INTERNATIONAL ATOMIC ENERGY AGENCY

REPORT OF THE

OSART

(OPERATIONAL SAFETY REVIEW TEAM)

TO THE

Mühleberg

NUCLEAR POWER PLANT

SWITZERLAND

6 - 23 NOVEMBER 2000

AND

FOLLOW UP VISIT

9-14 JUNE 2002

DIVISION OF NUCLEAR INSTALLATION SAFETY

OPERATIONAL SAFETY REVIEW MISSION
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PREAMBLE

This report presents the results of the IAEA Operational Safety Review Team (OSART) review of Mühleberg nuclear power plant, Switzerland. It includes recommendations for improvements affecting operational safety for consideration by the responsible Swiss authorities and identifies good practices for consideration by other nuclear power plants. Each recommendation, suggestion, and good practice is identified by a unique number to facilitate communication and tracking.

This report also includes the results of the IAEA's OSART Follow-up visit, which took place 19 months after the OSART mission. The purpose of the Follow-up visit was to determine the status of all proposals for improvement, to comment on the appropriateness of the actions taken and to make judgments on the degree of progress achieved.

Any use of or reference to this report that may be made by the competent Swiss organizations is solely their responsibility.

FOREWORD
by the
Director General

The IAEA Operational Safety Review Team (OSART) programme assists Member States to enhance safe operation of nuclear power plants. Although good design, manufacture and construction are prerequisites, safety also depends on the ability of operating personnel and their conscientiousness in discharging their responsibilities. Through the OSART programme, the IAEA facilitates the exchange of knowledge and experience between team members who are drawn from different Member States, and plant personnel. It is intended that such advice and assistance should be used to enhance nuclear safety in all countries that operate nuclear power plants.

An OSART mission, carried out only at the request of the relevant Member State, is directed towards a review of items essential to operational safety. The mission can be tailored to the particular needs of a plant. A full scope review would cover eight operational areas: management, organization and administration; training and qualification; operations; maintenance; technical support; radiation protection; chemistry; and emergency planning and preparedness. Depending on individual needs, the OSART review can be directed to a few areas of special interest or cover the full range of review topics.

Essential features of the work of the OSART team members and their plant counterparts are the comparison of a plant's operational practices with best international practices and the joint search for ways in which operational safety can be enhanced. The IAEA Safety Series documents, including the Nuclear Safety Standards (NUSS) programme and the Basic Safety Standards for Radiation Protection, and the expertise of the OSART team members form the bases for the evaluation. The OSART methods involve not only the examination of documents and the interviewing of staff but also reviewing the quality of performance. It is recognized that different approaches are available to an operating organization for achieving its safety objectives. Proposals for further enhancement of operational safety may reflect good practices observed at other nuclear power plants.

An important aspect of the OSART review is the identification of areas that should be improved and the formulation of corresponding proposals. In developing its view, the OSART team discusses its findings with the operating organization and considers additional comments made by plant counterparts. Implementation of any recommendations or suggestions, after consideration by the operating organization and adaptation to particular conditions, is entirely discretionary.

An OSART mission is not a regulatory inspection to determine compliance with national safety requirements nor is it a substitute for an exhaustive assessment of a plant's overall safety status, a requirement normally placed on the respective power plant or utility by the regulatory body. Each review starts with the expectation that the plant meets the safety requirements of the country concerned. An OSART mission attempts neither to evaluate the overall safety of the plant nor to rank its safety performance against that of other plants reviewed. The review represents a `snapshot in time'; at any time after the completion of the mission care must be exercised when considering the conclusions drawn since programmes at nuclear power plants are constantly evolving and being enhanced. To infer judgments that were not intended would be a misinterpretation of this report.

The report that follows presents the conclusions of the OSART review, including good practices and proposals for enhanced operational safety, for consideration by the Member State and its competent authorities. It also includes the results of the Follow-up visit that was requested by the competent authority of Switzerland for a check on the status of implementations of the OSART recommendations and suggestions.

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INTRODUCTION AND MAIN CONCLUSIONS

INTRODUCTION

At the request of the government of Switzerland, an IAEA Operational Safety Review Team (OSART) of international experts visited Mühleberg Nuclear Power Plant, from 6 to 23 November 2000. The purpose of the mission was to review operating practices in the areas of Management organization and administration; Training and qualification; Operations; Mechanical and electrical maintenance and engineering; Radiation protection; Chemistry; and Emergency planning and preparedness. In addition, an exchange of technical experience and knowledge took place between the experts and their plant counterparts on how the common goal of excellence in operational safety could be further pursued.

The Mühleberg OSART mission was the 109th in the programme, which began in 1982. The team was composed of experts from Brazil, Belgium, Canada, Germany, Sweden, the USA, and the host plant peer, together with the IAEA staff members and observers from China, Spain and the IAEA. The collective nuclear power experience of the team was approximately 290 years.

Before visiting the plant, the team studied information provided by the IAEA and the Mühleberg plant to familiarize themselves with the plant's main features and operating performance, staff organization and responsibilities, and important programmes and procedures. During the mission, the team reviewed many of the plant's programmes and procedures in depth, examined indicators of the plant's performance, observed plant conditions, work in progress, and held in-depth discussions with plant personnel.

Throughout the review, the exchange of information between the OSART experts and plant personnel was very open, professional and productive. Emphasis was placed on assessing the effectiveness of operational safety rather than simply on the content of programmes. The conclusions of the OSART team were based on the plant's performance compared with good international practices.

At the request of the Government of the Switzerland, the IAEA carried out a follow-up to the Mühleberg OSART mission from 9-14 June 2002. The team comprised of four members, one from Brazil, one from Sweden and two from the IAEA. Three of the four reviewers in the team had been members of the original OSART team. The purpose of the visit was to discuss the action taken in response to the findings of the OSART mission.

During the five days visit, team members met with senior managers of the Mühleberg Nuclear Power Plant and their staff to assess the effectiveness of their responses to recommendations and suggestions given in the official report of the Mühleberg OSART mission. The team provided comments on the responses, provided some additional suggestions for improving response actions and categorized the status of response actions. Definition of categories of response status and a summary of the results in a quantitative manner are provided at the end of this report.

MAIN CONCLUSIONS

The OSART team concluded that the managers of Mühleberg nuclear power plant are committed to improving the operational safety and reliability of their plant. This commitment was clear when observing plant conditions, work being performed and discussions with plant staff. The team found good areas of performance, including the following:

– The material condition of the plant is outstanding even though it has 28 years of operation. Contributing to this, the team noted a long history of low maintenance backlog and a comprehensive aging management programme;

– The plant has been, for a long time upgrading plant systems and implementing programmes to improve safety. This includes: the addition of the SUSAN system which reduces core damage frequency; use of noble metal chemistry; installing hardware modifications to keep radiological doses ALARA; and developing ways of measuring Safety Culture within the organization;

– Plant personnel have an excellent sense of teamwork, which contributes to the safe operation of the plant.

The team offered a number of proposals for improvements in operational safety. The most significant proposals include the following:

– Plant management should clearly state a lower threshold for identifying and reporting events and near misses. The team observed some examples of these events in the areas of operations, industrial safety, and radiation protection. The plant may be missing many opportunities to identify early precursors to more serious events. The plant should also ensure that events are investigated so that root causes are well determined, with special attention paid to human factor analyses;

– The plant should evaluate, develop and implement, as needed a more complete set of policies, standards and procedures to meet the goals of the Quality Management programme. The team identified this need especially in the areas of Training and qualification; Maintenance, and Emergency planning and preparedness;

– The plant should strengthen the contamination control programme.

As the team confirmed, there is a long history of good performance in Mühleberg. At the same time, the nuclear industry is going through many changes. Therefore, the plant should assure its ability to detect and correct complacency, and maintain the ability to manage change. In addition, the plant management should continue to maintain safety objectives as the highest priority, being prudent in the future not to shift goals and priorities to economics.

The team recognizes that several actions are already in place to address some of the above proposals. The Mühleberg NPP management expressed a determination to improve in the areas identified by the team and indicated a willingness to accept an OSART follow up visit in about eighteen months.

FOLLOW-UP MAIN CONCLUSIONS

The team received excellent co-operation and support from the Mühleberg staff during the follow-up visit. The team concluded that Mühleberg has done an outstanding job analyzing the OSART issues and taking prudent actions to deal with the significant elements within each issue that would be the most benefit to improving the operational safety of the plant.

The Governing Board and the management of BKW FMB Energy Ltd., the sole owner of the Mühleberg nuclear power plant (NPP), has stated on several occasions it's topmost priority on nuclear safety. This is clearly reflected in the plant regulation manual (Kraftwerksreglement), which is mandatory for the entire staff of the Mühleberg NPP. The willingness of plant management to look broadly into each of the OSART issues shows the characteristics of a strong self-assessment approach and a desire to achieve operational excellence. In all cases, there was agreement between the IAEA team and Mühleberg on the evaluation and conclusions of the actions taken to improve operational safety.

The team noted the following areas where good progress was observed:

Significant effort has been placed on the development of safety performance indicators. The restructuring of the plant regulation manual together with the goals and requirements of the plant Quality Management system has led to the development of a hierarchy of good safety performance indicators. There was a significant effort by the Swiss plant manager organization (GSKL) to develop the structure that led to the development of these safety indicators, thus, demonstrating the ownership and support from upper level management from all Swiss nuclear plants. IAEA TECDOC-1141 was used as the basis for developing the hierarchy structure for these safety indicators.

Further enhancements were made to improve management expectations for the reporting of events and near misses. A marked increase in the reporting of events, near misses and injuries as well as malfunction and critical situation notifications showed that management expectations for this effort is being understood at all levels in the organization. The team viewed the actions taken in this area as a significant cultural change that, with the plant's efforts already underway for a strong self-assessment program, will continue over time to improve the operational safety at Mühleberg.

The team recognized the good progress taken by the plant to address and improve industrial safety at Mühleberg. A significant amount of effort has been placed on taking advantage of existing controls and training activities in place to further improve industrial safety standards. Some examples of the plants efforts in this area are; the eye wash packages have been made more user friendly, swing range of automatic doors are clearly marked, performance testing in industrial safety training has been improved, work preparation for industrial safety aspects has been enhanced and improved management oversight for identification of industrial safety hazards has been increased in the field. The team also noted improvement in oversight activities by the plant safety officer. The team concluded that with sustained management attention in these areas, industrial safety practices at KKM would continue to improve.

The team was impressed with the actions taken to remove un-needed material that was stored in and around the plant. All levels in the turbine and reactor buildings showed significant improvement. Also of significance, was the clear identification of lifting slings, ladders and mechanical eyebolts that were approved for use.

The plant has taken action to improve many aspects of training in all departments. Industrial safety training has been improved, training for radiation protection workers has been enhanced and plant specific simulator training and testing for all operations personnel has been significantly improved. The team concluded that the training for personnel at Mühleberg meets good international and IAEA safety standards.

The team noted that satisfactory progress to resolve some of the issues identified by the OSART team continues. Specifically;

- The actions taken to date to enhance the reporting of near misses and potential accidents
- The control of operations documents
- The analysis and control of temporary modifications

The team encouraged the plant to continue work in these and other areas so as not to loose the good momentum that the staff has exhibited. Plant management at Mühleberg acknowledged the team's conclusions during the follow-up visit and showed a determination to continue to strive for excellence in operational safety at Mühleberg.

1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION

1.1. CORPORATE ORGANIZATION AND MANAGEMENT

The Kernkraftwerk Mühleberg (KKM) is a single unit boiling water reactor owned and operated by BKW FMB Energie AG (BKW), Bern. In addition to KKM, BKW is the owner of eight hydropower stations and is the part owner of 18 other power generation installations. KKM is the only nuclear plant operated by BKW and the support functions for the plant are located on site.

The responsibilities for safety are clear within the organization. The plant manager is the senior official responsible for safety, he puts emphasis on safety in most of his communication with workers, and the staff appears to have a good attitude concerning the priority of safety. The plant policy, plant manager's vision, guiding principles, (Kraftwerksreglement für Mühleberg) and quality management procedures clearly state that safety is the first priority. Personnel from the plant have actively participated in drafting safety performance indicators that could be used in all Swiss plants and will be used by KKM as goals in 2001. However, quantitative indicators for 2000 contain fewer indicators related to safety than those prepared for 1999. The graphically displayed performance indicators are cost versus budget, production in kw-hr versus plan, and personal exposure versus plan. The team suggested that written plant indicators should clearly show the same high regard for safety that is found in the plant policy and in the quality management procedures. The plant has sufficient resources, both human and material, to perform required safety functions.

1.2. PLANT ORGANIZATION AND MANAGEMENT

The plant staff has an excellent sense of teamwork, which was recognized by the team as a good practice. Workers take pride in anticipating the needs of others and making preparations so that work can be efficiently performed. On their own initiative operating personnel spend extra time coaching new people in the most effective way to perform their duties. The managers and workers in the plant understand their duties and their role in ensuring safe operation.

The operations department clearly plays the leadership role in plant activities. They control the schedule for the plant and set priority for the work done in the plant. Other departments actively support the operations department. This was recognized by the team as a good practice.

The plant makes effective utilization of an internal safety committee to review activities that impact safety at the plant. The safety review committee consists of three groups; a subcommittee for nuclear safety, a subcommittee for industrial safety and the general committee. The subcommittees are staffed with young professionals who bring energy, fresh ideas and a questioning attitude to the job.

KKM has a significant number of people on the staff who will reach retirement age in the next few years. The plant has a long-term plan to recruit and train managers and workers. The management team has identified those staff who will retire in each of the next few years. In addition, replacement candidates for these positions have been identified several years before each retirement and the replacement personnel are being provided with appropriate career experience to prepare them for promotion.

The company is in the process of reorganization. Since the industry has become market based, the vision behind the reorganization is that the overall number of employees will remain the same, however, there will be a shift away from technical professionals to marketing professionals. BKW should monitor the reorganization to ensure that it does not distract workers at KKM.

The plant has a long history of continuous improvement in safety. The commitment to safety is evident in the upgrading of plant systems and the institution of programs to improve safety and reduce the core damage frequency. This was recognized by the team as a good practice.

1.3. QUALITY ASSURANCE PROGRAMME

The plant has recently put in place a quality management program. The program includes audits of safety related activities. Department and personnel goals include indicators on implementation of the program. 67 audits have been completed since the advent of the program. Audits result in findings and corrective actions. Corrective actions are tracked to completion. The backlog of corrective actions is low.

The plant has instituted an Integrated Operation Management System (IBFS), which is used to report malfunctions, plan maintenance, schedule surveillances, order parts and other activities. The system is widely accepted by the workers at the plant. It also serves to standardize requirements for work at the plant. Procurement of safety related items is well controlled. See associated good practice in operations.

The threshold for identifying and reporting events or near misses is very high. Since 1998 a procedure to voluntarily report near misses has been in place, however reporting has seldom occurred. As a result, only eight events, seven near injuries and three near misses were reported in 1999. There were several low level events in radiation protection and industrial safety that were not reported. Many of the events and near misses that go unreported to top management involve weak worker practices. The team recommended that plant management should clearly state a lower threshold for identifying and reporting events and near misses that is in accordance with good international practices.

The investigation of some events is inadequate, sometimes the investigation is not completed in a timely manner, and actions derived from investigations are not shared plant wide. Human factors analysis, although required by internal procedure WEI-B-11, and necessary to improve human performance, is sometimes not evident when reviewing analyses done by the plant**.** The investigation of the inadvertent opening of a safety valve was weak in the area of human factors analysis. An event involving the mix up of gas bottles may be due to human factors weaknesses. The event with the gas bottles occurred two months before the OSART and the investigation is not complete. The team observed that other investigations were also not completed in a timely manner. Failure to determine the root cause in human factors areas and failure to complete investigations in a timely manner permit weakened safety barriers to remain in the plant, thus increasing the possibility of a more serious event. The team recommended that the plant should ensure that investigations are completed in a timely manner, and actions derived from investigations are shared plant wide. In addition, root causes in human factor areas should be identified when investigating plant events.

1.4. REGULATORY AND OTHER STATUTORY REQUIREMENTS

The Swiss regulatory body (HSK) has primary oversight of activities at KKM. Representatives of the regulator visit the plant often to review and observe activities at the plant. The regulator is routinely informed of plant activities and certain categories of events. Regulatory approval is required for changes in technical specifications, modifications, restarting the reactor and other actions.

There is a professional relationship between the regulator and the plant. Plant personnel understand the vital role that the regulator performs and they are open in communicating with the regulator. Letters and issues between the plant and regulator are carefully tracked. Commitments to the regulator are identified and completed on a timely basis.

The plant is open to initiatives by the regulator. In response to one issue at the plant, the regulator requested a meeting. The plant involved a large crossection of staff in the discussion with the regulator and the management of the facility ensured that plant staff did not respond defensively to the points raised by the regulator.

1.5. INDUSTRIAL SAFETY PROGRAMME

The plant is very clean, leaking equipment is virtually nonexistent, and pathways are well lit throughout the plant. In addition, exit pathways are well marked and free from obstruction. During the plant wide meeting on November 7, a senior manager made a detailed and well organized presentation on electrical safety for extension cords. An example from the plant was used and the new program for inspecting these cords was presented. Management is active in promoting programs to reduce accidents at work and also away from work.

However, several industrial safety practices at the plant are below good international practice. Some examples of weak practices were identified in the use of personal safety equipment, fire prevention, protection from falls, vehicle use, control of gas bottles, and other areas. The team recommended that the plant should adopt and enforce strong individual safety standards to lessen the probability of injury.

1.6. DOCUMENT AND RECORDS MANAGEMENT

Generally, procedures are available to control the functions of the plant. Through the quality management program an aggressive campaign has been put in place to write procedures in a standard format. The team reviewed several of the new procedures and found them to be exceptional. For example, the procedure for loading the spent fuel cask was clearly organized and included step by step color pictures of how the evolution should be carried out.

The quality management program covers nine process areas and each area has an initiative to improve procedures. Goals are established in each of the areas, including goals for timely completion of the new procedures. Most processes are meeting their goals, however, some are not. Since the procedures are relatively new, there has not been a need to make revisions and therefore no clear program is in place on reviewing procedures to determine if a revision is necessary. Procedures are available at many worksites throughout the plant. While this makes it easier for workers to use the procedure, it also requires that many procedure locations be controlled to prevent the use of outdated procedures. See the recommendation on this topic in the operations section of this report.

Recordkeeping at the plant generally complied with good international practices, although some examples of recording data in pencil were found.

STATUS AT FOLLOW-UP VISIT

The plant has done an effective job addressing the recommendations and suggestions offered by the OSART team in the area of MOA. Two recommendations and one suggestion were found to be resolved and one recommendation was found to have satisfactory progress. The plant has shown a strong desire to improve industrial safety awareness in the plant and has shown a high attention to improve the reporting and communication of internal events and near misses. Measurable improvements were noted in both of these areas as well as good industrial safety practices observed in the plant.

Following the OSART mission the plant revised its regulation manual (Kraftwerksreglement, approved by the board of management of BKW FMB Energy Ltd) to clearly emphasize safety as the highest priority. This effort led to the development of good plant safety goals and further to good safety performance indicators. Although work continues by the Swiss nuclear power plant management organization on the development of safety performance indicators, the team concluded that Mühleberg has resolved the issues addressed by the OSART team. The team concluded that the actions taken in this area meet good international practice and IAEA safety standards.

The plant has done an excellent job improving the timeliness and thoroughness of event investigations and root cause analysis. Following the OSART mission the plant contracted with the University of Berlin to adapt a computer program that would integrate the technical and human performance aspects of root cause determination for a wide range of events. This effort led to a significant decrease in time in determining root causes of events. This program is currently being used in two Swiss plants and is planned to be used by the remaining two Swiss plants by the end of the year.

Following the OSART mission the plant made significant progress in addressing the issue of reporting of near misses, near accidents and critical situations. Since the OSART mission, near miss reports have increased by a factor of three. Work is still progressing in this area and it is expected that, over time, further improvements will be seen. The plant has recognized that success in this area will depend on enhanced communication for all staff concerning a zero tolerance approach for injuries and critical situations and co-operation and trust among peers for maintaining this approach.

The team observed a good momentum by all Mühleberg staff to strive for excellence in operational safety and concluded that plant management are committed to maintain nuclear safety as their highest priority. Good effort has been taken to improve industrial safety work practices and elimination of potential work hazards.

DETAILED MANAGEMENT, ORGANIZATION AND ADMINISTRATION FINDINGS

1.1. CORPORATE ORGANIZATION AND MANAGEMENT

1.1(1) Issue: Although worker attitudes and management communication exhibit a strong commitment to safety, the written quantitative performance indicators for 2000 stress cost and production. The plant policy (Kraftwerksreglement für Mühleberg) guiding principles, plant manager's vision and quality management procedures clearly state the priority of safety. Personnel from the plant have actively participated in drafting safety performance indicators that could be used in all Swiss plants, and will be used by KKM as goals. However, qualitative indicators for 2000 contain fewer safety indicators than those prepared for1999. If safety is not clearly given priority in stating performance indicators, workers may not continue to give it top priority.

Suggestion: Quantitative performance indicators should clearly show that safety is given highest priority. Written plant goals should consistently state the same high regard for safety that is found in the plant policy and in the quality management procedures.

Plant Response/Action:

The plant regulation manual (Kraftwerksreglement für das Kernkraftwerk Mühleberg) has been completely restructured and revised with emphasis placed on safe operation of the plant. The revised version was approved by management in the middle of 2001 and has been accepted by the licensing authorities HSK.

Plant management goals for the years 2001 and 2002 were established on the basis of this revised plant regulation manual together with the requirements of the plant QM system and emphasize primarily plant safety. Goals for the individual QA processes were derived from these Plant management goals and were also applied at the level of personal goals for the individual members of staff by means of Management by Objectives (MbO) described in Issue 2.1 (1).

A working group of the Swiss nuclear power plant manager organization (Gruppe der schweizerischen Kernkraftwerksleiter GSKL) has developed safety indicators structured in a three level hierarchy based on the May 2000 issue of IAEA-TECDOC-1141. Reporting of safety indicators of the two upper levels has already been implemented. Further implementation of the third level indicators will be performed gradually in a test phase during 2002.

Introduction of these measures has further focused on the safe operation of the Swiss plants.

IAEA Comments:

The team noted that the President of the Governing Board for BKW was committed to emphasizing to all employees at Mühleberg that safety was the highest priority. Good effort has been taken to develop management goals that emphasize this message to the staff.

The plant has developed a sound strategy for identification of safety performance indicators and is continuing its efforts to further improve its processes in this area. The work developed in this area by the Swiss nuclear power plant manager organization was found to be of high quality and meeting best international standards. The team encouraged the plant to continue its efforts in this area.

Conclusion: Issue resolved

1.2. PLANT ORGANIZATION AND MANAGEMENT

1.2(a) Good Practice: The plant has a long history of continuous improvement in safety. The commitment to safety is evident in the upgrading of plant systems and the institution of programs to improve safety and reduce the core damage frequency. Examples of these improvements are:

— the addition of the Additional Emergency (SUSAN) system. The SUSAN system consists of a redundant SCRAM system, diesel generators and core cooling capability;
— the modification of the outer torus to mitigate severe accidents;
— KKM was the first plant outside of Scandinavia to increase the area of ECCS strainers;
— development and installation of the process visualization system (PVS) to display plant parameters;
— use of high quality remote video in radiation areas;
— use of noble metal chemistry, in conjunction with hydrogen injection, where the hydrogen is produced from the electrolysis of water;
— early installation of core shroud tie rods;
— in cooperation with The University of Bern, developing a method to measure safety culture within the organization;
— development of the IBFS system to report plant conditions and document work planning and completion of work.

1.2(b) Good Practice: The plant staff has an excellent sense of teamwork, which contributes to the safe operation of the plant. Workers take pride in anticipating the needs of others and making preparations so that work can be efficiently performed. Teamwork is evident in the daily morning meeting and the training committee. On their own initiative, operating personnel spend extra time coaching new people in the most effective way to perform their duties. The managers and workers in the plant understand their duties and their role in ensuring safe operation.

A good example of teamwork is the way in which young professionals are involved with the internal safety committee. The safety review committee includes a subcommittee for nuclear safety. This gives a greater number of managers and supervisors an opportunity to discuss safety in a cooperative manner. The subcommittees are staffed with young professionals who bring energy, fresh ideas and a questioning attitude to the job.

1.3. QUALITY ASSURANCE PROGRAMME

1.3(1) Issue: The threshold for identifying and reporting events and near misses is higher than good international practice. As a result, eight internal and nine official reports to the regulator, seven near injuries, and three near misses were reported in 1999. Several low level events have not been reported. For example, in radiation protection, no events have been reported for two years, but TLDs have been used by the wrong person and the team observed some minor personal contamination events and contaminated equipment not being properly controlled. See recommendations in the RP part of this report. In industrial safety, poor worker practices involving protection against falls, open buckets of oil, and hard hat and safety glasses usage are below good international practice. The team noted some near misses in these areas that were not reported. Many of the events that go unreported may involve weak worker practices. Failure to identify and report events and near misses prevents the plant from early identification of precursors to more serious events.

Recommendation: Plant management should clearly state a lower threshold for identifying and reporting events and near misses that is in accordance with good international practices.

Plant Response/Action:

Implementation of this recommendation began already during the OSART Mission in the process of establishing plant management goals for the year 2001. These goals were immediately formulated to emphasize the importance of lower reporting thresholds.

Further attention is now also called to industrial safety (IS) and radiation protection (RP) with current status information depicted on posters at locations around the plant. Implementation of Operations procedure WEI-B-023, issued in 1999, has been greatly improved by means of targeted communication and training measures to better understanding. This enhanced awareness resulted in an increase in the number of events reported.

The majority of reporting are made by Operations shift personnel who are requested regularly by the IBFS System to review past observations or occurrences and review them concerning possible classification as events or near misses.

These measures described above resulted in a marked increase in the number of internal reporting of all categories (near injuries, events, malfunction notifications, internal event reports etc.). This increase occurred over a period of constant and efficient plant operation (with excellent production levels) during which number and seriousness of reported occurrences to the regulator remained stable.

Lowering of reporting thresholds has clearly contributed to added safety at KKM.

IAEA Comments:

The plant has done an excellent job to improve employee awareness in the area of industrial safety practices. Emphasis has been placed on improving the training of new employees and installing posters and aids on safety awareness around the plant.

The team concluded that the actions taken to improve the reporting of near injuries and internal events were very good. Progress has been seen in the reporting of such events and improved employee awareness to the importance of safety. The actions taken to address this issue are of good quality and continued success will depend on open communication and support to the staff for their deliberate efforts in reporting near misses, near accidents and critical situations.

The team concludes that the actions taken were good. Implementation of the actions taken to resolve this issue should be tracked further to ensure that management expectations are met.

Conclusion: Satisfactory progress to date

1.3(2) Issue: The investigation of some events is inadequate, sometimes the investigation is not completed in a timely manner, and actions derived from investigations are not shared plant wide. Human factors analysis, although required by internal procedure WEI-B-011, and necessary to improve human performance, is sometimes not evident when reviewing analyses done by the plant**.** The investigation of the inadvertent opening of a safety valve was weak in the area of human factors analysis. An event involving the mix up of bottles may have been due to human factors weaknesses. Human factors issues were not fully investigated in the event where the SUSAN diesel failed to start. The event with the gas bottles occurred two months before the mission and the investigation is not yet complete. Other examples of untimely investigations of events were identified by the team. Failure to determine human factors related root causes and failure to complete investigations in a timely manner permit weakened safety barriers to remain in the plant, thus increasing the possibility of a more serious event.

> **Recommendation:** The plant should ensure that investigations are completed in a timely manner and actions derived from investigations are shared plant wide. In addition, root causes in human factors areas should be identified when investigating plant events.

Plant Response/Action:

KKM recognizes that timely investigation of plant events and rapid communication of conclusions is an important contribution when considering the human factor in performing root-cause analyses. The number of root-cause analyses has been doubled since the mission began. Where the human factor was of relevance, further investigations were made by a method called the human performance enhancement method.

In addition the KKM Internal Committee for Nuclear Safety (ISA-N) analyzes these events and forms its opinion from the nuclear safety point of view.

The KKM Internal Committee for Industrial Safety (ISA-A) also performs the analysis of reported accidents or situations with a potential for injuries (near accidents) applying the Swiss accident insurance authority (SUVA) method, see also issue 1.5 (1).

Results of previous analyses were reviewed and with the introduction of the Safety by Organized Learning (SOL) method at the beginning of 2002 we expect a substantial speed up and improvement of the analyses.

IAEA Comments:

The team noted that the plant has made excellent progress to ensure that events are investigated and communicated in a timely manner. The results of internal audits have shown good results for analysis of such events and the use of the Safety by Organized Learning method should enhance the processes used for event analysis and identification of root causes. The team also concluded that the actions taken by the plant address the root cause of this OSART issue and are in accordance with best international practice and IAEA safety standards.

Conclusion: Issue resolved

1.5. INDUSTRIAL SAFETY PROGRAMME

1.5(1) Issue: Several industrial safety practices at the plant are below good international practice. Examples include:

- hard hats and safety glasses are seldom worn in the plant;
- although smoking is forbidden in some areas of the plant, a cigarette butt was found in the diesel generator room of the SUSAN system;
- workers stood under the spent fuel cask while it was suspended from the overhead crane;
- a worker climbed on the spent fuel cask without fall protection while it was wet and half out of the fuel pool;
- a forklift driver reversed his vehicle without checking the path behind him. People were behind the forklift at the time;
- many gas bottles, including sixty hydrogen bottles grouped in pallets of twelve, are not painted with colors to indicate the type of compressed gas inside and recently, because of confusion, the wrong bottles were installed in a system;
- eye wash packages are extremely difficult to use;
- fire extinguisher locations are obscured by the storage of equipment in the plant;
- the opening paths of automatic doors are not marked;
- uncontrolled oil is present in the turbine building in open buckets and containers;
- storage of wooden work benches on the turbine floor contribute to fire loading;
- the program for inspection of lifting slings could allow some to escape inspection;
- some ladders in the plant are not properly stored.

Failure to enforce strong industrial safety standards increases the probability of injury.

Recommendation: The plant should enforce strong industrial safety standards to lessen the probability of injury.

Plant Response/Action:

KKM analyzed the team's recommendation. KKM will take advantage of the existing fields of training (Issue 2.8 (1)), work preparation and controls of implementation of safety measures, for example:

- Swing range of all automatically driven doors has been marked clearly.
- User friendly modification of eye wash stations was introduced. Use of the eye washes included in training first aid and work safety, (Issue 7.5 (1)).
- Storage areas for spare fire extinguishers have been marked more clearly and access has been improved.
- Performance testing of industrial safety course participants has been enhanced.
- An improvement in the working of the internal KKM committee for industrial safety (ISA-A) was made which reduced the back-log of open items. Evaluation of near misses and critical situations is performed promptly.

Measures concerning the control of testing and inspection of lifting devices as suggested by the team in Issue 4.2 (2) have been implemented.

Plant control rounds by the plant safety officer have been intensified. Regular retraining in the fields of industrial safety, accident prevention and protection of health, in particular for leading staff, will increase awareness for these important safety elements of work.

The plant management performs inspections on a regular basis in all parts of the plant with the aim to identify industrial safety hazards, housekeeping problems and fire hazard issues.

The aspects of industrial safety are now taken into greater consideration in the planning and preparation phase of work activities. Furthermore we enforced the STAR (stop, think, act, review) principle through training and management interactions.

Swiss safety standards and their implementing rules and regulations together with elements of industrial safety and accident prevention practices are communicated in all grades of technical education (apprenticeship, technical college etc.).

Employers are required to deal with these subjects in a greater depth for the specific working conditions concerned and in particular encourage personal responsibility.

After the introduction of the new federal industrial safety regulations KKM was subject of an audit by the Swiss accident insurance authority SUVA. Preliminary results of this audit are positive with regard to KKM's industrial safety performance practices.

The team's recommendations were valuable for KKM. Review of the team's observations and implementation of the new legal safety requirements based on enhanced organisational awareness and personal responsibility of each individual convinced us that industrial safety practices in KKM have now been improved.

IAEA Comments:

The plant has taken significant actions to improve industrial safety awareness at Mühleberg. Training programs have been improved and emphasis has been placed on the identification of near injuries and critical situations. The plant conducted a plant specific risk analysis for industrial safety aspects to identify and correct potential hazards before the work is performed. Improved management oversight of plant work conditions combined with the enhanced personnel enforcement of the STAR principles has significantly improved industrial safety awareness at Mühleberg. The team did not observe any deficiency in industrial safety work practices or potential critical situations that could cause personnel injuries during the follow-up visit.

Conclusion: Issue resolved

2. TRAINING AND QUALIFICATIONS

2.1. ORGANIZATION AND FUNCTIONS

There are many aspects of the current KKM training programs that reflect the elements of performance based training, particularly in the area of operations training. The training also supports the KKM initiatives to further enhance its safety culture initiatives.

Each KKM Department Leader is accountable for the training programs and the qualification of staff within her department. They have effectively delegated this to their respective section managers. The Operations Department's Training Section Manager (TSM) has the additional role of co-ordinating training of all other departments. The TSM is supported in this task by a recently established KKM Training Supervisory Committee, which appears to have effectively established itself and its credibility over the past several months.

Although a department leadership team demonstrates oversight and ownership of training, there are currently few measurable plant training goals or targets by which can be benchmarked to track improvements. For example, KKM monthly and annual training reports deal with numbers of courses, numbers of trainees etc, but do not measure these against any specific targets, such as hours of continuing training received, or, performance deficiencies that contributed to operating events. KKM department leaders are encouraged to set measurable training goals and targets that can provide them with assurance that their staff are receiving effective and efficient training.

The KKM Quality Management Program (QMP) provides the framework on which plant-training staff have documented many details of their current training programs. The team suggested that KKM should continue to review, develop and implement, as needed a more complete set of training policies, programs, standards and procedures to meet the goals and intent of its QMP. The ongoing review and pragmatic expansion of this material will lead to an effective written description that documents how the plant will continue to meet its requirements for trained and qualified staff. This process will also support the transfer of the current body of plant knowledge to future staff.

Although the Team's review found many elements of performance based training at the plant, it also found that some specific components needed to fully satisfy the intent of the QMP are either missing or incomplete. The team recommended that KKM revise its current processes for determining the effectiveness of its various training activities.

Each department leader is also accountable for maintaining the training and qualification records of his staff. Although they currently meet this requirement, there is no overall KKM policy, standard or procedure that prescribes how training records are to be documented, controlled and then securely stored. Nor is there a standardized system to allow supervisors to check and verify the qualifications of plant staff. As examples, continuing training records of some staff could not be produced for the team to review, and each department uses it's own system to electronically store training records. A common and plant wide system of records would provide greater assurance against loss and also ensure a consistent format and content.

Full time training positions exist only in the operations training section, which currently has 2.5 training staff, plus administrative support. The TSM effectively utilizes the shift, Pikett

Engineers, part time trainers from the other departments, trainers from BKW and a number of external organizations to manage the overall KKM training demand. Pikett engineers are on shift. Senior licensed supervisors who supervise plant operations during emergency condition.

The team observed that instructors had excellent knowledge of their subject area for which they were providing training. Although the proficiency of instructor skills varied, the team noted a positive interaction between instructors and trainees.

The team found that the plant effectively takes advantage of opportunities to obtain training from a wide variety of external organizations such as the Swiss Technical Universities and the Paul Scherrer Institute. All those interviewed had high praise for external training.

2.2. TRAINING FACILITIES, EQUIPMENT AND MATERIAL

KKM relies heavily on the Swiss educational and vocational training and apprenticeship system to supply new employees. Additionally, KKM takes full advantage of many qualified off site services and facilities to provide knowledge and skill training for its initial and continuing training programs. This approach permits KKM to maintain very compact internal training facilities, as well as a smaller number of training staff.

The KKM training center had adequate facilities for classroom training. The training center does not require laboratory or shop facilities since this type of training is either done externally or in various plant locations.

Operations staff had high praise for the full scope plant simulator that was installed in the training center in 1996. KKM training staff has been systematically expanding its capability. Simulation maintenance and upgrades are well managed by a solid partnership between operations, the operations trainers, plant personnel and the vendor. Although the simulator has a wide range of simulated events and malfunctions, it is still not fully able to simulate all important plant events. For example, it can not yet simulate the main generator cooling and hydrogen seal parameters, although this upgrade is planned.

In addition to using the simulator as a training tool, KKM uses it to support several other key aspects of plant operations. For example, KKM has used the simulator as a valuable tool for designing the Process Visualization System (PVS) display system, and they routinely use the simulator to check plant modifications before they are installed. KKM also uses the simulator to receive critical plant information in the event of a plant emergency.

In general, the team found a recognition and utilization of the principles of adult learning, such as effective use of in-plant mockups and rehearsal facilities to requalify maintenance staff to work on the reactor during outages. However, the team noted significant variations in the quality of training materials. For example, forklift-training materials were generally well organized and current whereas basic training material for industrial safety and radiation protection were somewhat limited in content and depth. The team noted that the full time operations training section instructors have clearly benefited from courses in instructional techniques, and KKM may wish to consider expanding this training to all staff that does some significant part time instruction.

2.3. CONTROL ROOM OPERATORS, SHIFT SUPERVISORS AND PICKETT ENGINEERS

The Team Members found that a carefully planned and detailed process was in place for the training and qualification of operators, shift managers and pikett engineers. There is strong operations management and staff involvement in the evaluation process and, as a result, the programs leading to the licensed B operator, A operator, shift supervisor and pikett engineer position are very comprehensive. Training activities are carried out by experienced licensed operations training staff, experienced staff on the shifts and by respected external institutions such as the Paul Scherrer Institute (PSI).

The overall training program content for each of the KKM programs is specified in a regulatory document titled HSK – 27. The KKM programs are documented in a recently issued operations training program description (TPD) (VA-BA-007). Current program elements satisfy regulatory requirements and reflect a process whereby subject matter experts develop task-based training required for each position. The operations training program contains all appropriate components of a comprehensive program, such as generic knowledge training, station systems training, simulator training and abnormal operation and emergencies, plus quality in-plant training. The training process involves a combination of classroom training, "on the job" training" and simulator based training on normal, abnormal and emergency aspects of plant operation.

Testing of trainees is done by a variety of techniques, which include internal "milestone" examinations and verification of completed on-the-job training (OJT). There is also an HSK license exam requirement for each of the B Operator, A Operator, Shift Supervisor and Pikett Engineer positions. The license exam is jointly administered by a team of Operations and HSK experts. Although the HSK exams consist of an oral component and a main control room segment, the team noted that they do not include assessment of an individual's performance in the simulator environment. The team recommended that the plant should review, and revise as necessary, the standards and processes it uses for testing the performance of its initial license candidates.

Review of training programs by the training staff and the operations managers, although not formalized, produces appropriate recommendations for change. For example, there has been a recent review of generic knowledge requirements, which will identify requirements for changes in some training provided by the PSI. In addition, there is also an effective process in place to get advance information of proposed plant modifications and procedural changes. A documented process is also used to review significant plant events for training significance, although it is somewhat limited by the relatively short list of such events that the plant has analyzed for training purposes.

There is an effective process for preparing, delivering and documenting continuing training programs. In 1999, the licensed staff received approximately 22 days of continuing training. Approximately two weeks of this training was focused on events that were reviewed, practiced and tested on the simulator. The team recognized as a good practice the value of the plant's unique on-shift training programs that contribute 2 to 7 days of the total training received.

The team noted that the plant might benefit from a review the percentage of simulator – focused time within the current continuing training program. An increase in simulator focused training would provide additional opportunity to get hands on experience and trainee feedback on low-level events.

The team reviewed the current process used for requalification testing of licensed staff and noted that KKM has recently initiated an improved format for testing on the simulator. This new format contains an acceptable rating system for assessing performance and competencies in an appropriate number of areas. However, it does not describe the standards, process or procedure that the plant will adhere to. For example, it does is not define criteria for selecting simulator scenarios, criteria for pass/fail, or, actions that will be required if an individual or crew actually does fail a test. The team recommended that KKM should develop a formalized operations department policy and procedure for the simulator based assessment of the licensed staff.

Although the operations department has an adequate system for the collection and storage of training and qualifications records, as noted elsewhere in this report, this system can be improved.

2.4. FIELD OPERATORS

The plant has an effective training program for qualification of plant field operators. New operator trainees come from a KKM pool of staff with external qualifications in an electrical or mechanical trade. This approach takes full advantage of the solid foundation training provided by the Swiss educational and apprenticeship system.

The field operator-training program is performance based and derived from an ongoing assessment of job requirements by experienced operations staff. It is documented in a recently issued Training Program Description (TPD) (VA-BA-005). Each stage in the process involves a combination of classroom training and “on the job” training”. All appropriate components expected in a comprehensive program are present; such as the KKM introductory training programs (refer to Section 2.8), station systems training and in-plant training. Training materials for station systems training are particularly well organized and comprehensive.

The Plant also pairs up new operators with an experienced shift operator in order to maximize the on shift learning opportunities. This ensures that the shift organization structures provides strong support and training for candidates between formal training segments.

Effective and thorough assessment of trainees is done by a variety of techniques that include internal “milestone” examinations and verification of their OJT learning. The trainees are also required to pass an external Swiss Government examination to obtain a Swiss “field operator qualification”.

The team noted that the continuing training program for field operators was very good. The operations training section has an effective process for preparing and delivering a well documented continuing training program. Topic and content decisions are jointly made between senior operations managers and the operations training section manager. This is done on a time frame that permits effective planning and scheduling of training programs.

Additionally, the picket engineers and shift supervisors also conduct extensive evening and night shift continuing training activities with their crews.

In 1999, field operators received approximately 12.5 days of continuing training. This included 5 days of on shift training led by their shift supervisors. It also included 0.5 days of training at the simulator where they have the role of field operators during simulator scenarios.

2.5. MAINTENANCE PERSONNEL (Includes engineering)

The Team concluded that the maintenance organization provides effective job related input into its training programs and that the content of the program is based on job performance requirements.

Maintenance staffs are qualified in an electrical or mechanical trade when hired to work at the plant. This approach permits a relatively short and straightforward internal training program for individuals.

Each new employee's training program is set up after discussions with their supervisor and is tailored to specific needs. This includes the mandatory introductory training. Additional training on any plant specific tasks is obtained in a variety of acceptable manners, which can include vendor-supplied training, skills and technical courses provided by external agencies and "on the job training".

The OJT training process is well established and administered by very competent and experienced staff. The mechanical maintenance department has also implemented additional practices to improve the effectiveness of their training programs. For example, they make very effective use of mock-ups as well as real plant equipment on the refueling floor to qualify and requalify individuals on specific tasks they will perform during an outage.

The two departments (Electrical and Mechanical) have training program descriptions (TPD) in place that list specific training requirements for their staff. They are encouraged to periodically review them and to continue to add information to document their respective training program processes and qualification records.

As the maintenance staff progress though their initial training phase, their performance is appropriately assessed and recorded in files maintained by each of the two departments. Once complete and signed off, a permanent record is kept in each department.

The team noted that there are appropriate continuing training programs in place for maintaining the qualification of maintenance staff. As with initial training, a variety of acceptable options are used, including training on in-plant mock ups, the use of vendors and contractors and training via government or registered trades agencies.

The team noted that an acceptable and appropriate process was in place to recruit, train and evaluate the performance of plant engineering and scientific staff.

The Swiss Universities provide a well educated source of new staff. The plant also recruits experienced staff from other external sources. Regardless of the route taken to obtain employment at the plant, each new employee takes the basic and introductory training programs. New employees and their supervisors then agree on a package of additional external and internal training that will be required for their current position. This is normally tailored to their background, current job duties and their career pathway. Progress in this program is tracked and assessed as part of the BKW Employee Assessment Process.

The plant also has a proactive practice for identifying and placing an individual into a potential management vacancy well before the incumbent leaves the position. This overlap ensures an effective transfer of the knowledge required for the position.

Continuing training programs are also developed and tracked on an individual basis. To obtain this training, the plant takes advantage of external courses offered by such agencies as the Swiss Atomic Energy Association, Vendors, Consultants and Technical Universities.

2.6. CHEMISTRY AND RADIATION PROTECTION PERSONNEL

New staff hired to the Chemical Technicians must be graduates of the Swiss apprenticeship system, and therefore come to the plant with high quality initial skills.

A new employee must take an initial qualification program that is determined by the section manager and tailored to his or her individual background. This includes some mandatory topics, such as radiation protection, on the job training and some orientation experience on shift. New trainees are also required to take the plant introductory training. During this phase, they get additional training in a variety of areas, such as plant systems, safety culture and quality management. The length, scope and depth of OJT training is determined by the senior staff in the section and covers all of the approved laboratory procedures. The training is given by very experienced staff. Given the level of experience that exists within the chemistry section and the relative small numbers of new hires, this approach is very adequate.

In anticipation of the need to preserve the chemical technician training program and it contents for future staff and trainees, the chemistry section is encouraged to develop some additional quality management documentation. This documentation could be a written training program description (TPD) and further detail in the recording of the successful completion of each task in the OJT program.

Trainee progress is regularly assessed and documented to provide an accurate measure of performance. As with other sections, appropriate training records of staff are kept by the section manager. As previously noted a more formalized and standardized plant wide procedure for documenting these important records might be more appropriate.

The Team found that the chemistry section also uses an effective process to define and implement an effective continuing training program for its entire staff. A wide variety of external, BKW and internal sources are used to provide the training. It takes full advantage of training supplied by vendors and appropriate external courses and seminars. The staff also uses a team approach to ensure that they learn and train on new procedures and equipment.

New radiation protection (RP) staff must complete the basic training and introductory training programs offered at the plant. New staffs are enrolled in a well-structured and prescribed HSK program for the successive levels of radiation protection qualification. The generic portion of RP training is done at the Paul Scherrer Institute (PSI) and consists of the academic and practical components. This external program provided at PSI appears to be very adequate. It also includes formal oral, written and practical examinations at the end of training for each of the intermediate and advanced level qualification courses.

In order to work independently, RP employees must also have experience. This activity appears to be mainly comprised of shadowing qualified staff but does not have any specific documented task training or evaluation.

The Team found that the total amount of job related continuing training provided for this group is lower than current industry standards. For each of the three levels of qualification, KKM subscribes to training courses offered at the PSI. Maximum time for these basic requirements is 2 days per person every 2 years. Beyond this, the additional continuing training offered at KKM is not well documented, mostly informal and has no testing. Planning activities for continuing training appear to be mostly informal and do not consider such items as radiation dose trends as the basis for determining the kind of continuing training that the staff might require. The Team also noted some inconsistencies in the way records of the training had been maintained. As a result, the team recommended that the plant should enhance the continuing training program for its RP staff to ensure qualifications are met.

2.7. MANAGEMENT PERSONNEL

The Team found that initial and continuing training provided to management personnel is adequate to maintain required skills. The training program is tailored by their respective supervisors. It is based on current requirements for the job, and a development plan for future advancements. Examples include mandatory EP training for senior management, a variety of BKW Courses and seminars and external training by qualified vendors and contractors on topics such as Management by Objectives.

Most managers are experienced staff that have been promoted from within the plant, and have extensive experience, training and knowledge of plant activities. Individuals recruited externally are given more extensive initial training including the basic and introductory training required by all new staff. This pathway is supported by the plant’s succession planning process, which also provides promising future leaders with rotational opportunities between departments.

2.8. GENERAL EMPLOYEE TRAINING

A half-day of basic information on industrial safety and radiation protection is provided to new employees who require access to the plant. In addition, the plant provides a more extensive follow up introductory training program that all new employees are required to take as part of their initial qualification training.

The introductory training program has been recently developed by the Plant’s Training Supervisory Committee (TSC) and is coordinated by the operations training section manager. It represents a particularly good example of the teamwork within the TSC, and should ensure that a new employee gets a solid foundation of station information upon which to build his or her career at the plant. Topics covered include, station systems training, radiation protection, quality management and safety culture.

The team found an acceptable level of quality in most components of these programs. However, it also found that the content and depth of the industrial safety and radiation protection components had limited depth and scope and that there is a need to improve the formal assessment of knowledge and ability. Consequently, the team recommended that KKM should improve these two components of its basic and introductory employee training programs and also suggested that follow-up action also include both written and performance assessment.

The Team also reviewed the new Quality Management Web Based Training Program that has recently been produced by station staff and found its contents to be appropriate and well presented. The team was particularly impressed by the manner in which the plant had fostered the development and acceptance of the course and recognized this as a good practice. The plant should support further projects in the area of web based training in order to capitalize on its full potential.

Initial training for fire crew members is done to government standards by the local Canton. As a result, the plant has a well-trained fire response organization. Continuing training and drills are also effectively coordinated and administered.

KKM has recently revised its emergency preparedness procedures. In parallel, KKM developed a training package, which was delivered by the EPP department leader to all members of the Emergency Response organization. The Team recognized the effort that was put into this process and the supporting training sessions and encouraged the plant to more fully document the training package including instructor components.

STATUS AT FOLLOW-UP VISIT

In the area of Training and Qualification, the OSART team made four recommendations and one suggestion. The follow-up OSART visit resulted in all five issues being fully resolved. The amount of work done to cope with issues was impressive. The new data bank on training information and records contains all necessary and required elements and are to be used by any manager at this plant.

DETAILED TRAINING AND QUALIFICATION FINDINGS

2.1. ORGANIZATION AND FUNCTIONS

2.1(1) **Issue**: There is an incomplete set of policies, standards or procedures for many of the training program initiatives needed to meet the goals of the Quality Management Program (QMP). Plant staff has already documented the details of many training processes within the KKM QMP framework. However, this process is not yet complete. For example, there are no formalized criteria with which to systematically benchmark and assess training programs. There is no overall plant policy and standard for the formalized assessment (testing) of trainee performance. There is no overall policy, standard and procedure that prescribes how training records and qualifications are to be documented, controlled and protected. Without a well-documented and comprehensive QMP for training and qualification there could be inconsistent and ineffective preservation and transfer of plant experience and collective knowledge. Additionally, there could be insufficient focus in those areas that are required to contribute to the continued growth of an effective safety culture.

Suggestion: Consideration should be given to continue the review, development and implementation of a more complete set of training policies, standards and procedures to meet the goals and intent of its Quality Management Program. One option would be to review the training programs at similar size plants that have recognized good practices in the area of performance-based training.

Plant Response/Action:

The plant regulation manual (Kraftwerksreglement) has been restructured, focusing clearly on the fundamental objectives for safe plant operation (Issue 1.1(1)). Also clear objectives are set concerning training and retraining of plant personnel.

Training procedures and training material from events at other power plants are incorporated in personnel training as appropriate. Additionally, training managers of all four Swiss plants meet on a regular basis to exchange experience and review training programs.

Quality management in the field of training has been reviewed by means of audits.

A fundamental systemization of training policy resulted also with the introduction of Management by Objectives (MbO) in the plant. By means of this, management goals have a direct effect on processes and sub-processes and have a direct impact on individual personnel goals. Goals are evaluated and necessary improvements are agreed upon. Future training improvements can then be better targeted.

A further formalization of our training system took place with the introduction of an Access database. This database provides a means of which current training status of all persons can be reviewed at any time. It has also proven to be an excellent tool for planning and scheduling of training activities.

Detailed requirements concerning systemization of training and the required documentation have been incorporated in procedure WEI-A-013.

With the measures taken the Quality Management Program (QMP) for training and qualification should now be well documented and comprehensive. Preservation and transfer of plant experience is now more effective. Special focus has been put on areas contributing to continued growth of an effective safety culture.

IAEA Comments:

The plant regulation manual (Kraftwerksreglement) was completely revised and incorporated a complete list of procedures, standards and policies to be followed by the entire plant personnel. As an immediate consequence, some initiatives were made to fulfill the requirements of the guide procedure. One of them was the issue of the procedure WEI-A-013 (Administrative Steps for Training Applications) and the other was the development of a comprehensive new data bank on personnel training information.

These documents were thoroughly reviewed by the IAEA team and they addressed all issues raised by the OSART suggestion, such as criteria to assess training programs, as well as the training records management.

The data bank on training records is impressive and contains all elements for a complete retrieval of all necessary information about training history and future scheduled training.

Conclusion: Issue resolved

2.1(2) Issue: The current plant processes for determining the effectiveness of training does not ensure that its training will meet the quality standards for ongoing and future staff performance needs. For example, there are few measurable targets for the expected performance improvements that results from training. The team noted several examples of poor radiation protection and industrial safety performance and determined that the plant process to link inadequate performance to potential training program deficiencies was not sufficient. There is no formally documented process for an internal self-evaluation of training by the respective departments. The current quality management audit process does not define a complete set of questions and criteria for independent audit assessments of training.

Without a more systematic process for assessing the effectiveness of training, some employees could complete training that is not fully effective. This could result in actions that adversely affect the safe operation of the plant or the safety of its people.

Recommendation: All plant departments should review and revise its current processes for determining the effectiveness of training to ensure that it will meet the quality standards for ongoing and future staff performance needs. Methods used in other plants include training evaluation processes that place significant emphasis on post training feedback from an employee' s supervisor and the employee.

Plant Response/Action:

Review of effectiveness of training has been formalized through introduction of systematic assessment by participants. Measurable performance targets such as using tests and implementation of Management by Objectives (MbO) enables quantification of the effectiveness of KKM's training.
These training requirements are described in a new complete revision of procedure WEI-A-013.

As a consequence of the team's recommendation, training is performed at a greater depth in radiation protection and in industrial safety (Arbeitssicherheit, Unfallverhütung und Gesundheitsschutz, AUG training program). This also applies to the introductory training for new staff members.

The team's recommendation has led to a successfully systemized and improved training process in KKM.

All assessments are evaluated critically by the instructor providing input for measures in subsequent training.

KKM Instructors attend special courses providing deeper training in methodology and didactics thus improving efficiency and transparency of training performance.

These introduced measures ensure that all employees will be effectively trained and any possible adverse effects on safe operation due to incomplete training are not to be expected.

IAEA Comments:

The above referenced procedure WEI-A-013 addresses the evaluation of the effectiveness of the required training. Furthermore, the implementation of the program Management by Objectives (fully implemented in 2001) also encompasses staff requirements on performance enhancement needs. There are included targets for each individual needs. The team concluded that significant progress has been made to ensure consistency and high standards for training effectiveness.

Conclusion: Issue resolved

2.3. CONTROL ROOM OPERATORS, SHIFT SUPERVISORS AND PIKETT ENGINEERS

2.3(1) Issue: The standards and processes for testing of license candidates and for retesting licensed staff on the plant simulator require improvement. For example the simulator is not utilized as part of the licensing examinations for operators, shift supervisors or pikett engineers. Current examinations consist of an oral exam plus a component administered in the main control room. The plant has recently initiated an improved format for retesting the performance of the licensed staff on the simulator. However, it does not define the standards for preparation and security of test scenarios, pass/fail decision criteria and how the operations and training department would respond to an individual or crew failure.

The current processes for testing the initial and continuing performance of the licensed staff on the simulator may not be sufficient to identify and remediate performance deficiencies in either individuals or crews.

Recommendation: The plant should review, and revise as necessary, the standards and processes it uses for testing the performance of its initial license candidate and for retesting its licensed staff on the plant simulator. The improved format that was recently initiated for retesting the licensed staff would be a valuable component of such standards. One option would be to review simulator assessment procedures used at similar plants that have good practices in the area of simulator-based testing.

Plant Response/Action:

The team's recommendation has been closely studied and KKM came to the conclusion that this is a matter of importance, which will be remedied in a step-by-step manner.

A new procedure VA-BA-009 has been issued and implemented describing standards for preparation and security of test scenarios.

Procedure VA-BA-008 has been revised to include pass/fail decision criteria and how the operations and training department would respond to an individual or crew failure. After implementation some changes became necessary and another revision of the document was issued.

The experience with simulator training and performance testing of pikett engineers has been very encouraging.

KKM will consider the possibility of extending performance testing on the simulator to other licensed personnel after sufficient experience with pikett engineer simulator performance testing has been gathered and evaluated.

Measures already introduced and others planned will lead to additional improvements in the performance testing process for initial and continuing training of licensed staff on the simulator.

IAEA Comments:

The team thoroughly reviewed the new edition of the procedures VA-BA-008 and VA-BA-009 and now they address the pass/fail criteria and the control and security of the test scenarios.

According to the Swiss regulations, there are no requirements to use the Simulator as part of the initial licensing examinations. However, extensive training on Simulator is performed, with tests (with pass/fail criteria), during the preparatory training period.

Also, during the requalification period, every licensed operator has at least eighty hours (80 hrs) of training in the Simulator, with tests at the end of the training section. However, the Mühleberg NPP is now advancing towards a more extensive use of the Simulator during initial licensing examination. The Pikett engineers licensing program was revised and incorporated a Simulator test as part of their licensing process. In fact, the Swiss plants are discussing, during periodic and formal meetings to incorporate common approach on this issue.

Conclusion: Issue resolved

2.3(a) Good Practice: The Plant has implemented a unique and effective approach to accomplishing meaningful and significant quantities of continuing training during late and night shifts. The process involves teamwork and coordination between the shifts, the operations training section and the operations line management.

During late shifts, pikett engineers lead shift crew discussions on nuclear safety topics, such as Operating Experience (OPEX) events and World Association of Nuclear Operations, (WANO) operating events. Licensed and non-licensed staff participates in these discussions. New topics are jointly selected by operations managers and the training sections manager on six-week intervals.

Additionally, ongoing review sessions of operating documentation are routinely scheduled for night shifts. These sessions are led by the shift supervisor and include detailed reviews of plant procedures, including operating manuals and operating instructions. The process is very straightforward. Lists of documents to review is periodically prepared via the Integrated Operation Management System (IFBS) and sent to the shifts. The shift supervisor and available crewmembers conduct the reviews. The process has been in place since 1994, and records have been kept of all documents reviewed to date.

Both programs are well received by the shift organization, and supplement the normal simulator based continuing training program. For example, of 22 hours of continuing training received by the licensed staff in1999, 7 hours were accomplished by the above processes.

2.6. CHEMISTRY AND RADIATION PROTECTION PERSONNEL

2.6(1) Issue: The continuing training for Radiation Protection (RP) staff is not adequately planned, implemented or documented. The team noted that the amount of continuing training for RP staff is much lower than current industry practice. The maximum time allocated for basic component training is only 2 days per person every 2 years. Although there is some additional job related specific training at the plant and with external vendors, it is mostly informal with no assessment criteria and not well documented. There are also inconsistencies in which the continuing training records of the staff have been maintained. Inadequate continuing training for RP staff may result in insufficient knowledge and abilities necessary to fulfill their nuclear safety related responsibilities.

Recommendation: The plant should enhance the continuing training program for its RP staff to ensure that they maintain their knowledge, skills and ability. One option would be to review the RP continuing training in similar nuclear plants that have a good systematic performance based approach.

Plant Response/Action:

The team's recommendation was analyzed within the context of all Training and Qualification (TQ) findings and prompted us to incorporate all training activities for specialists such as Radiation Protection (RP) and Chemistry (CH) staff into the general TQ process of the plant (see Plant Response 2.1 (2)).

Recognized KKM radiation protection staff takes on several functions in KKM (e.g. operative radiation protection, measuring technique, transport etc.) within radiation protection and thus receives continuing training accordingly. The intervals of the refresher training courses were reduced from every two years to once a year.

The criteria for the basic and continuing training for radiation protection staff are laid down in the HSK directive HSK-R-37. A large part of the training in radiation protection takes place at the School for Radiation Protection of the Paul Scherrer Institute PSI). This training institute is financially supported by the Swiss nuclear power plants, so that this school can provide specific radiation protection training anytime and even for a small number of trainees. Those responsible for training at the various Swiss nuclear power plants have a say in the program for continuing education of the School for Radiation Protection and can have it adapted to current situations or to lack of training in specific fields, that has been recognized.

In addition, the members of the section Radiation Protection take part in various national and international specialists’ meetings and seminars (Fachverband für Strahlenschutz, VGB, HSK, SVA, TÜV etc.) and are active in various bodies and working parties (VGB, Fachverband für Strahlenschutz, GSKL, Expertengruppe für Dosimetrie etc.).

Depending on their function, the employees in KKM participate in internal training courses, such as emergency training, knowledge of the plan, staff management, project management etc.

In total, every radiation protection staff receives 1 to 2 weeks of specific basic and continuing training.

Plant specific RP training at KKM is conducted on a multidisciplinary basis in close cooperation with maintenance personnel and includes use of mock-ups when applicable.

Individuals designated for managing RP training keep the database updated and maintain a complete documentation of training performed.

With the measures taken training of RP staff should be adequate to ensure that they possess necessary knowledge and abilities to fulfill their nuclear safety related responsibilities.

IAEA Comments:

The Paul Scherrer Institute (PSI), has the mandate, according to Swiss authorities, to qualify and certify all persons working with Radiation Protection. The team reviewed some of the offered courses and some of the qualification programs and the conclusion is that they are side by side with the best qualification programs in the nuclear industry and IAEA safety standards.

The requalification of the RP personnel is done every year, at PSI, with a minimum of four days of retraining. On the job training is applied and recorded adequately by the RP department. A sample of such in house training records was reviewed and confirmed that the RP portion of the new data bank on training records is complete.

Conclusion: Issue resolved

2.8. GENERAL EMPLOYEE TRAINING AND FOLLOW UP INTRODUCTORY TRAINING

2.8(1) **Issue:** The General and Introductory Training of new employees is not sufficiently adequate in the areas of industrial safety (IS) and radiation protection (RP).
The team noted that the RP and IS training content was limited in both depth and quantity. For example, the introduction program's module on IS is less then ½ day in length and consists of a multiple choice test that has only six questions, with 3 answer choices for each. The team also noted that there was no testing of the employee's post- training knowledge or performance following the RP modules.

The team observed several examples of poor industrial safety and radiation protection behavior at the plant. The current IS and RP of the basic and introductory training programs may not provide adequate training to ensure employees maintain safe work practices.

Recommendation: The plant should improve the IS and RP components of the basic and introductory employee training programs. It is also suggested that follow up action include both written and performance assessment.

Plant Response/Action:

The general and introductory training of new plant staff has been revised. The individual training program is agreed between the new employee and his supervisor.

As a first step every new person working in the plant is required to pass the enhanced basic RP and IS introductory training. This enhancement was carried out on the basis of the team's recommendation.
Furthermore we are in the process of defining additional possibilities of enhancement, which will lead to a new introductory training using audiovisual methods and assessment testing. This new introduction will be operational at the end of March 2003.

The in-depth and quantitative extension of basic and introductory training and performance assessment will minimize occurrences such as those observed by the team and help to implement safe work practices to be used by all employees.

IAEA Comments:

The General and Introductory Training Program was completely revised and now has two weeks of classroom training. The time dedicated to Radiation Protection and Industrial Safety training was considerably increased and specific tests are now applied. The test contents were revised and a post-training test on Radiation Protection was also implemented.

The actual Performance Indicators on collective dose rate and Industrial Safety accident rate demonstrate a declining tendency, which is a signal of the enhancement of these processes at Mühleberg NPP.

Conclusion: Issue resolved

2.8(a) Good Practice: The Plant has used an effective process to develop and implement a new Web Based Training (WBT) Package for its Quality Management Program. The project team obtained senior management support for the initiative and then involved plant staff in the selection of the topics and in the development of the contents. This development technique significantly strengthened the outcome of the training package. The plant also took advantage of lessons learned from previous WBT projects and produced a training package that provides good training for the subject. The training has been very well received by those who have taken it. Of particular note is the integration of plant staff in the supporting photos and the use of a practical example of a pump replacement to illustrate the Quality Management process. The result is a package that the plant can be proud of, and a process that will serve it well as the basis for future WBT modules.

3. OPERATIONS

3.1. ORGANIZATION AND FUNCTIONS

The operations department is well organized with clear responsibilities stated in plant documentation. It comprises the following two sections, plant operations and training, and six specialist groups, which include computer applications and statistics.

Operations managers have a daily presence in activities that affect operations. This includes the coordination of the plant morning meeting, visiting the control room and touring the plant. They are very knowledgeable, some of them being at the plant since the commissioning 28 years ago. The plant manager was also noted to frequently visit the control room.

Pikett Engineers are senior operations engineers, including the operations department head, with extensive training and experience. At least one is present in the plant 24 hours a day, including outage periods and is responsible for handling abnormal situations or emergencies. The shift supervisor reports to the Pikett engineer. Pickett engineers are required to perform systematic field inspections every weekend. Shift supervisors were noted to be professional and to be in control of the plant activities.

Plant expectations and goals are broken down into operations department goals. From these goals the operations department derived objectives and activities down to the shift and field operator positions. In the last two years several goals and improvements were noted to be effectively implemented. Examples of goals important to improve safety are the STAR (Stop, Think, Act, Review) philosophy, the dose reduction program and the checklists for system line-ups.

During normal plant operation the organization is clearly operations orientated with all other departments supporting operations. The quality management process clearly states a focus on operations. During outages the nuclear department takes the lead for plant activity. The team noted that there is a strong sense of teamwork in the plant and the interfaces between departments and working groups are very professional.

Operations personnel were found well qualified and experienced. The level of education required to qualify as an operator is above industry average. The operations department has a good staff replacement program. It includes conservative overlaps between people and includes all necessary training and experience. The training time can vary up to 8 years, e.g., Pikett engineers.

The team noted that there is no structured up-date training program in place for shift personal returning on shift after absence for less than six weeks. For a longer period of absence the plant operations section head prepares an individual up-date training program. The operations department should consider formalizing this up-date training. In addition, the department only applies this training if the period of absence from the department is greater than six weeks. The plant should consider reducing this time.

The shift staffing is sufficient for normal operations and events within the design basis including initial fire fighting activities. However, if procedures for beyond design basis accident need to be performed, the shift is expected to be supported by operations personnel who respond to the emergency call up.

The team noted that the shift schedule includes 13 days of work in a row, and 12.5 hours on Sundays. However, the plant has had studies to ensure that there is no adverse impact on personnel performance. The studies were approved by an advisory group composed of work psychologist, doctors and representatives of the Mühleberg shift personal.

3.2. OPERATIONS FACILITIES AND OPERATOR AIDS

All operating instructions are placed in the field close to the relevant component as well as in the main control room and the full scope simulator room. These instructions are listed and checked periodically. The instruction in the field help operators to get prompt information on the component during field tours and maneuvers. However, due to the quantity of field instructions the team noted that a well-developed program to control revisions should be in place.

Although the plant was noted to have excellent equipment labeling, some unauthorized handwritten information was observed on equipment in the field. The plant should consider identifying and eliminating unauthorized operator aids.

Sufficient alternative communication systems are in place for normal operations and emergency situations. They are clearly understood by the users.

Many panel red lamps in the main control room (MCR) are not fully illuminated to clearly indicate component status. The team recommended that the plant should review the deficient component status indication lamps in the MCR and take appropriate action to ensure that the component status is clearly indicated.

The number of lit alarms in the main control room (MCR) are nearly zero. Alarms that are lit are well known, controlled and relate to tests and work in progress. Mühleberg NPP has been successful in its principles to have no lit MCR alarms.

The Process Visualization System (PVS) system, comprising the PVS, Safety Parameter Display System (SPDS) and the Trend View System is visually clear, sophisticated and enables shift personnel to observe plant status and see trends or parameters easily. This was recognized by the team as a good practice.

Equipment and procedures to support normal and emergency activities are well maintained. Operations records are securely stored and equipment isolations are clearly identified. The plant cleanliness and housekeeping is generally good.

3.3. OPERATING RULES AND PROCEDURES

Operating Limits and Conditions (OLC) are clearly indicated in the Technical Specifications. The shift supervisor is responsible for maintaining a controlled list of current OLC’s in the plant. Surveillance procedures are generally of good quality. However, the team noted one instance where the acceptance criteria for startup time of a diesel generator was missing. The operators performing the test knew the value. The lack of such important information may lead operators to inappropriately declare a system operable. Such deficiencies should be resolved.

The operations department has a well-controlled surveillance program established through the Integrated Operation Management System (IBFS). See good practice in the section 3.6 of this report.

Temporary changes in operating procedures are regulated by the procedures B-Anweisung and Schichtanweisung. The procedures are clear, and the changes made are well indicated in the IBFS system.

The quality of the information contained in the operating procedures is good and the operations staffs were very knowledgeable in their use. However, the procedures also include system descriptions, which makes them more extensive than needed to perform plant operations. In addition, this could make the review and revision of these procedures difficult. Operating documents are generally well maintained and stored in a good manner. Nevertheless, some improper control of operation documentation and practices to correct information were observed. The team suggested that consideration should be given to review and revise plant policies on controlling and correcting information on operations documentation.

The operating procedures are not routinely reviewed to ensure that they contain technically correct information. The operations department reviews a procedure only when a revision is made. The plant may consider reviewing this policy.

Emergency and abnormal operating procedures and alarm procedures are readily available to the operating staff. They are of good quality. The set of emergency procedures is a combination of a symptom-based procedures followed by event oriented procedures. During the implementation of the event-based procedure the safety functions are periodically verified and as necessary, the operator returns to the symptom based procedure. The PVS system is a good additional aid for the control room staff in emergency situations.

3.4. OPERATING HISTORY

The plant has no clear criteria to report low-level events. The number of these reports has been low. In addition, the team could not find enough evidence that root causes dealing with human factors have been systematically analyzed. See recommendations on these topics in the management, organization and administration section of this report.

3.5. CONDUCT OF OPERATIONS

The main control room atmosphere was found to be very professional and the arrangements of panels and workstations permit the development of a good team environment.

During the OSART review the team witnessed a planned power reduction of 50% to perform tests and maintenance work. The coordination between departments was excellent. Shift supervisors clearly maintained control of the work being performed and groups involved. The STAR concept was observed to be used by operators when performing their tasks. Procedures were followed, communications were good and actions in the field were well coordinated.

There was clear indication of good teamwork and respect for the operations crew. A few unexpected problems arose but were resolved or addressed promptly.

Operations department personnel normally perform actions on valves. In some cases the shift supervisor can allow people from other departments to perform specific and small maneuvers. However, when performing such maneuvers shift personnel are not always immediately informed and this may lead to operations not be totally aware of system status. The operations department may consider minimizing maneuvers by other than operations personnel.

Interlocks provided for the command switches and buttons on some of the plant main control panels are not being adequately used by operations personnel. Although the team observed that a well-established STAR program was in use, it suggested that operations adequately use these interlocks for their intended purpose.

Operators use some log sheets to record the reading of instruments during field tours and in the MCR, but the sheets contain no information about the normal range of the readings. The team suggested that consideration should be given to improve the log sheets and include normal ranges of readings to minimize operator reliance on memory for important plant parameters.

Shift turnover briefings observed by the team were noted to be good. Although the communication seemed to be effective, improvements may be obtained if the shift supervisors walk down control panels together. The entering shift supervisor conducts an excellent briefing to the new crew. There is good cooperation between the operations and nuclear department. A reactor engineer frequently updates the control room staff on the status of the reactor core.

The team noted that plant material conditions, cleanliness and housekeeping were good. See good practice in the Mechanical maintenance part of this report.

Investigations following a reactor trip verified adequate system reliability for restart. Plant restart is directed by plant procedure and has to be submitted to and approved by the regulatory authority prior to reaching 5% power. Following a plant outage the regulatory authority conducts a plant inspection and reviews records of safety activities carried out during the outage prior to authorizing plant start up.

3.6. WORK AUTHORIZATIONS

Work procedures have clearly defined responsibilities and authorities and the entire work process is supported by the IBFS. The post maintenance testing for components and system restoration to service is well documented, however, there is no clear guidance from management on the scope of the testing. The team was informed that in most cases the shift supervisor uses the operations checklists for surveillance testing.

IBFS provides an accurate overview of the current status of work and tagging in the plant. It is an excellent tool used by operations to plan and process all deficiency reports work-orders, related work-sheets, and manage the periodic-work order system (WKAU). IBFS annually processes 16, 000 tasks in operations for tagging equipment and returning equipment to service. The system has 1600 accurate standard tagging lists available. IBFS is also the basis for the plant daily meetings and after the meeting the agreed program is made available to all IBFS users. This was recognized by the team as a good practice.

Work authorization is done taking into consideration the results of a specific probabilistic risk assessment developed for the plant. This is done through the application of the limiting conditions for operations of the Technical Specifications and specific checklists.

The control of permanent plant modifications is well developed and implemented by specific plant procedures. However, some temporary modifications were found in the plant that were not documented or adequately installed. See recommendation in the Electrical maintenance part of this report.

3.7. FIRE PROTECTION PROGRAMME

Fire protection at the plant is generally strong. The onsite fire response teams appear to be well trained and well organized. Fire detection systems are provided in appropriate areas. Some automatic suppression systems are available, for example in the diesel area and electronic cabinet rooms. Other areas of the plant are provided with hose stations and portable extinguishers. The team had some concern with fire loading and uncontrolled open oil containers. See recommendation in the management, organization and administration section of the report.

Fire protection activities between the plant and the professional fire brigade in Bern are well coordinated. Fire plans exist which identify routes, hazards and fire loading. Periodic training is held for members of the fire fighting teams. This training also includes precautions for fighting a fire in a radiological area. Radiation protection professionals are also assigned to the fire fighting team to assist in monitoring radiological hazards.

3.8. ACCIDENT MANAGEMENT

The plant has developed accident management measures such as alternative core cooling and flooding of the reactor. The responsibility for making decisions on taking accident management measures is clearly defined to the Emergency Staff. Operation personnel perform activities to implement the decisions made by Emergency Staff. They have received sufficient training in both theory and practical applications.

The SUSAN building which provides independent shutdown and residual heat removal systems is well equipped for safe shutdown in case he main control room is not available. It is well designed to protect against external events such as flooding, airplane crashes and lightning.

The plant has a well-developed Probabilistic Safety Assessment (PSA). A shutdown state PSA for internal and external events has been conducted. Insights from the PSA are incorporated into the Technical Specifications and compliance with these will mitigate the occurrence of a severe accident.

STATUS AT FOLLOW-UP VISIT

The plant has responded effectively to the recommendation and suggestions offered by the team in the original mission. The recommendation and two suggestions were found to be resolved. One suggestion was found to have satisfactory progress to date. Willingness to improve in this area is evident and should assist resolving the remaining part of the issue.

The panel dim red lamps issue was properly addressed by the plant and, as a result, a plant modification application to replace them was issued. Discussions with operating personnel indicated a positive improvement in being able to better see the lamps and the new lamps generate less heat than the old ones.

The plant modification evaluation went beyond the recommendation: the green lamps in the MCR as well as other similar lamps in the plant (including the simulator) were also verified to ensure that component status were clearly indicated. As a result, all the red and green lamps in the MCR were replaced by a new model. The remaining component status indication lamps were found to be adequate. The plant modification application documentation was already closed by the time of the follow-up visit.

The issue on control of operations information and practices was also properly addressed by the plant and, by the time of the follow-up visit, the plant Operations rules for verifying current document revision status and for revising documents were already in place in the procedures SA-AB-00/9 and SA-AB-97/8, respectively. Periodic review of Operations procedures as well as a periodic inventory of checklists and field procedures available for Operations personnel use were recently implemented. The plant took advantage of the already existing IBFS (Integrated Operation Management System) to implement proper programs controls. Although now procedures and adequate training have been implemented, there will be a need to ensure that these actions result in the high expectations and standards within the operations department.

The plant has performed a thorough functional evaluation on all key operated command switches and decided to keep 19 out of 212. The procedure SA-AB-99/1 was updated to include the list of all command switches and to indicate those, which will have the key in. The procedure also requires a weekly inspection on the command switches. A training program for operators was established and is still on going. The team concluded that the actions taken to address this issue were thorough, deliberate and involved all necessary input from the operations personnel.

The issue on operators log sheet was properly addressed by the plant, and, by the time of the mission, all log sheets used for recording instrument readings during field and MCR tours were revised. Wherever applicable normal ranges of system readings were included. Feedback from operations personnel indicated a positive improvement in this area. Requirements for periodic review of the log sheets were properly added to the procedure SA-AB-97/8 and a program was established.

DETAILED OPERATIONS FINDINGS

3.2. OPERATIONS FACILITIES AND OPERATOR AIDS

3.2(1) **Issue:** Many panel red lamps, which show component status in the main control room (MCR) are not fully illuminated to clearly indicate the component status. Operators confirmed that sometimes they had difficulty immediately identifying equipment status and in some cases relied on alarms associated with the change of the equipment status. Operators need to shadow the room light (e.g.: hold paper over lamp) in order to see some of these component status lamps. Dim component status lamps could prevent operators from immediately identifying safety parameters, particularly when they are under stress during abnormal or emergency situations.

Recommendation: The plant should review the deficient component status indication lamps in the MCR and take appropriate action to ensure that component status is clearly indicated.

Plant Response/Action:

The recommendation was analyzed and a plant modification application (AÄA-B-01/5) was issued.

At the modification review meeting it was unanimously agreed that the red and also the green status lamps be replaced by LED Single T.5.5 ones as soon as possible.

Timely replacement was carried out and completion is documented in Internal Report IM-SS-01/3 dated August 7th 2001.

The newly installed lamps enable clear status reading even under strong ambient lighting conditions.

The team's recommendation motivated KKM staff to check the situation with other similar lamps in the plant. They were found to be in a satisfactory condition.

IAEA Comments:

The plant has evaluated the recommendation and, as a conclusion, has issued a plant modification application to replace the deficient component status indication lamps in the MCR. The evaluation went beyond the recommendation: the green lamps in the MCR as well as other similar lamps in the plant (including the simulator) were also verified to ensure that component statuses were clearly indicated. As a result, all the red and green lamps in the MCR were replaced by a new model. The remaining component status indication lamps were found to be adequate.

The plant modification application documentation was closed by the Internal Report IM-SS-01/3, issued on August 7th, 2001. The warehouse spare parts inventory was updated to reflect this plant modification.

The team concluded that the plant did a very thorough job analyzing the issue and recommendation.

Conclusion: Issue resolved

3.2(a) Good practice: The PVS (Process Visualization System) is a visually sophisticated computer system, which enables shift personnel to follow plant status easily. The PVS consists of 3 parts: PVS, SPDS (Safety Parameter Display System) and Trend View System. The quality of the displays as well as the human factors input from operations make this system unique. Visualization is on large screens situated above the relevant control panels in the control room providing an overview of status and important data without having to look at individual instruments. There are three of these screens, which are of LCD technology and 100 x 75 cm in size. PVS has today access to 2700 process data points, which can be presented digitally or trended. Many images can be displayed simultaneously as thumbnails. The system is also very helpful in providing an overview of normal, abnormal and emergency conditions.

SPDS provides presentation of important operational data for operational and abnormal conditions. The Trend View System can present trends of up to 24 hours of all of the 2700 process data points. The SPDS is also provided in real time display in both the plant specific simulator and the SUSAN building control room.

Operations personnel, including shift staff actively participated in the design of these systems. This resulted in greater acceptance of the system by the shift personnel. In addition, the quality of the drawings and presentation of charts and values is excellent and easy to understand. These systems are also easy to operate.

3.3. OPERATING RULES AND PROCEDURES

3.3(1) Issue: Improper control of operations system information and improper practices to correct this information were observed during the review. The following are examples of improper control of documents:

— different revisions of operating document “BV-AB-20.1” were noted in the MCR and the full scope simulator room. This practice could cause an operator error or a loss of correct information which might be useful for improving plant safety;

2 checklists (M5, E15) were placed in the back-up emergency core cooling “SUSAN” control room. They were the latest version but should have not been there because the official checklists are stored only in the MCR. The checklists are voluntarily used for daily operators rounds as guidance.

The following are examples of improper correction of information:

— in the operating document “BV-AB-96/196/296”, a yellow sticker was applied which pointed out mistakes;
— in the operating document “BV-AB-68.1”, opaque correcting fluid was used to correct information errors.

Without proper control and correction to system information, less than adequate understanding of the system and wrong equipment operation may be performed.

Suggestion: Consideration should be given to review and revise plant policies on controlling and correcting information on operations documentation. Deficiencies in this area should be identified and corrected.

Plant Response/Action:

The process of verifying current document revision status is described in shift procedure SA-AB-00/9 and the procedure of exchanging revised documents is described in chapter 5 of Shift Procedure SA-AB-97/8.

The persons responsible for correct document revision verification and exchanging of documents have received refresher training on this subject. Shift Supervisors have been instructed to ensure that shift procedure SA-AB-97/8 is applied strictly and not to tolerate any uncontrolled storage of checklists etc. in localities as found in SUSAN control room during the OSART review.

The only location where checklists are permitted to be stored is the main control room store. Shift Supervisors have been retrained on handling of incorrect documents in accordance with this shift procedure. The improperly corrected operations documents BV-AB-96/196/296 and BV-AB-68.1 have been revised in the correct manner.

A review of shift procedure SA-AB-97/8 indicated that no rules existed for periodic review of the contents of operations procedures and technical correctness of field procedures. The shift procedure was revised accordingly and periodic reviews are now required. Operations procedures are now reviewed annually by the author of the document and field procedures every second year by operators in the course of the late shift trainings.

Measures taken have contributed to a greatly improved operator familiarity with the contents of the documents. The measures also ensure that documents are kept strictly up to date.

IAEA Comments:

The issue was properly analyzed by the plant and, by the time of the follow-up visit, the plant Operations rules for verifying current document revision status and for revising documents were already in place and properly documented in procedures SA-AB-00/9 and SA-AB-97/8, respectively.

The plant has taken actions in two areas in order to address the team suggestion: the procedures were evaluated and training was provided to all personnel involved in those activities.

The evaluation indicated the need of a periodic review of Operations procedures as well as a periodic inventory of checklists and field procedures available for Operations personnel use. Both procedures were recently updated to establish these programs.

The plant took advantage of the already existing IBFS (Integrated Operation Management System) to implement proper program controls.

The new procedures and corresponding IBFS programs were presented to Operations personnel throughout training sessions. Further enhancements will be trained accordingly.

The team concludes that the actions taken were good. Implementation of the actions taken to resolve this issue should be tracked further to ensure that management expectations are met.

Conclusion: Satisfactory progress to date

3.5. CONDUCT OF OPERATIONS

3.5(1) Issue: Interlocks provided for the command switches and buttons on some of the plant main control panels are not being adequately used by operations personnel.

No clear plant expectation is in place for use of equipment operating buttons in conjunction with general interlock button. This interlock is intended to create additional defense in depth against human errors. Plant staff does not always consider this interlock and in some cases operators act in a manner contrary to the intention of the design; first they press the general interlock button and then the equipment specific button.

Current practice has keys left in the command switches. The preferred approach would be to insert the keys in the command switches only when the operation needs to be performed. That way, the operator is reminded to confirm the need of that operation.

The team noted switch keys in place on the SUSAN panel, in the main control room (MCR) close to the control rod panel, e.g. to reset isolation of the main steam isolation valves (MSIV), reactor scram, on the local panel of the emergency diesel system 90 and on the local panel for a partial scram.

Although it was observed that a well implemented STAR (Stop, Think, Act, Review) method by the operations staff could compensate for not using the above interlocks correctly, the team noted that the plant is losing opportunities to minimize human errors which may lead to inadvertently operating wrong systems or components.

Suggestion: Consideration should be given to implement the use of the interlocks provided for command switches and buttons in the plant panels.

Plant Response/Action:

The team's suggestion to change the manipulation sequence of the control buttons initiated a closer detailed analysis of the situation within Operations.

The sequence used successfully at KKM for a long time was analyzed in depth and discussed with all of the operators during simulator retraining 1/01, (22^{nd} January to 2^{nd} March 2001). Operators participating in the training agreed that selecting the "release" as the initial step has more advantages.
This procedure is trained regularly on the simulator and is performed according to the KKM successfully used STAR principle.

The team observed that a number of switch keys are in place on the SUSAN control panel, in the main control room (MCR) and in other locations.

The suggestion was taken up and a review of the key switch policy was carried out and an analysis performed for each key switch. The number of keys was reduced to a minimum. The keys still in place are only for those switches where a quick reaction is of vital importance for safe operation. If a key has been removed a quick reaction is no longer assured, because the operator must first retrieve the key from a locked key box. During this period of time the operator will inevitably loose invaluable time required for supervision of the plant in a critical state. The fact that a switch is equipped with a key is also a reminder to the operator that he is confronted with an unordinary plant situation. Before manipulation of the key the operator is also reminded of the STAR principle.

Key locks are also used for tagging purposes during refueling outages thus providing an additional safety measure.

Shift procedure SA-AB-99/1 has been revised to include a list of all of the switches equipped with keys. For each key left in place a reason is given from the results of the analysis made.

IAEA Comments:

The team concluded that the actions taken in regard to analyzing the sequence for interlock button operation were adequate.

The plant has performed a thorough functional evaluation on all key operated command switches and decided to keep 19 out of 212. The procedure SA-AB-99/1 was updated to include the list of all command switches and to indicate those, which will have the key in. The procedure also requires a weekly inspection on the command switches.

Again, the plant took advantage of the already existing IBFS (Integrated Operation Management System) to implement proper program controls. A training program for operators was established and is still on going. The team concluded that the actions taken to address this issue were thorough, deliberate and involved all necessary input from the operations personnel.

Conclusion: Issue resolved

3.5(2) Issue: Operator log sheets used to record instrument readings during field tours and in the MCR, they do not contain information on the normal range of the readings. Without this information operators may miss the opportunity to immediately identify an abnormality or undesired trend in a plant parameter.

Suggestion: Consideration should be given to improve the log sheets operators use to record plant parameters during field tours and in the MCR. This should include the normal ranges of system readings, which will minimize reliance on memory for important plant parameters.

Plant Response/Action:

All the operator log sheets used for recording instrument readings during field and MCR tours have been reviewed and the normal range of system readings have been added as applicable.

Operator response to this improvement for taking readings in the field has been very positive as the additional information available minimizes reliance on memory and effectively reduces sources of error.

Operating personnel have been instructed and encouraged to use a questioning attitude in the field and make proposals for improvements according to shift procedure SA-AB-97/8.

Additionally a review of shift procedure SA-AB-97/8 indicated that no requirement existed for periodic reviews of log sheets used for recording plant parameters in the field and in the MCR. The shift procedure was revised accordingly and periodic reviews of log sheets are now required annually.

IAEA Comments:

The issue was properly addressed by the plant, and, by the time of the mission, all the log sheets used for recording instrument readings during field and MCR tours were revised. Wherever applicable, normal ranges of system readings were included. Feedback from operations personnel indicated a positive improvement in this area.

In addition, requirements for periodic review of the log sheets were properly added to the procedure SA-AB-97/8 and a program was established.

Again, the plant took advantage of the already existing IBFS (Integrated Operation Management System) to implement proper program control.

Conclusion: Issue resolved

3.6. WORK AUTHORIZATIONS

3.6(a) Good practice: The IBFS (Integrated Operation Management System) is an excellent tool for planning and processing all deficiency reports, work-orders and related work sheets and managing the Periodic Work-order-System (WKAU). IBFS annually processes 16 000 periodic work orders. The system has 1600 accurate Standard Tagging lists available. IBFS provides the basis for the plant daily meetings and is distributed electronically throughout the plant. This includes access to the information through computer terminals in the controlled area.

Standard tagging lists are available in the IBFS system for all important systems and components. These lists have been verified by a formal quality control process ensuring that correct tagging is carried out. All components within the tagging boundary are linked to the tagging list, making selection of the correct list easy. Human errors are also reduced. All of these prepared tagging lists are quality assured with sufficient rechecking. A good example of the benefits of this standard tagging is the provision of efficient and safe tagging for outages with little requirements.

The WKAU is an excellent tool for managing periodically required activities and for distributing the workload uniformly. By using the standardized task plans, workers are not required to prepare new plans each time the task is performed. Examples of this application are:

— programming of all periodic checks required by the Technical Specification;
— programming of all other periodic activities required for operation of the plant;
— programming of periodic administrative and statistical tasks.

with an excellent search program providing a reliable overview of work-orders and their processing status. In addition, history of defects and maintenance are promptly available. This system has been used in the plant to better prepare the work to be performed and make available maintenance experience feedback.

4. MECHANICAL MAINTENANCE AND ENGINEERING

4.1. ORGANIZATION AND FUNCTIONS

Maintenance and engineering at KKM is divided into two processes; mechanical maintenance and electrical maintenance. Each process consists of several departments and sections. Interfaces and interactions between the two processes in maintenance and other plant organizations work very well. Processes used between the involved groups are very focused on identifying and solving problems. Work activities are well coordinated and ample support is provided within each maintenance section. Coordination is done in the morning meeting and through the integrated operation management system (IBFS).

Mechanical maintenance and engineering (MME) activities at KKM are divided between two departments. Mechanical maintenance is defined as a process in a matrix organization consisting of different sections in the two departments. The process leader is the manager of the nuclear department. Responsibilities and authorities are clearly defined and understood. The maintenance organizations at KKM work well together and to a common goal. Adequate recourses are provided for maintenance activities. Nuclear safety and maintenance policies have been clearly defined in the process of mechanical maintenance.

In the mechanical maintenance and engineering departments there is a strong commitment to safety culture. The team noted on numerous occasions that plant maintenance personnel and management had a strong focus to safety. Supervisors were observed to correct maintenance personnel when procedures or policies were not being followed. Supervisors were also observed following the work in progress and managers were often observed making regular tours in the plant. The outage manager and the plant manager tour the plant at least once per day during outages. The team noted that the mechanical maintenance department focused on keeping the plant equipment in good condition.

MM&E is adequately staffed with well-qualified personnel during both normal operations and outages. In MM&E there is almost no backlog of work. MM&E duties are carried out in a timely manner and with limited overtime. During an outage, maintenance personnel keep good control of work being performed by contractors. Personnel belonging to mechanical maintenance and engineering supervise the contractors. The only visible difference in organizational structure during outages is that the outage manager, instead of the operations manager, chairs the daily meeting. To support operations each section in the KKM organization visits the main control room every morning between 0700 – 0800 and also checks the IBFS system, before the morning meeting, for any new malfunctions that occurred during the previous shift.

KKM has a small and effective maintenance organization staffed to take care of all work performed during normal operations and to lead contractors during outages. The team noted that both KKM and contractor experience level was high. Personnel performing work demonstrated a high level of proficiency. It was also noted that KKM takes full advantage of on-the-job training during maintenance activities. Both contractors and maintenance workers from KKM are knowledgeable about current work practices and procedures.

4.2. MAINTENANCE FACILITIES AND EQUIPMENT

Maintenance facilities and equipment are very good in size and condition and thus promote safe and efficient completion of work. Workshops are very well organized, clean and tidy and have adequate space for the preparation and performance of work. Well-developed training facilities and mock-ups are available for major activities and training is performed just prior to work. Many tools, spare-parts, material, and equipment needed for outage work is stored throughout the plant. However, the plant has not fully implemented adequate control of this material. The team recommended that the plant should complete implementation for establishing adequate controls over equipment and material stored inside the plant. The team recommended that the plant should complete implementation for establishing adequate controls over equipment and materials stored inside the plant.

Maintenance equipment is segregated to prevent use of unserviceable equipment. Measuring and test equipment was found to be calibrated and controlled to ensure accuracy and traceability. Consumable supplies are adequate and available when needed. Tools, spare-parts and equipment are readily accessed and very well maintained although more attention should be paid to lifting slings, eyebolts and shackles. The team suggested that consideration should be given to enhance the policy of testing and inspecting lifting devices.

Decontamination facilities and additional workshops in the controlled area (RCA) were added to the plant 5 years ago. This has helped facilitate maintenance work and to minimize radiation dose for workers. Procedures for controlling and using chemicals and flammables were well developed and easily accessible.

4.3. MAINTENANCE PROGRAMMES

At KKM, a correct balance of resources is assigned to each facet of the maintenance program. Well-developed programs were being implemented for in-service inspection, plant aging, predictive, preventive and corrective maintenance.

An aging management program is required at KKM. The maintenance-aging program clearly identifies all aspects of degradation processes that could affect plant safety. The team noted that the aging programs are considered to be a good practice and contributed to the excellent material condition in the plant.

4.4. PROCEDURES, RECORDS AND HISTORIES

Mechanical maintenance has developed a clear policy as to when procedures to perform work shall be used. Procedures, work instructions and their revisions are properly controlled and readily available to users.

Procedures and work instructions are periodically updated to reflect appropriate in-house and industry operating experience. The component or system supplier provides vendor specific maintenance procedures, which then are updated by plant personnel based on plant experience.

History files in MM&E are accurate and maintained up to date for equipment important to plant safety. History files are sufficiently detailed to be able to trend maintenance work on safety related equipment. MM&E history files are easily retrievable, reviewed periodically and are used in the planning and execution of corrective and preventive maintenance work.

4.5. CONDUCT OF MAINTENANCE WORK

Maintenance work is authorized either by a work order (Arbeitsschein) in the IBFS or at the morning meeting if tagging is not required. Work is conducted competently and professionally and adequate resources are available. Post maintenance and modification testing is carried out in good cooperation with the different maintenance groups and operations. Parts are tested as often as possible before components are assembled.

4.6. MATERIAL CONDITIONS

The material condition in the plant is outstanding even though its age is 28 years. This was noted by the team as a good practice. The equipment is well labeled and maintained in excellent condition. Components and systems are clean, leak-free with no visible signs of degradation. Each component is clearly and permanently labeled in a size that is easy to read. The team noted however, that the plant has not fully implemented adequate controls for all phases of operation to ensure that foreign material exclusion (FME) practices are in place. The team recommended that this be done. The team recognized that the plant operational history does not show any evidence of damage related to foreign material.

4.7. WORK CONTROL

Work planning is timely and thorough. The same work planning and control system is used during operation and outages. The procedure for malfunction notification, work order management and tagging is incorporated into the IBFS. The IBFS was also used to improve the maintenance programs. This was considered by the team to be a good practice. See section 3.6 of this report.

All work to be carried out in the plant must be reviewed by radiation protection (RP) together with the cognizant system engineer who estimates the dose to be received and determines measures to minimize dose. Radiation work permits (RWP's) are not used in maintenance activities. See the RP section of the report. However, work observed by the team in high radiation areas was very well prepared and was efficiently and professionally carried out.

4.8. SPARES PARTS AND MATERIALS

Responsibility for procurement and receipt inspection is adequately defined in procedures and well understood. Spare-parts are available to the plant when needed in an efficient way. All major components have a complete spare unit in the plant or in the storehouse. During repair work, with the plant on line or during outages, only complete components are being replaced which saves both time and radiation exposure received.

The team found many spare-parts stored in different locations within the plant in areas not marked as storage areas. The stored spare-parts were possible to track in the computer system. See recommendation in Section 4.2 of the report. Flammable and hazardous materials are generally controlled in physically separated rooms.

Special attention is given to spare parts with limited shelf lifetime and good control of these spare parts exits in the IBFS. The warehouse was in good order, clean and tidy.

Safety related mechanical spare parts and materials are traceable from supplier to installation by using the component fabrication number together with the plant 'Artikel-Nummer' in the IBFS. This system of traceability is well understood.

4.9. OUTAGE MANAGEMENT

Long term planning and scheduling provide for safe, timely and orderly work at KKM. Currently KKM plans on annual outages. Every second outage is a shorter refueling outage including where surveillance testing required by the authorities is conducted. The other refueling outage is longer due to all preventive maintenance work being conducted. A computerized scheduling system is integrated with the work order system in IBFS.

4.10. OPERATIONAL EXPERIENCE FEEDBACK (OEF) SYSTEM

Plant events are shared with the nuclear community by reporting according to HSK requirement R15. KKM participates in all relevant national and international owners groups for similar reactors, WANO, INPO, IAEA and NUMEX (Nuclear Maintenance Exchange). Personnel frequently present papers and/or participate in international meetings on nuclear power issues worldwide.

External events are reviewed and necessary corrective actions are taken. The plant has quickly responded to major nuclear events elsewhere. Some examples include the Barsebäck event in July of 1992 where clogging of the suction strainer in the ECCS systems prompted the plant to immediately start to work on increasing the strainers area from 1 m^2 to 40 m^2. New strainers were installed at KKM in 1993. The Chernobyl accident in 1986 prompted the plant to install a passive filtering system for the primary containment in case of core melt accidents. This system allows release to the atmosphere, if required, before containment pressure has increased to the maximum allowable value. See further good practice in section 1.2(a).

Plant personnel were found to demonstrate a good awareness of industry experience. Each department meets every Monday and one of the topics that the section manager shall report on is any internal or external event his or her section has had to analyze.

4.11. PLANT MODIFICATION SYSTEM

The plant modification program and procedures at KKM were found to be well understood and well coordinated. Anyone at KKM may request a plant modification. An average of 60 – 80 modifications are carried out annually. Responsibilities between maintenance and operations were clear. However, during plant tours, the team noted some examples of unapproved and uncontrolled temporary modifications to plant equipment. See examples and recommendations in section 5.11 of this report.

Technical and safety reviews are well established. Measures for categorizing the safety significance based on safety system classification are done and adequate review by the KKM safety committee (ISA) is performed.

Modifications are effectively coordinated with appropriate departments. However, the team found that the section responsible for the FSAR does not always review the modification before implementation of the work. The team noted the FSAR has only been updated twice during the last 10 years.

Testing and commissioning of modifications are of good quality and test results are documented and reviewed against established criteria. Turnover of modifications to operations is done formally. Operations are trained on new equipment before turn over and revised procedures and flow schematics etc. are controlled to be available in the main control room before plant start up. The closeout of modifications follows a well-developed plant procedure. All affected documents are checked that they have been revised and that training has been provided for maintenance and operations personnel. Review of the modification status is performed regularly and the backlog is reasonably low.

4.12. REACTOR ENGINEERING

Comprehensive core management functions exist at KKM. In-core fuel management and safety analysis are to a great extent performed by the fuel vendor. Procedures are clearly understood and technically accurate. Clear lines of responsibility are established and engineering personnel are qualified and experienced. The team noted however, that the plant had no formal failed fuel action plan established, with necessary key elements, such as action levels for fuel investigation activities, restriction of power operation etc.

The team noted that a very good fuel channel measurement program had been implemented during each refueling outage. Reactor core performance and associated safety parameters are adequately monitored and trended by reactor engineering every morning. Reporting of reactor engineering results is timely and adequately performed. Criticality tests were performed in cold shut down at the end of each fuel cycle to verify calculated values and after the refueling outage just prior to start up. This is more than most utilities do. However, the criticality tests are being performed with an open vessel since the plant only considers control rod drop accidents during start up and not during criticality tests.

To prevent a control drop accident from occurring KKM uses in core source range monitor (SRM) instruments to confirm rod withdrawal. The SRM measurement is used to verify that the strongest rod is withdrawn. The plant may consider that control rod drop accidents could occur not only during normal start-up of the plant but also during local criticality measurements.

4.13. FUEL HANDLING

Inspection, movement, storage and verification of spent and fresh fuel is well organized by the nuclear department at KKM. Leaking fuel rods are segregated and stored in an independent canister.
Adequate controls were in place for the movement of heavy loads. The plant has not fully implemented adequate controls for all phases of plant operation to ensure that foreign material exclusive (FME) practice are in place. See recommendation in Section 4.6 of the report.

STATUS AT FOLLOW-UP VISIT

The OSART follow-up team recognized that Mühleberg has made significant effort to resolve the issues in the Mechanical Maintenance and Engineering area. All the identified issues are resolved.

The plant took a deeper and more thorough study in the area of temporary storage of equipment and material in the RCA of the plant than expected by the OSART mission. This has given excellent results in storing material and equipment needed in designated locations and making them retrievable in a timely manner when needed. The removal of combustible material from process area of the plant has increased even more the safety of the plant by decreasing the potential for a fire. Removing superfluous material has improved the housekeeping, cleared the escape routes, improved the pathways for the fire-fighting brigade and improved the accessibility of fire fighting equipment particularly in the reactor building.

The improvement in housekeeping and foreign material exclusion (FME) will certainly improve the long-term availability of safety systems and components in the plant. Today, the plant appears even neater than during the original mission, which the team hopes the plant will mange to keep even in the future.

The introduction of qualified inspectors of lifting devices and an enhanced program for testing of lifting devices will decrease the risk of damage to personnel and equipment.

However not an issue in the OSART mission, the plant was asked by the original mission team to further investigate the necessity of global and local criticality measurements with the reactor vessel open.

KKM performs cold criticality tests to obtain data on the core reactivity. With a better understanding of the core performance, KKM and the fuel supplier can extend further their database used to validate their core engineering methods and can therefore more accurately and more confidently predict future core performance.

The original OSART comment caused both KKM and HSK to review the plant situation with regard to control rod drop accident (RDA) and open vessel criticality measurements in more detail. Several discussions including a formal technical discussion (Fachgespräch) was held between KKM and HSK to review the topic. The KKM checklist for future cold criticality tests will include additional measures such as extended control rod coupling checks as agreed upon.

In the technical discussions it was agreed by both KKM and HSK that the open vessel during the criticality tests is, with the additional measures, not a safety concern. The further investigation suggested by the team has led KKM to conclude that this best practice should be continued and will also be improved with the additional measures introduced.

DETAILED MECHANICAL MAINTENANCE AND ENGINEERING FINDINGS

4.2. MAINTENANCE FACILITIES AND EQUIPMENT

4.2(1) **Issue:** The plant has not fully implemented adequate controls over materials stored inside the buildings. Although seismic evaluations have been conducted, the team observed numerous areas in the reactor and turbine buildings where excess tools, materials and equipment were stored without proper identification.

The plant recently conducted a study to ensure that the seismic aspects of materials stored in its buildings were within the design envelope for the plant. The team noted that the program for reduction and identification of stored material is not yet fully implemented. The team also found material stored in some plant areas that exceeded the fire loading requirements for that area.

Inside the turbine building the team observed 31 carts for gas bottles, scaffolding, lead shielding bricks and wooden turbine shaft supports in areas not marked for storage.
Inside the reactor building the team observed the following:

- heavy shield blocks of several tons used as radiation shields and spare RWCU-pumps in an area of few square meters. There was no formal indication of an engineering analyzes performed on the load;
- reactor building – 11m elevation. Calculated fire load in the room did not reflect the report Brandschutzkonzept BSK-TD-002 but was in agreement with weekly checklist Nr. 94-3;
- a gas bottle containing nitrogen was stored at elevation +29m in the reactor building. The procedure controlling the locations of gas bottles did not identify this gas bottle.

Without adequate control of material stored inside the plant buildings there is a risk of accidental displacement of such material, which could cause a malfunction, or unavailability of an instrument or system component.

Recommendation: The plant should complete implementation for establishing adequate controls over equipment and material stored inside the plant.

Plant Response/Action:

KKM has recognized the great importance of this finding and has issued and implemented a new Mechanical Maintenance procedure VA-MI-15 "Storing of Components inside the Radiation Controlled Area" in order to improve our controls over equipment and material. Storage of components is now only permitted in a small number of allocated areas inside the plant. Each component is labeled with a special "Status Tag". These "Status Tags" are described in Operations procedure WEI-B-015. The tag provides information on component identification number, allotted storage area, functional status etc. This system provides effective controls over equipment and material stored inside the plant and is an efficient method for preventing unintentional or incorrect use.

Procedure VA-MI-15, also addresses fire risks and building loading capacity when storing heavy components.

Many components were removed from the reactor building and several previously used storage areas were closed. The remaining storage areas in the plant have been reorganized and clearly identified.

Procedure VA-MI-15 describes the registering system for the KKM main store in conjunction with use of the Status Tags and also the requirements for storage of tools and equipment in the Radiation Controlled Area (RCA).

The implementation of these improvements was consistent with those introduced by Electrical Maintenance, see Issue 5.2 (1) and allows adequate control of material inside the plant buildings and minimizes the risk of malfunction or unavailability of an instrument or system by accidental misallocation of material.

The individual observations made by the team were addressed separately.

IAEA Comments:

Inside the reactor building the team observed the implementation of the new procedures that have been enforced. Storage of components has almost entirely disappeared. The remaining few contaminated components are clearly marked and placed in a separate locked room solely used for that purpose. Separate areas have been established and clearly marked on the floor where special material can be stored. All areas inspected were empty. These areas will only be used during the outage or when temporarily needed during repair work. Gas bottles, which are not needed for the use in the process of the plant, have been removed from the reactor building. In the reactor building only very few storage areas are now present. All the equipment that was stored in many places in the reactor building has been removed and the storage areas are now completely empty. The storage area at RG elevation +21 meter is a particularly good example of outstanding work on this issue. The area is now a clean and well-organized place where special tools needed for the services during an outage are kept. In the same way, the storage areas for equipment, tools, spare parts etc observed during the OSART mission have either been organized, tagged, evaluated or completely removed. All clear plastic has been removed and replaced with the proper material. Floor coatings, which were chipped during the OSART mission, have been completely redone and look brand new.

The team also observed significant improvements in the turbine building and in the south annex building. The combustible materials has been removed from the turbine building to the south annex building which amongst other things have been designed to house combustible material. Many temporary storage areas have been reduced to a minimum or completely removed. In the south annex building the storage areas have been reorganized and superfluous material has been taken out. Subsequently, this material was either disposed of or stored in the ordinary non-radioactive storage outside the RCA. In the south annex storage rooms the components and spare parts have been evaluated, tested, put into shelves, clearly marked and entered into the IBFS system. The plant has gone further with their actions taken than expected by the follow-up OSART team, which indicated a strong commitment by the staff to exceed best international practice.

Conclusions: Issue resolved

4.2(2) Issue: There is no assurance that lifting slings, shackles and lifting eyebolts are properly inspected and tested. In addition, they are not individually identified to demonstrate their status.

The plant has a program to periodically inspect their lifting devices, but the inspection is done per building floor, and does not register the individual lifting device status. The plant expects workers to inspect lifting devices just before using them.

Lifting devices not properly inspected and tested increase the risk of personnel injury and equipment damage.

Suggestion: Consideration should be given to enhance the policy of testing and inspecting lifting devices.

Plant Response/Action:

Review of this suggestion lead to several improvements in the KKM procedures. KKM testing and inspection policy has been extended to all lifting devices.

An efficient system has been implemented which identifies the test status of all lifting devices (cables, slings, shackles and eyebolts) in easily accessible and clearly arranged permanent special storage areas in the plant. This was developed under the leadership of ISO qualified outside specialists. In the process of implementation a further benefit was that the number of items in the plant could be reduced considerably.

Individual methods used for marking and identification of these items is described in maintenance procedures AA-MU-08, AA-MU-03 and AA-MU-11.

Implementation of these procedures and training of personnel on this system was also carried out with the same outside specialist support.

Cables and slings are marked with test tags indicating when the next test is due.

Eyebolts, shackles, etc. use a color code indicating when the next test is due.

Information on selection of items (item marking) is provided by:
— information sheet placed in the storage area
— instruction of contracted personnel by KKM safety officer
— memorandum addressed to all plant personnel

Additionally, KKM personnel were informed of significant changes in procedures at the monthly personnel information events.

Introduction of all of these measures minimizes the risk of injury to personnel and damage to equipment due to lifting devices not properly inspected and tested.

IAEA Comments:

The plant has responded to the suggestion made by the OSART mission in an excellent way. During the follow up mission the team noted that all the lifting devices that were present during the OSART mission at numerous places have now been reduced to a few allocated storage locations. Excessive lifting devices have been removed. Subsequently, these devices were either disposed of or stored in the ordinary non-radioactive storage outside the RCA. In the remaining areas in the RCA the lifting devices have been organized and put in special racks. The number of lifting devices in these special locations has been significantly reduced in number and are all inspected and clearly marked when the next inspection is due. Procedures for periodical inspection of lifting devices have been revised or newly established as well as qualifying personnel to perform the inspections. All ladders observed during the follow-up visit were also inspected and marked indicating when the next inspection is due.

Conclusion: Issue resolved

4.6. MATERIAL CONDITIONS

4.6(1) Issue: The plant has not fully implemented adequate controls for all phases of plant operation to ensure that foreign material exclusion (FME) practices are in place. During plant tours and field observations of maintenance activities, the following examples were identified:

- in the reactor and turbine buildings, some tools, spare parts and equipment have clear plastic wrapped around them;
- viewing aids made of Plexiglas are currently used in the fuel pool. A best practice is to use a metal frame that can withstand outer impact in a safer way;
- the team observed work on the air compressor and found problems with FME. During the mission the plant took action to correct the observed problems;
- during plant operation there is no requirement to secure or remove loose pieces on the refueling floor close to the fuel pool such as glasses, writing instruments, finger rings, watches;
- several small items in the plant were not effetely controlled. These included an Allen wrench found close to the fuel pool, a pipe cap at the turbine oil tank, a piece of glass and a screw on the pedestal of the torus cooling pump and a lifting eyebolt and screw on a pump pedestal in the reactor building. In procedure GAFV-B Gesamtanlagefahrvorschrift chapter 6 a program exists on FME on the refueling floor during outage when the reactor pressure vessel is open and during fuel movements. The team believes this procedure should be followed during all phases of operation.

Although the plant has a long history (over 10 years) of no fuel failure, inadequate foreign material exclusion may increase the risk of fuel failures due to debris. In addition, equipment operation may be impaired.

Recommendation: The plant should fully implement FME practices during all phases of plant operations.

Plant Response/Action:

The recommendations were analyzed and improvements were implemented to cover the specific areas of concern. KKM strongly supports FME. This is an important best practice, which assures continued excellent operation.

A new Operations procedure WEI-B-025 has been implemented for formal Housekeeping in the plant.

The principle fields included are:
- assuring industrial safety
- minimizing danger of fire
- maintaining clear escape routes
- reducing radiation dose
- preventing damage to components
- excluding of foreign material
- seismic housekeeping aspects

This procedure provides guidance for tidiness and cleanliness and recommended corrective actions. Formal extensive housekeeping reviews are carried out by teams, which are composed of the different responsible technical sections. In addition the industrial safety officer and the fire brigade commander routinely inspect for situations that may impact industrial safety or fire protection. Plant management is also engaged by performing review rounds.

KKM has issued and implemented two procedures, which improve material control. Mechanical Maintenance procedure VA-MI-15 for controlled storage of contaminated components in Radiation Controlled Areas is used in combination with Operations procedure WEI-B-015 for additional status labeling of the individual components (ready for use, damaged, for repair, tested etc.) see Issue 4.2 (1).

Controls over lifting devices such as slings, shackles and eyebolts inside the plant, which are the subject of Issue 4.2 (2), were improved by implementation of new procedures.

Electrical Maintenance procedure VA-EI-08 addresses electrical components in a similar manner.

For refueling floor activities a special Operations procedure WEI-B-026 has been issued to exclude foreign material in the reactor cavity, reactor internals storage pool and in the fuel storage pool.

During refueling outages the GE procedure BN1-FME-001 "Foreign Material Exclusion in RPV" is enforced to cover refueling and maintenance activities in the reactor vessel area. This is in addition to those requirements stated in the above-mentioned procedure WEI-B-026 and enables KKM to use best practices already learned at other nuclear power plants.

Open components are the subject of mechanical maintenance procedure AA-MU-19. This procedure includes precautionary measures for avoiding the introduction of foreign material into components or piping during maintenance activities. This minimizes the possibility of foreign material introduction, which may later cause damage to equipment or fuel. Appropriate cleaning and a visual check of the interior of the component is required before final closing in order to eliminate any foreign matter or material which may have otherwise entered or been deposited.

IAEA Comments:

During the OSART follow-up visit the team toured the plant to check the implementation of the new procedures developed to enhance FME. In the reactor building on the refueling floor (+29 m) work was carried out on modifying the stand for the spent fuel transport cask. The work place was neat and tidy and loose items were neither found close to the pool nor at the working place itself. It was generally observed a significant improvement in the fuel pool area were the numerous tools present at the OSART mission now have been removed, decontaminated and placed in special storage places in racks, cabinets etc. to be used at the next outage. Viewing aids in clear plastic were not present in the pool area. Loose personal items such as glasses were all tied off. The team concluded that the new procedures issued after the OSART mission have been well established and implemented and personnel adhere to these procedures. During inspection at the follow up mission no small items were found. It was also noted that clear plastic has been completely removed and replaced by approved 'striped' plastic.

It was also generally noted that the housekeeping has been improved in an excellent way in the whole RCA.

Conclusion: Issue resolved

4.6(a) Good Practice: The material condition of the plant is outstanding even though its age is 28 years. There is long history of low maintenance backlog. The team noted that the ageing management program was thorough and well implemented. The program includes a wide range of samples taken from the civil structure to test the strength in the concrete, measuring distance between reinforcement bars and their imbedded depth in the concrete. Measuring humidity and crack growth in the concrete is continually ongoing in the plant. Measuring temperature fluctuations and stratification on vulnerable components such as feed water nozzles is ongoing. The plant has an aggressive in-service inspection of components in the plant, not only parts of the pressure boundary but also components important to safety functions of the plant. As an example a 600-mm wide and 4,8 m long hole in the outer concrete of the primary containment was drilled to be able to measure the condition of the primary containment liner. As part of the ageing program the plant was the first BWR to inspect and detect cracks in the core shroud (in 1990). The plant was also the first BWR to take a sample from the identified crack in the shroud to characterize the defect. Furthermore the plant measured neutron flux in the reactor during plant operation 1997 – 1998 in the pressure vessel and its internal parts to validate calculation in neutron flux received.

The records kept enable the plant to track the ageing process. As a result of the good ageing management, maintenance programs have been improved and many actions have been taken. Examples includes:

— reinforcements of pipe support foundations and building walls;
— reactor building external coating of reinforcement bars less deep than 18 mm;
— reactor building and main stack coating to prevent humidity in the concrete;
— replacement of stainless steel piping susceptible to IGSCC;
— injection of hydrogen to the feed water in order to mitigate consequences of IGSCC using innovative technique;
— replacement of condenser brass tubes with titanium tubes and stainless steel in the outer row;
— modification of feed water nozzle sleeves and replacement of feed water safe-ends;
— replacement of carbon steel piping systems with stainless steel throughout the plant;
— replacement of almost all electrical and I&C equipment, including cables;
— fire separation up-grades including replacement of existing cable penetrations and fire doors.

In addition to the comprehensive ageing program contributing to excellent material conditions, the team identified a long history of low backlog in maintenance, clearly labeled components, and an outstanding engagement of managers and supervisors frequently touring the plant and especially places where work was being performed.

5. ELECTRICAL MAINTENANCE AND ENGINEERING

5.1. ORGANIZATION AND FUNCTIONS

The Plant Regulation document KWR-KL-2000/12 accurately describes the plant organization and functions. Nuclear safety is clearly stated in this document. Three organizations, the mechanical department, the nuclear department and the electrical department carry out effective engineering and maintenance activities at the plant.

Maintenance activities are well coordinated in; the electrical engineering and maintenance department. Three sections; the electrical engineering (SS), the instrumentation and controls (MR) and the computer technology (IT) have a total of thirty-eight employees. Contractors are hired for outage work as needed and in accordance with plant requirements. Good interface with operations were observed.

The Quality Manual clearly describes the nine processes identified for plant operation and also lists the specific guidance procedures required to implement the processes and their interfaces. For the electrical engineering and maintenance department there are 21 procedures.

Job descriptions are well defined in the KKM personnel manual. Written responsibilities, competencies and system assignments are clearly established for all electrical engineering and maintenance (EEM) department employees.

Department goals are derived from plant goals. Specific goals are clearly established for each of the EEM department employees together with management expectations. Goals are evaluated on a yearly basis.

The requirements for initial and continuing training are well established by procedures. The workers are highly experienced and are knowledgeable about work practices and plant procedures.

5.2. MAINTENANCE FACILITIES AND EQUIPMENT

The electrical and the I&C workshops inside and outside the Radiological Controlled Area (RCA) are well arranged and allow for safe and efficient completion of the work. Tools and equipment are well maintained.

Measuring and test equipment are calibrated in the I&C laboratory according to a specific programme. Procedures are used for calibration activities and adequate stickers are placed on them to indicate the calibration status. Measuring and test equipment are controlled and, when found out of specifications are, segregated to prevent misuse.

Instruments in the I&C shop are pre-calibrated prior to installation in the field. Following installation a functional loop test is conducted in order to confirm the calibration adequacy. However, defective I&C process equipment is not adequately controlled and segregated. Uncontrolled use of defective I&C process equipment could impact the reliability and operation of safety related systems. The team recommended that the plant should establish and implement a policy to adequately segregate and control defective I&C process equipment.

Workshops with specific mock-ups are available for training on I&C and electrical practices as well as for tests following repair and/or prior to installation in the process instruments racks.

5.3. MAINTENANCE PROGRAMMES

The scope and frequency of the preventive maintenance (PM) programme is based on technical specification requirements and on the supplier's recommendations. In-house experience is used to improve the programme. Electrical and I&C PM activities are performed on 100% of the safety systems and on 60-70% of the non-safety systems related to availability. Activities on the remaining systems are carried out through corrective maintenance. The majority (90%) of the PM activities are performed during outages. The backlog is well controlled and kept at a minimum.

The maintenance history file is computer based and contains sufficient information on plant equipment. This allows for easy retrieval and is used during the planning phase of maintenance activities and for trend analysis.

The predictive maintenance programme started early in 2000. A few thermo graphic measuring activities have been conducted to date. The electrical engineering and maintenance department has successfully used a comprehensive programme for sensor dynamic calibration monitoring. This programme allows for early detection of problems based on the instruments frequency response. In some cases, instruments have been replaced based on such analysis, even though the static calibration requirements did not show any problem.

Corrective maintenance is reported through malfunction notification. The operations department is responsible for the control of open malfunction notifications. A pending items list is issued on a weekly basis.

A comprehensive aging programme was developed together with Switzerland’s other nuclear power plants. The programme has three steps. The first two, the aging mechanisms identification and the diagnosis methods were established by the Swiss Nuclear Power Plant Managers (GSKL) aging group. The third, established by each plant, defines procedures to assess components that may be subject to harsh environment. Priorities ranging from one to six were established for plant components. Presently the evaluation is done for the priorities one and two type components. See good practice in the MME section of this report.

An extensive replacement programme for the I&C equipment was developed in 1985. Up to now, almost 95 % of the process instrumentation has been replaced. This programme has improved plant reliability and has reduced the time required to carry out maintenance activities. See good practice in the MOA section of this report.

5.4. PROCEDURES, RECORDS AND HISTORIES

The electrical engineering and maintenance procedures are of good quality, written in a comprehensive way and contain adequate information. Procedures were properly used by workers during maintenance activities observed by team.

A specific procedure establishes responsibilities as well as guidelines for procedure content, format and writing. The use of the guidelines ensures completeness of all procedures including surveillance and special test preparation. Several of the procedures reviewed by the team were recently issued. Although they are of good quality, there was no specific requirement for periodic review to ensure that these procedures are effective and updated as necessary. The plant may consider establishing a policy for periodic review of safety related procedures.

Also, there is no provision for issuing and controlling temporary changes to procedures. The plant may consider establishing a policy on temporary changes to maintenance procedures.

A very comprehensive integrated database exists where sufficient, accurate and current information is available for history and trend analysis. It includes the Station Electrical Process Measuring Programme (MESP) for equipment history on calibration data, the Station Electrical Process Trending Programme (TRENDVIEW) for trend evaluation on tests results and the Station Electrical Process Sensors Dynamic Calibration Measuring Programme (SENSBASE) for trend evaluation on sensors dynamic calibration.

5.5. CONDUCT OF MAINTENANCE WORK

Maintenance activities are properly authorized, controlled and documented. They are carried out in a very professional manner in accordance to procedures and work sheets. Contractors are required to follow the same rules as plant employees.

The system owners carry out work planning which helps ensure that preparation is thorough. They are also responsible for establishing and conducting the post-maintenance tests. Calibration data and test results are inputted into a specific database upon job completion.

5.6. MATERIAL CONDITIONS

The overall material condition of the plant is very good. However, the team observed numerous equipment, tools and spare parts throughout the plant. Although some seismic evaluations have been conducted, it was not clear what the plant policy was for keeping such items in the plant. See recommendation in the MME section of this report.

Existing plant fire barrier sealant at pipe and cable penetrations are well identified. The system in place also allows quick visual identification of the penetration status based on the label color. This was identified by the team as a good practice.

5.7. WORK CONTROL

The work control system is well detailed in plant specific procedures and is controlled through the Integrated Operation Management System (IBFS). This programme is used for issuing malfunction notifications, job prioritization, issuing work orders, ALARA requirements, tagging and for system functional tests requirements after job completion. Interfaces are clearly defined through work sheets. See good practice in the OPS section of this report.

System owners' assignments to plant systems and equipment are also available in IBFS in such a way that job supervision and planning responsibilities are easily determined.

Work is initiated either by a malfunction notification or a work order. Malfunction notifications issued are discussed at the daily morning meeting where priorities are established and activity area assignments are made. Malfunction notifications are tracked by plant system on a graphic monthly report. When an abnormal number of notifications are identified, an evaluation is required to be performed by the head of the section together with the system owner.

The operations department assesses the technical specification requirements regarding equipment unavailability to establish maximum outage duration for maintenance activities.

5.8. SPARES PARTS AND MATERIALS

Spare parts and material procurement procedures clearly define responsibilities and establish comprehensive guidelines on all steps related to the procurement process. It includes checklists for purchasing specification requirements, vendor proposal requests, vendor proposal evaluations, purchasing process follow up and receipt inspection. Non-conforming or damaged spare parts are well controlled to ensure that they are not accepted. Spare parts are controlled by the IBFS computer based system and are easily identified and retrieved. Safety related spare parts are traceable from supplier to installation.

The warehouse installations are well organized and environmental conditions are adequately controlled. Parts are also stored at designated areas at the plant and identified in the warehouse computer system. For example, some electronic cards for the process instrumentation are kept energized in a spare panel in the I&C instrument racks room and some of the additional emergency core cooling “SUSAN” spare parts are stored in the SUSAN building.

The system owners are responsible for the stock levels of spare part. Based on monthly reports, the stock levels are reviewed for accuracy.

5.9. OUTAGE MANAGEMENT

The nuclear department manager is responsible for outage management. Within the EEM department, no organizational changes are made during an outage. In this way, responsibilities remain the same as for normal plant operation.

General and detailed schedules are issued by the nuclear department for each outage and systems owners plan and schedule all maintenance activities for the upcoming outage in IBFS. For some activities, specific detailed schedules are also issued. The planning is to be completed two months before the outage.

During the outage, the systems owners are responsible for the timely completion and quality of all activities carried out on their systems. This is achieved by advanced planning and the use of knowledgeable staff and experienced contractors. Specific training requirements are included in the work orders.

The operations department is responsible for maintaining the plant in a safe shutdown condition. This is carried out by assigning experienced shift supervisors to the outage organization who closely monitor system unavailability during the outage. Following each outage an outage report is issued and the lessons learned are incorporated into the planning for the next outage.

5.10. OPERATIONAL EXPERIENCE FEEDBACK (OEF) SYSTEM

The OEF procedure provides good guidance with clearly defined responsibilities for the EEM department operating experience feedback programme. The OEF programme also includes safety review committee evaluations and requirements for submittal to HSK. However, there is no evidence of the use of performance indicators.

The operations department is responsible for the initial evaluation of in-house events. After which they are assigned to a specific department. In this case, a non-conformance notification (AM) is issued. After a complete analysis, actions like design change, training or documentation update would be initiated. The same process is applied to external experience evaluation. Plant events are shared with the nuclear community through HSK.

The team determined that the number of evaluations conducted per year (about 10) is considered low when compared to international experience. See recommendation in the MOA section of this report.

5.11. PLANT MODIFICATION SYSTEM

The electrical engineering and maintenance plant modification process is well detailed in an internal procedure where a flow path is established for the entire modification process. This procedure defines clear responsibilities, assignments and specific requirements for evaluation, review, approval, planning, installation and inspections of plant modifications. A comprehensive checklist is used to follow plant modifications to completion. This checklist includes document update, training requirements and simulator upgrades. When applicable, plant modifications are tested on the simulator prior to installation in the plant. The team noted however, that several plant modifications already in place have not had the modification package closed. The plant may consider including closeout time requirements in the plant modification process.

Temporary modifications are not always adequately evaluated, approved, installed and controlled. During plant tours, some examples of inadequate temporary installations were identified. The team recommended that the plant should review their practice for temporary modifications to ensure that they are adequately evaluated, approved, installed and controlled.

5.12. SURVEILLANCE PROGRAMME

The electrical engineering and maintenance department surveillance programme is well structured and based on plant technical specification requirements. Responsibilities and interfaces are clearly described. The applicable surveillance procedures, test frequencies and the group responsible for carrying out the test are well understood by the staff.

Although the surveillance programme is controlled by the IBFS programme, the operations department is responsible for the control of test procedure due dates as required by technical specifications. Deviations outside of the surveillance acceptance criteria are reported through malfunction notifications and are promptly corrected. Deviations found outside TS limits are reported as a plant event.

Surveillance test calibration data is recorded in the MESP database for equipment history and the tests results are fed into the TRENDVIEW and SENSBASE database for trend evaluations.

STATUS AT FOLLOW-UP VISIT

The plant has responded effectively to the recommendations offered by the team in the original mission. One recommendation was found to be resolved and the other one has satisfactory progress to date. Willingness to improve in this area is evident and should assist resolving the remaining part of the issues.

The defective I&C process equipment control and segregation issue was properly addressed by the plant and, as a result, a comprehensive status labeling system was put in place.

General directives on replacement components and parts not in use and stored outside the official storage rooms were established on the plant general procedure WEI-B-015 and instructions for the use of the status labels were detailed in the area procedure VA-EI-08. Specific segregation areas were designated in the I&C shops. The use of the labels was discussed with and formally notified to all employees.

The procedure WEI-B-002 was revised to include specific requirements to track temporary installations. As a result, temporary installations are now clearly identified in the field. The control of temporary installations in the plant is done by the Operations department. Periodic reviews are conducted on a regular basis twice a year and before plant start-up after refueling shutdowns. Implementation of the actions taken to address this issue should be tracked to ensure that management expectations are met.

DETAILED ELECTRICAL MAINTENANCE AND ENGINEERING FINDINGS

5.2. MAINTENANCE FACILITIES AND EQUIPMENT

5.2(1) Issue: Defective instrumentation and control (I&C) process equipment is not adequately controlled and segregated. In the radiation controlled area (RCA) I&C shop, the team noted defective transmitters that were replaced in previous refueling outages (one in 1998 and two in 2000) together with a new transmitter that was withdrawn from the warehouse. The defective transmitters had no tags or labels indicating their status. Also, in the I&C shop there is no specific segregation area to keep instruments that are waiting for repair or calibration. In the I&C shop, outside the RCA, the team noted defective instruments and parts in a cabinet not segregated**.**

Installation of inadequate or unserviceable I&C process equipment could impact the reliability and operation of safety related systems.

Recommendation: The plant should establish and implement a policy to adequately segregate and control defective I&C process equipment.

Plant Response/Action:

KKM analyzed this issue together with issue 4.2 (1) concerning similar inadequacies in Mechanical Maintenance. KKM came to the conclusion that a new system is needed through which component status can be readily identified.

A system of Status Labels has been introduced, described in procedure WEI-B-015, for all replacement components and parts not in use and stored outside the official storage rooms. New or serviced replacement parts are handled in accordance with procedure VA-A-104.02 . If any component is found to be defect, require repair or scrapping, it will be labeled accordingly. This label may only be detached after completion of required measures. After successful testing relabeling can be carried out as necessary.

Use of these Status Labels by the Engineering Departments is described in detail in procedure VA-EI-08 and VA-MI-15.

This system ensures that electrical components and equipment can only be used for their designated purpose and that defect, repaired and tested components are clearly identified. Defect equipment is segregated and stored in special areas to prevent its use. With these measures the installation of inadequate or unserviceable I&C process equipment inspecting the reliability and operation of safety related systems is avoided.

IAEA Comments:

The issue was properly addressed by the plant and, as a result, a comprehensive status label system was placed in. General directives on replacement components and parts not in use and stored outside the official storage rooms were established on the plant general procedure WEI-B-015.

Instructions for the use of the status labels were detailed in the area procedure VA-EI-08 and specific segregation areas were designated in the I&C shops. In addition, the use of the labels was discussed with and formally notified to all employees.

Conclusion: Issue resolved

5.6. MATERIAL CONDITIONS

5.6(a) Good Practice: A simple and effective system to identify and control the status of existing plant fire barrier sealant at pipe and cable penetrations has been implemented at the plant.

The system consists of a standard red and yellow tag where data such as penetration number, building, elevation and room number are indicated. Over the yellow part of the tag, there is a removable white sticker with the same penetration data as on the yellow tag. When a penetration is released for work, the white sticker label is removed. The penetration remains identified by the red and yellow tag, indicating that it is open. The white stickers are then used on a specific control form for open penetrations. Once the job is finished and the penetration is resealed, the white strip is reapplied over the yellow tag indicating its return to normal status.

This system has several advantages such as good labeling and clear penetration status identification that permits a quick check during plant inspection and also is easy to control and maintain. The plant fire barrier sealant at pipe and cable penetrations were found to be very well maintained.

5.11. PLANT MODIFICATION SYSTEM

5.11(1) Issue: Temporary modifications to plant equipment are not adequately evaluated, approved, installed and controlled. During plant tours, the following examples of inadequate temporary modifications were identified:

— the Gammameter installed at the turbine hall for the H_2/O_2 generator system was found with insecure temporary cabling and power cable over the top rack of the system. This installation was in place according to a procedure that was found to be out of date;
— the Electrochemical Potential Measuring System installed in the reactor building, elevation + 8.0 m, was found with some temporary cabling through a wall penetration. This installation was in place according to a procedure that was found to be out of date;
— O_2 monitors installed in the Chemistry Sampling Room, were in place according to a procedure that was found out of date;
— green unsecured I&C cables with open terminals, used for feed water flow tracer method calibration, were coming from the top of the wall of the sector 2 to the area between sectors 1 and 2 in the turbine hall. The cables were marked with gray tape and handwritten ”top” and “bottom” with no further identification. This installation does not meet plant electrical standards;
— temporary instrumentation (recorders) were installed on the 380 V and on the 6 kV buses, with only yellow tags for identification;
— temporary installation to re-direct leakage on the cooling water line check valve in the intake house with no identification;
— the stack gas monitoring installation at the turbine building, at elevation – 3.0 m does not have identification and has been in place for more than three years.

The plant has guidance for issuing temporary test procedures, which allows additional monitoring to be installed. However, there is no plant guidance to ensure that all necessary steps for temporary modifications have been completed.

Inadequate evaluation, approval, installation and control of temporary modifications could affect plant configuration and could impair safe plant operation.

Recommendation: The plant should review their practice for temporary modifications to ensure that they are adequately evaluated, approved, installed and controlled.

Plant Response/Action:

KKM reviewed the current procedures for temporary installations and agrees that improvements should be made. The procedure WEI-B-002 "Operational Security Tagging" has been revised to accommodate temporary modifications and their installation.

This system has been included in an extension to the KKM IBFS system and provides a complete control of planning, application, controls as well as the period of operational validity of temporary modifications made to the plant.

Consideration and evaluation of this issue resulted in an important benefit to the plant and to introduction of a comprehensive instrument for planning and control and to improve plant safety.

IAEA Comments:

The actions taken by the plant have properly addressed the issue. The procedure WEI-B-002 was revised to include specific requirements to track temporary installations. As a result, temporary installations are now clearly identified in the field.

The control of temporary installations in the plant is done by the Operations department. Periodic reviews are conducted on a regular basis twice a year and before plant start-up after refueling shutdowns.

The team concludes that the actions taken were good. Implementation of the actions taken to resolve this issue should be tracked further to ensure that management expectations are met.

Conclusion: Satisfactory progress to date

6. RADIATION PROTECTION

6.1. ORGANIZATION AND FUNCTIONS

The plant has a separate and independent radiation protection service. The head of this section has direct access to the plant manager for issues on radiation protection. Administrative limits, such as maximum individual dose, are clearly defined and controlled. The reduction of collective dose is one of the station main goals. Other goals, sustaining the station goals, are established on an individual basis for all RP staff. There is a formal follow up of these goals, also on an individual basis. RP staff is aware of the most important goal, dose reduction, but have no clear overview of other important goals. Performance indicators are not widely used to assess the performance of the section. As a result, there is no clear and general view of the possible areas for improvement.

Responsibilities and authorities are clearly defined and understood. RP workers have the authority to stop work; this is recognized by everyone.

Attention to industrial safety could be strengthened in the RP section. Several occasions of poor industrial safety practices were observed. Also, more effort is needed to make workers understand and adhere to management expectations in details, such as the correct positioning of dosimeters.

Except for reportable events to the regulator, other events are not formally reported or investigated. In the radiation protection section, there hasn't been a report in the last two years. Investigations of events are only done in an informal way. See recommendation in the MOA part of this report. More particular, personnel contamination events are not registered or formally investigated. The team suggested that consideration should be given to register and investigate each personnel contamination event with the objective to reduce the number of these events as much as possible.

Adequate budget and resources have been attributed to the RP section and for As Low As Reasonably Achievable (ALARA) issues in general. Qualification of personnel is excellent, as required by the Swiss authorities. Initial training and qualification of RP personnel is very well organized in an external school. Most RP workers have lengthy experience in the plant and therefore have very good practical knowledge of their work. Continuing training of RP staff however could be improved. Apart from the limited arrangements with the external training organization, there is no structured approach and the documentation is only partially available. See recommendation in the TQ part of this report.

Other departments, such as operations and maintenance, have a good understanding of RP issues and a good cooperation with RP staff.

Medical surveillance of plant staff is adequately organized and controlled according to the industrial accident insurance company's requirements (SUVA).

6.2. RADIATION WORK CONTROL

No use is made of a written radiological work permit that includes protective measures to be taken on dose projections. There is only an indication on the work permit whether RP assistance is needed or not. If yes, an RP worker has to sign the work permit, but no written instructions are given. Although this is not common international practice the team found no evidence of problems resulting from this lack of formalism. The team is nevertheless concerned about some exceptions in the work permit system that allows certain work to be done without a work permit. In a number of these exceptions RP assistance could be needed and the program provides no guarantee that this will always be done. However, there is a good cooperation and understanding between maintenance and RP workers. Radiological hazardous work is generally planned in advance and the plant morning meeting makes sure that everybody knows what is going on. In general, the instructions provided to radiation workers are adequate.

All Radiation Controlled Area (RCA) entry points are adequately equipped with personnel contamination monitors and equipment contamination monitors or friskers. The entrance to contaminated areas inside the RCA is also clearly marked and adequate provisions are made to change protective clothing at these points. Some plants also provide friskers at these points to prevent spread of contamination; this is not the case at KKM. The team noted that the installation of fixed barriers to separate some contaminated areas from the rest of the RCA was a good idea.

The entrance to higher-level radiation areas is not adequately inhibited as compared to good international practice. Some areas with an ambient dose rate up to 7 mSv/h and contact dose rates of over 100 mSv/h can be entered with only a warning sign mentioning the dose rates. This could lead to people inadvertently entering and receiving a high dose. The team recommended that the station should better inhibit the entry to higher radiation areas.

The contamination control program in the RCA and the contamination controls at the RCA exit also present deficiencies. Some practices present a hazard of personnel contamination. Because the plant does not do investigations on personnel contamination events, this problem was not discovered. Moreover, taking into account that some small items are not adequately monitored before leaving the RCA, contamination could be spread to clean areas. The team recommended that the station should strengthen the contamination controls and provide clear guidance on the monitoring of small items that leave the RCA. The limits for clearance of materials could also be adapted to best international practices.

The radiation and contamination survey program has been established taking into account that the dose should be ALARA. The program was considered to be adequate, apart from the fact that no regular contamination surveys are done outside the RCA to check the effectiveness of the contamination control program.

Internal exposures are routinely monitored. However, more attention could be paid to check internal exposure when external contamination of personnel is detected.

6.3. RADIATION DOSE CONTROL

The station has a long history of implementing hardware modifications, modifying water chemistry and installing fixed and temporary shielding to keep doses ALARA. The team considered this to be a good practice. It was also recognized that maintenance supervisors had a good knowledge of ALARA issues.

On the other hand, radiation workers do not always show enough attention to the ALARA principle in their daily work. On several occasions, workers were observed standing close to radiation sources without a reason for being in the area. This behavior was not corrected by RP staff. Also, collective dose is only reported regularly for the plant as a whole. Dose results per department or service are not regularly produced to keep everyone's attention on the topic. Not all departments or services have dose objectives, although it is one of the plants main objectives. Finally, a formal ALARA investigation is only rarely carried out (one or two times in the last two years). Although it must be recognized that the plant put a lot of effort in ALARA (see good practice), strengthening the attention of all workers to basic ALARA principles in their daily work could further reduce unnecessary dose.

Internal radiation dose control was considered to be adequate. However, the use of the correct TLD is not always assured. This could result in workers official dose not being correct. Therefore, the team suggested that the station should make sure, by a system check or at least by an administrative check, that everybody wears the correct TLD. Although TLD and electronic doses are routinely compared, the 1 mSv threshold from which an investigation is conducted was considered to be rather high.

6.4. RADIATION PROTECTION INSTRUMENTATION, PROTECTIVE CLOTHING AND FACILITIES

The inventory and the locations of equipment to measure dose rates and surface contamination was found to be adequate. Also, sufficient continuous monitoring equipment is present to measure airborne particles and I-131 contamination. All these instruments are adequately calibrated and maintained in a good condition. The team however, questioned why there were no mobile noble gas monitors available for operational RP.

The station could better assure the correct functioning of the equipment by a daily source check or a source check before use of the portable instrumentation. In the laundry room the monitor for overalls had a paper showing set points in Bq/dm^2. Normally, every surface contamination is expressed in Bq/cm^2. Calibration of individual dosimeters as well as of the equipment for measuring internal contamination was found to be adequate. The station is equipped with adequate gaseous and liquid effluent monitoring equipment. The calibration and functional tests of this equipment was found to be accurate. Calibration of the gaseous release monitors includes frequent (yearly) calibration of the aerosol transport rate.

Adequate dedicated equipment is used for environmental monitoring. The equipment that is normally used for emergency situations is also sufficient. Protective clothing is provided where necessary and clear instructions are given on ITS use. Respiratory protection is available when needed.

Facilities for decontamination, laundry, temporary storage of waste and waste sorting and handling are all maintained in good condition. Contaminated tools and equipment are located throughout the radiation-controlled area and, although clearly indicated in most cases, mixed with uncontaminated equipment. The team noted that it would be better to provide a separate storage area for uncontaminated equipment.

6.5. RADIOACTIVE WASTE MANAGEMENT AND DISCHARGES

The station has played a pioneer role in the development of several waste treatment processes. This includes; 1. development of a comprehensive database including all safety relevant parameters which is used together with the NAGRA (the organization responsible for the final storage of the waste) and the other Swiss nuclear power plants; 2. the development of a new process for the treatment of spent resins allowing to increase the load of one barrel by about 50%, and; 3. the development of a computer code allowing characterization of the reactor internals before they become waste. The team found this to be a good practice.

While the program for the treatment of the radioactive waste is very comprehensive, and efforts have been successful to reduce the final amount of waste to be disposed of by treatment, more attention could be paid to the reduction of the waste that is generated. Some efforts have been successful to reduce the amount of spent resin that is generated, but the numbers for burnable, compressible and non-compressible waste do not show a decrease in the last five years.

Next year, sensibilisation of the general workforce to reduce the amount of waste is foreseen in general employee training. The introduction of quantitative goals for waste reduction could also be very helpful in further reducing the waste production.

Effluent release calculations and record keeping are adequately managed within the chemistry information system. Liquid as well as gaseous releases represent only a very small fraction (less than 1%) of the authorized limits. The environmental monitoring program is considered to be adequate with good data recorded and trended.

6.6. RADIATION PROTECTION SUPPORT DURING EMERGENCIES

During a radiological emergency all RP staff are called and asked to come to the station. This ensures adequate RP staffing in case of such an event. However, very little written guidance is provided for assessing the radiological situation on the site and for adequately protecting the people that are present on the site. See recommendation in the EPP part of this report.

RP staff was trained in the new emergency plan organization in 1998. However, no further training has been conducted or is foreseen and the team noted that an internal program for continuing training on emergency preparedness would be beneficial.

STATUS AT FOLLOW-UP VISIT

The plant made a considerable effort to respond to the suggestions that were made by the original OSART team and were very successful in doing this. Three of the issues were resolved and one has satisfactory progress to date.

In the area of register and investigate personal contamination, a manual system has been taken into operation which already has given statistics useful to determine when, why and where contamination is taking place. The plant has decided to complement this further by an automatic system that will enhance the ability in reducing contamination in the plant.

In the area of preventing inadvertent entrance to high radiation areas, the plant has installed hardware locked hindrance with two justified exceptions. The installed physical barriers will minimize the risk of involuntarily entrance to high radiation areas.

In the area of strengthening the contamination control program the plant has taken both hardware and software actions. Procedures introduced (e.g.: which items only should be taken through the exit monitors and the control of contamination outside the RCA) are well implemented and the routines used for free release of material from the RCA are all well enforced and implemented.

Actions have successfully been taken to ensure that the correct legal dose is entered into the dose register. This consists amongst other by lowering the threshold for investigation the difference between TLD and EPD values. The plant will develop this further by introducing barcodes on the TLDs that must be in agreement with the badge when entering or exiting the RCA.

DETAILED RADIATION PROTECTION FINDINGS

6.1. ORGANIZATION AND FUNCTIONS

6.1(1) Issue: Personnel contamination events are not routinely registered and therefore no formal investigations on these events are conducted.

During the mission, two events were observed where a worker alarmed the exit contamination monitors. In one case, the contamination could be removed by washing hands. In the other case, two extra hand washings were necessary. Although radiation protection (RP) personnel were present, and in the second case also helped with the decontamination, no questions were asked to determine the reason for the contamination. No registration of the events were made. When asked, radiation protection staff declared that:

— such contaminations frequently happen during an outage (4 to 10 each day);
— no investigation is made as long as the contamination can be removed by simply washing a couple of times;
— when more abrasive cleaning methods have to be used, an informal investigation is made (the person is asked where he worked and the RP worker responsible for this area is warned), however no registration or more formal investigation is made.

There are registration forms available, but, according to the RP staff, they are rarely used. Only when a chemical decontamination is necessary such a form would be completed.

There is no data available to know whether the number of personnel contamination events is increasing or decreasing from year to year. Therefore, the station is not able to measure the effectiveness of the personnel contamination prevention program. Also, opportunities are missed to reduce the number of these events in a systematic way and to reduce the risk for more serious contamination events.

Suggestion: Consideration should be given to register and investigate each personnel contamination event with the objective to reduce the number of these events as much as possible.

Plant Response/Action:

KKM analyzed this issue and also came to the conclusion that the situation must be improved.

In a first stage we implemented in 2001 a manual administrative procedure based on alarm signals received from the personnel exit contamination monitors.

This allows contamination of personnel to be kept under control and data to be collected regarding origin, contamination intensity and corrective measures taken.

In a second stage the procedures tested in 2001 will be automated together with measures taken for Issue 6.3 (1) improving the use of TLDs. The new automated system will be operational in July 2002.

Radiation Protection personnel will then be enabled to perform timely evaluations of work place conditions with which to instruct other persons working in the same area. The data collected will be available for further analyses. For example Radiation Protection (RP) personnel will be able to check for correlation between possible location of contamination as well as frequency and levels of contamination, which will improve the ability to implement appropriate improvement measures for future activities in the plant.

KKM expects with these improvements to acquire a better knowledge of when, where and why contaminations occur and respond appropriately. This will improve the effectiveness of the KKM personnel contamination prevention program and facilitate early intervention prior to more serious contamination events.

IAEA Comments:

As stated above the plant has implemented a procedure to log and investigate contamination alarms in the exit contamination monitors. During the follow up visit no such alarms were observed to occur. However, statistics from the database were presented to the team. During the last outage in 2001 the number of entrances to the RCA and the number of contamination were presented. In average 9 people per day were contaminated in comparison to an average of 1282 entrances to the RCA. The RP section has tried to obtain data from other nuclear power plants to compare but no such comparison data is available. It seems that investigation of alarms from exit monitors do not exist in other NPP or are not available. The investigations at Mühleberg have also been segregated between locations from were the contamination originated and which part of the body that was affected. During the outage 2001 a total of 191 contamination cases were detected at the exit monitors. Of those, the majority originated (74 cases) from the refueling floor (+29 m), which is normal since the potential for contamination is highest there. All contaminations could be removed with standard decontamination procedures for contaminated persons.

The plant has decided to develop the strategy to investigate the contamination alarms from the exit monitors further than suggested by the OSART mission as stated above. See also issue 6.3. In this case the contamination alarm in the exit monitors will also be locked automatically and coupled to the personal TLD data.

The already implemented manual system has helped the plant to get a better understanding why, where and when contamination occurs and improves in the prevention of such contamination to reoccur. Furthermore it will contribute to the systematic analysis of contamination.

Conclusion: Issue resolved

6.2. RADIATION WORK CONTROL

6.2(1) Issue: The entrance to higher-level radiation areas is not adequately controlled as compared to good international practice.

There are several areas in the plant where the ambient radiation is more than 1 mSv/h. In all cases, there is a warning sign and in most cases also a small barrier with a warning "No entry without permission of radiation protection". Good international practice is to use more substantial physical barriers to restrict entry.

Examples are as follows:

— turbines: ambient radiation up to 4 mSv/h, delimitated by a rope;
— hydrogen recombiners: ambient radiation up to 7 mSv/h, only a warning sign;
— main steam tunnel in turbine hall: ambient radiation up to 3 mSv/h, delimitated by a small barrier (one of these barriers was partially turned aside);
— reactor cleanup system: up to 3 mSv/h, delimitated by a small barrier;
— personnel hatch to the drywell: up to 3 mSv/h (gamma + neutrons), fenced off with a chain.

The existence of higher radiation areas where entry is not adequately inhibited may lead to people inadvertently entering and receiving a high dose.

Recommendation: The station should better control the entry to higher radiation areas. A clear audible and visual alarm when entering (apart from the dosimeter), or locked doors or solid fences could be used for this.

Plant Response/Action:

KKM reviewed the team's recommendation and has realized that in some cases a number of more distinctive inhibitory methods such as physical barriers would prevent unauthorized or inadvertent entrance to areas of high radiation in the plant.

KKM's analysis of the specific situations showed that by means of relatively simple physical barriers such as gates significant improvements can be made to prevent unauthorized or unintentional entry to the high level radiation areas. These measures have been completed and contribute substantially to inhibit persons from entering these areas.

IAEA Comments:

The plant has analyzed the areas throughout the plant where possible entrances can be made involuntarily into areas with higher radiation fields greater than 1 mSv/h. During the OSART follow-up visit all areas where such an entrance existed were reviewed. The entrances were all now equipped with a locked steel grid door with two exceptions. The exceptions are the entrance to the main-turbines and the entrance area outside the containment air lock. These two areas are roped off with warning signs saying entrance is not allowed without permission from RP. The signs also tell the maximum ambient radiation dose rate. No occurrences during the 30 years of operation have been observed in violating the signs.

The team asks the plant to reconsider installing a metal grid door to the entrance area of the containment air lock since the general radiation level is high (3 mSv/h). The team believes the roped off entrance to the main-turbines is acceptable since the general radiation levels are low (0,2 - 0,6 mSv/h) and the layout of the plant makes it difficult to design a physical barrier.

Conclusions: Issue resolved

6.2(2) Issue: The contamination control program in the radiation-controlled area (RCA) and the contamination controls at the RCA exit present deficiencies.

- on the 29m level of the reactor building, a heavily contaminated tool (contact dose up to 50 µSv/h) was lying on a table unprotected. Another contaminated item was present in an open box on the same table. On the table, loose contamination was present. This table was used by radiation protection staff and others to write down the necessary readings following work on the spent fuel cask. There were procedures, pencils and documentation on that same table.
- In the same area, a toolbox was standing on another table. The underside of this toolbox was rusted, had apparently not been cleaned for a long time and presented some minor loose contamination. In the turbine hall, 8m level, some equipment with loose contamination was found in a bag without warning sign/tape. In the annex building to the turbine hall, a big grid box was present, containing contaminated hoses from the decontamination service, without warning signs;
- on the reactor building lift, at the 29m level, there is no warning or barrier on the lift door preventing workers to go from a contaminated area to a clean area in the RCA;
- at many places, the protective floor coating in the RCA is damaged;
- the limits for clearance of materials are not always applied when possible: at the gate of the annex building to the turbine hall (the place where larger equipment and waste is cleared), a device for measuring mass specific activity is in place, but not always used;
- when leaving the RCA, many workers, including RP staff, put a number of small items in a small bag and put this bag in the beta counter for small material in the personnel contamination monitors. This counter is also used to measure small books etc. This is not adequate. One occasion was noted where a worker left the RCA with an A4 clipboard with some paper, without monitoring this item;
- contamination checks outside the controlled area, for example on the roads in the neighborhood of the gates, have been carried out only once to check the effectiveness of the contamination control program;
- these practices present a contamination hazard to personnel and could lead to spreading contamination to clean areas.

Recommendation: The plant should strengthen the contamination control program and provide clear guidance on the monitoring of small items that leave the RCA. In addition, the plant should consider performing contamination checks outside the RCA on a more regular basis.

Plant Response/Action:

Corrective measures initiated by the team's findings contributed to further optimization of RP's control measures to reduce the spread of contamination.

All personnel working in Radiation Controlled Areas (RCAs) are sensitized to avoid the spread of contamination beyond the working area.

Additional measures were implemented such as:

— The use of the RG 29m lift is now regulated by means of a key control.
— The floor protective coating in the RCA is repaired continuously.
— The device for measuring mass specific activity in the annex to the turbine building (south) is only used for material of suitable size. Larger or smaller material is measured manually.
— All small items (except personal dosimeters, badges, keys and pagers) are required to be exited via the specially monitored small item exit (Post No 2).
— Beginning with the completion of the outage in 2001 a yearly routine measuring campaign is performed to check for contamination at the plant site.

Corrective measures introduced contribute to further optimization of RP control measures and to lowering the potential for the spread of contamination.

IAEA Comments:

During the follow up mission a representative sample of plant-activities was observed using the same methodology as in the original mission. The work inspected during the follow up mission show that the plant has taken appropriate action to solve the issue. During the follow up mission work performed on the refueling floor elevation +29 m in the reactor building was followed as well as free classification of tools in the south annex building and the use of the smaller unit close to the exit area from RCA. Those activities observed were strictly following the rules and no deficiencies in the controls of contamination in the RCA were observed. The review of the +29 m elevation of the reactor building showed no contaminated tools, boxes etc. that were unprotected. All contaminated tools were neatly stored and clearly marked in special designated cupboards. The elevator to the refueling floor (+29 m) had a key lock so that only RP personnel could release the elevator to go up to the refueling floor elevation. The floor coating in the reactor building and otherwise in the RCA area had been repaired or completely redone.

The monitor for specific activity measurement in the south annex building used to monitor large items or items that are impossible to measure by hand monitor was used in a sensible way when it is most suitable. Smaller items are measured by hand monitors since that will give a more accurate reading than the larger monitor can do.

In the smaller unit for specific activity measurement adjacent to the exit are from the RCA a new procedure has been put in force. Pictures on the exit monitors, the doors to the monitor and to the exit area clearly show which items that only shall be monitored in the exit monitors. All other equipment shall be monitored in the apparatus placed adjacent to the exit RCA area. In the follow up mission no misuse of the exit monitors were observed.

After the original OSART mission the regulator had issued a new guideline HSK R-13d "Inaktiv Freigabe von Materialien und Bereichen aus kontrollierten Zonen (Freimessrichtlinie)". This detailed guideline has cleared many questions raised in the area of free release of material from RCA. The guideline was issued in February 2002 and is already implemented by the plant although the time limit given by the regulator to implement the guide is at the end of the year.

Contamination checks outside the RCA are now routinely carried out on a yearly basis. The procedure AA-SU-09.30 has been revised to reflect this. Already after the outage 2001 extensive checks were made of e.g. the ground outside the exits from the turbine building, the south annex, the personal restaurant, the pump house building, the work shop building, the service building, the radwaste building, etc.. In addition the gate area for trucks was measured.

Conclusion: Issue resolved

6.3. RADIATION DOSE CONTROL

6.3(1) Issue: The use of the correct TLD (Thermo Luminescent Dosimeter) is not always assured.

There is no check by the dosimetry system to see whether workers have their own TLD when they enter the RCA. Workers are not required to check whether they have taken the correct TLD.

The team noted from interviews that in average 15 to 25 times in a outage someone takes the wrong TLD.

The dosimetry service starts an investigation only when the difference between the TLD and the Electronic Personal Dosimeter (EPD is more than 1 mSv (which is already a rather big difference). In case of doubt, the highest dose is registered. As a result, workers official dose may not be correct.

Suggestion: Consideration should be given to make sure, by a system check or at least by an administrative check, that everybody wears the correct TLD.

Plant Response/Action:

In order to minimize inadvertent use of Thermo-Luminescent Dosimeters (TLDs) in the plant it was decided to furnish each individual TLD with a bar code number assigned to a person.

In addition to the badge control on entering the RCA the TLD bar code will be checked for agreement and only then will the turnstile unlock. On leaving the RCA the badge and the TLD bar code will again be checked for agreement at the contamination monitor and if correct, exit will be permitted. If contamination is detected, then the data is passed on to the system automatically together with badge and TLD information.

This automatic control system not only provides KKM with a tool for rapid registration and documentation of personnel contamination occurrences but also with a reliable method of keeping inadvertent use of TLDs to an absolute minimum.

IAEA Comments:

The new equipment with the bar code reading of TLDs was demonstrated to the team during the follow up mission. The bar code reader will be tested in July during a three-week test period and be in ordinary use during the August refueling outage. The bar code reader will be present in the entrance to the RCA, which will check the agreement between the badge and the TLD. If no agreement is present the entrance will be denied. The bar code reader will also be present at the exit monitors and assigns the result of the exit monitor measurement to the person.

To identify the correct doses the plant has strengthened the control between the electronic personal dosimeter (EPD) and the TLD. The threshold for investigating difference between the EPD and TLD has been lowered to 0,5 mSv from 1 mSv. The evaluation frequency of the TLDs has been increased from every quarter of the year to once per month. Also checks are now performed down to 0,3 mSv to find out if there are special cases between 0,3 to 0,5 mSv. Tests have also been performed to compare TLD and EPD values to measure how much they differ given different radiation energies.

After investigation, when the readings from TLDs and EPDs differ more than 0,5 mSv and it has been established that the EPDs have the correct reading, that dose is entered into the legal dose register with a notice why this has been done.

The team concludes that the actions taken were good. Implementation of the actions taken to resolve this issue should be tracked further to ensure that management expectations are met.

Conclusion: Satisfactory progress to date

6.3(a) Good practice: The plant has spent significant effort in installing hardware modifications to keep doses ALARA. In the past 20 years, the plant has had an extensive program to evaluate and trend the plant radiological conditions yearly. The results have been used to improve plant radiological conditions and reduce collective dose. Examples implemented during the last ten years to reduce dose rates in the plant include:

- fixed shielding installed in numerous places in the plant. During each outage, a large quantity of temporary shielding (approximately 90 tons) is installed, mainly in the drywell;
- in approximately 50 places, piping was modified in order to be able to clean the piping and to flush hot spots by means of high pressure cleaning;
- stellite containing 'pins and rollers' in the control rods have been replaced by low cobalt sliding pieces;
- zinc conditioning was introduced to reduce dose rates;
- chemical decontamination of the reactor water cleanup system;
- recently, application of noble metal to minimize the impact of hydrogen injection.

6.5. RADIOACTIVE WASTE, MANAGEMENT AND DISCHARGES

6.5(a) Good practice: The station has played a pioneer role in the development of several waste treatment processes. Examples are as follows:

— all safety-relevant data required for a final storage of radioactive waste are managed by means of an efficient databank system (Information System for Radioactive waste, ISRA). This system is recognized by the Swiss authorities (HSK) and is also used by the company that is responsible for final storage of the waste (NAGRA) and by the other Swiss nuclear power plants. It has been recognized in an earlier OSART as a good practice;

— modern methods are used in order to reduce the volume of spent resins and sludge and to put it in a waste matrix. The new method, called Cement Volume Reduction Solidification (CVRS) minimized also the personnel radiation doses;

— for conditioning spent resins and sludge, a solidification system has been installed in the existing radwaste processing building. The conditioning process includes the pretreatment of raw wastes, a thermal treatment of resins, and the immobilization in cement, which has been optimized with regard to volume;

— the CVRS solidification system is suitable for the conditioning of the resins and sludge either arising from current plant operation or already existing. Pretreatment of the resins allows the waste load of the cement matrix to be increased by 50% compared to conventional cementation techniques. In spite of cementation, this treatment even results in a slight volume reduction of approximately 10% since the wet waste, due to its lower density, takes more volume than the waste matrix produced;

— for spent incore components, the plant uses a new calculation method to characterize the radioactive inventory only by calculation. The code, developed in cooperation with GRS (Gesellschaft für Anlagen- und Reaktorsicherheit), allows reliable characterization of a wide range of reactor internals. Extensive analyses performed on KKM fuel channel pieces from normal reactor operation made it possible to validate the new code, to the extent of determining the nuclide inventories of the structural material of all reactor internals except neutron absorbers. For neutron absorbers, recently another calculation code was developed and used to characterize the nuclide inventory of KKM control-rods and curtains of boron. In the future, costly sampling and measurements on activated reactor internals will thus no longer be necessary. The code, which runs on a PC, is accepted and used also by the NAGRA.

7. CHEMISTRY

7.1. ORGANIZATION AND FUNCTIONS

The chemistry staff at the plant functions well as a strong service organization supporting other departments and sections such as Operations, Mechanical Maintenance Nuclear Engineering and Radiation Protection. It was noted by the team that good interaction and co-operation existed between the staff of the chemistry section and the staff of other sections.

The Chemistry staff is fully aware of the plant mission and objectives and has developed chemistry objectives to support the plant objectives for 2000. The quality assurance of chemical measurements and computerization of the quality control charts is supportive of the plant goal to “live up to and implement Quality Management“, while the objective to reduce resin consumption supports the plant goal of reducing production cost.

Within the section the development of formal job descriptions has ensured that the staff are informed of their technical functions and responsibilities, goals and chain of command. The responsibilities of the chemistry section include monitoring of gaseous and liquid effluents, monitoring of the chemistry of the water/steam system and balance of plant systems and the recommendation of corrective actions when needed.

Audits of water chemistry, liquid effluents and gaseous effluents are performed by personnel from other sections who have been trained as auditors.

The Chemistry staff has developed a clearly organized flow diagram to show its interface with other groups within the plant and to better understand its responsibilities within the plant.

Adequate communication and flow of information within the chemistry section is provided by the weekly meeting held by the head of the section with the staff. The meeting is informal and the communication and flow of information includes special chemistry activities for the week, discussion of problems and plant management communications.

The chemistry section is sensitive to changes in measured chemical parameters and has incorporated a section in Chapter 7.1 of the Laboratory Manual that provides possible causes and corrective measures for a change in an important measured chemistry parameter such as reactor water conductivity. For example, reactor water conductivity has increased since the application of Noble Metal Chemical Addition and injection of hydrogen. The chemistry staff are aware of this shift, which has been an observed transient seen at other BWRs which have added noble metals and injected hydrogen, and have determined that the change in conductivity was due to an increase in soluble iron in the coolant.

The chemistry technicians are technically well qualified and showed a high degree of expertise and knowledge with respect to the operation of laboratory instrumentation, need for a Quality Assurance Program and anticipated values for parameters being monitored.

Additional training is supplied by instrumentation suppliers and manufactures, the Paul Scherrer Institute and attendance at seminars. This has been very effective as a continuing education and training tool.

The team noted that the technicians work as a self directed work force and this has worked well. However, 24-hour coverage is not provided except during the first 48 hours of a shutdown. During holiday periods such as Christmas the “96 hour” rule. i.e. the maximum time that can elapse between samples (tech specs) is invoked. It should be noted that there is no indication that the lack of 24-hour coverage has been detrimental to the plant performance, but the team noted that the time between sampling, at these times, could be reduced.

7.2. CHEMISTRY CONTROL IN PLANT SYSTEMS

Overall the control of chemistry in plant systems is good. The plant has implemented effective programs to protect vessel internals from Intergranular Stress Corrosion Cracking, minimize radioactivity buildup in the recirculation system and minimize corrosion in the cooling water systems. These programs are:

1. Noble Metal Chemical Addition and Hydrogen Injection for vessel internals protection.
2. Zinc injection, using zinc oxide depleted in Zn-64, for minimization of radioactivity buildup.
3. Use of inhibitors for corrosion protection in the intermediate cooling systems and the district heating circuit.

The team recognized the application of Noble Metals as a good practice and the use of the polymer electrolyte membranes for the generation of hydrogen and oxygen required for hydrogen injection as a good practice.

Adequate requirements are in place to ensure that out of specification diesel fuel is not transferred to the storage tank at delivery and subsequent testing for the impact of aging is performed by EMPA. Other chemicals used in the plant, for chemical treatment, are purchased to a specification and some are also subjected to an on site delivery acceptance test.

The make-up water treatment system, reactor water clean up filters and condensate polishing filters produce water that meets specifications. For example, water effluent quality from the condensate polishers is in line with the industry (0.060 uS/cm). The condensate polishers are precoated with powdered resin, which becomes waste when the polishers are backwashed. The chemistry staff was involved in the testing performed to determine if the amount of resin being used in the condensate filters could be reduced without compromising water quality in the feed water and reactor water (VP-B-99/5). It was concluded that the test data did not support reducing the amount of resin being used to precoat the condensate filters. The chemistry section is continuing to look at other ways of reducing resin usage.

Chemical parameters are properly monitored using in-line instrumentation, which provides continuous information, and grab samples collected on a regular frequency to meet requirements such as technical specifications and fuel warranty. Data is recorded in the chemistry information system (CIS) and trend graphs are prepared of the parameters. Where needed flags have been installed to indicate that a value is not possible. Flags could also be installed for those times when a limit has been exceeded but this has not been done at this time.

The success of the optimization of the water chemistry program is reflected in the WANO chemistry performance index and the WANO fuel reliability indicator with the plant being a top performer.

7.3. CHEMICAL SURVEILLANCE PROGRAMME

The chemical surveillance program is well documented in the laboratory manual which includes specific procedures used by the staff and also includes a section in Chapter 7.1 that provides possible causes for a change in an important measured chemistry parameter and possible corrective measures to be taken. It was noted by the team that the laboratory manual was also available on line to the chemistry staff as well as being available as a hard copy in the laboratory. The quality control schedule and job rotation/sampling schedule is posted in the laboratory and is accessible on-line.

Effective use is made of in-line instrumentation for monitoring selected plant chemistry parameters and by the collection of samples from various systems on a scheduled frequency. Data is recorded in the Chemical Information System (CIS), with gamma spectroscopy data being directly downloaded from the instrumentation. In addition it is used to prepare various reports and trend graphs.

There is good documentation of chemistry results and communication of chemistry monitoring results to plant organizations and offsite agencies. For example, daily reports of important parameters for reactor water, feed water and condensate chemistry, off gas and stack effluents are available to operations when generated. A goal for the future is to put trends of the important parameters on the Intranet for review by plant personnel.

Calibration of the analytical instrumentation is done using accepted methodology. However, the team observed that although the energy calibration for a gamma detector was tight and within the control chart band neither the full width half max. or efficiency calibration was within the control chart bands and that corrective actions had not been taken. This is not in accordance with the chemistry section goal of establishing quality assurance in the laboratory and the stated actions to take when the measurements lie outside the control bands. The team recommended that the chemistry section should determine the reason why two parameters were outside the control chart bands and take the appropriate corrective action to meet the quality control requirements.

Chemistry is a participant in both a chemistry round robin program and a radiochemistry measurement round robin program and performance has been good indicating good calibration and analytical techniques are in place.

While observing the weekly change out at the stack the team noted that the charcoal was transferred from the collection container to a counting container with no catchment device underneath. This was discussed with the staff and it was agreed that a catchment device in case of a spill was appropriate.

7.4. CHEMISTRY OPERATIONAL HISTORY

There is an effective utilization of the CIS as a tool for the reporting of results, for communication and for trending of performance. This is an IT-based system used to record, check, and evaluate analytical and operational data. The system is also used to produce the daily, weekly, monthly, and annual reports. A variety of data records can be exported from CIS to programs such as Excel to perform calculations and to generate diagrams. Data from 1991 are stored in this system and, using “quick graphs“, allows trending of a number of parameters over any time period since 1991.

In addition, chemical and radiological data for the water and steam systems are characterized for each operating cycle and the relevant data since 1979 are updated annually in a report. This report captures long term trends and changes that have occurred as a result of changes in chemistry. The report also captures data on materials, such as pipe replacement, pins and roller replacement, and condenser tube replacement.

An exchange of experience is achieved by attendance at seminars and meetings with other Swiss nuclear facilities on a regular basis and by the discussion of industry events through the Internal Safety Committee (ISA).

7.5. LABORATORIES, EQUIPMENT AND INSTRUMENTS

The laboratory facility is large, well lit, and a high standard of housekeeping is maintained. The facility is generally well equipped with most of the instrumentation being up to date. However some of the counting equipment is old and consideration should be given to its replacement. Some concern was expressed by the team regarding the prevelence of gas cylinders that are needed for operation of some of the instrumentation, in the laboratory. Some tubing is run overhead to point of use and it is suggested that this practice be evaluated for its impact upon safety and alternative routings be determined.

One laboratory, within the laboratory facility , was designed to meet zone B requirements and has been used in the past to examine fuel scrapings. At this time no high activity work is being performed so the classification of this area is C.

High quality water and ultra pure acids are used to ensure that contamination of samples is minimized and the primary standards and the ultra pure acids come provided with certificates. The storage of chemicals in the laboratory meets requirements and the requirements can be found in the Laboratory Manual. The laboratory is provided with a safety shower and eye wash station.

The safety requirements for the chemistry staff are in the Laboratory Manual and meet the Federal Safety Requirements for chemical laboratories. Safety glasses are not worn in the laboratory and were not worn during sampling of the reactor water and intermediate cooling system at the sample stations. Procedurally safety glasses are only required to be worn when dealing with acids and alkalis. The team suggests that consideration be given to making it a requirement to wear safety glasses in the laboratory at all times.

The eye wash packages provided at some locations where chemicals are stored were not adequate to ensure that eyes in which chemicals have splashed, can be rinsed in a timely manner. The team suggested that consideration should be given by the plant to evaluate other types of eye wash stations.

The PASS sampling system is well designed and provides the capability of automatic and manual sampling. An evaluation (BBC Technischer Bericht HTKS-ST 0009, Mai 1980) was performed by ABB (formerly BBC) of dose rates at the sample stations after a LOCA and this evaluation supports the policy of not using a PIG to transport the samples to the laboratory. This evaluation has been validated by a study in 2000. It is suggested that use of a suitable shielded transport device, that can be carried by hand, be evaluated as a replacement for the plastic bag.

7.6. QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

It is the policy of KKM that chemicals used in the controlled area be totally free of chloride, sulfate and organic materials if the risk exists that they can enter the water/steam system. Requests for new chemicals are reviewed by the chemistry staff and approved for use if deemed acceptable. Each storage site is provided with a set of information, which includes the safety data sheets for the products stored at the location, a copy of the European Union Symbols and Codes for materials and copies of the site procedures for “Handling of Chemicals“ and “Measures and Rules of Behavior When Handling Chemicals in KKM Operations“.

Important chemicals are purchased to a specification and some are subject to test analysis upon delivery prior to acceptance. Depleted zinc oxide is purchased to a specification, comes with a certificate and although not tested upon delivery, a sample is taken and saved for analysis should a problem arise.

All chemicals transferred to containers other than the primary container, as well as those prepared in the laboratory, carry the chemical designation, expiration date and preparer‘s signature.

STATUS AT FOLLOW-UP VISIT

The plant has responded effectively to the recommendation and to the suggestion offered by the team in the original mission. Both the recommendation and the suggestion were found to be resolved.

An evaluation on the γ-Spectroscopy issue was conducted and additionally the software for the analyses of γ-spectras was replaced. Further investigations indicated the need of an equipment specialist evaluation. As a result, the detector was replaced and the equipment electronics was upgraded. Since then, the detection is operating within the acceptable limits. Additionally, external-training sessions on equipment software were provided for chemistry personnel.

Following the team suggestion to improve eyewash packages, an evaluation was conducted and the plant decided to pre-assemble the package to make its use easier and to eliminate the assistance of a second person. In addition, the use of the eye wash packages was included in the General Employee Training Program and a figure was posted at each location to indicate its correct use. The team concluded that the plant adequately addressed this issue.

DETAILED CHEMISTRY FINDINGS

7.2. CHEMISTRY CONTROL IN PLANT SYSTEMS

7.2(a) Good Practice: Noble metal chemical addition, a chemical treatment used in conjunction with hydrogen injection to provide protection against intergranular stress corrosion cracking (IGSCC) while minimizing the impact of hydrogen injection upon dose, has been implemented. The use of noble metal chemical addition will enable the plant to protect single-phase wetted surfaces of the vessel components against IGSCC while remaining within the radiation protection limit of 100 μSv/week at the site fence. The site developed a plan to ensure that the dose limit at the fence would not be exceeded with implementation of hydrogen injection following the application of noble metal chemical addition. As part of this project the plant also installed electrochemical potential (ECP) electrodes and a durability monitor. The data from the ECP electrodes are used to monitor and trend the effectiveness of the selected hydrogen injection rate in lowering the ECP. The data from the durability monitor will be used to determine when another noble metal application will be required. The plant is the first BWR in Europe to implement this technology.

The team determined that the initiative to protect reactor vessel components using noble metal chemical addition in conjunction with hydrogen injection is a good practice.

7.2(b) Good Practice: The plant has implemented an innovative technology to generate the hydrogen and oxygen required to implement hydrogen injection in conjunction with noble metal chemical addition. This system eliminates the need for an external manufacturing and or supply system and the safety concerns associated with keeping supplies of oxygen and hydrogen on site and transporting them to the injection point.

The generation of hydrogen and oxygen is performed using a polymer electrolyte membrane technology which takes condensate and generates the hydrogen and oxygen required to meet the plant goal for ppm hydrogen in the feed water, provide oxygen to the off gas and maintain a stoichiometric ratio of oxygen to hydrogen.

7.3. CHEMICAL SURVEILLANCE PROGRAM

7.3(1) Issue: Radiochemistry data being used to measure reactor coolant and off gas activity had been obtained from an instrument where two of the three quality control parameters were outside the quality control chart bands.

The Chemistry Section has a 2000 goal of establishing quality assurance in the laboratory and has established quality control charts, using accepted methodology, with stated actions to take when the measurements lie outside the control bands. However, the team observed that although the energy calibration was tight and within the control chart band neither the full width half max. or efficiency calibration was within the control chart bands, and that corrective actions had not been taken. Subsequent investigation showed that the agreement span with a mixed gamma standard, counted on this detector, was in the ± 5% agreement range, which is acceptable. There is no impact upon reported values obtained from this instrument but the failure to take corrective action is not in compliance with stated quality control requirements. Standard industry practice is to have an agreement requirement of ± 5%. New data reported using suspect equipment is highly questionable and can result in failure to identify a developing problem and failure to recognize that an activity limit may have been exceeded and that corrective actions be implemented.

Recommendation: The Chemistry Section should determine the reason why two parameters were outside the control chart bands, and take the appropriate corrective action to meet the quality control requirements.

Plant Response/Action:

This issue led to a critical review of procedures designed to ensure that only correct functioning and calibrated measuring equipment is employed for measurement and detection. In particular it was checked that clear quality requirements are specified for parameters in order to perform measurements correctly.

Special emphasis is now placed on the recognition of and dealing with quality-relevant deviations in Chemistry section training.

Evaluation software used for γ-Spectroscopy permits automatic checking of quality-relevant instrument parameters. These automatic checks of energy, counts and resolution are performed at the intervals specified in the Laboratory Manual, chapter 2.3, annex 3. Required action to be taken on detection of a deviation is also described in this manual. Chemistry section staff is trained in this procedure.

A subsequent thorough investigation of the specific detector concerned indicated that leakage current of the crystal had increased considerably. The detector was replaced by an improved model. Additionally, it was also decided to replace the electronic part of the equipment. This results in a completely renewed measuring chain.

The reason why two parameters were outside the acceptable bands and appropriate corrective actions were to meet the quality control requirements was determined. Following standard industry practice with a tolerance requirement of ± 5% helps to ensure that no data is reported using defective equipment. This practice assists in identifying developing problems and thus avoiding the activity limits being exceeded.

IAEA Comments:

The γ-Spectroscopy problem was properly addressed by the plant. An evaluation was conducted according to equipment specific procedure.

Investigations indicated the need of an equipment specialist evaluation. As a result, the detector was replaced and the equipment electronics was upgraded. As a further and precautionary measure the analyzing software was replaced. Since then, the equipment is operating within the acceptable limits.

Additionally, external-training sessions on equipment software were provided for chemistry personnel.

Conclusion: Issue resolved

7.5. LABORATORIES, EQUIPMENT AND INSTRUMENTS

7.5(1) Issue: The eye wash packages provided at some locations where chemicals are stored were not adequate to ensure that eyes in which chemicals have splashed, can be rinsed in a timely manner.

The eye wash packages that have been provided at some locations, in place of a standard eye wash station, would be difficult to use should a person get a chemical substance in the eye. The person would need to be able to read the directions, then assemble the station and use the eyewash. A demonstration on assembly of the package verified that these would be difficulty to use without assistance from a second person. Preassembly of the package would make it easier to use if needed.

Without adequate eye wash protection plant personnel could suffer sight impairment should a chemical substance be splashed into the eye.

Suggestion: Consideration should be given to evaluate other types of eye wash stations that can be safely used, while meeting regulatory requirements, or to modifying the current eye wash package to make it more user friendly.

Plant Response/Action:

A review of the KKM eye wash procedure (to be applied after eye contact with chemicals) revealed that a modification of the plastic bottle as was suggested in the team's recommendation would provide a user-friendly solution and facilitate its rapid application.

Modification consisted of pre-assembly of the package so that only the tube clamp requires removal to make the wash package ready for use. Pre-assembly has the additional advantage that it reduces the potential danger of microbiological contamination of the eyes.

Mobile wash stations are necessary because water supply is not always at hand at required locations in the plant. Evaluations showed, that our modified mobile sterile eye wash packages provide a good solution comparable with others on the market.

Correct use of the eye wash packages is depicted in a figure in instructions at each location.

The pre-assembly modification has been introduced and use of the packages is demonstrated within the scope of annual first-aid training and training of potentially endangered personnel (see KKM Internal Memorandum IM-CH-01/1)

Evaluation of the eye washing procedure lead to an improvement of the industrial safety Effective eye washing can be carried out quickly and with reduced potential for microbiological contamination. This improvement assures personnel will not suffer sight impairment should a chemical substance be splashed into the eye.

IAEA Comments:

The eye wash package problem was immediately addressed by the plant. Following the team suggestion, an evaluation was conducted and the plant decided to pre-assemble the package.

Following the modification, the use of the eye wash packages became easier and the assistance of a second person is not required anymore.

The use of the eye wash packages was included in the General Employee Training Program to make all plant personnel aware of the modification implemented. In addition, a figure was posted at each location to indicate the correct eye wash package.

Conclusion: Issue resolved

8. EMERGENCY PLANNING AND PREPAREDNESS

The overall Swiss emergency organization has already been evaluated in previous OSART missions. This mission only evaluated the plant specific items in emergency planning and preparedness.

8.1. EMERGENCY ORGANIZATION AND FUNCTIONS

The plant has a well-defined and structured emergency organization. Responsibilities and authorities are clearly defined and understood. Sufficient staffing during an emergency is assured by calling a large number of staff to the plant. However, there is no assurance that, at any time, at least one trained person from a given plant department is available for each corresponding section in the on-site emergency organization. This is particularly important for the radiation protection area. The team suggested that consideration should be given to make sure that, at any time, there is at least one trained person from each department available for the corresponding section in the internal emergency plan.

The plant has a large and well-established fire fighting organization, including about 100 persons that can be at the plant in a short time. All fire fighters are frequently trained according to their grade (officer – team leader – fire fighter).

The organization provides the necessary support and information for the off-site emergency plans. The team noted good cooperation between the plant and the off-site organizations.

All organizations involved in the emergency plan, internal as well as external, make common use of an information system that runs on PCs connected via the Internet. This system was used to the full extent for the first time in a dedicated exercise with all involved organizations. The team considered this to be a good practice.

8.2. EMERGENCY PLANS

The on-site emergency plan is very well established to take the necessary counter measures on-site to mitigate an accident. It also provides adequate support and information for the external organizations that are involved.

Generally, the process to identify the situation, classify the event, notify and activate the emergency response is adequately implemented. However, in case of a rapid release, there is no clear guidance to make the required evaluation of the I-131 and aerosol releases in order to declare the highest state of alarm as per the plant emergency plan. The team recommended that the plant should provide clear guidance in order to facilitate a quick estimation of I-131 and aerosol accident releases, as required by the Plant emergency Plan.

The off-site emergency plan and equipment of the Bern cantonal police was also evaluated and found to be very useful and well developed. It has already proven its excellence in real (non nuclear) emergency situations.

8.3. EMERGENCY PROCEDURES

Emergency procedures are well established for mitigating accident consequences. Procedures describing the emergency organization are rather general and could describe the different tasks of the different sections in a more detailed way.

The team found that there was no written guidance on how to protect the people that are on the site or that are called to come to the site in case of a radiological emergency. As a result, actions to protect these people could be considerably delayed. Therefore, the team recommended that the plant should develop the necessary guidance for the protection of the people on site in case of a radiological emergency.

Initial notification is done from the control room. There is also a table, where meetings are held in case of an emergency. The team had some concern that this could disturb activities in the control room. Separating this area from the rest of the control room could ensure that operator activities are not disturbed.

8.4. EMERGENCY RESPONSE FACILITIES

The main control room provides adequate protection in case of radiological releases. Furthermore, the 'SUSAN' emergency control room can be used and provides the same level of protection in case the main control room is not available.

The on-site emergency coordinating center provides much space and facilities to house the emergency staff. It is however not protected against airborne contamination. In this case, the coordination center has to be relocated to the SUSAN building where very little accommodation is present. The team noted that procedures give guidance on how and where to retrieve accommodation equipment. However, the team felt that this could delay the actions and in the worst case bring radioactive contamination from the coordination center to the SUSAN building.

All three emergency centers are provided with adequate communication equipment. The essential plant safety parameters, including the SPDS, can be consulted on-line in all three locations.

Personnel gathering points exist but are not used for everybody: only the fire fighters, the emergency section managers and the visitors have a dedicated gathering point. The remaining staff stays in their normal offices making protective actions and dosimetry for these people difficult to realize. A medical center is available and adequately equipped.

8.5. EMERGENCY EQUIPMENT AND RESOURCES

The station can use an impressive number of independent communication means to alert and keep contact with the competent authorities. Also, the SMT telephone calling system, operated by the Bern cantonal police, considerably facilitates calling a lot of people at the same time to the plant.

Sufficient emergency equipment for fire fighting and first aid was found to be available and was maintained in good working condition. The control room, as well as the SUSAN facilities was adequately equipped with respiratory protection equipment for interventions outside the protected areas. However, additional equipment could be needed in case of contamination off-site in order to keep the facilities free from contamination.

There is no need for dedicated radiation protection equipment because the normal equipment is suitable for use in case of an emergency.

8.6. TRAINING, DRILLS AND EXERCISES

Basic training for all BKW and contract employees is provided before access to the site is given.

Training and exercises for fire fighters and first aid teams is extensive and very well conducted. However, feedback from fire fighters (not only the officers) when evaluating the exercise afterwards could be beneficial.

For the remaining emergency response staff, specific emergency plan training is only given to the 26 managers that can be on the emergency management team. This training is general and the same for everyone. More specific training covering the specific skills needed in some sections (e.g. radiation protection) could be helpful.

Apart from fire fighting, infrequent emergency exercises are generally covering most of the on-site organization. A more structured approach to individual responsibilities in case of an emergency would further improve emergency preparedness of all staff. Only the exercises that are conducted together with the authorities lead to a written evaluation and corrective actions. The plant could improve the emergency plan by conducting more formal evaluations of the internal emergency exercises.

8.7. LIAISON WITH PUBLIC AND MEDIA

The emergency organization has a dedicated section for information. This includes all kinds of information to the authorities as well as to the public and the media. Moreover, professional support for information to the media is foreseen and can be present at the site in a short time by professionals from the corporate headquarters in Bern. As KKM has regular contacts with the media, the dissemination of public information by the power plant should not be a problem.

The plant’s information center can be used to provide information to the media. However, this facility is rather small and support equipment, such as telephone connections, fax and radio/TV, is limited. The hydroelectric plant, located several kilometers from KKM can also be used to facilitate information exchange.

STATUS AT OSART FOLLOW-UP VISIT

The follow-up team assessed the excellent progress on Emergency Planning and Preparedness. Three issues were followed up, including one suggestion and all of them were completely resolved.

Significant improvements were made on the Rapid Mobilization System (SMT) and a larger number of staff can now be easily contacted during any emergency. A real drill exercise was then realized to test this new communication system and the personnel attendance and the final results were very good.

Also, new procedures have been issued to deal with the responsibilities of each group involved in the emergency, as well as the names of the persons belonging to each group.

New software was developed and implemented to cope with potential aerosol and Iodine 131 releases.

During the initial phase of a technical emergency situation or a precursor-event, the emergency team normally reports and assembles at the Main Control Room (MCR). KKM's experiences with this ground rule are very good. With this way to proceed the emergency team (at the beginning a small number of persons) is able to get very fast a clear picture of the technical situation on the basis of first hand information. This clearly reduces the potential for misunderstandings. The fact is that for a certain time the number of "extra" personnel in the MCR (could reach up to ten) have the potential to divert the attention of the MCR personnel from their primary tasks. This potential is relieved through the fact that the MCR is favorably structured and spacious.

As soon as possible and based on the technical situation, the emergency team is displaced to the alternate or the SUSAN emergency room. This displacement was trained during several emergency drill exercises with the aim not to interrupt the activities and working procedures of the emergency team during the transfer time.

Furthermore, depending on the special situation (type of emergency such as fire, forcible penetrations etc.) an other meeting point can be defined and communicated using the internal loudspeaker system during the normal working hours or by other technical means during off hours.

DETAILED EMERGENCY PLANNING AND PREPAREDNESS FINDINGS

8.1. EMERGENCY PLANNING AND PREPAREDNESS

8.1(1) Issue: There is no assurance that at least one trained senior person is available for each corresponding section in the on-site emergency organization. This is particularly important for the radiation protection (RP) area.

For the following functions, the availability of a trained senior person is assured:

- emergency director: informal agreement in case of holidays, etc. between senior plant managers;
- pikett engineer: there is always one on site;
- fire fighting: shift personnel;
- instrumentation and Control: one technician per shift.

For the leaders of the different sections in the emergency plan (operations, mechanical maintenance, radiation protection, electrical maintenance, support and information), no provisions are made to be sure that there is someone of the corresponding department available at all times. The station calls everybody in case of an emergency and considers that for each section at least one trained senior person will be available at all times. For some sections there are only a few persons from the corresponding department that are trained in the emergency procedures.

The plant approach is that everybody in the management team (e.g. all pikett engineers) can fulfill any function in the emergency plan.

In case of an emergency the most senior staff are called by the SMT communication system. However, some managers are not included, e.g. the two RP managers. There is no formal guidance to call the managers not included in the SMT call list.

Monthly tests of the SMT system are performed to check the availability of the system. As such, they give little information on the presence of the staff at all times. The tests have been generally conducted at noon in the past, when everybody is at work. So, the performance tests of the SMT give no guarantee on the availability of sufficiently trained senior persons are available all the time.

It is however common international practice to have arrangements for each important function in the emergency plan to have a trained person available and fit for duty to respond to an emergency.

Without adequate provision for the availability of the essential members of the internal emergency organization, the plant may delay to accomplish emergency tasks during emergencies.

Suggestion: Consideration should be given to make sure that, at any time, there is at least one trained senior person available to lead the corresponding section in the internal emergency plan.

Plant Response/Action:

KKM selects emergency staff members based on their leadership qualifications and technical capabilities.

An in-depth analysis of the current situation was carried out. KKM agrees with the team's suggestion. The actions taken were to extend training and to increase the number of persons to be mobilized. In order to implement these improvements two new procedures for the Basic Emergency File, GNO-B-006.0 "Availability of Emergency Staff" and GNO-B-006.1 "Areas of possible deployment of Emergency Staff" were issued.

Procedure GNO-B-006.0 describes the basic structure and defines responsibilities and procedure GNO-B-006.1 consists of a list of emergency staff and areas of their possible deployment within the emergency organization.

Each person receives sufficient additional training to increase the range of his or her potential responsibility. Suitable training has been and will be performed. Its application is tested in internal exercises.

The Rapid Mobilization Telephone System (SMT) has been modernized in an action together with the Canton of Berne and the geographical coverage of mobilization has been extended to make all KKM emergency staff available. Additionally, the new system allows finer groupings of people to be called. This enables KKM to mobilize people on a improved and more selective basis (compare GNO-B-002.1, Rev. 5).

Verification of this extended emergency staff team was carried out during internal training sessions and during emergency exercises in the spring and autumn of 2001.

The Spring 2001 exercise demonstrated that in a short time the required emergency staff members were available at the plant.

With these improvements KKM is confident that all required emergency staff will be available at the plant in an adequate response time.

IAEA Comments:

Two new procedures, GNO-B-006.0 "Availability of Emergency Staff" and GNO-B-006.1 "Areas of possible deployment of Emergency Staff", issued on January 2001, were reviewed and they cope with the suggestion of the OSART team. Training on these procedures was completed and all necessary plant personnel received the appropriate information. The team concluded that the plant did a good job to address this issue.

Conclusion: Issue resolved

8.1(a) Good practice: All organizations involved in the emergency plan, internal as well as external, make use of an information system that runs on PCs connected via the Internet ("Elektronische Lagedarstellung" – electronic representation of the current status). All organizations provide comprehensive input on the actual status and about individual activities on this system. Background information about the power plants is also available. All organizations have access to the information. In this way, everybody is informed on-line about the actual status. It relieves the stress on the organization to supply information to a large number of partners. This was already recognized as a good practice in an earlier OSART mission to Switzerland, but at that time the system was not yet fully utilized by some organizations. Today, all involved parties are connected to the system: the power plants, the NAZ (national alarm center), the HSK (regulator), the cantonal police and the federal government. Press releases are also entered into the public sector of this system, which helps the different organizations to give a uniform message to the public.

8.2. EMERGENCY PLANS

8.2(1) Issue: In case of a rapid release, there is no clear guidance to make the required evaluation of the I-131 and aerosol releases in order to declare the state of alarm as per the plant emergency plan.

In case of a rapid release, the pikett engineer must be able to give an immediate warning to the cantonal police of Bern and have the sirens in ‘zone 1’ activated. There are specific criteria for this: release of the yearly limit of noble gases, particulates and I-131 (Procedure AMM-B-013). However, the pikett engineer is only able to evaluate and check against the criteria in the noble gas release (Procedure ANA-B-003.6). An evaluation of the I-131, which is a very important isotope in severe accident releases, is not described in the procedure but could easily be done with on line measuring equipment that is available. For aerosols, the criterion asks to take into account these aerosols with a half-life of more than 8 days. This requires someone who can quickly operate a gamma spectrometer. However, nothing is foreseen to be able to do this in a short time, which could lead to slowing down the necessary actions for public protection.

Recommendation: The plant should provide clear guidance in order to facilitate a quick estimation of I-131 and aerosol accident releases, as required by the plant emergency plan.

Plant Response/Action:

KKM analyzed this issue on the basis of the general emergency procedure ANA-B-003.6 This review indicated that improvements could be made in response to the team's recommendation.

Procedure ANA-B-003.6. was modified and computer software was enhanced to include the iodine and aerosols as recommended in the first emission estimates performed during the initial phase of radioactive emission.

Licensed operations and Radiation Protection staff were trained on the changes to procedure ANA-B-003.6 and use of the software concerning emission determination of Iodine and aerosol nuclides. This revised computer assisted procedure allows shift personnel and Radiation Protection specialists to perform a rapid estimate of the released activity.

IAEA Comments:

The revision of the procedure ANA-B-003.6, and with the development of the new software to include the required evaluation of aerosol and Iodine releases, fulfill all requirements of this issue. Adequate training was also applied to the responsible personnel, as well. This software is in the internal plant intranet and it is very easy and friendly to be used.

Conclusion: Issue resolved

8.3. EMERGENCY PROCEDURES

8.3(1) Issue: There is no written guidance on how to protect the people that are on site in case of a radiological emergency.

In case of an emergency, the workers that are present in the radiation controlled area leave this area and proceed to the RCA exit; the ones that are not in the radiation controlled area stay in their normal offices; visitors go to the restaurant; the members of the emergency sections (fire fighters and emergency section managers) proceed to their dedicated meeting points.

There are no pre-established plans or guidance, to perform some essential actions or evaluations to protect the people on site, such as:

- to make a radiological evaluation (radiation, surface and airborne contamination) of the places where people are located;
- to relocate people on the site to the less affected areas;
- when to evacuate the site;
- to delimitate contaminated or high radiation areas on the site;
- to provide dosimetry to the people on site;
- to the use of thyroid blocking agents: there is a procedure on how to use them but there are no criteria on when these agents have to be distributed and used.
- in case of an emergency outside normal office working hours, about 200 people are called to come to the plant. There is no strategy to evaluate the number of call-ups in case a release has already taken place or is imminent.

No electronic dosimeters for fire fighters are foreseen. This makes it difficult to make an estimation of their dose after each intervention.

Without clear guidance on protection to people on site, actions to protect them in case of a release or in case of high radiation fields outside the radiation-controlled areas could be considerably delayed.

Recommendation: The plant should develop the necessary guidance for the protection of people on site in case of a radiological emergency.

Plant Response/Action:

KKM recognized the problems and has taken the following measures.

Personnel deployment and initial protective measures are performed in accordance with emergency procedure GNO-B-001.1 and 1.2.

Subsequently, on orders of the emergency team leader, all persons not directly engaged in the emergency are required to gather in the personnel restaurant where personnel are informed of the situation and a triage is implemented if necessary. Any persons not needed can be safely evacuated as the situation allows. Those persons required are allocated to the onsite shelters (operations building, SUSAN, Administration building). Operation of filter systems in the main control room, SUSAN and shelters is performed on the basis of procedures AMM-B-015 and 016.

In the case of an emergency outside of office hours, staff is mobilized as needed (see issue

8.1(1)).

Evaluation of the radiological situation is performed with the permanently installed on-line dose rate measuring equipment. Additional measurements will be carried out by Radiation Protection staff as needed. These results are discussed among the emergency staff and appropriate actions are taken.

The Emergency staff provides clear guidance to ensure the protection and safety of personnel as quickly as possible in response to a changing situation during an emergency.

IAEA Comments:

The team reviewed the four procedures mentioned above, with the results of the performed training and determined that they were all of high standards. The team also reviewed different documents dealing with required actions during emergencies, from different organizations and issued by the Swiss Authorities. The issues identified by the OSART team were adequately addressed by the Plant.

Conclusion: Issue resolved

SUMMARY OF STATUS OF RECOMMENDATIONS AND SUGGESTIONS OF THE OSART FOLLOW UP MISSION TO MUEHLEBERG –JUNE 2002

	RESOLVED	SATISFACTORY PROGRESS	INSUFFICIENT PROGRESS	WITHDRAWN	TOTAL
Management, Organization & Administration	1 S 2 R	1 R	---	---	3 R 1 S
Training & Qualification	4 R 1 S	---	---	---	4 R 1 S
Operations	1 R 2 S	1 S	---	---	1 R 3 S
Mechanical Maintenance	2 R 1 S	---	---	---	2 R 1 S
Electrical Maintenance	1 R	1 R	---	---	2 R
Radiation Protection	2 R 1 S	1 S	---	---	2 R 2 S
Chemistry	1 R 1 S	---	---	---	1 R 1 S
Emergency Planning and Preparedness	2 R 1 S	---	---	---	2 R 1 S
TOTAL (R) (%)	15 88 %	2 12 %	---	---	17 R 100 %
TOTAL (S) (%)	8 80 %	2 20 %	---	---	10 S 100 %
TOTAL (R) + (S) (%)	23 85 %	4 15 %	---	---	27 100 %

DEFINITIONS

DEFINITIONS - OSART MISSION

Recommendation

A recommendation is advice on how improvements in operational safety can be made in the activity or programme that has been evaluated. It is based on proven, good international practices and addresses the root causes rather than the symptoms of the identified concern. It very often illustrates a proven method of striving for excellence, which reaches beyond minimum requirements. Recommendations are specific, realistic and designed to result in tangible improvements.

Suggestion

A suggestion is either an additional proposal in conjunction with a recommendation or may stand on its own following a discussion of the pertinent background. It may indirectly contribute to improvements in operational safety but is primarily intended to make a good performance more effective, to indicate useful expansions to existing programmes or to point out possible superior alternatives to ongoing work. In general, it is designed to stimulate the plant management and supporting staff to continue to consider ways and means for enhancing performance.

Good Practice

A good practice is a proven performance, activity or use of equipment, which the team considers to be markedly superior to that observed elsewhere. It should have broad application to other nuclear power plants and be worthy of their consideration in the general drive for excellence.

DEFINITIONS - FOLLOW-UP VISIT

Issue resolved - Recommendation

All necessary actions have been taken to deal with the root causes of the issue rather than to just eliminate the examples identified by the team. Management review has been carried out to ensure that actions taken have eliminated the issue. Actions have also been taken to check that it does not recur. Alternatively, the issue is no longer valid due to, for example, changes in the plant organization.

Satisfactory progress to date - Recommendation

Actions have been taken, including root cause determination, which lead to a high level of confidence that the issue will be resolved in a reasonable time frame. These actions might include budget commitments, staffing, document preparation, increased or modified training, equipment purchase etc. This category implies that the recommendation could not reasonably have been resolved prior to the follow up visit, either due to its complexity or the need for long term actions to resolve it. This category also includes recommendations which have been resolved using temporary or informal methods, or when their resolution has only recently taken place and its effectiveness has not been fully assessed.

Insufficient progress to date - Recommendation

Actions taken or planned do not lead to the conclusion that the issue will be resolved in a reasonable time frame. This category includes recommendations on which no action has been taken, unless this recommendation has been withdrawn.

Withdrawn - Recommendation

The recommendation is not appropriate due, for example, to poor or incorrect definition of the original finding or its having minimal impact on safety.

Issue resolved - Suggestion

Consideration of the suggestion has been sufficiently thorough. Action plans for improvement have been fully implemented or the plant has rejected the suggestion for reasons acceptable to the follow-up team.

Satisfactory progress to date - Suggestion

Consideration of the suggestion has been sufficiently thorough. Action plans for improvement have been developed but not yet fully implemented.

Insufficient progress to date - Suggestion

Consideration of the suggestion has not been sufficiently thorough. Additional consideration of the suggestion or the strengthening of improvement plans is necessary, as described in the IAEA comment.

Withdrawn - Suggestion

The suggestion is not appropriate due, for example, to poor or incorrect definition of the original suggestion or its having minimal impact on safety.

ACKNOWLEDGEMENTS

The Government of Switzerland, the Nuclear Regulatory Authority of Switzerland and the Kernkraftwerk Mühleberg (KKM) provided valuable support to the OSART mission to Switzerland. In particular, the staff of Mühleberg Nuclear Power Plant provided excellent support throughout preparation and conduct of the mission and follow-up visit. Team members felt welcome and enjoyed good co-operation and dialogue with Mühleberg managers. This contributed significantly to the success of the mission. Mühleberg managers and especially the team's counterparts, engaged in frank discussions and assisted the team in understanding Mühleberg's performance and the basic factors contributing to it. Mühleberg managers were receptive to comments and suggestions made by team members and seemed dedicated to achieving operational safety improvements, where possible. The personal contact made during the mission and follow-up visit should promote continuing dialogue between team members and Mühleberg staff. The support of liaison personnel was outstanding. Their help was highly professional and greatly appreciated by the teams.

Switzerland has provided other support to the OSART programme, including experts for missions to other countries. Switzerland has also hosted one other combined operational and design review mission.

The IAEA, The Department of Nuclear Safety, the Division of Nuclear Installation Safety and the Operational Safety Section wish to thank all those involved for the excellent working conditions and support of the Mühleberg OSART mission and follow-up visit and for the on-going support of the OSART programme.

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