Generic Design Assessment)	Nuclear site licence. Establishes hold points/consent points, typically: • First nuclear concrete • First nuclear island construction • First fuel brought to site • Start of active commissioning
US	Design certification Early site permit	10 CFR part 52: COL (combined construction and operating licence) 10 CFR part 50: 1. Construction licence 2. Operating licence

One-step or multi-step licensing – the preferences

When asked about their preference, all respondents seemed to be quite happy with the system they have – everyone indicated a preference for the one-step or multi-step system they already have in place.

In the view of proponents of a one-step system, this gives more certainty and reliability. At the time the first concrete is poured and the main expenses are incurred, the fact that there is no further licence to be applied for gives comfort to project developers. However, this advantage might not apply to all nuclear power plant projects. One respondent made the point that the advantages of a single-licence process are more apparent for standardized plant built at several sites, where "licensing/design finality after the first unit makes the remainder of the units very predictable," whereas for single units and unique technology applications, "a two-step process can be advantageous as the licensing process can proceed while detailed design and some construction is underway." Another respondent emphasized that a COL gives more certainty, "given enough lead time to a project and not a FOAK project." Finally, one respondent stressed that the one-step licensing approach needs a previous generic design approval (such as the US design certification) and the existence of standardized design.

Proponents of a two- or multi-step system stressed the fact that it gives more flexibility and that it may allow for an earlier start of construction. Besides, it was stated that activities and responsibilities of the operator are very different during construction and operation. One respondent, who left the question of preference open, stated that a two-step licence has higher risk but, on the other hand, the separation of licensing and construction may result in simpler project management. In any case, it was identified that it is necessary to make sure that the existence of several steps does not lead to uncertainty and issues being re-opened. The potential drawback of the two-step system – lack of certainty that an operating licence would eventually be issued – needs to be balanced by a system that ensures a smooth transition from construction to operating licence. As one respondent put it: "The preference would be an integrated two-step system which allows for transition from one licence to another with minimal risk or regulatory burden." Finally, as for a one-step procedure, the benefits of a previous generic design approval and of the deployment of a standardized design were stressed.

In summary, the survey demonstrated that, from a developer's perspective, it is more important that the process is understood (predictable) and stable (certain) rather than whether it is one-step or multi-step.

Pre-licensing

Generally, pre-licensing of designs or sites is seen by the nuclear industry as an effective means of enhancing predictability. Pre-licensing allows for an important part of licensing to be resolved by the time the licensing process for a particular nuclear power plant starts. A confirmation statement by the competent authority can give potential project developers confidence that they can implement the project.

The most clear-cut and well-known example of generic pre-licensing of designs and site is the US NRC design certification and early site permit. Both documents have a certain legal and binding effect which stays valid for a certain number of years.

This is not the case for some other pre-licensing processes. In Canada, the regulator can be asked to perform a pre-project design review of a new reactor design in order to assess compliance with Canadian regulatory requirements and identification of any fundamental barriers to licensability. However, as a survey respondent points out, this is not very formal nor is it legally binding and the applicant cannot rely on such reviews for licensing purposes. Similarly, in the UK, the Generic Design Assessment (GDA) was created by the regulator without legislation. Its aim is to improve predictability by reviewing potential designs and assess whether they will be able to be licensed once site-specific factors have been taken into account. The nuclear and environmental regulators have "undertaken not to re-review matters considered in the GDA process as long as there are no safety significant design changes," which is obviously less binding than the US design certification. Similarly, the "review of safety options" done by the French regulator ASN is expressly stated by ASN not to be binding. Nevertheless, in practice the ASN would, in a subsequent licensing process, not contradict its own "review of safety options" statement unless there is a compelling reason to do so.

It also became apparent that the terminology is not entirely clear and that it may be difficult in some cases to assign a regulatory statement to the pre-licensing or licensing phase. Concerning design approval, this should be rather straightforward: if a design is approved upon application by the vendor (not the operator) and if it is approved independently of a specific site, then this is clearly pre-licensing. Legally speaking, it is not a 'licence' since it does not authorize the vendor or anyone else to construct a nuclear power plant of this design. Nevertheless this is sometimes seen as the first step of the overall licensing procedure. To give an example, one respondent from the UK qualified the UK process as a two-step process, with the Generic Design Assessment and Nuclear Site Licence processes; whereas the conventional definition is that the Nuclear Site Licence is a one-step process with GDA as pre-licensing. The two French respondents qualified the French process as two-step, with authorization decree (DAC) as the main licence plus the operating permit; however, one respondent noted that the French regulator ASN defines the French system as a three-step process by including the previous generic 'review of safety options'.

Concerning the approval of a site, the distinction between pre-licensing and licensing may be less apparent because normally the owner/operator is applicant in both processes. However, the difference is that in pre-licensing the site is assessed against an envelope of criteria and not against the parameters of a specific design. A model for this is the US early site permit. In Canada, the survey answers seem to suggest that the licence to prepare a site can be done according to design-independent criteria, which would qualify it as pre-licensing. In the Czech Republic, the site licence is the first step of the legal licensing procedure for any particular nuclear plant.

Alignment of schedules

The WNA members were asked whether in their view a formal integrated schedule – agreed in advance with the regulators – would be beneficial or viable, and whether they thought mandatory deadlines for steps by regulators could be feasible.

In some countries, there is a scheduling process between applicant/licensee and regulator, in others not. Most respondents make the point that mandatory deadlines for regulators are not feasible because the regulator has to complete his thorough safety review before granting any licence. Deadlines and schedules (to be extended when justified) may have the function, however, to put some responsibility on the regulator to plan his budget, resources and activities in a manner to make compliance possible. The practical answer to these conflicting requirements is accurate anticipation of work by all parties (regulator, licensee and vendor).

Keeping to time schedules is stated to be particularly challenging for FOAK projects. These require maximum efforts from all parties involved, concerning both the quality of submissions and the quality and timeliness of review.

Causes for delay can be due to a lack of sufficient communication, underestimation of effort required, an initial application that lacked quality or was incomplete, requirements changing during the licensing or construction process, political changes, reactions of the public (contested hearings, appeals against licences), delays in regulatory assessment of the applicant's safety case, and limited resources of the regulator for multiple projects.

Duration of licensing steps

When asked about the time needed for preparation of a licence application and for the licensing procedure, the answers varied to a high degree.

For a multi-step procedure, nine answers were received, with the following ranges:

- Preparation of application – 12 to 48 months.
- Construction licence process – 12 to 40 months.
- Operating licence process – 6 to 36 months.

For a one-step procedure (COL), four answers were received. Here, the range of answers was as follows:

- Preparation of application – 12 to 24 months.
- COL (US) – 24 to 60 months, depending on whether the COL is a first or a subsequent one. For the UK Nuclear Site Licence the timeframe seems to be somewhat less.

This wide range between responses might be at least partly due to the various national regulatory and licensing systems in place. For example, the longest preparation times were given by respondents from Germany (48 months) and Ukraine (36 months). This possibly reflects the fact that there was (Germany) or is (Ukraine) no design certification process. There might also be a trade-off between the time taken for preparing the application and the actual licensing process. In Germany and the Ukraine, the duration of the licensing processes as indicated by the respondents is somewhat below average.

The range probably also reflects the different situations that the respondents had in mind, whether they dealt with FOAK and/or FIAC reactor construction or with NOAK reactor construction; the latter situation would obviously involve a reduction in licensing times.

As some respondents pointed out, it is difficult to make a clear distinction between preparation time and licensing time. Both will overlap: preparation of documents and their regulatory review go simultaneously. Therefore, the overall time period may amount to less than the sum of preparation and licensing phases indicated by respondents.

A final aspect may be the tendency to reduce risk as far as possible before starting construction, which may result in project developers investing more time in preparing and handling the licensing process.

In any case, the fact remains that there are significant differences in the answers which cannot be explained merely by a different depth and length of safety review.

Nuclear safety requirements in licensing

This question is aimed at whether respondents were satisfied that they had sufficient certainty concerning regulatory expectations and requirements and knew what was expected of them.

The answers show that some regulatory systems are more detailed and prescriptive than others but generally respondents claimed to be able to cope with their systems. For example, the UK guidance, which is well known for its non-prescriptive, goal-setting approach, was described as "providing adequate guidance without being prescriptive."

Some countries have only high-level requirements. On the design safety level, there may be room for applying requirements from the country of origin of the chosen design (South Africa). Some respondents emphasized the fact that the licensee has the responsibility of defining his "owner's requirements" in the contract with the vendor (Canada).

Again, the importance of good upfront communication with the regulator is stressed in order to minimize differing interpretations of requirements.

Comparing the three groups of requirements addressed by this question (design safety requirements, site requirements and requirements on the applicant), it seems that the last group (requirements on the applicant) is most susceptible to unclear regulations. Part of this issue is that 'soft' requirements like safety culture cannot be defined in great detail and are open to interpretation. A similar issue is the requirement on the licensee to be an 'intelligent customer' and to retain a sufficient level of design expertise ('design authority'). Such a lack of clear requirements is not seen as a big problem but one respondent proposed some work on international standards (which may question whether existing IAEA and INSAG[1] documents are known well enough or whether they indeed need to be revised).

One respondent noted that in his view it is not beneficial to prepare 'sophisticated' regulations (in the sense of detail). He instead proposed working on a common understanding of requirements by regulators and industry and common evaluation of design prior to the licensing process.

Even if requirements are clear and well understood, there may be arguments about practical implementation. One respondent noted that the best solution is a NOAK project with a clear reference project.

[1] International Nuclear Safety Group, a group of experts convened under the auspices of the IAEA which issues highly relevant recommendations and opinions. See http://www-ns.iaea.org/committees/insag.asp

First-of-a-kind and n^{th}-of-a-kind

Almost all respondents who have had experience with a series of nuclear plants confirm that the schedule of the following units ("n^{th}" units) is shorter than that of the first one. A country with significant experience in this respect is France. In the US, the concepts of 'lead plants' and 'one issue, one review' help to generally shorten time schedules for all subsequent plants.

Some respondents, however, caution that site-specific aspects should not be neglected and may limit the shortening of the time schedule.

Non-nuclear permits

There are a number of key non-nuclear permits required for nuclear projects, and the survey attempted to identify those most important to commercial considerations. From the various answers given, environmental permits emerge as the most relevant (for example, US Section 404 Clean Water Act permit). In addition, there are planning/zoning permits, construction authorizations applicable to any large infrastructure project, grid connection permits, and so on. At some stages, the applicant must demonstrate/obtain the necessary rights and titles, for example the public domain concession (France).

The majority of respondents agree that some of the non-nuclear permits are time critical for the project. Most also agree that some non-nuclear permits should be in place before the FID is taken. One respondent noted the practice in his country that the availability of certain key permits must be confirmed before the FID. The actual delivery of these permits will take place afterwards.

In general, there does not appear to be any contradiction or duplication between the nuclear licence and any particular non-nuclear permit; however, the different licensing and permitting schemes can be complicated and confusing. Some respondents hint at difficulties in the radiological impact assessment which may be treated both in the nuclear licensing and the environmental permitting processes.

Sometimes non-nuclear permits may be subject to special political interference or to appeals and can therefore bring an element of uncertainty into the entire project.

Considering the parallel handling of nuclear licensing and non-nuclear permitting processes, effective coordination of authorities seems essential to avoid any omissions or undue duplication. In the regulatory systems covered by the survey, there appears to be no issue with coordination amongst authorities. Sometimes there is a lead authority, for example the US NRC. The NRC Environmental Impact Statement includes a list of permits that either have been obtained or must be obtained prior to certain activities for a nuclear power plant project. Sometimes the nuclear licence can only be granted if all other requirements have been met by the applicant. This sometimes simplifies the procedure (Germany) but it can also be a problem for the nuclear regulator. In Canada, for example, a site operation licence requires that all laws of the land (municipal, provincial and federal) must be complied with in addition to the laws and regulatory requirements for nuclear power. The potential issue is to determine how the regulator ensures that those laws (of the land) are addressed and met. Problems such as these underline the importance of clearly defining the competencies and duties of all authorities involved in the licensing and permitting processes.

3 Technology and Site Selection

After an initial decision to proceed, two early commercial considerations are site selection and choice of technology. The role each commercial decision plays in the licensing process varies widely among jurisdictions. In market-driven systems, site selection and choice of technology are key commercial decisions that form the basis for entering the licensing process.

Concerning technology selection, the survey responses emphasize the need to make a choice as early in the process as possible, ideally before the licence application.

Site selection

Site selection decisions must be made particularly early in a free-market system where the developer (as distinct from the government) chooses the site, because much of the necessary site-specific information requires years to develop (for example, information on site-specific hydrology, seismology, meteorology). For this reason, some countries, such as the US, have created an early site permit process to enable a developer to bank a site for potential future use. This enables a critical regulatory decision to be made in advance of a significant FID.

In some countries, such as the UK, site selection is an initial governmental decision reached in advance of a commercial project.

Vendor (technology) selection

Some respondents indicated they had not carried out a vendor selection process, obviously because the technology was pre-determined from the beginning of the project. In some countries (Russia, France, Korea), choice of technology is linked more to national policy than commercial considerations.

Those respondents that did carry out a vendor selection process unanimously recommended that this be done as early as possible. At the latest, the vendor should be chosen before the actual licence application is made. Indeed, a licence application must be based on a specific design and many issues in the licensing process depend on the technology chosen for the project. One respondent also pointed out that the owner must establish his ‘intelligent customer’ capability early on, and be able to demonstrate this to the regulator during the licensing process. Some answers seem to suggest that it is theoretically possible to go into licence application with several designs but this would lead to substantial additional costs. These costs would be particularly high in a non-prescriptive licensing regime (UK).

Some respondents commented on the relationship between a design certification/approval process and vendor selection. If the applicant has the choice between several pre-approved designs, it seems this can slightly prolong the time window in which the applicant can keep the choice open, because it can refer to the existing approvals/certifications.

In other countries, it is the reverse: the regulator will not make a design assessment and certification until a design has been chosen by the applicant (Ukraine).

One respondent suggested that political influences may delay technology selection, leading to the problem that some project workstreams would have to go on without this selection. On the other hand, it may be disadvantageous for the vendor to be selected very early, if the first licensing steps (for example the Environmental Impact Assessment) take very long and the contract is more or less idle during this time. However, this may be taken care of by contractual clauses.

One respondent makes the point that the necessity of early choice of vendor applies only to the NSSS vendor. For other contracts, the choice may be made later.

4 Contracting

As soon as the technology/vendor is chosen, contracts need to be signed. Over the last few years, a system of contractual steps has become more preferred to single contracts. Particularly in a market-driven environment, contracting now consists of a step-by-step process in which the partners enter into commitments at each step, as risk gradually reduces in line with the progress of the licensing procedure. In less market-driven environments, the survey shows that the 'classic' approach of concluding an early full-scope engineering-procurement-construction (EPC) contract covering licensing and construction, is still in use.

The Task Force initially considered – but later rejected – the merits of developing 'standardized' contracts similar to the concept of standardized plants. The survey results confirm it is not practical to develop such contracts due to the large range of factors driving commercial considerations in specific projects.

General

As is well known, there is a variety of implementation models used for nuclear power plant projects, the main types being turnkey, split package and multiple package contracts. The survey results show that there is no strict interrelation between the overall licensing approach of a country and the implementation model/contractual approach. No respondent stated that any particular implementation model could not be used with a certain licensing system.

At the same time, respondents make the point that the contractual arrangements do have an impact on the way the licensing process is implemented. For example, a turnkey contract puts more responsibility in the licensing process on the vendor. A multi-lot contract shifts the responsibility more to the owner and its architect engineer. As is also pointed out, regulations put a minimum responsibility on the licensee ('intelligent licensee', 'informed customer', 'design authority') which cannot be delegated to the vendor, even in a turnkey arrangement. However, new ways of sharing design responsibility between operators and vendors may be needed (as investigated by the Design Change Management Task Force of the World Nuclear Association's Cooperation in Reactor Design Evaluation and Licensing Working Group)[2].

Generally, fit-for-purpose contractual arrangements help define roles and responsibilities and make the licensing process more efficient. Naturally, licensing milestones and steps have to be taken into account in developing the contractual arrangements. For example, one respondent noted that contracts of main components are concluded after the regulator's acceptance of the safety inspections and that this acceptance is the condition for finalizing the plant's specifications. Another respondent made the point that a lack of pre-defined and 'prescriptive' requirements in the regulations of his country made it impossible to include plant specifications in the contractual model at an early stage.

Timing and sequence of contracts; pre-contracting

In most projects, the contractual situation evolves to some extent as the project unfolds. Initial contractual arrangements need to be in place for the licence application, as this is not possible without the support of the vendor. On the other hand, at this point in many projects the FID has not yet been taken (often it will occur once the construction licence or COL has been

[2] *Design Change Management in Regulation of Nuclear Fleets*, WNA Cooperation in Reactor Design Evaluation and Licensing Working Group (July 2012), http://www.world-nuclear.org/uploadedFiles/org/reference/pdf/CORDEL_Design_Change_Management_Report.pdf

issued) so – according to the majority of respondents – it is not feasible to commit to full project implementation. Generally, the approach in these cases seems to be to commit to contractual obligations stepwise, as the risks connected to each step become understood and controlled.

Such an approach may lead to a decoupling of the licensing phase from the actual construction phase, which seems to be a major development over the past years. To try to eliminate, or at least mitigate, the risk of the regulator taking de facto control of the construction schedule, several project promoters have concluded that the only remedy is to change the way the main phases of the project are sequenced.

Thus a two-stage reactor contracting scheme is emerging. The first-stage contract will cover engineering and preparation works and will include the bulk of the licensing work. The real construction would be covered by a separate contract. This new approach results in a lengthening the overall time schedule between the start of the first phase of the project up to commercial operation. It might well be that under some regulatory environments this way of proceeding is the only realistic method for controlling the regulatory risk.

Following this approach, a number of respondents split the contractual approach into a pre-contract with limited scope, focussing on licence application, and a final contract which is concluded after the licence has been issued and the FID has been taken. The pre-contract might be referred to as an 'early works agreement' or 'early contractor involvement'. The same situation is reached by another model where one contract is concluded before the licence application, but with several parts, the later ones conditional on milestones being reached. For example, one respondent identified in the contract a limited work authorization (LWA) phase and final notice to proceed (FNTP) phase. If the LWA phase does not result in a construction licence, the FNTP phase will not be released.

According to the respondents, the pre-contracts aim to:

- Enable the submission of the licence application.
- Achieve cost and schedule certainty for design and construction.
- Define the customer's specifications and to adapt the design accordingly (*e.g*. to the specific site conditions).

In some cases, the government is involved and imposes some prerequisites on the pre-contract (US).

In this system of entering stepwise into contractual obligations, some respondents suggest that large components (long-lead items) may be a difficulty because they may have to be ordered before the licence is issued. However, no generic solutions for this are suggested. One respondent makes the general statement that "the safety-related equipment contracts can be placed when the risk of change through the licensing process is understood."

In contrast, some respondents seem to take a generally different approach, suggesting that final contractual arrangements are taken at the outset of the project. As with the early FID (see above) this model seems to be feasible for projects with state ownership or strong state management. For example, in the Ukraine the contracts are signed after Parliament has taken the decision to implement the project.

In line with this, there were different views about whether the desire to control project risks leads to early or late conclusion of final contracts. The answers seem to depend on slightly different notions of risk. Some respondents feel that licensing risks could be better managed if binding and comprehensive contractual arrangements were concluded early on, as this forms a firm framework in which all parties know what is required through the entire project. Those respondents active in a competitive commercial environment (such as the UK) focus on their own risk of entering into costly financial commitments at a time when it is not yet entirely clear whether the project will succeed. Consequently, those respondents agreed that the final contract should be concluded as late as possible, with pre-contracts with limited scope filling the gap in between.

Concerning pre-licensing activities (design certification), this is not automatically part of a contracting scheme for a particular project since it is a generic exercise and in most cases the vendors, and not the future operators, are the project owners. It would seem to depend on the situation whether there is a direct contractual relationship with a future applicant/licensee ('sponsor') at this stage or not. In some countries there might be a co-application from the vendor and an architect engineer (*e.g.* in the UK). In France the regulator would normally respond to the application of the licensee but it is also willing to review the direct application of a vendor (an example for this is the ATMEA1 safety review).

Pricing methodologies and the licensing regime

As the aspect of pricing methodologies is somewhat commercially sensitive, some respondents chose not to give any answer. However, most respondents did answer and gave some generic views.

Some respondents indicated there is a connection between the licensing system and pricing methodologies: to the extent the licensing system provides for certainty and predictability, it becomes easier to make lump sum pricing arrangements. Quite naturally, in this group of respondents there are differing views between operators and vendors. Operators seem to prefer lump sum arrangements even more when licensing is uncertain, in order to transfer as much risk as possible to the vendor, whereas vendors would prefer reimbursable models.

Other respondents stated bluntly that there is no connection whatsoever between the licensing system and pricing methodologies. Instead, one respondent suggested that options for pricing methodology may rather be predetermined by the legal regime of public tender than by the licensing regime.

Generally, any uncertainty in the licensing process will have to be dealt with in the pricing arrangements. The same respondent suggested that contractual clauses are based on current licensing requirements; in case any new requirements are established by legislation after the contract is signed (which could lead to design modification of the plant), there would have to be arrangements about who bears the additional cost.

Some answers also made clear that pricing methodologies may evolve and change as the project unfolds. Some pricing methodologies require a minimum level of certainty and may, for example, only be the preferred option when the design is completed or when the licence has been issued.

5 Design Development

Throughout the course of the project, the design undergoes some specific steps: basic design, detailed design and procurement specifications (the latter can be more or less included in the detailed design). All this applies to a full extent only to a FOAK project – or, to some extent, to a FIAC project, namely when the design has to be adapted to specific national regulations and some redesigning is necessary. For a NOAK project or for a FIAC project where the regulatory system allows for an 'international' design to be taken over without national safety requirements necessitating major redesigning, the design may be ready from the start.

Two main questions arise. One is the timing of the design development steps and their relationship to licensing phases and to contractual arrangements (EPC contract). Here, the survey again gives a range of solutions which largely depend on the given regulatory system and commercial environment.

The other question is closely connected to the first: a crucial issue for FOAK projects is to what extent the design needs to be developed at the time the construction licence or COL is issued. While there is a consensus that some maturity of design is beneficial or even necessary for licensing and that a certain degree of completion of the detailed design should be reached at the time of first concrete, the percentages of design completion actually suggested vary considerably.

Timing of design development steps

Respondents were asked to give their views on the timing of the three design development steps – basic design, detailed design and component specifications – in relation to licensing milestones (application and construction licence) and the main contract (*e.g.* an EPC contract).

Respondents were not provided with a definition of basic design or detailed design. The responses reflected their own definition or practice, which might partly explain the variations in responses.

Four respondents indicated the order (with some slight differences) given in Figure 2.1. According to these respondents, the design must be essentially finished at the time of the licence application. The EPC contract comes much later, after granting of the construction or combined licence.

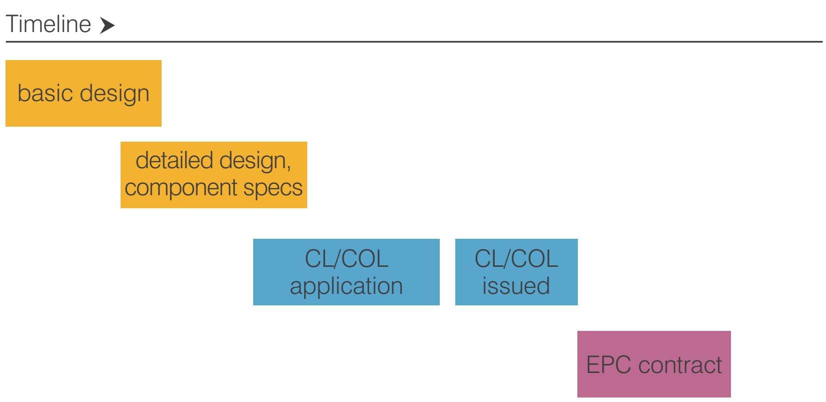


Figure 2.1: Timeline of design development steps, variant 1

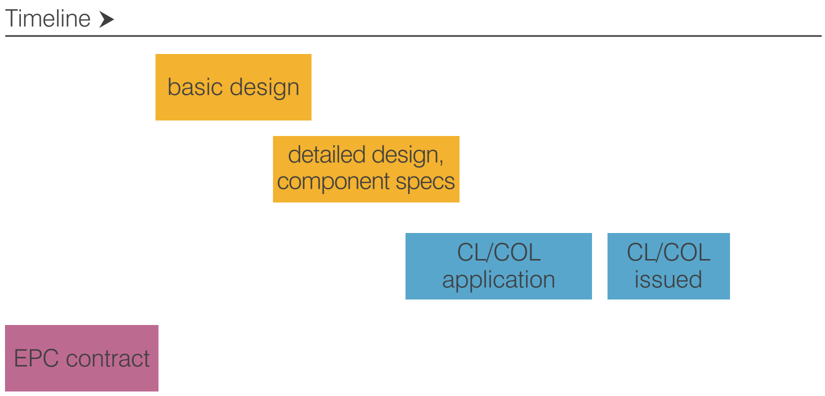


Figure 2.2: Timeline of design development steps, variant 2

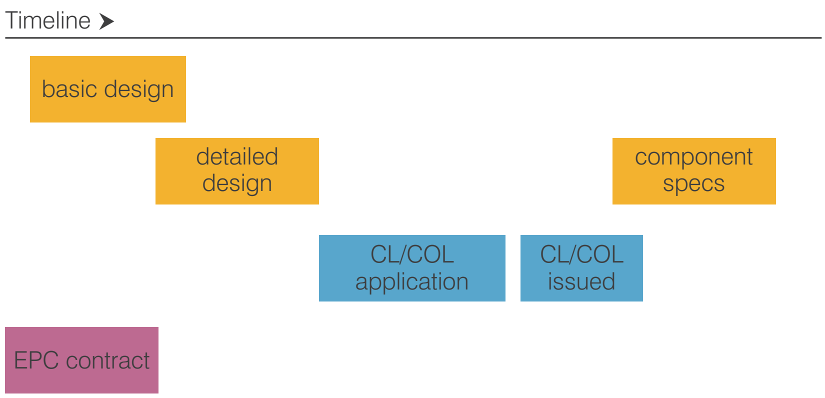


Figure 2.3: Timeline of design development steps, variant 3

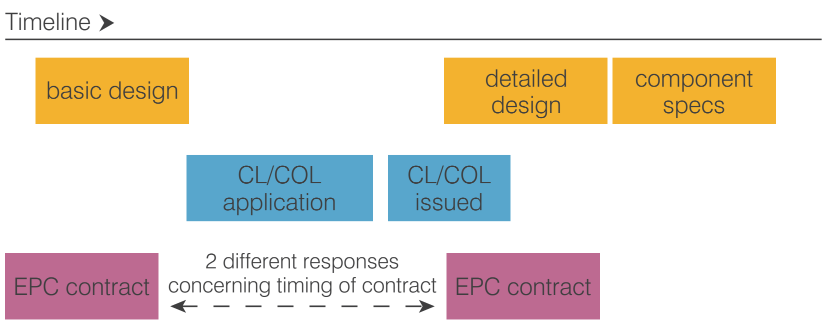


Figure 2.4: Timeline of design development steps, variant 4

Four other respondents had a similar order of design development steps as related to licensing, but placed the EPC contract at the outset of the procedure instead of after the licence has been issued (see Figure 2.2).

The issue of timing of the EPC contract – whether it is right at the start or as late as possible, only after the construction licence/COL has been issued – is covered in Chapter 4. The sequence shown in Figure 2.2 reflects the traditional way to handle construction of nuclear plants for which an owner-architect engineer or a vendor would take the responsibility from the onset of the project up to the end through a full turnkey contract. However, as explained earlier, the present trend at least in market-driven environments is to shift the final investment decision to a later time of the project when key licensing milestones have been reached.

Two respondents had the order of events shown in Figure 2.3, which deviates from the one shown in Figure 2.2 only by giving a distinct place to the preparation of component specifications, which takes place after the licence is issued.

Two respondents gave an order of events where the detailed design would come only after the construction licence has been issued. The respondents, however, had differing views on the timing of the EPC contract (see Figure 2.4).

Finally, one respondent took the view that component specifications should be prepared before the detailed design is finished (see Figure 2.5).

This respondent added: “It is possible to finalize the long lead item equipment specifications as soon as the key structural integrity questions have been resolved with the regulator.”

Looking at the large variety of answers, once again it seems difficult to draw conclusions because the respondents had different project organization schemes and different regulatory conditions, and they may have also had different notions of basic design and detailed design.

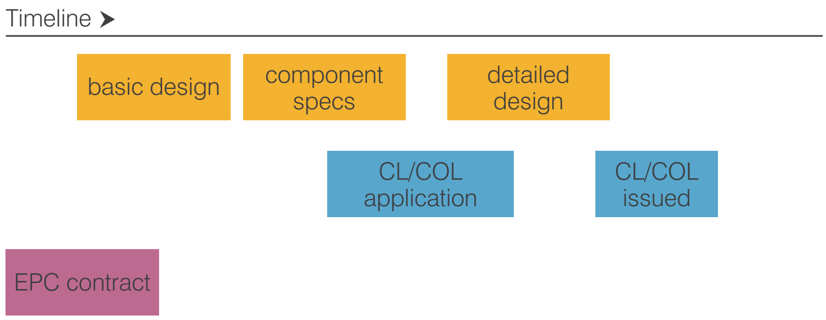


Figure 2.5: Timeline of design development steps, variant 5

Table 2: Duration of design development steps as indicated by Survey respondents

Basic design	Detailed design	Component specifications
2 years	5 years	Typically around 2 years (during the first phase of the detailed design)
5 to 10 years (from scratch)	3 years	3 years
Several months (modification of standard design)	Several months to years	Several months to years
1 to 2 years depending on design (which could be preceded by a pre-project design phase)	~ 3 years	~ 3 years
For a nuclear plant where the basic design is ready (as technology)	Around 2 to 3 years	Perhaps 1 year; can be done simultaneously with detailed design
2 to 3 years	2 to 3 years	Included in detailed design
5 to 7 years depending upon the licensing process	2 to 4 years	1 to 2 years
3 years	3 years	2 years
12 to 18 months	22 months	22 months
There is a 1-year period after design approval where the basic design is updated with site specific and owner’s requirements	2 years following the basic design, but in parallel with the preliminary works and early construction	It is possible to finalize the long lead item equipment specifications as soon as the key structural integrity questions have been resolved with the regulator
Several years	Several years	Several years. Detailed design and component specifications together: More than 4 years in total

The situation is of course depends very much on whether it is a FOAK, FIAC or NOAK design. Nevertheless in all cases the trend is the same. The design completion ratio is a key factor to facilitate the licensing. Quite obviously, it is much easier to meet a high completion ratio for a NOAK design than for the other cases. For a NOAK construction project it even seems possible, while keeping risk at a low level, to place the EPC contract upstream of all the other phases.

The most complicated case is the FOAK/FIAC construction for which staggered development phases with most of the design work performed in advance of the construction is the most recommendable sequence. Clearly, some respondents had this situation in mind when they answered.

Time needed for design development steps

Concerning the length of time needed for the different steps, the responses were given as shown in Table 2.

Concerning the basic design, once again a large variety of answers was received. Some respondents did not give any duration for the basic design at all as the basic design was obviously supposed to be in existence and offered by the vendor as soon as the project starts. Others seem to have taken into account only the time needed to adapt a pre-existing basic design to the project. Others clearly had in mind the entire process of basic design, starting from scratch.

Concerning the detailed design, a qualitative analysis gives the majority of responses ranging from around 2 to 3 years.

Concerning component specifications, the problem seems to be that these tend to overlap with the detailed design phase. Some respondents expressly indicated that component specifications are included in the duration given for detailed design. Other respondents may have been of the same opinion without expressly stating it, especially those who gave the same duration to component specifications as to detailed design.

Design completion

The issue of how far a design should be completed before application for, or granting of, a construction licence or COL is rather specific to FOAK and, to some degree, FIAC projects.

One respondent argued that this is a clear advantage of the NOAK projects when they are possible. Generally, an investor should have a natural wish to develop a consistent fleet of reactors whenever possible.

The same respondent stated that for FOAK or FIAC projects the licensing plan needs to be defined and agreed between the stakeholders concerned. Different scenarios for the licensing and the design completion can be envisaged in this case. The safest solution for all parties is to achieve a large part of the detailed design before licensing; however for obvious reasons it is also the solution which will lead to the longest overall schedule. Finding the right balance to suit all parties is a matter of compromise.

All respondents agreed that design maturity is highly important and beneficial for licensing and construction, and that a relatively high degree of completion of the detailed design should be reached at the time of first concrete. On the other hand, there may be advantages of obtaining an ‘early’ licence.

Some respondents say it is difficult to reconcile the aim of design maturity at the time of licensing with other aspects. One is the fact that, in many cases, the FID and conclusion of final contracts take place only after approval of the construction licence. For the optimal design maturity, it would be necessary to contract much earlier with the engineering companies. Another respondent wrote that the licence should be obtained as early as possible to ensure public acceptance before substantive financial decisions are made. A US respondent made the point that US applicants have an interest to obtain the licence rather early in order to secure financing, gain political support and ease public controversies. According to this respondent, completion of detailed design after licence approval is possible.

Several respondents suggested that not only is the percentage of design completion important, but also what is covered by this percentage. As one respondent stated: “The amount of detailed design for licensing is weighted to systems/components with the most significant impact on safety for the particular design.”

Some respondents mention the role of the Preliminary Safety Analysis Report (PSAR). This is a prerequisite for the construction licence and cannot be obtained without the design having reached a certain degree of maturity.

Some respondents emphasized the benefits of having completed the design certification process before actual licensing starts. One respondent from the UK stated that the generic design approval accounts for about 80% of the detailed design even before any site-specific aspects have been introduced. This greatly helps in licensing as well as contractual negotiations with the vendor. Other respondents from the UK made similar statements.

UK respondents also made the point that the UK Nuclear Site Licence is not fixed to a stage in the design process and therefore does not suppose a specific degree of design completion. It is more of a formal step that establishes the 36 standard licence conditions and defines hold points for future regulatory consents where the actual evaluation process will take place. This is obviously different in other countries, where the licence supposes a safety evaluation which requires a certain degree of design information to be available.

Some respondents stated that a multi-step approach gives more flexibility in that the detailed design can continue after the construction licence has been issued and construction is underway.

Given the very sophisticated scope of answers balancing the benefits of licensing a (largely) completed design against the benefits of earlier licensing, it is not surprising that the respondents differed considerably in their estimates of the degree of design completion needed for a construction licence/COL. The responses, arranged in order of magnitude of design completion, are as follows:

- The basic design completion required to support design approval/certifications is approximately 10-15%.
- 30% design completion for CL.
- CL or COL can be obtained with about 30 % of the design completed.
- 40% of detailed design complete at first concrete (however, difficult to achieve in practice).
- An estimate of completeness would be 60-70% complete before issuance of construction licence.
- 70% would be ideal (but it is important which 70%).
- Suggest 70%.
- The basic design should be better than 90% complete at the point of licence award.
- For first concrete, a detailed design maturity of approximately 95% needs to be achieved.
- Ideally, the design should be 100% complete prior to the submission of the construction licence application, but it may not be practically possible.
- Detailed design completion (100%) (and safety analysis report) is necessary for the construction licence to be issued.

There seem to be three groups of opinions: one requires about one-third of the design to be completed, the second about two-thirds, and the last full or near-full completion of design before the relevant licence is issued. All three groups seem to be fairly balanced in terms of respondents.

One respondent said that figures are not very meaningful. Instead, he argued that the detailed design for almost all the civil works should be available. This means that main piping routing is defined and therefore the choice of the main components should already be made. The respondent acknowledged this is difficult to reach and theoretically results in a longer schedule.

A basic issue concerns the level of design completion the regulator requires before allowing the start for ‘irreversible’ construction or manufacturing activities. One respondent explained that this has to be addressed and agreed between all parties before the contract is signed. The list of required documentation for full design completion, the required timing for, and licensing significance of, each document, as well as the procurement time schedule must be part of the contractual arrangements. The respondent also stressed that the overall schedule should be reviewed by the regulator upfront and that the regulator should, to some extent, commit to this.

In addition to the reasons given above, there may be other explanations for the wide spread of answers. Some respondents give a percentage of basic design, some of detailed design, some just of ‘design’ completion – all of which might lead to different results. Furthermore, respondents are used to different licensing systems and might also have different understandings for what is meant by ‘design completion’.

Concerning the detailed design, it is important to find ways to progressively freeze the detailed design through milestones that are agreed in advance with the regulator – who should commit to not review the design again.

6 Financing

The main issue in this section is the timing of the financial investment decision (FID) and its relationship to the main licensing steps. The situation is similar to contracting (and indeed both aspects are strongly linked, as the main EPC contract supposes that the FID has been taken and the project developer has resolved to enter into full commitment). Again, the main question is whether the FID is taken before the licence application or only after the licence has been issued. Both views were given by respondents – again depending on their national regulations and the commercial and market environment.

Another question is whether the licensing regime has any impact on the availability of financing. There seems to be a connection in the sense that a clear and predictable licensing regime makes financing easier.

Financing mode

When asked about the financing of their projects, all respondents essentially referred to balance sheet financing, partly with additional elements such as participation of foreign investors or government loans/loan guarantees and borrowing and debt financing. There seems to be no example of a pure project financing approach. In a regulated environment, cost recovery mechanisms (like in some US states) or state funds financed by a portion of the electricity price play an important role.

Financial investment decision

From a commercial perspective, the FID is a vital milestone. According to one response, it can be defined as "the decision to mobilise the capital and means to carry out a project." The survey asked at what stage of licensing the FID is taken and what prerequisites need to be in place.

The responses show that the main decision to be taken by a project developer is whether the FID should be taken before or after the construction licence. As one respondent noted, this depends on the investor or group of investors, and on their degree of experience and risk appetite. Because final contracts can only be concluded after the FID has been taken, the question of timing is strongly connected to the question of early or late contracting discussed above.

As might be expected, two diverging sets of answers were received on this question. A number of respondents stated that the FID can only be taken after the CL or COL has been issued because only at that point has a sufficient degree of certainty been reached. As one respondent noted: "The main final contracts will only enter into force following delivery of the CL. As a general rule, it may be said that in order to take the FID, it is necessary to have a sufficient view over the economic state of the project in order to estimate cost." Even after the CL or COL has been issued, one respondent believes an additional project review is required, to evaluate specific financing plans based on the prevailing market conditions, policy and regulatory considerations. One respondent identifies the environmental authorization as a prerequisite for the FID, another the Preliminary Safety Analysis Report.

Other respondents take the opposite approach and locate the FID much earlier, at the outset of the project. This seems to be the case when the nuclear power programme is supported by the state and largely depends on a government decision to proceed, or on the government's long-term energy plan.

Does the licensing regime have an impact on availability of finance?

Generally, the respondents state that the licensing system must be predictable and stable in order to give certainty to investors. One issue is the length of the licensing and construction process which, if too great, exposes the investor not only to increased financing costs, but also to inflation and foreign currency risks. Therefore, all elements of uncertainty leading to delay should be avoided as much as possible. One respondent mentioned prolonged public hearings as a potential risk leading to delay and possibly to changes in regulatory requirements which are not justified on technical grounds.

Some respondents claim that a non-prescriptive, goal-setting regulatory regime such as in the UK leads to some uncertainty and that this enhances the importance of licences and permits to be obtained before the FID can be taken. Another respondent suggests that more prescriptive requirements do not automatically give more certainty.

Yet another respondent suggests that a non-prescriptive approach eases financing: "Certainly, a less prescriptive licensing process and fewer formal stages before a plant is placed into operation benefits the cost of obtaining funds (interest charges) and minimizes the effects of inflation on construction materials and plant equipment." Similarly, another respondent states that financing would become easier with "more flexibility" in the licensing system.

Financing and the regulator

While regulators clearly require the applicant/licensee to have sufficient financial means to guarantee safety – which seems to be more relevant for the operating licence than for the construction licence – the responses show that regulators do not interfere to any significant extent with the financing scheme and that the FID is not a milestone the regulator would necessarily want to look at. Should any problems occur during licensing and/or construction due to a lack of financial resources, the regulator has its own tools to ask for improvement or to stop any activity by the applicant/licensee.

7 Involvement of Stakeholders

Involvement of stakeholders is an important aspect of a nuclear new build project throughout the timeline of the project.

The government is an important stakeholder (if not a shareholder) and a formally binding positive decision about the nuclear plant project at the outset may ease licensing by relieving the licensing process of political considerations and allowing it to focus on safety issues.

During licensing and sometimes even before the licensing procedure actually starts, the public will be involved. Laws and regulations define the extent of mandatory involvement of the public; this tends to increase. The main issue seems to be how to balance meaningful public involvement with the necessity to take basic decisions early in the project and not to open them up for discussion again at a later stage.

After licensing decisions have been taken, law courts may play a role if appeals are filed. All stakeholders in the licensing process must take care that sound and well-documented decisions are taken so they will successfully withstand scrutiny by the courts.

Role of government

By taking a formal and binding decision at an early stage in the project, a government can give comfort to investors that the necessary licences will be issued (provided of course no technical reasons emerge that would result in refusal of the licences). A well-known example for this is the decision in principle in Finland which is taken by government and confirmed by Parliament. One respondent mentioned that the Finnish system in his view is a good model because it separates very clearly the political phase (feasibility study, public involvement, parliament decision) from the technical phase.

Again, the aspect of giving certainty to investors is more relevant for projects in a market-driven commercial environment. The survey responses made clear that for projects developed by state-owned organizations and/or driven by government, the necessity of a formally binding government decision is less pronounced.

An early strong statement by the government has nothing to do with the independence of regulators (a point made by some respondents). An early decision in principle by political bodies does not relieve the regulator of its task and duty to decide whether the planned reactor complies with safety regulations.

In some countries there is a binding political decision. In France for example, the government establishes the multiannual investment programme (PPI - plan pluriannuel d'investissement) which identifies the need for a new reactor. Afterwards, the authorization decree is adopted by the ministers responsible for nuclear safety and thus represents a governmental decision. For the UK, respondents presented slightly diverging views. While one respondent said there is no formally binding decision, others mentioned the national policy statement on energy infrastructure as such a document. This may be a problem of defining what "formal and binding" means.

There seems to be a range of governmental programmes and decisions which is not formally binding but which can be used as a basis for nuclear power projects. For South Africa, a white paper with a clear government statement was mentioned. In Canada, there is a government directive establishing a target share of nuclear in the electricity mix of a province. In Japan, the utilities execute the projects in accordance with the energy policy of the government.

In other countries there is no government decision. This was the case in Germany at the time the nuclear plants were built. In the Czech Republic, there is only a programmatic statement by government with no binding effect. In the US, the government likewise does not take decisions about nuclear projects. In these countries, respondents nevertheless seem to be generally happy with the situation: US respondents mention their trust in the stable regulatory framework. Several respondents stated that there is a supportive political environment and that the risk of negative political interference is considered to be low.

Participation of the public

Almost all respondents stress the fact that early and adequate public involvement is essential. They are mostly satisfied with the transparency achieved in their countries.

Fairness in the process of public consultation certainly is a vital factor for acceptance of nuclear projects. At the same time, it seems crucial to achieve a balance between meaningful public participation and the fact that basic decisions need to be taken early in the licensing process and should not be revisited later. Perhaps a principle could be established that public participation should coordinate with the steps of the licensing process, concentrating on the early phases when the basic decisions are taken, and that discussions, once they are resolved, should not be re-opened later. As one respondent noted, it is essential to separate the 'political phase' (which should include the participation of the public) from the 'industrial phase'. In the industrial phase the public should be informed of the project progress in full transparency, but the project's merits, previously discussed in the political phase, should be protected from being put into question once again.

In some countries, the public is consulted once (*e.g*. Germany), in other countries this happens several times as the project unfolds (*e.g*. UK). In most countries, site selection and the environmental impact assessment (EIA) processes constitute the main opportunities for public participation. In some countries, there is an initial public consultation even earlier. In France, the process of public debate (débat public) requires the developer to submit to the National Public Debate Commission a file presenting the objectives and main characteristics of the project, including its social and economic impacts, estimated cost, and an identification of the significant impacts of the project on the environment or on town and country planning. Only after this debate has taken place and the commission has summarized the results can the developer file its licence application.

There may be an issue with parallel authorization processes leading to repeated public involvement. One respondent mentioned that the public is consulted during the EIA as well as the nuclear licensing process. The respondent stated it would be preferable to have public involvement in one consolidated process. Such a consolidated process exists, for example, in Germany, where the EIA is incorporated in the nuclear licensing process and there is only one public enquiry serving both purposes at the same time.

Because licensing and permitting processes often involve public participation, important project milestones tend to intersect with public involvement. In a project environment where the investor gives high priority to reducing risk as far as possible, before entering commitments, major project decisions such as the FID can therefore only be taken when both the licence has been granted and the public consultation has taken place. Survey answers made it clear that the timing and extent of public information and participation are established in laws and regulations and do not depend on the project developer. Nevertheless, a distinction can be made between the legal requirements for public consultation and the voluntary efforts of the project developer to engage the public beyond the legal requirements. For example, one respondent explained that utilities hold explanatory sessions for the local population.

Role of law courts

When asked whether the project schedule was at any point influenced by an appeal (in a law court) against a regulatory decision, some respondents said yes, others no, and some said that, though it hasn't happened yet, it could be possible.

Those countries where projects have actually been delayed are Germany and the US. In the US, there is currently a contention against a COL application which will require a contested hearing. According to one respondent, this hearing is likely to add about six months to the COL application review schedule. In Canada, an appeal against a site hearing process has been filed.

In France, there were several cases of judicial reviews but the law courts did not grant an interim order (which would have affected the project schedule) and eventually dismissed the claims.

The best way of coping with the risk of appeals is summarized by one respondent: "The potential of appeal of a regulatory decision is a known risk to the project and a reason to ensure sound regulatory decisions, clarity as to the scope of each decision, and a regulatory process that allows for involvement of external participants in a practical manner throughout the review preceding the decision. This may extend the regulatory process leading up to a decision, but will minimize the risk of delay after the decision."

Other issues

Two respondents mentioned the issue of transboundary consultation of governments and the public. This seems to become more and more important and has to be taken into account by project developers.

8 Procurement, Documentation, and Manufacturing Oversight

Procurement is a stepwise process with integrated decision-making based on pre-defined requirements and factors such as regulatory review, design progression, economic and financial review and commercial procurement activities. As with contracting and the FID, the right timing can be an issue.

Design documentation and manufacturing documentation needs to be efficiently and effectively reviewed between all parties involved. The answers given by the respondents reveal a great variety of measures aimed at making sure this happens.

As to manufacturing, there is again a timing issue. On the one hand, the project developer is 'on the safe side' if relevant qualifications, reviews and approvals are fully completed prior to manufacturing. On the other hand, this may put a strain on the project schedule. One of the outcomes of the survey in this respect is the suggestion to take more 'flexible' solutions into account and to proceed on a case-by-case basis, provided regulations leave room for this. Issues such as these are felt most acutely in the case of long-lead items.

Enhanced international standardization and greater cooperation of regulators may be a means to reduce some of the difficulties and to make component manufacturing more predictable.

Timing of procurement

Several respondents made a connection between FID and the decision to start manufacturing and construction. Some stated that the construction licence or COL must first be in place. At least the regulatory framework required for the acceptance of those components needs to be set up and agreed by all parties – which might itself be a significant challenge.

Some respondents explained their hold point system and the prerequisites for giving the green light, other than the necessary permits being in place. It follows from several answers that procurement is a stepwise process with integrated decision-making based on pre-defined requirements and factors such as regulatory review, design progression, economic and financial review and commercial procurement activities. One respondent put special emphasis on quality management processes which must be in place and agreed with the regulator before any safety related processes can begin. This is demanding and time-consuming, as well as critical for the schedule, but later on it saves time and gives more certainty by defining the roles of all parties. Generally, there were different statements about mandatory involvement of the regulator in procurement. This seems to reflect different approaches to licensing and regulation.

Another respondent mentioned a government requirement for localization of procurement, which will lead to delays due to the fact that local industry has to be ramped up to comply with nuclear standards.

Managing documentation

Experience shows it is essential to make sure that design and manufacturing documentation is efficiently produced, communicated and reviewed (before and after manufacturing) by the relevant parties: applicant, contractor, subcontractors and regulator. The respondents stress the importance of this and offer a wide range of aspects and solutions to be considered:

- Strong architect engineer.
- Efficient document management system.
- Sufficient resources for all parties involved to ensure timely review of documents.
- Procurement plan.
- Support by qualified suppliers and vendors.
- Quality assurance system.
- Correctly translating regulatory requirements and owner's requirements into documents – "it is fundamental to get the design requirements captured in the right way." Here, a pre-licensing design review is helpful.
- All parties should agree early on in the schedule to a comprehensive list of requirements.
- Challenges to be managed proactively by vendors and by owners' groups.
- Using lessons learned from previous projects.
- Adequate attribution of responsibility to all parties for consequences of wrong decisions.
- Regular meetings between relevant parties.

The main message seems to be the importance that clear processes are in place to attribute responsibilities and roles, and that requirements are clearly established and understood by all parties.

Long-lead items

For long-lead items, early procurement is necessary, if possible with an exit clause in the contract. This is again a good reason for licensing to take place early on in the process.

In case orders for long-lead items are placed before the (construction) licence is obtained (which is the standard situation for FOAK or FIAC projects), there may be a risk that components manufactured before the licence is granted run into non-compliance with the licence once it is issued. Obviously, one solution would be to agree on specifications with the regulator before orders are finalized.

Some respondents seek the regulator's approval for the specifications of long-lead items before ordering them, others do not. Those respondents who replied that they do not agree specifications beforehand and proceed at their own risk can mostly be attributed to countries with a state-driven nuclear development programme (*e.g.* Ukraine, Korea).

If previous consent of the regulator is needed for ordering components, the scope of the consent can differ from country to country. In some countries the regulator has to agree with the specifications (either in broad terms or in full detail). In other countries, the regulatory consent encompasses quality and safety management systems, which allows leaving the detailed specifications to a later phase.

In other systems, it seems the regulator cannot relieve the licensee of risk by giving a manufacturing consent before the licence is granted. In these cases, the decision whether to wait or to place an order is with the applicant. If it decides to proceed, it will try to negotiate with the supplier to reach a satisfactory sharing of the risk.

In this context, pre-certification of design is again important. Major specifications may be part of the design certification so the applicant can confidently go on with ordering the components. This is especially important for FOAK components. As respondents pointed out, in the US the design certification is expected to be at a level of detail to permit preparation of procurement specifications and construction and installation specifications. Procurement specifications need not be developed at the time of certification, but the level of detail would support such development, with more detail being added later in the procurement specifications. The US NRC does not require applicants or licensees to submit procurement specifications for review. However, the NRC may audit procurement specifications or the information that would be contained in them[3].

Some respondents stress the important role of an independent inspection body. Clearly, the role of such bodies varies greatly from country to country.

Component manufacturing oversight

Concerning component manufacturing, the answers give a range of activities carried out by the regulator, authorized inspection bodies, the vendor or the licensee. Those mentioned are:

- Review of component specifications.
- Qualification of manufacturing programme.
- Qualification of manufacturer.
- Approval of quality assurance (QA) programme (licensee and manufacturer).
- Inspection and oversight during manufacturing.

Not all activities are used in all regulatory environments. In Korea, for example, the regulator does not review component specifications. In France, there is no qualification of manufacturers as such; instead, the manufacturing programme is qualified.

If there is qualification of the manufacturer, it is generally done by the vendor or the future operator (licensee) and reviewed by the regulator.

The degree of regulatory review seems to vary. One respondent suggests this is a question of confidence between operator and regulator.

Obviously, the degree of involvement of the vendor and the owner/licensee is also a function of the contract (EPC/turnkey or multi-lot with owner's engineer).

One respondent indicates some key principles to be enforced as part of the supplier selection process:

- Availability of multiple qualified suppliers.
- Proven suppliers.
- Nuclear qualified.
- Full suite of capabilities to manufacture equipment depending on its nuclear class, testing requirements; and suitable quality assurance and quality control facilities.
- A 'lessons learned' database.
- Not too many exceptions to specifications.

Concerning timing, on the one hand there seems to be a consensus that the relevant qualifications, reviews and approvals should be completed prior to manufacturing in order to reduce risk. On the other hand, some respondents suggest that this may put a constraint on schedules. They advocate introducing more flexibility

[3] As an example, see US-NRC regulations in 10 CFR 52.47

– by offering a choice – and/or to proceed on a case-by-case basis. For example, one respondent stated that the 'ideal' order would be to first fully agree the specifications of the component and then qualify the manufacturing program based on the agreed specifications. However, according to this respondent it is not always possible to proceed in this way. Therefore, there should be an option to depart from this general principle and, for example, to start qualification before the full specifications are available. In this case, the owner would have to prove later on, when the specifications are completed, that the qualification complies with them (which puts a certain risk on him). In some jurisdictions, however, this may not be possible since regulations state that specifications and qualification must be fully in place before manufacturing.

The survey also addressed the issue of the role of the regulator in inspection and oversight during manufacturing. There seem to be some slight differences from country to country in the regulatory approach, whether the regulator is 'deeply involved' or not. Some respondents stress the responsibility of the licensee or vendor. One respondent clearly stated that in his view the level of regulatory inspection is too high. Another respondent said that in his country, participation of authorized inspection bodies is agreed before manufacturing starts and that for some components a system of witness and hold points is put in place. The respondent believes this is good practice, however he says the licensee has to foot the bill of the inspection body which is "quite expensive".

An interesting aspect mentioned by some respondents is the development towards international component manufacturing oversight, for example through the Multinational Design Evaluation Programme (MDEP). In the long-term, harmonization of requirements and strong cooperation of regulators could lead to 'off-the-shelf' manufacturing of large components, meaning that components do not necessarily have to be destined for one particular nuclear plant, but could be employed in a range of projects of the same design. This would obviously ease the scheduling issues mentioned above.

Another interesting issue raised was that, in the case of a 'deferred' construction project that has been revived after a long pause, there is the issue of regulatory approval for using equipment which has been stored for a long time or was supplied for a slightly different design.

9 Support for International Standardization

International harmonization of safety requirements and standardization of reactor designs could greatly facilitate licensing. Particularly in the case of a FIAC, implementing a standardized design and using licensing results already obtained in another country would be much easier than starting from scratch and re-doing the entire assessment. However, there is still a long way to go to reach this aim, as the survey answers show.

Another issue covered by the survey concerns the point at which reactor design standardization would be most beneficial and would have the highest impact. For example, the site qualification and selection stage would likely not be directly influenced by international standardization, whereas reactor design licensing or procurement would tremendously benefit from making use of already existing approvals and qualifications.

International standardization of reactor designs would mean that each reactor design, regardless of its country of origin, could be built in every country with few changes, if any. Changes should only be due to site-specific factors and to specific requests by the operator, and not because the national regulations of the host country are different from those of the design's country of origin.

Therefore, standardization would require national safety standards to be aligned, as well as increased cooperation among regulators. In a world of standardized designs, it should be possible for regulators, during their safety assessment, to give some consideration to the certification of similar designs already issued in other countries or to the resolution of generic safety issues in other countries. These issues have been investigated by the WNA's Cooperation in Reactor Design Evaluation and Licensing (CORDEL) Working Group and described in the 2010 report *International Standardization of Nuclear Reactor Designs*.[4]

The survey answers indicate that there is a certain level of cooperation and mutual acceptance between regulators, which would help with working towards international standardization. At the same time, there is a limit to this. A substantial principle emerging from the answers is that, while regulators may accept or take into account the requirements, standards or codes of other countries, they never accept the design approval decision of another regulator.

Standards and requirements

Several respondents mentioned that the requirements in their country are based on International Atomic Energy Agency (IAEA) and – if applicable – Western European Nuclear Regulators Association (WENRA) models. This leads to a degree of harmonization, at least concerning high-level requirements.

Several answers suggest that the regulator does look at the requirements to which the design was originally designed. A respondent from France pointed out that foreign standards can be used provided they comply with the French regulations and their equivalence is established. A respondent from the UK noted that the non-prescriptive nature of the UK regulatory approach allows for some flexibility with regard to accepting international standardization. As long as the foreign standards and certifications are logically consistent and meet the expectations of the UK regulator, they can be used.

There are, however, limits to such an acceptance. One respondent from

[4] International Standardization of Nuclear Reactor Designs, World Nuclear Association's Working Group on Cooperation in Reactor Design Evaluation and Licensing (January 2010), http://www.world-nuclear.org/uploadedFiles/org/reference/pdf/CORDELreport2010.pdf

[5] RD/GD-369: Licence Application Guide, Licence to Construct a Nuclear Power Plant

the UK mentioned local design codes and grid codes; another said the UK-specific requirements that would lead to design changes are: safety classification methodology; fracture mechanics analysis design codes; and civil structures. Besides, it was mentioned that it was essential to provide adaptation documents for the use of foreign standards in the UK.

A respondent from the US gave the example of steel plate reinforced concrete structures. There are no US codes and standards on this topic. The Japanese standard which does exist is not accepted as such by the NRC. However, it was taken into account in the way that comparison of test data against test data from Japan was found to be acceptable to regulatory reviewers in limited instances.

In Canada, in a Licence Application Guide identifying the information that should be submitted in support of an application for a licence to construct a nuclear power plant[5], the regulator states: "Where the licence applicant relies on the use of documents not traditionally used in the Canadian nuclear industry, the applicant should submit an accompanying assessment to facilitate a timely review of the submission. This assessment may be a gap analysis between the documents referenced in the application versus Canadian industry-equivalent documents." The Canadian respondent concluded that this seemed to suggest some regulator consideration of vendor documents that may have been used as part of a design certification process elsewhere.

One respondent made the point that more predictability would be achieved in the licensing process if standards for safety culture were internationally standardized, particularly those requirements concerning supplier and sub-supplier control.

Licensing

Most respondents pointed out that their regulators participate in international regulators' groups like MDEP and WENRA. At the same time, they said that each regulator takes its own decision in licensing, based on its own processes and the national legislation. As one respondent stated, the cooperation among regulators has the status of experience exchange and is not part of the licensing regime. Currently, there is no mutual acceptance of approvals or licences.

One respondent suggested that discussions between his regulator and other regulators may have an effect on the level of depth of scrutiny in some areas.

Another respondent, who is currently undergoing a tender process including some foreign designs, says that the bid invitation specifications (BIS) contain the requirement that the design is licensed in its country of origin or in an EU country. The regulator is expected to collaborate closely with the regulator who has already issued the licence.

Qualification of subcontractors and/or quality control of manufacturing

About half of the respondents stated that foreign standards can be used in this context, provided their equivalence and compliance with national regulations can be established. The other half gave a negative answer.

Where standardisation would have the greatest benefits

The survey mentioned certain actions and milestones and asked whether they would be substantially facilitated if the regulator would make relevant use of approvals and activities already performed by the regulator of another country.

Site selection and qualification — 1 yes / 9 no

Almost all respondents pointed out that site selection and qualification is based on site specific evaluation; therefore they do not see any potential for foreign licensing decisions to facilitate this. One respondent noted that site selection criteria are not sufficiently standardized to be of use in another country. The one respondent who answered "yes" stated that the foreign site licensing decision builds confidence in the ability of a specific technology to meet siting requirements.

Design/vendor selection — 6 yes / 3 no

Here, a majority is of the opinion that the approval of a foreign design licence would facilitate this step. Quite obviously, the design certification would give confidence that the design is mature enough to be licensable. One respondent said that a 'proven design' is a prerequisite for the tender process. On the other hand, some respondents caution that the design must still comply with the national standards. For this reason, three respondents came to the conclusion that the foreign design approval would not substantially facilitate their national licensing processes.

Licence application — 6 yes / 2 no

A majority of respondents answered positively, stating that relevant documentation like Preliminary Safety Analysis Review, detailed studies and specifications for systems, structures and components would be immediately available. This would greatly ease licensing. One respondent cautioned, however, that this effect depended on the reputation of the regulator of the reference licence. Another respondent held that licensing processes were too different to transfer over licence approvals from other countries.

Financing scheme, FID — 3 yes / 3 no

Here, the opinions were balanced. Three respondents answered positively: a licence in another country would show that the design is mature enough and that risks are under control. It would also help reduce timescales for the design review. Three other respondents answered negatively, stressing the responsibility of the national project owners. There were many abstentions, suggesting that the connection between international acceptance of design licence and the financing of a project is not obvious.

Main contract (EPC) — 2 yes / 4 no

While two respondents saw a positive influence on the main contract, for the same reasons as given for FID, four respondents did not share this view. As one of them put it: "Placing the EPC is purely a commercial decision. The ability to work with the EPC is far more important than the technology."

Manufacturing — 5 yes / 2 no

Here, a majority of respondents agreed that manufacturing would be facilitated by an approach of international acceptance. One respondent acknowledged that this was not straightforward due to different national specifications for components, but having a vendor with a functioning QA/QC system and a long list of qualified suppliers would significantly reduce the risk of delay. Another respondent, who is a vendor, mentioned that it would be particularly beneficial if regulators could accept ingots (for long-lead items) accepted by other regulators.

One of the two respondents who gave negative answers concentrated on the contractual situation and stated that differences in international regulations had little impact on manufacturing contracts.

Investment in nuclear

One respondent stated that, beyond the possible advantages of standardized designs and mutual acceptance of standards and approvals for licensing, the overall decision to start a new project might be facilitated if such an approach exists. Clearly, standardization reduces uncertainty and licensing risk and may be crucial to allow project developers to take the final decision to proceed with a nuclear new build project.

10 Conclusions

The results of the survey and the discussions within the report's drafting group have provided a comprehensive picture of the relationship between licensing processes and commercial project decisions. This picture is full of variety because views and experience depend on the regulatory system and commercial and political environment within which each project has to be carried out.

In countries with a competitive market environment and with private project developers, the survey has revealed the strong tendency to reduce risk as far as possible before entering into irreversible commitments. This results in approaches such as:

- Late FID.
- Multi-stage contractual approach, with separation of licensing and construction stages.
- Design to be as mature as possible before first concrete.
- Facilitative role of pre-licensing.

Some responses suggest that these approaches may extend the project schedule, which opposes the need in a competitive environment to keep schedules to a minimum.

Other countries, with state-owned industries and government-led projects, put less emphasis on these issues.

Main structures of various licensing and permitting systems

Concerning the topic of one-step licensing versus two- or multi-step licensing, the survey indicated that commercial developers value predictability and certainty in any system rather than having a preference for a particular system.

For a two-step licensing system, however, a predictable and smooth transition between both licence processes is considered essential.

Pre-licensing of a design or a site is seen as an important feature of a regulatory system, reducing the risk of licensing and making the outcome of a licensing process more predictable. The adherence, as much as possible, of all stakeholders including the regulator, to a pre-agreed schedule, which should include the list of documents to be provided and subject to review, is another crucial element.

Vendor/technology and site selection

In market-driven systems, site selection and choice of technology are key commercial decisions that form the basis for the licensing process. Particularly for technology selection, the survey responses emphasize the need to make a choice as early in the process as possible, ideally before the licence application.

Contracting

During the last few years, there has been a tendency for single contracts to give way to a system of contractual steps. Particularly in a market-driven environment, contracting consists of a series of steps during which the partners enter into further commitments as the project risk reduces with the progress of the licensing process. This means the main contract is concluded relatively late in the project, sometimes only after the licence has been issued. In less market-driven environments, the survey shows that the 'classic' approach of concluding an early full-scope contract covering licensing and construction is still in use.

Design development

The survey shows that there is a range of solutions, which largely depend on the given regulatory system and commercial environment, to address the timing of the design development steps and their relationship to licensing phases and contractual arrangements.

A crucial issue for FOAK (and FIAC) projects is the extent to which the design needs to be developed at the time the construction licence or COL is issued. While there is a consensus that a certain degree of design maturity is beneficial or even necessary for licensing and that a relatively high degree of completion of the design should be reached at the time of first concrete, the percentages of design completion actually suggested are varied.

Financing

As to the timing of the financial investment decision (FID) and its relationship to the main licensing steps, the situation is similar to contracting. Again, the main question is whether the FID is taken before the licence application or only after the licence has been issued. Both views were given by respondents – again depending on their national regulations and the market environment.

There seems to be a consensus that a clear and predictable licensing regime makes financing easier.

Involvement of stakeholders

The government is an important stakeholder (even if it is not a shareholder) and a formally binding positive decision on the project at the outset may ease licensing by relieving the licensing process of political considerations and allowing it to focus on safety issues.

The main issue concerning public involvement seems to be balancing meaningful public involvement with the necessity to take basic decisions rather early in the project and not to open them up for discussion again at a later stage. A separation of a 'political' phase with the main decision about the project and a 'technical phase' with the review of safety issues is recommended.

All stakeholders in the licensing process must take care that sound and well-documented decisions are taken so they will successfully withstand scrutiny by the law courts.

Procurement, supply chain, documentation, component manufacturing oversight

Procurement is shown by the survey responses to be a stepwise process with integrated decision-making based on pre-defined requirements and factors such as regulatory review, design progression, economic and financial review and commercial procurement activities. As with contracting and the FID, the right timing can be an issue.

Design documentation and manufacturing documentation needs to be efficiently and effectively reviewed between all parties involved. The answers given by the respondents reveal a great variety of measures aimed at making sure this happens.

As to manufacturing, there is again a timing issue. On the one hand, the project developer is 'on the safe side' if relevant qualifications, reviews and approvals are fully completed prior to manufacturing. On the other hand, this may put a strain on the project schedule. One of the outcomes of the survey in this respect is the suggestion to take more 'flexible' solutions into account and to proceed on a case-by-case basis if the regulatory system allows for this. Long-lead items are a group of components where these issues tend to come up in a particular urgent way.

Enhanced international standardization and greater cooperation of regulators may be a means to reduce some of the difficulties and to make component manufacturing more predictable.

Support for international standardization

International harmonization of safety requirements and standardization of reactor designs could greatly facilitate licensing, regardless of the regulatory and economic environment in a country. Particularly in the case of a FIAC project, implementing a standardized design and using licensing results already obtained in another country would be much easier than re-doing the entire assessment. However, there is still a long way to go to reach this aim, as the survey answers show. While regulators are often open to taking into account standards and requirements stemming from the vendor's country, they may never formally accept or endorse, even partially, the design approval of another regulator.

Areas identified in the survey where international standardization would bring the greatest benefits to nuclear projects are vendor selection, licence application and manufacturing.

Appendix

The following Table illustrates the relevance of the survey items to the different types of new build countries.

"(x)" means "possibly relevant", "x" means "relevant", "xx" means "extremely relevant".

	1 Established market-driven	2 Established state-driven	3 Established but small	4 Newcomers	5 SMRs
Licensing and permitting					
Multi-step vs. one-step	x		x	x	x
Pre-licensing	x		Small number of projects	(x) Depends on the number of projects and the size of the national programme	xx Could be of special relevance for SMRs
Keeping to schedule	xx	(x)	x	x	x
Prescriptive vs. non-prescriptive	x	(x)	x	x	x
Coordination with non-nuclear permits	x		x	x	x
Financing					
Timing of FID	xx		x Important if foreign partners involved		
Contracting					
Contracting model	xx	x	x	xx Contract may include 'import' of regulations	xx
Relevance of pre-contracts (early works agreement)	x		x	x	
Vendor selection					
Time of vendor selection	x		x	x	x
Design development					
Design development and its relationship to contracting, licensing and FID	xx	x	xx	xx	xx
Importance of design completion at the time of licensing	xx If FOAK		Would rather not be FOAK	Would rather not be FOAK	??
Subcontractors, supply chain, manufacturing, documentation					
Timing of procurement, relationship with licensing milestones	xx		x	x	x
How to best manage licensing documents	xx		x	x	x
Role of regulator in manufacturing process	x	x	x	x	x

	1 Established market-driven	2 Established state-driven	3 Established but small	4 Newcomers	5 SMRs
Involvement of stakeholders					
Managing involvement of the public and other stakeholders	xx	(x)	xx	(x) Depends on legal system in country	(x) Depends on legal system in country
Necessity of political decision before licensing	xx		x	Part of general decision to start nuclear energy programme	Part of general decision to start nuclear energy programme
Role of legal appeals	x		x		
Role of international standardization					
Role of foreign standards	Depends on whether there is a domestic vendor	Depends	xx	xx	xx
Importance of using earlier licences given in another country	Depends on whether there is a domestic vendor		xx	xx	xx

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This report is based on the results of a survey of World Nuclear Association conducted by members of the joint Task Force organized by the CORDEL and Law Working Groups. It explores the relationship between licensing and regulatory systems on the one hand and important commercial project decisions on the other. The results of the survey and the discussions within the report's drafting group have provided a comprehensive picture of the relationship between licensing processes and commercial project decisions. As shown in the report, this picture is full of variety because views and experience depend on the regulatory system and commercial and political environment within which each project has to be carried out. In any case, it does show that international harmonization of safety requirements and standardization of reactor designs could greatly facilitate licensing.