ITER Licensing

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Abstract

ITER was fortunate to have four countries interested in ITER siting to the point where licensing discussions were initiated. This experience uncovered the challenges of licensing a first of a kind, fusion machine under different licensing regimes and helped prepare the way for the site specific licensing process. These initial steps in licensing ITER have allowed for refining the safety case and provide confidence that the design and safety approach will be licensable. With site-specific licensing underway, the necessary regulatory submissions have been defined and are well on the way to being completed. Of course, there is still work to be done and details to be sorted out. However, the informal international discussions to bring both the proponent and regulatory authority up to a common level of understanding have laid the foundation for a licensing process that should proceed smoothly. This paper provides observations from the perspective of the International Team.

1. Introduction.

ITER was fortunate to have four countries interested in ITER siting to the point where formal and informal licensing discussions were initiated. During the course of Negotiations on the ITER Joint Implementing Agreement, the four candidate sites presented to the Parties were: Clarington (Canada), Cadarache (France), Vandellos (Spain) and Rokkasho (Japan). Subsequently, the field was narrowed to the current contenders, Cadarache and Rokkasho. This paper reviews the activities and discussions for licensing ITER at these candidate sites and the regulatory processes to be followed, and provides observations from the perspective of the International Team (IT).

2. ITER Licensing History

From the beginning of the Engineering Design Activities it was a requirement that ITER be able to be sited in any of the participant countries with only minor design changes. There can be a number of acceptable safety approaches to meet the project's safety objectives, and there can be different choices or emphasis made in implementing a safety approach to meet a particular country's regulations. In the absence of a particular site, the idea of a generic site consistent with the ITER site requirements and design assumptions, an ITER-specific safety approach, and non-site-specific safety documentation was developed. For example, the Generic Site Safety Report (GSSR) for the Final Design Report (2001) describes the ITER safety approach and an implementation utilising a generic site intended to support siting by any party.

2.1 Parties' Designated Safety Representative Meetings

To confirm the acceptance of the ITER-specific safety approach, meetings of the Parties' Designated Safety Representatives were convened between 2000 and 2002. These meetings were agreed by the ITER Council and confirmed by the Negotiators to allow the Parties' Designated Safety Representatives, representatives of Parties' regulatory authorities, site

issues for licensing ITER and to define the expected sequence of steps towards its fulfilment. Meetings were held in Garching (October 2000), Tokyo (May 2001) and Cadarache (June 2002).

The following are some of the main points agreed upon at these meetings:

- The basic approach to ITER safety is largely uniform among the Parties and the ITER IT. Most importantly, it is based on a deployment of defence-in-depth and the As Low As Reasonably Achievable (ALARA) principles, taking into account fusion's safety characteristics and ITER's experimental nature.
- National dose criteria for normal operations are largely based on recommendations by the International Commission on Radiation Protection (ICRP) with regard to exposure of staff and public. Criteria for accidents, including criteria for specific countermeasures affecting the public, are less uniform among the Parties.
- Depending on the host, a safety options report or a preliminary licensing basis document or a preliminary dialogue with the regulatory authority are described as being characteristic of the preparation for the licensing process. Throughout this process, it is required to maintain process continuity and future commitments. In some countries a "legal entity" (referred to as the ITER Legal Entity, ILE) is required; in others, the present and future agreements provide this continuity.
- It is mandatory to have a competent ITER 'Design Authority' (responsible for the design) to support (when required) the dialogue with the regulatory authority. This 'Design Authority' must provide for taking into account regulatory requirements in the design, for continuity of the safety organisation, and for their transfer to the organisation that eventually obtains the licenses.
- The international nature of ITER must be respected, which will require a level of understanding the implications by the host regulatory authority, and by all project participants on the regulations and process to be applied to ITER.
- An overall Quality Assurance (QA) programme is required for ITER, and it should be proposed by the ILE to the regulatory authority for the licensing process. QA standards for nuclear activities, like IAEA *Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations*, 50-C/SG-Q, focus on safety and the relationship between operator and regulatory authorities; QA standards, like ISO 9001-2000, *Quality Management Systems*, focus on industrial procurement and contractual aspects between customer and suppliers. The QA programme needs to cover all interfaces between the ILE and the regulatory authorities and between the ILE and its suppliers.
- Issues raised by one or more potential hosts include:
  - identification of safety-relevant systems and their requirements
  - justification of design codes and standards and of materials for safety relevant components
  - human factors incorporation into the design and operation
  - demonstration of application of ALARA
  - demonstration of feedback of lessons from similar facilities
  - coherence of licensing submissions with design and supporting assessments
  - basis for authorised operating domain and facility lifetime
  - use of enveloping analysis
  - quality assurance and the management of quality including information on operating organisation and technical control over safety aspects
  - reporting requirements.

These meetings proved to be a fruitful forum to introduce the regulatory process to be expected for ITER, to review the work of the IT against generally accepted regulatory requirements, and to gain a better understanding of these processes and requirements by all participants (at that time, Canada, Europe, Japan, the Russian Federation and the IT).

2.2 Joint Assessment of Specific Sites

In the process of negotiation, a Joint Assessment of Specific Sites (JASS) was undertaken looking at the characteristics of the sites against an agreed set of criteria. One of the criteria addressed licensing aspects, specifically:

(1) Regulatory framework
(2) Safety design approach /guidelines
(3) Steps of licensing procedures
(4) Road map for licensing
(5) Design standards, quality assurance, etc.
(6) Restrictions on long lead procurement, site preparation, and financing activities

Table 1 presents a summary of the safety design approach for each of the four sites based on the JASS submissions. It can be seen that the safety-design approaches for all sites are similar and generally consistent with the ITER-specific approach documented in the Final Design Report[1]. Of particular importance for a first-of-a-kind facility like ITER was the finding: "Well defined licensing and decommissioning processes were ascertained for all the Sites."[2]

TABLE 1 SAFETY DESIGN APPROACH /GUIDELINE

Cadarache [3]	**Rokkasho** [4]	**Clarington** [5]	**Vandellos** [6]
Clear principles in Règles Fondamentales de Sûreté (RFS) are defining accident sequences and taking all possible steps to minimise consequences to the public, environment and plant personnel. In all stages of lifetime, safety approach is based on implementation of both ALARA and Defence-in-Depth principles, which must be demonstrated to Safety Authorities. For each event objectives are: - Minimisation of exposure of personnel to radiation, at least below regulatory limits; - Limitation of quantity of radioactive releases, and optimisation of their characteristics; - Limitation of quantity of radioactive waste produced, and of industrial releases or wastes.	Major safety requirements to be examined are: - Appropriate radiation protection of the public and workers against radioactive materials and radiation released to the environment during normal operating conditions; - Prevention of accidents by, for example, ensuring structural strength of components that contain radioactive materials and their supporting structures on the basis of the safety features peculiar to ITER; - Mitigation of consequences of accidents by using ventilation and clean-up systems etc.	Canadian Nuclear Safety Commission (CNSC) sets high-level requirements to meet the safety objective of “no unreasonable risk”. The proponent develops the safety design approach and technical implementation along with the requirements through dialogue with CNSC staff. The CNSC approach is risk-based but does not require probabilistic safety analysis. ITER safety criteria would be similar to those established for small reactors.	- Definition of basic safety objectives, based on Defence-in-Depth deterministic approach, but using probabilistic targets for radiological doses to public, operators and environment. - Derivation of safety requirements. - Safety classification of structures, systems and components, with reference to unmitigated release and in relation to radiological hazard. - Application of a conservative design. - Deterministic application of Defence-in-Depth concept with definition of number and quality of safety levels, as well as ALARA principle in relation to radiological hazards. - Development where applicable and practicable of a probabilistic study. - Development of radiological dispersion analysis as a final check.

JASS provided an opportunity to obtain a common, more detailed understanding of what would be required for licensing at the specific sites and to provide confidence to the Parties that regulatory activities for the site would not present an undue risk of cost increases or schedule delays. For Cadarache, ITER is classed as “Installation Nucléaire de Base” (INB), and in particular “Laboratory and Fuel Plant” category (as opposed to “Nuclear Power Reactor”). For Rokkasho, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Nuclear Safety Commission have established the basic requirements for securing ITER safety, and MEXT is considering development of specific nuclear safety legislation and regulations. For Clarington, ITER would be licensed as a Class-1 nuclear facility under the Nuclear Safety and Control Act (NSCA). For Vandellos, ITER is classed as a Nuclear Radioactive Installation, and would be treated in a manner analogous to a fission research reactor.

2.3 Regulatory Discussions

Sites proponents in Canada, France, Spain and Japan entered into discussions with their regulatory agencies in various stages of formality (Table 2).

As a result, the licensing processes and timetables were better defined, the requirements for submissions clarified, and the elements of the ITER safety approach that needed further attention were identified. A key aspect in all cases was the need to 'educate' the regulatory authority about ITER's safety issues and in particular how it differs from fission facilities they are more experienced with. In this context, site proponents for Clarington provided, and Vandellos planned, for 'seminars' for staff of the regulatory authorities to introduce them to fusion, ITER and fusion safety issues.

TABLE 2 STATUS OF REGULATORY DISCUSSIONS
(as of mid-2004)

Site	Responsible Institution	Regulatory Agency	Comment
Cadarache, France	Commissariat à l’Energie Atomique (CEA)	Autorité de sûreté nucléaire (ASN)	- “Dossier d’Options de Sûreté” submitted and comments received from ASN. - Discussions are underway.
Rokkasho, Japan	Japan Atomic Energy Research Institute (JAERI)	Ministry of Education, Culture, Sports, Science and Technology (MEXT)	- Basic requirements for safety established by MEXT, based on ITER unique features - Informal discussions are underway.
Clarington, Canada	Iter Institute (established specifically for ITER licensing in Canada)	Canadian Nuclear Safety Commission (CNSC)	- Letter of Intent submitted. - Licensing Plan submitted. - Scope of Environmental Assessment issued by CNSC. - Discussions were underway.
Vandellos, Spain	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT)	Consejo de Seguridad Nuclear (CSN),	- Site Permit documentation submitted. - Summary memorandum for Environmental Impact Assessment submitted. - Discussions were underway.

3. ITER Regulatory Approval Processes

The licensing process for all sites would have been similar, involving a number of steps examining the site, design, construction, operation and eventual decommissioning (Table 3). Timing and content of regulatory submissions would differ. In Japan, it is based on confirmation of design basis for construction license, confirmation of design specifications during construction, and inspection during operation. In addition to nuclear regulatory aspects, site approval generally requires some sort of environmental impact assessment including local public input. Besides this, the ILE will have to observe conventional industrial safety, domestic laws concerning environment protection, building, fire protection, electric transformation/distribution, high pressure, worker's health and safety, etc. A step-by-step approach through the operational phases of ITER, from H-H stage, D-D stage to D-T stage, is seen as important in demonstrating the safety case for such a first-of-a-kind facility. Regulatory authorities indicated that they would take into account the operation plan in determining when nuclear operation and a full operating license would be required.

At present, the status for regulatory approval in Cadarache is as follows. The “Dossier d’Options de Sûreté” has been formally submitted and comments received from the regulator, ASN. The Rapport Préliminaire de Sûreté (RPrS) Volume I (descriptions) is more or less complete (in French) based on the Final Design Report. The RPrS Volume II (analysis) will be based on GSSR and subsequent work and drafting has begun. The need for a detailed review of the RPrS by the ITER IT and difficulty in translation are recognised, but it is preferred to have any translation problem to be discussed within the ITER team and not between ITER and the ASN. Meanwhile, CEA will continue preparation of RPrS and discussions with ASN until the ILE is in place. Further informal meetings are planned on the scope of RPrS and specific issues such as analysis methodologies.

TABLE 3 REGULATORY REQUIREMENTS
FOR EACH STAGE IN THE REGULATORY APPROVAL PROCESS

Stage	Regulatory Requirements
For site selection	- Environmental impact assessment including public enquiries undertaken among local communities on the effect on the environment resulting from construction and operation. - For Cadarache, Public Debate (“Débat Public”), countrywide discussion on socio-economic and/or environmental consequences. - For Vandellos, description of the site and outline of the planned facility for Site Permit.
When major conceptual choices completed	- For Cadarache, “Dossier d’Options de Sûreté” (DOS) to define safety functions, identify risks and describe means for risk mitigation and minimization
Before start of construction	- Construction license issued after basic design has been verified to meet safety requirements; codes and standards, generally based on a Preliminary Safety Analysis Report consisting of detailed description and comprehensive safety analysis.
Before start of operation	- During construction phase, detailed technical reviews and inspections may be conducted. - License for operation requires updated report, typically in a Final Safety Analysis Report, including final design data, safety analyses and results of commissioning tests.
Regular follow-up throughout life	- During operation phase, inspections take place at regular intervals. - For Clarington, Operating licence granted for limited period (2-5 years) and operation etc. is reviewed for renewal.
Before and after dismantling	- Approval to decommission. - Approval for site abandonment.

For Rokkasho, the status can be summarised as follows. In March 2003, the ITER Safety

carried out since August 2002 to ensure the safety of ITER in case it would be sited in Japan. The working group has further discussed confirmation of safety during the operation stage and decommissioning stage since the issue of the interim report and summarized these into a document as its final report providing a fundamental approach to ensure safety and the basic procedures for confirmation of safety. Technical standards, items for confirmation, and a guide for review for ITER in Japan are addressed in the above. The legislative framework and regulations have been drafted in outline, and MEXT will proceed if Rokkasho is selected as the site. Finally, confirmation of the technical basis against the guidelines has been drafted (in Japanese) and will need to be reviewed and updated by the ILE.

4. Observations

ITER is the first reactor-scale fusion facility to seek regulatory approval, and in fact the process was initiated in four countries. The perspective of the ITER IT as the project proponent and surrogate for the ILE is somewhat different from the specific-site proponent, and of course different from the regulatory authority. From this perspective, the following are some observations.

4.1 National Similarities

As noted in Section 2, all regulatory regimes would have similar processes, based on their experience with previous nuclear projects. There is a staged approach to regulatory approvals from site approval, through construction and operation, to decommissioning. The required documentation to support the request for approval for each stage is also similar for each site, including some sort of environmental assessment for site approval and safety report for construction and operation approvals. Documentation is submitted from the proponent to the regulatory authority on requirements and compliance with these, safety aspects of the design, in particular safety-related components, and assessments to demonstrate the acceptability of the design. Generally these submissions and the response by the regulatory authority are preceded by technical discussions to ensure that the scope and content are appropriate. The expectation of defence-in-depth, ALARA and a comprehensive QA programme is similar as well.

4.2 Fusion Realities Versus Fission Preconceptions

All regulatory authorities (and some specific-site proponents) have a fission bias - focussing on the classic "shutdown, cool down and contain" philosophy, whereas for fusion (at least ITER) criticality and decay heat removal are non-issues. The principal safety aspect for ITER is confinement of radioactive materials, and even here the hazard is modest, comparable to a small research reactor. Application of detailed guidelines developed in the fission context can be inappropriate in the ITER context; either imposing unnecessary requirements or missing key factors. Therefore, there is a need to ensure everyone is conversant with fusion hazards and ITER-specific issues; particularly proponents and regulatory authorities who had not been involved in the evolving ITER safety-design. Seminars for regulatory authorities on fusion and ITER helped to expedite this.

IAEA documentation has provided a useful basis for safety design, to the extent they are applicable for fusion and ITER. In this context, an international effort to develop fusion specific safety guidance would be helpful for post-ITER facilities and could build on the ITER experience.

4.3 ITER specific issues

Specific issues raised by regulatory authorities, particularly for Cadarache and Rokkasho, are similar and include:

- clarification of radioactive source terms and how these will be monitored.
- elaboration of the confinement design and monitoring and the bases for these.
- potential for beryllium steam/air reactions and resultant hydrogen production.
- provisions for toxic materials (such as beryllium).
- provision for dust explosions.
- fire hazard analyses and fire protection schemes.

For a first-of-a-kind fusion facility, it is difficult to estimate in advance with a high degree of confidence the tritium retention rate, dust production rate, as well as dust characteristics etc.. Therefore, a step by step approach is essential in ITER operation and licensing. During the design and construction phase, a set of initial administrative limits and guidelines based on current understanding is under development as well as identification of possible measurement and removal techniques. For example, the tritium inventory will be tracked during every plasma campaign in the vacuum vessel, in the fuel cycle subsystems (pumping, fuelling, tokamak exhaust processing, isotope separation and storage and delivery), and in the long-term storage system using mass balance and pressure-volume-temperature-concentration techniques. The tritium inventory in the Hot Cell and Radwaste areas will be also be estimated. The calculated tritium inventory should be updated at the start and end of each campaign by measuring inventories in the tritium process, in the long-term storage, and in the primary coolant. In addition, R&D is continuing to better define limits, techniques and options for inclusion in regulatory submissions for construction and operation.

During the initial HH phase, measurements are planned to validate items such as dust characteristics (size, shape, composition, etc.) and distribution, tritium (hydrogen) co-deposition characteristics, analytical models (for production, distribution, mobilisation, etc.) and the selected measurement and removal techniques. If necessary, limits and guidelines will be updated, measurement and removal techniques will be refined and it may be possible to investigate new options. On the basis of results obtained, it will be possible to define the validation strategy for DT operation. Finally during the DD and DT phases there will be on-going measurements to ensure safety limits are not exceeded. In addition there will be on-going validation of the measurements. It is expected that based on the on-going experience gained, it will be possible to update limits and guidelines and improve measurement and removal techniques in a manner acceptable to the regulatory authorities.

For an international project like ITER, language can be a problem since the working language for the project is English and that of the regulatory authority generally is not. At some point there will be problems in translation and communication. The approach taken has been to communicate (through the specific-site proponent) with the regulatory authority in their native language so that the translation issues (such as review and approval of regulatory submissions by the Design Authority) are managed within the ITER team. Maintaining a consistent set of regulatory documents in the two languages throughout the life of the project will be a challenge for configuration management, but essential if the ILE is to operate ITER safely and within authorised limits.

5. Summary

The ITER safety case has been developed in conjunction with an international team of safety experts for over a decade. For the past five years, discussions have taken place with the actual regulatory authorities who would have been in charge of licensing ITER for their country. These initial steps in licensing ITER have allowed for refining the safety case and provide confidence that the design and safety approach will be licensable. With site-specific licensing underway, the necessary regulatory submissions have been defined and are well on the way to being completed. Of course, there is still work to be done and details to be sorted out. However, the benefits of informal international discussions to bring both the proponent and regulatory authority up to a common level of understanding have laid the foundation for a licensing process that should proceed smoothly.

References

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