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REFLECTIONS ON THE WANO PEER REVIEW PROCESS

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Summary: This paper has been written as a part of the LearnSafe project to take look on the WANO peer reviews with the aim of providing views and suggestions for further refinements of the process. The interest of LearnSafe in the WANO peer reviews is obvious, because they can be seen as a systematic approach to organisational learning. Peer reviews have an important position in the nuclear industry in the support of continuous improvements of safety. The main objective of the peer reviews is to identify possible weaknesses to enable the nuclear power plants to make their own improvements in areas identified. The reviews have in addition an important function in the collection, documentation and distribution of good practices. The peer review process is in many ways an ideal tool for improving performance, but there are also many challenges that have to be approached to in making them efficient. The perhaps most important challenge is to create trust and confidence in the process to enable an open discussion of possible problems. A second challenge is to make the peer reviews an efficient instrument in a continuing process of improvements. From a theoretical point of view there are various possibilities, which should be considered when the peer review process is developed. The perhaps most important question to approach is the extent various models of contributing factors to good safety performance can be made explicit. In conclusion it is argued that see the peer review programme should be seen in connection to all the other WANO programmes, which are offered as parts of a comprehensive package of services given to the nuclear industry in the world.

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REFLECTIONS ON THE WANO PEER REVIEW PROCESS

1 INTRODUCTION

The WANO peer review programme was initiated in the year 1991. As a concept it was built on experience collected by the Institute of Nuclear Power Operations (INPO) from their own peer review programme. Since its start the WANO peer review programme has got a very large appreciation by its members. Early in the year 2000 already 50% of the nuclear power plants in the world had hosted a peer review and in the year 2005 it is expected that all operational nuclear power plant has hosted at least one WANO peer review.

The present paper has been written as a part of the LearnSafe¹ project to take a closer look on the peer review process with the aim of providing views and suggestions to be used by WANO for further refinements of their peer review process. The paper has been written from a theoretical and scientific standpoint with the hope that this view can provide additional insights through a reflection on factors contributing to human and organisational performance. The report is based on written material obtained from WANO and on discussions with WANO staff during meetings at the WANO offices in Paris in June 2002 and in January 2003.

The interest of the LearnSafe project towards the peer review process is evident. From a theoretical point of view the peer reviews can be seen as a systematic instrument to enhance organisational learning. Peer reviews also have many opportunities for both participating organisations and involved persons to take a fresh look on issues that are connected to performance. Experience has shown that this kind of reconsideration of the basics often can bring in new components of insight and understanding to contribute to both individual and organisational learning.

2 PEER REVIEWS IN THE NUCLEAR INDUSTRY

Peer reviews have become an important part of the safety management practices in the nuclear industry for many good reasons. Firstly it is important to conduct systematic assessments and reviews to collect and evaluate achieved performance and to use results for improving factors that contribute to good performance. Secondly the reviews can contribute to a better understanding of preconditions for a good performance and thus also of signals that should trigger concerns and remedial actions. The peer reviews that are used in the nuclear industry place a focus on safety, because deterioration in safety may carry very large costs through incidents and/or regulatory interventions.

2.1 The WANO peer reviews

The WANO peer reviews are the main subject for the discussion in this paper and the process is briefly described in the Appendix 1. A WANO peer review is initiated at a request from the host plant. The whole process relies on full confidentiality between all parties involved. A WANO peer review can be characterised as a bottom-up process, because it is mainly based

¹ The project FIKS-CT-2001-00162 "Learning organisations for nuclear safety" funded by 5th Euratom Framework Programme 1998-2002, Key Action: Nuclear Fission by the European Commission. For additional information see the web-site <http://proxnet.vtt.fi/learnsafe/>, which is open for the LearnSafe partners. Access to this web-site can be gained by sending a mail to Ulla.Peltonen@vtt.fi. The project has also established an open web-site at the address <http://www.vtt.fi/virtual/learnsafe/>.

on observations in selected areas at the host plant. The areas selected typically follow managerial responsibility, which has the benefit that it is easy to find both peers and their counterparts at the plants. The station manager at the host nuclear power plant is viewed as the customer for the peer review.

In the WANO peer reviews stress is laid on the collection of actual observations from the plants to identify deviations from what can be considered as standards at the host plant or within the industry. The observations are discussed within the review team to ensure that a consensus is found on the importance of the observation. The observations are then sorted under a smaller number of headings to be further structured into operational or cross-functional areas in a process to generate a report of findings and recommendations. During the whole peer review a close interaction is maintained with the staff at the host plant, both to gain their confidence for the process and to brief them on the development of the peer review.

In the WANO peer reviews there is a considerable interaction with other WANO programmes, for example to brief the peer review team on collected operational experience and to give feedback from the peer reviews to other programmes on issues of generic interest. WANO is also collecting feedback from the peer reviews in a more general internal report. This information is available for WANO members only.

2.2 The OSART reviews of IAEA

The IAEA OSART programme was set up in 1982 to assist Member States in the safe operation of nuclear power plants.² The IAEA OSART-missions consist of three basic types: missions to operating power reactors; missions to power reactors under construction; and Technical exchange missions that cover a limited range of topics. OSART missions are conducted at the request of the Members States of IAEA.

A full scope OSART mission lasts typically three weeks and covers eight areas of review: management; organisation and administration; training and qualification; operations; maintenance; technical support; radiation protection; and emergency planning and preparedness. The general structure of the OSART missions and the composition of the review team resemble the WANO peer reviews.

IAEA has documented generic findings from the OSART missions in a series of reports.³ On a very generic level the experience from the OSART missions is that even at the best performing plants there were areas where improvements could be made and even the less well performing plants had areas that could be used as models for others.

2.3 The IRRT reviews of IAEA

The IRRT programme was initiated in 1989 to provide advice and assistance to IAEA Member States to strengthen and enhance the effectiveness of the nuclear regulatory body in Member States.⁴ IRRT missions are assumed to compare nuclear regulatory practices in a Member State with existing international consensus guidelines and equivalent good practices elsewhere. The basis for the review is formed by the IAEA Safety Standards Series publications and is further supported by the IRRT Guidelines.

² IAEA (1994). OSART guidelines 1994 edition, IAEA-TECDOC-744.

³ IAEA (1998). OSART mission highlights 1995-1996, IAEA-TECDOC-1018.

⁴ IAEA (2002). Guidelines for IAEA International Regulatory Review Teams, IAEA Services Series No.8.

IRRT reviews are performance oriented, which means that they accept different approaches to the organisation and practices of a national regulatory body that contribute to ensuring a strong nuclear safety regime in its country. Recommendations are made on items of direct relevance to safety, whereas suggestions made might enhance the national safety regime indirectly, but would improve the organisation or performance of the regulatory body. Good practices identified may be communicated to other Member States for long term improvement.

So far only relatively few IRRT missions have been carried out. An international review mission to Sweden was carried out in 1995.⁵ An interview of the Swiss regulatory system was carried in out the year 1998⁶ and of the Finnish regulatory system in the year 2000.⁷

2.4 Other peer reviews

There have been examples where nuclear utilities voluntarily have chosen to carry out peer reviews. For some cases outsiders have been invited to carry out the interview to give them independence. Two reviews of the major nuclear utilities in Sweden were carried out after the strainer incident in the year 1992 at the Barsebäck nuclear power plant.⁸ Both review teams were chaired by high level officials and the reports were placed in the public domain. Later one additional review of the nuclear operation of the Swedish State Power Board was conducted by a small international team, but the report of this review was kept confidential.⁹

One important review was carried out during the year 1995 at all nuclear power plants of Ontario Hydro in Canada.¹⁰ This review resulted in the dramatic decision that several plants were shut down for extended periods. Another example of nationally organised peer reviews is that German utilities recently have agreed to conduct peer reviews in all of German nuclear power plants. The review teams are intended to be composed of staff members of other German plants.

The ASSET missions¹¹ of IAEA can also be considered to be a kind of peer reviews that is focusing on the feedback of operational experience. In these reviews one or a few actual incidents at the host plant are picked as examples for carrying out an in-depth incident analysis and to compare that with the analysis as carried out earlier by the plant itself. Recently IAEA has been involved in the creation of a new kind of service to Member States in which the focus is placed on safety culture. WANO is offering similar kinds of targeted peer reviews under the heading of Technical Support Missions, which are focusing on specific areas as selected by the host plant.

⁵ Commission of inquiry for an international review of Swedish nuclear regulatory activities (1996). Swedish nuclear regulatory activities, Volume 1 - an assessment, SOU 1996:73, Volume 2 - descriptions, SOU 1996:74.

⁶ IAEA (1999). Report of the International Regulatory Team Review to Switzerland, IAEA/NSNI/IRRT/99/01.

⁷ IAEA (1999). Report of the International Regulatory Team Review to Finland, IAEA/NSNI/IRRT/00/2.

⁸ G. Brodin (1993), Säkerhets och informationshanteringen inom Vattenfalls kärnkraft produktion - en granskning (Safety and information management within the nuclear energy production of the Swedish State Power Board, in Swedish). O. Hörmander (1994), Säkerhetskulturen i Sydskrafts kärnkraftverksamhet (Safety culture in the nuclear activities of Sydskraft, in Swedish), Kristianstad.

⁹ Magnus v. Bonsdorff (1999), Metoder använda vid en granskning av kärnkraftsäkerheten (Methods used during a review of nuclear safety, presentation in Swedish given at an NKS seminar in Finland).

¹⁰ Andognini, G. C. (1999): Lessons from plant management for achieving economic competitiveness for evolutionary reactors, pp.330-337 in Evolutionary water-cooled reactors: Strategic issues, technologies and economic viability, IAEA-TECDOC-1117. The full text of the review was made available at the web-site <http://www.hydro.on.ca/OHNewSit.nsf/Public/ConsInfoNewsIIPARreport>.

¹¹ IAEA (1991). Asset Guidelines, Revised 1991 Edition IAEA-TECDOC-632.

2.5 Regulatory reviews

Various reviews are carried out by the regulatory bodies in all countries at regular intervals. The periodic safety reviews are the most comprehensive and they are carried out with an interval of about ten years.¹² These reviews are to a large extent based on a comparison of actual practices with well-established norms, but they also include more open-ended components as seen in peer reviews.

In the United Kingdom the nuclear regulator NII, which is a part of the Health and Safety Executive (HSE) has conducted a few very extensive reviews of selected nuclear installations in the UK.¹³ To one extent these activities can be seen as an attempt to regain a regulatory confidence in the safety of selected nuclear installations after a series of events.

2.6 Differences between the reviews

The different peer reviews have many similarities, but also differences. The differences are mainly related to the activities addressed, the organisation conducting the review and the composition of the team. The IAEA reviews have a certain official flavour, because they are agreed on at a governmental level in the country of the host plant. The results of the IAEA review have often been made public in one way or another, which in practice often leads to a quite diplomatic report.

The WANO peer reviews are initiated at a request by the host plant and the results of the review are always kept confidential. This has the potential to carry out the review more openly and it can therefore also be more valuable in its learning characteristics. Still many people at the host plant often view the peer review just as an additional burden.

Peer reviews commissioned by a nuclear utility itself can be based either on outsiders or own people from other nuclear units. Such reviews can be even more open, but due to their lack of established forms they are vulnerable to influences of hidden agendas.

The regulatory reviews are to a large extent depending on national regulatory practices. They often rely on inspections that complement self-assessment carried out by the licensee. Sometimes they are triggered by surprising incidents that have raised a suspicion that certain safety threats may exist in the operational practices as used on some plant. Regulatory reviews are very much depending on the regulatory atmosphere in the country, but the possibilities of regulatory interventions typically make them quite formal.

2.7 Peer reviews in a process of building public confidence

Peer reviews could have a position in building public confidence and trust in the nuclear industry in general and in the specific nuclear power plant. If the peer reviews would be used in this way it is evident that there has been a public confidence in the organisation, which has carried out the peer review. It should also be possible for the public to acquire an understanding of how the peer review is carried out and how the results are reported and reacted on.

¹² IAEA (1994). Periodic safety reviews of operational power plants, Safety Series No.50-SG-O12.

¹³ HSE (1998). Safety audit of Dounreay. HSE (1999). An audit by the HSE on British Energy Generation Limited and British Energy Generation (UK) Limited. HSE (2000). An Investigation into the Falsification of Pellet Diameter Data in the MOX Demonstration Facility at the BNFL Sellafield Site and the Effect of this on the Safety of MOX Fuel in Use. Available at <http://www.hse.gov.uk/nsd/index.htm>.

If the peer reviews would be used for convincing the public of the safety of nuclear power there is evidently the danger that their main objective would be made more diffuse. A larger public interest in the peer reviews may also make it more difficult to keep them confidential, which is one of the crucial requirements for them to be open enough to carry their full learning benefit. If this path is entered there is a danger that unsound competition could be the result either between plants carrying out peer reviews or between different organisations doing peer reviews. On the other hand a careful consideration of the information distributed can have a positive influence on public trust and confidence.

3 METHODOLOGIES FOR PEER REVIEWS

Peer reviews differ from other kinds of performance reviews in that respect that they are carried out by persons who have an own personal experience of the work processes and tasks that are reviewed. This arrangement has the benefit that it brings in a kind of implicit norm with which the observed practices are compared with. In the methods for peer reviews there are variations that may have an influence on the review process itself and the results achieved.

3.1 Basic assumptions and objectives

The main objective of a peer review is to identify possible weaknesses to enable the reviewed nuclear power plant to make its own improvements in the areas identified. Sometimes the peer reviews are in addition assumed to collect examples of good practices, which are seen on the plants reviewed. It is assumed that the team members have a good understanding of the work processes and tasks that are selected for the review. They should therefore be able to detect practices that may have an adverse impact on safety and they should be able to identify practices that can be considered exceptionally good.

The peer review should be able to bring any observation to a discussion, which means that the team members should be independent from the people involved in the work processes and tasks that are reviewed. The peer review is also assumed to have a customer that is responsible for initiating necessary remedies to the findings of the peer review. To be efficient a peer review should always be done with an open mind, which means that any hidden agenda should not be allowed to influence the results.

One important component of a peer review is that it is forcing people at the host plant to think and reflect on possible safety threats. It is also assumed the team members take back experience on good practices to their home organisations as an additional benefit of the peer review. A peer review is from a psychological point of view to be considered as an intervention, which is affecting both the reviewed and the reviewers.

3.2 Underlying models of performance

Peer reviews are typically not relying on explicit models of performance. Instead the team members are assumed to bring their own tacit models of performance to the review. This is both a strength and a weakness in the peer review process. The strength is that performance is assessed without prejudices, but the absence of an explicit model of performance makes it difficult to define what should be considered as an observation.

The peer review can be seen as a bottom-up process, where the reasons that a certain observation is considered to be as a potential threat to safety are constructed as a team effort. In a top-down review, performance and characteristics of work processes are observed and compared

to defined standards to record deviations. Both approaches have their own advantages that are often combined in actual performance reviews.

One performance model that at least tacitly is used in the peer reviews is how human errors and organisational deficiencies can influence performance. Peers participating in the team have their personal experience from incidents at their own plants, which are forming their search for signals of deteriorated performance. This experience is very valuable, because it relates to real world problems.

Academic research has pointed to various factors that may trigger errors at the "sharp end"¹⁴ of the organisation. Insights from this research can be used to sensitise team members to the small and seemingly unimportant things that may have a crucial influence on the sequence of events leading to an accident.

3.3 Restricting the review

In targeting a peer review there is a possibility to decide whether it should be broad or deep. A broad review will have the objective of assessing all possible functions and characteristics of an organisation that may have an influence on safety. A deep review is targeted to a specific area of interest, which is considered to be the most important at the time for the review. A broad review is always more resource demanding, but it has the benefit of taking a look on the entirety. A deep review has the benefit of being more sensitive in the selected area, but has the drawback that it may be difficult to look at broader interactions between various work processes and tasks.

A common observation is that organisations often have a good understanding of their own strengths and weaknesses and that would suggest that a targeting of the review could enhance its efficiency. The peer review would in such a case have its major task to help the organisation in putting enough emphasis on the need for improvements, because it is sometimes difficult for the organisation itself to be forceful enough in its own improvement efforts. A practical approach is often to use a combination of reviews to in a first phase to identify potential areas for improvements and in a second phase to concentrate on the areas, where the largest potential for improvements can be found.

3.4 Organising the review

Sometimes peer reviews are carried out by an ad hoc organisation assembled especially for this task. In these cases the team leader is often selected as a person known to have a high integrity and long experience from the field. This solution carries the difficulty that the team cannot rely on an accumulated practice for carrying out the review, but it may on the other hand be more flexible and adapted to a specific purpose.

When specialised organisations, such as WANO and IAEA, perform the review it is possible to carry over learning experience from one review to another. It is also possible to create additional understanding of the content of the peer review together with strengths and possible weaknesses. The involvement of international organisations gives the peer review credibility and makes it possible to collect good practices for the benefit of a larger group of plants. In a way it is a large advantage if the peer reviews have the stability to create an organisational memory that can be nurtured over time.

¹⁴ James Reason (1998). Managing the risk of organizational accidents, Ashgate Publishing Company.

3.5 Methods for information collection

Performance reviews can use a large spectrum of instruments for information collection. These could include observations, review of documents, questionnaires, surveys, interviews and discussions in focus groups. All information collection methods have their own strengths and weaknesses. Peer reviews often restrict themselves to observations and interviews.

Sometimes performance reviews are preceded by a self-assessment that is carried out according to a specified framework. Self-assessments can have the benefit of sensitising the host organisation to certain characteristics of performance and thereby enhance the benefit of the peer review. When a self-assessment is a part of the review one important task of the review team is to assess the honesty and openness in the self-assessment.

3.6 Selection of team members

The selection of team members is one of the most crucial parts of any peer review. In general they should combine a broad and a deep knowledge and the team should be assembled to give it a combined competency that is covering the target area of the review. A team carrying out a review of a nuclear power plant should naturally involve people having many years of experience from the nuclear field. It may still sometimes be beneficial to engage outsiders, who have experience from safety management in some other industrial area.

The basic assumption of the peer review process is that reviewers in their daily work are closely connected to the activities they are reviewing. This gives them an opportunity to understand possible difficulties in the activities they see. They may for example themselves have tried out some of the solutions that they observe at the host plant. This close connection with actual work makes it easy for them to identify deficiencies and possible problems. This carries the additional benefit that the reviewed and the reviewer can engage in fruitful discussion on preconditions for and obstacles to good performance. Although the peer reviews rely extensively on the involvement of peers, there may still be benefits of engaging specialists in selected areas such as quality systems, human factors and operator training.

A peer review is process in which many people interact. To be efficient this process has to be based on a common language, because the use of interpreters makes communication slow and cumbersome. The peer review can be seen as a group learning exercise, where both the team itself and the host plant engage in a process of exposing views on good performance. The team leader has a very important role in facilitating this process. He or she should be insightful and diplomatic to bring out the best of all people participating in the peer review.

3.7 The time for the review

Mostly there are not any specific arguments for selecting one time before another for the peer review, but there should always be enough lead-time for the preparations to take place. If one peer review is to be undertaken by WANO or IAEA it should naturally be fitted into a schedule of other peer reviews. Some incident or accident can be a trigger for a specific review targeted at an in-depth investigation of the sequence of event and their contributing causes. If a peer review has been carried out at some instant of time, it is a good idea to have a follow up review about one year later to investigate how observations and recommendations have been attended to.

Peer reviews imply a considerable investment of resources. It is therefore not practical to use them as an instrument in the day-to-day safety activities. On the other hand they should be repeated at some regularity, because there is a benefit of bringing in fresh views on the organ-

isation and its practices. If a nuclear power plant has an efficient program of regular self-assessments, which in addition is supported for instance by benchmarking activities it is likely that a longer interval between peer reviews can be accepted.

4 CHALLENGES IN THE PEER REVIEW PROCESS

The WANO peer review process has deliberately been designed to be bottom-up. This means that observations are collected by individual team members and brought to a consideration of the group. This design has the advantage that the process is based on insights and understanding of people, who are involved in similar work as they are reviewing. It is also building on the collected experience from many similar reviews. In addition, because team members come from many different organisations and countries, the peer review becomes a true multi-organisational learning exercise. These characteristics create challenges of their own that have to be responded to.

4.1 Creating trust and confidence in the process

Any peer review process relies on trust between the personnel at the host plant and the peer review team. There should be a mutual perception that the process is fair and based on an objective consideration of actual facts. It may be necessary to place some summary information on the peer review in the open domain, but when confidentiality can be assured at least in details it is far easier to have an open dialogue in the process. Without openness and honesty the whole exercise is likely to be misdirected. It is also important to ensure that the review team is independent from the host plant and has integrity not to be persuaded in taking easy shortcuts in a willingness to please.

The WANO peer review process was established based on the successfully implemented INPO peer reviews with slight modifications to make an adaptation to an international context. The present way the peer reviews are carried out is based on a track record of earlier peer reviews that have been used to refine the process. Useful results from earlier peer reviews have also made managers at the nuclear power plants positive to them and they have achieved a considerable status within the whole nuclear industry. Today it is common that people at a selected host plant have met colleagues with a positive experience from earlier peer reviews.

4.2 Collection and documentation of observations

The collection and documentation of observations is a challenge for all peer reviews, especially when very few norms are given for what to consider as acceptable regarding performance and practices. Just as an example there may be some practices, which in isolation appear peculiar, but taken together may be sound and efficient. It may also be very hard to provide evidence that some specific observation carries a possible threat towards safety. The documentation of some observation in writing is also a delicate task. The writing should characterise a fact and not an opinion. Statements should furthermore be neutral and should never criticise persons.

In the WANO peer review process this challenge has been identified and responded to. All observations that are brought to the attention of the team are according to used practices challenged with the question "so what". The grouping of the observations under selected headings also emerges into a team exercise, which gives an opportunity to discuss their safety implications. The team leader has in addition the responsibility to polish blunt statements to be reasonably diplomatic.

4.3 Overcoming cultural bias

Anecdotal evidence from peer reviews tells about cases, where one of the team members has expressed very strong opinions on some observation. Such strong opinions are often based on a cultural bias, making it difficult to understand advantages or disadvantages with some specific practice. The peer review process can sometimes bring such values and beliefs into the open, when team members disagree on some of the observations made. The resolution of such internal conflicts within the team requires tact and diplomacy of the team leader. If cultural bias is allowed to enter the final report from the peer review it is due to loose in credibility.

WANO has evidently identified and reacted on this challenge, because this issue was described to be an important part of the training process before a peer review. A proper approach to this challenge has to be based on the insight of individual team members that a cultural bias can be devastating for the final result. This insight should however also be paired with integrity not to yield without tangible explanations and evidence. A resolution of such issues often require that team members bring their own internal models of contributors to safety and good performance into the open to be explicitly assessed by the other team members.

4.4 The need to see the whole picture

Safety practices as applied at a nuclear power plant should always be seen in their entirety. There should be work processes and task to ensure that no important function is left unattended. The work processes and task should support each other to form an efficient whole. Efficiency is typically not considered in the peer reviews, but inefficient practices may spill over to safety activities to cause inferior work quality.

The organisations at the nuclear power plants have typically been built gradually over time to fulfil a more or less explicitly defined mission. This mission may have been modified a few times to adapt to a changing environment. There may also have been strong managers in the organisations all with their own views on the best way to reach high performance. This means that there is a historical context at the nuclear power plants in which practices have to be reflected to be fully understood. The challenge in this connection is to be able in a short time absorb the whole picture and to make sense of details that are observed.

This challenge is difficult to approach in the peer reviews. One approach is connected to the selection and training of team members. Another approach is to assemble packages of inside information from the host plants for the use of team members, which partly is done already today. In the WANO peer reviews this challenge is well understood, but it may still be beneficial to spend additional thoughts on how to approach it.

4.5 Commitment and resources

A peer review will need a large commitment from all parties involved. It will also need a proper amount of resources in terms of both people and time. The participants in the peer review team will not be compensated in any other way than for their direct costs, which implies that good will is required both from the individual team members and from their host organisations.

A peer review involves a considerable commitment from the host plant. One initiating factor may have been a mounting pressure to go through a peer review, but without a proper commitment of the host plant, it might be an empty exercise. If for example the host plant is only

moderately interested in the results, or even sees the peer review as an additional burden, it is likely that its full benefit will not be realised.

A peer review involves a considerable commitment from WANO, which is acting on the request of the host plant. The results and the usefulness of the peer review rely on a proper allocation of resources in all phases of the process. If WANO for example cannot get suitable people for the peer review team there may be considerable difficulties in generating expected results.

WANO has evidently identified and reacted on these challenges. The peer review programme has been systematically developed over time. The nuclear power plants are well informed and they have shown a large willingness to provide resources for the peer review teams. WANO maintains a list of possible peers for different areas. The participants in the individual peer reviews have found the exercises challenging and well worth the effort. The identification of the plant manager at the host plant as the customer of the peer review has apparently also shown to be a good practice in ensuring a proper commitment.

4.6 Transferring insights from the peer review team to the host plant

Peer reviews should evidently not be confined only to the generation of observations, but they should also suggest improvements at the host plant and initiate work towards their implementation. This implies that observations and suggestions have to be brought to persons who are able to do something about them. A necessary precondition is then that these persons understand that the observations are important and have to be acted upon. They should furthermore be willing to change things, have a vision of how improvements could be made and put themselves on stake to have them implemented.

It may sometimes for different reasons be difficult to transfer insights of the peer review team to the host plant. Some of the difficulties may be connected to deficiencies in approaching the challenges as described above. It is for example important to note that an observation always is somewhat connected to criticism, which may give rise to defensive reactions if not conveyed in a diplomatic manner.

Experience from peer reviews has shown that observations are recurring. This is also a common experience from quality audits within the nuclear industry. There are various explanations for this experience. One is that observations from audits and peer reviews are abstract and thus disconnected from normal everyday tasks, which makes it difficult to find good cures. Another explanation is that the observations are reflections of underlying organisational dilemmas for which it is very hard to find satisfactory solutions. A third explanation may be that the organisation is simply overwhelmed with too many operational tasks that have to be solved before more subtle problems are dealt with.

Discussions with WANO staff confirm the existence of this challenge. According to the discussions there is presently no clear view for the best way to approach this challenge in all its aspects.

4.7 Peer reviews as a part of continuous improvements

The final challenge for the peer review process is perhaps more distant, but it may still be important to discuss. This challenge is connected to the possibility that the peer review process as exercised today will generate very few observations. Such a situation may arise if the nuclear industry has made large improvements and consequently very few deviations from agreed standards could be found. It may also arise if all nuclear power plants have absorbed

the set of questions typically posed during a peer review to a degree that they are made irrelevant as compared with usual way to organise work at the nuclear power stations.

This challenge has also to do with a need of maintaining interest in and strength of the peer reviews. A response to this challenge has to be found in a continuous rethinking of what actually is needed to maintain safety at the nuclear power plants. If there within the strategic rethinking of the content and format of the peer review process is an ongoing reflection of how safety is constructed it should be possible to meet also this challenge. On a more practical level in the peer reviews such a development may imply a transfer more to discussion oriented review methods, which have a function to initiate reflections within the group of peers in their interactions with people at the host plant.

WANO is very clearly committed to excellence in all its programmes. There is also a clearly expressed view that the programmes are components in a comprehensive package of services given to the nuclear industry in the world aimed at ensuring a continued safety of the plants. It seems evident that peer reviews at least in the foreseeable future will have an important position in this work, but this implies also that there has to be an understanding of the need for continuous improvements and willingness to take the necessary steps.

5 MODELS OF SAFETY PERFORMANCE

Models of different kinds can be of large help for understanding, communication, planning and control of complex dynamic systems. This is also the reason why various models could be used to support peer reviews. Unfortunately modelling of people and organisations are far more difficult than modelling of technical systems and therefore no single model can cover all needs that may arise. The models briefly described in this section have characteristics that capture some essential behaviour of people and organisations that may be applicable to the peer review process and its interactions with the organisation at the nuclear power plant and the people involved in the process.

5.1 Reasoning about performance

Already reasoning about performance can bring in additional understanding of important factors that influence safety. If there in a nuclear power plant is no reasoning about necessary and sufficient conditions for good safety performance, one inference might be that safety is not very high at the agenda. Performance can only be built through a continuous search for improvements, which in turn implies a continuous reconstruction of important contributors in the minds of people. This search should involve the identification of both contributors to good performance and causes for bad performance.

Reasoning about performance is actually a process of constructing a more or less explicit model of how performance can be achieved. At some stage of development this model will only link factors contributing to various performance components, but at some point of time a larger picture will emerge. In an early stage the model is more a question of intuition on what matters, but it will gradually become more explicit to be sharable with others. In a peer review already the question whether or not people at the host plant involve themselves in discussing performance, possible threats to good performance and possibilities to improve can give important threads to follow up in further discussions.

5.2 Tasks and work processes

There are many tasks and work processes at the nuclear power plants that are interlinked to produce required safety performance. The picture is made even more complicated by recognising the role that instructions and procedures play in controlling how tasks and work processes are carried out. Instructions and procedures are in turn maintained by their own work processes and initiatives to initiate changes that are coming both from own experience and from a collected experience of the whole nuclear community.

A common way to model this complexity is to consider work processes as governed by four concepts, inputs, outputs, control and resources (cf. Appendix 2). In the models each work process is assumed to get inputs, process them and to give outputs. In the work processes there are controls to ensure that the processing is done in a correct way and that proper resources are available and used in the processing. Further in this modelling concept, work processes are thought to be able to break down into smaller tasks, which in turn can be described using the same basic concepts.

This modelling concept is useful in structuring interrelations between task and work processes. It can serve as a tool to ensure that different persons view certain tasks in the same way. The suggestion is not that these formal models should be used in a peer review process, but to use the general idea of interlinked work activities, goals and resources for going down in details of selected parts. Differences in interpretation of how selected activities are supposed to be carried out can also be detected by comparing descriptions given by different persons.

5.3 Decision making

Many models of decision-making have been built in the academic literature. Most models make the distinction between phases in a decision making process to separate between detection of the need for a decision, generation of decision alternatives, evaluation of the alternatives, selection of the best decision, execution of the decision and follow up. This separation into phases can actually be used as a structure on each of the phases to expand it into smaller details.

One model that has got a large attention uses a distinction between knowledge, rule and skill based behaviour (cf. Appendix 3). The model was originally developed for an understanding of operator behaviour in the control rooms of nuclear power plants, but it has also a wider applicability. Important in the model is the recognition that certain parts of a decision are made almost unconsciously on a skill-based level. For other decisions certain rules are applied in a set of procedures or learned by heart. Success for these types of decisions implies that the task is well known and analysed and that the decision-maker has got appropriate training. Decisions on a knowledge-based level are decisions, which require conscious pondering and the use of explicit knowledge.

The value of this model in the peer review process is perhaps more to provide an understanding of human behaviour than to give explicit guidance in the process. Using the model one can argue that people with an increasing proficiency, tend to shift decision making from the knowledge level down to rule and skill based behaviour. This reduces the load on attention, but it at the same time assumes that decision making situations are identified correctly. For important high-risk decision it may be a wise strategy to invest enough attention to handle it on a knowledge level.

5.4 Control of performance

Control of performance involves both feedback and feed forward loops. The feedback is necessary to correct control signals in the case of performance below target. The feed forward loops are used for setting targets and estimating future control needs. An understanding of factors contributing to good performance and agreement of performance targets to be achieved helps in selecting appropriate control strategies. A feedback of actual performance and an analysis of reasons for good and bad performance are crucial for improving selected strategies (cf. Appendix 4).

In reality control of performance splits into two parts, the results obtained and the resources spent. Better performance can be obtained either by getting the same benefits with less resources or by getting more benefits using the same amount of resources. Managerial skills are often measured in how they in practice resolve this dual objective. Control of performance can therefore be seen as the problem of allocating available resources in an optimal way.

In the control of performance it is also important to note that there are different types of resources used in the work processes, such as for example people, time, money, tools, methods, procedures, instructions, etc. Some of these resources are more versatile and for example money can as a resource be converted almost to any other resource.

This way of reasoning about performance in terms of objectives, feedback and feedforward loops may have an application on the peer review process, for instance to ask questions if the feedback and feedforward paths are functional. If they are the respondents may provide examples, where not only the work processes themselves, but also strategies, practices, norms and values of the organisation have been challenged.

5.5 Formal and informal organisations

A recognition by many scholars is that it often is useful to talk about formal and informal organisations. The formal organisation is then understood to be the part of the organisation, which is documented as authorities and responsibilities, lines of command and reporting, etc. The informal organisation is similarly understood to be the practices that are used, but not documented in descriptions of the organisation. It is necessary to consider both the formal and the informal organisations to arrive a correct understanding of the real organisation in its full complexity.

Nuclear power plants describe their formal organisation in organisational handbooks of which the quality systems is an important part. The management system is to some degree of detail described in the organisational handbook, but a large part can also be found in other documents. Practices for yearly and strategic planning can also be seen as important parts of the formal organisation. Finally procedures, instructions and more generally formally maintained documentation is a part of the formal organisation. It is evident that safety to a large extent relies on the appropriateness of the formal organisation, but it is equally evident that that the formal organisation can only provide a skeleton to give firmness and consistence to decisions and actions.

The informal organisation consists of unwritten practices and the understanding of members in the organisation how things should be done. It also contains the implicit interpretation of what is good and what is bad, as well as an image of who actually is in charge of what. The informal organisation can be seen as providing the necessary smoothness for things to be done, which the rugged formal organisation may not provide in all situations. The informal organisation is seldom a product of conscious design efforts, but it actually lives its own life

as a result of interactions between members of the organisation. Sometimes the informal organisation may develop even in directions explicitly forbidden by the formal organisation and then hazardous situations may emerge. The concept of an informal organisation can be important during peer reviews to initiate questions how things actually are done.

5.6 Tacit and explicit knowledge

The nuclear industry is relying on a broad base of knowledge and one recurring question is how that knowledge can be developed and maintained. In the academic literature a distinction between tacit and explicit knowledge¹⁵ has been proposed, which can be fruitful in explaining some phenomena also seen in the nuclear industry. The model proposes that knowledge in an organisation go through a spiral from sharing tacit knowledge between members of the organisation in a socialisation phase. Further the knowledge is externalised to trigger a phase of dialogue and collective reflection, which helps other members of the organisation to articulate their tacit knowledge. Then this new knowledge is networked within the organisation to be combined with existing knowledge. Finally learning by doing is internalising the new knowledge and a new cycle could start.

This distinction between tacit and explicit knowledge has a relationship to the formal and informal parts of the organisation, because tacit knowledge is created in informal interactions between members of the organisation. In nuclear power operations it is important that this tacit knowledge is made explicit to be shared with other parts of the organisation for two reasons. Firstly because an efficient sharing of knowledge has a potential of bringing forward important innovations for the use of the whole organisation and secondly because proposed innovations may not be acceptable due to some requirement that is not known in the smaller group where the innovation was made.

The need for making tacit knowledge more explicit has been identified in the consideration of an ageing work force. People that were involved in building and taking the present nuclear power plants into operation acquired important knowledge in this process. The important question is then if it is possible to make this knowledge explicit to make transferable to a new generation of operators. Some nuclear power plant have identified this challenge and have consequently started project that aim at identifying tacit knowledge in the organisation to make it explicit, documented and sharable.

5.7 Organisational learning

Learning is usually seen as something more than simple feedback control. According to this view learning is used to characterise changes in structure, control strategies and thinking, which gives an improvement of performance that is applicable to a larger set of situations. Organisational learning relies on the learning of people in the organisation, but the concept of organisational learning carries the implication that it is something more and that it has a persistent effect on the organisation. A considerable amount of academic research has been directed to the investigation of different aspects of organisational learning.¹⁶

In a consideration of organisational learning it has to be noted that it can be both for the good and for the bad. An organisation could learn to take into use better and more efficient tools, but it could also jump at new solutions that appear to be beneficial, but in the longer run prove

¹⁵ Ikujiro Nonaka, Hirotaka Takeuchi (1995). *The knowledge-creation company*, Oxford University Press.

¹⁶ Bethan Jones (2002). *Theoretical approaches to organisational learning*, available at the LearnSafe web-page, <http://www.vtt.fi/virtual/learnsafe/>.

to produce unacceptable side effects. Organisational learning is usually initiating organisational change and organisational change usually creates uncertainty, which in turn may lead to stress and alienation.

Organisational learning has in many reports been mentioned as a desirable trait for the nuclear industry. This view is based on the recognition that there in practice may be several barriers for an efficient use of collected experience. Such barriers are often associated to attitudes and beliefs of people within the organisation. Given a typical list of barriers to organisational learning, it may during peer reviews be possible to use them indicators for additional questions to be asked.

5.8 Safety culture

Safety culture has become a concept to which very much attention has been given within the nuclear industry worldwide. IAEA has been instrumental in its original introduction.¹⁷ Further development has aimed at establishing instruments that can be used for assessing and improving the safety culture.¹⁸

Safety culture is closely associated to the concept of organisational culture. One model of organisational culture separates between three layers of culture, artefacts, espoused values and basic underlying assumptions.¹⁹ The artefacts are the visible organisational structures and processes. Espoused values cover strategies, goals, philosophies and they give justification for the artefacts to be as they are. Basic underlying assumptions are the unconscious, taken for granted beliefs, values, perceptions, thoughts and feelings that are the ultimate source of behaviour and action.

In a consideration of organisational culture it is important to note that there at the nuclear power plant actually may be several subcultures that co-exist side by side. One may for example speak about an operations culture, a maintenance culture and a quality culture. These concepts can in some cases prove to be useful in an understanding of conflicts and difficulties of communication. Safety culture is already a concept explicitly considered in the peer reviews, but due to its fuzziness, it may be advantageous to spend some time to let both team members and representatives from the host plant state how they interpret the concept.

5.9 The construction of safety

A final model of safety is that it to be operational needs a continuous reconstruction. This means there should be a continuous pondering of the influence of crucial components on safety and how they are understood and built into the work processes at the nuclear power plants. To some extent this concept can be said to be a part of the questioning attitude that has been proposed as one of the important components of safety culture.

In the construction of safety there is no a single model that can provide all the answers, but instead a need for using a spectrum of different models to illustrate various aspects of safety performance. This also involves building an understanding of what is relevant in these models and how they can be used to explain certain phenomena that can be observed in organisations.

¹⁷ IAEA (1991) Safety Culture, a report by the International Nuclear Safety Advisory Group, IAEA Safety Series No. 75-INSAG-4.

¹⁸ IAEA (2002). Safety culture in nuclear installations; guidance for use in the enhancement of safety culture, IAEA-TECDOC-1329.

¹⁹ E. H. Schein (1992). Organisational culture and leadership (2nd. ed.) San Francisco: Jossey Bass.

In one way this also involves understanding of the sometimes competing goals that an organisation has to respond to.²⁰

Ideally a peer review should be able to get down to the basic assumptions of how safety is constructed at the host plants. This is evidently an unreachable goal due to restrictions in available time and resources, but it may still open up discussions on what essence of safety actually is.

6 FURTHER IMPROVEMENTS IN THE PEER REVIEW PROCESS

There are various ways in which the peer review process may be developed and strengthened. WANO has in striving for excellence in all programmes already entered this discussion and identified the benefit of seeing the programmes as an entirety. The discussion below is intended to support WANO in a thinking process from a slightly different angle of view. In this way it is believed that the present report could make its own contribution to the rethinking and reformulation of mission and strategies, which forms the foundation of a continuous improvement of any organisation.

6.1 Establishment of performance norms

The perhaps largest methodological challenge in the peer review process is to establish norms to which observed performance can be compared. WANO has established Performance Objectives and Criteria (POC)²¹, which to some extent are used as performance norms in the peer reviews. The peer reviews, however, still relies on observations created in a bottom up process in such a way that they are reflected against corresponding performance objectives or criteria to determine if they should be reacted on.

One approach, which may be helpful, is to try to build more accurate definitions of factors contributing to good performance, i.e. a model of how safety is constructed. If an agreed and manageable set of preconditions for safe and efficient work processes can be defined it would be easier to make assessments of the extent to which these preconditions are fulfilled. Whenever they are not, the reasons may be investigated to arrive at concrete suggestions for improvements. It may not be possible to define absolute norms, but already the definition of some kind of organisational counterpart of the well known safety technical specifications that are used at all nuclear power plants may helpful.

Performance norms should not only address performance, but also the work processes that are responsible for achieving that performance. If a set of necessary conditions for safety can be defined together with a similar set of sufficient conditions for emerging problems, it would be far easier to do safety reviews. These conditions may also include statements on manifestations of attitudes and beliefs as held by the staff at the host plant. Benchmarking work processes at two or more nuclear power plants can also be helpful in the making implicit norms more explicit.²²

²⁰ Geneviève Baumont, Björn Wahlström, Rosario Solá, Jeremy Williams, Albert Frischknecht, Bernhard Wilpert, Carl Rollenhagen: Organisational Factors; their definition and influence on nuclear safety, VTT Research Notes 2067, Technical Research Centre of Finland, Espoo, Finland, ISBN 951-38-5770-0.

²¹ WANO (1999). Performance Objectives and Criteria, Revision 2, March.

²² Björn Wahlström, Jari Kettunen (2000). An international benchmark on safety review practices at nuclear power plants, VTT Research Notes 2015, Technical Research Centre of Finland, Espoo, ISBN 951-38-5638-0.

6.2 Self-assessments before the peer review

Many review practices presume a prior self-evaluation, which is documented and sent to the reviewers before the site visit. This practice is not made formal in the peer reviews, but many plants do some kind of self-assessment before the actual review. Sometimes these are triggered by a wish to be one step before the reviewers and perhaps decrease the number of observations made.

A general experience from various reviews is that self-assessments can be very valuable, provided that they are done with prudence and honesty. One may actually assume that a self-assessment can sensitise the organisation for important interactions between performance and work processes and thereby make it easier for them to accept useful insights from the peer review. A self-assessment can also be valuable for the peer review team to make it easier to concentrate on issues of importance.

If self-assessments are included as a standard component of peer reviews WANO could consider the creation of guidance for them. It might for example be beneficial to ask the host plant to do a broad assessment of strengths and weaknesses to be used as a reference for discussions. If this path is taken WANO could perhaps concentrate on the more subtle questions connected to safety performance.

6.3 Members in the peer review team

It is important that there are enough WANO staff members taking part in the peer reviews, because they are maintaining the traditions in the programme. It would also be important that they document their own experience to be integrated in a larger pool of lessons learned. Taking into account that WANO staff has only restricted assignments of usually five or less years, there is a need for a systematic accumulation of experience within the WANO office to ensure a proper organisational memory from the peer reviews.

The selection of the team members for the peer reviews is a very important task. WANO has defined the skills needed in different roles of the peer review team. These specifications are important to be communicated and understood at the nuclear power plants from which team members are recruited. From a WANO perspective there are two needs that have to be balanced in selecting the team members, one is connected to the need for creating an efficient team and the other is connected to the need for training new members into a pool of available team members.

Presently the policy is to invite team members only from other nuclear power plants. This is important in creating trust in the peer review process, but in a longer term perspective it might be a good idea to occasionally involve also persons engaged in safety management within other areas, such as airlines, off-shore activities, chemicals, health care, etc.

6.4 Training and team building efforts

WANO is before each peer review making considerable investments in training and team building. One part of the training should be devoted to sensitising team members for possible observations and the other part to make team members familiar with each other as persons. In training the team members are already now introduced to possible areas of weaknesses that are based on information collected in the other WANO programmes.

One question that may be addressed is the extent according to which tasks should be divided between the team members. If for instance WANO staff members take a more active respon-

sibility in the review in selected areas, it may give the peers in the team more time to concentrate on their own areas of expertise. One may for example speak about the two roles of being either a specialist or a generalist. This approach may lead to a larger need for investments in the training of WANO staff members.

Selecting and training team leaders to give them skills in creating enthusiasm, commitment and devotedness within their teams is a very large challenge that has to be attended to. A special challenge is to give all team members a proper introduction to a systemic thinking in terms of considering human and organisational factors. There are many insights the behavioural and management sciences that can be used for this purpose.

6.5 Collection and documentation of good practices

The peer review programme has already in its present form an important function in the collection of good practices. If this is considered appropriate these efforts may be expanded and made more systematic. Other WANO programmes such as the operating experience programme and the good practices programme already have taken important steps towards collection and documenting good practices, but the interfaces to these programmes may still be strengthened.

A crucial component in the collection and documentation of good practices is to make the collected information accessible and used. For this end it is necessary to structure and analyse the collected data and to make it available through a database. This would need some kind of a generic model of safety, because only then potential users would be able to pose sensible questions to the database. It would also be necessary to make the database well known and easy to use. Presently information from WANO is available for members on-line from the databases, but there are rather large differences in how this information is utilised.

6.6 Expanding the scope of the reviews

A full WANO peer review covers ten areas, i.e. organisation and administration, operations, maintenance, engineering, radiological protection, operating experience, chemistry, training, fire protection, and emergency preparedness. These areas are considered from a management point of view with an emphasis on safety. This is a well-motivated focus, but in a consideration of the tasks of the senior management at the nuclear power plants it may still be somewhat restricted. It is for example not immediately clear how more strategic long-term issues are covered in the peer reviews of today.

If the scope of the peer reviews is expanded this may also introduce the need for a reconsideration of the used methodology. If this path is taken the peer reviews may actually evolve into a spectrum of different review activities such as, quality audits, self-assessments, benchmarks and peer reviews, each with its own focus, but supporting each other to give a comprehensive view on strategies, plans and actions in various areas. The review activities could be targeted to be either broad or deep. In a broad review there is a kind of a search for the problem, but in a deep review a certain problem has been selected for further investigations and there is a search for the best solutions.

6.7 Supporting processes of improvements

The peer review programme is ultimately aimed at initiating improvements. The responsibility to implement the recommendations however lies clearly with the host plant, but WANO may for instance on request take further steps towards suggesting remedies for some of the problems identified. The most crucial step in starting a process of improvement is perhaps the

creation of an understanding that a specific finding actually is a problem and that there is a certain urgency in solving it. If this step is managed it is then easier to find cures and implement them.

The present practice that a peer review is followed up about one year afterwards is an important step in the direction of supporting a process of change at the host plant. WANO may also consider additional steps and perhaps create missions aimed at supporting the host plant with a small team to serve as a discussion partners for the plant people involved in setting up specific improvement programmes. If steps in this direction are taken it would still be important for WANO not to step into the area of consultancy.

6.8 Review of the peer review process

The peer review process should, as all work processes be the object for a continuous review. This was clearly stated by WANO at the discussions between LearnSafe and WANO staff in June 2002. There are many ways for implementing such a continuing review and the perhaps best recommendation is to view the process from as many angles as possible. The perhaps largest challenge lies in avoiding routine, which may creep in when many peer reviews have been conducted and the first goal has been reached that all nuclear power plants in the world have gone through at least one peer review.

One simple way to review the peer review process is to invite participants in the peer review process to document their experience and thoughts. Performing a systematic collection of views from persons, who have participated in the peer review process at a selection of host plants, can give valuable ideas. Another possibility, as this report actually to some extent is doing, is to have a small group of outsiders to comment on the peer review process from their own perspective.

Self-reflection is one important component in striving for excellence. The ability to reflect honestly on performance in own activities and in their relationships to objectives, resources, stakeholders and customers often gives clues to improvements. This is however possible only there is enough time for the people involved, which means that performance targets should not be too high in comparison with available resources.

6.9 Contacts to stakeholders in nuclear safety

WANO is an organisation founded on the belief that it is necessary to bring up all plants in the world to a certain safety standard. The track record demonstrates that WANO has been successful in this endeavour. In a continued development of its strategy WANO may consider stakeholders in nuclear safety on a more general level.

The nuclear industry is the stakeholder in the activities of WANO. As long as WANO activities are considered useful by the nuclear power plants in their quest of finding practices that provide high safety and efficiency a continued support is granted. The recognition that the whole industry is influenced by its worst performers brings an additional rationale for their own investments in time and resources.

In pondering future activities of WANO it may also be important to consider relationships with other international organisations such as IAEA and OECD/NEA. Already now these organisations have a considerable amount of joint activities, but it may be necessary make some alignment of tasks not to stretch available resources too much. Such discussions may at some point in time also to initiate some dialogue with regulatory organisations to create a mutual understanding of the legitimacy and borders of regulatory oversight.

At some point of time it might be necessary for WANO to open up towards the general public, perhaps mostly in such a way that the mission and programmes of WANO are explained and described. This may have a positive impact on the credibility for the industry in large. In a search for the best directions it is however important to note that an open communication of operational experience between the nuclear power plants in the world is a necessary precondition for a continued safety and this can only be granted with some agreed confidentiality. WANO should also avoid activities, which might be interpreted as a ranking of the nuclear power plants in the world.

7 CONCLUSIONS

Peer reviews are important instruments for organisational learning in the nuclear industry. They serve their primary purpose to identify and correct organisational deficiencies very well. They have an important function in mounting a peer pressure to improve in organisations that may not be fully up to acceptable standards. They also serve as an important facilitator in the diffusion of good practices in the whole nuclear community in the world. This recognition does however not mean that they cannot be further improved. The previous discussion has presented some views that can be used by WANO in the development of their peer review process.

There are many participants in the peer review process all with their own roles. A necessary precondition for the success of a peer review is that all participants have a clear understanding of their roles together with a commitment to give their best. This also involves a willingness to reconsider own attitudes and beliefs and when given explanations and evidence to accept view that in a first round are considered strange. In the peer review the plant manager at the host plant and the team leader of the peer review have the two most important roles and the extent to which the exercise becomes a positive experience for all persons involved are crucially depending on their skills and commitment.

Today the peer review process is to large extent based on observations, which are grouped to become findings and further converted into recommendations. When the nuclear plants improve it may prove to be more difficult to collect observations and it may then be necessary to revise the peer reviews to be more oriented towards discussions between colleagues on components of performance and possible ways to reach high performance in a sustainable way. Even in the best performing industry there is the need for self-reflection and discussions, which the peer reviews at their best can give.

Some of the comments as expressed above actually go beyond the peer review process itself and considers the use of operational experience in a broader frame. It is hoped that this report should be found useful in future strategic discussions at WANO. In these discussions WANO may see itself as an actor among others, which together in their own fields are contributing to the overriding goal of making the nuclear power plants safe enough to be acceptable as a source electric energy. In this quest there is most likely also a need of combining theoretical thinking with practical insights

APPENDIX 1. A BRIEF DESCRIPTION OF THE WANO PEER REVIEW PROCESS

This short description is only aimed at making this working paper self-standing, as far more accurate descriptions of the peer reviews are given in various WANO documents. The peer review programme was established in 1991 and it is clearly directed towards safety performance.

Initiating a peer review

A peer review is typically initiated by the nuclear power plant (a WANO member). The team consists of experienced persons from other nuclear power plants. During the peer review the team members will take note of strengths that may be useful for other WANO members and areas in which improvements can be made at the nuclear power plant hosting the peer review. At least the functional areas of organisation and administration, operations, maintenance, engineering support, radiological protection and operating experience review will be assessed during the review.

Preparations before the peer review

The peer review team consists typically of one team leader, one assistant team leader and two reviewers for each of the selected functional areas. Sometimes a peer review co-ordinator from the WANO regional centre is used support the team leader in various tasks. The team members will receive training in the peer review process before the actual peer review. Team members also receive briefings on the status of applicable recommendations from the collected operational experience at WANO. A visit at the host plant will be made before the peer review by WANO staff. The host plant will prepare an information package for each of the team members to be used before and during the peer review.

The peer review

The actual peer review at the host plant will typically take about three weeks of which the first week is used for training and familiarisation and the two other weeks for the actual peer review. The first week of the actual peer review is used for observations and discussions at the plant in various areas to compare actual performance with WANO performance objectives and criteria. Observations are recorded and discussed within the team during daily meetings. Daily meetings are also held with representatives from the host organisations to ensure that observations are correctly recorded. The second week of the actual peer review is concentrating on sorting out specific questions in small ad hoc groups and to characterise them in writing. These statements are then gradually collected, checked and cross-referenced to build up an interim peer review report. During the final week an exit representative is entering the process to ensure that there is an understanding and an agreement within the peer review team on issues taken up in the interim report.

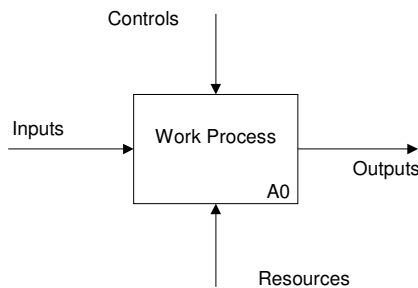
Activities after the peer review

After the peer review the team leader and the exit representative together finalise the peer review report in about 3-5 weeks time. The final report is presented by the team leader at an exit meeting for the CEO and the station manager of the host nuclear power plant. After the peer review it is very usual to have a follow-up review led by the same team leader one to one and a half years after the peer review.

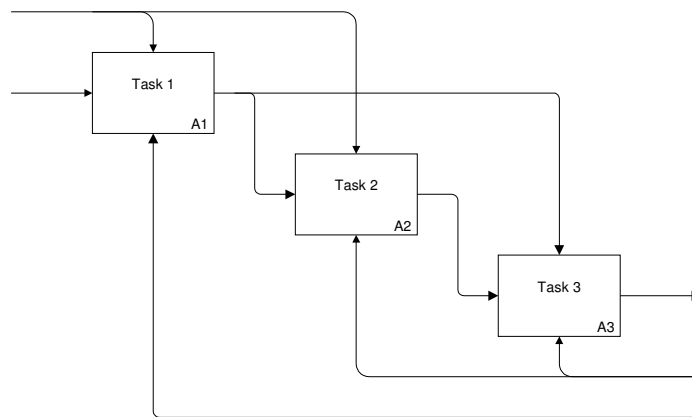
APPENDIX 2. MODELS OF TASKS AND WORK PROCESSES

A common approach for describing tasks and work processes is to describe them using the concepts of *inputs*, *outputs*, *control* and *resources*. This approach was originally developed for descriptions of software development and was called the Structured Analysis and Design Technique (SADT). The approach has later been applied also more generally to the modelling of tasks and work processes. The approach has been standardised (IDEF0) and there are computerised tools available on the market to support this kind of modelling.

The modelling relies on the following basic block,



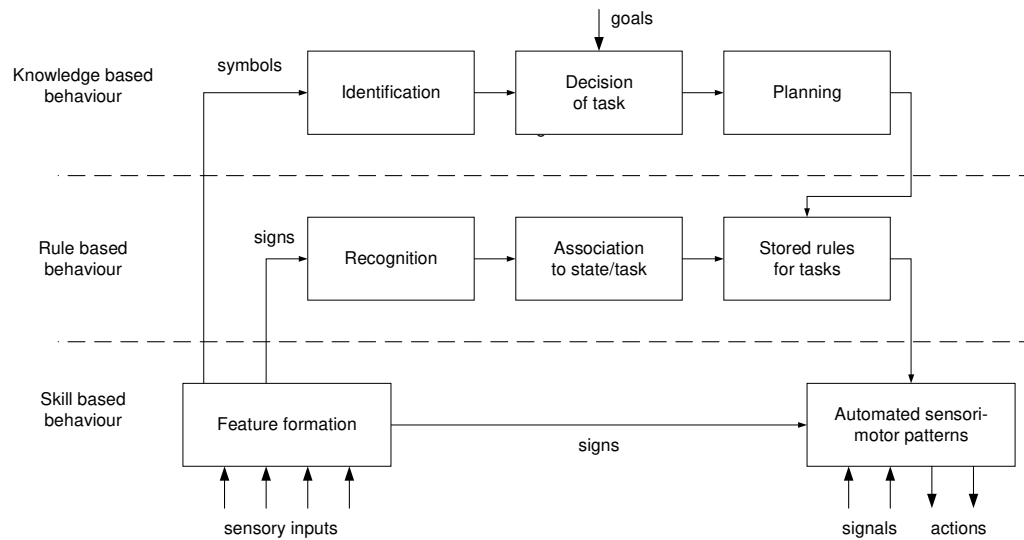
which on the next level can be broken down into tasks for instance according to the following kind of diagram.



The separation between work processes and outputs of a work process also gives the possibility to separate between product quality and process quality. This distinction is important, because it suggests that peer reviews may be directed not only to performance that can be observed as outputs of the work processes, but also that work processes themselves could be targets for the review. This will however require models of what can be considered acceptable for a work process and what cannot.

APPENDIX 3. A MODEL OF DECISION MAKING

Most models make the distinction between phases in a decision making process to separate between detection of the need for a decision, generation of decision alternatives, evaluation of the alternatives, selection of the best decision, execution of the decision and follow up. In a slightly different formulation one could separate between knowledge, rule and skill based behaviour and speak about identification, definition of task and planning on the upper level, recognition, association to state/task and stored rules to task on an intermediate level and feature formation and automated sensory-motor patterns on the lowest level.²³



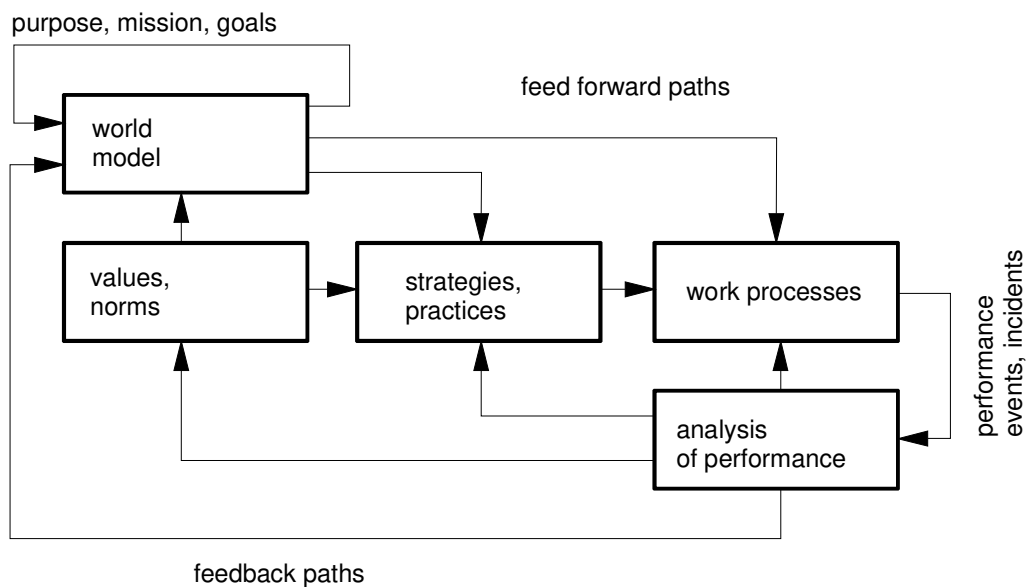
In this model the important recognition is that decisions only seldom move to the knowledge-based level, but more often only go through the lower levels in rapid jumps of association between signs and tasks.

The model was originally designed to describe the decision making of control room operators in nuclear power plants, but it is applicable to decision making more generally. Managers at nuclear power plants for example base their decisions on a more or less intuitive judgement on what is important and what can be postponed. Important decisions certainly go through the tedious path on the knowledge level, but a high level of stress in overload situation may force even important decisions down to be rule based.

²³ Jens Rasmussen (1985). The role of hierarchical knowledge representation in decision management and system management, IEEE Transactions on Systems, Man and Cybernetics, Vol.SMC-15, pp. 234-243.

APPENDIX 4. A CONTROL BASED MODEL OF PERFORMANCE

The control of organisations is based on both feedback and feed forward loops. The feedback loops are in place to ensure that control signals are changed in a way to get better performance. This is done by defining a target performance and letting the control signal react on deviations between the target and the actual performance. Feed forward loops are used especially in the case when there are large time delays between control signals and actual observed performance. In these cases feed forward control signals are applied to force down stream systems to adapt to expected changes in conditions and not just wait for their reaction at a later instant. Any organisation is depending on a large number of feedback and feed forward control paths as illustrated in the figure below.



In this model an analysis of performance is assumed to be fed back to not only the work processes themselves, but also to strategies and practices on one level and values and norms on the other. At some instances it might even be necessary to change basic assumptions in the world models. The world models on the other hand help through feed forward paths to set strategies and practices and to design the work processes. Finally the world model generates its own feedback from through an interaction with the environment to set the purpose, mission and goals for the organisation.

This model is intended to illustrate that more deeply held assumptions and beliefs may be necessary to challenge when additional experience is obtained. Basically this model is also driven by a detection of a mismatch between expected and actually achieved performance. In the case such a mismatch is detected on the level of the work processes, then the problems should be sought among the strategies and policies and so on. Ultimately the world model has to be challenged and changed to give a more correct picture of the world.