The event in the Swedish Forsmark nuclear power plant in 2006 – what have been learned from managing a serious event?

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The company
- An important company in Sweden, Uppland and Östhammar municipality
- Production value/year 1000 M€
- Employees 1045 persons
- Full time consultants ~550 persons

The electricity producer
- Meets demand of three "Stockholms" 25 TWh
- Market share in Sweden 15-20%
- Market share in the Nordic Market 7%
Overview of the event 25 July 2006

• Triggering Event
  – Short circuit in 400 kV Switchyard
  – Error in switching routine

• Consequences
  – Voltage & frequency variations
  – 22 min. loss of 2/4 redundant subdivisions in several safety systems
  – After 35 min. normal shutdown conditions
  – Reactor shutdown, core cooling and residual heat removal ensured during the whole event

• Classification
  – Unit performance deviated in some aspects from the disturbance as analysed in SAR
  – INES 2 (“Incident”)
FN ska granska kärnkraftverken

"En trovärdighetsfråga", säger Forsmarks vd

En av reaktorerna i Ringhals har stängts och det finns ett radioaktivt läckage i kärnkraftverket i Västervik. Man väntar att problemet förskapas och att produktionen kommer att fortsätta. En av reaktorerna har stängts av som ett följe av en teknisk avvikelse. Man väntar att problemet förskapas och att produktionen kommer att fortsätta.

– Vi får hir experter från hela världen. Dessutom är granskning som runnit från ett system till ett annat system, säger Ramberg.
Operators’ quick work rescued Forsmark-1 from complex transient

“The situation in the control room was strange, because half the displays were lost,” said Lennart Carlsson, director of the SKI’s Department of Reactor Safety at the Swedish Nuclear Power Inspectorate, or SKI. “But the operators performed excellently.”

“Excellent” performance by Forsmark-1 operators ensured that the unit quickly recovered from a July 3 2 p.m. partial power loss event that took it out of service for 50 minutes when two emergency diesel generators powering some emergency core cooling systems, the unit had switched off and all control rods had been inserted. Carlsson said that in a worst-case scenario where all power was lost, it could have taken about two hours for initial uncovering of the core, but in this case, “We were very far from that.”

Carlsson said Forsmark-1 never lost power entirely, and operators could reconnect it to a separate 70-kilovolt line. (Continued on page 8)
Outside perspective

• Rules are not followed
• Managers do not intervene
• Routines missing or are not followed
• Conservative decision-making not in place
• Problems with attitude

It does not matter if this picture was right or wrong!

• We had to change it!
• We had to give evidence!
Consequences from the event 2006

- Technical measures

- Special supervision from the SSM, Swedish Radiation Safety Authority

- OSART PeerReview
Technical measures
Consequences from the event 2006

Examples

• Modifications in switch yard

• Modifications on diesel generators
Lessons learned: operation

Examples

• Resources from other unit – new perspective
• Focus on control room personnel
• Availability of el.operator
Special supervision from the SSM, Swedish Radiation Safety Authority
Special supervision

SKI (SSM) decided in September 2006 to FKA would be placed under "special supervision" as a result of the shortcomings identified in terms of:

• valuation and decision making
• maintenance process
• renewal process
• safety culture.

Linked to the injunction FKA should develop and implement a program to remedy the situation and create conditions for them not to be repeated.
Scope of the safety program

SKI requirements
• Decision making
• Maintenance process
• Plant modification process
• Safety culture

WANO Area for improvements

F1/F2/F3
Experiences from July 25

Supporting activities
Overview safety culture program

• The program was put together and approved in mars 2007. It contained detailed schedules and lists of activities. These were revised after decision in the local Safety Committee (SKI requirements) and by CEO for the other activities.

• Follow up and reporting was done monthly on activity level.

• Follow up of the effects was done by internal and external revisions.

• The progress was presented for the employees on the Intranet.
Programs

1. Decision-making
   - Activities to ensure conservative decision-making (seminars, training, procedures)

2. Maintenance
   - Activities to improve testing, preventive maintenance and the maintenance process
   - Integration to plant modification process
   - Activities to remove back-log in maintenance documentation

3. Plant modifications
   - Activities to review and modify the process
   - Evaluation of competence and human recourses
   - Activities to remove back-log
4. Safety culture

- Audits with respect to compliance issues
- Activities to improve the understanding of “management expectations”, the need for compliance with rules and the knowledge about the quality system
- Development of improved indicators for quality and safety
- Improved methodology for corrective action tracking and management safety oversight
WANO – Areas for improvement

Actions to manage WANO-findings not included in other programs
- Work management
- Industrial safety
- Human performance
- Organization and administration
- Operational experience
- Operations
- Radiation protection
- Chemistry
- Training and qualification
6. Experience from July 25
   - Mainly issues with regard to the design of the plant and procedures in the light of the incident
     (prioritized, planned and performed)

7. Other supporting activities
   - Miscellaneous activities outside of programs e.g. organizational and human recourses
Inspection by IAEA - OSART

- Management, Organization and Administration
- Training and Qualification
- Operations
- Operational experience
- Maintenance
- Technical Support
- Radiation Protection
- Chemistry
- Emergency Planning and Preparedness
- 25 of July 2006 (only in Forsmark)
Regarding the event on 25 July 2006:

- Technical issues of the event were investigated in depth, however underlying organisational issues took longer to recognise and were requested by the regulatory authority afterwards.

- The event was communicated to international organizations, including the IAEA, in an open and timely manner.

- The corrective actions from the plant investigation and those required by the regulatory authority were satisfactorily addressed.
OSART Recommendations and suggestions

- A review of responsibilities for the operating staff

- Implementation of an independent high-level review to maintain safety accountability beyond the operator

- Strengthening and improvement of control and review process of operational documentation, emergency preparedness procedures, and operator’s aids.

- Improvement of feedback on operating experience

- Establishment and implementation of appropriate control of fire load especially in areas containing safety systems

- Implementation of further appropriate chemistry specifications
The team also identified best practices of the plant, such as:

- A well-structured management manual which supports communication of management expectations and commitments

- Computerized monitoring of safety functions and operating status checks

- Effective management of fire cells in order to prevent the spread of any fire and associated fumes

- Use of the training simulator to describe complex events to the media and other key groups, and to demonstrate the orderly work methods in the control room,
Special supervision end April 2009

After FKA's implementation of the program and after a number of follow-up of FKA and SSM, the SSM in April 2009 said that the "special supervision" of FKA would end.
Experience after Special supervision

1. Focus efforts on preventing the need for special supervision by:
   
a) Clear signals from the Authority

b) Listening license holders.

c) Apply clear steps for comments / suggestions / discrepancies / …. and finally, special supervision.

2. Early in the process (in special supervision) evaluate and develop a clear target image and desired end state for the license holder.
OSART follow-up has begin – November 2009
**OSART result follow up**

<table>
<thead>
<tr>
<th>Area</th>
<th>Resolved issues</th>
<th>Issues with Satisfactory progress</th>
<th>Not Satisfactory progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOA</td>
<td>4</td>
<td>0</td>
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<tr>
<td>Maintenance</td>
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<td>Operations</td>
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<tr>
<td>Chemistry</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Technical Support</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Experience feedback</td>
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<td>1</td>
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<tr>
<td>Training &amp; Qualification</td>
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<td>0</td>
</tr>
<tr>
<td>Radiation protection</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

All issues with “Recommendations” are resolved. The 5 issues with satisfactory progress were related to “Suggestions” from the OSART team.
OSART follow-up summary 2009

Audit 2008
24 observations
- 12 "recommendations"
- 12 "suggestions"

"One of the best result of a follow-up since follow ups was introduced into the OSART-system 1991", Miroslav Lipàr, team-leader IAEA.

Follow up 2009
19 "issue resolved" ("big A") including all "recommendations"
5 "satisfactory progress to date" (B)
NONE measures with "insufficient progress" (C)
ALL "recommendations" recieved "issue resolved" (A)

We made our purpose
At least "satisfactory progress" in every observations
80% "Issue resolved" – is an extremely good result!
We have set a goal to be world class in about 5 years.

We must go from being average to being the best quarter.

International examinations are an important part in the development

**OSART follow-up become what we had hoped for: A (big) step forward …**

**International reviews make us better!**
Safety culture
Background – Safety culture development at Forsmark

Start of Safety Culture survey

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

WANO peer review

Event at Unit 1

Injunction from SSM: Actionplan regarding SC completed

Injunction from SSM: Actionplan regarding SC ended

OSART Follow up

OSART

WANO peer review – Follow up

WANO 2011

"Result not meeting goal"

"28 AFI:s"

"Poor safety Culture"

"No major change"

"Meets internat. standards"

"Excellent results"

Working with actionplan

Safety Culture development implemented in safety programme
Indicators and Measurements of safety culture – Other qualitative measures

• Results from internal and external audits
  – WANO peer review
  – OSART
  – SSM
  – FQA (Forsmark QA-audits)

• Gives statements on safety culture issues

• Also evaluation of
  – Handling of events
  – Special actions, ex.
    • response from employee dialogue workshops
Implemented measures

• The programs have been transferred in the ordinary course of business.
Examples of areas and measures

- Organizational processes
- Leadership
- Management Planning
- Employees
- Skills
- Motivation raising measures / incentives
- Work environment
- Error prevention methods / procedures
Organizational processes

- Employee dialogues:
  Cross-functional Employee Dialogues with information from senior management and group work on past events. The events are discussed and suggestions for improvement admitted. This information provides the individual with more knowledge about the conditions of work and group work / dialogue about the events provide further insight into the proper behavior in different situations. The ambition is also to undertake similar communication / dialogue on safety culture with contractors and agency staff with long contracts.
• Management training of feedback:
Under the umbrella of the "strong leadership" is also implemented a manager training feedback to enhance the ability to provide feedback on individual behavior and performance. Training is also provided in the Rules of legal consequences if an individual refuses to correct their behavior after the warning from the head. Feedback is also part of the FKA's manager information program "Manager FKA" which is a part of the introduction program for all new managers.
Cont. Organisation

- Whistleblower:
  To further improve the feedback of grievances, incidents and events to FKA's leadership, has an opportunity to anonymously criticize and views created by a "whistleblower" in FKA's intranet “Canalen”.

- Open “Canal”:
  All employees can send comment to "Öppen Canal", questions to management and get answers directly on the intranet “Canalen”.

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Leadership

- VCMP (Vattenfall Core Management Program): Undergraduate education in leadership for managers within Vattenfall. VCMP based on Vattenfall's priority areas of leadership: Lead activities (Thought Leadership), Results Based Leadership (Performance Leadership), lead other (People Leadership) as well as Communications Based Leadership (Communicative Leadership).

- The Strengthening Leadership: Seminars with Management by objectives Feedback as a basis implemented a leadership / management approach based on using objective and feedback of behavior / performance in all units. The strengthened leadership will help to a strong safety culture in FKA.

- Manager FKA: Awareness programs for all managers in FKA focuses on chief partner. Includes information about the FKA's management / objectives / strategies, safety culture, values and ethics, FKA's requirements and expectations of managers, feedback, and administrative tasks in finance, human resources and purchasing.
Management Planning

- Planning of successor candidates in FKA's management team

- Operations Manager role: Analysis of requirements and workload for operational managers
Employee responsibilities and role

The management system described management's expectations of staff of FKA.

The starting point is the awareness that their work is part of a whole and that each contributes in its own way to the plant's safety and production. Everyone should take personal responsibility for safety and quality of their work. Each one must give priority to safety up. Orderliness, reporting discrepancies, the application of STARK (Stop-Think-Act-Reflect-communicate), follow the rules and self-evaluation are key words.
Skills

- Training in Operational acumen / craftsmanship: The training is carried out at Barseback Training Center (craftsmanship), respectively. KSU's Learning Center (Operational Acumen).

- Training in safety culture at NSMI (Nordic Safety Management Institute) as well as ongoing participation in the Institute's activities.

- Seminar series of conservative decision-making for operational management level 1, 2 and 3 and, VHI, cFQ, cFQS.

- HUSC
Motivation raising measures / incentives

- Quality Premium: Controls against objectives and based on these is explained and anchored in individuals. Reward achievement of goals.

- "80/90/100": Does that older employees under one or more periods of time can work 80% with 90% pay and 100% of normal salary pensionable salary. The investment helps to motivate and provide the conditions for older employees to work longer and give a new, younger colleagues, support and feedback of experience.

- My Opinion and Safety Survey: Provides an opportunity for individuals to influence and achieving improvements in leadership behavior and working.
Work environment

- Working environment, both physical and psychosocial, is an essential part of the prerequisites for correct behavior / performance of the individual. Safety activities and priority actions outlined in FKA's Company program for wor
Error prevention methods / procedures

The error prevention methods must be based on the concepts: Safety first, questioning attitude, conservative decision making, STARK (Stop, Think, Act, Reflect, Communicate) and the use of Instructional.

- Pre Job Briefing (PJB): Application in the operation and maintenance. Preparing for labor to clarify the task, the expected result, work process, roles and risks.

- Two party control / peer checking: In the operation and maintenance (in applicable cases). Means that two colleagues, performing a task together, check each other to ensure that operations are carried out correctly.

- Workplace Observation / Coaching: Application in all activities. The aim is to provide constructive feedback to reinforce professional behavior, to increase safety awareness and to identify improvement opportunities.
Cont. Error prevention

- Post Job Debrief (PJD): The operation and maintenance. Rules Follow-up to ensure that the work was done properly and to take advantage of views to improve the safety and effectiveness.

- Secure communications / Three-way communication: The operation (and in some cases, maintenance). A method of communication with the transmitter that provides a message / an order will receive a confirmation of the recipient then the sender confirms that the message perceived correctly.
Safety culture

Audits with respect to compliance issues
- Activities to improve the understanding of “management expectations”, the need for compliance with rules and the knowledge about the quality system

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President’s demands

Chapter. 3
Requirements on all department

Management’s interpretations

Chapter. 4
Answers from all departments on how to fulfil the requirements, references to manuals, instructions etc.
Operational experience

*The organization can never learn from mistakes that never have been reported!*
Why Operational experience?

• Learn from others mistakes

• To prevent repetition of our own and others mistakes

• Make it possible for constant improvements by supporting a teachable organization

• Take advantage of "good practice"
Operational experience

- New group for handling experience
- Established a new method of working to handle experiences in FKA
- Take care of every experiences in purpose to prevent repetition
- Have the competence in primary analysis / MTO- investigations
- Have behavioural science competence (MMI)
- Be responsible for trendsetting and be a support in the work to analyze experiences
- Be in the possession of key function in the system ERFKA
- Education/information within annual responsibility
World Class Safety and Focus areas
Vattenfall will challenge the best

Vattenfall aims at a leading global position in Nuclear Safety and Operation, and to be recognized for this.
The Directive on Nuclear Safety defines the order of prioritisation between safety and operation

**World Class Safety**

**Priority 1: Safety**
- Safety First
- Safety Culture
- Safety Management
- Continuous Improvement
- Open & Learn from Others

**World Class Operation**

**Priority 2: Maximum Lifetime Availability and Reliability**
- Reliable Operations, High Availability
- Reliable outages, on plan

**Priority 3: Efficient Production**
- No focus short term on cost reduction but on cost control

World Class Safety and Production

• Vattenfall has the ambition to have World Class Safety and Production in the nuclear field

• Vattenfall is investing heavily in the nuclear power plants to increase safety, extend lifetime and increase power

• A large number of projects are going on to improve safety culture

• Vattenfall has created a safety council with several known, well recognised and highly skilled members – among them Dr Hans Blix, former IAEA Director general – and has appointed a chief nuclear officer
WANO 2011

• WANO’s next audit will be in autumn 2011.
• This time Forsmark 3 are in Focus
2010 Focus areas

• Safe and stable everyday operation

• Confirm OSART and prepare for WANO 2011

• Take advantage and learn from the Forsmark 2 outage 2009
"Vigilant even when safe circumstances existing"

- ETIAM IN TUTIS VIGIL was Earl Samuel af Ugglas device. It can be found in Forsmarks church above the entrance hall.