# Advanced Licensing and Safety Engineering Method - ADLAS™

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## ABSTRACT

Complex nuclear projects, with long supply chains require detailed understanding and management to succeed. One of the most important success factors is licensing, which has been very challenging in past years in many nuclear projects (both new build projects and modernization projects).

To better understand the licensing aspects and the safety features that are behind the licensing requirements, the high level safety engineering method has been developed in Finnish energy company Fortum

*Key Words*: licensing; defence-in-depth; diversity; requirements management; configuration management

## 1 INTRODUCTION

Licensing has been part of operations in Fortum from the beginning of Loviisa VVER power plants' life cycle. Fortum owns and operates the 2 VVER-440 units in Loviisa which have been designed and constructed in 1970-1976 and commissioned in 1977-1979. From these days, the units have been developed, partly redesigned and operating licenses have been renewed. In Finland the current practice with operating license is that they are valid 10 or 20 years at a time and every 10 years the periodic safety review is done.

Loviisa NPP automation renewal begun in late 1990's. Initially the aim of the project was to replicate the functionality of existing automation system with new automation platform. During the project it became evident that also design basis of the plant needed to be partly re-designed due to new, restricted regulatory requirements.

Renewal of the regulatory basis was started in Europe to prepare for nuclear renaissance. Aim of the renewal was to enhance safety of the nuclear power plants. Since this development has been partly learning from the experiences, it meant more restrictive and detailed requirements. Also due to long period without new-build projects, understanding and know-how of the safety requirements has degraded. Ultimately this development has led to overlapping requirements which has increased complexity of the regulatory basis. In Finnish case, the regulatory requirements are developing into the more descriptive way, in contrary as in the US NRC requirements. However, descriptive regulatory requirements cannot be utilized as design requirements without further elaboration. In addition the current regulatory requirements do not have clear hierarchy or grading concerning safety relevance. Lot of licensing work has to be done by the owner, not only in the automation but also in the plant and architectural level. To tackle this challenge and to make licensing more comprehensive and better understood, a new approach called ADLAS ™ method was introduced.

This paper introduces the history of licensing issues. Next the method itself is described and finally case study of using ADLAS™ in Loviisa NPP automation renewal project is described.

The ADLAS™ method has been earlier presented in reference [1].

## 2 LOVIISA EXPERIENCES AS BASIS OF ADLAS™

Fortum is operator and license holder of Loviisa NPP. Also, Fortum is an engineering office and basic ally all nuclear safety related design changes to Loviisa NPP are carried out by Fortum itself.

Some design examples:

- Power uprate 9%
- Implementation of Severe Accident Management (SAM) strategy and systems
- Bunkered pumping station
- Diverse Residual Heat Removal
- Automation renewal (ADLAS™ case)
- Diverse spent fuel pool cooling (ADLAS™ case)

## 3 LICENSING CHALLENGES

Both nuclear new build and major retrofit projects have suffered from budget and schedule overruns. The following challenges have been recognised as root causes for these difficulties, especially in cases of retrofits:

1. Changes in requirements during plant lifetime

2. Complicated, descriptive licensing documentation

3. Lack of clear high-level requirements

4. Lack of traceability in system level requirements

5. Poor design data configuration management

### 3.1 Changes in requirements during plant lifetime

The Defence-in-depth definition has evolved over the years. Normal operation (Level 1), anticipated transients (Level 2) and postulated accidents (Level 3) were included in the original definition back in the 1970's. Severe accident mitigation (Level 4) was requested after the Three Mile Island and Chernobyl accidents as well as offsite emergency response (Level 5). Western European Nuclear Regulatory Association (WENRA) introduced Level 3b in 2013 ([2]). The intention of Level 3b is in response to common cause failures, complex sequences or extreme external hazards so that severe fuel damage would be avoided. As we can see, the nuclear power plants originally designed in the 1970's do not include all defence-in-depth levels as an original design basis.

In addition to defence-in-depth levels also other regulatory requirements may have been changed but with lesser effects to the design basis. Lower level requirements may have been changed even without further justification in high-level requirements. This has led to dispersion of the overall design basis.

Depending on the regulatory regime, plant safety level needs to be enhanced to meet the latest regulations as far as reasonably practicable. It is quite obvious that in these cases the plant design basis needs to be reformulated so that a uniform safety justification is still available. Reformulation shall be done so that it will comply with the renewed regulatory requirements. Unfortunately it seems that the formal methods of requirement engineering and configuration management aiming to transparency and traceability has not been utilised thoroughly. Instead, new plant features have been added to the safety case without top-down justification. This has led to complicated, descriptive licensing documentation.

### 3.2 Complicated, descriptive licensing documentation

In many cases licensing documentation does not provide clear design requirements. Regulatory requirements, as they are not intended for design, are written so that interpretation is required. Unfortunately neither original documentation, nor documentation after plant modifications, clearly states how the interpretation of regulatory requirements is done during the design. Instead of stating the elaborated design requirement, original documentation provides a description on the end result of the design or realisation. In other words, traceability from high-level regulatory requirements to system level design requirements is lost in the safety case documentation. This will eventually lead to a situation where the licensing documentation does not give sufficient background for major retrofits or safety enhancements. Unfortunately it appears that this is also the case in many new build projects, even though new regulatory requirements require far more transparency and traceability in the design process. This is reflected for instance in regulatory requirements in Finland ([3]), Hungary ([4]) and United Kingdom ([5]).

Not only the engineering or design documents of a nuclear power plants has become fuzzy. The same applies to the safety analyses part of the safety case. Regulatory requirements demand a large amount of safety analyses; deterministic, probabilistic, failure mode, failure criteria, and hazards - you name it. All these are most likely needed but the reasoning on the extended list of analyses is very difficult to find.

### 3.3 Lack of clear high-level requirements

Several international efforts have been made in order to create aligned principles for ensuring nuclear safety. These basic principles are usually taken into account in the national legislation and safety regulations. These principles are taken into account in the plant design as described in the licensing documentation presenting the plant design basis. However, it seems there is rather long gap between high-level requirements and system or equipment level specifications.

### 3.4 Lack of traceability in system level requirements

Original design documentation is probably not organised in a hierarchical manner. High-level principles have been generally stated but the exact system level requirements and the link between high-level principles and system level design is missing. Instead, the original documentation describes how systems are realised. In this case fitting in new features, like a new defence line to the original system set-up is very challenging and thus interaction between utility and regulator may become difficult. Especially the role of new mitigation systems, their contribution to the safety and thus the safety classification and reliability requirements are difficult to define without full revision of the plant design basis.

### 3.5 Poor design data configuration management

As stated and recognised in ([6]) there has been identified a lot of problems in design data configuration management. Traditionally configuration management has been concentrating in physical configuration (systems, structures and components). Lately more emphasis - but not enough - has been put to requirements management. Database system suppliers may have not understood the essence of design data in case of nuclear power plants and thus these suppliers could not fully contribute to overcome the problem. Also utilities have not taken the issue too seriously. Licensing documentation has been kept in some sort of the order, but that is not exactly the same thing with design data. However, these two have clear interconnection as explained later on.

## 4 INTRODUCTION OF ADLAS™ METHOD

As a response to the previously mentioned challenges the ADLAS™ method was developed. The method aims at defining the licensing lifecycle of the whole plant so that there is a clear role and place in the hierarchy for every engineering document or analysis report. The engineering process is hierarchical and transparent and thus easier to understand both from a project management and regulatory review point-of-view. This enables better follow-up leading to lowered costs as well as smoother regulatory review, thus saving time and money. However, the biggest winner when applying the method is nuclear safety. Since the design basis is clear, the safety relevance of each system is known in more detail and the quality of systems corresponds to the systems safety relevance.

The method is based on the framework of systems engineering, where formal methods of requirement management and configuration management are applied. The method also includes product lifecycle management model but with a new approach to validation. Validation is not performed only after realisation, but traditional analyses are seen as as-designed validation. This is generally described in figure 1.

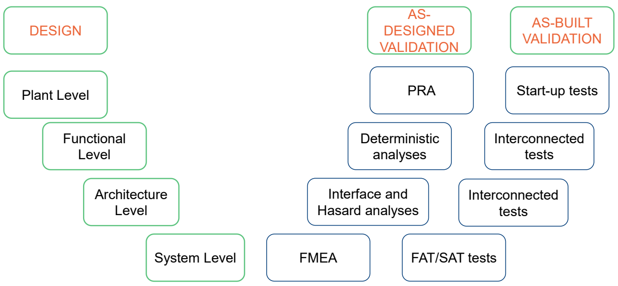


Fig. 1. Design lifecycle applied in the method

An example of this approach is given in chapter "Validation of functional design" concerning functional level validation and deterministic analyses.

Requirement management has been put in place in some cases. However, requirement management tools or databases, are not alone sufficient for providing sufficient transparency to the design basis requirement, if the requirements do not have sensible hierarchy. ADLAS™ /provides a method for building up understandable structure for the database, which can be implemented to several different database or requirement management tools

## 4.1 History and background

Development of the method began in the automation renewal of the Loviisa NPP. The aim of Loviisa automation renewal project was to replace analogical safety automation of the plant with digital systems. During the project it became evident that the original plant design basis needed to be described more in detail. The existing documentation didn't give clear enough justification for the existing system configuration. In addition since a software common cause failure needs to be taken into account the design basis had to be revised.

## 4.2 Clear high-level requirements

In order to take into account the software common cause failure the application of the diversity principle needed to be redefined. Common cause failures were taken into account already earlier for instance in the safety injection system functional design, but due to digital safety automation the scope of the diversity was totally reconsidered. Simultaneously the national regulatory body specified a requirement based approach, which is basically also mandated in international standards ([7]). Also safety classification of the functions needed to be reconsidered, since the regulatory requirements concerning safety classification had been changed during the plant lifetime.

This lead to development of two new formal issue that can be considered as methodological aspects. These topics are key in this new methodology since they were not widely introduced earlier. Firstly high-level principles were formalised into Essential Safety Requirements. Essential Safety Requirement have properties of good requirements. Good requirements are for instance: unitary, complete, consistent, unambitious, traceable and clearly targeted. Most of all good, high-level regulatory requirements are verifiable.

The second new formal method is introduction of Task Categories. Task Categories are functional entities or groups of functions, which have the same functional and non-functional requirements. Task Categories are having very simple functional requirements such as: "bring plant to controlled state" or "bring plant to safe state". The non-functional requirements reflect the high-level design principles, especially concerning the safety class, redundancy, diversity, separation/segregation and quality. All these non-functional requirements are aiming at the same goal - reliability of safety functions. In other words Task Categories combine functional and non-functional safety requirements to a group of safety functions.

It also became evident that when applying new technologies such as digital automation, specific requirements were needed at high level in order to limit lower level design into certain specific solutions. In the product lifecycle management (PLM) there seems to be a trend to define requirements from top to down. Basically this approach is also the background to the ADLAS™ method. However, the specific requirements that may be considered, even showstoppers at the lower level shall be taken into account in the high level. From the licensing point-of-view this means that the most difficult issues are taken to the regulator in the very beginning of the project. This also reflects to a good safety culture, where safety concerns are discussed openly. From the methodological aspect this is called both-ends-meet-in-the-middle. This method is illustrated in figure 2.

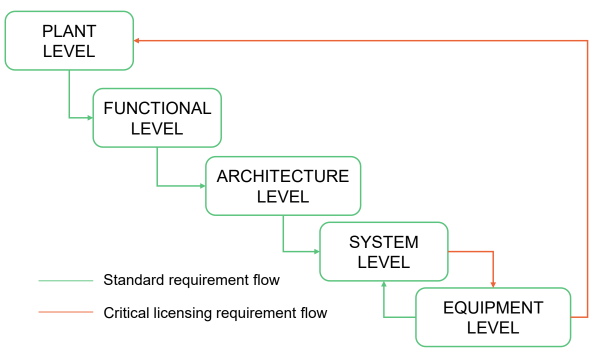


Fig. 2. Both-ends-meet-in-the-middle approach applied in the method

## 4.3 Functional design

The aim of the functional design is to make a comprehensive list of safety functions required for mitigation of initiating events. The safety functions shall be designed so that the acceptance criteria related to the barriers is met. The safety functions are related to three main safety objectives as presented in ([8]). The importance of the functional design is sometimes overlooked. However, it is more essential to define what the systems should do instead of how well the system will do it. Therefore more attention should be paid on the correct functional design and its validation.

When looking at the international standard concerning the functional safety ([9]), we will notice that the functional safety shall be based on the hazard recognition. Traditionally in the nuclear power plant that is a list of initiating events, internal and external hazards taken into account in the design. This list was for a long time based on the US standard review plan ([10]) and it is still a basis nowadays. However, the development of probabilistic methods extended the actual listing and gave an insight to the most probable failures and hazards leading to core damage. The list is complemented with the probability of events in order to define design basis categories. In the ADLAS™ method Task Categories are assigned to the design basis categories so that the non-functional requirements of the safety functions can be transparently seen in the design document.

Secondly, when initiating events are recognised the safety functions shall be assigned to each event. This is of course one of the hardest tasks in nuclear power plant engineering. Deterministic design analyses are used as a support for the task. Also a general understanding on the plant behaviour is required so that not every single scenario needs to be analysed during the design. The approach is basically the same with the traditional design. However, a remarkable difference is that the iteration between the functional design and design analyses is limited in the scope of functions and their performance criteria, whereas the traditional iteration loop was significantly longer going up to the high level design principles and down to the system or even equipment level design.

As indicated earlier, the extent of the analyses has increased significantly since the 1970's. Therefore ADLAS™ emphasizes the role of analysis. In the ADLAS™ method the role of each analysis and test is defined in the overall V&V plan. In the method the functional design is validated by deterministic accident analyses. The difference between the ADLAS® method and the traditional deterministic accident approach is that the analyses shall confirm that the allocation of safety functions is correct. In other words, the functions allocated to the event are sufficient for bringing the plant to the desired end state. Of course, simultaneously the barrier performance is validated so that the acceptance criteria are met.

## 4.4 Architectural design

Architecture shall define the systems performing the safety functions and the interfaces between the systems. Sometimes it is said that the architecture is a system of systems. Architectural design is traditionally applied only in automation system design but the method extends the definition also to other disciplines. It is quite clear that the automation systems are the most complex ones from an architectural point-of-view. However, there are clear benefits for applying the same approach to process engineering, electrical engineering, control room engineering and civil/layout engineering.

First of all the role and contribution of each system related to accident and hazard mitigation becomes clearly defined. This leads to a transparent definition of systems safety significance as well as safety significance of system components. Since the safety functions are assigned to systems and each safety function belongs to a Task Category, each system will receive the non-functional requirements from the top of the hierarchy based on system functions and the system designer has a clear basis for the system requirement specification. The traditional definition of a single process or electrical system does not necessarily refer to the system's functional requirements. The same system may have safety functions, (system operation during incident or accident) and non-safety functions (testing for instance). Therefore the safety classification of the system does not necessarily reflect to the real safety significance of the system components. When applying a safety function based approach, classification rules and boundaries become clearer. The safety critical parts are recognised based on the system's safety functions and the safety requirements are addressed to those parts only. Since the safety functions are defined more in detail, the functional requirement also includes information concerning safe direction of actuation. This is useful especially in the electrical systems but also in the process systems. The preferred failure mode and thus fail-safe behaviour has a thorough basis.

Secondly when applying this approach to civil/layout design, the safety classification of buildings and building structures will also have a functional basis, whereas traditionally the classification basis has been in the codes and standards. This helps especially in dimensioning the structures against internal and external hazards. When the safety functions needed for the hazard mitigation are assigned to the buildings and rooms, their functional requirements become clearer.

The approach is applicable also for the control room design. The control room will have a functional allocation (not only based on the safety functions but also based on the task analyses). Non-functional requirements can be set to HMI's based on the functions related to the Task Categories. HMI's will have different ergonomic requirements depending on the safety relevance i.e. the safety function's Task Category assigned to the HMI. In the control room design the organisation and procedures shall also be taken into account. Similarly to the HMI's also the procedures and the organisation will have Task Categories based on the defence-in-depth approach. Realisation of, for instance, diversity requirements can be tasks of the safety engineer on duty in contrast to the shift supervisor and use of the symptom based procedures in contrast to the event-based procedures.

### 4.5 System level design

Traditionally the functional level and architectural level design has not been thoroughly documented or at least formal requirement management has not been applied. High-level principles have been assigned directly to the systems and interpretation of the principles has been unclear. This has at least on some cases led to inconsistencies in the system configuration and further on to licensing problems.

In order to improve the situation, the system level requirements are determined already in the architecture level. So in contrast to most existing requirement management methods, system level requirements are “pushed” from the top down instead of “picking” requirements to the system level from the architecture level. The purpose is to elaborate all those system level requirements of the discipline in a consistent manner and thus to ensure that the system level requirements follow the very same rules in all the systems.

### 4.6 Equipment level design

In the equipment level a more traditional approach is applied in the ADLAS™ method. Requirements are “picked” from the system level documents. There are still some specific cases where the abovementioned “pushing” is used. This refers especially to the critical licensing issues, mentioned in chapter "Clear high-level requirements". These requirements may be elaborated to the equipment level already at the plant level. Such critical issues may arise especially from the diversity requirement. Diversity can be applied in several levels. The functions may be diverse or the systems performing basically the same functionality may be diverse. However, at the end, the question is about the diversity of the equipment, where the common cause failure may occur.

### 4.7 Configuration management

In the method the configuration management takes into account also the design data configuration management. The design and licensing documents recognize design data as configuration items. These are for instance safety functions, initiating events and Task Categories. Configuration is clearly stated in the documentation itself and also recorded in the database. Otherwise configuration management practices concerning the physical configuration and the requirements are based on the configuration management guidelines ([11]). This is illustrated also in figure 3.

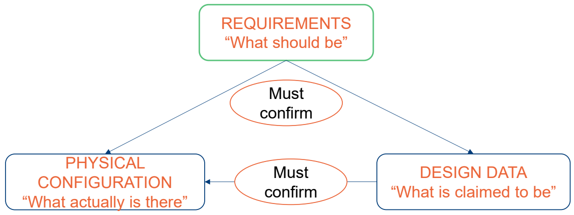


Fig. 3. Configuration management principle applied in the method ([6]).

## 5 RESPONSE TO LICENSING CHALLENGES WITH THE METHOD

There are several different contributions how the method can help to tackle the licensing challenges presented in chapter "Licensing challengers". First of all if the regulatory requirements change during the plant lifetime the thorough requirement management included in the method helps to recognise possible gaps between the new regulations and the existing licensing basis requirements. Also the implementation of the new regulations is easier, since traceability from high-level requirements to the system and equipment level is clearly shown. For instance adding a new initiating event to the highest level of hierarchy will impose new safety functions or new assignments of the existing safety functions. Performance criteria of the safety functions are checked and the architecture will be reviewed. If a system level requirement specification is sufficient, the safety justification is done only in the three highest levels of hierarchy. If system requirements do not meet performance criteria of the new functional allocation, there is anyway a clear basis for the new specification, which makes the procurement and the change processes more straightforward. Since the configuration management approach applied in the method takes into account also the design data the consequences of change can be clearly recognised from the database and then traced to the configuration items in the documentation. This significantly eases the updating of the design and the licensing documents.

Descriptive documentation has a lack of transparency whereas the documentation created according to the method shows clearly the elaborated requirements (interpreted requirements), which are used in the actual design. The requirement database then gives clear links to the native requirements, for which the elaborated requirements are based on. This clearly shows both for the designers and the regulator how requirements are interpreted. This means that a large part of the licensing work and the interaction between the license holder and the regulator is done at the beginning of the project, when interpretation of requirements is discussed.

Formal high-level requirements are elaborated at the very beginning of the engineering process. This clarifies the principles that are applied in the lower levels of the design. Clearly stated functional and non-functional requirements give a clear basis for system requirements specification. This ensures that there is only minor iteration in the system level design. Based on our experience this is the most critical issue for project schedules and costs.

## 6 CASE LOVIISA NPP - AUTOMATION RENEWAL

The ADLAS™ method was first used in full scale in the second automation renewal of Loviisa NPP. The project, realised with Rolls-Royce technology, has accomplished the first phase to install the new safety related preventive protection system to the defence-in-depth level 2 in 2016. Defence-in-depth (DiD) level 2 was not clearly defined in the original design basis back in the 1970's, though some functions were assigned to this level. Thanks to the method, the definition and scope of defence-in-depth level 2 is now clear and the licensing part of the project has progressed well according to the project schedule. Next phases where the manual accident management prioritization system and new diverse safety functions applied with diverse automation system (DiD level 3b) will be installed and the reactor trip system will be renewed. Installation of new automation systems is scheduled for outages 2017 and 2018. Fortum carries the responsibility on licensing in plant and architecture level design and supplier is responsible to ensure licensing of new automation systems.

### 6.1 Plant and architecture level design

ADLAS™ method was applied for plant level, functional architecture level and automation architecture level design. This meant that the whole safety related functionality of the plant was defined. Thus, high level requirements are defined also for those parts of the plant which are not renewed in the project. This will create a solid basis for any modification to the reactor plant safety systems in the future.

Also, control room & procedure architecture was defined to make functional allocation of new HMI systems.

### 6.2 Plant and architecture level V&V

V&V of plant and architecture level is made with analyses and tests. The main objective was to validate new automation systems as part of the plant. In plant level PRA was used to analyze the effect of new automation systems. Due to fact that functional architecture covers the functionality of the whole plant, it was not possible to renew analyses which cover only the new safety functions. Also, new YVL guides introduced new requirements related to safety analyses. Therefore, all safety analyses of the power plant had to be renewed.

To ensure smooth and effective analysis work, an analysis specification for safety analyses was developed. Purpose of the analysis specification was to define and justify safety analysis scope and their purpose. Analyses specification defined general analysis assumptions and information concerning all analysis cases. As stated earlier functional architecture defines what safety functions are needed in initiating events and the correctness of functional architecture is validated by deterministic safety analysis. Also, new analysis categories and analysis cases were introduced. Ultimately, analysis cases and results are presented in FSAR chapter 15.

As analyses specification includes all safety analysis cases, it was used as input for simulation-assisted automation testing. See [12].

Besides deterministic analyses also other V&V activities were performed in functional and automation architecture level to ensure independence of DiD levels in which new automation systems were applied to them. For example regarding preventive protection system installed in 2016 this meant performing common cause failure analyses (passive and active) and separation analyses. Deterministic approach was used. Common cause failure analyses were performed by studying safety functions and equipment attached to them. It was also studied how active or passive common-cause failure affected to the plant behavior. Separation analysis was performed using same approach, i.e. safety function and equipment attached to them were studied and it was analyzed is there any connections to equipment of other DiD levels and what kind of effect this had. Independent third party review for high level documents was made.

## 7 OTHER REFERENCES

Fennovoima Oyj is building a new nuclear power plant in Finland with AES-2006 reactor technology delivered by RAOS Project Oy. In this project the ADLAS™ method is applied in full scope in the licensing of reactor plant safety features. High-level requirements have been determined and the functional level has been mostly defined. Architecture level design is underway at time of writing this article. In the same site there will be a separated spent fuel storage facility. Fortum is conceptual designer of the facility and the method is used in full scale for creation of the licensing basis of the facility.

## 8 OTHER ASPECTS

The method not only enhances the safety, licensing and project management. Our experience is that the method significantly contributes to knowledge management. When junior engineers participate together with senior experts in the development of the documentation based on the method, the depth of understanding on the design basis among the junior engineers is increased much faster compared to the traditional approaches.

The method gives a more solid justification for the scope and extent of the safety improvements. On the one hand this will give more insight to the regulator and on the other hand it justifies the safety improvements for the business control of the utility. Basically the safety level is then optimised between different stakeholder interests in a very transparent manner.

## 9 CONCLUSIONS

The ADLAS™ method was developed to overcome the licensing challenges faced in the safety critical plant modifications in Loviisa NPP. The method gives more transparency and traceability for the design and licensing of safety critical systems. It has already now had significant contribution to project schedules and costs in demanding plant modifications. The method is applicable not only for the reactor plant but also for the other self-standing safety critical system such as spent fuel storages and pools. In addition to the design and the licensing it has positive features related to knowledge management and stakeholder communication.

## 10 ACKNOWLEDGMENTS

Several persons in Fortum Power and Heat Oy have contributed to the development of the ADLAS™ method.

## 11 REFERENCES

1. P. Nuutinen, S. Sipola and A. Rantakaulio, "*Advanced Licensing and Safety Engineering Method - ADLAS*®", Nuclear Science and Technology Symposium (NST2016), Helsinki, Finland, Nov 2-3 (2016).
2. Western European Nuclear Regulators Association, *Safety of NPP designs*. WENRA Reactor Harmonization Working Group. (2013).
3. Finnish Radiation and Nuclear Safety Authority. YVL B.1 Safety design of a nuclear power plant. (2013). ISBN 978-952-309-047-,
4. Hungarian Atomic Energy Authority. Annex 3/A on Government Decree No. 118/2011: Design requirements for a new nuclear power plant units. (2015)
5. Office for Nuclear Regulation. The purpose, scope and content of safety cases. NS-TAST-GD-051 Revision 4. (2016)
6. International Atomic Energy Agency. Configuration management in nuclear power plants. IAEA-TECDOC-1335. , Vienna, Austria (2003)
7. International Electrotechnical Commission. Nuclear Power Plants – Instrumentation and control systems important to safety – General requirements for systems. IEC 61513, rev. 1.0(2010)

8. International Atomic Energy Agency. Safety of Nuclear Power Plants: Design. IAEA SSR 2/1 (rev. 1.0). (2016)
9. International Electrotechnical Commission. *Functional Safety of Eletrocal/Electronic/Programmable Electronic Safety-related Systems (E/E/PE or E/E/PES)*. IEC 61508 (ed. 2.0). (2010)
10. U.S. Nuclear Regulatory Commission. *Standard Review Plan for the Review of Safety Analysis Report for Nuclear Power Plants*: LWR Edition. NUREG-0800. (1987).
11. International Organisation for Standardization. *Quality management systems – Guidelines for configuration management*. ISO 10007:2003(en). (2003)
12. V-M. Tikkala and A. Rantakaulio, "*Test Case Selection Procedure for Simulation-Assisted Automation*", (NPIC&HMIT 2017), San Francisco, United States June 11-15 (2017) (submitted)