Views on the Finnish nuclear regulatory guides

Björn Wahlström, Risto Sairanen
VTT Automation
VTT Energy

1 INTRODUCTION

This chapter describes the background and content of a study on views on the Finnish nuclear regulatory guides carried out at the Technical Research Centre of Finland. The study was initiated as one part of a larger investigation of the Finnish Radiation and Nuclear Safety Authority (STUK), which was aimed at assessing if the nuclear regulatory system in Finland can be considering too prescriptive and detailed.

1.1 The study

The study was commissioned by the Finnish Radiation and Nuclear Safety Authority (STUK) as a part of a larger assessment of the Finnish nuclear regulatory system. The intent with this assessment was to gain insights in the prescriptiveness and consistency of Finnish nuclear regulatory system. If the system is too prescriptive and detailed the own initiative of the licensees may be hampered in safety issues with a negative impact on their safety culture.

The Technical Research Centre of Finland (VTT) was contacted in September 2000 by STUK on its willingness and ability to perform an independent review of the Finnish nuclear regulatory system. After an internal pondering and some initial discussions the two VTT institutes VTT Automation and VTT Energy prepared a tender for the review in November 2000. That tender was divided into three parts consisting of a general assessment of the regulatory guides, interviews with representatives from the licensees and detailed reviews of single guides.

In the negotiations between VTT and STUK it was concluded that a more restricted study would be sufficient. As a result STUK placed an order for the independent review where the number of interviews was reduced and no detailed review of individual guides was to be carried out. It was also agreed that the draft report would be issued to STUK at the end of April 2001. Björn Wahlström (VTT Automation) and Risto Sairanen (VTT Energy) have been the main investigators in the study, but the valuable inputs of Pentti Haapanen (VTT Automation), Seppo Kelppe, Kari Rasilainen, Timo Vanttola (VTT Energy) and Reijo Pelli (VTT Manufacturing Technology) are also recognised.

1.2 The interviews

The interviews were carried out in the period of 16 February to 7 March 2001. A total of 17 persons from Fortum Engineering Oy, Fortum Power and Heat Oy, Posiva Oy, Teollisuuden Voima Oy and VTT Chemical Technology were interviewed. The persons to be interviewed were selected by a contact person within the organisation in consideration. That contact person also asked the persons to be interviewed to prepare themselves in beforehand with the set of questions to be asked in the interviews (cf. Appendix A). The aim was that the interviews should consider the complete set of YVL-guides, but in fact the discussions concentrated mostly on a few guides. All interviews were taped and transcribed. Some of the persons interviewed had prepared short memos, which were handed over to serve as a confidential material in the preparation of the report.

The interviews differed somewhat in nature depending on the mission of the organisation in consideration. Fortum Engineering Oy has experience in design and construction and the interviews therefore concentrated on those aspects. Fortum Power and Heat Oy and Teollisuuden Voima Oy are both operating nuclear power plants and these discussions concentrated more on operational issues. Teollisuuden Voima Oy has in addition filed an application for a decision in principle to build a fifth reactor in Finland and some discussions therefore dwelled on possible problems in the licensing process of a new plant. Posiva Oy is responsible for the final repository of spent fuel from all plants in Finland, but these activities are still relatively far in the future and at the moment, the main activity of Posiva Oy is more oriented towards research. Finally VTT Chemical Technology is operating a small research reactor which is used for medical purposes.

The results from the interviews are treated more in detail below with the exception that very few observations were drawn from the interviews at VTT Chemical Technology. In fact the people interviewed at VTT Chemical Technology where quite satisfied with the regulatory oversight as carried out by STUK. This is very much connected to the flexible approach used by STUK in applying the YVL-guides for the research reactor. This approach is well motivated due to the small risk potential of the reactor and the skilled personnel in charge of its operation.

1.3 The report

The report has been written to provide self-contained description of the study. The chapter 2 gives a very brief introduction to the Finnish regulatory system. Interested readers can refer to more detailed descriptions and the full text of regulatory documents through STUK:s website http://www.stuk.fi. Chapter 3 is based on general assessment criteria developed specifically for the study, but relies to a certain extent on available reports. Chapter 4 gives an account of comments and suggestions given by representatives of the licensees in the interviews. Chapter 5 discusses the YVL-guides that were found problematic by the people interviewed. Here the questions connected to a possible new plant are discussed separately, because there are some special considerations, which have to be observed in this respect. Chapter 6 brings forward some recommendations for further development of the YVL-guides, which are based on the criteria defined in chapter 3, and the comments from the interviews presented in chapters 4 and 5. Chapter 7 presents the main conclusions from the study.

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2 NUCLEAR REGULATION IN FINLAND

Nuclear regulation in Finland is set forth in the nuclear law (990/87) and the nuclear decree (161/88). The nuclear law and decree are rather detailed and they define some fundamental issues connected to the licensing process and nuclear safety. The Decision of the Council of State (VNP 395/91) gives the second level of nuclear regulatory requirements as applied in Finland and it also in its 29§ specifies that STUK issues more detailed requirements, i.e. the YVL-guides. The YVL-guides form the actual regulatory system, although they in principle are on a lower level than the decisions of STUK.

2.1 The nuclear law and decrees

The nuclear law and decrees define fundamental issues connected to the regulation of nuclear safety. The Nuclear Energy Act (990/1987) and the Nuclear Energy Decree (161/1988) apply to the construction and operation of nuclear facilities. They also define the principles for possession, use and transport of nuclear materials. One main statement of the legislation is that the licence holder is given the full responsibility for plant safety.

The Radiation Act (592/1991) and the Radiation Decree (1512/1991) apply to ionising radiation, radiation appliances, radiation practises, and radiation work, i.e. to applications in which radiation or nuclear reactions are not used as a source of energy.

The Act on the Radiation and Nuclear Safety Authority of Finland (1069/1983) and the later Decree on the Radiation and Nuclear Safety Authority of Finland (618/1997) define the responsibilities and organisation of STUK. The legislation gives the principal responsibility of safety to the operator, whereas the role of STUK is the regulatory control of the safe use of nuclear power. To fulfil this mandate, STUK shall issue regulations, set detailed requirements for licensed operation, and monitor plant operation.

Nuclear legislation further consists of the Nuclear Liability Act (484/1972) and the Decree on the Implementation of the Nuclear Liability Act (486/1972), Decree on the Advisory Committee on Nuclear Safety (164/1988), and the Decree on the State Nuclear Waste Management Fund (162/1988).

2.2 Decisions of the Council of State

Decisions of the Council of State give the second level of nuclear regulatory requirements as applied in Finland. The State Council Decision on general regulations for the safety of nuclear power plants (VNP395/1991) applies for light water reactors. The overlying principle is to guarantee that operation of a nuclear power plant does not cause danger to the health of employees or public or damage to the environment. In most topics, VNP395/1991 gives only a framework for more detailed requirements, and refers to the YVL-guides. VNP395/1991 does, however, give quantitative limits for the individual dose resulting from plant transients and design basis accidents. Setting a limit for the source term and by requiring that the containment should be able to withstand loads imposed by severe accidents makes them a part of the design basis.

The State Council Decision on general regulations for the physical protection of nuclear power plants (VNP396/1991) and the State Council Decision on general regulations for the emergency response arrangements at the nuclear power plants (VNP397/1991) apply to the organisation and their responsibilities against illegal acts and in emergencies.

The State Council Decision on general regulations for the safety of a disposal facility for reactor waste (VNP398/1991) and the State Council Decision on general regulations for the safety of disposal of spent fuel (VNP478/1999) apply to the waste generated from the operation of the nuclear power plants. The Nuclear Energy Act (990/1987) clearly specifies that the operator generating the nuclear waste shall be responsible for all waste management and is responsible for their costs. Like the analogous decision for nuclear power plants (VNP395/1991), VNP478/1999 gives quantitative limits for the effective annual dose resulting from facility transients and design basis accidents. It also gives guide to the safety analyses that are required to show that the long term safety and suitability of the site are assured.

2.3 The YVL-guides

In most practical applications, the YVL-guides form the actual regulatory system. A total of 68 YVL-guides are in force, a complete list is given in Appendix B. The guides are grouped under the following subdivisions:

- General Guides, YVL 1.0 ... YVL 1.16,
- Systems, YVL 2.1 ... YVL 2.8,
- Pressure Vessels, YVL 3.0 ... YVL 3.9,
- Buildings and Structures, YVL 4.1 ... YVL 4.3,
- Other Structures and Components, YVL 5.1 ... YVL 5.8,
- Nuclear Materials, YVL 6.1 ... YVL 6.21,
- Radiation Protection, YVL 7.1 ... YVL 7.18,
- Radioactive Waste Management, YVL 8.1 ... YVL 8.4.

The YVL-guides are, as the name actually indicates, not legally binding but advising rules for the licence holder. The regulatory system allows deviations from the requirements of the YVL-guides, if the licence holder presents an acceptable solution by which the safety level given in the YVL-guides is attained. This possibility puts some demands on the content of the YVL-guides. In addition to giving one acceptable procedure or solution, a practical guide should also clearly state the safety target, against which alternative solutions can be judged.

The YVL-guides as such apply to new nuclear facilities. Upon revision of an old guide when a new guide is issued, the licence holder sends to STUK a statement, how the requirements of the new guide are to be applied on the installation. STUK makes then a separate decision of the application to these installations. It should also be pointed out, that the publication of a YVL guide does not necessarily alter any decisions by STUK made prior the publication.

STUK also issues another set of guides, the ST-guides. The ST-guides mainly apply to non-energy applications of nuclear or radiation technologies. These guides were only mentioned very briefly during this survey.

2.4 Decisions by STUK

The nuclear law and decrees gives STUK the mandate to set and supervise the safety requirements of the nuclear installations. In Finland this is done through the regulatory system and not in individual plant licensing conditions. In addition STUK can issue letters to the licence holder, if a plant inspection or some other cause reveals findings that require corrective actions. Letters may also list new requirements or other actions that the licence holder must conduct within a specified time.

3 CRITERIA FOR ASSESSING A REGULATORY SYSTEM

Any review has to rely on some set of criteria against which the object of review is compared. This chapter establishes some general criteria, which can be applied in a review of a regulatory system. The criteria have been divided into four broad classes structure, content, application and updating. Structure has to do with the regulatory system as such, how different issues are addressed in different parts of the system and the degree of detail selected. Content is concerned with specific regulatory guides, how they are related to the issues they regulate and how the requirements compare with similar requirements as applied in other countries. Application is concerned with how the regulatory guides are applied and, how they are interpreted in the daily regulatory work. Finally the guides have to be updated to reflect new operational experience, the updating has to be organised and the updated guides have to be brought into use.

3.1 The position of national regulatory guides

Before setting down criteria by which a regulatory system can be assessed it may first be necessary to discuss for whom the regulatory guides are written. It can be noted that a regulator may decide to regulate based on cases and decisions without a system of comprehensive guides. The Finnish guides, like many other similar guides, are written for several purposes. Firstly they are evidently intended to give guidance to designers and operators of nuclear installations. Secondly they are intended to give guidance to regulatory inspectors as a standard of reference in inspections and reviews. Additionally they provide explanations for various people both in Finland and internationally of the nuclear safety standards, which are applied.

Regulatory guides should support decision making in defining the requirements that should be fulfilled by solutions for them to be acceptable. The guides should specify a safety level to be reached, but should not give prescriptions for certain solutions to be selected before others. This may sound easy, but it is rather difficult in practice, because safety criteria and requirements are often related to specific technical solutions. It is also important that the guides have an appropriate level of detail, to be guiding without being too prescriptive. Detailed requirements may tempt licensees to comply with their letter, which could cause a dilution of the responsibility for safety. Ideally the requirements should define a safety envelope, within which the designer has a real opportunity to optimise the design.

In a historic perspective it is natural that the guides have become more stringent with time, when an accumulating experience has pointed out weaknesses in earlier solutions. A high level requirement is also that all reasonable improvements in safety should be implemented, but that should not automatically imply that the requirements should be tightened all the time. One may instead even assume that certain requirements could be relaxed for example when technological development has advanced to a level where an acceptable quality is obtained as a standard without the extensive testing and documentation typically associated with a nuclear grade quality.

3.2 Structure

Structure is very important when a regulatory system is built. In deciding on the structure one has to agree on what requirements to place on which level. Very general requirements should be brought into the high level documents whereby more detailed requirements have to put into lower level documents. This separation can be found in the separation between the Nuclear Act and Decree on the highest level, the Decision of the Council of State on an intermediate level and the YVL-guides on the lowest level. The YVL-guides also have an internal structure where the first guides in the groups often are more general.

Another structural question is how to divide the regulatory guides between different technical areas. One approach is to follow the areas of design, which can be advantageous when a new plant is licensed, but which may not be equally fitting when applied during plant operations. Generally it important that all aspects important for safety are addressed in one way or another, which means that not only technical matters, but also matters connected to people and organisation should be given due regard.

The structure of the regulatory system should also be logical to make it easy for its users to find specific requirements. This also implies that single guides should have a content, which can be expected according to its title. The guides should be balanced in a way that the level of detail is about the same throughout the whole system. Finally the regulatory system should be consistent in its use of concepts and terminology.

3.3 Content

Content is concerned with specific regulatory guides and how they are related to the issues they regulate. The content of the single guides should be non-contradictory both internally and compared with other guides in the system. The requirements should be based on technical and scientific arguments to remove possibilities for arbitrariness and interpretation. Specific guides should as far as possible be independent of selected technical solutions.

The requirements should be reasonable in comparison with the issue they regulate and they should be comparable with similar requirements as applied in other countries. Whenever there are differences between other similar guides they should be possible to motivate for instance with a reference to local conditions.

The YVL-guides have a specific clause that they are binding only with respect to the safety level reached, with the meaning that also other solutions are acceptable, if the licensee can demonstrate that they are as good or better. In practice this exemption may be difficult to get accepted if the regulator does not have the skill to rethink a specific safety case.

3.4 Application

A regulatory system is always applied to practice in some way. Generally the application of the regulatory system should be independent of the inspector who is interpreting the requirements. This may be difficult to reach in an absolute sense, because requirements are written in natural language and therefore they always will depend on some interpretations. Some of the requirements are clearly written for specialists, but there is a benefit if the requirements could be understandable also for non-specialists.

It may pose some difficulties to ensure that interpretations are stable over time, especially when the people who are interpreting the requirements change. With time there is also a tendency that interpretations become stricter. When interpretations are unavoidable they should be done with a due consideration of the importance of the issue on safety. In such cases arguments behind a regulatory decision should be documented and communicated as accurately as possible.

A practice may develop where specific requirements are given a lax interpretation or even are considered not to be binding, especially if the requirements are not considered important for safety. This is however a dangerous path to take, because it may undermine attitudes towards the guides. The only sound policy to be followed is that all requirements are equally binding, but requirements, which are not considered important, are removed from the guides.

3.5 Updating

Regulatory guides have to be updated to reflect new operational experience. This means that the regulatory guides should be connected to the feedback of operational experience to identify needs for changes. It is a good policy to reconsider each guide and its possible needs for changes at a regular basis. Actually it would be beneficial to have a separate document in which a more general policy and strategy for the guides and their development would be stated explicitly.

The YVL-guides are presently mainly a paper-based system, which makes it difficult to introduce changes in a consistent way to all its parts. This difficulty is further complicated by the policy STUK has selected to make single YVL-guides self-standing by including direct citations from the higher level regulation.

The consideration of similar requirements from other regulatory system is a natural part of including new experience in the regulatory systems. Some caution should always be exercised in this connection, because it is easy to introduce contradictions in the system, especially if requirements are copied from one context to another without enough thought. Changing the YVL-guides should not be considered as an end in itself, but should always be considered on the basis of perceived advantages and disadvantages.

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4 ISSUES BROUGHT FORWARD IN THE INTERVIEWS

This chapter gives an account of comments and suggestions as given in the interviews by representatives of the licensees. The views were rather consistent. In general people were satisfied with the regulatory guides and thought they have provided structure to the safety activities. To that general positive attitude there were however also critics expressed. Most critics to the YVL-guides actually arouse from a few problematic guides, which seem to require additional efforts before the whole system can be considered completely satisfactory. In the creation of regulatory system there are several pitfalls, which should be avoided. It is not an easy task to build a consistent system where the requirements defined in different areas are on the same level. It is also difficult to write the requirements in such a form that they do not leave room for different interpretations, but at the same time provide the designer with a true guidance. A regulatory system has to be updated continuously and then one question is how to maintain internal consistence in the system. This chapter deals with the general comments given in the interviews.

4.1 The role of STUK

The Finnish legislation gives STUK several roles in nuclear power plant safety. The Nuclear Energy Act assigns the main responsibility for safety to the operator. According to the Nuclear Energy Act the role of STUK is to:

- *issue regulations* and put forward proposals for general requirements,
- *control* the fulfilment of licence conditions and set detailed requirements concerning plant operation as referred to in the plant licence,
- the Nuclear Energy Degree gives STUK also a role on *inspection* of pressure components in nuclear power plants.

In addition, STUK has research and some service activities.

A unanimous opinion of the interviewed persons was that the main roles of STUK should be regulation and control of the licence conditions. The utilities were prepared to take the full responsibility for safety.

There were some concerns of the possibility for conflicting roles in inspection and research. In the area of pressure components, STUK can in theory be a body that conducts inspections, as well as a body that accepts the results of the inspections. A similar situation could also occur in such research areas, where STUK self is active. It should however be pointed out, that all these concerns were based on hypothetical possibilities. No actual occurrence of this conflict in roles was mentioned.

The inspection programme for nuclear facilities was revised in 1999 in order to reduce the routine work. The revised programme was in principle welcomed, but it was felt that the revision has not yet reduced any of the old activities. The utilities also thought that the objectives of the periodic inspections should be more clearly defined.

4.2 General comments on YVL-guides

All persons interviewed were satisfied with the system of having STUK regulatory guides and thought that they have provided structure to the safety activities. The fact that they are guides and are not legally enforced was also seen positively. Alternative solutions are possible, if the licence holder can provide justification for them.

The negative comments focused on a limited number of YVL-guides that were considered problematic. These are discussed in more detail in Chapter 5. Some general comments and suggestions were also given and are described below.

It was commented that the importance of individual YVL-guides for nuclear safety varies to a large extent: Some guides are quite detailed in aspects that have a minor impact on nuclear safety. Maintaining of a large set of regulatory guides requires considerable manpower, which some of the interviewed thought could be better used for other more important safety-related activities. To reduce the effort, development of the YVL-guides could in the future be restricted to nuclear specific issues, whereas the conventional part of the plant would be regulated by normal industrial standards. The reference to international regulations and standards could also be increased. As Finland has not an own nuclear industry the utilities are dependent on international vendors and suppliers that are more familiar with international standards.

Another general type of comment was that an extensive set of regulations always tends to be conservative and therefore reflects practises of the time when the regulations were written. As such they are often promoting old as compared with new technologies.

As mentioned, the Finnish legislation allows deviations from the solution given in the YVL-guide, if justification for the alternative method can be given. To enable this, a guide should clearly state the safety level or safety target, against which the alternative method could be compared. This is not achieved in all YVL-guides. Some of the persons interviewed asked for more instructive guides, for example providing lists of documents, which are required for plant modifications.

The structure of the guides could be more logical. As a general rule, one guide should focus on only one specific issue. Now, a single guide can contain a number of items that have only a vague relation to each other. The guides should use a consistent set of definitions. One possibility is to issue a separate document of definitions, to which all guides would refer. This arrangement would force different persons to use the same interpretation for a given definition. The definitions should be consistent with international conventions, or if they are deviating, there should be a justification for the deviation. One example of an unpractical definition mentioned, is the STUK interpretation of single failure criterion, which deviates from the IAEA definition. The YVL-guide 2.7 requires that if a safety function is implemented by diverse systems, the single failure criterion should be applied to both systems. This interpretation does not encourage designers to add diversity, and may therefore have a negative influence on safety.

4.3 Definition of requirements

The need to have a balanced safety profile in the YVL-guides was expressed frequently. The interviewers got the impression that the Finnish utilities take the YVL-guides very seriously and spend quite a lot of resources to ensure compliance with the guides. Resources are however always limited and they should therefore to be spent on issues, which are important for safety. Several of the persons interviewed noted that that safety will not be optimised, if large resources are needed to comply with details, which have minor safety significance. Single requirements should not be allowed to dominate, unless they are recognised to be crucial for safety.

Too detailed and prescriptive regulation was thought to have a negative effect on safety, because it obscures the responsibilities and restricts the possibilities available for the designer. Equipment is under continuous development, and detailed regulation may favour outdated technology. It was in fact mentioned, that sometimes a conservative, but otherwise less optimal solution has been chosen, because it has been possible to licence it with a smaller regulatory effort. Another comment was that regulation might hinder the nuclear industry from utilising the rapid technological development of other industrial sectors. There were some opinions, that regulation should in fact be prescriptive and detailed, to give guidance and support unambiguous interpretations. The majority of the interviewed persons thought however, that some of the guides in part are too detailed.

There was a common wish that regulation to a larger extent should be based on risk considerations. It was proposed that STUK should establish a safety philosophy, by which the relationship between probabilistic targets and deterministic requirements can be clarified. This was pronounced when the YVL-guide 1.0 and severe accidents as design basis accidents were discussed. Severe accidents are characterised by a large catalogue of very low probability events, and therefore a purely deterministic approach is not practical for them. The acceptable residual risk level should be determined, below which initiating events or phenomena need not to be considered. A common view was that the objective should be to prevent rather than to mitigate severe accidents and the regulation should clearly emphasise this preference.

The requirements on documentation to be supplied seem sometimes not to be in accordance with applied design and construction practices. Unnecessary disputes are created if some document is asked for in a stage before the design process has produced information to be included in that document. The handling time before an approval of STUK is obtained may also leave unrealistically short production times for the object in consideration.

4.4 Application of the guides

The YVL-guides give room for interpretation, which sometimes obviously leads to disagreements. Several of the interviewed persons had the impression that interpretation of the YVL-guides changes when the person in charge of the subject at STUK is changed. To some extent this was considered understandable, but nevertheless not desirable. The reasons for changes in interpretations is that the background of a specific formulation in the YVL-guides sometimes are forgotten when the responsible persons have been moved to other tasks or have been retired and new persons consequently have taken responsibility.

The possibility of differing interpretation complicates the design work, because a reservation must be made for the most demanding of the possible interpretations. Consequently guides, which enable widely differing interpretations, were not considered appropriate.

It was mentioned that the policy of different STUK inspectors seems to vary to some extent. Some inspectors consider the text in the YVL-guide absolute from which no exemptions are allowed even if the regulatory system gives the possibility of alternative solutions. A wish was expressed that STUK internally should discuss the justification of the requirements and agree on common interpretations.

The utility representatives respect even demanding requirements and demanding interpretation of existing rules, if they feel that decisions are based on a deep technical understanding of the issues. They also expressed the opinion, that inspectors who have a profound technical expertise in their field are more flexible to accept alternative solutions. For some inspectors, independent decision making seems to be difficult. This may lead to serious delays for example in plant modification projects, if indecision continues in spite of additional clarifications provided.

Someone of the interviewed mentioned cases, in which the STUK inspectors have required adherence to international standards, even when they did not completely agree with the YVL-guides. There have also been cases where STUK by separate decisions has required matters not directly incorporated in the YVL-guides.

A change in interpretation that was considered particularly difficult concerns the role of containment in case of severe accidents during maintenance in the guide YVL 1.0. This subject is discussed in more detail in Section 5.1.

4.5 Updating the YVL-guides

The present way of updating individual guides is that STUK first prepares a draft that is sent for comments to the utilities and to the Advisory Committee on Nuclear Safety. When the new or revised guide is issued, utilities are asked to send a letter in which they explain how the requirements of the new guide will be applied at their plants. STUK will then by a separate decision define how the new guide will be applied at the existing installations.

The way of preparing individual guides was considered satisfactory by almost all interviewed persons. The utility personnel saw that the main responsibility of the safety authority is to prepare such requirements, and the utilities did not wish to have a very large part in preparation of single guides. A recent guide preparation that was well received was the new guide YVL 8.4 on spent fuel, where STUK provided answers to all comments together with justifications for the final formulation selected.

Some of the interviewed made reference to cases where STUK did not seem to want an in-depth discussion of the principles behind certain requirements. Other referred to cases where even very motivated suggestions for changes in the draft guides had not been taken into account when a new guide was issued. Several persons asked for a better feedback on the background and reasons for certain formulations in the guides.

Many of the persons interviewed asked for preparatory activities, where STUK could inform of their objectives and the strategy for regulation, and where safety philosophical questions could be discussed. Some of these types of questions mentioned were the risk based vs. deterministic requirements, application of defence-in-depth principle, etc. Justifications for new more demanding requirements should also be presented. In such discussions the utilities could inform STUK of the status of existing and emerging technologies. A fundamental prerequisite for such discussions is that STUK internally develops a strategy for regulatory oversight and a basic safety philosophy.

4.6 The YVL-guides compared to practises in other countries

Most of the interviewed persons considered the Finnish requirements more demanding as compared with similar requirements elsewhere in the world. Compliance with the requirements may be achievable, but the justifications for the more demanding requirements were asked for.

One example of such requirements is the consideration of severe accidents as design basis accidents, which have not been regulated elsewhere to the same extent. The persons who discussed these requirements expressed a clear appreciation and respect for the expertise at STUK that has made it able to introduce them. On the other hand, the present requirements are not easy to fulfil. Another example where the Finnish requirements deviate from other similar requirements is the YVL 5.3 on valves and actuators, which contains requirements that are applied generally to all valves when they elsewhere are applied only to valves operating in very specific conditions. When analysing fire situations, STUK applies single failure criterion, whereas this is not required elsewhere.

The persons interviewed considered STUK to be very independent. This independence has both negative and positive aspects. Some thought that STUK has replicated work that has been available elsewhere. Some of the examples given were an own QA terminology and the different interpretation of the single failure criterion. The utilisation of resources of other inspection organisations was considered small, as STUK seems to prefer its own technical inspection capabilities.

The independence of STUK was also praised, in the respect that STUK has been able to keep their requirements technical and consider them in risk perspective. Examples were also given of cases where STUK has taken a rather practical approach as compared with regulators in other countries.

4.7 Spent fuel management

Up to date, regulation of the spent fuel management has differed from plant operation, due to the different nature of the activities. The work conducted is has been mainly controlled through the Decision by the Council of State (VNP478/1999). A new guide, YVL 8.4 is under preparation.

Planning of spent nuclear fuel management has continued on a schedule that was outlined as early as in 1983. Some reasons for this continued progress are that the legislation in Finland is relatively clear, and that the roles and responsibilities of the organisations are well defined. There has also been a genuine commitment among the parties to keep up with the schedule.

Compared to other countries, the Finnish model of proceeding has some unique features. The decision in principle (DiP) process, for instance, is unique. While being a policy decision it adds an element of commitment also from the part of political decision-makers. The environmental impact assessment process (EIA) was a structural part of the DiP process. This gave also the whole EIA process a clear technical meaning.

The site investigation programme in Finland has been quite extensive and systematic from the very beginning and it has been converging stepwise from the whole country to a set of most promising sites. The stepwise approach was supported by STUK and gave a good basis for the site selection process in a gradually focusing manner. The performance assessments of spent fuel repositories in Finland have been deterministic in nature. This has lead to relatively clear and transparent assessments that are easier to communicate to decision-makers and the general public than the probabilistic analyses, which have been used in some other countries.

4.8 Some problematic YVL-guides

The interviewed persons were in general satisfied with the guide system and the majority of the individual guides within the system. A few guides, which received most of the criticism, are discussed in detail in the following chapter. Of these, the guide YVL 5.5, Supervision of electric and instrumentation systems and components at nuclear facilities, was by far most often mentioned. The existing guide dates from 1985 and is obsolete. The guide has been under revision since 1995 and several draft versions have been presented, which also to some extent have been utilised in the practical work. There is a need for modernisation of plant instrumentation and control at the nuclear power plants and therefore a renewed guide capable of addressing the application possibilities of modern automation systems is required.

The guide YVL 2.1, Nuclear power plant systems, structures and components and their safety classification, also received quite a number of comments. The guide has been updated in 2000. A new feature of the revised guide is the safety class 4, which contains systems that have some safety significance but are not classified to upper classes. Examples are the fire fighting and flood protection systems and the plant computer. The utilities have a feeling that the amount of documentation the licensee has to deliver to the authority is increased by the new system, and that more equipment has been raised from the non-safety class to class 4 than has been moved from class 3 to class 4. YVL 2.1 has been changed two times during operation of the plants, and the utilities felt frustrated by the additional work needed to implement the changes in classification. It was a widespread opinion that the work connected to a reclassification actually has created considerable costs without any significant influence on safety.

The central guide for new plants is YVL 1.0, Safety criteria for design of nuclear power plants. The main comment to this guide was that it is very demanding, and perhaps the most demanding in the world. The guide sets severe accidents as the de facto design basis accidents. All persons interviewed accepted inclusion of severe accidents as design basis accidents for new plants. The main problem was seen in the balance between the probabilistic and deterministic targets. The guides YVL 2.2 Transient and accident analyses for justification of technical solutions at nuclear power plants and YVL 6.2 Design bases and general design criteria for nuclear fuel, form a pair, in which the former lists the cases and assumptions required in the safety analyses and the latter the success criteria for these. The guides have been updated separately and there is currently a discrepancy between the two. YVL 2.2 uses a classification into transients, accidents and severe accidents, whereas YVL 6.2 further divides the accidents class into two.

5 A DISCUSSION OF SOME PROBLEMATIC GUIDES

This chapter gives an account of critics and suggestions as given in the interviews by representatives of the licensees. In this chapter some problematic YVL-guides are taken up for a closer discussion. The YVL 1.0 deals with general safety principles, which should be applied, in the design of a nuclear power plant. The YVL 2.1 defines how systems, structures and equipment should be safety classed. The YVL 2.2 take a stand on disturbances and accidents to be analysed. YVL 5.5, which regulates the instrumentation and control, seems presently to be the most problematic of all the guides. YVL 6.2 is concerned with the requirements placed on the fuel. In addition there are some specific concerns which are connected to the licensing of a possible new plant to be built in Finland.

5.1 YVL 1.0

The guide YVL 1.0, Safety criteria for design of nuclear power plants, gives the design targets for new plants. A particular feature of YVL 1.0 is that it sets severe accidents as design basis accidents. The guide has been considered very demanding, mainly due to some specific requirements.

The unbalance between probabilistic and deterministic requirements of the YVL 1.0 guide was criticised. Severe accidents form an inexhaustible catalogue of very low probability events. Contrary to the conventional design basis accidents, a purely deterministic approach is not possible. It was suggested that a residual risk level should be determined and accepted, below which initiating events or phenomena need not to be considered. An example of overlapping probabilistic and deterministic targets in the current YVL 1.0 are the requirements set on primary system depressurisation. The guide requires firstly that high-pressure melt ejection has to prevented and secondly that the primary system must be equipped with a highly reliable depressurisation system. It also requires, that high-pressure melt ejection must be taken into account in design of the containment. The latter requirement may not be achievable in a strict sense, and may divert the design focus from the prevention to the mitigation aspects of the scenario.

Another unclear case with probabilistic and deterministic targets is the assumption of a severe accident during refuelling. New BWR designs exist, in which a severe accident during refuelling has a very low probability. On the other hand, designing BWR containment capable of withstanding all severe accident loads during refuelling is very difficult task. Balancing of probabilistic and deterministic targets has also been mentioned when considering anticipated transients without scram (ATWS) as a design basis accident.

YVL 1.0 requires that 100% oxidation of easily oxidising materials in the reactor area must be taken into account in the containment design. The assumption of 100% oxidation is high, but it can not been completely ruled out by research results. This requirement has therefore been generally accepted by the Finnish utilities as basis for the containment design.

YVL 1.0 states that the systems that are used to ensure the containment integrity in severe accidents are required to satisfy the single failure criterion. They must also be independent of the normal operation systems and of the design basis safety systems. These requirements are demanding as compared to other countries. Single failure criterion has been usually required only in conventional design basis accidents. It was felt that the requirement of independence is restrictive and does not necessarily guarantee reliability. A similar argument was given for monitoring of severe accidents. YVL 1.0 in addition requires information to be provided on re-criticality, pressure vessel melt-through, debris location and containment threats. The instrumentation providing this may not be practically achievable, and is not directly connected to management actions of severe accidents.

5.2 YVL 2.1

The guide YVL 2.1 Nuclear power plant systems, structures and components and their safety classification, gives guidance for establishing a safety classification system. The classification systems is intended to make both the design and the licensing processes practical by assigning the most strict requirements to the highest classes and more relaxed requirements to lower classes. In general there is no specific reasons to apply one specific classification system before another as long as it is followed consistently.

A new version of the safety classification guide YVL 2.1 was issued for trial use by STUK 26.6.2000 and has been in force since 1.1.2001. This version introduces a new safety class 4 thus leading to a four level safety classification (plus the non-nuclear Class EYT).

The purpose of the safety classification is to grade the plant systems, structures and components according to their importance for the plant safety. The safety class specifies the procedures to be employed in plant design, construction, monitoring and operation and also defines the level of the regulatory control directed to the classified items. Classification is an important tool in allocating resource to achieve the highest possible safety level with available resources. This means a thoroughly balanced classification is of utmost importance and can contribute to savings in costs, time and efforts in the design, operation and qualification of safety related systems, structures and components.

The YVL 2.1 defines the safety classes and classification principles. It also in an appendix gives an example of safety classification in a light water reactor plant representative for present day technology. For future, advanced LWR plants with more passive safety features this example is less valid. The actual licensing requirements for the classified items are given in other, system specific guides. The key question connected to the safety classification is therefore not the classification itself, but the way in which requirements are connected to the selected safety class and how they are interpreted in each individual case. There have been problems in this interpretation as revealed in some recent project concerned with the licensing of new software-based instrumentation and control systems. The interpretation of the classification requirements is, mainly connected to the system specific guidelines, but better guidance would be desirable also in YVL 2.1.

The cause of the problems is connected to two matters:

- classification of functions, and
- reliability requirements for systems and equipment.

For the first, the basis of the classification guideline is the Council of State Decision on the safety of nuclear power plants (395/91) which states that the functions important to the safety of the systems, structures and components of a nuclear power plant shall be defined and the systems, structures and components classified according to their safety significance.

The classification thus starts from functions, but results in a classification of the systems, structures and components. For instance in the case of instrumentation and control, the essential issue is the abstract functions and their requirements. When the functions are defined, the designer has many alternatives to realise them with systems and equipment with certain reliability by proper application of the redundancy and diversity principles. It would therefore be desirable to augment the classification system with principles on when it can be considered acceptable to realise a function belonging to higher safety class with systems and equipment belonging to a lower safety class.

Secondly, the four safety classes provide a crude division of a continuum of safety importance for the functions. This means that problems always will be found in the higher and the lower ends of the classes where either stricter or more relaxed requirements are motivated. In many cases the majority of the licensing effort is spent on defining and attesting the required reliability level of systems and equipment by which a certain function is implemented. The reliability requirement can depending on the level of redundancy and diversity vary considerably even inside a certain safety class, which makes it difficult to assign fixed procedures for design, construction, monitoring, operation and regulatory control directly to the safety class without considering the corresponding reliability requirements.

The practical concerns raised in interviews were the following:

- One of the purposes of the changed classification was to focus and reduce the amount of documentation the licensee has to deliver to the authority, but the utilities feel that the opposite has been the result. One special observation is that more equipment has been raised from the EYT-class to safety class 4 than has been brought down from class 3 to class 4.
- If the utilities are enforced to change the existing classification in present plants, this will cause a large amount of additional work, which they do not consider to have any influence on the safety level of the plants. If the new guide is applied in upgrade and replacement projects only, this can cause a lot of contradictions and confusion. The utilities therefore would prefer not to apply the new guide to the existing plants.
- The compatibility of the safety classification with equipment available on the market poses a problem especially with electrical components. Most of the vendors to the nuclear industry apply the old two-level classification into 1E- and non-1E-classess. This discrepancy causes many problems in buying electrical components such as:
    - difficulties in finding reliable suppliers,
    - high prices,
    - dispensable re-engineering and re-documentation work, and
    - project schedule and cost overruns.

5.3 YVL 2.2 and YVL 6.2

The guides YVL 2.2 Transient and accident analyses for justification of technical solutions at nuclear power plants and YVL 6.2 Design bases and general design criteria for nuclear fuel, are closely coupled. The former gives the cases and assumptions required of the safety analyses, the latter among other fuel related requirements the success criteria for the safety analyses. The guides have been separately updated and do not use the same classification for accidents.

A frequently mentioned difficult issue in YVL 2.2 was inclusion of Anticipated Transients Without Scram (ATWS) among design basis accidents, a selection not common elsewhere. The main criticism was that considering ATWS as a design base accident apparently requires classification of the systems used to manage it to safety class 2. These systems, however, are mainly ordinary normal operation systems, whose qualification to class 2 is a large task without any significant impact on safety. Another comment was that having a kind of additional type of design basis accident complicates discussions with foreign NPP vendors regarding a possible new reactor in Finland.

A logical conflict was also pointed out when requiring single failure approach in the safety systems, and allowing that normal operational systems and operators are assumed to act in the most probable way. YVL 2.2 actually states that ATWS must be analysed as other design basis accidents, using a conservative approach in calculation models and selected parameters. For safety systems, an N-2 requirement must be applied, assuming that simultaneously with a single failure, another redundant system is out of operation due to repair. On the other hand, normal operating systems may be assumed to operate without faults. The differing assumptions may lead to non-physical calculation cases.

The ATWS requirement has already caused renewal of operating instructions and plant modifications at the existing plants. Some of the modifications have certainly improved the plant safety, such as for example the concern given for the boron dilution type of transients. In some other cases, the benefit for the total safety is more difficult to assess.

YVL 6.2 is the central fuel related guide, where the fuel design bases and general design criteria are defined. It covers a range of fuel phenomena depending on fuel and reactor designs and operation history. The guide has been recently revised. The revised guide has unique features that have not been applied elsewhere. A major new feature is division of accidents into two classes with clearly differing requirements.

Several other changes have also been brought in, of which the most notable is introduction of a limit for assembly burn-up (40 MWd/kgU). Smaller updates are introduction of limits for the number of rods to undergo DNB or transition boiling in transients and class 1 accidents (0.1% and 1%, respectively), a limit for the number of failing rods in class 2 accidents (10%), and requiring that the failure rate due to pellet-to-clad (mechanical) interaction is extremely small in transients and class 1 accidents.

One gets an impression, that revision of YVL 6.2 has been triggered by research and makes an attempt to introduce a variety of recent fuel related research results and new calculation methods. The guide would have been more logical, if an effort had been made to reduce the requirements to a more limited set of necessary safety objectives. The current version includes for example a number of overlapping requirements. The criteria for transients require firstly that there is a 95/95 confidence level for the hottest rod not experiencing a heat transfer crisis. Secondly a limit has been set on the number of rods experiencing heat transfer crisis (0.1% of total). In addition, failures due to pellet-clad-interaction are required to be extremely small.

The most criticised issue in the revised guide has been the burn-up limit, which was considered too low. Burn-up induced fuel structure changes are most important in the reactivity-induced accidents. Current experimental programmes work for increasing the high burn-up fuel database. The burn-up increases of these programmes are quite high, 20 to 40% of the current limits, and they have a lengthy schedule. Gradual increase of burn-up may be considered, assuming that the margins for enthalpy increase in reactivity accidents are large enough.

5.4 YVL 5.5

The guide YVL 5.5, Supervision of electric and instrumentation systems and components at nuclear facilities, is concerned especially with instrumentation and control systems. The technical and economical ageing of analogue instrumentation and control systems and equipment and the disappearing of their supporting infrastructure force nuclear utilities to turn to programmable digital technology. Old analogue system will gradually be replaced with software-based systems in existing plants and new plants will from the beginning use such equipment. There is a widespread consensus about the superior functionality and reliability of programmable systems over their analogue counterparts, but it has turned out that the demonstration of high reliability with the required high confidence is a difficult task. Despite large preparatory efforts many cost and time-schedule overruns have been recorded in nuclear projects all over the world.

The transition from the old analogue technology to new programmable digital technology caused a need to revise the existing YVL 5.5 guide, which is dated 7.6.1985. The work of revising this guide was initiated in 1995 and the work is still ongoing. The old version of the guide is still in force, but various drafts of the new YVL 5.5 guide have been used in a trial fashion over the last few years in upgrade and replacement projects of instrumentation and control systems at the existing plants.

The utility companies have encountered severe difficulties in the licensing of software-based systems in their projects. This has made them cautious in adopting the new technology and many plans for upgrade and renovation projects have been delayed or put on a hold. Old analogue systems have been kept alive by purchasing decommissioned equipment and residual spare parts from all over the world or by disassembling them from their own less important system. From a technical point of view it would be preferable to exchange the old equipment with newer and more modern.

The cost, effort and time schedule overruns in previous, relatively small projects, has also lead the utility companies to ask themselves if the initiation of a new plant construction project would be possible, before the licensing problems of software-based instrumentation and control systems have been satisfactorily solved. The financial risk for the prolongation of the plant construction time schedule may be far too big to be taken.

There were several comments pointing to problems with clarity and legibility of the present draft of the YVL 5.5 guide, but the main problem seems not to be the guide itself but the way in which it is interpreted. A tight and detailed commitment to all, even the less important, requirements in the guide together with other standards and guidelines referred to in it, may imply that it is difficult or even impossible to find suppliers on the market. For the most critical safety systems belonging to the class 2 tight interpretations are justifiable and manageable, but especially in class 3 severe difficulties arise. Class 2 contains a rather limited set of relatively simple instrumentation and control applications, which usually are specially designed, constructed and validated.

Class 3, instead, contains a large amount of various safety related and operational instrumentation and control applications with a wide range of reliability requirements. In most cases the only viable way to realise these functions is to use a high quality, standard industrial instrumentation and control system platform, which is widely used in other applications of power and process industry. For these systems information and detailed documentation about the applied design, production and quality processes are usually not available and the qualification process has therefore to rely on operational experience. Also the large variety in the reliability requirements should be better reflected in the interpretation of the guide.

In commenting on the preparation of a new version of the YVL 5.5 guide the interviewed persons gave their appreciation to the willingness of STUK to listen to their concerns, but complained about the slowness of the preparatory process. Several people saw the trial application of a draft guide as questionable and expressed a concern that the ambiguity in the situation may have an influence on safety. Some even referred to an increasing difficulty to keep experts, as they become frustrated in a seemingly endless process of preparing papers for the licensing of simple equipment. In general the whole atmosphere seems to be strained in matters concerned with the guide YVL 5.5.

5.5 Applications for new plants

The possible new nuclear power plant places a large challenge on the whole regulatory system. The YVL-guides give a structure for the whole licensing process. The guides have actually been written a new plant in mind, but it may be necessary to make a prior assessment of their practical applicability.

A few issues were frequently mentioned when discussing the possible new plant:

- the requirements concerning severe accidents imposed by YVL 1.0,
- digital instrumentation and control, YVL 5.5,
- application of the YVL-guides to passive safety systems, and
- functioning of the whole licensing process during the construction time.

Comments concerning YVL 1.0 and YVL 5.5 have been described in previous sections. For both guides, a specific comment concerning new plants was that Finland does not have a nuclear industry and therefore requirements vastly differing from the international practice will complicate discussion with suppliers.

YVL guides can not be applied as such for passive safety systems. The interviewed persons acknowledged that STUK is actively considering this subject, but pointed out that the present YVL-guides are not yet complete in this respect. One central question concerns the single failure criteria. YVL 2.7 states that the safety systems must be able to accomplish their function in the event of a single failure although any component affecting the safety function would simultaneously be inoperable due to repair or maintenance, the so-called N-2 requirement. The passive safety systems are typically not maintained during operation and the requirement should therefore be refined. The passive safety systems may on the other hand also require some active components, actuating signals or external power for example. Work on classification principles for such systems should be initiated if a new plant with passive safety features seems to be likely.

The main concern for the new plants was the functioning of the complete licensing process during a design and construction project, which by necessity is restricted in time. Recent plant modernisation projects have shown, that sometimes a small modification project reserves all expert capacity that STUK has, resulting in long delays. It was suggested that all YVL guides should be reviewed in advance bearing in mind the schedule and decision making needed during plant design and construction. The utilities were concerned that undue requirements on documentation will introduce unreasonable delays without any contribution to plant safety. The role of the preliminary safety analysis vs. the system level pre-inspection documents should be clarified. Ideally a licensing process should be adapted to assess the solutions in the order they are produced of a design and construction process.

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6 RECOMMENDATIONS

Based on the earlier chapters of the report this chapter develops some recommendations for how to further develop the YVL-guides. There are some obvious improvements to be implemented in the YVL-guides in a short-term perspective, but STUK should also initiate a discussion of a more long-term strategy for the development of the YVL-guides. There is also a need to discuss how the YVL-guides are written and used with the aim of making interpretations less dependent on the inspectors. Safety requirements build on a combination between deterministic and probabilistic considerations, but it sometimes appears to be difficult to find a proper balance between the two principles. This has to do with an interpretation of the residual risk and an agreement when it is small enough. The classification of functions, structures and equipment is an issue, which is under discussion in various standardisation committees and here some rethinking seems to be necessary. Finally, in a long-term perspective, there are obvious needs for harmonised regulatory approaches. STUK may take an active role in an international discussion of future approaches to regulatory oversight.

6.1 Near term development of the YVL-guides

One would have expected that the development of the YVL-guides is guided by a clearly expressed strategy. A tacit strategy has evidently been governing their development over the years, but it is would be recommendable to make that strategy more overt. Further development of the strategy would most certainly benefit of general discussion within the nuclear community in Finland on ends and means of regulatory oversight.

There are also a number of larger and smaller needs for improving present guides. The far most problematic is YVL 5.5 which in the present form may even lead to non-optimal practices. Closely connected is YVL 2.1 of two reasons, firstly connected to efforts to reclassify present nuclear power plants and secondly connected to the application of the requirements of YVL 5.5. The requirements of YVL 1.0 that are connected to severe accidents seem to require modifications to balance the probabilistic and deterministic requirements in a logical way.

The possibility that a new nuclear power plant should be licensed in Finland places a large challenge on the whole regulatory system. The YVL-guides themselves give an eminent platform for the licensing process, but it may be necessary to make an assessment of the practical arrangements to ensure that undue requirements on documentation to be supplied will not introduce unreasonable delays in the design and construction process. Ideally a licensing process should be adapted to assess the solutions of a design and construction process in the order they are produced.

6.2 A harmonisation of interpretations

There seems to be some problems in maintaining a consistent interpretation of the YVL-guides. This is something, which has to be expected with requirements written in a natural language, and it may even be counterproductive to try to formulate the requirements in a way to minimise the room for interpretations. According to the interviews the problems are accentuated when new inspectors are taking charge of some area. The underlying problem seems to be partly connected to the maintaining a pool of knowledge at STUK and partly connected to the decision-making processes applied. If younger inspectors can get advice and support for their own judgement this problem should be possible to combat.

Another problem is that some YVL-guides are interpreted more stringently and others more freely. To some extent this is natural, because different issues have a different weight on nuclear safety, but the same general principles should still apply. This problem may be pre-empted with an increased internal dialogue within STUK to transfer a kind of a meta-interpretation between different areas of regulatory oversight.

Finally, in the light of the interviews, there seems also to be a need for a harmonisation of interpretations between different regulatory systems. A growing globalisation and a diminishing number of vendors makes it increasingly important to reach a better international harmonisation of safety requirements. Such a harmonisation can be achieved only in a dialogue between STUK and other regulators in the world.

6.3 Deterministic and probabilistic requirements

The interactions between deterministic and probabilistic safety requirements are one of the keys to the high safety level reached in the nuclear industry. These concepts seem difficult to integrate in practice and people seem often to be tuned to one or the other. Finding a correct balance between deterministic and probabilistic safety thinking has to do with the fundamental question of what is safe enough. Deterministic requirements are needed for essential nuclear safety related components and phenomena. On the other hand, there should be a cut-off probability, below which deterministic safety requirements are not more asked for.

The relationship between deterministic and probabilistic criteria can be illustrated by a simple example. Consider a certain safety function at a nuclear power plant, which is designed according to applicable deterministic principles and with a certain reliability target in mind. Can the deterministic criteria be relaxed if the reliability of the system can be shown to be very high? Safety functions are typically implemented with systems, which for their function rely on various auxiliary systems. What principles should then be applied for setting deterministic and probabilistic requirements on such auxiliary systems? Deterministic design principles can sometimes be used to eliminate certain failure mechanisms and then it would be fair to credit for that property in a probabilistic analysis. Similarly if some sequence can be shown to be very unlikely in a probabilistic sense, then a corresponding accident analysis should be possible to restrict to a few representative cases.

This issue has also an application on the requirements set for the so-called process initiating events. What kinds of reliability requirements are prudent and reasonable for functions and systems, which are needed to cope with certain disturbances, incidents and accidents? When should the single failure criterion be applied also for sequences that can be considered very unlikely and what kind of credits can be given for diversity in functions. A resolution of these questions has to reflect a view on residual risks. It would be beneficial if STUK could enter a discussion on the relationships between such deterministic and probabilistic criteria and their interpretation in a few selected illustrative cases.

6.4 Classification of functions, structures and equipment

The classification system, by which functions, structures and equipment are graded with respect to their importance for safety, is a key to many other issues. If the classification system and the requirements in different classes cannot be agreed upon, there is little prospect that present disagreements and confusion will disappear. In this connection it is important to note that the concern is not only the classification system itself, but also how it is interpreted and how different functions, structures and equipment actually are allocated to different classes.

A second issue connected to the safety classification has to do with changes introduced in YVL 2.1. The guide has been changed two times and the nuclear power plants made serious attempts to comply with the new requirements. It became soon evident that a total plant reclassification would be counterproductive and it was agreed that only plant modifications would be classified according to the new system. This principle is practical, but it also has a potential of introducing confusion. It was a widespread opinion among the persons interviewed that the work connected to a reclassification actually has created considerable costs without any significant influence on safety.

Experience from incidents as well as PSA results demonstrate that the conventional systems can have an important influence on safety. Classification practices of today do not typically recognise this fact. If the principles for the classification of functions, structures and equipment are reconsidered there might be an opportunity to reconsider also principles for handling presently non-classified systems such as for instance the ultimate heat sink.

YVL 5.5 would also warrant some rethinking on how to carry out the classification. There have been international standardisation efforts aimed at a better approach for classification of instrumentation and control functions and systems important to safety. It is too early to predict in which directions these efforts will lead, but it is clear that STUK should involve itself in the discussions.

6.5 Challenges for the future

Any system of requirements should be updated to reflect the technical development. A reasonable requirement is also that nuclear power plants built today should be better than those built twenty years ago. The way such a general feeling for the need of improved solutions should be converted into safety regulation is a different matter. In this connection there may be a need for opening up a societal discussion on the risks of nuclear power as compared to risks of other sources for primary energy. STUK should probably not be too much involved in such a discussion, but an emerging debate may place a need on STUK to explain the content and the assumptions of nuclear regulation in a language, which can be understood by educated laymen.

Another question is how regulatory oversight will change in the future. STUK has had an outspoken policy to move away from inspecting technical details to inspect and review work processes of the licensees. According to the interviews such a development would be welcome, but signs of such a change have been small so far. Instead many of the interviewed expressed the opinion that the regulatory oversight had been moving further into details.

STUK has selected not to be directly involved in matters concerned with economics. Experience from nuclear power plants in the world demonstrate however, that safety can be achieved only when the economic situation of a nuclear power plant is sound. This observation may have some influence on future regulatory approaches.

One issue to be considered is how modern information technology can be utilised efficiently. It is evident that the technology has many potentials, which will require considerable investments before they are fully realised. Experience from information technology projects call however for realism in the expectations. STUK has in this connection taken a small, but welcome step forward in making the regulatory system easier to access in a new computer based system.

A final question towards the future has to do with how the technical development will continue. The conventional industry has already in many fields surpassed the nuclear industry in its quality requirements. Will this influence the nuclear regulatory systems and if so in what way? The nuclear industry itself is considered too small by the large international vendors to motivate the development of specialised nuclear products. This may lead to a situation where special nuclear grade equipment can not be bought at any price, or the equipment available is inferior as compared with normal industrial grade. It seems however likely that a requirement that the technology used should be proven will stay, but such a requirement should not be allowed to stop a search for better solutions. Again it is important that STUK takes an active role in a discussion of future directions in the development of regulatory oversight.

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7 CONCLUSIONS

This chapter gives the general conclusions of the study. The main conclusion must be that the YVL-guides have to be considered as a large asset for the Finnish nuclear community. The guides in general can not be considered too prescriptive. There are however a number of improvements which could be made in the structure of the YVL-guides, in the content of specific YVL-guides, in the way they are interpreted and in the processes for keeping them up to date.

In a general evaluation of the YVL-guides one can conclude that they fulfil earlier described criteria reasonably well. They have a structure, which is logical and covering. They are relatively well balanced with a reasonable level of detail. The requirements put forward in the YVL-guides are reasonable and they are reflecting international practice. The guides are understandable and fairly straightforward to interpret. STUK is putting in a considerable effort to keep the guides up to date.

The main question asked in the assignment was whether or not the YVL-guides could be considered too prescriptive and binding for the nuclear utilities in Finland. Based on the interviews and a general assessment, this question has to be answered with a definitive no. All persons interviewed had a clear positive view of the YVL-guides and they were seen as giving structure to the safety activities at the plant. This positive view has however to be qualified with respect to a few problematic YVL-guides. These guides have been treated more in detail in the earlier chapters of the report.

The YVL-guides can be considered as an asset of the Finnish nuclear regulatory system. It is clear that STUK should continue the work they do in keeping the YVL-guides up to date. The strategy for further development of the guides should however be reconsidered, discussed and documented on a continuing basis. The possibility that a new nuclear power plant will be built in Finland gives a number of new challenges to STUK which have to be reflected.

In a long-term perspective, the position of the YVL-guides as a component of the regulatory oversight in Finland may change. The extent to which there will be an international harmonisation of regulatory guidelines remains to be seen. It is however evident that the nuclear community all over the world would benefit from more harmonised approaches to safety. With the present experience and skills STUK could most certainly play an important role in this development.

ACKNOWLEDGEMENT

The open and frank discussions during the interviews are gratefully acknowledged. All persons interviewed showed a deep commitment to nuclear safety. The comments given were by the interviewers seen as sincere attempts by the interviewed persons to improve the present Finnish regulatory system. There were no indications that the views expressed could be interpreted as an unfounded groan on something the utilities have to live with. In a way this can be seen as a reflection of a good safety culture at the organisations visited.

Appendix A. Questions during the interviews

The questions to be discussed were sent to the persons to be interviewed in beforehand. The interviews were taped and transcribed. Some of the interviewed persons handed over short memos addressing various aspects of the YVL-guides. The analysis has been done using the transcriptions and these memos.

The following questions were asked during the interviews:

1. What are the most important YVL-guides in your field of responsibility?
2. How have they functioned in practise?
3. What requirements have been the most difficult to implement?
4. Are there YVL-guides, which call for unreasonable efforts as compared with the importance of the issue regulated?
5. Are there issues, where more stringent requirements could be motivated?
6. Have there been disagreements between you and STUK on how the YVL-guides should be interpreted?
7. What issues have generated such disagreements?
8. How do the YVL-guides relate to similar guides in other countries and more generally to international regulation?
9. How has the updating of the YVL-guides come off, including notifications, accounting for comments and bringing the new guides into practise?
10. What kind of general score would you like to give the YVL-guides concerning their appropriateness and function in practise?

Appendix B. List of the YVL-guides (as per the time of writing)

General guides

YVL 1.0 Safety criteria for design of nuclear power plants, 12 Jan. 1996

YVL 1.1 Finnish Centre for Radiation and Nuclear Safety as the regulatory authority for the use of nuclear energy, 27 Jan. 1992

YVL 1.2 Documents pertaining to safety control of nuclear facilities, 11 Sept. 1995

YVL 1.3 Mechanical components and structures of nuclear power facilities. Inspection licenses, 22 Oct. 1996 (in Finnish)

YVL 1.4 Quality assurance of nuclear power plants, 20 Sep. 1991

YVL 1.5 Reporting nuclear power plant operation to the Finnish Centre for Radiation and Nuclear Safety, 1 Jan. 1995

YVL 1.6 Nuclear power plant operator licensing, 9 Oct. 1995

YVL 1.7 Functions important to nuclear power plant safety, and training and qualification of personnel, 28 Dec. 1992

YVL 1.8 Repairs, modifications and preventive maintenance at nuclear facilities, 2 Oct. 1986

YVL 1.9 Quality assurance during operation of nuclear power plants, 13 Nov. 1991

YVL 1.10 Requirements for siting a nuclear power plant, 11 July 2000

YVL 1.11 Nuclear power plant operating experience feedback, 22 Dec. 1994

YVL 1.13 Nuclear power plant outages, 9 Jan. 1995

YVL 1.14 Mechanical components and structures of nuclear facilities. Control of manufacturing, 4 Oct. 1999 (in Finnish)

YVL 1.15 Mechanical components and structures in nuclear installations, Construction inspection, 19 Dec. 1995 (in Finnish)

YVL 1.16 Control of nuclear liability insurance policies, 22 March 2000 (in Finnish)

Systems

YVL 2.1 Nuclear power plant systems, structures and components and their safety classification, 26 June 2000

YVL 2.2 Transient and accident analyses for justification of technical solutions at nuclear power plants, 18 Jan. 1996

YVL 2.3 Preinspection of nuclear power plant systems, 14 Aug. 1975 (expires)

YVL 2.4 Primary and secondary circuit pressure control at a nuclear power plant, 18 Jan. 1996

YVL 2.5 Pre-operational and start-up testing of nuclear power plants, 8 Jan. 1991

YVL 2.6 Provision against earthquakes affecting nuclear facilities, 19 Dec. 1988

YVL 2.7 Ensuring a nuclear power plant's safety functions in provision for failures, 20 May 1996

YVL 2.8 Probabilistic safety analyses (PSA), 20 Dec. 1996

Pressure vessels

YVL 3.0 Regulatory control of pressure vessels in nuclear facilities. General guidelines, 11 Sep. 1996

YVL 3.1 Construction plan for nuclear facility pressure vessels, 27 May 1997 (in Finnish)

YVL 3.3 Nuclear power plant pressure vessels. Control of piping, 4 Dec. 1996

YVL 3.4 Nuclear power plant pressure vessels. Manufacturer's competence, 16 December 1996 (in Finnish)

YVL 3.7 Pressure vessels of nuclear facilities. Commissioning inspection, 12 Dec. 1991

YVL 3.8 Nuclear power plant pressure vessels. Inservice inspections, 13 Dec. 1993

YVL 3.9 Nuclear power plant pressure vessels. Construction and welding filler materials, 6 April 1995 (in Finnish)

Buildings and structures

YVL 4.1 Concrete structures for nuclear facilities, 22 May 1992

YVL 4.2 Steel structures for nuclear facilities, 19 Jan. 1987

YVL 4.3 Fire protection at nuclear facilities, 1 Nov. 1999

Other structures and components

YVL 5.1 Nuclear power plant diesel generators and their auxiliary systems, 23 Jan. 1997 (in Finnish)

YVL 5.2 Nuclear power plant electrical systems and equipment, 23 Jan. 1997 (in Finnish)

YVL 5.3 Regulatory control of nuclear facility valves and their actuators, 7 Feb. 1991

YVL 5.4 Supervision of safety relief valves in nuclear facilities, 6 April 1995 (in Finnish)

YVL 5.5 Supervision of electric and instrumentation systems and components at nuclear facilities, 7 June 1985

YVL 5.6 Ventilation systems and components of nuclear power plants, 23 Nov. 1993

YVL 5.7 Pumps for nuclear facilities, 23 Nov. 1993

YVL 5.8 Hoisting appliances and fuel handling equipment at nuclear facilities, 5 Jan. 1987

Nuclear materials

YVL 6.1 Control of nuclear fuel and other nuclear materials required in the operation of nuclear power plants, 19 June 1991

YVL 6.2 Design bases and general design criteria for nuclear fuel, 1 Nov. 1999

YVL 6.3 Supervision of fuel design and manufacture, 15 Sept. 1993

YVL 6.4 Transport packages for nuclear material and waste, 9 October 1995

YVL 6.5 Supervision of nuclear fuel transport, 12 October 1995 (in Finnish)

YVL 6.6 Surveillance of nuclear fuel performance, 5 Nov. 1990

YVL 6.7 Quality assurance of nuclear fuel, 23 Nov. 1993

YVL 6.8 Handling and storage of nuclear fuel, 13 Nov. 1991

YVL 6.9 The national system of accounting for and control of nuclear material, 23 Sept. 1999 (in Finnish)

YVL 6.10 Reports to be submitted on nuclear materials, 23 Sept. 1999 (in Finnish)

YVL 6.11 Physical protection of nuclear power plants, 13 July 1992 (in Finnish)

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