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Preparedness Organisations at Nordic nuclear Power Plants

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Abstract

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The results indicate potential for improvement in several areas. A number of the improvements are related to introduction of new technology and they should be seen in connection with ensuring safe and reliable communication lines and power supply.
Analysis of the data identified four main categories where further studies could contribute to improvement:

-Communication and exchange of information
-Tools and technology
-Staffing and organisation
-Procedures

The usefulness of the Man Technology and Organisation method in analysing the emergency management decision-making process within the authorities was considered as an interesting issue for continuation of the project. The interface between utility and authorities was pointed out as an important area for continuation.

Key words

Emergency Preparedness, Man Technology Organisation, command centre, Nordic nuclear Power Plants

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Analysis of the data identified four main categories where further studies could contribute to improvement.

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Distribution

NKS, Ringhals NPP, Forsmark NPP, Loviisa NPP

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Contents

1 Introduction

The main purpose of this project has been to compare how emergency preparedness is organized at the Nordic nuclear power plants. Vattenfall, Fortum and IFE have participated in the project. The project has focused on evaluating the work processes and the decision-making process in the existing emergency management's preparedness room (Command Central) at the sites. The aim has been to evaluate if there is a common Nordic understanding of these issues among the emergency management teams and to identify possible improvements in the processes. The collaboration and communication with the authorities in the emergency management process has also been partly addressed during this survey.

The project has been carried out in cooperation with relevant staff in the emergency management teams at Vattenfall, Fortum and IFE using a method developed by IFE. This method is used today for evaluating work processes and decision-making processes in control- and collaboration rooms with several references within the oil- and gas industries. The methodology and analysis experiences have been utilized and adapted for use in the nuclear emergency preparedness domain.

The project team would like to thank the staff at Loviisa, Ringhals and Forsmark emergency preparedness organisations. Special thanks to Klaus Sjøblom, Jan-Olof Bengtsson and Staffan Henningor for their invaluable contribution of knowledge and experience and their brilliant organisation of the data collection.

1.1 Integrated operations (IO) as input to nuclear emergency organisations development

In autumn 2004, the Norwegian Oil Industry Association (OLF) decided to implement an industry-wide IO program, being a new self-service concept for remote, real-time management of oil & gas fields on the Norwegian Continental Shelf (NCS) [9, 10].

IO is a new approach to solving the challenges of having personnel, suppliers and systems located offshore, onshore and in different countries. IO is about removing the physical boundaries between people, making cooperation across different locations in real time possible. IO involves using real time data and new technology to remove the division between disciplines, professional groups and companies. It's about how information technology that makes remote operation possible forms the basis for new and more effective ways of working [8].

In the autumn 2005, a work group established by OLF and representatives from the major oil companies, licensing authorities and the Norwegian energy research institutes, delivered a report that has become the guidance for implementation of new work practices [11].

In its simplest form, insights to a decision making structure and consequently a potential organisational structure outline may be revealed by the following questions [11]:

• What Decisions are to be made?

• What Information is needed to be able to make those decisions?

• Which People are best qualified to make that decision?

• Where should those people be located?

• What Work Processes and Technology are needed to present the decision makers with the right information at the right time irrespective of location and organisational belonging?

In its operationalised form, IO is about utilisation of the new technology for working more efficiently and making better decisions. During the last years the focus areas have changed from technology to more emphasis on the human and the organisation. Work processes based on existing and new models for integrated work and cooperation is believed to be the main vehicle for changing the way of working according to the new IO philosophy.

The nuclear industry has traditionally been more conservative than the petroleum in implementation of new technology and organisational models. In some areas like instrumentation and safety systems, the nuclear standards and requirements will make it difficult to utilize IO technology in the near future. However, the good results achieved from implementation of IO concepts in the organisation of petroleum activities should be investigated and adapted for potential use in the nuclear domain.

One area where cooperation and decision-making processes are of high importance is in the emergency preparedness organisations.

The Swedish national audit office “Riksrevisionens” has written a report focusing the consequences of accidents and the nuclear industry ability to handle the situation [4].

“The government's objectives and requirements, including those for participation of the authorities in the emergency efforts and exercises, is unclear and not followed up. The emergency preparedness exercises that responsible authorities should implement have deficiencies in efficiency and synergy. The majority of the exercises have focused on the acute phase during a nuclear accident, while the long-term phase has been exercised very rarely. The authorities' transfer of information between each other and to the public is not working well enough. The audit also shows that the rescue services agency's supervision of the county board's relief work is weak and that the agency's evaluation of preparedness exercises need to be improved. The three affected county boards have no or only draft reorganization plans, despite the fact that plans are required by rule.”

The IO approach could be a strong and relevant input for identification of improvements in the areas of information exchange, reliable communications, information to the public and work processes, addressed in the conclusions of the Swedish national audit office.

2 Method

A two- to three-days survey of the situation in the preparedness room has be carried out at each site (Forsmark NPP, Ringhals NPP and Loviisa NPP) by means of interviews and analysis with personnel representing each category of the personnel in the emergency command central. For each category of personnel a total of up to 14 persons pr. site, a two hours interview and analysis has been carried out with focus on their work instructions (initial and recurring activities). All their activities within the work instructions have been reviewed and mapped with focus on understanding of instruction clarity, what they do, where they do it, how they do it, who do they communicate with during work process and what type of media they use for communication.

The interview material from the various emergency management teams which has been collected and analysed by the IFE team with the aim to obtain a common Nordic understanding of these issues among the nuclear power plants. What is common? What is different? This material also reveals possible improvements both in work processes, organization and enhanced technical solutions. The results have been presented and discussed with the emergency management teams from Forsmark NPP, Ringhals NPP, Oskarshamn NPP and Loviisa NPP in a workshop where also the authorities in the Nordic countries and members of the NKS board were represented.

The analysis of the interviews has focused on improvements of the command centre work situation, including way of working, staffing, understanding/competence, and new technology.

The interviews with the emergency management's command centre personnel at the sites were successfully carried out according to the following schedule:

a) Interviews at the Forsmark NPP carried out in the period 31st May - 3rd June, 2010

b) Interviews at the Ringhals NPP carried out in the period 24th August - 27th August, 2010

c) Interviews at the Loviisa NPP carried out in the period 18th October - 21st October, 2010

A comparison of the personnel categories is shown in Table 1.

All data mapped and analysed in the interviews are provided in the data appendix to this report. These matrixes were used as a basis for further analysis in the "Data Analysis" phase. A total of about 900 tasks were mapped during the interviews and the interview subjects provided a total of 270 proposals for improvements.

3 Nuclear preparedness organisations

This chapter gives an overview of the connections between the 2nd line utility internal organisation and the external cooperation partners. A comprehensive description of the national nuclear preparedness organisations in Sweden, Finland and Norway is presented in the NKS report "Nuclear Emergency Preparedness in the Nordic and Baltic Sea Countries" [1].

3.1 Swedish Nuclear Emergency Preparedness Organisation

As shown in figure Figure 1 the EPO work is a comprehensive collaboration between the utilities and the local and central authorities.

In a crisis situation the division between utility and the supporting organisations will typically be along the fence surrounding the nuclear site. Outside the utility area the County administrative board (Länsstyrelsen) is responsible for both emergency preparedness and radiation protection measures. Within the utility area the licenced operator is responsible for maintaining necessary measures for safety and emergency preparedness.

Cooperating institutions is shown in Figure 1.

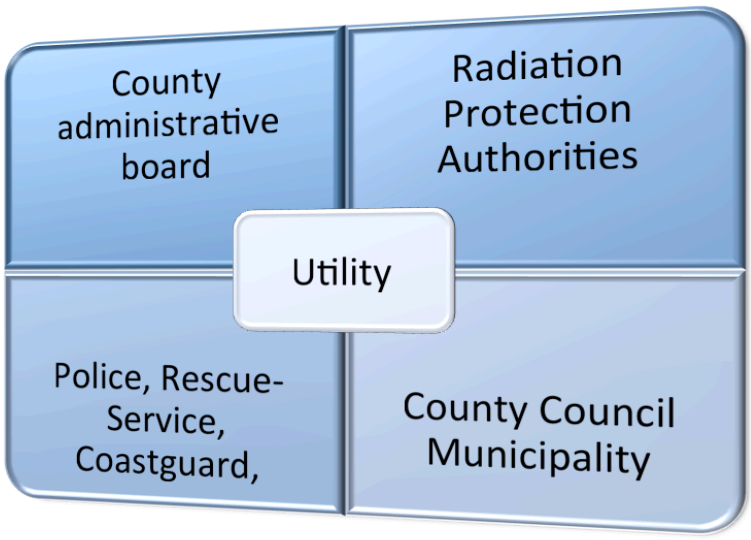

Figure 1. Utility cooperation partners

The internal utility organisations can be compared with the 1st, 2nd and 3rd line EPO we know from the international industry. First line consists of the personnel located at the reactor unit that has the problem, the second line is a dedicated command central at the utility, and the third line at company headquarters.

3.1.1 Emergency alarm levels

Should an event occur in a Swedish nuclear power plant, two different alert levels are used. If there is no immediate threat of radioactive releases, the plant issues are raised to a preparedness alert. If a radioactive release has already occured or a release cannot be ruled out within twelve hours, an accident alarm is issued. Responsible authorities are alerted both in case of a raised preparedness alert and in case of an accident alarm [4].

Both Ringhals and Forsmark have introduced a third emergency alarming level for utility preparedness. At Forsmark this level is new from 2009. Emergency alarming is divided into three levels:

1. ***Utility preparedness*** (anläggningberedskap – FAB and RIHAB) where an event has led to or can lead to a demand for personnel to handle a internal situation at the plant.
2. ***Raised preparedness (Alert)*** (høyd beredskap) where an incident or disturbance has led to a situation threatening the surrounding environment.
3. ***Accident alarm (General Emergency)***, where an incident or disturbance has led to disposal of radioactivity, or where disposal of radioactivity can take place, and where protective measures have to be taken outside the utility area. The nuclear power station alerts regional and central authorities through regional and national alarm centres. The preparedness organizations of the authorities come into action.

In their report “Strålsäkerhetsläget vid de svenska kärnkraftverken 2009”, SSM states that the emergency preparedness at the Swedish NPPs is developing, and that there are improvements. However, the complexity and scope of scenarios used in radiation source calculations

(källtermsbedømning) and the competence for work with difficult breakdowns should be looked into.

3.1.2 First and second line emergency preparedness

In an emergency situation, the Central Control Room (CCR) unit staff and a technical support group constitute the 1st line staff. The technical support group consists of competence within the process, radiation protection, chemistry, reactor core analysis and emergency situations. This is the contact point for the second line organisation.

Second line is located in the command central of each utility. The command central organisation can be seen in Figure 3.

3.2 Nuclear Emergency Preparedness Organisation in Finland

The Finnish way of division between utility and the supporting organisations in a crisis situation is similar to the Swedish organisation presented in Figure 3. Outside the utility area the County administrative board is the responsible body for both emergency preparedness and radiation protection measures. Within the utility area the licenced operator is responsible for maintaining necessary measures for safety and emergency preparedness.

3.2.1 Emergency alarm levels

Emergency is divided into three levels:

- ***Emergency stand-by*** **-** NPP emergency organisation is alerted to ensure the plant safety
- ***Site emergency*** - NPP safety deteriorates or is in danger of deteriorating significantly
- ***General emergency*** **-** there is a hazard of a radioactive release that may require protective measures in the vicinity of the NPP.

The Finnish and the Swedish levels of emergency alarming correspond.

3.2.2 First and second line emergency preparedness

Similar to Swedish utilities, in an emergency, the unit CCR staff and a technical support group constitute the 1st line staff in Finnish plants. The technical support group consists of competence within the process, radiation protection, chemistry, core analysis and emergency situations. The technical group is the contact point for the second line organisation.

Second line is located in the command central of each utility. The command central organisation can be seen in Figure 3 above. The Loviisa 2nd line has also a connection to the technical support organisation in Espoo.

3.3 Nuclear Emergency Preparedness Organisation in Norway

Similar to Sweden and Finland, the division between utility and supporting organisations in Norway follow the principle of responsibility inside and outside the utility area.

3.3.1 Emergency alarm levels

The nuclear emergency response organisation possesses two levels of preparedness - *"information preparedness"* and *"heightened nuclear emergency preparedness"*.

3.3.2 The organization at IFE

Norway has no nuclear power plants. The research reactor in Halden and the isotope-producing reactor in Kjeller represent the most important domestic nuclear threat. Radiation emergency can also be connected to the wide use of radiation sources in industrial, especially petroleum and medical applications, and potential terror actions.

The structure of the 1st, 2nd and 3rd level is inversed compared with the normal labelling, but the responsibilities within each level can be compared with the other Nordic organisations.

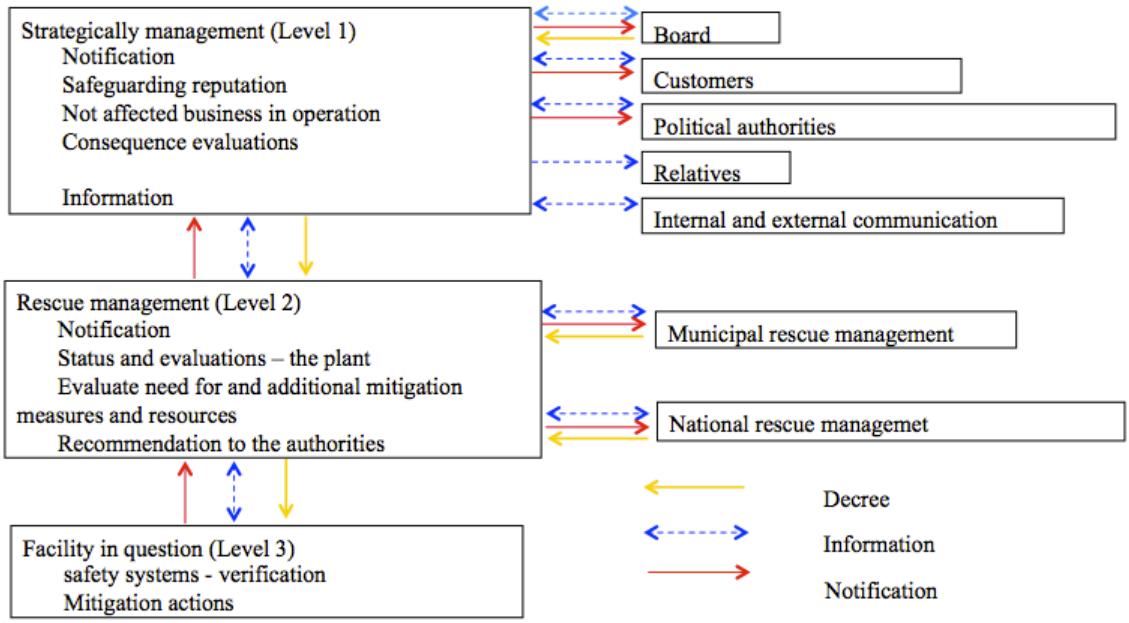

Figure 2. Emergency preparedness organisation and information flow at IFE

3.3.3 Statens strålevern

The Norwegian Radiation Protection Authority is the Secretariat for the Crisis Committee. In the daily preparedness work, the Secretariat shall carry out courses, exercises and build up good lines of communication in the preparedness organisation. In case of a nuclear incident, the NRPA shall obtain and work with information and measurement data, prepare prognoses and maintain the overview of the situation, together with placing a motion for action [6].

4 2nd line nuclear emergency preparedness organisations

The purpose of this chapter is to provide an overview of the function and describe features of the 2nd line of the nuclear EPOs (Emergency Preparedness Organisations). The description will start with the Swedish organisation and this will be compared with the Finnish organisation. It is also provided relevant links to the Norwegian organisations.

The organisations in Sweden, Finland and Norway can be compared with nuclear EPO organisations worldwide as well as EPO organisations in other industries.

A common structure is the division between 1st, 2nd and 3rd line in EPOs worldwide. As shown in Figure 3, when an incident is detected according to procedures, a technical team supports the control room staff and field operators. In addition, the 2nd and 3rd line emergency organisations are established.

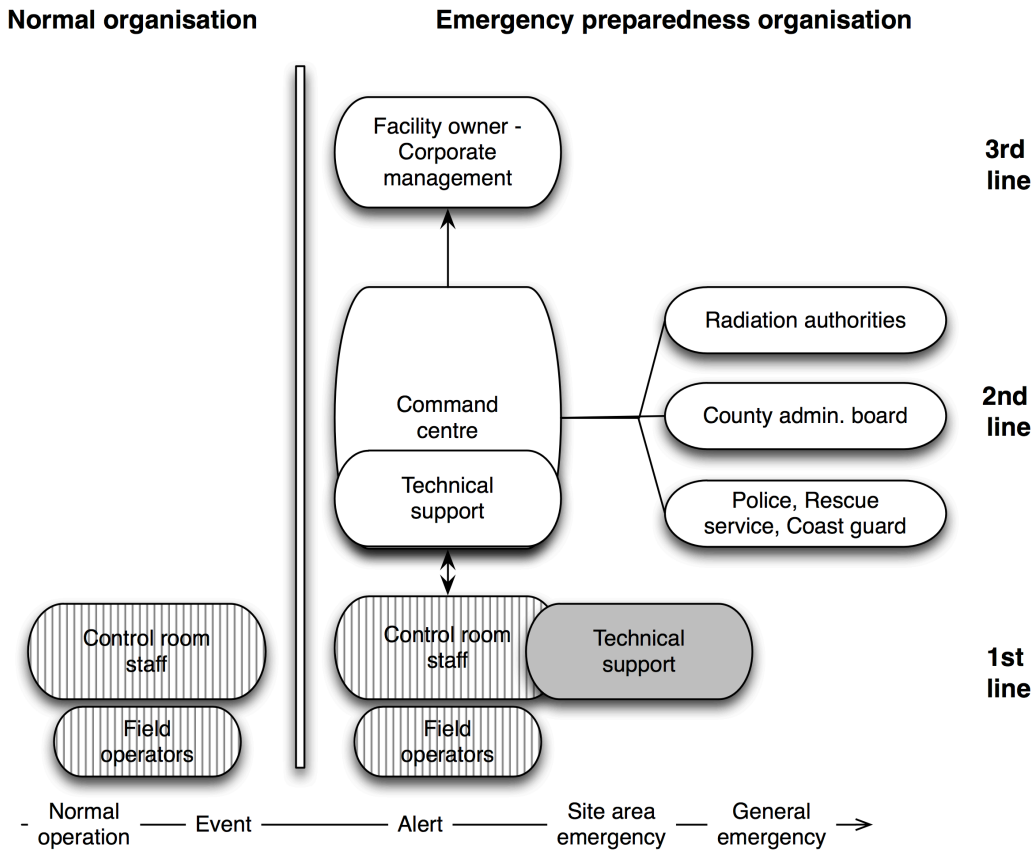

Figure 3. Establishing the emergency preparedness organisation.

4.1 Command centre organisations

The staffing of the command centre EPO is made to cover the 3 most important areas in a crisis handling.

- Reactor safety
- Radiation safety
- Information

By comparing the 2nd line organisations of Ringhals, Forsmark and Loviisa one can see that the similar positions appears in all three organisations. One significant difference may be that the Loviisa repair manager, which has direct control of a number of repair, teams. In the Swedish utilities these teams are primarily managed from the affected units control room

managements and the CC operation manager (“Anläggningsledare”) has the task of supporting the affected unit’s management with personnel for the repair teams.

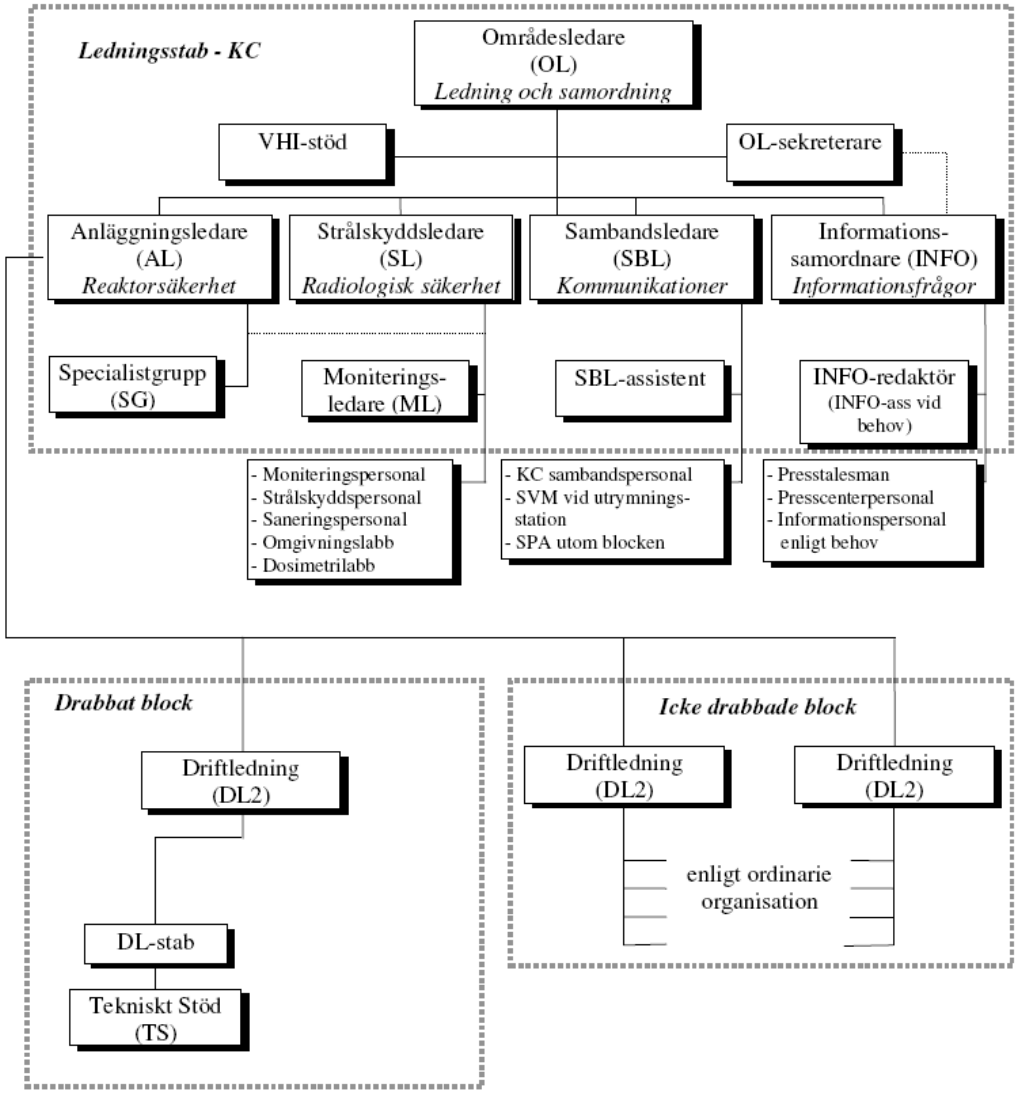

Figure 4. EPO organisation at Forsmark NPP

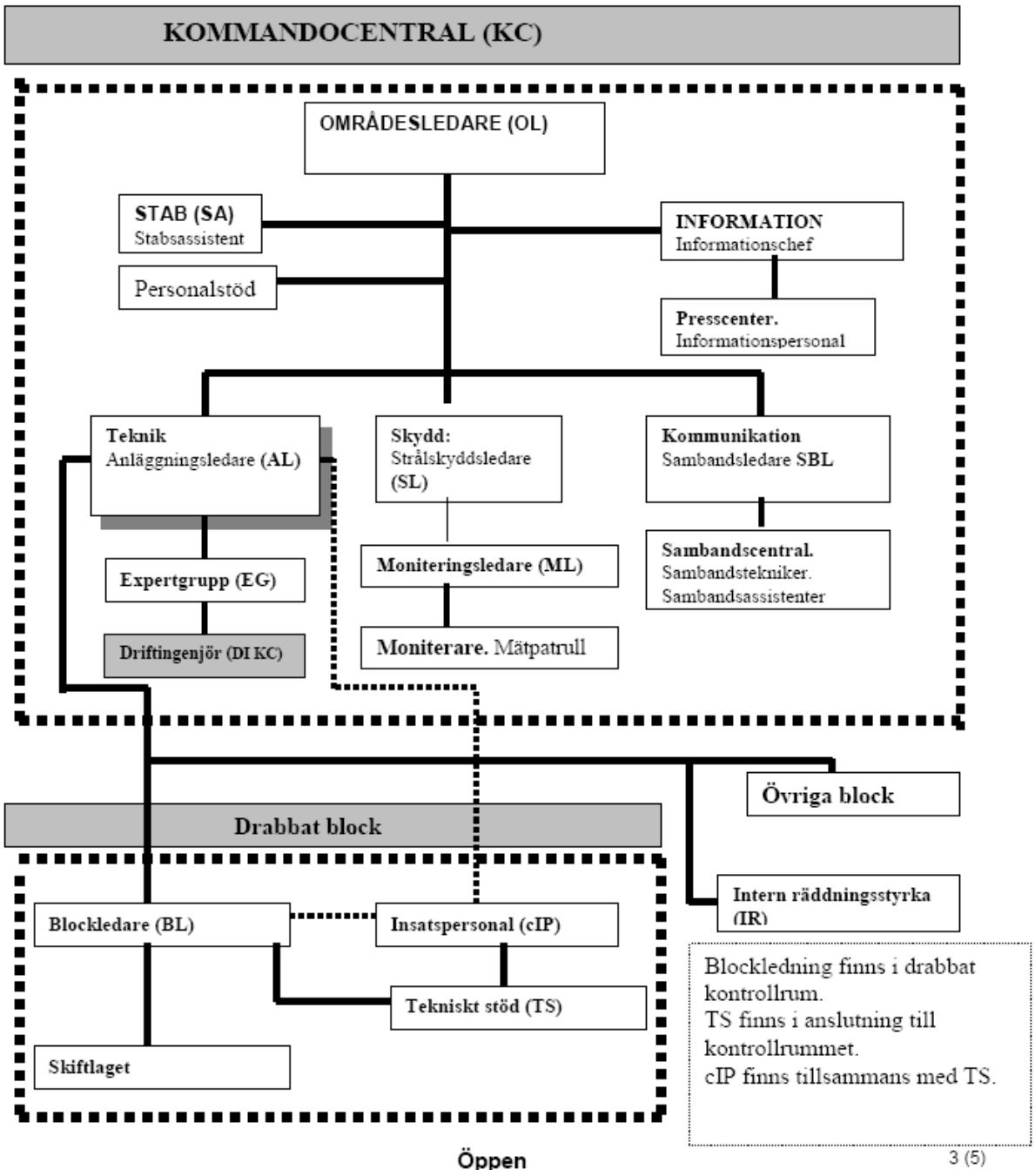

Figure 5. EPO organisation at Ringhals NPP

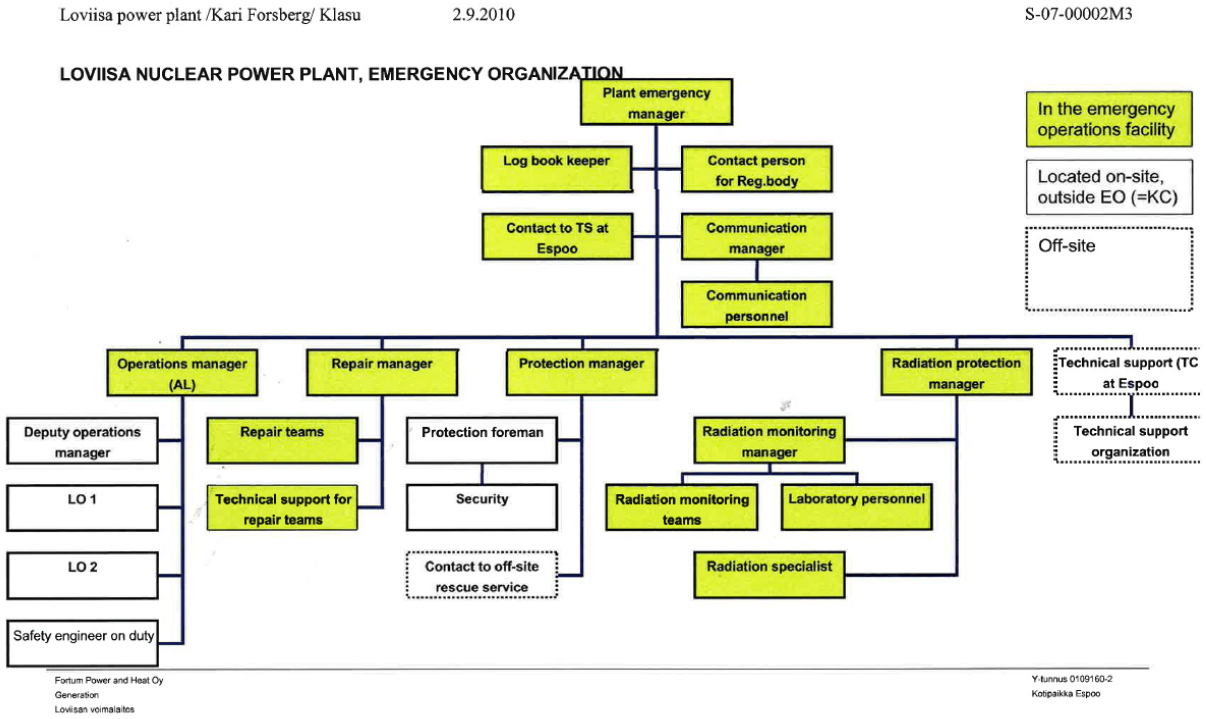

Figure 6. EPO at Loviisa NPP

A comparison of the emergency Command Central (CC) positions is given in table 1.

Role category	Ringhals	Forsmark	Loviisa
OL	Områdesledare	Områdesledare	Plant emergency manager
	Personaladm. stöd		Contact person STUK
			Contact person technical support
AL	Anleggningsled	Anleggningsledare	Operation manager
	Anleggningsled	Spesialistgrupp - Reaktorsäkerhet	Repair manager
	DI-KC (Driftsingeniør)	Spesialistgrupp Radiologi	Technical support
	Expertgrupp		
INFO	INFO	INFO-redaktør	Communication person
	INFO-ass	Informationssamordnare	Communications manager
		Informatør/Presscenter	
		Presstalesmann	
LOGG	Stabsassistent	OL-sekretærare	Log book keeper
RADPROT	Monitoreringsledare	Monitoreringsledare	Laboratory personell
	Strålskyddsledare	Strålskyddsledare	Radiation monitoring manager
			Radiation protection

Role category	Ringhals	Forsmark	Loviisa
			manager
			Radiation specialist
SBL	Sambandslede	KC-expedition	
	SBL-ASSISTENT	Sambandsledare	
	SBL-tekn.		
PROT			Protection manager

Table 1. Comparison of CC positions between Ringhals, Forsmark and Loviisa

A short description of each position responsibility is presented below.

Plant emergency manager: The task of the plant emergency manager (OL) in an accident is to coordinate and direct rescue and recovery work at the plant, and maintain formal contacts with the authorities.

Operation manager: The task of the operation manager (AL) in an accident is to coordinate the technical work at the power plant unit to achieve a safe operating mode of the affected unit.

Information manager: The task of the information manager (INFO) in an accident is to compile and coordinate power plant information, develop information materials for the county board, monitor news reports and be responsible for information within the plant.

The information staff in the CC at Ringhals and Forsmark has quite similar tasks and function in the organisation. Forsmark has a mobile information centre, Loviisa has a different divison between CC and the 3rd line level in the organisation. Handling of media at Loviisa is primarily at the corporate level.

Staff assistant: The role of the Staff Assistant (SA, log book keeper) in an accident is to assist the Plant emergency manager, collect information needed for management activities and coordinate team work.

Radiation protection manager: The task of the radiation protection manager (SL) in an accident is to coordinate the radiological work at the plant, prepare the basis for protective measures within the power plant and prepare material for the County Board on protective measures outside the plant.

Radiation monitoring manager: The radiation monitoring manager (ML) leads the CC protection group, and helps the radiation protection manager to compile data on radiation levels reported from the block and external monitoring.

Communication manger: The task of the communication manager in an event that leads to the manning of CC, is to be responsible for the technical and functional maintenance of communications.

Protection manager: The protection manager has both an internal safety function for the CC and plant evacuation, in addition to responsibility for the telecommunication. This function is specific for the Loviisa organisation.

Expert group: The expert group (EG) is a technical resource that supports the affected unit and work on the plant level.

Staff administrative assistance: The task of the staff administrative assistance (PAS) is, in case of accidents and deaths, to act as a support for the organization in terms of contacts with relatives and to provide emergency support to the staff.

The process engineer: The process engineer (DI) is part of the expert group in CC, and their task is to assist the operations manager (AL) in case of an accident, by collecting data from the process by way of the process engineer in the technical assistance group (TS). The tasks also include making summaries of the process and present to the operations manager (AL).

On duty engineer: The on duty engineer position (VHI) plays a central role in mobilising the emergency organisation. After the initial phase, he returns into being a member of the technical support organisation.

4.2 Governing documentation

The governing documentation for the EPO organisation looked at in this study cover:

- Responsibilities, organisation and operation
- Operational support documentation
- Education and Training
- Equipment

The main focus has been on the responsibilities and operation in a situation with emergency handling.

4.2.1 Command centre procedures structure

In an emergency situation the command centre staff work is guided by a set of work instructions.

There is a slightly different way of describing the work tasks for each of the CC-staff. One way is to have a 2-3 line summary for each position in the start of each procedure, and the other is to collect the information in a common document and describe the task together with the principles for the work.

For all NPPs the procedures are divided by “initial tasks” and recurring tasks.

The way the instructions are built with regard to handling different emergency levels differ.

4.2.2 Personell selection and callout

All organisations studied have a similar way of callout routines. Personnel for the emergency organisations are recruited from relevant positions at the utilities. The selection of personnel is done on basis of competencies needed to build an organisation with the capabilities required for handling an emergency situation.

The emergency organisation is mobilised on basis of decisions by the operations management. The decision is based on a number of pre-defined safety related criteria. In these

extraordinary situations the staffing of the emergency organisation is prioritised, allocating staff from units not affected by the accident.

4.3 Command centre way of working.

The initial work carried out of the CC staff is governed by a set of procedures for the respective responsible positions in the emergency organisation.

The plant emergency manager is leading the CC work. The form of cooperation is formalised due to the needs for documentation of information flow and decisions. The various responsible staff are the Operation manager, Information manager, Radiation protection manager and the Communication manager.

The work in the CC relies very much on direct contact between staff and discussion and work within and between disciplines. The main shared information source is the event-log, which is projected on a wall. For the Swedish utilities the secretary to the plant emergency manager or the staff assistant updates the log. Loviisa use a common document updated by the key staff positions in the CC.

Each staff position is the owner of a whiteboard where important information is written and updated by the responsible person.

The switchboard personnel are used for the communications by telefax.

4.3.1 Staff briefing

Status updates (staff briefings) for the CC staff are done on regular basis or depending on the actual situation.

The briefings are a short status meetings used as an instrument for exchange of information within the staff and allocation of new work tasks. A number of fixed criteria decide when and how the briefing shall be carried out. The participants are primarily the management group and local representatives for the authorities.

4.3.2 Technology for communication and information sharing

Telephone communication through safe lines is the backbone for the command centres.

Loviisa has an internal mobile phone communication net. It is also possible to call out from the CC mobile telephones to external locations.

At Loviisa, E-mail can be used in addition to telephone for status updates between CC and the reactor units or external 2nd line cooperation partners. Telefax is used for backup.

Loviisa uses a common overview presented in 3 different rooms in the CC. This is the common screen for visualisation of the overview information.

At Loviisa, screens in the different rooms can be used for presentations from local computers within the same room. There is no way to present information from an EG computer in the other rooms.

At Forsmark and Ringhals, collaboration and shared situational understanding is mostly developed through the staff briefings and whiteboards. Some information is displayed using projectors. E.g., Forsmark is currently testing an overview picture for use in the CC. This picture gives an overview of key reactor parameters like reactivity, core cooling, barriers, heat removal and power supply.

5 Summary of input from workshop with utilities and authorities

Based on an interpretation of common needs and important areas, the workshop (see chapter 2) answered a number of questions relevant for the reporting and further work.

In the group work discussions, the following topics were discussed:

1. Pros and cons of alternative division between KC and 3rd line?
2. Evaluation of training and how to provide feedback to training participants
3. Good practice for the information function?
4. What are the important areas for further work?

A summary of the group discussions follows, divided in sequence of the topics discussed:

1. Pros and cons of alternative division between KC and 3rd line?

Media must as far as possible be handled at corporate level. Technical information must be handled internally at the plant.

Technical support is to some extent available externally. One example is the O3 and F3 reactors, which are similar. OKG has in addition to local competence, technical staff in Germany and a small group in Malmö, which could be used to handle technical questions.

Radiation protection: SSM has high competence and can provide support.

2. Evaluation of training and how to provide feedback to training participants

Good practice for evaluation after exercise:

- Immediate evaluation after the exercise
- Reference group with one observer per role
- Evaluation of exercise management
- Evaluation report to be followed up on next exercise
- Longer time used on evaluation
- Feedback, use the experiences and ensure actions based on experiences

The plants should give priority to the feedback after training issues.

3. Good practice for the information position

- One spokesperson at the press center near the plant
- Common information system for the county board and the plant

- Information boards at muster points
- Information editor
- Collect all text on the web - leads to less workload on the media organisation

4. Important areas for further work

Topic 1 - alternative division between CC and 3rd line - could be part of a follow-up project.

Study the interface between CC and internal (radiation protection, muster points, affected plant, field, HQ) cooperation partners will be important. The most important external connection will be to the authorities both locally and centrally.

Look at communication between CC and media (press conference) and the communication between other external / internal and media

6 First interpretation of data material

The table below gives an overview of relevant observations from interviews and workshop. The first table is a common table for Ringhals, Forsmark and Loviisa.

All utilities	
MTO – FOCUS	INTERPRETATION
Man	
The EPO organisations are well trained and with a high competence within each persons respective specialised areas	High degree of correspondence between tasks in the daily work and tasks the emergency organisation
Training is planned and performed by a professional staff within each utility	Typically 2-3 positions are doing development and planning of training scenarios as part of their full time position in the EPO
Scenario based rehearsals with duration less than one day	The realistic scenario for a large-scale event has a time frame from up to 4 weeks. Handover training?
How to handle technical language. Only a few understand this fully. What does this mean for others in the command central who shall translate and provide information externally?	Communication training for development communication skills across disciplines may be relevant
Should use more time on evaluation of the exercise (now use much more time on planning than evaluation).	The evaluation part of the exercises may be improved. Professional staff for measurement and debrief?

Get more feedback about the measurements made, about the reporting. Get feedback on how did we perform compared to the plans for the exercise.	
Familiarisation with the CC procedures and equipment could be done by more regular visits.	If single staff or groups of staff could have easy ways of agreements for accessing the CC, this may improve their competence.
Technology	
All utilisation of technology is restricted by security and probability for breakdowns in the power supplies for a larger area around each plant	Conservatism with regard to implementation of new systems not validated as safe in situations with loss of power supply in a larger area.
Telephone and telefax is the main tool for communication	Sharing and visualisation of information is the main topic. Improvements possible even by using the "safe" analogous lines. Email 2 fax could be an effective way of handling digital information without relying on internet services.
Procedures are paper-based	Possibilities for improvements use and maintenance by electronic presentation.
Need for a more updated continuous picture of the situation and a better overview of important events and decisions that are made in the operations room. Visualisation of data, process parameters, process, weather, pre-programmed trends. Shared visualization surface for collaboration with e.g. BL, SSM, DI-KC/EG to support information quality and create a common correct situation picture. Same common work space with Technical support. Using computer-based information may help to eliminate communication errors. Simple circulation pictures of the process Information coming through different resources (phone, email, some data not simulated), makes it difficult to get an	The need for common information presentation if data, trends and status information is an issue common for all utilities. Identification of key process indicators and development of good visual representations for common information.

overview (especially in training). Trends useful. The log-book is a good way to get and provide a common understanding of the situation. One should not disturb the emergency plant manager (and other managers) too much.	
Organisation and Governance	
The organisation is – and needs to be – strictly hierarchical.	Network-based principles may be applied by IO-principles for sharing problem solving outside the CC, given that data are provided for external resources.
Each member in the organisation has a detailed procedure with stepwise description of all responsibilities and tasks	Possible weakness in the initial phase of an event.
Each role in the command central has a high degree of specialisation.	Flexibility is restricted
The command centre organisation has a technical support group that works with calculations and support the core CC team	Communication and information issues that could be looked into for all three plants.
The organisations are built and extended over time, with experience for what positions are needed, and involves a quite high number of people	This development has lead to increased number of people in the CC and the efficiency potential by utilisation of better tools and less people should be investigated. Distribution of sub-tasks out of the CC could be done by providing data for resource groups outside the CC.

Focus national and international media – all utilities	
MTO – FOCUS	INTERPRETATION
Man	
Lack of relevant understanding of figures and concepts in media	Available material for easy understanding and explanation can be improved. Development of the public understanding of radiation is a relevant to avoid unnecessary spread of fear, uncertainty and doubt.

Lack of trustworthy sources of information. Current IAEA services are bound to presenting 100% correct information and will be to late and to slow to provide the right time information to media.	Necessary to compare information from a number of sources to get an overview. One trustworthy non official channel could be established with sufficient expertise to do qualified interpretations.
Total lack of competence within national newspapers, television is a better medium due to more nuanced information when experts are interviewed. The interviews are not so much misinterpreted by the reporter.	A need for translation of standard nuclear industry notations and concepts.
Technology	
Internet is the main information source.	Efficient and agile tool. How can internet be used for "right level" information
Common logging systems within the national information systems exist.	Smart features to feed the public with updated and relevant information
Organisation and Governance	
Lack of standardisation for measurements and time.	Problems with old presentation material not updated with SI units. Lack of understanding of radiation as function of time. Figures presented in media are often peak measures.
Different approach to division between 2nd and 3rd line functions	What is the best solution?
A template for press releases	Development of a set of templates for press releases for different common situations. Preparing these in advance will both improve quality, save time and increase speed of press releases.
The INFO personnel will typically spend time writing up general information	Could be an advantage to prepare a set of information from operation manager and radiation protection manager, (repair manager later in the process). Possible that others have a need for the same information.

The table below gives an overview of relevant observations from interviews and observation of an emergency training situation at Ringhals.

Focus group Ringhals	
MTO – FOCUS	INTERPRETATION
Man	
The EPO organisation at Ringhals is well trained and with a high competence within each persons respective specialised areas	
Training evaluations are done directly after the rehearsals and has the form of a debrief	This area has (as confirmed by the PONPP workshop February 2011) a potential for improvement. New tools and procedures
The senior staff in the Ringhals organisation seems open for improvement and has contributed with a number of ideas for how to improve the EPO	
Use ZLK model from KSU. Prepare before exercise, then exercise, then evaluate. Preparation phase can be improved to give increased effect of training. Make it possible to split more, put more of the situation exercises to unprepared personnel.	
Technology	
Compared to the two other plants, Ringhals lies a little behind in KC technology. They are however planning for an upgrade	
Better control of status reports. These end up as more and more pieces of paper.	Change to electronic status reporting
Would like a visual picture of what is going on outside Command central	Ringhals BC already has ITV-cameras that can be used for this purpose.
Shared logging system with the county board and SSM	
Organisation and Governance	
High number of people in the control room with lack of overview and shared common situation understanding	The high number of people in the control room can be a function of “legacy positions”

Communication manager is currently the position with the lowest workload, while the Staff assistant has the highest workload.	Reallocation of tasks between staff.
Logistics coordination is an ara that require a lot of work. Is there a need for a dedicated position for this area.	Reallocation of tasks between staff could be done to prioritise the logistics responsibility.
All positions in KC have a responsibility to inform the INFO function about development.	Development of procedures and skills within this area could be relevant.
To handle all tasks, radiation protection staff should be doubled.	It should be possible to solve the tasks with the current manning in the CC given optimal division of tasks within the CC. Another option is also to look at technical solutions and external support.

The table below gives an overview of relevant observations from interviews and observation of an emergency training situation at Loviisa.

Focus group Loviisa	
MTO – FOCUS	INTERPRETATION
Man	
The senior staff in the Loviisa organisation gave the impression of skilled personnel with high competence.	
Training. Could be useful to have more frequent exercises training part-tasks of the scenarios with smaller groups.	Useful for training basic skills within the staff functions.
Technology	
Look into using video communication with external parts	Video meetings will contribute to better quality of the communication. It also allows for more use of shared collaboration surfaces and redundancy in the presentation understanding.
What additional data could be provided to the emergency room in Espoo to provide a common picture of the situation?	Limitations by analogous lines for data transfer, need smart solutions to get the most out of the line capacity

Are using the same procedures, independent of what incident occurs or in normal situation. Using the same toolboxes (PCs etc.) independent of situation.	This is a good practice for avoiding the training needs for multiple tools.
Organisation and Governance	
Division between 2nd and 3rd line work tasks related to the information handling are not the same as in the Swedish utilities. Loviisa has more handling of media and journalists from the Fortum central location.	This division seem to be in line with the general trend from other industries.
Plant communicates everything that happens within the fence. Authorities communicate what happens outside the fence.	A similar division was done very strictly between IFE and the Norwegian Radiation Protection Authority during the first days of the Fukushima accident. This division seem to have been a success due to the fact that it makes a clear division between process and radiation.
Using the same toolbox and procedures independent of normal or alarm situation.	Effective for maintaining the skills and competence in tools and procedures.
High workload in the communication group.	Wish to have at least 3 positions within this area.
Need to know what is happening outside the plant. Two-way communication with the outside.	Need for improved feedback from cooperation partners outside the plant to get a good picture of the grid and the logistics situation for spare parts and supplies.
The pressure in Espoo can be lower than in the emergency centre at Loviisa, so that some tasks can be easier to do in Espoo.	This is one of the main potentials for use of knowledge from the integrated operations area. Development of safe and efficient work sharing has been one of the main focus areas in the Norwegian oil and gas industry.
Improve handling of the first two hours - tools and equipment. Enable to start handling the situation before you are on site.	See preceding point
Has prepared a flowchart / checklist to be used instead of procedures	Taking this even one step further would be to digitalise checklists to track missed actions and give automatic notice.

Need more support from operation to know the situation in the process and the influence to the process.	Supporting

The table below gives an overview of relevant observations from interviews and observation of an emergency training situation at Forsmark.

Focus group Forsmark	
MTO – FOCUS	INTERPRETATION
Man	
The EPO organisation at Forsmark is well trained and with a high competence within each persons respective specialised areas	
The senior staff in the Forsmark command centre organisation seems to be more restrictive towards technological changes compared with the other utilities	Senior staff seems to have high competence in the existing tools and routines and find the supporting tools well integrated with the way they currently perform the work.
Technology	
Forsmark has recently started to use a shared overview picture for central process parametres.	
Organisation and Governance	
A significant part of the SG-S and AL time is spent writing situation reports (lägesrapportering).	
Provide frequent information to the press centre both in the situation when new information is available, and when the situation not has changed.	Ubiquitous tools for information gathering, mechanisms for the press-centre people to ensure that they have the most updated information.
Sharing of information within the CC-staff (log visualisation etc.).	The CC staff consist of different disciplines. Not all information is relevant for sharing by the large screen principle. Development of position relevant information screen may me feasible. (Pull, not push principles for information exchange, possibilities for each position to configure relevant information pictures.)

7 Data analysis

7.1 General assumption for all discussions about use of new technology

All discussions and proposals for use of new communication technology and automation of data flow assumes that a fallback system is maintained for a situation with a total blackout and lack of power to the communication systems outside the CC.

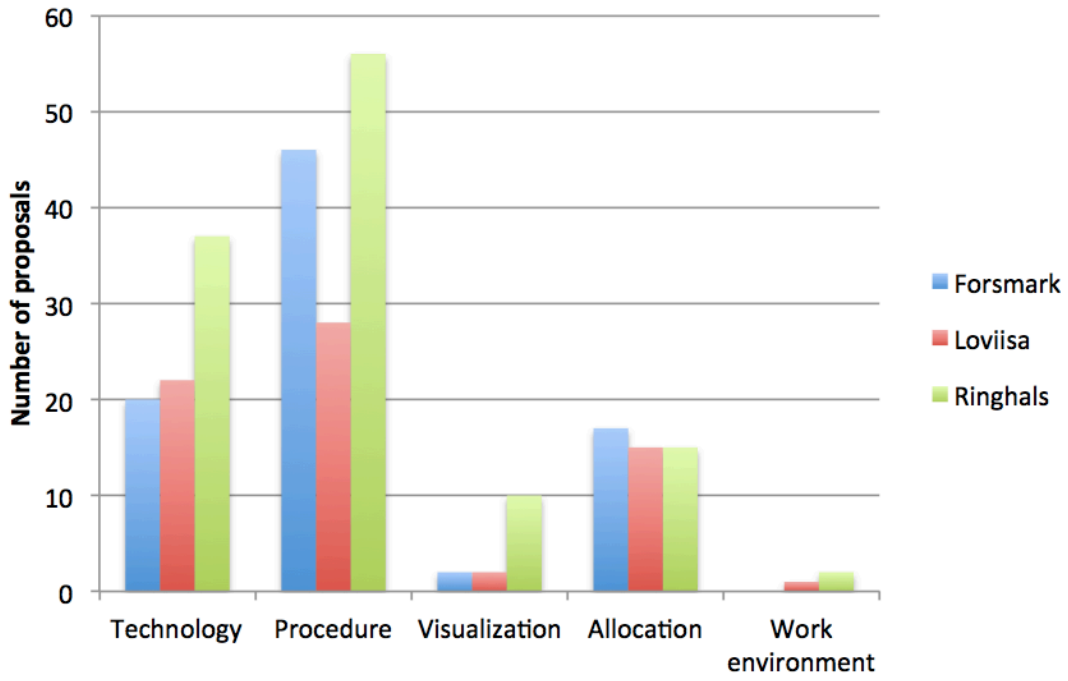

Figure 7. Improvement proposal categories

Based on the first interpretation of data, improvement proposals were divided into 5 categories. The categories are allocation, work environment, procedure, technology and visualisation. The number of proposals within each category is in not any way meant to be interpreted as a statistical expression of needs or deficits. However, the do to some extent reflect the researchers impression of where the emergency organisations could place their short horizon improvement work. Improvements within allocation are mainly about how to distribute workload in an optimal manner, while the procedure category is typically detailed improvements and minor corrections to the CC procedures. The technology category is also dominated of minor modifications and proposals small steps to improvement.

A detailed listing of improvement proposals is reported back to each utility based on the same categorisation. The official part of the report will only cover general observations across and within categories.

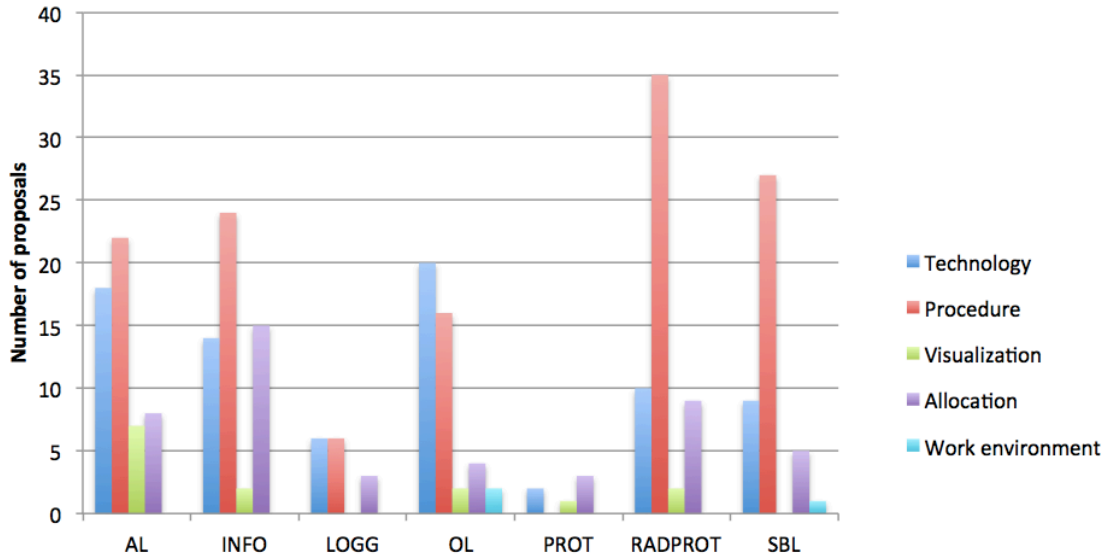

Figure 8. Improvements proposal categories divided by position

The improvement proposal categories were split into positions. The graphics shown in

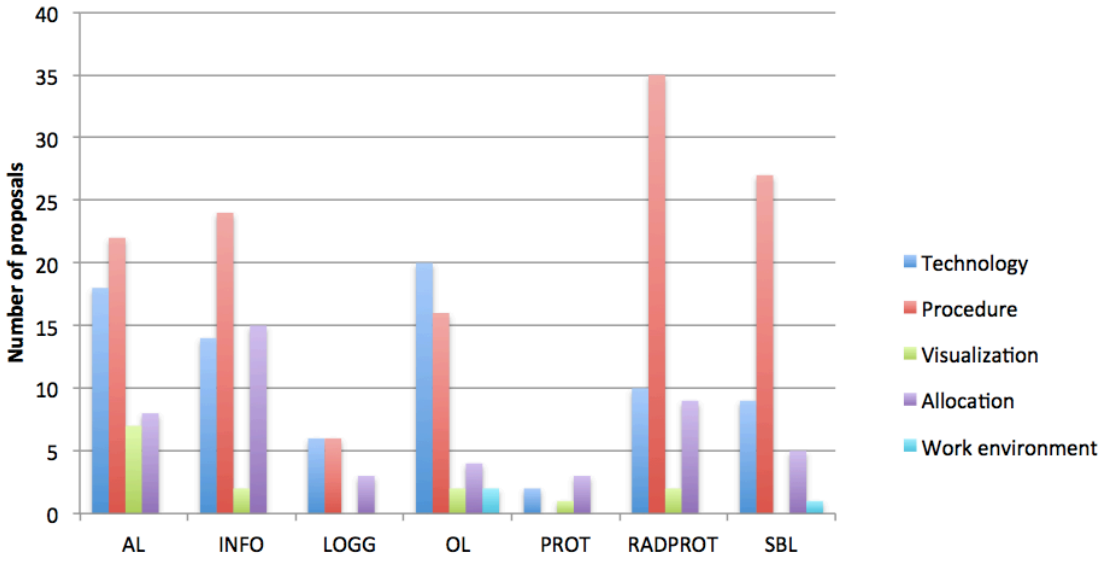

Figure 8 presents which positions (grouped according to Table 1) forms the basis for Figure 7, above. Figure 9 shows the same distribution divided by plant. The data has been used for judgement together with the insights presented in chapter 6.

Roles / Row Labels	Proposal / Allokering	Arbeidsmiljø	Prosedyre	Teknologi	Visualisering	Grand Total
Forsmark	17		46	20	2	85
AL	3		4	2	1	10
INFO	5		9	8	1	23
LOGG	1		5	1		7
OL	2		2	2		6
RADPROT	5		8	3		16
SBL	1		18	4		23
Loviisa	15	1	28	22	2	68
AL	3		2	7	1	13
INFO	7		4	1		12
LOGG				3		3
OL		1	6	8		15
PROT	3			2	1	6
RADPROT	2		16	1		19
Ringhals	15	2	56	37	10	120
AL	2		16	9	5	32
INFO	3		11	5	1	20
LOGG	2		1	2		5
OL	2	1	8	10	2	23
RADPROT	2		11	6	2	21
SBL	4	1	9	5		19
Grand Total	**47**	**3**	**130**	**79**	**14**	**273**

Figure 9. Improvements proposal categories divided by position and plant

The use of technology for supporting communication within the emergency organisation was of particular interest in the analysis. Figure 10 below, show the distribution of proposals divided by utility.

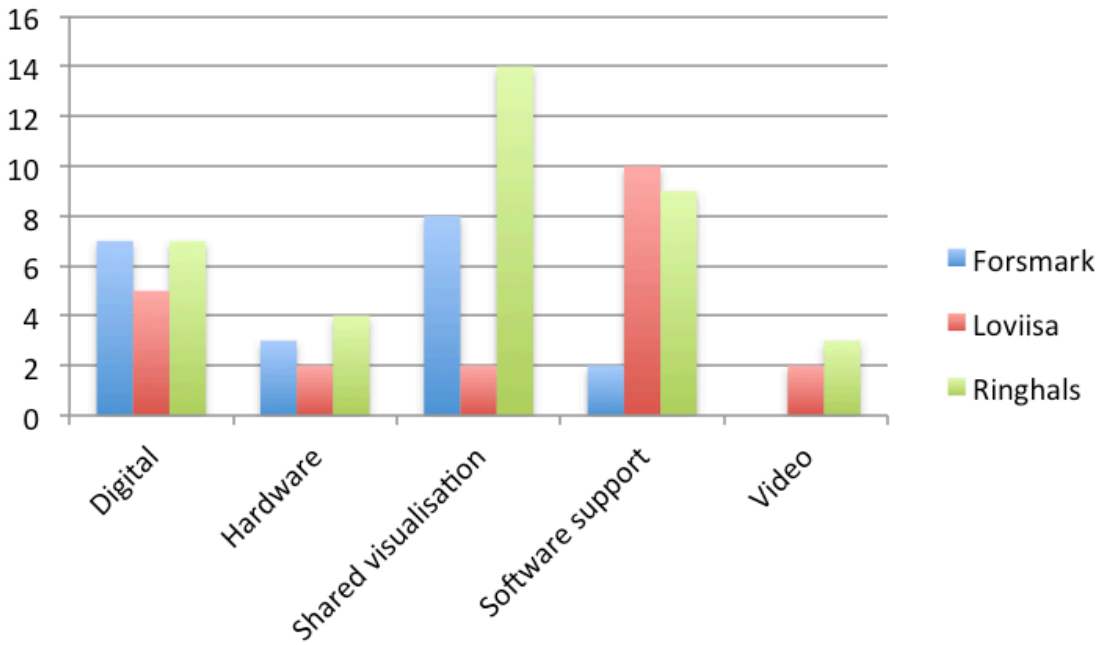

Figure 10. Distribution of technical improvement categories

7.2 Physical layout of the CC

The basic layout for the CC is in principle the same for all CCs in the project.

As shown in Figure 11, typically five rooms are used.

- Operation management room
- Expert group room
- Conference room
- Communication and technical support
- Information and personal administration

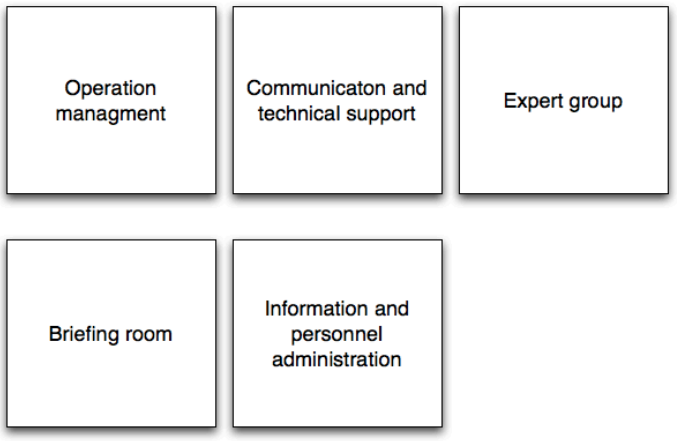

Figure 11. Sketch of typical room layout for the CC

Different philosophies are used for placement of external representation from radiation authorities and police. The authority representatives are either in the operation management room, together with the expert group or in a separate room together with representatives for the police.

The communication personnel are either located in the operation management room or together with the switchboard.

The information personnel do also have different localisations in the different plants. They are either gathered in the operation management room or divided between the operation management room and an information and personnel administration room.

Function	Operation management	Communication and tech support	Expert group	Information and personnel administration
Leader	F,L,R			
Radiation protection	F,L,R		F,L,R	
Info	F,L,R			L,R
Communication	F, L	R		
Personnel				R

External rep.	L		F	R
Switchboard		F,R		

The improvement potential seems to be within the combination of information exchange and location of the different functions.

7.3 Gathering and use of input parameters

For all plants a significant part of the data are manually punched from telefax, e-mail and telephone/radio into software used for calculations and status overview. In the information flow the same data can be punched several times by different levels in the EPO and also by different users at the same level. For example data can first be filled into forms by the 1st line technical support group, then transferred from telefax form to a computer by the CC operational management and CC technical support group.

In the current situation much of the time is spent punching the data into the different calculation programmes used for decision support. The technical solution for improvement would be automatic or semi automatic data input to calculation software codes. I.e. the calculation software request parameters or parameters is transferred to the calculation software by a central agent.

An example would be the coupling between core damage information, weather information and the gas and dissipation programme. In these calculations there are a high number of manual entries with a potential for human error in the punching.

The organisational improvement would be to ensure that only one end-user handles data and deliver processed results to the other users.

7.3.1 Use of tools and technology

A number of software tools are used for calculations and different types of forecast. One observation from the interviews is that use of these tools require good understanding and familiarity with the interfaces. The frequency of exercises is normally not more than maximum twice per year and normally the use of tools will not be trained between the exercises. The current philosophy is to have dedicated tools for dedicated problems. But the downside of having tools more dedicated to different situations, is that this may lead to less training with the tools. Going in the other direction would maybe be a better solution. Having the same tools applied for all tasks, maybe splitting in modules, but with a common interface and seamless exchange of data between modules could support both training needs and efficiency when using the tools. The ultimate solution would be if emergency organisation tools could be more integrated with the tools used for everyday work. A solution like that would lead to more training with the tools and make it less cumbersome to use the tools when the emergency situation occurs.

Input to common log seems feasible and it could be a recommendation for all utilities to look into if a common updated document – like the one in Loviisa - could give valuable input to improved overview and shared situational understanding by the CC staff.

7.3.2 Organisation and Governance

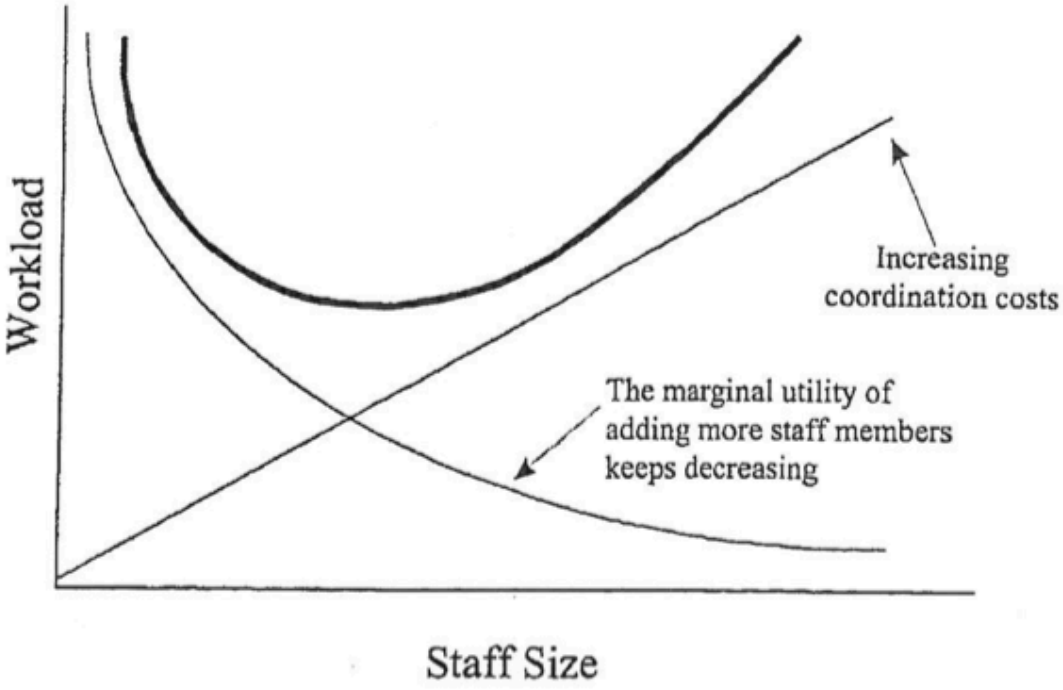

Figure 12. The Klinger and Klein curvilinear effect of increasing staffing on workload

The organisations under study have been built and extended over time with experience for what positions are needed. As shown in the Figure 12 above, increasing the staffing also increases the cost of transactions. Information exchange, handovers, updates of staff steals time and resources from the CC work [12].

The number of people in the CC and the efficiency potential by utilisation of better tools and less people should be investigated. Distribution of sub-tasks out of the CC could be done by providing data for resource groups outside the CC. Improved tools could reduce both transaction cost and the need for positions.

8 Conclusions and future work

Emergency preparedness at nuclear facilities is of high importance and the organisations studied have given an impression of high quality and competence.

This project has been looking for potential areas of improvement. Input to this work has been the experience and methods utilised in the Norwegian oil and gas industry.

The interview material from the various emergency management teams which has been be collected reveal common issues, some different ways of organizing the work/teams and possible improvements both in work processes, organization and enhanced technical solutions. A total of about 900 tasks were mapped during the data collection phase. A total of 270 items for possible improvements were collected.

The analysis of the data identified four main categories where further studies could contribute to improvement.

Communication and exchange of information

Necessary exchange of information within the CC is mostly done by face-to-face communication, and frequent staff briefings are used to ensure a common understanding of the situation. Communication in and out on the CC is mostly done by telephone or telefax. Possible areas for further research could be pros and cons of using more visualisation technology within the CC and more use of digital support for the communication in and out of the CC.

Tools and technology

Software tools are in many cases dedicated for different areas of the CC work. Having the same tools applied for all tasks, maybe splitting in modules, but with a common interface and seamless exchange of data between between modules could support both training needs and efficiency when using the tools. Automation of data transfer from 1st line, integrated in the tools could reduce time consumption and increase accuracy.

Staffing and organisation

Current organisations seem to have the necessary manning. However, there may be a potential for optimisation with regard to function allocation and workload. Smart use of technology and task allocation may even allow for a staff reduction.

Procedures

Paper procedures are currently standard. Typically most of the improvement comments were focused on small corrections to the procedures. Looking into use of computerised checklists and guidance may contribute to both reduces maintenance and improved status overview for remaining tasks to be carried of in the checklists.

During the interview phase both Forsmark NPP, Ringhals NPP and Loviisa NPP got some input from the PONPP project to correct/improve the their work procedures (“Initiella- og Återkommande Uppgifter”), also discovering some overlapping activities between personnel in different categories.

Discussions about what are common, what is different and possible improvements were presented in a workshop at IFE Halden, February 2011. The participating organizations (Forsmark NPP, Ringhals NPP and Loviisa NPP) have shown great interest in continuing the PONPP project.

The usefulness of this method in analysing the emergency management decision-making process within the authorities was considered as an interesting issue for continuation of the project. As an example of proposal from utilities is further MTO analysis of:

- Study the interface between CC and internal (radiation protection, muster points, affected plant, field, HQ) cooperation partners will be important. The most important external connection will be to the authorities both locally and centrally.

- Alternative division between CC and 3rd line i.e., communication between CC and media (press conference), and the communication between other external and internal parties (authorities) and media.

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Abstract

The report presents an overview of Emergency Preparedness Organisations (EPO) in Sweden, Finland and Norway and presentations of insights from a study of the staff positions' work instructions in the command centre in an emergency situation.
The results indicate potential for improvement in several areas. A number of the improvements are related to introduction of new technology and they should be seen in connection with ensuring safe and reliable communication lines and power supply.
Analysis of the data identified four main categories where further studies could contribute to improvement:

-Communication and exchange of information
-Tools and technology
-Staffing and organisation
-Procedures

The usefulness of the Man Technology and Organisation method in analysing the emergency management decision-making process within the authorities was considered as an interesting issue for continuation of the project. The interface between utility and authorities was pointed out as an important area for continuation.

Key words Emergency Preparedness, Man Technology Organisation, command centre, Nordic nuclear Power Plants