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According to Chapter IV and V of the
"Conclusions of the Melk Process and Follow-Up"

Item 5
Qualification of Safety Classified Components

Final Monitoring Report

Report to the Federal Ministry of Agriculture, Forestry, Environment and Water Management of Austria

Vienna, May 2005

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EXECUTIVE SUMMARY

The operability of safety equipment in a nuclear power plant (NPP) shall also be assured under accident conditions, when the temperature, humidity, pressures and radiation fields could be much higher than under normal operating conditions. The equipment is normally designed taking these conditions under considerations. To assure safety of a NPP it is essential to confirm that the equipment was verified to be able to operate under these accident conditions. The process of the preparation and maintenance of evidence to establish that the safety equipment will operate upon demand in the environment that is expected to be present at its respective physical locations is called the equipment qualification (EQ). It constitutes an important part of the safety requirements and defense in depth for each NPP.

The equipment qualification requirements and practices differ among countries operating NPPs. In particular, the EQ requirements which are typical in Western countries have not been standard applied to original Soviet designs. For Temelín NPP, the requirements for the EQ in force during the design and construction phase were much less than the actual requirements for EQ in Western countries.

The EQ, being an important safety element for Temelín NPP, was recognized and addressed as the Safety Issue #19 of the initial phase of the Melk process. Since this safety issue could not be resolved during the Melk process, it was adopted for the monitoring on technical level in the "Conclusions of the Melk Process and Follow-up", the Agreement between the Czech Republic and Austria of November 2001 ("Brussels Agreement") as item #5 "Qualification Safety Classified Components".

ENCONET Consulting was contracted by the Umweltbundesamt (Federal Environment Agency), on behalf of the Austrian Government, to provide the technical support for the monitoring process related with the EQ. This report summarizes the activities undertaken by ENCONET on the monitoring of the status of the EQ on Temelín as performed between August 2002 and December 2004. The evaluation of the status of EQ at Temelín was based on the information obtained from a variety of sources (presentations, IAEA reports, etc) and in particular from the Topical two-day Workshop devoted to the EQ and held in Prague on 9-10 December, 2002, as well as additional contacts and clarifications in October 2004. The Workshop was one of the measures agreed to be implemented in the "Road Map" regarding the "Brussels Agreement".

The status of the EQ at Temelín was compared with the state of the art of the requirements and the approaches to the EQ in western countries. Using this as the criteria, the conclusions on the adequacy of the EQ at Temelín were established. The findings, criteria and the status at Temelín are all documented in this report.

Temelín EQ program that was introduced in 1999 to fulfill regulatory requirements set forth in the Atomic act of 1997 and Decrees, follows western principles and methods. The EQ was to be completed in 2002 but due to delays, it is now scheduled for the completion in 2006. There is no special regulatory approval of the EQ in the Czech Republic. SUJB however, monitors the implementation of the EQ through periodic regulatory inspections. Large progress in EQ is visible, and the number of open issues has been greatly reduced over the last year. Difficulties with the lack of proper documentation for some equipment necessitated additional analysis and, in some cases, testing of specific components.

The overall conclusion of the evaluation is that the EQ at Temelín is now comparable with the western approaches in principles, methods used and results achieved. The regulatory requirements and the technical basis for the EQ are comparable with western requirements, the implementation of the EQ follows prudent practices and the EQ documentation of the EQ is comparable (or even better) than for some western plants. The methods used in establishing the status of EQ as well as the acceptance criteria appear broadly similar to western practices.

While significant improvement in the number of components for which the EQ is completed is noted, there are still safety components not having the EQ finalized. The plans to complete the EQ on all equipment were presented and evaluated by ENCONET experts as realistically achievable. For some of the components where the EQ is not completed, compensatory measures have been introduced in the form of specific operating instructions. An example confirmed that the compensatory measures were successfully implemented. The full list of equipment where compensatory measures were introduced were not provided.

The following points are of future interest in relation with EQ activities at Temelín:

- The continuation of completion of the EQ on all equipment (for 5 equipment groups general EQ is incomplete and for 14 equipment groups ageing qualification is incomplete as of December 2004), including EQ for ageing phenomena
- Consideration on localized effects on selected components outside the containment of Temelín.
- Significant findings of regulatory inspections related with EQ that could influence successful completion of the EQ program.

Nevertheless, the level of achievement so far and consideration of the on-going activities is supporting the conclusion that the EQ at Temelín is not an open safety issue any more.

KURZFASSUNG

Die Funktionstüchtigkeit der Sicherheitseinrichtungen in einem Kernkraftwerk muss auch unter Störfall-Bedingungen garantiert sein, wenn Temperatur, Feuchtigkeit, Drücke und Strahlenfelder wesentlich höher sein können als unter normalen Betriebsbedingungen. Generell sind die Sicherheitseinrichtungen in KKWs unter Berücksichtigung solcher Bedingungen ausgelegt. Um die Sicherheit eines KKWs zu gewährleisten, ist es von wesentlicher Bedeutung zu bestätigen, dass die Sicherheitseinrichtungen geprüft wurden und nachgewiesen wurde, dass sie unter Unfallbedingungen funktionieren können. Der Prozess der Erstellung und der laufenden Aktualisierung des Nachweises, dass die Sicherheitseinrichtungen unter den erwarteten Umgebungsbedingungen am jeweiligen tatsächlichen Standort im Bedarfsfall funktionieren werden, wird Qualifizierung von Komponenten (Equipment Qualification – EQ) genannt. Sie stellt einen wichtigen Teil der Sicherheitsanforderungen und des „Defense-in-Depth“-Prinzips bei Kernkraftwerken dar.

Die Anforderungen und die Praxis der Qualifikation sind international bei den Kernkraftwerke betreibenden Ländern nicht einheitlich. Insbesondere sind die für die westlichen Länder typischen Anforderungen an die Qualifizierung von Komponenten bei Kernkraftwerken ursprünglich sowjetischer Bauart nicht standardmäßig angewendet worden. Für das Kernkraftwerk Temelín waren die während der Auslegungs- und Errichtungsphase gültigen Anforderungen an die Qualifizierung der Komponenten wesentlich niedriger als die heute in westlichen Ländern geltenden Anforderungen.

Daher wurde die Qualifizierung von Komponenten, die für das KKW Temelín ein wichtiges Sicherheitselement darstellt, in der Anfangsphase des „Melker Prozesses“ als Safety Issue #19 definiert und angesprochen. Da dieses Safety Issue während des „Melker Prozesses“ nicht gelöst werden konnte, wurde es zur Überwachung auf technischer Ebene in den ANNEX I der *„Schlussfolgerungen des Melker Prozesses und Follow-up“*, der Übereinkunft zwischen der Tschechischen Republik und Österreich vom November 2001 („Vereinbarung von Brüssel“) als Punkt #5 *„Qualifikation von sicherheitsrelevanten Komponenten“* aufgenommen.

ENCONET Consulting wurde vom Umweltbundesamt im Namen der österreichischen Regierung beauftragt, die technische Unterstützung für den mit der Qualifizierung verbundenen Monitoringprozess zu leisten. Dieser Bericht stellt eine zusammenfassende Darstellung der Aktivitäten dar, die ENCONET im Rahmen des Monitorings zum Status der Qualifizierung von Komponenten in Temelín zwischen August 2002 und Dezember 2004 unternommen hat. Die Bewertung des Status der Qualifizierung von Komponenten in Temelín basiert auf einer Reihe von Quellen (Präsentationen, Berichte der IAEO etc.), insbesondere auch auf einem zweitägigen Workshop zum Thema Qualifizierung von Komponenten, welcher von 9. – 10. Dezember 2002 in Prag abgehalten wurde. Dazu kamen weitere Kontakte und Klarstellungen im Oktober 2004. Der Workshop zählte zu den Maßnahmen, deren Implementierung in der “Road Map” zur „Vereinbarung von Brüssel“ vereinbart wurde.

Der Status der Qualifizierung von Komponenten im KKW Temelín wurde mit jenen Anforderungen und Ansätzen zur Qualifizierung von Komponenten verglichen, die dem Stand der Technik in westlichen Ländern entsprechen. Auf diesen Kriterien basierend, wurde die Schlussfolgerung abgeleitet, dass die Qualifizierung von Komponenten in Temelín adäquat ist. Die Erkenntnisse, die Kriterien und der Status im Kraftwerk Temelín sind in diesem Bericht dokumentiert.

Das Qualifizierungsprogramm des KKW Temelín, welches 1999 eingeführt wurde, um die im Atomgesetz von 1997 festgelegten aufsichtsbehördlichen Anforderungen und andere Vorschriften zu erfüllen, entspricht westlichen Prinzipien und Methoden. Die Qualifizierung der Komponenten sollte 2002 abgeschlossen werden. Aufgrund von Verzögerungen wurde der Fertigstellungstermin jedoch nun auf 2006 verschoben. Für die Qualifizierung von Komponenten ist in der Tschechischen Republik keine gesonderte Genehmigung vorgesehen. Den-

noch überwacht die Aufsichtsbehörde SÚJB die Implementierung der Qualifizierung von Komponenten durch periodische Überprüfungen. Bei der Qualifizierung von Komponenten sind große Fortschritte erkennbar, und die Anzahl der offenen Punkte konnte im letzten Jahr beträchtlich reduziert werden. Schwierigkeiten aufgrund des Fehlens adäquater Dokumentation für einige Komponenten machten zusätzliche Analysen und in einigen Fällen auch Tests für spezifische Komponenten notwendig.

Die generelle Schlussfolgerung der Bewertung lautet, dass die Qualifizierung von Komponenten in Temelín heute betreffend Prinzipien, verwendeten Methoden und erzielten Resultaten mit westlichem Herangehen vergleichbar ist. Die Anforderungen der Aufsichtsbehörde und die technische Grundlage für die Qualifizierung von Komponenten sind mit den westlichen Anforderungen vergleichbar, die Implementierung der Qualifizierung von Komponenten entspricht einer verantwortungsvollen Praxis. Die Dokumentation der Qualifizierung ist mit der von westlichen KKWs vergleichbar (oder sogar besser). Die Methoden zur Ermittlung des Status der Qualifizierung von Komponenten wie auch die Akzeptanzkriterien stellen sich in groben Zügen als den westlichen Methoden ähnlich dar.

Während sich die Anzahl der Komponenten, für die eine Qualifizierung abgeschlossen worden ist, deutlich erhöht hat, gibt es noch einige sicherheitsrelevante Komponenten ohne abgeschlossene Qualifizierung. Die Pläne zur Fertigstellung der Qualifizierung für alle Einrichtungen wurden präsentiert und von den Experten von ENCONET als realistisch durchführbar bewertet. Für einige Komponenten ohne abgeschlossene Qualifizierung wurden Kompensationsmaßnahmen in Form von spezifischen Betriebsvorschriften eingeführt. Ein Beispiel hat bestätigt, dass die Kompensationsmaßnahmen erfolgreich implementiert worden sind. Eine vollständige Liste aller Komponenten, für die kompensatorische Maßnahmen eingeführt wurden, wurde nicht zur Verfügung gestellt.

Die folgenden Punkte werden in Zukunft für das Thema Qualifizierung von Komponenten in Temelín von Interesse sein:

- Die weiteren Fertigstellungsarbeiten der Qualifizierung für alle Komponenten (mit Dezember 2004 ist die allgemeine Qualifikation für 5 Gruppen von Komponenten unvollständig, und die Qualifikation für Alterungsphänomene für 14 Gruppen von Komponenten), einschließlich der Qualifizierung von Komponenten für Alterungsphänomene.
- Die Überlegungen zur Definition lokalisierter Effekte auf ausgewählte Komponenten außerhalb des Containments von Temelín.
- Wesentliche Erkenntnisse aus den Inspektionen der Aufsichtsbehörde zur Qualifizierung von Komponenten, die auf die erfolgreiche Fertigstellung des Qualifizierungsprogramms Einfluss haben könnten.

Das Niveau des bisher Erreichten und die Berücksichtigung der aktuellen Aktivitäten lässt dennoch die Schlussfolgerung zu, dass die Qualifizierung von Komponenten in Temelín keine offene Sicherheitsfrage mehr darstellt.

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1 INTRODUCTION

1.1 The framework

Republic of Austria and the Czech Republic have, using the good offices of Commissioner Verheugen, reached an accord on the “Conclusions of the Melk Process and Follow-up” (Brussels agreement) on 29 November 2001. In order to enable an effective use of the achievements of the initial “Melk Process” in the area of nuclear safety, the ANNEX I of this “Brussels Agreement” contains details on specific actions to be taken as a follow-up to the “trialogue” of the “Melk Process”. The pertinent Czech-Austrian Bilateral Agreement governs this follow-up.

To enable an effective “trialogue” follow-up in the framework of this Czech-Austrian Bilateral Agreement, a seven-item structure each presenting an important safety issue was adopted and specified in the ANNEX I of the “Brussels Agreement”. These individual items are linked to 1) Specific objectives set in the licensing case for NPP Temelín and 2) Description of present status and future actions foreseen by the licensee and SÚJB, respectively. Each of seven items under discussion is pursued according to the work plan agreed at the Annual Meeting organized under the pertinent Czech-Austrian Bilateral Agreement.

Furthermore, the Commission on the Assessment of Environmental Impact of Temelín NPP, set up on the basis of the resolution of the Government of the Czech Republic, presented a report and recommended in its Position the implementation of twenty-one concrete measures (ANNEX II to the “Brussels Agreement). The signatories agreed that Czech and Austrian experts within the Czech-Austrian Bilateral Agreement would also regularly monitor the implementation of the measures.

The framework for the monitoring on the technical level of implementation was established in the “Roadmap” developed within the Czech-Austrian Bilateral Agreement as foreseen in the “Brussels Agreement”. This Roadmap has been elaborated and agreed upon by the Deputy Prime Minister and Minister of Foreign Affairs of the Czech Republic and the Minister of Agriculture and Forestry, Environment and Water Management of the Republic of Austria on 10 December 2001.

This „Roadmap“ is based on the following principles:

- *The implementation of activities enumerated in ANNEX I and II of the “Brussels Agreement” will be continued to ensure that comprehensive material is available for the monitoring activities set out below.*
- *Having in mind the peer review procedure foreseen by the EU to monitor the implementation of the recommendations of the AQG/WPNS Report on Nuclear Safety in the Context of Enlargement, the Czech and Austrian sides agree that this peer review should serve as another important tool to handle remaining nuclear safety issues.*
- *As a general rule the regular annual meetings according to Art. 7(1) of the bilateral Agreement between the Government of Austria and the Government of the Czech Republic on Issues of Common Interest in the Field of Nuclear Safety and Radiation Protection will serve to monitor the implementation of those measures referred to in Chapter V of the Conclusions and to address questions regarding nuclear safety in general, in particular those issues which – according to Chapter IV of the Conclusions have been found, due to the nature of the respective topics, suitable to be followedup in the framework of this Bilateral Agreement.*
- *In addition, specialists’ workshops and topical meetings will take place, organized as additional meetings according to Art. 7(4) of the bilateral Agreement between the Government of Austria and the Government of the Czech Republic on Issues of Common Interest in the Field of Nuclear Safety and Radiation Protection, as set out in the “Roadmap”.*

In Austria, the Federal Ministry of Agriculture, Forestry, Environment and Water Management entrusted the Umweltbundesamt (Federal Environment Agency) with the overall management of the implementation of the "Roadmap". For each of the items of the "Roadmap", specific technical project was established.

Item No.5 "Qualification of Safety Classified Components" of the ANNEX 1 of the "Brussels Agreement" is supposed to evaluate the level of completeness and the appropriateness of equipment qualification at Temelín. This is to assure that safety components are qualified to perform their intended functions during all environmental conditions and under other external influences envisaged during normal and accidental conditions at Temelín plant.

The objective regarding this item as stated in ANNEX I of the "Brussels Agreement" is "all safety systems shall be qualified for their dedicated safety functions".

ANNEX I of the "Brussels Agreement" further specified the "Present Status and Specific Actions Planned" as follows:

> *"Seismic qualification is completed. Electromagnetic compatibility qualification is completed. Respective documentation is completed and filed. In the case of environmental qualification, all processes (test and/or analysis) required by the licensing program have been performed. Qualification of I&C and electrical supplies that represents the majority of equipment relevant for qualification is documented and filed in standard format. In limited number of cases (where equipment was procured in beginning of nineties), regulatory authority requested the transfer of documentation to standard format till the end of 2001. This submittal will be subject to regulatory review and approval taking into the account the requirement for the accessibility of the documentation according to state of the art standards.*

Following the "Roadmap" guidance that a Specialists' Workshop be held in the 2nd half of 2002, the workshop was held in Prague on Dec 6-8 2002 to discuss this issue. Recognizing that the Czech-Austrian Bilateral Agreement is an appropriate framework that provides the opportunity for further discussion and sharing additional information on this issue, the presentation and the discussion on the Environmental qualification of equipment at Temelín NPP was placed on the Agenda for the Austrian-Czech bilateral meeting that took place in Vienna in December 2003. Following the presentation by Austrian experts on the findings, the Czech representatives offered to provide an update reflecting the developmental of the EQ at Temelín since the 2002 Workshop.

This update was provided in a format of a report prepared by Stevenson & Associates and UJV Rez, presented to Austrian side in October 2004 [Stevenson 04]. The report reflects the developments and main issues between the time of the Workshop (December 2002) and July 2004. This report, together with other available information, was used to review and modify, where appropriate, the Preliminary monitoring report to prepare this Final Monitoring report.

ENCONET Consulting was contracted by Umweltbundesamt GmbH (Federal Environment Agency Ltd.) on behalf of the Austrian Government to provide the technical support for the monitoring process related with the EQ, succinct to the ANNEX I of the Conclusions of the Melk Process and Follow-up. This technical support to the monitoring was defined as a specific project, which is referred to as the "Project PN4". The project itself comprises seven predefined "project milestones" (PM), each devoted to specific technical aspect and/or interface requirements.

1.2 International EQ requirements and practices

The requirements for establishing and preserving the environmental and seismic qualification of safety equipment exist in all countries operating NPPs, although practices vary, sometimes to a large extent. Some notable differences include consideration of ageing, irradiation degradation models, special stresses during operation, man-made hazards and steps within the qualifying test sequence. Possibly the best documented systematic approach to the EQ is found in the USA. This approach is followed in many EU countries, although some notable specifics, in particular in assigning responsibilities are present in German and French practices. Original requirements for Soviet-design were significantly inferior to western requirements.

Typically, the qualification of equipment important to safety should be ensured and demonstrated before fuel loading. Formal qualification reports should be completed (and where required, evaluated by the Regulator) before startup tests. Normally, the NPP is responsible for the overall qualification program, which will cover all aspects of the EQ process from establishing the qualification requirements and criteria to assuring long-term preservation of the qualified status of equipment important to safety. The NPP would co-ordinate the support of its suppliers while implementing various activities relevant for equipment qualification. Where compulsory, the NPP would also submit relevant documentation to the Regulator to demonstrate the fulfillment of the EQ requirements.

It has to be noted that the EQ programs, in their modern form were not in place at the time when most of the NPPS that are in operation today were starting up. Thus, the EQ has been implemented on operating plants in most countries (as it is now being implemented at Temelín). This however does not apply to recent startups in western countries.

1.3 Status of EQ at Temelín in 2001 (Initial Melk process)

The investigations within the Melk process in 2001 established that the original approach for qualification of equipment at Temelín followed Soviet practices. Those were significantly inferior to internationally accepted EQ practices [IAEA 96]. To respond to the requirements for EQ set by the Regulatory authority, SUJB, Temelín NPP initiated a complex program for environmental re-qualification of equipment important to safety to follow western practices and criteria. Temelín's POSAR (page 3.11.3) specified that the implementation of the EQ program began in early 2000 and should have been completed by the middle of 2002.

Four major steps characterize this program:

- Reassess the list of equipment to be qualified
- Asses and establish the EQ requirements for specific components and locations
- Define the EQ specifications and review the qualification status of individual equipment
- Issue or upgrade the EQ reports and establish EQ preservation program.

Some of the main conclusions of the review of the status of the EQ at Temelín performed in 2001 within the process of realization of the “Roadmap” developed within the Czech-Austrian Bilateral Agreement as foreseen in the “Brussels Agreement”. were:

1. Temelín NPP, being at that time at the end of the commissioning phase and trial operation, did not complete the EQ activities on all “safety” and “safety related“[1] equipment. The fuel loading and subsequent nuclear tests were authorized without having fully established EQ. The regulator was informed on the details of the equipment for which the EQ was not completed as well as on the schedule that would assure completion of the EQ in a reasonable time. This justified the issuance of the commissioning and operating licenses.
2. The formal qualification reports on all equipment where the EQ was incomplete were not prepared at that time of the commissioning. The lack of documentation on equipment qualification on site may deprive operators of important information in case of abnormal and emergency conditions affecting non-qualified equipment.
3. During the presentation on EQ held in Prague in March 2001, it was stated that a decision by SUJB placed priority to the process of environmental qualification for **safety systems**. The EQ for **safety related systems** was to be implemented subsequently. Detailed information about the current situation of qualification of **safety related systems** and the planning of the process for full establishment of their environmental and seismic qualification was not clarified.
4. The primary responsibility to demonstrate and maintain the qualification of equipment important to safety rests with the Operator. Contractors can perform tests and analyses and provide technical support to the Operator during the licensing process. Nevertheless the Operator has to demonstrate his own culture and knowledge in the matter of qualification, manage all the aspects related to equipment qualification, review available documentation for the identification of additional actions to be taken, integrate the work performed by different contractors ensuring correct interfaces and demonstrate the correct and complete implementation of EQ to the Regulator.

1.4 Assessment of Temelín EQ within the Melk follow up process

Within the framework of the project, ENCONET experts identified issues of interest and established criteria against which Temelín EQ program could be objectively assessed. This preparatory work encompassed establishing the criteria to reflect the state of the art practices and requirements in western Europe and USA. The regulatory requirements in the Czech Republic and the status of the EQ at Temelín were assessed against these criteria. To document the status and the practices on the EQ in western countries, ENCONET Consulting prepared several documents including the “Verifiable Line Items” (VLI), “Specific Information Request”, "Regulatory Practices for Equipment Qualification in Western Countries", and extensive briefing materials for the Austrian delegation. All these were used as the basis for the evaluation during (and after) the Workshop on Equipment Qualification at Temelín NPP, which was held in Prague on 9 and 10 December 2002.

[1] According to Temelin POSAR: – **Safety systems** are defined as main protection and control systems, their operability must be maintained during all internal and external DBA. – **Safety related systems** are defined as non important protection and control systems, actuation systems and support systems, their operability does not have to be ensured in all events assumed in the design

As specified by the "Conclusion of the Melk process and follow-up", the Workshop on EQ in Prague on Dec 9-10, 2002 *''will serve to address regulatory review and approval of environmental qualification documentation taking into account requirements for accessibility of documentation according to state-of-the-art standards."*

The Workshop was expected to be an event where a comprehensive exchange of information and discussions of the status of implementation of the EQ program at Temelín would take place. In effect, the Workshop was the key element in establishing the findings on the following issues:

1. What are the content, requirements and current status of implementation of the EQ Program for Temelín. In particular, of interest were the findings and results of the three major steps that characterize this program:
   a) *Identification of the equipment to be qualified and service conditions*
   b) *Status of the qualification of safety and safety related equipment*
   c) *Equipment upgrading actions undertaken or planned, issuance of qualification reports and preservation programs;*
2. What is the current status of the licensing process in relation with the EQ;
3. What is the current status of availability of the EQ documentation at Temelín NPP;

Specific information to enable Austrian team to evaluate the status and in particular completeness of the EQ using the VLI and western practices as the criteria was supposed to be collected on the basis of Czech presentations and follow up discussions during the Workshop. The material presented at the Workshop included 12 topical papers. In addition, at ENCONET request, the Austrian delegation received two additional documents, namely the list of safety related systems and SUJB guide on EQ in WWERs [SUJB 98]. Also, upon request, ENCONET experts have been shown the details of the EQ data base, which is in the center of Temelín's activities for establishment and preservation of EQ.

Thanks to extensive technical preparation and clarifying discussions during the Workshop, ENCONET experts achieved good level of technical understanding of the actual status of EQ at Temelín NPP. This enabled the preparation of the Preliminary monitoring report that was published in 2003. The Preliminary Monitoring report identified several EQ-related issues that were incomplete and thus warranted further monitoring within the framework of the implementation of the "Brussels Agreement" and/or the pertinent Czech Austrian Bilateral Agreement.

To provide an update on the status and developments of the EQ at Temelín between the Workshop (December 2002) and July 2004, Stevenson & Associates and UJV Rez prepared a report entitled "Answer to the Conclusion of the Melk process Qualification of Safety Classified Components of the NPP Temelín" (#068-04.ete, August 2004). The information provided by that report was used to update the findings of the Preliminary monitoring report to allow for the most up-to-date status to be presented in this Final monitoring report.

While this Final monitoring report recognizes that not all the issues related with the EQ at Temelín were completely resolved at the end of 2004, those issues where further interest is warranted are recommended to be put on the agenda for future regular meetings according to the pertinent Czech Austrian Bilateral Agreement.

1.5 Objective of this report

The objective of this report is to present the evaluation of the status of the EQ for Temelín based on the information available to the Austrian side. This include the information provided during the workshop and Answers to the Conclusion report of August 2004, but also information available to Austrian experts from other sources, including IAEA mission reports and similar. The aim of the report establish the status of the EQ at Temelín as of end of 2004 and to point out the issues which are still pending. This would create the basis for further discussions within bilateral Czech-Austrian activities, if so decided.

1.6 Report structure

The evaluation of the actual status of the EQ program at Temelín NPP is presented in the Section #2. This evaluation is mostly based on the information received during the Prague workshop of December 2002, “Answers to the conclusions” report of August 2004, specific discussions with Czech counterparts but also on other information sources available to the evaluation team within this project. To enable comparison with international standards as well as specific western practices and criteria, this section follows the structure of the “VLIs” and the state of the art practices on EQ in western countries. The criteria are often provided as a reference to the US practice, which is the one best defined in the western world.

Section #3 of the report discusses topic relevance for specific aspects of the implementation of EQ at Temelín. Section #4 summarizes general conclusions, focused on specific elements of EQ process. Section #5 highlights the issues related with the EQ at Temelín, which may warrant further attention within bilateral Czech-Austrian activities.

2 EVALUATION OF EQ AT TEMELÍN USING VLI CRITERIA

2.1 Licensing basis and criteria

2.1.1 Regulatory Documents and Licensing Process on EQ (VLI 1.1 to 1.3 and 1.10, 1.11)

2.1.1.1 US approach

Reference documents used by regulatory bodies (regulatory documents) in many countries for licensing of NPP projects are structured in a hierarchy with three levels:

- legislation
- regulations
- regulatory guides.

Legislation is the highest level of regulatory documents and is approved by the highest national legislative body. Legislation effectively separates the responsibilities between the regulatory body and operating organizations, provides a legal basis for the regulatory body to conduct the licensing process, and sets long-term and broad objectives taking into account other existing legislation and regulations.

Regulations are formally issued by the government or on behalf of the government, which as necessary extend or detail the legislation. Regulations provide mandatory requirements or conditions with which operating organizations shall comply. Regulations assure support to the regulatory body in the achievement of the minimum level of nuclear safety.

The regulatory body establishes regulatory guides, which specify the regulatory position and recommended methods that operating organizations should follow. Alternative methods are acceptable if the achievement of the same or higher level of nuclear safety can be demonstrated. Regulatory guides assure that the regulatory body will maintain consistent practices when performing evaluation of the activities, facilities or operating organizations.

Industrial codes and standards issued by specialized institutions are typically based on consensus of experts. Those provide technical guidance and methods to meet the safety principles and objectives. When being referred to in regulations, regulatory guides or other regulatory documents, industrial codes and standards become mandatory or recommended by the regulatory body.

In the US, the requirements for the EQ are embedded in the legislation (10CFR50) and detailed requirements and practices provided in a variety of supporting documents issued by the regulator and industry itself.

The details of the practice in USA, France and Germany were analyzed by ENCONET and used as appropriate in this evaluation.

2.1.1.2 Situation in respect of Temelín NPP

Until 1998, the activities on EQ for Temelín NPP were based on general requirements of QA program according to the Czechoslovak Decree No. 2/1978. The Atomic Act of 1997 and accompanying regulations established the requirements for equipment qualification within a regulatory framework. Those are now comparable to the requirements in Western countries. The plant has undertaken the development and realization of an extensive EQ program to fulfill the regulatory requirements.

Implementation of Equipment Qualification practices according to Western approach is a complex task in a new nuclear power plant, but even much more complicated in a plant, which has already been built according to rules previously in force in the Soviet Union.

Therefore the State Office of Nuclear Safety (SUJB) developed and issued a safety guide on EQ in WWER 440/213 NPPs being in operation [SUJB 98]. This Guide, although originally meant for Dukovany NPP, is also applicable to Temelín NPP. The Guide specifies the elements of the EQ programme, provides the guidance on the list of equipment to be qualified, on qualification methods and on the implementation of the programme in an already built NPP. ENCONET reviewed the guide, and found its contents and specific requirements well in line with modern international practices and requirements.

As required by the regulations, Temelín NPP was to develop its own program describing the principles of EQ management process. Stevenson and Associates developed the program for Temelín NPP. The program includes procedures for qualification of all types of equipment. The program and conditions for its fulfillment are documented in POSAR for Temelín.

The regulatory practice in the Czech Republic does not require specific approval for EQ program. However, within the frame of regulatory inspections, elements of the EQ programs are reviewed on the regular basis. Any specific requirements or conditions identified through those inspections are documented in the inspection protocols, thus becoming mandatory for the licensee.

By the virtue of having the EQ program described in POSAR, which is the document upon acceptance of which the commissioning/operating license is issued, the EQ program is implicitly approved by the regulator. The POSAR also established the schedule for the completion of the EQ activities (2002). Due to various reasons, in most cases related to lack of documentations on specific equipment (mostly those imported from FSU), the completion of the EQ program slipped. Upon a request of Temelín, the SUJB agreed with new schedule that calls for completion in 2004 (2006 for ageing related issues).

2.1.1.3 Comments and recommendations

The situation in Czech republic where EQ program is not directly approved is similar to some, but different to other western countries. The SUJB approved the EQ program implicitly (through its acceptance of POSAR) and not explicitly, as would be the case in some other countries. In the US, the program of EQ “shall be submitted to the NRC for approval” according to [10CFR50 App. B] and [IEEE 627 section 7].

Although lack of formal approval of the program should not be, by itself, seen as a deficiency, in some cases, regulatory review of EQ principles and implementation would assure increased consistency of the EQ implementation.

Furthermore, if the EQ program implementation is not subject to direct “control” of the regulatory authority, this could lead to a situation where some elements of the program may be unacceptable to the regulator and not corrected on time. Regular SUJB inspections focused on EQ continued through 2002 and 2003 with documented evidence of findings and specific agreed deadlines for addressing specific findings.

As it could be seen from the discussion in the Section 2.2 of this report, the evaluation team did not find evidence that the lack of formal regulatory approval and oversight resulted in the licensee being less vigilant in the implementation. Apart from delaying the schedule (which might have been too optimistic at the first place, possibly due to lack of experience on subject area) the evaluation team did not raise any specific concerns that could be related to lack of regulatory oversight. The guidance provided in the regulation [SUJB 98] and the periodic reviews of SUJB inspectors in conjunction with implementation of standard US practices by S&A company being in charge of EQ programme have resulted so far in results which do not give basis for any objections.

2.1.2 Safety Classification of equipment (VLI 1.4, 1.5)

2.1.2.1 US approach

A system of **four safety classes** for structures, systems and mechanical components (SSC) are established in ANSI N18.2 "Nuclear Safety Criteria for Water Reactor Plants" and ANS 51.1 "Nuclear Safety Criteria for Design of Stationary Pressurized Water Reactor Plants", consistent with the ASME Boiler and Pressure Vessel Code, Section III, for boundaries of fluid-retaining components.

This classification system is based on identification and ranking of safety functions and analysis of postulated accidents. Safety Class 1 (SC-1) is most important to safety and includes components of the reactor coolant system up to and including the isolation valves. SC-2 and SC-3 are less important, and SC-4 in ASME Code or Non-Nuclear Safety (NNS) Class in ANSI or ANS Standards is the least important to safety.

The safety classification of electrical (including I&C) equipment is described in RG 1.89 "Environmental Qualification of Certain Electric Equipment Important to Safety for NPPs", where electrical equipment is categorized into four classes:

- Equipment important to safety (Class 1), which are further categorized into
  - safety-related electric equipment (Class 1E)
  - non-safety-related electric equipment (non-Class 1E)
  - post monitoring equipment
- Equipment not-important to safety (Class 2).

Safety-related electric equipment is that relied upon to remain functional during and following design basis events to ensure

a) The integrity of the reactor coolant pressure boundary
b) The capability to shut down the reactor and maintain it in a safe shutdown condition
c) The capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures.

Non-safety-related electric equipment whose failure under postulated environmental conditions could prevent satisfactory accomplishment of safety functions specified.

Appendices A and B of RG 1.89 provide, respectively, a list of typical safety-related electric equipment or system, and a list of typical examples of non-safety related equipment.

Criteria for seismic classification for SSCs are established in Appendix S to 10CFR50 and are defined in RG 1.29 "Seismic Design Classification". Based on the required capacity to withstand the effects of SSE and remain functional or lack of such requirement, two basic seismic categories are established:

- Seismic Category 1, which are able to withstand the effects of the SSE and remain functional.
- non-Seismic Category 1, which may be further categorized to
  - Category 2
  - Category 3, and
  - Category 4 (taking into account conventional risks).

A list of safety related SSCs, including 17 systems that are designated as Seismic Category I is given and described in the RG 1.29.

2.1.2.2 Situation in Temelín NPP

The classification of equipment at Temelín NPP is based on the division into two classes: safety systems and safety related systems.

The review of "safety related systems" as defined for Temelín NPP shows that some of the elements of equipment and systems classified at Temelín as "safety related" would be classified according to the IAEA [IAEA 98] as "non-safety systems". While the naming scheme introduces some doubts (appears to be different from Western practices and the IAEA requirements), a careful evaluation of the actual classification confirmed that all systems that the IAEA lists as "safety" and "important for safety" are in Temelín classified as "safety systems" and their EQ is being completed as the first priority.

Concerning the equipment classified as "safety systems", the requirements for their EQ follows the IAEA recommendations [IAEA 98] and the US practice. In particular, the whole approach to seismic qualification of Temelín equipment is adopted directly from the US practice and follows US codes and regulations.

This yields generally satisfactory results in practical work. Although no formal documents were produced which would specify the required basis for classification, the classification is documented in the Safety Analysis Report, which has been reviewed by SUJB.

In relation to the “safety related systems”, in some cases it appears that the requirements for the EQ may be even stricter that typical in western plants for systems having similar functions. However no systematic comparison was made to fully support this finding.

2.1.3 Identification of Service Conditions (VLI 1.6 to 1.9)

2.1.3.1 US approach

The design bases for protection against natural phenomena are described in GDC 2, including equipment required to function during and after SSE (Safe Shutdown Earthquake). Environmental and dynamic effects design bases are described in GDC 4, of Appendix A to 10CFR50. DBAs are described in SRP 3.6 and SRP 15; there are in total more than 25 events that could be considered as DBAs of PWR NPPs.

The events in normal operation and under accident conditions are divided into five sets of plant conditions (PC-1 to PC-5). Aggravation of plant conditions possibly due to coincident occurrence (CO) and/or single failure (SF) concurrently with the initialing event (IE) (Table 3-4, [ANSI/ANS 51.1]). For each of the plant conditions offsite dose criteria are determined. As various criteria of classification of incidents and accidents have been proposed by different US organizations (RG 1.70, ASME, and ANS standards), the respective frequencies and relationships are presented in Figure B-1 of [ANSI/ANS 51.1].

The specific environment for which individual electric equipment must be qualified will depend on the installed location and the length of time and conditions under which it is required to perform its safety functions. The following are some general considerations [RG 1.89]:

(1) Equipment outside containment would generally see a less severe environment than equipment inside containment;

(2) Equipment whose location is shielded from a radiation source would generally receive a smaller radiation dose than equipment at the same distance from the source but exposed to its direct radiation;

(3) Equipment required to initiate protective action would generally be required for a shorter period of time than instrumentation required to follow the course of an accident;

(4) Analyses taking into account arrangements of equipment and radiation sources may be necessary to determine whether equipment needed for mitigation of DBAs other than LOCA of HELB could be exposed to a more severe environment than the LOCA of HELB.

2.1.3.2 Situation in Temelín NPP

The list of equipment needed to function under various accident conditions was prepared for Temelín NPP and the service conditions for this equipment are determined, taking into account equipment location and duration of exposure to transient or accident conditions. This covers all the equipment of relevance for the EQ. The actual status in Temelín was compared with the Western requirements and found satisfactory as shown in VLI 1.6-1.9. The list of DBAs has been significantly expanded in comparison to the original list provided by the plant supplier by inclusion of steam generator collector break, Anticipated Transients Without Scram (ATWS), etc. The frequencies of DBAs have been established for the plant lifetime. The equipment required to function during DBAs and after SSE has been identified.

Thus the situation at Temelín NPP in this regard corresponds to the Western practice.

2.2 Equipment Environmental Qualification Program

2.2.1 Establishment of the Equipment Qualification Program (VLIs 2.1 to 2.3, and 2.9)

2.2.1.1 US approach

In case of electrical equipment, an EQ program is required to be established by 10CFR50.49 (a) and (b) that "Each holder of or an applicant for a license for a nuclear power plant shall establish a program for qualifying the electric equipment", which includes:

(1) Safety-related electric equipment.

(2) Non-safety-related electric equipment

(3) Certain post-accident monitoring equipment.

IEEE 627-1980 in Section 4 outlines the general mandatory requirements for an equipment qualification program for safety system equipment in a NPP, including:

(1) Qualification criteria

(2) A qualification program to demonstrate satisfaction of qualification criteria by analysis, test, operating experience or a combination of these.

(3) Evidence of successful completion of qualification

(4) Documentation of all of above.

In Section 5, IEEE-627-1980 specifies the EQ program specifications, which as a minimum should include:

1) Equipment performance requirements, including a description of its safety functions
2) The equipment boundary, including components that are inside the boundary, and the physical orientation of the equipment
3) Description of the interfaces, loads, power source and control signals, as applicable
4) Design codes and standards applicable to the design of the equipment
5) Specific qualification standards, if any, that pertain to the specific type of equipment
6) Definition of the service conditions for the equipment
7) Margin in the qualification program
8) Identification of significant ageing mechanisms if any
9) Acceptance criteria for qualification
10) Requirements for documentation of the equipment qualification.

2.2.1.2 Situation at Temelín NPP

The Western practice for establishment of the EQ program is closely followed. A formal EQ program has been established, clearly identifying the criteria for selection of equipment to be qualified. It provides the guidance on the evaluation of environmental effects on equipment.

There is, however, a difference in comparison with the western practices as for the VLI 2.2. The EQ program has not been approved because the Czech regulations do not require SUJB approval for EQ program. This has been commented in section 2.1.1.3.

2.2.2 Determination of the Harsh Environments (VLIs 2.4 to 2.8)

2.2.2.1 US approach

The electric equipment qualification program must include and be based on the following: Temperature and Pressure, Humidity, Chemical effects, Radiation, Aging, Synergistic effects and Margins [10CFR50.49 (e)]. Design basis events are defined as conditions of normal operation, including anticipated operational occurrences, design basis accidents, external events, and natural phenomena for which the plant must be designed to ensure functions [RG 1.89].

In RG 1.89, Appendix C lists methods for calculation of mass and energy release in LOCA and MSLB accidents. Appendix D highlights methodology and sample calculation for radiation dose in qualification.

The DBAs for which radiation dose has to be considered in equipment qualification are specified in RG 1.183 *“Alternative Radiological Source Terms For Evaluating Design Basis Accidents At Nuclear Power Reactors”.* A complete list of more than 25 DBAs for PWRs is provided in Chapters 3 and 15 of [NUREG 800] together with NRC recommended methods for evaluation of them.

The plant areas affected by harsh environment are identified in documents setting the methods of determination of parameters in these areas. 10CFR50.49 (d) requires that equipment specifications to include performance and environmental conditions. RG 1.89 provides the following environmental parameters:

a) Temperature and pressure conditions inside containment for LOCA and MSLB. This Guide provides acceptable methods to the NRC staff for calculations and establishing the containment pressure and temperature envelopes that the equipment should be qualified.
b) Effects of sprays and chemicals. The effects of containment spray system operation should be considered. This consideration should include, as appropriate, the effects of demineralized water spray or chemical spray systems.
c) Radiation conditions inside and outside containment. The radiation environment for qualification of electrical equipment should be based on the radiation environment normally expected over the installed life of the equipment plus that associated with the most severe DBAs during or following which the equipment must remain functional.
d) Environmental conditions for equipment outside containment. Electric equipment that is subject to the effects of pipe breaks and is required to mitigate the consequences of the breaks or to bring the plant to safe shutdown should be qualified for the expected environmental conditions.

RG 1.183 stresses in Appendix I that not only LOCA and HELB, but also other DBAs can involve harsh environment and requires EQ to be designed in accordance with the maximum environmental loads anticipated under specific accident conditions

Section 4.3 of IEEE 627-1980 makes reference that the pressure containment integrity and passive structural requirements of mechanical equipment covered by ASME, ATSC or ACI codes are considered qualified by adherence to those codes.

For equipment located in a mild environment zone, 10CFR50.49 *(c) does* ***not*** *require environmental qualification.* A mild environment is an environment that would at no time be significantly more severe than the environment that would occur during normal plant operation, including anticipated operational occurrences.

2.2.2.2 Situation at Temelín NPP

The determination of the service conditions within EQ program at Temelín NPP corresponds to Western practices. Specific conditions for EQ equipment and the timing of those functions are specified, as well as equipment post-accident functions and their timing. Specifically during the Workshop the Czech side stated that time functions within the EQ are defined in a way to assure that the equipment is able to fulfill its safety functions as long as it is required for nuclear safety.

The criteria of change from mild environment, which corresponds to temperatures in the range of 25 – 65 °C and pressure up to 1 bar, to harsh environment are well defined. In particular, the plant assumes that harsh environment will appear always after LOCA and HELB accidents. The areas of the plant subject to harsh environment conditions are specified on a room-by-room basis, which is similar to the western approach.

The parameters that are considered for harsh environment are the same as required by US standards and include pressure, temperature, effects of chemicals and sprays, radiation conditions both for accidents initiated inside the containment and outside containment.

2.2.3 Procedures for EQ (VLI 2.10 – 2.13)

2.2.3.1 US approach

(VLI 2.10) The criteria for the selection of test samples are usually provided in industry standards, first of all those developed by American Society for Testing and Materials. For example the guidance on the size, composition, and surface preparation for test samples of protective coating for use in qualification testing of coating used in NPPs is described in [ASTM D 3911-95]. These criteria are approved by NRC staff, e.g. the criteria for coating testing were approved in [RG 1.54].

(VLI 2.13) The procedures for EQ equipment qualification are established in accordance with the requirements presented in [10CFR50.49 section (j) and (g)]. Methods for EQ are presented in [IEEE 323 section 5], which are listed below:

Type testing – satisfies qualification if it accounts for significant aging mechanisms, subjects the equipment to specified service conditions and demonstrates that such equipment can subsequently perform its intended safety functions for at least the required operating time.

Operating experience – the validity of this method depends on the adequacy of documentation establishing the past service conditions, equipment performance, maintenance, and similarity between the equipment to be qualified and that for which the operating experience exists. Operating experience can provide information on limits of extrapolation, aging characteristics; failure modes and failure rates:

Analysis – requires a logical assessment or a valid mathematical model of the equipment to be qualified. Qualification shall consist of quantitative analysis supported by test data, operating experience or physical laws of nature to demonstrate that the equipment can perform its safety functions under specified service conditions. Aging effects shall be considered. The analysis including logical bases and data used to support it, shall be presented in a step by step manner for one completed set of computations so a person reasonably skilled in the type of analysis used can follow the reasoning and computations.

Combined methods – for example where size, application, time or other limitations preclude the use of a type test on the complete equipment assembly, type testing of components supplemented by analysis may be used in the qualification process [IEEE 323 section 5].

2.2.3.2 Situation in NPP Temelín

The procedures for the performance of the EQ evaluation, including the criteria used for the selection of test samples, the approach to determining the compliance and other procedures and methods used are similar to or along the lines of the requirements in the US.

2.2.4 EQ documentation (VLI 2.14 – 2.24)

2.2.4.1 US approach

(VLI 2.14) The scope and structure of EQ documentation is specified in accordance with the requirements of [10CFR50.49 section (j)], which state that a record of qualification including documentation must be maintained to permit verification that the item is qualified for its application and meets its specified performance requirements when it is subjected to the conditions predicted to be present when it must perform its safety functions up to the end of its qualified life.

Further information is provided in [IEEE 323 section 8] which provides contents of qualification files for:

1. Type test data
2. Operating experience data
3. Analysis
4. Equipment for mild environment
5. Combined qualification.

(VLI 2.15) The documents used for qualification purposes are validated and copies controlled as required in 10CFR50 App. B and in [10CFR50.49 section (j)], which stresses that the record of qualification must be maintained in an auditable form for the entire period during which the covered item is installed in a NPP or is stored for future use.

(VLI 2.16 – 2.18, 2.21) Reference test reports are specified and a supporting analysis is made to show that they provide sufficient basis to demonstrate that the equipment to be qualified is acceptable as required in [10CFR50.49 section (f)].

(VLI 2.19) If the testing deals with a similar item, then a supporting analysis of similarity of tested and plant equipment is made to show that the equipment to be qualified is acceptable in accordance with [10CFR50.49 section (f)].

(VLI 2.20) The qualification database is established and maintained over the lifetime of the plant as per [10CFR50.49 section (j)] and [IEEE 627 (6),(7)].

(VLI 2.22) The provisions for re-assessment of the equipment previously qualified to current codes and standards are established in [NUREG 0588].

(VLI 2.23) EQ master lists are established with indication of data relevant to EQ (identification, seismic class, safety class, electrical class, system, location etc) in accordance with the requirements of [10CFR50.49 section (d)].

(VLI 2.24) The items on the EQ list are generally uniquely identified to plant application, but the criteria may envelop the service conditions for more than one application. In addition, a family of equipment may be qualified by qualifying one or more members and extending the results across the family by analytical methods. Such analysis requires consideration of significant design parameters to establish the similarity of the qualified members to other family members of the equipment [IEEE 627 section 4.3].

The pressure containment integrity and passive structural requirements of mechanical equipment covered by ASME and other codes are considered qualified by adherence to those codes [IEEE 627 section 4.3].

2.2.4.2 Situation in Temelín NPP

The scope and structure of qualification documentation is clearly specified. Comprehensive computerized files are established. The documents are validated, one full set is provided to Temelín NPP, working documents are with consulting companies acting as subcontractors to Temelín NPP.

The reference test reports are specified and their applicability to the plant is evaluated and documented. In case of doubt, an item is declared to be an open issue and to be qualified through testing/analysis or other means. The traceability of the plant equipment to test reports is assured through the working procedures established. Examples provided by Temelín NPP fully confirmed this.

The provisions under which the third party data and documents could be used are identified. The use of test reports and the approach to qualification of families of equipment are similar as in the US.

Reassessment of equipment previously qualified is done on a case-by-case basis. For case of seismic testing that was initially performed with single axis excitation, and where present requirements (i.e. IEC) require multiple axis testing, new and/or additional testing will be performed. Where allowed, to provide required safety margin, the results for single axis testing taken from an excitation level will be increased by a factor of 1.5 (such an approach is acceptable for sites which, like Temelín, have low levels of seismic acceleration).

The master equipment list developed for Temelín follows the requirements of the App. E of RG 1.89. The importance of reliable manufacturer is recognized; in particular, while dividing equipment into groups, the equipment of different manufacturers is placed into separate groups. The Master Equipment List for Temelín was presented during the Workshop and ENCONET experts verified the traceability and retrievability of the information. The results were positive, and information could be traced easily. The information as presented in the list was consistent and complete.

2.3 Environmental Service Conditions

2.3.1 Principles of Determination of Environmental Parameters (VLI 3.1 – 3.15)

2.3.1.1 US practice

(VLI 3.1, 3.2) Normal, accident and post accident environmental parameters are to be specified for plant areas according to [IEEE 627 section 5.6] and [IEEE 323, section 6.1.5.2]. The specification covers the range of parameters expected in normal operation, such as external pressure, ambient temperature, relative humidity, radiation rate or integrated dose of neutron, gamma and beta radiation, as applicable, vibration, duty cycle, load delivered, corrosion effects, power supply. Specification of service conditions and conditions resulting from design basis events (e.g. seismic, LOCA etc) for the equipment and the nature of safety functions to be performed is required. The time period the equipment must remain operable shall also be specified [IEEE 627, section 5.6].

The actual practice concerning this requirement and those of 3.3, 3.4, 3.9, 3.11-3.14 is discussed in section 3.2 below.

(VLI 3.3) Postulated Initiating Events and DBAs to be considered as reference for EQ are identified for each equipment location as required in [IEEE 323 section 6.1.5.2].

(VLI 3.4) The most limiting envelope PIE/DBA is identified for each plant location. Acceptable curves enveloping those events are shown in [IEEE 323 section (6.1.5.2) and (7)].

(VLI 3.7) The environmental data sheets are generated and approved for determined zones following the guidance in [RG 1.89(c.2.a)].

(VLI 3.8) Plant areas are grouped into EQ zones having similar environmental parameters chosen as envelope values for EQ. When establishing the simulated environmental profile for qualifying equipment located inside containment a single profile is preferred that envelopes the condition produced by the MSLB and LOCA. [NUREG 0588, section 2.2]

The requirements concerning determination of conditions inside containment will be discussed in four sections, covering

1. LOCA temperature and pressure
2. Chemical spray parameters
3. Main Steam Line Breaks, and
4. Radiation conditions

LOCA Temperature and Pressure (VLI 3.9, 3.11 – 3.14)

(VLI 3.9, 3.11, 3.12, 3.13) The accident pressure and temperature profiles are generated for EQ zones, the highest temperature, pressure and humidity are determined and their changes in time taken into account as required in [IEEE 323].

The time dependent temperature and pressure, established for the design of the containment structure and found acceptable by the NRC staff, may be used for the environmental qualification of equipment [NUREG-0588, section 1.1]. In general, the containment temperature and pressure as a function of time should be based on analysis in the FSAR and bound those expected from coolant and steam line breaks inside the containment with due consideration of analytical uncertainties. Superheated steam followed by saturated steam may be a limiting condition and should be considered [RG 1.89, section C.2.a]. US regulations specify codes to be used in calculations, requesting that they should be of the class similar as CONTEMPT-LT. [RG 1.89, section C.2.a].

(VLI 3.14) The impacts of humidity after LOCA/MSLB on EQ equipment inside containment are considered as required in [IEEE 323].

Chemical Spray (VLI 3.19 – 3.21)

(VLI 3.19, 3.20, 3.21) Spray composition, flow rate, start and duration are specified as required in [IEEE 323].

The effects of caustic spray should be addressed for the equipment qualification. The concentration of caustics used for qualification should be equivalent to or more severe than those used in the plant containment spray system. If the chemical composition of the caustic spray can be affected by equipment malfunction, the most severe caustic spray environment that results from a single failure in the spray system should be assumed [NUREG 0588, section 1.3].

Pressure is considered a driving force influencing ingress into vital components through materials such as seals, jackets, and so forth. It is therefore recommended to ensure during testing that chemical sprays are introduced at or as close as possible to the simulated maximum containment peak pressure conditions [NUREG 0588 –Comment responses].

Main Steam Line Breaks (VLI 3.14, 5.8)

(VLI 3.14) The environmental parameters used for equipment qualification should be calculated with a plant specific model reviewed and approved by NRC staff. The test profiles included in App. A to IEEE Standard 323-19734 should not be considered an acceptable alternative in lieu of using plant – specific containment temperature and pressure design profiles unless plant specific analysis is provided to verify the adequacy of those profiles. If qualification has been completed but only LOCA conditions were considered, it must be demonstrated that the LOCA qualification conditions exceed or are equivalent to the maximum calculated MSLB conditions. This can be done by showing that the peak surface temperature of the component to be qualified does not exceed the LOCA qualification temperature. If it cannot be demonstrated, then for new NPPs the NRC staff requires that requalification testing with appropriate margin be performed or physical protection provided to assure that the surface temperature will not exceed the actual qualification temperature [NUREG 0588, section 1.2].

In case of operating NPPs with vintage equipment it is permitted also to provide an additional justification to demonstrate that the equipment can maintain its required functional operability if its surface temperature reaches the calculated value. If it cannot be demonstrated, then requalification of equipment or provision of physical protection is required [NUREG 0588, section 1.2].

(VLI 5.8) Thermal lag is considered in analysis for massive equipment and short time temperature peaks at HELB [NUREG 0588 App. B].

According to DOR guidelines, equipment qualified for a LOCA environment is considered qualified for an MSLB accident environment in plants with automatic spray systems not subject to disabling single component failures. This position is based on the “Best Estimate” calculation of a typical plant peak temperature and pressure and a thermal analysis of typical component inside containment [DOR, section 4.2]. The final acceptability of this approach i.e. use of the Best Estimate approach, is pending the completion of Task Action Plan A-21, MSLB Inside the Containment.

Flooding (VLI 3.10, 3.16-3.18)

(VLI 3.10) Equipment should be located above flood level or protected against submergence by locating it in qualified watertight enclosures [NUREG 0588 section 2.2].

(VLI 3.16, 3.17) The areas of possible submergence are determined as required in IEEE 323, the flooding levels are calculated and provisions for preventing internal flooding specified as required in [RG 1.102]

(VLI 3.18) Potentially submerged equipment is identified as required in [IEEE 323], [NUREG 0588 section (1.3)], [RG 1.89 (C2b)] and [10CFR50.49(e)].

Radiation Conditions (VLI 3.22 – 3.33)

(VLI 3.22, 3.23) Radiological parameters are determined, in particular total integrated dose (TID) according to guidance in [RG 1.89] and [NUREG 0588]. The radiation environment for qualification of equipment should be based on the normally expected radiation environment over the equipment qualified lifetime, plus that associated with the most severe design basis accident (DBA) during or following which the equipment must remain functional. It should be assumed that the DBA related environmental conditions occur at the end of the equipment qualified life [10CFR50.49], [NUREG 0588, section 1.4]. Much more detail on this item is provided in [ENCONET 02/3]

2.3.1.2 Situation in Temelín NPP

The approach to determination of service conditions is similar as in Western countries. Both normal environmental parameters and accident parameters are identified for the plant on a room-by-room basis. The PIEs and DBAs to be considered as reference for EQ in each equipment location are identified, and the most limiting envelope of PIE/DBA conditions is established.

The SSE and OBE floor response spectra are established for plant areas, and the environmental data sheets are generated and approved for each room.

The areas where submergence is possible are identified, and the temperatures and pressures in harsh environment areas are calculated. The possible impact of LOCA/MSLB humidity on EQ equipment is considered both inside and outside the containment.

Flooding levels are calculated and identified, and provisions for preventing internal flooding are taken. Spray composition and flow rate is determined in the SAR, and the spray start and duration are specified.

The design parameters for accident conditions inside containment are 150 C and 500 kPa, with maximum radiation intensity of 1000 Gy/h and the period of evaluation of post accident conditions equal to 30 days. The calculated peak values inside the containment are lower, so that a safety margin exists. For the EQ purposes, the radiation dose rate is taken 3 times higher, namely 3000 Gy/h. Similarly, for the rooms outside containment where High Energy Line Break is possible, the design maximum values of temperature and pressure are 104 oC and 120 kPa, while calculations show that the maximum values are 101.6 °C and 113 kPa. Similarly, while site seismicity was evaluated to be in the range of 0.06 g, the value of maximum horizontal acceleration is taken as 0.1 g.

In radiation load calculations both gamma and beta doses are included, a normal Total Integrated Dose (TID) is considered and summed up with the accident dose. During the Workshop the Czech side stated that the detailed analyses performed for post accident conditions had shown that the beta dose is negligible. However, no further substantiation of this was given. Similarly, the neutron doses were found negligible and therefore no question of conversion factors for neutrons was discussed. These estimates should have been accepted by the SUJB, but in view of the limited activity of SUJB in EQ mentioned in section 1.1.3 it is unclear if those calculations were indeed independently reviewed.

Electromagnetic compatibility verification has been successfully performed fully following (and in some case, advancing) the US practice.

The overall conclusion is that in general the determination of service conditions for specific locations and equipment was thoroughly implemented following the principles and practices as in western countries. The values used are in line with expected environmental conditions in specific rooms, and are in all cases higher than the maximal value obtained through the analysis. The service conditions were determined on room-by-room basis. In line with practices in some western countries, it has to be noted that in specific cases some equipment may be subject to environmental conditions that are more difficult than those for the whole room (i.e. steam impact after Steam line break). Temelín reconsidered the localized environmental conditions for the equipment located within the containment and determined that the margins that exist are such that no negative localized effects are likely. Nevertheless, no information exist if the localized effects in areas outside the containment were determined in the same fashion.

2.4 Qualification Methods and Acceptance Criteria

2.4.1 Acceptable EQ Methods (VLI 4.1 – 4.14)

2.4.1.1 US Requirements

(VLI 4.1) The requirements and acceptable methods for equipment qualification are identified in [10CFR50.49 (f)], [IEEE 323 (5)], [NUREG 0588 (II)] and [RG 1.89 (C.3)].

The general requirements is that the equipment that must function in order to mitigate any accident should be qualified by test to demonstrate its operability for the time required in the environmental conditions resulting from the accident; Any equipment that need not function in order to mitigate any accident, but that must not fail in a manner detrimental to plant safety should be qualified by test to demonstrate its capability to withstand any accident environment for the time during which it must not fail; Equipment not needed to mitigate any accident and whose failure in any mode in any accident environment is not detrimental to plant safety need only be qualified for its non-accident service environment. [NUREG 0588, section 2.1 (3)]

The EQ methods include:

1. Testing an identical item of equipment under identical conditions or under similar conditions
2. Testing a similar item of equipment
3. Experience with identical or similar equipment under similar conditions
4. Analysis in combination with partial type test data

In all cases 1-4 a supporting analysis is required to show that the equipment to be qualified is acceptable [10CFR50.49 (f)].

2.4.1.2 Situation in Temelín NPP

The requirements for the equipment as well as the criteria and the methods to confirm the acceptance are all similar to the US practice. For all types of equipment discussed, no differences or deviation from international practices could be found.

2.4.2 Qualification by Test (VLI 4.2 – 4.5)

2.4.2.1 US practice

(VLI 4.2, 4.3) Performance parameters identified to address acceptance criteria and the acceptance criteria for the test shall be specified [IEEE 323 (6.7)], [10CFR50 App.B]

The time duration of the test should be at least as long as the period from the initiation of the accident until the environmental conditions return to the same level that existed before the postulated accident [DOR, section 5.2].

(VLI 4.4) Quantified margins should be applied to the environmental parameters to ensure that the postulated accident conditions have been enveloped during testing [RG 1.89 (C4)]

The bases should be provided for the time interval required for operability of the equipment.

The test specimen should be the same model as the equipment being qualified [DOR, section 5.2].

2.4.2.2 Situation in Temelín NPP

Equipment qualification by testing is the preferred method, but as most of the equipment has been assembled and installed in the plant before the EQ program was started, it has been in many cases decided to use parent type testing results to qualify the equipment actually in the plant. Such testing is allowed and also often used in Western practices.

In the cases of thermal tests that were done at NRI Rez there is one limitation, namely the maximum temperature that can be maintained during the test is 100 oC, while in the rooms outside containment the maximum design temperature is 104 oC. The Czech side declared that, in the tests, they use Arrhenius law to compensate for this shortcoming and keep the specimens in 100 oC temperature appropriately longer than the expected accident time. Arrhenius method is a standard test method also used elsewhere for similar purposes.

2.4.3 Qualification by other methods (VLI 4.6 – 4.10)

2.4.3.1 US Approach

(VLI 4.6, 4.7) Provisions for qualification by analysis and by combination of test and analysis are specified [IEEE 323(6.5) and (6.6)]. An item of Class 1E equipment may be shown to be qualified for a complete spectrum of service conditions even though it was only type tested for high temperature, pressure and steam. The qualification for service conditions such as radiation and chemical sprays may be demonstrated by analysis.

The equipment may be shown to be radiation qualified by performing a calculation of the dose expected, taking into account the time the equipment is required to remain functional and its location and analyzing the effect of the calculated dose on the materials used in the equipment. As a general rule the time required to remain functional assumed for dose calculations should be at least 1 hour.

<u>Chemical spray qualification:</u> Components enclosed entirely in corrosion resistant cases (e.g. stainless steel) may be shown to be qualified for a chemical environment by an analysis of the effects of the particular chemicals on the particular gasket materials [DOR, section 5.3]

(VLI 4.8) Provisions for qualification by operating experience (adequacy of service conditions, performance, maintenance, similarity, etc. are specified [IEEE 323, (6.4)].

Qualification by analysis or operating experience implemented may be found acceptable depending on the quality and detail of information submitted. These methods are most suitable for equipment where testing is precluded by physical size of the equipment being tested. It is required that, when these methods are employed, some partial type tests on vital components of the equipment be provided in support of these methods [NUREG 0588 section 2.4].

(VLI 4.9) Although actual type testing is preferred, other methods when justified may be found acceptable [NUREG 0588, section 2.1].

(VLI 4.10) Provisions for reporting of test anomalies are specified following the requirements of [10CFR21 section 21.21], [10CFR50 App. B, XV and XVI], and [IEEE 323 (8)].

2.4.3.2 Situation in Temelín NPP

Qualification by analysis is one of the basic approaches to the EQ. The qualification by analysis is mentioned as the basic approach for qualifying piping, conduit and cable tray raceway systems.

Performance parameters and acceptance criteria for test results are specified and quantified margins are applied to qualification parameters. There was no information on the rules directing determination of quantified margins to test parameters. It is done on a case by case basis. While the cases presented in the Workshop indicated that the choice of test margins is right, the lack of established procedures in this area could result in inappropriate practices.

Qualification by analysis and by test and analysis is based on US approach, but no general procedure appears to be established. Similarly, there are no provisions for qualification by operating experience, which is understandable for Temelín NPP. The practice is, generally, based on US regulations.

The provisions for reporting test anomalies are specified.

2.4.4 Seismic qualification by testing (VLI 4.11 – 4.14)

2.4.4.1 US practice

(VLI 4.11) Proof seismic testing and fragility testing approach are defined according to [IEEE 323 (6.3.5) and [IEEE 344]. Proof testing is used to qualify equipment for a particular requirement. A proof test requires equipment to be subjected to one of the tests with a particular response spectrum, time history or other parameters defined for the mounting location of the equipment. No attempt is made to explore the failure thresholds of the equipment. Therefore the proof test requires the preparation of a detailed specification. Generic testing is considered a special case of proof testing. The specification is usually written to encompass most, or all, of the known requirements. The resultant generic required response spectrum (RRS) typically encompassed a wide frequency bandwidth with relatively high acceleration levels.

Fragility testing is used to determine the ultimate capability of the equipment. Variations in the seismic environment have been shown to influence the fragility level of the equipment or system. One of such variations is the directional nature of excitation. [IEEE 344 Section 7.2, 7.3]

(VLI 4.12) The methodology to address type of motion in seismic tests (single or multiple frequency) is established in accordance with the guidance in [IEEE 344] and with Regulatory Position in [RG 1.100 [C.2)]. The types of motion available to best simulate the post-seismic environment fall into two categories: single frequency and multiple frequency. The method chosen will depend upon the nature of the expected vibration environment and on the nature of the equipment. In general the proof or generic test seismic simulation waveforms, which should produce Test Response Spectrum (TRS) that closely envelops the Required Response Spectrum (RRS), have a peak acceleration equal to or greater than the RRS Zero Period Acceleration (ZPA), do not include frequency content above the RRS ZPA asymptote, and have a duration in accordance with the requirements of IEEE 344 section 7.6.5.

When the seismic ground motion has been filtered due to one predominant structural mode, the resulting floor motion may consist of one predominant frequency. In this case, a short duration steady state vibration can be a conservative input excitation to the equipment. Further, single frequency testing may be used to determine (or verify) the resonant frequencies and dampening of equipment. If it can be shown that the equipment has no resonances, or only one resonance, or resonances are widely spaced and do not interact, or if otherwise justified, single frequency test may be used to fully test the equipment [IEEE 344, section 7.6.2].

Seismic ground motion is recognized to contain multiple frequency energy content up to approximately 33 Hz. When this relatively broadband ground motion has not been strongly filtered by the building or the soil, or both, the resulting floor motion, which affects the equipment, ends to retain the original broadband characteristics. Furthermore, even if strong filtering is present, but is caused by two or more distinct building modes, the floor motion will still comprise a complex wave with dominant frequencies at each of the building or soil natural frequencies, or both. In these cases, multiple frequency testing is applicable for qualification. Multiple frequency testing is intended to provide a broadband test motion that is particularly appropriate for producing a simultaneous response from all modes of a multi-degree-of-freedom system, whose malfunction may be caused by modal interaction. Multiple frequency testing provides a closer simulation of a typical seismic motion without introducing a higher degree of conservatism. [IEEE 344, section 7.6.3].

(VLI 4.13) The criteria to produce test response spectrum (TRS) conservatively enveloping required response spectrum (RRS) in seismic tests are established in [IEEE 344 sections 5.3 and 7.6] with the need for justification stressed in the Regulatory Position of NRC staff in [RG 1.100 C2, C3] and Standard Review Plan [NUREG 0800 section 3.10, II.1.a.(4)]. In general, the proof or generic test seismic simulation waveforms, or both should produce a TRS that closely envelops the RRS using single or multiple axis.

(VLI 4.14) The basis for single or multiple axis testing in seismic tests is established according to [IEEE 344, section 7.6.6] and SRP [NUREG 0800 section 3.10, II.1.a.(6)]. Seismic ground motion occurs in all direction in random fashion. However, for test purposes single axis, biaxial and triaxial tests are allowed. If single axis or biaxial tests are used to simulate the three dimensional environment, they should be applied in conservative manner to account for the absence of input motion in the other orthogonal direction(s). Single axis tests are justified when the input motion can be shown to be essentially unidirectional, or when the equipment being tested can be shown to respond independently in each of the three orthogonal axes.

Biaxial tests should conservatively simulate the seismic event at the equipment mounting location, and be performed with simultaneous inputs in horizontal and vertical axis. The IEEE 344 standard defines methods to provide statistically independent simulated motions [IEE 344 section 7.6.6.2].

2.4.4.2 Situation in Temelín NPP

The program of seismic EQ is conducted in full agreement with the US practice. Proof seismic testing and fragility testing approach are used; the criteria to produce TRS conservatively enveloping RRS in seismic tests are identified. The single axis test results are used in place for multiple axes testing by choosing test accelerations increased to 150% of nominal values.

2.5 Aging and Qualified life, margins

2.5.1 Aging (VLI 5.1 – 5.4, 5.7, 5.9)

2.5.1.1 US approach

(VLI 5.1) Aging mechanisms are defined [IEEE 323 (6)]. Aging effects on all equipment should be considered and included in the qualification program. Degrading influences, electrical and mechanical stresses associated with the cyclic operation of equipment and synergistic effects should be considered in the accelerated aging program [NUREG 0588 (4)].

(VLI 5.2, 5.3) The methodologies to address the thermal aging are defined [NUREG 0588 (4)], [IEEE 323 (6)]. The techniques available to address aging include testing, analysis and in-service surveillance/maintenance. Equipment shall be reviewed in terms of design, function, materials, and environment for this specified application to identify potential aging mechanisms. An aging mechanism is significant if in the normal and abnormal service environment causes degradation during the installed life of the equipment that progressively and appreciably renders the equipment vulnerable to failure to perform its safety functions under DBE conditions. If the equipment is determined to have a significant aging mechanism, then this mechanism shall be accounted for in the qualification program [IEEE 323, section 6.2.1]. The types of aging include thermal, radiation, wear and vibration. When natural aging is used in the qualification program it is not necessary to identify aging mechanisms. If naturally aged equipment is not available with proper documentation, the equipment shall be age conditioned. Age conditioning generally involves applying simulated in-service stresses (thermal, radiation, wear, vibration) at magnitudes or rates that are greater than expected in-service levels but less than the material property limitations.

The methodologies to address operational stresses are defined in [IEEE 323 (6)] and in [ASME III C].

In the case of anchorage, ageing is evaluated by walkdown and testing (25% of the bolts). For piping, 1 mm thickness is removed for all carbon steel pipe sections in order to check for the ageing effect in the thickness. In the course of walkdown, ageing is evaluated by measure of the actual size of anchorage and by torque check. With such an approach also the installation procedures and QA are assessed. [IAEA 02 section 4.6].

(VLI 5.4) The methodologies to address radiation effects are defined in [NUREG 0588, section 1.4]. The discussion of influence of doses below 10^4 rads is provided in [‘RG 1.89 (B)].

(VLI 5.7) The Arrhenius methodology is considered an acceptable method of addressing accelerated aging. Effects of relative humidity need not be considered in the aging of electrical cable insulation. [NUREG 0588, section 4].

(VLI 5.9) The methodology for qualified life calculations (limitations due to aging, surveillance/ maintenance requirements, service conditions requirements etc) is established following [NUREG 0588 (4)], [RG 1.89 (B)]

2.5.1.2 Situation in Temelín NPP

Methodology to address the thermal aging is defined. The methodology to address operational stresses is defined, too. Concerning radiation effects, general guidance exists, and specific results of radiation aging tests are evaluated taking into account requirements usually adopted in Germany.

Arrhenius methodology of equivalent time calculations is being used. It was reported (on one example) that in some cases the coefficients in Arrhenius equation were not known. In principle, when some of the data are not known, a piece of equipment would be declared to be an open issue. However, if the qualification has been performed by a qualified test center, the certificate of such a center could be accepted even if all the data are not available to the Czech organization. Such was the case of qualification of French cabling. On the other hand, in a very similar case when the testing centre was in Czech Republic, the results of another qualification test were declared to be insufficiently justified, and specific data need to be additionally collected.

The issue of aging is treated by the plant as being of secondary importance, because the plant has been just put into operation. Therefore the time horizon for solving the issues of aging is longer than for other issues. As there is no urgency in this area, taking into account that the plant has just been started, SUJB agreed to extend the time limit for resolving aging issues to 4 years. This could be seen as acceptable, given circumstances.

2.5.1.3 Comment

The aim of one of the presentations at the Workshop was to illustrate, on four examples, how the EQ for different equipment types is being implemented in practice. Unfortunately, the presentation raised more questions than provided answers or explanations. From the presentation, it appears that there are different approaches and acceptance criteria (for documentation and test results) used, depending on the country of origin of a component. It also appeared that there is no firm and consistent guidance as to the approach to be followed. A follow up discussion with Temelín staff and the consultants working on the EQ established that the examples used in the presentation may not have been well selected. Temelín staff indicated that, in fact, there is a consistent policy and principles on the acceptability the test results and various documents. Although the explanation sounded convincing, an underlying doubt remains in relation with the consistency, because a document that would clearly state what and when is acceptable was not presented.

The impression of the review team was that, while there might be only a relatively limited number of cases where this would become an issue, a clearly established policy in this respect, which could also be agreed upon with the regulatory body, is needed.

Temelín has a capable EQ project manager and experienced staff is supporting the EQ activities, but it appears that many activities within the EQ are in the hands of the contractors.

Although in discussions it was indicated that the plant is taking more active role in the management of the EQ process, the experts believe that the EQ should still be placed under a stronger management of the plant staff and monitored (in a more active way) by the SUJB. This will be also essential for the EQ preservation, and in addition will be also important for the direct use of EQ activities in other plant’s programs, like configuration control or establishment and maintenance of the Master equipment lists.

No additional information were provided on this subject in the report [Stevenson 04]. While the EQ program appears to be going-on in an appropriate manner, no indication exists if this is eventually due to a stronger involvement by Temelín NPP.

2.5.2 Margins (VLI 5.12 – 5.14)

2.5.2.1 US practice

(VLI 5.12 – 5.14) The standard [IEEE 323] defines margin as the difference between the most severe specified service conditions of the plant and the conditions used in type testing to account for normal variations in the commercial production of equipment and reasonable errors in defining satisfactory performance. The margins should:

- Account for uncertainties associated with the use of analytical techniques in deriving environmental parameters,

- Account for uncertainties associated with defining satisfactory performance (e.g., when only a small number of units are tested)
- Account for variations in the commercial production of the equipment
- Account for the inaccuracies in the test equipment to assure that the calculated parameters have been enveloped.

The methodologies to identify and define adequate margins for LOCA, HELB, seismic tests are developed (values of test parameters, number of tests, test duration, operation time etc.)

The methodologies to address margin requirements (account for uncertainty in performance, variation of commercial production, etc. are established [NUREG 0588 (3)], [RG 1.89 (C.4)], [IEEE 323 (6.3.1.5)]. For environmental transients two methods which may be used to apply margin are 1) temperature and pressure margin may be added, 2) the peak transient without temperature and pressure margin may be applied twice, combinations of these methods may be used. [IEEE section 6.3.1.5].

NRC staff believes that when the temperature and pressure conditions are derived using the methods identified in section 1.1 of NUREG-0588, or the qualification envelope in App. C is used or the radiation methodology described in App. D is used, the only additional margins to be provided are those accounting for the inaccuracies in the test equipment [NUREG 0588, section 3 and comment responses].

The suggested values in Section 6.3.1.5 “Margin” of IEEE Standard 323-1974, except time margins, are acceptable for meeting the requirements of paragraph 50.49(e)(8) [RG 1.89, section C4]. The NRC staff does require that equipment designed to perform its safety related function within a short time into an event be qualified for a period of at least 1 hour in excess of the time assumed in the accident analysis [IEB 79-01/2, section A.12].

2.5.2.2 Situation in Temelín NPP

At Temelín NPP, the margins are established by comparison of maximum parameters calculated using modern codes (e.g. RELAP 5 mod 3) with the designed values in the Russian design, to which the equipment has been qualified. As mentioned above, the calculated values are as a rule lower than the designed values, e.g. 101.6 °C and 113 kPa for HELB in room A 820, for which the design basis is 104 °C and 120 kPa.

However, in some cases the methods of calculation appear not to be sufficiently detailed to determine local (i.e. equipment position) temperatures that may be in excess of the global (i.e. the whole compartment) average temperatures calculated with codes using lumped parameters. Such is the case of maximum temperatures after Main Steam Line Break (MSLB), which results in steam condensing on the walls and thus greatly affecting sensors situated close to the break. At the Workshop Czech specialists acknowledged that the calculations are performed with codes treating the temperatures as average temperatures in a room. Thus, local temperature peaks could be overlooked in the process.

It is true, that a large heat capacity of the walls can result in local peaks being small and disappearing quickly. However, this is a task for the EQ project to ascertain that such conditions would not have a negative impact on the qualification of specific equipment.

As reported in the “answers to the conclusion “ report of August 2004 additional calculations to determine localized effects were preformed for the containment areas but nothing has been reposted for the steam lien rooms form which the issue was raised here. Therefore this issue remains to be followed in future bilateral activities.

2.6 Seismic qualification evaluation program

2.6.1 Seismic Re-evaluation Program (VLI 6.1 – 6.3)

2.6.1.1 IAEA recommendations and US practice

(VLI 6.1) Requirements for new design require rigorous analysis and testing of active and passive components to demonstrate their ability to function during and after a design basis earthquake or a review level earthquake. In countries that operate NPPs that do not have a complete seismic design basis established, it is important to establish criteria for re-evaluation that meet desired safety goals but that are efficient and practical to implement.

To date only a few countries have established official standards for the seismic re-evaluation of **existing** nuclear power plants. More often, general guideline documents have been issued but without legal force. The currently used guidelines of the IAEA and regulatory authorities of Member States are in fact established for the siting, design and construction of **new** facilities. [IAEA 02 section 2.3].

Seismic re-evaluation requires the consideration and DBE or SSE definition, the load applied to the structure and the force distribution in the structure, and the overall safety margin available in the plant.

The methodology of seismic qualification of NPP equipment actually acceptable by NRC staff is presented in [NUREG 0800 section 3.10] and in [IEEE 344-1987]. This standard replaced the previous standards of the same number, published in 1971 and 1975. The methodology of seismic EQ presented in the standard IEEE 344-1971 was found not acceptable in [NUREG 0800 section 3.10], which stated that components previously tested to IEEE Std 344-1971 should be re-evaluated according to the actually acceptable methods. The areas needing re-evaluation will be discussed in more detail below.

The programs of seismic re-evaluation are prepared by the plant owner and approved by the regulatory body. In the process of evaluation and approval of seismic EQ, NRC staff requires that the plants demonstrate conformance to the criteria listed in [NUREG 0800 section 3.10.1].

Tests and analyses are required to confirm the operability of all mechanical and electrical equipment during and after an earthquake of magnitude up to and including OBE and SSE and for all static and dynamic loads from normal, transient and accident conditions. Analyses alone without testing are acceptable only if the necessary functional operability of the equipment is assured by its structural integrity. When complete testing is impractical, a combination of tests and analyses is acceptable.

For seismic and dynamic loads the actual test input motion should be characterized in the same manner as the required input motion, and the conservatism in amplitude and frequency content should be demonstrated, i.e. the test response spectrum (TRS) should closely resemble and envelop the required response spectrum (RSS) over the critical frequency range.

Since seismic and the dynamic load excitation generally have a broad frequency content, multi-frequency vibration input motion should be used. However, single frequency input motion, such as sine beats, is acceptable provided the characteristics of the required input motion indicate that the motion is dominated by one frequency (i.e. by structural filtering effects, or the anticipated response of the equipment is adequately represented by one mode, or in the case of structural integrity assurance that the input has sufficient intensity and duration to produce sufficiently high levels of stress for such assurance. Components that have been previously tested to IEEE Std 344-1971 **should be re-evaluated to justify the appropriateness of the input motion used and requalified if necessary**.

For the seismic and dynamic portion of the loads the test input motion should be applied to one vertical axis and one principal horizontal axis (or two orthogonal horizontal axes) simultaneously unless it can be demonstrated that the equipment response in the vertical direction is not sensitive to the vibratory motion in the horizontal direction and vice versa. The requirements on time phasing and or test repetitions are provided in [NUREG 0800 section 3.10.II.1.(6)]. Further on, the Guide requires that **components that have been previously tested to IEEE 344-1971 should be requalified using biaxial test input motions unless justification for using a single axis test input motion is provided.**

(VLI 6.2) In the US the seismic re-evaluation program was expressly approved by the NRC which addressed this issue in the resolution of Generic Safety Issue A-46. Some 72 operating NPPs had incomplete qualification of equipment. After the NRC Generic Letter [GL 87-02] that requested all recipients to submit a schedule for implementation of the seismic verification program at their facilities, Seismic Qualification Users Group (SQUG) developed a Generic Implementation Program, and after correcting it according to the staff comments the improved version [GIP-2] was published and accepted in February 1992. SQUG developed efficient methods for demonstrating seismic adequacy using the results of the performance of similar equipment in strong motion earthquakes. In the discussion the staff formulated a number of comments that together with GIP-2 formed the document according to which the operating NPPs in the US may be verified for seismic adequacy.

(VLI 6.3) For design, the seismic hazard has classically been defined as a maximum event that can occur at the site. Peak Ground Acceleration is the basic parameter of the seismic EQ and must be specified for the plant taking into account regional and local seismic conditions. According to [10CFR50 App. S (IV.a.1)] the horizontal component of the Safe Shutdown Earthquake Ground Motion in the free-field at the foundation level of the NPP structures must be an appropriate response spectrum with a peak ground acceleration of at least 0.1 g.

Conservative deterministic methods have been used to establish the peak ground acceleration at the NPP site. The amplification of this peak ground acceleration has been defined by the US Regulatory Guide 1.60 [RG 1.60] and is nominally a mean plus one standard deviation amplification of peak ground acceleration. Current guidance is to use probabilistic methods to define the peak ground acceleration and the spectral ordinates. Regulatory guide 1.165 [RG 1.165] describes current US NRC requirements. The SSE is defined as a 100,000 year return period median ground motion spectrum. [IAEA 02 section 2.2.1].

The deterministic rules for performing a seismic margins assessment and calculating HCLPFs are predicated on the Review Level Earthquake (RLE) being conservatively established as an 84^{th} percentile non-exceedance probability earthquake. In practice, the US regulators specified for most plants that the review level earthquake be 0.3 g pga and that the spectral ordinates be defined as a [NUREG/CR-0098] median amplification spectrum. The amplification of pga of the [NUREG/CR-0098] spectrum is much less than that of the Regulatory Guide 1.60 spectrum [IAEA 02 section 2.2.1].

2.6.1.2 Situation in Temelín NPP

Seismic re-evaluation program has been established, but not explicitly approved by SUJB (discussed under 1.1.3). Nevertheless, in practice the implementation of seismic re-evaluation program follows the US regulations and practices.

The Peak Ground Acceleration for the plant has been established with a large safety margin, assuming 0.1 g in place of 0.06 g that was defined to be the maximum value for the site. Owing to this, there was no need to deal with probabilistic analysis and to establish median amplification spectrum.

It has to be noted that another project within the Melk Follow up process is aiming at determining an objective PGA for Temelín site. If the PGA for Temelín remains around 0.1 g, for which the EQ was completed on most equipment, than the results of the EQ are valid. If however, the PGA is found to be significantly higher than the value used (i.e. 0.2 g), then the re-qualification of specific equipment will/may be necessary.

The analysis and other activities (i.e. replacement of the BRU-A motors) performed in the meantime are described in the report "Answers to the conclusions" of August 2004. The report claims that the additional analyses confirmed that the originally selected PGA is adequate, and no change in the qualification criteria is needed. Moreover, the modification of the BRU-A motors and sensors that was indicated in 2002, indeed took place in 2003. The new motors passed all the qualification tests as envisaged for that position. The new motor is comparable in weight and its fixing is equal to the original motor fixing. Therefore, the original seismic qualification of the whole BRU-A suffice.

2.6.2 Equipment to be seismically qualified (VLI 6.4 – 6.5)

2.6.2.1 US approach

(VLI 6.4) The list of equipment to be qualified based on seismically induced failures is prepared in accordance with the requirements of [IEEE 344 section (6)].

With regard to seismic re-evaluation of operating nuclear plants (i.e. older plants the original design of which did not sufficiently account for seismic hazard), it is common practice to define a more liberal set of safety requirements. Based on a minimum set of safety requirements (safety shutdown path) the seismic classification for operating nuclear plants should at least include the following items:

Seismic Class 1 (SC1):

Plant components

- which are required for shutting down the plant safely,
- which are required for maintaining the plant in a shutdown condition for at least 72 hours following an SSE,
- which are required for removing the residual heat for at least 72 hours following an SSE.

SC2 is kept as for the design of new facilities. [IAEA 02 section 3.1.1].

The objective of the verification of seismic resistance can be one of the following:

- Functional capability,
- Integrity,
- Support stability.

Seismic Equipment List (SEL) is a list of equipment and distribution systems that are seismically evaluated to meet the intent of DOE seismic requirements. To develop the SEL, postulated facility conditions, system interaction considerations, and seismic vulnerability considerations are evaluated. Postulated facility conditions include offsite utilities, seismic induced accidents, single active failure, operator actions, and other accidents. For system interaction considerations, seismic interaction effects, common-cause failure effects, and performance during a seismic event are considered, while seismic vulnerability considerations include structural configuration, potential failure modes, generic seismic performance, and actual attachment and support conditions. Finally, an operational review needs to be performed to address operational and functionality considerations. With these evaluations, equipment and distribution systems may be excluded from the SEL if they have low safety significance, or for other facility-specific considerations. [IAEA 02 section 3.3.3.2].

(VLI 6.5) Despite the differences in the national approaches, there is a general consensus on the reference methodology to be applied in the seismic qualification of equipment. It is mainly a three step process relying on:

- a screening “walkdown”, where qualification is straightforward based upon simplified criteria,
- a detailed “walkdown”, applied in the detailed assessment of equipment functionality, anchorage integrity and interactions for items meeting some general criteria;
- a solution of the “outliers” that might require some special techniques to solve the peculiarity of some components screened out by previous phases. [IAEA 02 section 2.4]

The seismic adequacy of the candidate item is verified by establishing its similarity to a reference item previously qualified by calculation, by test, or by plausibility.

Analogy requires that the seismic input to the reference item equals or exceeds that required for the candidate item. Analogy also requires that the physical and support conditions, the functional characteristics for active items, and the requirements of the candidate item closely resemble those of the reference item.

When performing a seismic verification based on analogy, seismic experience or generic test data, there is a generic problem: how to assess deviations between the component to be qualified and the reference item. A case by case approach is performed taking into account the fundamental design data and their effect on seismic responses. In the Generic Implementation Procedure [GIP-2], the problem has been solved by covering a series of items for each of the generic components (e.g. pumps), by accounting for a large range of geometric measure, flow rate, power rate. Basics of the similitude theory are presented in [IAEA 02, section 3.1.5].

Similarity of WWER-type equipment to equipment included in the SQUG databases [Kunar 91] is the most important keystone of practical application of the GIP-WWER procedure. Generally, the principle of similarity is based upon comparison of equipment dynamic and its most important physical characteristics [Lafaille 91]. The definitions used to categorize different items or aspects are presented in [IAEA 02 section 3.2.3].

Similarity of WWER-440/213 type equipment with equipment included in the SQUG databases has been summarized in [IAEA section 3.2.4].

2.6.2.2 Situation in Temelín NPP

The list of equipment to be qualified based on seismic-induced failures has been established.

The procedure for demonstrating the seismic design adequacy based on equipment similarity has been established. The VVER GIP approach, which follows on the widely accepted GIP approach for NPPs in the USA has been implemented.

The seismic qualification follows the three-step approach as recommended by the IAEA and which is the practice in western countries.

2.6.3 Floor response spectra (VLI 6.6 – 6.8)

2.6.3.1 US approach

(VLI 6.6) For design, the development of floor response spectra is governed by regulatory guides and the Standard Review Plans [NUREG-0800]. For seismic margins, median spectra are developed, but variations in soil parameters are required. Typically, the soil shear modulus is varied the same as for design and the results are enveloped but not broadened. Alternatively, probabilistic spectra can be developed and the median value used.

(VLI 6.7 – 8) SSE and OBE floor response spectra must be established for plant areas. The maximum floor acceleration is the zero period acceleration (ZPA) of the floor response spectrum. The requirements for analysis of floor level excitation at OBE and SSE are formulated in [IEEE 344, section 3.4.1 and 6.6].

Due to the peculiarity of WWER structures compared to the reference US plants used for the development of the statistics, the simplified and statistically based rules cannot be fully applied to the WWERs. Particularly, there are some locations where the structural behavior, according to the numerical analyses, are much different than a traditional NPP and therefore deserve a special analysis in order to qualify the equipment hosted at their elevation, namely valves, tanks and pipelines.

The identified critical locations are those zones of the main building complex for which the calculated seismic floor response spectra (FRS) significantly exceed the 1.5 times GIP-WWER bounding spectrum. These zones are as follows:

- Longitudinal Gallery: Elevation greater than + 6 m
- Transversal Gallery: Elevation greater than + 6 m
- Roof of the Turbine Building and Reactor Building
- Condensed Towers

For equipment in these locations, dedicated FRSs were calculated from the structural models. [IAEA 02 section 3.2.8]

2.6.3.2 Situation in Temelín NPP

The floor spectra are calculated using the same approach as in the USA. The peculiarities of WWER design are taken into account. Additional conservatism is inherent by assuming the bounding spectrum as 1.5 times GIP-WWER bounding spectrum.

2.6.4 GIP and non-GIP Equipment (VLI 6.12)

2.6.4.1 US approach

(VLI 6.12) The Generic Implementation Procedure [GIP-2] provides a special framework and guidance based on the methodology developed by the SQUG (Seismic Qualification Utility Group) in order to verify the seismic adequacy of existing and already installed equipment required to bring the plant into a safe shutdown condition.

The GIP includes 20 equipment classes, the seismic ruggedness of which may be verified by applying specific caveats. Furthermore, special guidance is provided also for the following items

- Relays
- Tanks and heat exchangers
- Cable and conduit raceways

as well as for the evaluation of the following generic aspects:

- Anchorage
- Seismic interaction

The criteria to be met for the qualification of an item are the following:

- o the experience based capacity spectrum should bound the plant seismic demand spectrum
- o the equipment item should be reviewed against certain inclusion rules and caveats
- o the component anchorage should be evaluated
- o any potential significant seismic systems interaction concerns that may adversely affect component safe shutdown function should be addressed. [IAEA 02 section 2.4].

In order to provide a comprehensive tool for qualification of nuclear power plants – especially of WWER NPPs – the GIP equipment classes and items have been extended to appropriate modifications (ModGIP category) and supplements (NonGIP category).

ModGIP may refer to plant-specific topics or to NPP type-specific topics. With reference to the US nuclear power plants, it accounts for deviations in material, design and quality. ModGIP criteria catalogues have been elaborated for

- Anchorage verification,
- Cable tray verification,
- Seismic interaction evaluation.

The criteria are based on simple calculations or on tests.

NonGIP covers those topics not treated in the GIP. The NonGIP criteria catalogues are elaborated applying simple calculations as well as small computer programs, taking plant-specific items like seismic excitation for input. NonGIP criteria are presented in

- Piping evaluation guidelines (providing admissible spans, support loads, component nozzle loads, displacements, and flexibility criteria),
- Piping support criteria catalogues (providing admissible support types and dimension),
- HVAC ducts criteria catalogues (providing admissible spans). [IAEA 02 section 3.1.3].

2.6.4.2 Situation in Temelín NPP

GIP based procedures have been developed for non-GIP equipment. The status is acceptable and consistent with western practices.

2.6.5 Requirements for Re-evaluation of Specific Equipment of NPPs (VLI 6.13 – 6.17)

2.6.5.1 US approach

(VLI 6.13 – 6.19) If the existing seismic qualification of NPP equipment is not acceptable, then the re-evaluation program should cover all mechanical and electrical equipment important to safety, including bolting and anchorage. As mentioned above, this extends not only to electrical equipment, but also to mechanical elements. Piping systems designed to ASME code are considered to be qualified, but if the design was not done according to ASME, a re-evaluation is required. The extent of re-evaluation covers also HVAC ducting, conduit and cable tray raceway systems and relays.

(VLI 6.13) Concerning piping systems, it clearly appears from the feedback experience that they survive earthquake shaking motion particularly well, even amplified by the bearing structures. It is worth to mention that most of them were not designed against earthquakes. The observed cases of rupture of piping systems are consequences of differential input motion on excessively rigid pipes. (Other causes are non-mechanical causes as for instance poor maintenance that results in a lack of detection of excessive erosion of the pipe wall.) This very good feedback experience is collected in [IAEA 50-SG-S1].

In the US, piping seismic response was reviewed to describe failure mode and design margin based on laboratory test data and field earthquake experience. It was pointed out that the inherent margin in piping systems designed with conservative codes was beneficial to the seismic re-evaluation of existing nuclear power plants. [IAEA 02 section 6.2].

In the USA, for PWR primary systems, SSE and LOCA do not need to be combined together, based on “leak before break” consideration. For limited cases, decoupling of pipe breaks and SSE for secondary systems was accepted by the US NRC. The basis for decoupling of pipe breaks and SSE is that the probability that both would occur at the same time is extremely low and leakage monitoring can prevent unstable large flaw from occurring. [IAEA 02 section 6.2.2].

According to GIP-2 the NSSS equipment made to ASME standard requirements is excluded from the necessity of seismic qualification. NRC staff found out that the technical basis for this claim is acceptable with the exception of relief valves, so there is no basis for excluding relief valves from the USI A-46 scope. [Suppl. 1 to GL 87-02].

(VLI 6.14) Modifications and extensions of the GIP have been performed to accommodate conditions that the standard GIP does not cover or excludes. Modifications have included:

- Addition of criteria for HVAC ducting, vertical tanks, horizontal tanks
- Modifications to cable raceway systems to address plant specific conditions
- Modifications to anchorage criteria to address plant specific conditions
- Modifications to caveats to increase voltage from 4.16 kV to 6.3 kV
- Elimination of the method A ground spectra comparison for certain structures
- Increases in the minimum frequency for GIP screening.
- Increases in the screening levels for inherently rugged mechanical equipment [IAEA 02 section 5.4].

(VLI 6.15) Section 8 of GIP-2 describes the screening guidelines for cable and conduit raceway review. The screening procedure is based mostly on earthquake experience data and some shake-table test data. The guidelines consist of a set of walkdown guidelines and a set of limited analytical review guidelines.

The analytical reviews are primarily based on the back-calculated capacities of raceway supports in the seismic experience database.

(VLI 6.16) For new design, qualification of active and mechanical components including relays is conducted by analysis, test or combinations of both. Analysis is governed by the appropriate design codes and standards such as ASME or AISC. Testing is governed by IEEE 344 [17]. The GIP procedures are based on walkdown screening and detailed inspection and analysis of anchorage. Components that do not meet the GIP screening criteria are deemed outliers and should be demonstrated to be acceptable by other means or else upgraded. [IAEA 02 section 2.2.4].

In many WWER NPPs relays have been totally replaced bypassing the qualification problem for the existing ones. [IAEA 02 section 4.2.2].

(VLI 6.17) There is a Section of ASME III code which is devoted to support structures and which may be used. It has been noticed that it is very conservative, as it requires an elastic behavior under all load cases, even thermal. It is a general opinion that the approach can be adapted to the specific case: for re-evaluation, some plastic deformation may be accepted under seismic load provided steel sections and anchoring systems are adequate.

In general, it seems incorrect to consider the supports as part of a building if they do not participate in the equilibrium of horizontal seismic loads. [IAEA 02 section 6.3.3.3].

2.6.6 Situation in Temelín NPP

The re-evaluation program covers all components, both mechanical and electrical equipment important to safety, including bolting and anchorage.

Piping systems in Temelín NPP have not been designed to ASME code, but to Russian codes, which have been repeatedly compared with ASME and found to be at least as conservative as ASME code. Thus, the piping in Temelín NPP that has been designed to Seismic Category I is not subject to seismic re-evaluation. Those pipes that are re-evaluated are checked by analysis with special verification of anchorages and supports, and final walkdown taking into account seismic interactions.

Modifications and extensions of GIP have been performed in keeping with the US practice.

The HVAC ducting and valves are subject to re-evaluation, which is performed by non-calculation evaluation, and final walkdown including supports and anchorages.

Conduit and cable tray raceway systems are re-evaluated by simplified analysis and final walkdowns.

The relays are re-evaluated by seismic tests, GIP procedures and walkdown with checks of anchorages.

Bolting and anchorage criteria are specified and checked by seismic analysis and final walkdowns.

2.7 Equipment qualification preservation

2.7.1 US requirements

Complete and auditable records must be available for qualification to be considered to be valid. These records should describe the qualification methods in sufficient detail to verify that all of the guidelines have been satisfied. A simple vendor certification of compliance with a design specification should not be considered adequate [DOR, section 8].

The NRC staff position does not exclude the use of data from tests conducted on similar equipment as long as independent verification of similarity or equivalence can be established [NUREG 0588 comment responses].

The statement of requirements in the IEEE standard 323-1974 is accepted by the NRC. The qualification documentation shall verify that each type of electrical equipment is qualified for its application and meets its specified performance requirements. The basis of qualification shall be explained to show the relationship of all facets of proof needed to support adequacy of the complete equipment. Data used to demonstrate the qualification of the equipment shall be pertinent to the application and organized in an auditable form [NUREG 0588 section 5].

(VLI 7.1) The system of reporting EQ non-conformance is established in agreement with the requirements of [10CFR 21 section 21.21] and [10 CFR 50 App. B]

2.7.2 Situation in Temelín NPP

The final phase of EQ process, which is still not completed at Temelín NPP, includes all the activities needed to preserve qualification along the plant operating lifetime. It deals with activities such as maintenance, monitoring or replacement parts management.

At Temelín NPP, this phase is described in the Quality Assurance procedure: “Principles of equipment qualification management process” and in the working procedures.

The EQ preserving process will include:

- Modification control with verification of the list of equipment to be qualified and of the qualification requirements and conditions for every design change,
- Control of spare parts and replacement equipment qualification,
- Verification of operating and test conditions to check if they coincide with the design conditions. This can result in equipment requalification or equipment change.
- Establishment of EQ documentation data base. At Temelín NPP, EQ documentation will be divided into 4 groups:
  - Group A including the list of equipment for qualification, qualification requirements and conditions, qualification methodology
  - Group B including qualification protocols
  - Group C including qualification specifications and qualification tests and analyses
  - Group D including records from controls and inspections.

The process of EQ preservation will be subject to periodic safety assessment and to Regulatory Body oversight. The situation at Temelín is in this respect similar to NPPs in western countries.

The assessment of principles and activities for the EQ preservation supported the conclusion that it fully complies with western practices. If implemented as planned, it might be expected that the EQ will be adequately preserved.

3 EVALUATION OF SPECIFIC TOPICS OF INTEREST FOR EQ

While in the previous chapter the results of a detailed review of Verifiable Line Items were summarized, this chapter presents specific issues of interest for the overall understanding of different aspects of the EQ at Temelín. This evaluation is mostly based on (and thematically tied in with) the topical presentations by the Czech experts held during the Workshop, but also subsequent discussions and answers to Austrian questions. The information of the status of EQ as provided in the report [Stevenson 04] was also taken into the account to update the findings established in the Preliminary monitoring report.

The evaluation documented in this section, together with the evaluation discussed in the Section 2 establishes the basis for a comprehensive assessment of the actual status of EQ at Temelín.

3.1 Licensing requirements and regulatory monitoring of Temelín EQ

In relation with the regulatory requirements for EQ at Temelín, three distinctive phases are identified

Phase 1: 1978 – 1990

The requirements related to EQ were included in CSAEC decree No. 2/1978 that established general design criteria equivalent, in a way, to 10CFR50 App. A

The CSAEC Decree No. 5/1979 and CSAEC decree No. 436/1990 dealing with Quality Assurance were used as a ''vehicle'' to manage implementation of EQ requirements. In this period, the EQ was not fully compatible with the western practice in particular with respect to Russian supplied equipment.

Phase 2: 1991 – 1998

This was a transition period for the design upgrade of Temelín. In this period, the Regulatory Authority specified new requirements for EQ implementation based on international standards (IEC, IEEE, IAEA, etc.)

Phase 3: 1998 – now

The Atomic Act (No. 18/1979) established the framework requirements for the EQ. Based on those requirements the licensee (Temelín NPP) prepared the EQ program which was documented in the POSAR. POSAR was the basis on which the license for commissioning was issued. The Equipment Qualification Program was established in three steps (discussed within 3.3 EQ Program, below).

The details on the Temelín EQ program are documented in the POSAR rev. 1 (Dec. 1999). According to SUJB clarification, as part of POSAR it has not been formally approved by SUJB because the POSAR does not require a formal approval from SUJB (nevertheless the POSAR was the basis to issue the license for fuel loading and commissioning and, therefore, it shall be considered "accepted and approved" by the regulatory body). According to SUJB, the POSAR has to be considered as having received a ''consensus'' from the SUJB.

At the time of issuing the license for commissioning, there was no condition raised by the SUJB with respect to completion of the establishment of the EQ and its time schedule. The commitment from NPP to complete the EQ program, as reported in POSAR, was June 2002. There is a delay with the completion of the EQ, which was scheduled for completion in 2004 and for ageing related EQ in 2006. The SUJB accepted the new schedule.

The Atomic Act recognizes the “transition periods” for items that are incomplete. On this basis, the SUJB has conditionally accepted that for a limited number of components (mainly mechanical components, valve actuators, electrical drives which were not affected by design changes) the EQ would not be fully established by the time of startup. The SUJB considered that the deficiencies of the EQ at the time of the startup were not of the magnitude to warrant the interruption of the start-up of the plant. Although a review into all deficiencies that existed at the time for startup was not performed (and could not be performed, because all needed data were not available), the results of the work that has been performed since then confirm that the EQ for Temelín proceeds well. The EQ on almost all electrical equipment, which is usually the dominant issue in the EQ, was completed. “Open item” classification on some equipment was clearly due to lack of proper documentation from Soviet times. On engineering basis it is highly probable that those pieces of equipment are fully appropriate for their functions. Moreover, (as discussed below) compensatory measures were introduced in certain critical cases.

Nevertheless, the remaining incompleteness of the EQ process, albeit small, warrants the consideration for a continuing monitoring activity until the final completion of the EQ.

3.2 System classification

The system classification in Czech republic in “safety “ and “safety related“, being nominally different from that in western countries is often misunderstood. According to the Czech approach, the “safety systems” encompass most of the equipment important to safety. The “safety related systems” may contain a minor part of the equipment that needs to be available in a case of DBA.

Unlike in some countries where only “safety” systems are subject to EQ, at Temelín the EQ program encompass both “safety” and “safety related” systems, though the priority has been given to completing the EQ on “safety” equipment. The comparison of Czech classification with the IAEA classification of systems shows that the classification made by CZ corresponds to that of the IAEA. The difference is only in the names of the system categories, but the contents of higher and lower safety importance categories are the same.

The approach of "completing EQ for safety systems first" is correct. The EQ activities on “safety related” equipment will immediately follow the completion of the EQ activities on “safety” equipment. The list of equipment for which the EQ is still not fully completed may include both the “safety” and the “safety related” equipment. Unfortunately the report [Stevenson 04] is not fully precise as to which exact pieces of equipment still have the EQ incomplete.

3.3 Temelín EQ program

The responsibility and the management of Temelín EQ is retained by the utility. The overall Temelín QA requirements are fully applicable to EQ.

The EQ program encompass 3 distinctive steps:

Step 1 Identification of equipment to be qualified and related service conditions and qualification requirements

Step 2 Preparation of qualification technical specifications, criteria, procedures and methodologies. Screening and evaluation of qualification status of each component

Step 3 Upgrading of EQ, issue of qualification reports and programs for maintaining qualification requirements during operation.

The step 1 of the EQ program has been contracted to Czech design company Energoprojekt Prague (EGP), the step 2 has been contracted to Stevenson & Associates (S&A) (who followed the US practices), and the step 3 is, at the moment, under the management of the Engineering Dpt. of NPP. External support for the Step 3 has not been selected yet.

It appears that for the equipment identified as being "open issues" (i.e. the EQ not completed or not properly documented, so the equipment cannot be relied on during a DBA), the NPP approach consists in the ''preparation of specification of interim measures'' to manage this equipment while having non-conformity with respect to EQ requirements. Evidence of this was shown in an example of emergency procedures which indicates to the operator that he may not fully rely on a piece of equipment, because it was not properly EQ'd.

The upgrading activity that is a part of the Step #3, as presented by NPP, is referred mainly in terms of upgrading EQ documentation. It is obvious that finally the upgrading of the hardware will result also in the upgrading of EQ documentation, but it goes first through analysis and testing activity according to the methodology adopted and the deficiencies identified, whose resolution could also require the replacement of the equipment.

Further, the ''Upgrading and preserving" part of NPP Temelín EQ program is described in the QA procedure ''Principles of equipment qualification management process''. It seems unusual that a part of the EQ program (upgrading and preserving) is described in a QA procedure and not in the program itself. This, however, is a matter of the organization and does not raise a safety issue.

3.4 Preparation of the design input for the EQ

In the process of implementation of the EQ, preparation of the design input to include general safety requirements, DBA to be considered for identification of service conditions of equipment to be qualified, etc. is the first step. For Temelín EQ, this would mostly been done by the contractor EGP.

The detailed information on the methods and approaches used for determining the design input and the examples of the analysis, parameters and equipment selection confirmed that prudent practices and western approach were used throughout.

Additional qualification parameters regarding the different harsh environments which have been identified, the dose rate considered in the various location (inside containment and outside containment) in normal, accident and post accident conditions, the post accident period of time considered for EQ, the seismic response spectra calculated at the main floors, etc. appear all to be well founded.

3.5 Development of the EQ component list

The development of the EQ component lists and associated parameters for each component was done by the contractor, EGP. The approach used complies with western methods. Examples were provided showing the results obtained.

Five qualification categories have been presented covering harsh and mild environment and different functional requirements for safety equipment.

With respect to locations (outside containment) where the HELB could take place (i.e. room A820), the environmental conditions identified for the EQ (T_{max} 104 °C, P_{max} 120 kPa, dose rate 1E-03 Gy/h) are considered appropriate for the conditions applicable to the 28.8 m level.

3.6 The EQ qualification methodology

The qualification methodology and the approach that comprises the Step #2 of the EQ program was developed for Temelín NPP by another contractor, Stevenson and Associates. The general approach for the EQ is described in a logical diagram, which describes different possibilities (paths) to address the solution of cases where EQ, as identified, is insufficient or deficient.

An overview of the methods, standards, and criteria used for environmental qualification of Temelín NPP confirmed that all of those follow western standards and approaches. Typical test sequences used for equipment situated in mild and harsh environment are also similar to those used in the West.

Regarding the mild environment, the basis for (practically) excluding the aging mechanism (thermal, vibration, etc) from the test sequence of safety equipment (before seismic testing) needs to be better understood.

Different standards appear to be used for seismic qualification (Russian, German, American, etc.). A better understanding of compatibility of those to ensure equivalent and homogeneous results in terms of qualification could be of interest.

There is no information on the rules directing determination of quantified margins to test parameters. The margins are chosen on a case-by-case basis. This could possibly result in incompatibility. However, the cases examined could not identify any such incompatibilities, thus indicating that three is no specific safety issue here.

The general procedure for qualification by test and analysis, which is presently based on US regulations, could be formally documented and the approach to setting appropriate margins and other items specified. The compatibility of standards used for seismic qualification could be additionally verified within the EQ process.

3.7 The EMC Qualification

Due to high utilization of electronic components at Temelín NPP, the EMC qualification has a much higher importance than at old(er) plants. The equipment EMC qualification at Temelín NPP consisted of a systematic review and evaluation of the documentation for licensing requirements, plant design, construction, commissioning and operation.

The EMC qualification has been performed for the following groups of equipment:

- I&C equipment 396 items
- Sensors 252 items
- Transmitters 343 items
- Electrical Equipment 123 items.

In addition to these items, many post installation EMC tests have been performed on safety of commercially significant equipment.

The methodological basis, the extent of EMC qualification performed and the whole process for the EMC qualification corresponds to and in many cases goes beyond best western practices.

3.8 The level of completeness of the EQ at Temelín

Specific database to monitor and document all the EQ activities was developed. It is maintained for Temelín NPP by a contractor (S&A), but it is also available in most up to date version at Temelín site. The creation of the data base to document and to support the preservation of the EQ could be seen as a very prudent approach to EQ. ENCONET staff has been given a demonstration of the data base and found it to be at par or better as compared with EQ database of some western plants. The data base appears complete and user friendly. All the requested data could be found and displayed immediately upon request.

For each of the 233 Equipment Qualification groups, the evaluation needs with indication of related seismic class, qualification category, kind of environment, need of EMC qualification etc. was established.

The documentation needed to corroborate seismic, environmental and EMC qualification requirements is specified, to serve as the starting point for review of acceptability of the EQ. The documentation encompasses different design documentation, QA programs, drawings, testing program, etc.

At the time of the Prague workshop (December 2002) there were 37 groups with open issues (incomplete EQ). For each of those additional investigations and identification of measures to resolve them were determined.

The majority of open issues are related to mechanical components (it has been clarified that those are valve actuators, electrical drivers, etc) having seismic class 1a, EQ category K1 and located in harsh environment. Most of those were qualified in accordance with OTT-87 (Soviet Standard), and thus their EQ need to be re-evaluated or upgraded. The majority of problems come from incomplete documentation, so the actual tests or evaluations already done on the equipment could not be traced.

The assessment performed at the time of the Workshop concluded (on the basis of the review of planned qualification steps) that the overall approach for verifying the compliance with EQ requirements did not envisage the possibility that a piece of equipment would need to be replaced. That was seen as a deficiency of the EQ program. The report [Stevenson 04] indicates that for three qualification groups the actual replacement of equipment was carried out, thus confirming that the replacement as one of the measures to assure the EQ was indeed a part of the EQ compliance program.

The update of the status of the qualification as of the end of 2004 is also documented in the report [Stevenson 04]. It established that from the 37 equipment groups with incomplete EQ in 2002, at the end of 2004 5 groups remained regarding general EQ and 14 groups regarding ageing qualification. More precisely, in 2003 and 2004 the following was accomplished"

- Completion of the ageing qualification on 14 equipment groups
- Replacement of equipment in 3 qualification groups
- For five equipment groups the qualification process was concluded through the type tests of representative samples
- For equipment in 4 groups the qualification process was completed, but some minor formal defects remain

While the general EQ for all equipment should have been completed in 2004, apparently some slippage of the schedule occurred. Nevertheless, in accordance with the report [Stevenson 04], the following is expected to be completed in 2005

- replacement of equipment in 3 equipment groups
- EQ by qualification tests and analysis for remaining 2 equipment groups.

With completion of formal deficiencies on 4 equipment groups (as indicated above) this shall complete the EQ on all components.

In the case of ageing qualification the Stevenson 04 “Answers to the Conclusion” establishes that the ageing qualification on remaining 14 groups may be expected to be completed in 2005, before the scheduled deadline (i.e. 2006).

3.9 The cable ageing management at Temelín

The cable ageing and its management is a big issue for most, especially older plants. Temelín, having replaced all the cables with qualified cables before starting the operation is in a good position in this respect. In addition, numerous cable sampled were placed at selected locations through the plant, to be available for experimental determination of degradation and ageing phenomena assessment later in the plan life. Software was developed for the assessment of cable lifetime.

The mechanisms to be considered for cable ageing included oxidation in elevated temperatures, combinations of stress, thermal ageing characterized by Arrhenius equation and radiation ageing.

The preferred method of environmental qualification for cabling was type testing. Besides that operating experience, qualification by analysis and combined qualification were used. Vast majority of cables were EQ’d before the installation.

In the area of cable EQ, Temelín achieves or exceeds the level typical for modern western plants.

3.10 Upgrading and preserving EQ at Temelín

The strategy for preserving the EQ for the plant lifetime is established in general terms, and it is comparable to western practices.

At the time of the Workshop in 2002, the compensatory measures for equipment with deficient was of high interest. Four groups of equipment with deficient EQ (open issues) were established, depending on the character/magnitude of a deficiency. The safety evaluation was performed on all/most open issues and ‘’interim measures’’ identified.

Upon insistence of ENCONET as to what are those “interim measures” an example of a procedure was presented. That procedure clearly identified that a specific piece of equipment is not qualified (in fact, the documentation is incomplete) which may raise doubts as to its operability during specific sequences. Therefore, Temelín developed an addendum to the operating procedure that is an integral part of an EOP instructing the operators what to do. The procedure was very well prepared. ENCONET believed that if other “interim measures” were prepared with the same understanding and extent of details, none of the EQ open issues will be considered a safety issue in the short term.

The report [Stevenson 04] confirmed that the compensatory measures to assure that the control room operators could rely on the equipment with completed EQ were prepared for additional equipment groups. In accordance with the report this includes a total of 6 equipment groups. The compensatory measures may be expected to stay in place until the equipment qualification for that groups, either by replacement of some other means is assured.

3.11 Review of EQ activities on selected equipment

In an attempt to visualize the activities on the establishment of the EQ for different equipment, including the difficulties related with collection and evaluation of documents and test reports prepared by different institutions, a review of EQ activities on four pieces of equipment was prepared by Nuclear Research Institute in Rez (NRI). The purpose of this review was said to be solely to demonstrate the EQ activities for the Workshop within the Melk follow up process. This review was said not to be done for the account of the regulator, nor the regulator is to use its results for any of its activities. This is important to highlight, because the review was not performed by an independent organization, i.e. the NRI was as well involved in numerous EQ activities for Temelín.

The review of four EQ groups has been presented:

1. Alcatel cable NSK 0.6/1kV
2. Minco surface Mounted rtd model S100919
3. Limitorque Valve Actuator type SMB
4. ZPA Valve Actuator MoA OC

The review has shown that the results of the EQ review were generally positive for all four groups. In particular for two of them (Limitorque Valve actuator type SMB and ZPA Valve actuator MoAOC), for which "open issues" were identified, the conclusion was that the ''open issues'' were not significant and that the ''evaluated documentation demonstrated qualification''. While the presentation showed how a review of the EQ could be conducted, it raised some issues when it was found that the review decided that some of the EQ documentation was "acceptable" and at the same time this documentation was found "not acceptable" by the Temelín EQ team. It could not be judged if this would be an indication of extra conservatism on the side of the EQ team or a lack of understanding on the side of review.

4 MONITORING FINDINGS

The evaluations and assessments documented in the Section 2 and 3 of this report gave raise to a series of findings. Those are presented in below. The findings are grouped in categories of interest relevant for the technical understanding of the EQ process at Temelín.

Regulatory approach and practice

1. Until 1998, the concept of the EQ for Temelín NPP was based on the general requirements of QA program according to Czechoslovak Regulatory Decree No2/1978. With the introduction of the Atomic Act in 1997 and its accompanying regulations, the requirements for EQ were established to a level comparable to modern western practices. Consequently, Temelín was obliged to develop and initiate the implementation of a complex EQ program, which would comply with new regulatory requirements.
2. State Office of Nuclear Safety (SUJB) issued its own safety guide on EQ in operating WWER 440/213 NPPs, which is also applicable to Temelín NPP. This Guide defines the requirements for the preparation and implementation of the EQ for a NPP that has already been constructed and where equipment was delivered/installed without formal documents demonstrating equipment qualification for operation under accident conditions. ENCONET reviewed this Guide and found it to be well prepared having requirements for practices which are similar to those in western countries.
3. SUJB requested that Temelín develop a specific EQ program that would reflect the regulatory requirements and state of the art practices. The NPP designer, EGP identified the equipment to be qualified and the qualification requirements. Another contractor, Stevenson and Associates developed the EQ technical specifications, criteria, procedures and methodologies. It has also performed screening and evaluation of qualification status of each component and has been leading the work on full implementation of the program. The program, which is divided in three steps, encompasses all the elements needed for a successful implementation of the EQ at Temelín and includes procedures for qualification of all types of equipment.
4. The regulatory practice in Czech Republic does not require specific approval for EQ program. The EQ program was implicitly reviewed as a part of the “acceptance” of POSAR that was the precondition for the issuance of the license for the fuel loading and the commissioning. While this practice is different from that i.e. in the USA (where USNRC approves the plant’s EQ program), it is similar to the practice in some European countries (where a regulator does not specifically approve the EQ program). No specific deficiencies could be identified as being caused by a lack of formal regulatory review of the EQ program.
5. Within the framework of its regulatory inspections, elements of EQ activities are regularly reviewed by SUJB. The requirements and/or conditions identified during those regulatory inspections are documented in inspection protocols, which are official and mandatory requirements for the licensee. This brings in an element of the regulatory control of the EQ process. The SUJB inspections are regularly conducted and specific action items with scheduled completion dates are established in those.
6. The POSAR stated that the EQ program for Temelín would be completed for relevant equipment of “safety” and “safety related” systems by June 2002. This was not achieved. The regulatory body agreed with the request of the plant which asked for a 2 year extension of the deadline for the implementation of the EQ. At the time of the Workshop in 2002 the deadline for the completion of the EQ is 2004, with additional deadline for ageing related EQ in 2006. It is easy to understand that in relation with ageing, there is no particular pressure on EQ as the plant has just been commissioned, i.e. it is new and the

ageing issues will start playing an important role only later in the life. The SUJB accepted the extension. This appears acceptable, in particular with the consideration of a relatively few components still being “open issues”. Such extensions are not un-common in western countries and have been granted to many plants on case specific basis. The completion of the general EQ was not achieved in 2004. The EQ for a total of 5 equipment groups and ageing qualification fo 14 equipment groups remain incomplete as of end of 2004. Both the general EQ and the ageing EQ may now be expected to be completed during 2005.

Temelín EQ program

7. In its basic elements, Temelín EQ program is comparable to those at Western plants. The issue of having equipment that was manufactured to Russian standards and its characteristics and capabilities often not properly documented, places additional burden on confirming the EQ for those equipment. In general, the approaches, methods and specific standards followed in Temelín EQ program are in most cases those of US and Western countries. Czech specialists dealing with EQ have been trained in the US and are well aware of US EQ practices. There are also minor differences, e.g. environmental conditions are evaluated on a room by room basis, and not by zones as in the US. This, however, has no practical safety significance in relation with EQ at Temelín.
8. US standards are occasionally used side by side with former USSR standards or European standards without clear procedure how they should be combined in a consistent way. In the area of mechanical strength analysis the Russian standards have been shown to be equivalent or even to provide larger safety margins than the ASME code. In the area of electrical equipment mostly the US standards (IEEE and IEC) are used. In all cases discussed and reviewed, the resolution of individual EQ concerns seemed to be satisfactory (e.g. cable qualification or EMC effort), so the lack of predefined approach on specific standards has so far not resulted in any visible problems (this statement is based on a sample presented or evaluated during the Workshop).
9. The EQ program for Temelín encompasses 3 steps: The first step (list of equipment and design inputs), was contracted to EGP, and has been completed. The second step (screening and evaluation) contracted to S&A is being completed. There are still numerous open issues where the EQ of specific equipment is not documented. The third and last step (upgrading and preserving) has just been started under the coordination of NPP Engineering Dpt.
10. The determination of list of equipment, which needed to be qualified is well done, and in line with western practices. The list of DBAs has been extended and it is comparable to western lists. Czech own classification, which distinguish between “safety” and “safety related” equipment is different than western practice, but internally consistent. Upon closer evaluation it was confirmed that this classification does not have any negative impact on the selection of the equipment to be qualified.
11. The determination of qualification parameters is well done and follows western practices. The review team noted that for (practically) all parameters a recalculation using modern western codes was performed.
12. The screening and evaluation, which is the part of the second step of the EQ program, closely resembles western approaches and practices. The evaluation is based on a selection of type testing, parent testing and analysis, as appropriate for specific pieces of equipment.
13. To document the EQ assessment, and establish the basis for EQ preservation, the EQ database was developed containing all necessary information for the EQ. Data sheets have been elaborated containing information and data on the normal and accident conditions in the rooms (T, P, humidity, radiation, flooding level if any, etc.) and on the equip-

ment to be qualified (name, location, safety class, kind, manufacturer, etc.). Expert team reviewed the database on a spot check basis, and concluded that it is developed to a high standard of comprehensiveness, usability and user friendliness.

14. For the 28.8 meters platform, where all main steam and feedwater piping are routed, particular attention was to protection from the effects of a high energy line break (HELB). The parameters calculated by the plant for accident conditions turned out to be below those assumed as the design basis by Russian designers, so the higher parameters were taken as the basis for EQ. At the time of the Workshop in 2002 there were open issues on five equipment categories (fans motors, pressure sensors and transmitters, level measurements) that could possibly be affected by the HELB. The report [Stevenson 04] establishes that for many equipment groups the qualification was indeed completed, but does not precise which equipment remains non-qualified. It has to be noted that for the relief valves which are also located in this area, the EQ was satisfactorily completed (the qualification of those valves for the two phase flow, which is not a part of the EQ. It is being monitored through the project PN3 for Roadmap Item 2 "Qualification of Valves").
15. During the 2002 Workshop a deficiency of the approach for determining the environmental conditions was identified. The localized effects have not been determined for specific rooms and locations. The US practice requires the assessment of local effects for the sequence-critical equipment. The report [Stevenson 04] confirmed that additional analyses to determine possible localized effects were performed. The results determined that the available margins are appropriate to cover for any localized effects. This was done for the containment area. The issue of localized effects for areas outside the containment (i.e. areas where high energy lines are located) remains, for the time being, unanswered.
16. For BRU-A and the Main Steam Safety Valves (MSSV's) the status of seismic qualification was clarified in the report [Stevenson 04]. The BRU-A replacement motor is of the same weight and sues the same fittings, so that the previously completed seismic qualification is appropriate.
17. The demonstration of adequate consideration of the aging factors in the qualification process of the safety equipment seems to be one of the critical point identified in the review process as discussed in section 2.5.1. Since the plant operation has just been started, the issue of aging has been considered to less urgent than the other EQ issues and SUJB agreed to extend the time limit for resolving aging issues to 4 years. The way it is to be managed in the short and long term perspective has to be clarified. As per information of August 2004, the ageing qualification is already completed on 14 categories of equipment and will be completed for remaining 14 categories in 2005.
18. The Workshop has provided some evidence that for the equipment having open issues in relation with the EQ, interim measures are proposed/implemented. The approach to prepare provisional procedures, available in the MCR together with the Emergency Operating Procedures for the operator to handle this equipment is an example of a well designed interim measure. At the time of the Workshop in 2002 it was unclear if the interim measure were indeed established of other pieces of equipment. The report [Stevenson 04] confirmed that the interim measures are indeed in place for additional 4 equipment groups. The MCR operators could now shutdown and cooldown the reactor without relying on any of the non-qualified equipment.
19. The overall policy to address the solution of all open issues in the short and long term has to be established. This shall provide an adequate consideration to different safety aspects including relevance of the equipment and severity of EQ deficiencies. A statement "no impact on nuclear safety for a limited period of time" cannot be accepted if it is not based on a consistent approach and analysis of effects of individual equipment. While this assessment was appropriate at the time of the Workshop in 2002, the progress achieved in the completing the EQ and the interim measures implemented are such that no great concerns exist any more.

Remaining open issues

20. Since 2001, a large number of open issues identified at that time have been closed. In December 2002 there are 37 equipment groups (out of 223) with some open issues in relation with the EQ. Number of equipment pieces within these 37 groups is about 240. At the end of 2004 five equipment groups remain with incomplete EQ. Additional 14 equipment groups remain with incomplete ageing qualifications. The number of equipment pieces in these groups is not known.

5 ISSUES OF FURTHER INTEREST

With the consideration of extensive evaluation during and after the Workshop held in Prague in December 2002, and with additional information as provided by the Czech side in the report “Answers to the Conclusions” [Stevenson 04], the Austrian expert team established a series of conclusions on the status of the EQ process, as well as specific activities related with the EQ for Temelín. Those conclusions are presented in the Section #4 of this report.

The general conclusion is that the EQ process for Temelín is based on sound principles and is being well implemented, though delays have occurred and are still occurring in the process. ENCONET’s experts believe that the EQ shall not be seen as an important open safety issue any more.

Nevertheless, the EQ process is an important element of assuring the safety of Temelín plant in the long term. Even as of now the process of environmental qualification is not fully completed. Some issues remain and those may be continued to be monitored within bilateral Austrian Czech activities for the next year or two until a full completion of the EQ at Temelín. The chapters below discuss the issues that may be monitored.

The pertinent Czech-Austrian Bilateral Agreement is seen as an appropriate framework giving the opportunity for further discussion and sharing additional information on these issues.

5.1 Completing the EQ on all equipment

Justification

As of December 2004, there were 19 equipment groups with incomplete EQ. Those are treated as the “open issues”. Among those, 5 groups have incomplete general EQ and 14 groups incomplete ageing qualification. All the qualification is now expected to be completed during 2005.

All the safety relevant equipment is subject to the EQ requirements and the EQ needs to be implemented and documented on this equipment. The conclusion raised earlier that the lack of EQ may be a safety deficiency, and operators may not be able to utilize a component during an accident, although compensatory measures were implemented, remains until there is any equipment with non-completed EQ.

Monitoring activities

The completion of the EQ activities on all equipment. As of the end of 2004, five equipment groups for general EQ and 14 for ageing qualifications remain.

Schedule

The monitoring should be continued until all the equipment has been covered by the EQ. In accordance with the present plants, this shall be in 2005.

5.2 Completing the ageing EQ on all equipment

Justification

The qualification of equipment for ageing phenomena is incomplete, and the announced completion for remaining 14 equipment groups is during 2005.

Monitoring activities

The monitoring shall be focused on the progress in completing the qualification of equipment with consideration of ageing effects.

Schedule

The monitoring should be continued until all the equipment has been qualified. In accordance with the present plans, this shall be in 2005.

5.3 Local harsh environmental conditions for critical equipment

Justification

In the case of EQ at Temelín, the environmental conditions were established on the room-by-room (and DBA) basis. This implies that all the equipment located in one room would see similar environmental conditions. US practices requires that the local environmental effects (i.e. those in one part of a room) be considered for specific, sequence critical equipment. This applies mostly to HELB and similar effects, where much higher temperatures and pressure conditions could exist locally. Since the Workshop in 2002 the localized conditions were analytically evaluated for the containment areas. The local harsh conditions for other areas still remains to be evaluated.

Monitoring activities

For critical components for specific DBAs (mainly HELB) located outside the containment, where localized harsh environment conditions (i.e. as compared with room-averages) could exist, an investigation into localized environmental impact is suggested.

Schedule

This issue may remain of interest for discussions under the Bilateral Agreement until local environmental effects for areas other than containment are completed.

5.4 Findings of SUJB's inspections related to EQ

Justification

The vehicle that the SUJB uses to monitor the progress of the EQ activities at Temelín is the regulatory inspection. As the EQ is not completed, it is of interest to understand what kind of findings the regulatory inspection is obtaining and what kind of resolutions are being agreed upon. It is recognized that after the 2002 Workshop the SUJB continued its regulatory inspections. As the EQ is not fully completed, the interest in results of regulatory inspections remains.

Monitoring activities

Within the process of periodic information exchanges between the Czech Republic and Austria in the frame of the pertinent Czech-Austrian Bilateral Agreement, a summary of findings of regulatory inspections related to the EQ could be presented.

Schedule

The monitoring should continue until completion of the activities related with the establishment of the EQ for safety equipment at Temelín.

5.5 Possible effects of findings made in PN6 on seismic qualification of equipment

It should be remarked, that the qualification of Temelín equipment for seismic hazard conditions has been performed assuming maximum horizontal acceleration of 0.1 g. The conclusions reached in PN6 item of the Project appear to indicate that a higher value of acceleration may be appropriate. If the seismicity of the site is changed, the issue of seismic qualification of the safety related equipment in Temelín NPP should be revised.

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7 ABBREVIATIONS

ACRS	Advisory Committee on Reactor Safeguards
ANS	American Nuclear Society
ASME	American Society of Mechanical Engineers
ASOQ	American Society for Quality Control
ATWS	Anticipated Transient without Scram
CDFM	Conservative Deterministic Failure Margin
CFR	Code of Federation Regulations (of the USA)
DBA	Design Basis Accident
DBE	Design Basis Event
DSMA	Deterministic Seismic Margin Assessment
EDF	Electricité de France
EGP	Energoprojekt Prague
EMC	Electro-magnetic compatilbility
EPRI	Nuclear Power Research Institute (of the USA)
EQ	Equipment Qualification
EQML	Equipment Qualification Master List
EQR	Environmental Qualification Requirement
ESF	Engineered Safety Features
FA	Fragility Analysis
FRS	Floor Response Spectra
FSAR	Final Safety Analysis Report
FSU	Former Soviet Union
GDC	General Design Criterion
GIP	General Implementation Procedure
HCLPF	High Confidence of a Low Probability of Failure
HELB	High Energy Line Break
HVAC	Heating, Ventilation and Air Conditioning
I&C	Instrumentation and Control
IAEA	International Atomic Energy Agency
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers (of the USA)
INPO	Institute of Nuclear Power Operation (of the USA)
IPEEE	Individual Plant Examination for External Events
ISI	In-Service Inspection

ISRS	In-Structure Response Spectra
LOCA	Loss of Coolant Accident
MCR	Main Control Room
MSLB	Main Steam Line Break
NPP	Nuclear Power Plant
NRC	Nuclear Regulatory Commission (of the USA)
OBE	Operating Basis Earthquake
PC	Plant State
PIE	Postulated Initiating Event
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
QA	Quality Assurance
QC	Quality Control
RCC	Regles de Conception et de Construction (Rules of Design and Construction in France)
RCS	Reactor Coolant System
RFS	Regles Fondamentales de Surete (Fundamental Safety Rules in France)
RG	Regulatory Guide
RLE	Review Level Earthquake
RRS	Required Response Spectra
S&A	Stevenson and Associates
SAR	Safety Analysis Report
SC	Safety Class
SEL	Seismic Equipment List
SG	Steam Generator
SGCR	Steam Generator Collector Rupture
SLB	Steam Line Break
SMA	Seismic Margin Assessment
SME	Seismic Margin Earthquake
SPRA	Seismic Probabilistic Risk Analysis
SQR	Seismic Qualification Requirement
SQUG	Seismic Qualification Utility Group
SRP	Standard Review Plan
SSC	Structure, System and Component
SSE	Safe Shutdown Earthquake
TID	Total Integrated Dose
TRS	Test Response Spectra

US NRC	United States Nuclear Regulatory Commission
VLI	Verifiable Line Item
WO	Work Order
ZPA	Zero Period Acceleration
ZPGA	Zero Period Ground Acceleration