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# Upgrading of the Ukrainian NPPs and the "2+2" approach applied for the licensing of the major modifications

V. Redko (Ukrainian National Regulatory Authorities)

A. Gorbachev , D. Goetsch (IRSN/ France) and A. Madonna (ANPA)

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## 1. INTRODUCTION

Many of planned for Ukrainian VVER plants upgrading measures are financed by the European Union through TACIS, as for example:

- replacement of pressurizer safety valves, adding new safety functions
- replacement of steam generator safety valves
- modernisation of the containment's sump filters
- improvement of the liquid radioactive waste treatment systems
- modernisation of the Steam Generator level control

The Ukrainian National Regulatory Authorities (SNRCU) and the Operating organisation (NAEK) have established the main steps of the licensing of these measures implementation. The licensing procedure includes the following main steps:

- conceptual decision on modification,
- technical specification on tendering,
- decision on equipment mounting,
- decision on commissioning.

This report presents the principles applied for "2+2" approach as well as a summary overview of the main recommendations given by RISKAUDIT to the SNRCU in the frame of the licensing process.

## 2. LICENSING PROCESS

The licensing of any modification which is related to safety relevant equipment is required by the Ukrainian regulation. Main steps of the licensing process are presented in the Appendix 1.

In order to get approval from the SNRCU for each licensing step, the Operating organisation (NAEK) submits corresponding technical documents, which contain needed safety justification.

Usually, for preparing his decision, the SNRCU request their technical support organisation (SSTC) for the expert technical opinion.

However, for the Modification Projects related to the implementation of new equipment designed and manufactured in Western countries, NAEK and SNRCU are supported by EU organisations. Thus, EU utilities (EDF, DTN, Biblis) are involved in the on-site assistance on Ukrainian NPPs (Rovno,

Khmelnitsky, South Ukraine and Zaporozhye) and RISKAUDIT provides the assistance to SNRCU and to their national Technical Support Organisation (SSTC).

This “2+2” approach can be resumed as follows:

NAEK & EU Utilities + SNRCU & RISKAUDIT (which contracts EU TSO and SSTC)

This approach allows:

- Smooth adaptation of western technologies to VVERs
- Comprehensive verification of Ukrainian and Western regulatory requirements
- Transfer of know-how to the Ukrainian Organisations.

### **3. APPLICATION OF THE “2+2” APPROACH**

The following modification projects are covered by the “2+2” approach.

- U1.01/96A Replacement of safety valves of steam generators at unit 3 of RNPP
- U1.01/95 Replacement of safety valves of steam generators at units 1.2 RNPP
- U1.01/97B Hydrogen management in containment under operation and accidents 1.2 RNPP
- U4.01/94 Liquid radioactive waste processing at RNPP
- U1.01/97A Containment sump protection against clogging at units 1.2 RNPP
- U1.01/92B Control system of feed-water level and consumption in SG. SU1.2
- U1.02/96A Improvement of fire-protection system; SUNPP
- U1.02/97A Replacement of first circuit heat insulation of units 1-3; SUNPP
- U1.02/95A Chemical control improvement; SUNPP
- U1.01/99A Replacement of SG safety valves units 1-6; ZNPP
- U2.03/96 Replacement of impulse safety valves in pressurizer condenser at units 5,6; ZNPP
- U1.03/97B Reliability enhancement of containment isolation; ZNPP
- U1.03/99C Replacement of feed water control valves units 1-6; ZNPP
- U1.03/99B PORV modernisation ZNPP 1-4
- U1.04/97C Modernisation of reactor vessel monitoring system SK 187, phase 2; KhNPP
- U1.04/93A Liquid radioactive waste processing; KhNPP
- U1.04/97B Development and implementation of equipment and methodology of threaded holes eddy current monitoring at flanges of primary circuit main equipment; KhNPP.
- U1.01.98/A Replacement of pressurizer safety valves on units 1 and 2, RNPP

The flow-chart of the activities inside of each licensing step as well as the interface between involved organisations are presented in the Appendix 2.

For each of the steps the Ukrainian utility submit the corresponding technical documents to the SNRCU in order to substantiate the safety.

The SNRCU request his TSO (SSTC and EU TSO) to carry out a technical evaluation of the documents and to provide the experts conclusions. Then, the SNRCU makes the decision basing on these conclusions.

The EU TSOs and SSTC, being contracted by RISKAUDIT have organised their work in the following way:

- Technical Project Leader (member of one of the involved EU TSO) receives from SNRCU the technical dossier and distributes them to EU TSO (translated into English) and to SSTC.
- EU TSO and SSTC perform technical evaluation of documents in parallel. Then they produce their questionnaires, comments, and drafts of recommendations.
- Meetings are organised (if necessary) between EU TSO and the SSTC in order to harmonise the issues from performed parallel analyses.
- Harmonised common comments or questions are discussed with NAEK (who involves the corresponding on-site assistants and the suppliers). EU TSO and the SSTC prepare the final recommendations after the meeting.
- The SSTC submit the final recommendations to the SNRC U for the decision making.

In order to use the EU TSO capacities in the optimal way, they participate only in the “key-steps” of the licensing process.

Other steps being carried out by SNRCU with technical support from only SSTC, however very close contacts remain between the SSTC and EU TSO even for those steps where EU TSO are not supposed to be involved.

#### **4. GAINES FROM THE “2+2” APPROACH**

##### General

The assistance provided by EU Utilities and EU TSOs is very helpful for the Ukrainian organisations because it gives the possibility to enrich their safety culture and to implement in short period of time the equipment designed and manufactured in EU on the basis of the norms and standards that are not always well known to the Ukrainian Utility and Regulatory Body.

Moreover, a frequent exchange of technical information between EU TSOs, SNRCU and SSTC, as well as elaboration of harmonised statements, which are based on the eastern and EU practice of the licensing, is an efficient way for the know-how transfer from the EU TSOs to the Ukrainian partners and for obtaining of a high quality expertise in relatively short period (from two to five weeks for each steps).

##### Technical

Many aspects would not have been revealed without participation of the EU TSOs. Most important are the following:

- Classification of I&C equipment associated to the Cold Over Pressure protection of the Reactor Pressure vessels.

Indeed, the risk of a spurious actuation of the PORV should be minimised via a high class of the I&C equipment related to the Cold Overpressure Protection, otherwise, one shall consider that the estimated frequency of spurious actuation of Pressurise Safety Valves (due to errors in the computation by the algorithm) would be considerably increased, especially during the reactor states where the ECCS cannot be actuated automatically (cold state). Therefore the class of the related equipment has to be 1E. So far, the Ukrainian regulation imposes adequate requirements for such equipment (e.g. quality, redundancy, segregation of redundant trains) but not for the related software.

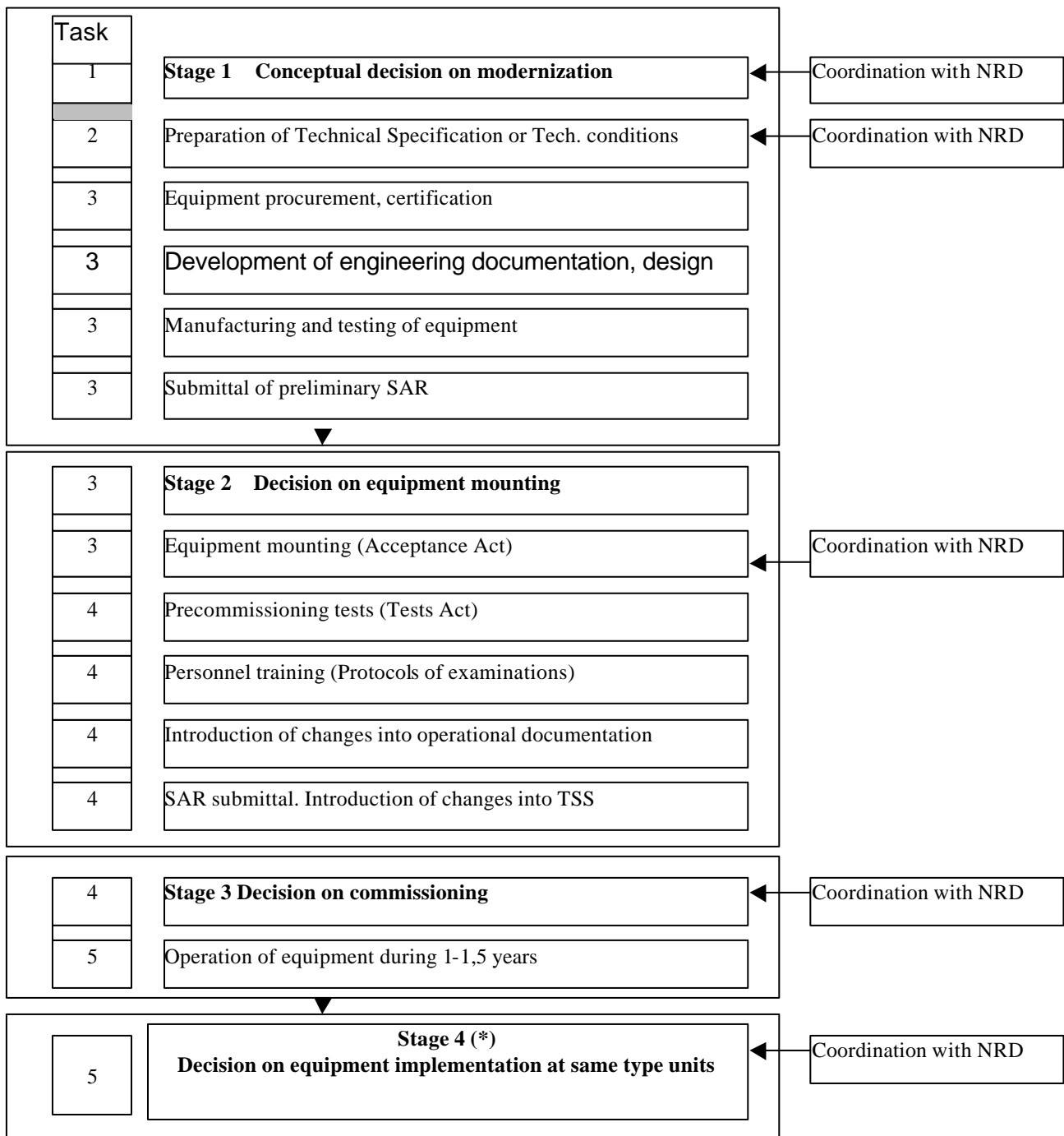
- Qualification of the Pressurizer Safety Valves to water at parameters corresponding to the accident when the pressurizer can be overfilled.

- Precautions to be taken in order to prevent a risk of PTS in case of voluntary opening of the Pressurizer safety valves for Feed and Bleed.
- Consideration of the temperature and hard particles on the porosity of the “bad” formed from the destroyed insulation in the frame of the modification of the containment sump.  
The influence of these phenomena are recently confirmed by the tests managed by IRSN.
- Requirements for qualification of the new cable coating; the cables located in the containment have to be coated with the product resistant to the accident conditions in order to avoid its decomposition in case of LOCA and accumulation of additional particles in the containment sump.

## **5. CONCLUSION**

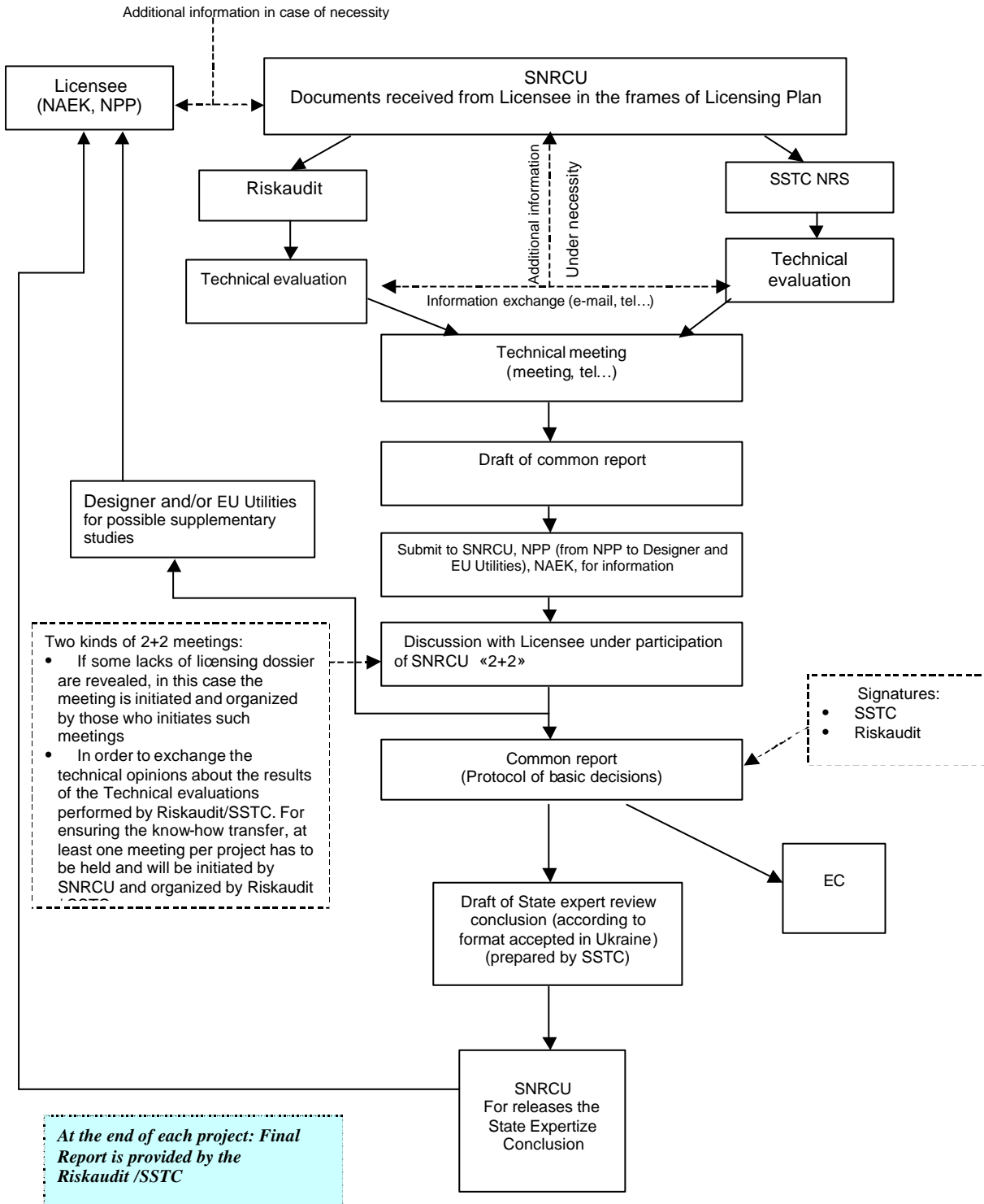
***1.1.1 The 2+2 approach is a very useful tool for the licensing of western equipment in Ukraine.***

1.1.2 Main steps of the licensing procedure



(\*) Not systematically included in the proposal, due mainly to time constraints

**Scheme of interaction according to “2+2” approach  
(applicable for each of licensing steps of UK/TS/19)**



A. Martirosyan (ANRA/Armenia)  
P. Kelm (GRS/Germany), A. Gorbachev (IRSN/ France)  
and A. Madonna (ANPA/Italy)

## 1. INTRODUCTION

Compared to Ukraine the situation in Armenia with regard to nuclear power in general and with the 2+2 approach in detail is quite different.

Armenia has only one Nuclear Power Plant of Medzamor in operation with one single reactor producing about 50-70 % of electricity into the isolated Armenian electrical grid.

The Armenian Nuclear Regulatory Authority ANRA is a relatively small body with very limited national technical (TSO) support.

This means that the role of RISKAUDIT in the 2+2 approach in Armenia is twofold: In addition to the objective of supporting the National Regulatory Authority ANRA in the licensing activity western experts have to perform another important role; to give support in developing technical capabilities, establishing competencies and clarify needs, roles and responsibilities within ANRA and its national technical support.

## 2. SAFETY STATUS OF NPP

Medzamor NPP consists of two VVER-440/V-270 units close to the VVER 440/230 model. Compared to this later, improvements mainly related to seismic and systems upgrading have been introduced already in the design phase, but also after a major fire in 1982 and before re-start in 1995. Major differences compared to typical W-230 design consist of:

- Seismic reinforcement of structures and components, (starting from original design, but ongoing from start-up till today)
- Additional seismic resistant Emergency Feedwater System and Secondary Residual Heat removal Systems, located in the Boron Compartment (from original design, further improvement after re-start)
- Main Coolant Pumps from V-213 reactor type with fly wheels (after fire in 1982)
- Emergency shutdown panel inside the restricted area (from original design, later improved)
- Improved redundancy, capacity and separation of electrical and C&I cables (after fire in 1982)
- Additional means for electrical supply of ECCS for Accident Management (after fire in 1982)
- Use of vital equipment as Diesel Generator from unit N° 1 (before re-start)

Support to ANRA in the frame of Tacis has been started beginning with 1996/97 (First RISKAUDIT contract). The main task during that contract was to assess the overall safety of the plant and to judge on the completeness of the ongoing Modernisation Programme.

In parallel it got necessary to provide support to ANRA to develop capabilities and establish effective licensing process and procedures. Based on the experience of the 2+2 approach, successfully implemented in Bulgaria a licensing procedure was elaborated in 1998 in collaboration with EU, TPEG, ANRA, NPP, ENEL and RISKAUDIT and applied for a series of safety modifications at Medzamor NPP.

### **3. LICENSING PROCESS**

Based on the results of RISKAUDIT and others investigation's results the EU has decided to supply Medzamor NPP with some equipment for short-term safety improvement and to promote the establishment of a Western style licensing process in Armenia. Thus, in order to further strengthen the regulatory authority the European Union is providing parallel support to the utility and to the authority, both. The aim is the establishment of a well balanced licensing process by implementation of a specifically defined licensing procedure for safety related equipment. This aid started in 1998. (Second RISKAUDIT contract).

Starting with 1996 also the Armenian utility is supported by a western company, the Italian Sogin (ex-Enel) Company, whilst the ANRA is supported by a group of westerns TSO (including ANPA and AVN) represented by RISKAUDIT. Sogin gives support for the industrial aspects of the modification (design, procurement, assessment of safety impact, preparation of safety documentation for licensing, etc), RISKAUDIT provides comprehensive support to ANRA in all the different steps of the licensing procedures.

A general overview on the licensing steps is given in Annex 3.

This six-steps-licensing approach was inspired by the applied Russian one for licensing of Western equipment, and adapted to the Armenian conditions (absence of national technical support for NPP and Regulator, e.g.).

For each of the mentioned six licensing steps a "2+2 Licensing meeting" is foreseen, this means a meeting with participation of the utility and their support (Sogin) on one side and ANRA and their technical Support (RISKAUDIT). The Russian Design Institutes are also invited and, as far as possible, they take part in these meetings. In preparation to the 2+2 meetings separate discussions take place before with ANRA in order to compare the results of separate analyses and to ensure a common understanding of the technical issues and to take a clear position during the 2+2 meetings.

The following safety modifications were chosen for application of this licensing procedure in the first stage (1998-2000):

- Replacement of the safety valves for the pressurizer (financed through Tacis),

The existing 4x25% unsafe and obsolete PRZSV had to be replaced by 2x100% tandem valves allowing primary bleed and feed. This led to re-calculation of the pipework from the valves to the

bubbler tank, re-design of supports and re-arrangement of one room of the hermetic compartment. The B&F procedure is going to be implemented in the current stage, only. Additionally, an automatic Cold Overpressure Protection device was included in the scope of supply. Currently it is operating in an open loop regime at NPP, final licensing is expected this, 2002, year.

- Replacement of the 12 Steam Generator Safety Valves by new ones able to carry steam water mixture and allowing remote control and secondary bleed and feed up to low parameters (financed through Tacis).

This activity led to the re-calculation of different operating and accidental modes and it was demonstrated that Steam Line break would neither lead to PTS nor to re-criticality,.

- Replacement of seven slow acting Motor driven Isolating Valves in the Steam Lines and the Main Steam Header by Fast Acting Isolation Valves (FASIV), (financed by US DoE).

This activity was closely linked with the previous one and required re-calculation of steam line supports in the turbine hall.

Later the Authority has used the same licensing approach when licensing the new Essential Service Water System, partially financed by US DoE.

In the current (third) Tacis/RISKAUDIT project the 2+2 approach is applied for licensing of :

- LBB application:

As it is generally known the safety of V-230 strongly depends on the warranty of the integrity of the primary circuit. This is due to the limited core cooling and confinement capacity. Therefore additionally to the positive design features of the primary circuit (austenitic steel, robust wall thickness...) a demonstration of break preclusion is necessary. Some measures being part of this approach have been introduced in the past, already. Here we can mention the introduction of a leak detection system and the elimination of a 200 mm primary pipe from the cold leg to the pressurizer. At present the technical specification for the LBB application is elaborated and the next step will be the evaluation of the existing leak detection systems. After that the next step will be the LBB analysis itself.

Other candidates for the 2+2 approach are:

- Replacement of Neutron Flux Source Range Monitoring System
- Installation of Reactor Head Gas Removal System and RPV Level measurement
- Improvement of the pressurizer injection system
- Installation of new Radiation Monitoring Systems;

For all these issues work is going in parallel and with different stage of completion.

#### **4. ADVANTAGES FROM THE 2+2 APPROACH**

The general advantage from the 2+2 approach, of course, is the improved licensing process between the Applicant and the Regulator and in particular the substantial technical support to evaluate the safety requirements and the safety documentation associated with the licensing of plant modifications covered in the frame of 2 +2 .

Before, the licensing was based on the Soviet approach. Due to severe financial problems of the utility and the weak position of ANRA in the past even this approach was not followed consistently in all cases. With help of the 2+2 approach knowledge and position of ANRA was reinforced significantly, more and more experts are being involved actively through learning by doing.

The same regards to NPP staff. Whereas in the first period the main and partially only active counterpart from the utilities side was the Chief Engineer, now several plant managers and experts are actively involved, especially young ones. The NPP, with the support of western on-site assistance company Sogin, has achieved a major attention to the licensing aspects and has started to involve in that the competent and responsible staff and management of the NPP. Of course this is the successful beginning of a process, only, which will lead in the time to effective safety management of the NPP.

These aspects, together, can be considered as a significant fact in terms of increasing the so called "safety culture" in Armenia.

With regard to NPP another important follow-up from the 2+2 approach is the substantial improvement in the safety documentation of the plant prepared for licensing purpose. In the frame of the new licensing procedure, according to western practice, there is the necessity to establish a safety case for each of the corresponding upgrading measures. These safety cases form the basis for the development of a new SAR for the plant.

In terms of developing technical support capability, in 2001 ANRA has established an own TSO consisting of a small group of experts in different areas like accident analyses, seismic, components and others. With support of the Ukrainian TSO SSTC first series of action for further development of this TSO has been started, financed through Tacis.

However, it appeared that the project implementation schedule established at the beginning cannot be followed in all details, mainly due to delay on the industrial side. Therefore flexibility and increased effort is needed from all partners involved in order to implement this programme and to finalize the project.

## **5. REMAINING ISSUES FOR SHORT TERM UPGRADING AND DEVIATION FROM CURRENT STANDARDS**

Despite of all progress achieved in its modernisation program there is still a number of items which need to be completed by the utility in the near future in order to ensure continued safe operation of the plant::

- Final implementation of the Leak Before Break (LBB) concept for the primary circuit
- Finalization of seismic upgrading
- Further Confinement improvement (improved capability, leak tightness)
- Improvement in operational safety, including training and maintenance, Development of an Operational Safety Modernisation Programme
- Validation of the emergency core cooling system capability for higher than D32 pipe breaks (initial design)
- Completion of Installation of Generator Breakers
- Installation of reliable supports of the steam lines considering not only seismic loads but also loads from pipe breaks
- Implementation of an automatic primary circuit cold over pressure protection device
- Implementation of the primary feed and bleed procedure

Due to their safety significance most of these measures should be implemented and licensed in the frame of the 2+2 approach. There does not exist, however an amended Safety Improvement Programme which would cover all these items in a consistent approach and there does not exist an Operational Safety modernisation programme, at all. One of the reasons for that is the strong pressure from the European Commission that remain on the position that NPP Medzamor should be put out of operation definitely before the year 2005.

Replacing capacity for energy production, however does not exist at present, resources (financial and fuel) are not available.

## **6. CONCLUSIONS**

The 2+2 approach in Armenia has been implemented effectively and has shown to be very useful to promote the roles and responsibilities of the different partners involved in nuclear safety. Continuation of this approach is needed.

Summarizing:

Safety improvements at Medzamor NPP have been implemented

Support to Operator and Regulator has been established successfully

A licensing process and procedure has been established

ANRA's technical capabilities have received a significant assistance and have improved but are still insufficient

Safety culture has received a substantial help in order to be established, but further improvement is needed

Further assistance is necessary and has to be ensured

Appropriate funding from Tacis is felt necessary considering the economic situation in Armenia

### **Appendix 3** Upgrading of Medzamor NPP and Licensing practice

#### **NLS 1**

Modernisation Programme

Safety Objectives

Conceptual Design *ANRA Agreement*

#### **NLS 2**

Technical Requirements *ANRA Agreement*

#### **NLS 3**

Engineering Documentation *ANRA Agreement*

#### **NLS 4**

Equipment Manufacture and Testing *ANRA Agreement*

#### **NLS 5**

Equipment Installation and Commissioning Tests *ANRA Witness*

#### **NLS 6**

Permit to operation *ANRA Approval*