SAFETY EVALUATION SUMMARY

NPP TEMELIN COMPREHENSIVE SAFETY CASE REVISIT

subjected to

HIGH-ENERGY STEAM AND FEED WATER PIPELINES AT THE 28.8M LEVEL
and
SAFETY AND RELIEF VALVES QUALIFICATION

Revision adapted for purpose of informing the European Council in frame of the EU enlargement process

Prague - October 2002

A/ Goal of the Safety Case Revisit:

For Temelín 1-2 ensure that the:

- Safety case demonstrating appropriate protection against high energy pipe breaks, and consequential failures of the steam- and feed-water lines, complies with requirements and practices widely applied within the EU and that an appropriate combination of measures are in place;
- Reliable function of key steam safety and relief valves under dynamic load with mixed steam-water flow is demonstrated in appropriate way.

B/ Problem Definition:

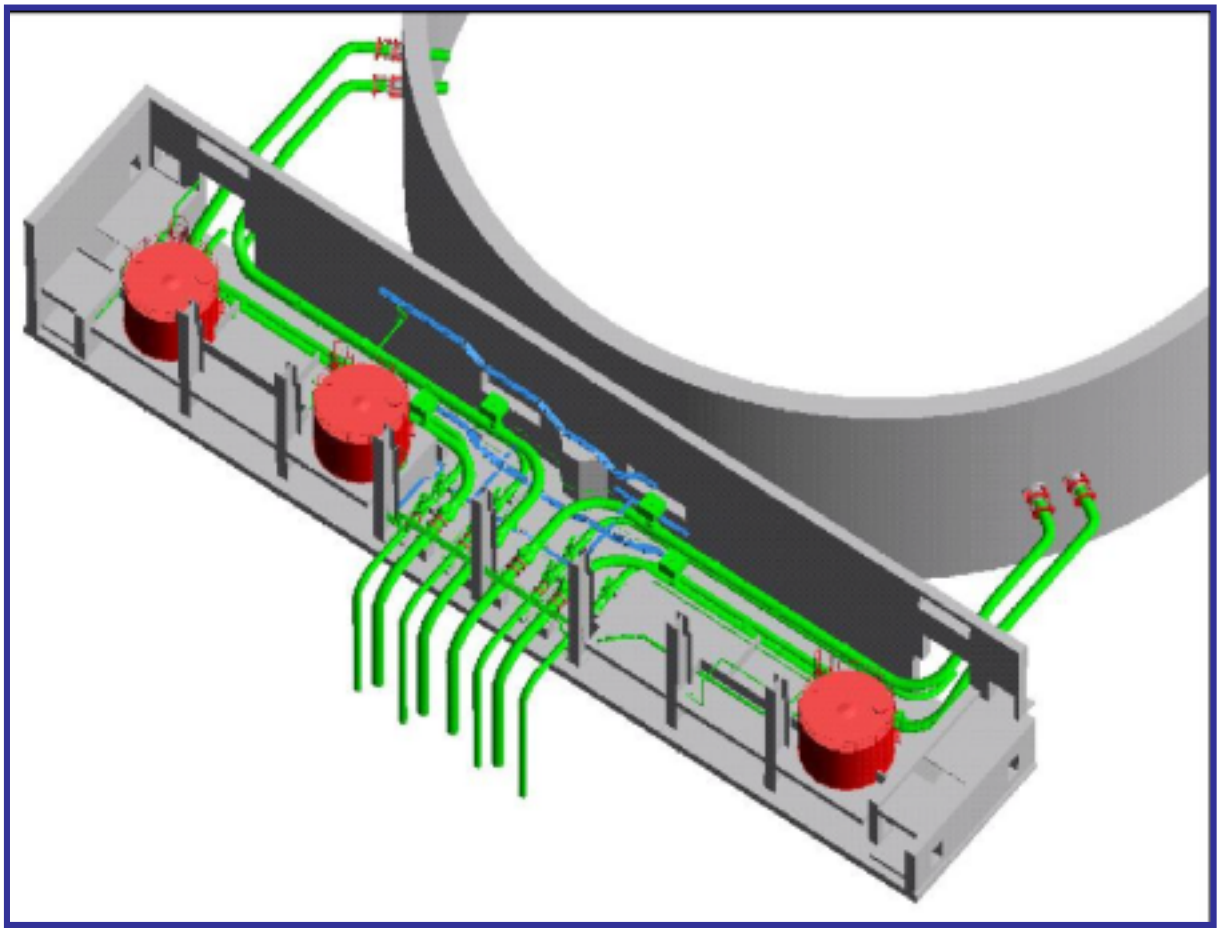
In generic VVER-1000 design, the safety mechanisms of the main-steam system (blow-off control and safety valves, main-steam isolating valves) are housed together with the main-steam and feed-water lines in a room outside the containment (28.8-m elevation) – see Figure 1. Safety case revision is initiated due to the fact, that this layout allows to draw a hypothesis of a pipe failure consequential damage involving adjacent safety-related components or systems that may lead to beyond-design-basis accident sequences.

Original safety justification of this main-steam and feed-water system was based, among others, on:

- Negligible probability of sudden breaks in such piping system for all modes of normal or abnormal operation, including seismic loads (proven also by experience of other industries);
- Favourable thermal-hydraulic characteristics of this specific PWR design (main difference are horizontal steam generators);

For the first time protection against high-energy pipeline break and consequential failure of the steam- and feed-water lines (e. g. hazard to the integrity of safety-relevant components) has been indicated as an issue for generic VVER-1000 design by safety assessments performed in course of the Extrabudgetary Programme organised under the IAEA umbrella in

Figure 1: Principal scheme of the NPP Temelín 28.8 m elevation



the mid of last decade. In reaction to recommendations of the IAEA listed in the "Safety Issues and their Ranking for WWER 1000 Model 320 Nuclear Power Plants" measures were proposed by the construction license holder for this specific case in form of addition of another layer of protection by introduction of pipe whip restraints to positions postulated as possible break zones – see Figure 2. This design change was included to the NPP Temelín safety documentation demonstrating resolution of issues indicated in the frame of the above mentioned IAEA Extrabudgetary Programme. After framing proposed technical solution to overall safety concept of the plant the regulatory authority found it acceptable, offering another layer of protection against consequential failures of the steam- and feed-water lines and related damage of adjacent safety-related components or systems.

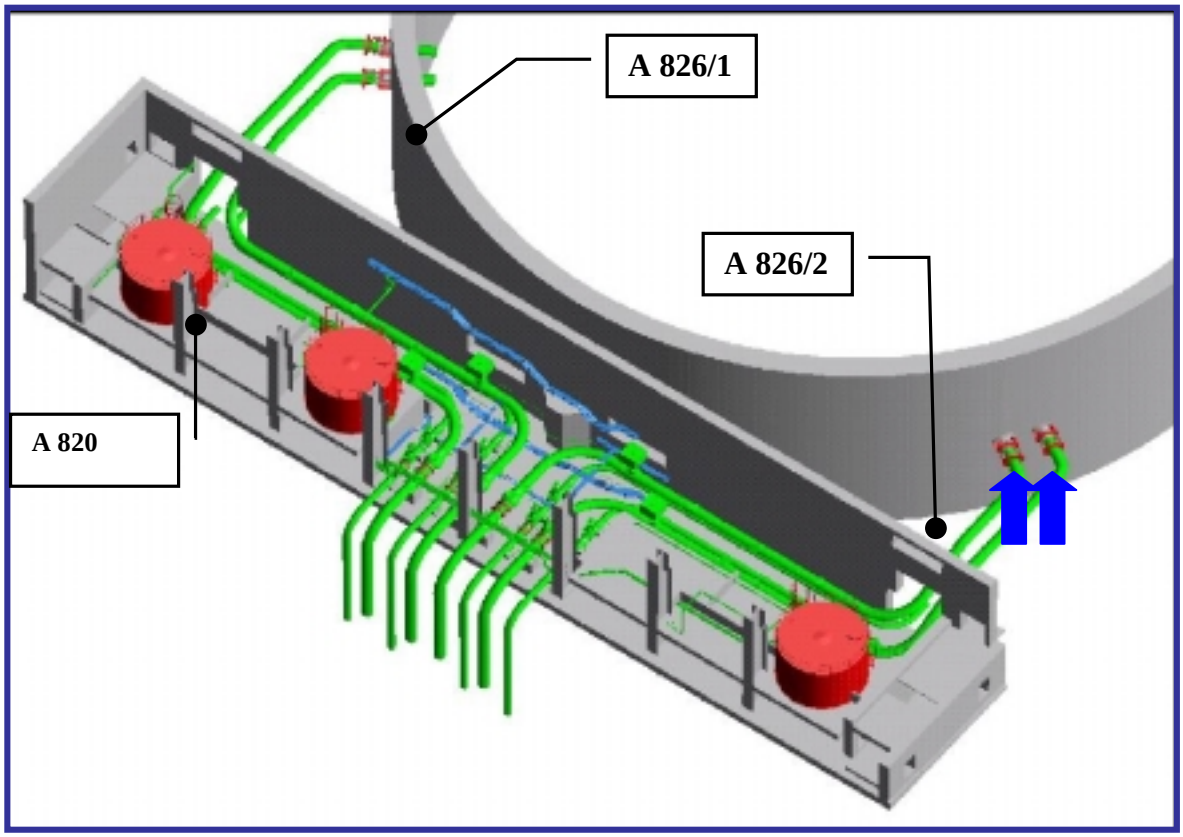
As a result of Czech-German bilateral talks organised in time of start of the NPP Temelín unit one commissioning, the GRS experts serving as technical support to Federal and Bavarian authorities concluded following on this issue:

"From the German regulations and German practice it can be concluded that in these cases two different kinds of measures have to be taken as protection against secondary damage due to pipe breaks. One way is to limit the failure of the affected piping to blow-down cross-sections with no further need to assume consequential failures due to pipe whip. The other measure consists of the physical separation of pipes so that pipe failure will remain restricted to the failing pipe itself.

Owing to the design and the overall layout or routing of the piping, conditions at NPP-T do not allow such measures. Therefore the requirements of the current German regulations to be applied here are not fulfilled.

At NPP-T, pipe whip restraints have been installed as partly used in other plants according to international practice. Their design follows the safety requirements of the US regulations, which had to be fulfilled as a requirement of SUJB. Within the framework of the Czech licensing procedure, break locations were identified on the basis of stress criteria and secured by the installation of pipe whip restraints in such a way that breaks in these locations cannot result in consequential damage the other safety-relevant components or systems. The review of GRS has shown that the methodical procedure to determine the postulated break

Figure 2: Principal scheme with pipe whip restraints position indication



locations and the other parameters (type, position and time of the break) follows the current US regulations, which - in contrast to German standard - are also applied in other Western countries.

Protective measures against consequential damage in the event of postulated leaks or breaks in the main-steam and feed-water lines are assessed by GRS according to the requirements of safety level 3 mainly. GRS was not able to estimate from the available documents how far the measures taken are sufficient to eliminate consequential damage. However, GRS considers the underlying spectrum of break assumptions and the associated consequential damage as too limited and therefore the design solution as not sufficiently robust. In addition, the welding of support plates onto the pressure-retaining wall - although in compliance with the safety standards of different countries - is not seen by GRS to be state-of-the-art for the solution of such problems." – Report on "In-Depth Analysis of Selected Safety Issues Relating to the Temelin NPP".

In addition to that, in the same report the GRS pointed out that its opinion on completeness of demonstration of reliable function of key steam safety and relief valves under dynamic load with mixed steam-water flow was not possible to base on a comprehension of the validations and evaluations, so issue remains open.

Issues of protection against high energy pipe breaks and qualification of steam safety and relief valves at Temelín NPP were discussed subsequently by the Working Party on Nuclear Safety (WPNS), an ad hoc formation of the Working Party on Atomic Questions (AQG) of the European Council. In the "Report on Nuclear Safety in the Context of Enlargement" submitted to the COREPER in May 2001, the WPNS stipulated for the NPP Temelín:

- One specific recommendation of type I for the high energy pipe breaks issue;
  The Czech Republic should, as short term priority, regarding protection against high energy pipe breaks in Temelin 1-2 ensure that the safety case demonstrating appropriate protection against high energy pipe breaks, and consequential failures of the steam- and feed water lines, complies with requirements and practices widely applied within the EU and that an appropriate combination of measures are in place.

- One specific recommendation of type II for the steam safety and relief valves issue;
  The Czech Republic should report on progress regarding qualification of Safety and

Relief valves in Temelin 1-2, i.e. on measures to complete the demonstration of reliable function of key steam safety and relief valves in Temelin 1-2 under dynamic load with mixed steam-water flow.

Based on the Czech regulatory authority (State Office for Nuclear Safety; hereinafter “SUJB” only) request the NPP Temelín license holder (CEZ) performed re-assessment of both safety issues raised by the WPNS in a complex project entitled "Comprehensive Safety Case Revisit" (hereinafter “CSCR” only). Top objective of the project was to produce safety documentation enabling the SUJB to settle the discrepancy in opinions of experts on above mentioned issues in a way standard for regulatory practices - by reassessment of existing safety case taking into account newly available information and technical arguments.

C/ Requirements for the Safety Case Revisit:

For the CSCR project the following high-level requirements have been defined with respect to hypothetical beyond design basis scenarios that may be initiated by the high energy pipe breaks and consequential failures of the steam- and feed-water lines:

- All fundamental safety functions of the nuclear installation shall be ensured for all defined initiating events, in particular:
  - Safe shut-down of the reactor;
  - Removal of residual heat from the reactor core after the shut-down;
  - Maintenance of the radioactive releases under the defined limits;
- A combination of measures shall be available for protection against high energy pipe break and subsequent consequential failures of the steam- and feed-water lines;
- Each of the measures shall be justifiable from the view of its compliance with requirements and practices widely applied within the EU.

With respect to individual layers of protection following particular requirements were set down:

- Safety assessment of credible events shall be performed to evaluate likelihood of sudden break of a pipeline under normal and abnormal modes of operation or safe shut down earthquake conditions;
- Correct location and sufficient function of existing pipe whip restraints shall be demonstrated;
- Possibility of "integrity proof" shall be investigated:
  - Integrity of pipelines shall be demonstrated with use of validated analytical methods for all credible initiating events and physical parameters (including the dynamic effects during the PRISE, i.e. the case of a primary to secondary leak);
  - Completeness and quality of material characteristics database shall be demonstrated;
  - All examinations performed in phase of manufacturing and assembling of the high energy pipe system shall be verified in order to validate data on initial status of the

piping system. In accordance with results of this activity the program of in-service inspections shall be subsequently adjusted (if needed);

  - Additional possibilities to monitor the high energy piping system status shall be investigated;

- Feasibility of possible arrangements for physical separation shall be investigated;
- Corrective or additional measures shall be proposed when appropriate.

With regard to key relief and safety valves reliable function under dynamic load with mixed steam-water flow shall be re-confirmed in accordance with international standards.

D/ Situation Before the Start of the Comprehensive Safety Case Revisit Project:

Detailed topology of the high energy pipe system can be seen in Fig.3. It shows identification numbers of rooms, positions of pipe whip restraints at the containment penetrations and in the vicinity of the anchoring supports. Refer also to the Chapter B/ for other information.

The considered case of a multiple failure of steam- and feed water pipelines as a consequence of pipe whip constitutes initiating event for beyond design basis scenarios for most of the pressure water reactors of the same vintage as nuclear power plants with VVER-1000 type reactors.

In the NPP Temelín case, a comprehensive set of modifications to generic VVER-1000 design has been introduced in order to provide for sufficient "defence-in-depth" protection, i.e. for necessary and adequate physical barriers against radioactive releases, as well as for safety levels (as described e.g. in the IAEA INSAG 12 document). Application of the "defence-in-depth" concept is demonstrated in the licensing documentation submitted separately for both NPP Temelín unit 1 and 2.

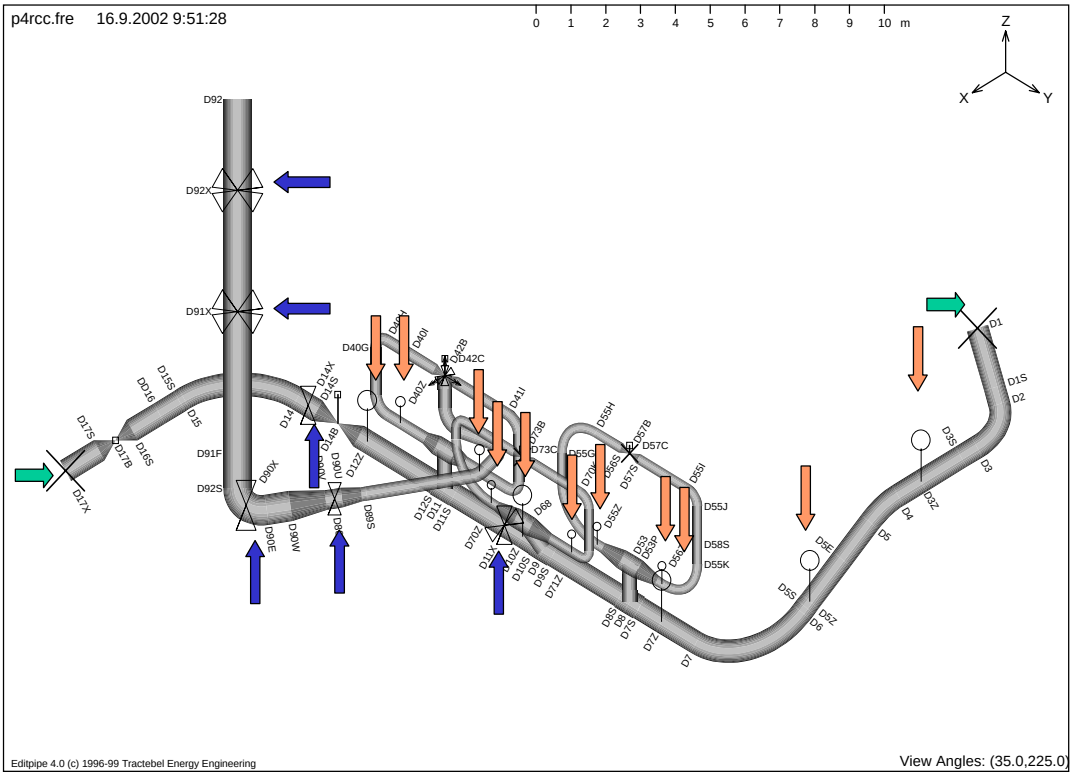
Note:
In the Czech Republic, since the end of 1970's basic design requirements have followed philosophy of U.S. regulations (10.CFR.50 Appendix A). Consequently, to the extent possible, Safety Assessment Reports for the NPP Temelín units are developed in accordance with U.S.N.R.C Regulatory Guide 1.70 and reviewed by the SUJB in accordance with standard review plan specified in U.S.N.R.C NUREG 800.

With respect to the issue of protection against high energy pipe breaks and consequential failures of the steam- and feed water lines (rooms A820, 826/1,2 in Figure 3), the NPP Temelín design has to comply with SUJB Decree No. 195/1999 Coll. This Decree sets forth in its part II, § 7:
„Systems essential for nuclear safety …must be positioned suitably and protected from dynamic and other impact effects (missiles, vibrations, leaks of liquids, high pressure overloads)"

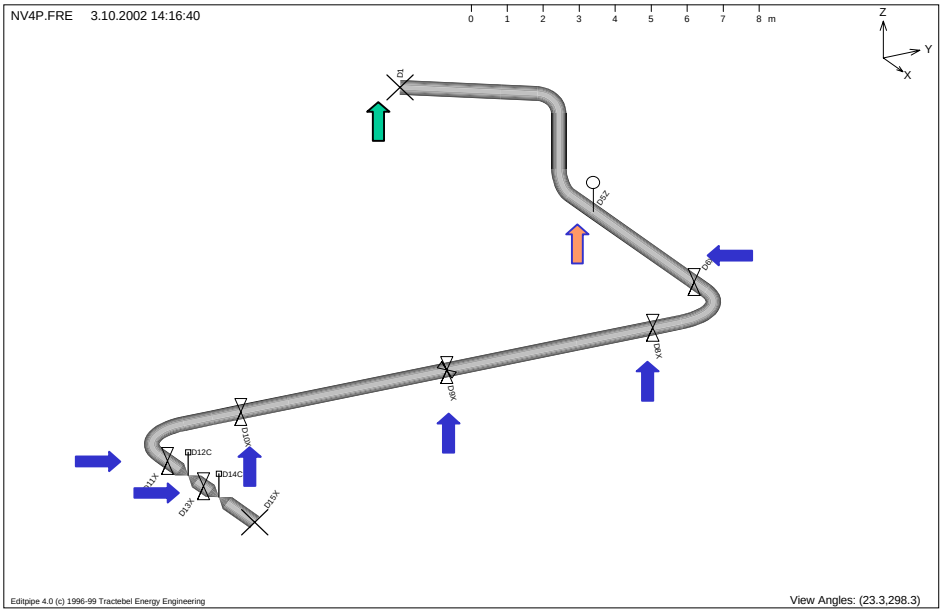
Effectiveness of countermeasures incorporated to the NPP Temelín design in order to achieve

Figure 3:

Steam line TX 80701 with position of hangers, supports, pipe whip restraints, anchor supports and pipe penetration



Feed water line TX 44 701 with position of penetration, hangers, supports, pipe whip restraints and anchor supports



above specified requirement were evaluated by the SUJB in course of the design modification appraisal as a part of start-up approval process. According to the NUREG 0800 Standard Review Plan (SRP), Chapter 3.6.1, compliance with the requirement can be achieved in three ways:

- By separating the pipelines from safety-related systems and components;
- If there is no separation, then by building protection barriers around the pipeline or around the system; or
- By adopting special protection measures to guarantee safety functions if any of above-mentioned separation and protection barriers are not feasible.

The NPP licensing documentation, as a basis for issuing the start-up approval, provides justification of adopted measures, mainly the:

- Implementation of quality assurance system (including non-destructive testing plan) for design, manufacture and erection of the high energy pipes in order do decrease the possibility of any sudden pipe break;
- Postulation of locations where the break is possible in reality (according to SRP, Chapter 3.6.2) and subsequent installation of whip restraints at these locations to eliminate possibility of consequential failures of the steam- and feed water lines;
- Emergency feed water supply system routing was changed in comparison with generic VVER-1000 design (out from the critical junction near the A 820) room.

For key steam safety and relief valves reliable function demonstration, including that under dynamic load with mixed steam-water flow, licensing documentation builds on following:

- Results of the main-steam relief valves tested at the French Cumulus facility are also applicable for the main-steam relief valves used for the NPP Temelín;
- Tested (“parent”) main-steam relief valves show no deviations from the valves used at the NPP Temelín with regard to their functional mode of operation and the materials used;
- Differences only exist in the geometrical dimensions (smaller diameter);
- With regard to the safety valves, test results also apply to the main-steam safety valves used at the NPP Temelín, since the safety valves are of identical design and made by the same manufacturer.

At time of the unit one start-up approval, above mentioned sequence of countermeasures, when framed appropriately to the overall safety concept of the plant (as described in licensing documentation), was declared by the SUJB as meeting the requirements of national legislation and IAEA recommendations. In addition, as far as the main-steam safety and relief valves are concerned, the SUJB accepts its qualification with regard to loading with water as sufficiently demonstrated and clarified in line with the safety requirements.

E/ Comprehensive Safety Case Revisit Project – Initial Considerations:

As indicated under B/, the SUJB requested the NPP Temelín license holder to perform re-assessment of both safety issues raised by the WPNS in a complex project structured in accordance with scheme presented in the "Sixth Additional Information to the Chapter Energy" (July 2001). Main objective of the project was to produce safety documentation enabling the SUJB to settle the discrepancy in opinions of experts on the above mentioned issues in a way standard for regulatory practices - by reassessment of existing safety case taking into account newly available information and technical arguments.

To achieve above set goals the Comprehensive Safety Case Revisit subjected to the NPP Temelín high energy piping system and BRU-A/SGSV steam-water mixture qualification was launched with following sub-tasks:

- Stress state calculation and measurement including:
  - Pipe whip restrain reassessment;
  - Pipe penetrations reassessment;
  - Integrity reassessment of steam piping due to water overfill;
  - Probability calculation according to PRISE methodology (US NRC) in comparison with LBB PIPE (SKI Methodology);
  - Stress state measurement projects.
- LBB concept application assessment including:
  - Comparison with "Break Preclusion Concept";
  - Dynamic loading calculations due to steam water hammer;
  - E-C assessment;
  - LBB concept application according to the US NRC SRP 3.6.3.
- TH analysis of multiple steam and feed water lines breaks with respect to:
  - Core cooling and final performance;
  - PTS situation;
  - Radiological consequences.
- Feasibility study on separation of steam- and feed water lines by qualified separation walls;

- UT Qualification of method, equipment and personnel according to ENIQ methodology for circumferential welds and pipe whip restrain fixation elements, UT testing and assessment of results;
- Qualification file development for the BRU-A valve and the SG SV (IPU-Valves) for steam-water mixture performance.

In summary, following initial considerations were made to ensure fulfilment of above mentioned activities.

At first, the Safety assessment of credible events shall be performed to evaluate likelihood of sudden break of a pipeline under normal and abnormal modes of operation or safe shut down earthquake conditions. The acceptability of risk values resulting from the analysis should be than evaluated from the best European/world practice point of view.

As for the WPNS recommendation to prove **that a combination of measures is in place**, installed pipe whip restraints may be considered as the **first level of protection** against consequential failures of the steam- and feed-water lines due to the pipe break. In course of the CSCR this has to be confirmed.

Subsequently, feasibility and safety justification of **additional measures of protection** should be investigated. Additional measures for protection may include:

- Application of integrity proof ("no break zone/super-pipe" / "leak before break" concept) on the pipeline from the containment penetration to the anchoring support;
- Application of a physical separation to the pipes in rooms A 820, A 826/1 and A826/2 on the 28.8m elevation;
- Application of validated, state-of the- art monitoring system.

As mentioned under C/, all the measures under consideration should be in compliance with requirements and practices widely applied within the EU.

With respect to key steam safety and relief valves reliable function demonstration, qualification file for the BRU-A valve and the SG SV (IPU-valves) is to be reviewed and, if needed, based on results amended.

F/ Results of the Comprehensive Safety Case Revisit:

After thorough review of the CSCR documents, the SUJB made following conclusions on fulfilment of requirements specified under the Chapter C/.

Results of safety analyses:

In accordance with US ANSI N18.2 standard, the event of one steam generator steam line break is classified as Category IV, where the expected frequency of occurrence is $10^{-2} > F > 10^{-6}$. This is the case of limiting design basis accidents for which the following criteria are applied in case of the NPP Temelín units, i.e.:

- Release of radioactive material shall not result in undue risks to public health and safety exceeding the limits set in the SUJB Decree No. 184/1997 Coll. (values in compliance with Basic Safety Standards);
- No loss of functionality of the systems necessary to cope with an accident shall occur, including such functions as reactor core emergency cooling and/or the containment function.

For specific case of the NPP Temelín, the data in safety analyses show that the compliance with much stronger design events criteria of Category II was proved for the event of one pipeline break (i.e. a design event even with the use of conservative assumptions). The criteria are as follows:

- Fuel cladding integrity shall be maintained by ensuring that the minimum departure from boiling ratio (DNBR) remains over the limit value with 95% probability of the 95% confidence level (95/95 DNBR limit);
- Integrity of the reactor cooling system (RCS) and the main steam system (MSS) is ensured by maintaining pressure at or below 110% of design pressure values for these pressure boundaries.

The analyses of steam line failures and/or the feed water lines were made for the opposite configuration of loops from the reactor entry point of view (towards SG1 and SG3, or towards SG2 and SG4). Nevertheless, in the failure evaluation performed the breaks in neighbouring steam and/or feed water lines were taken into account (towards SG1 and SG4 – neighbouring loops from the reactor entry point of view). This arrangement has no influence either on the

evaluation of the primary circuit integrity or radiological consequences of the event, since for the determination of reactor power the model of point kinetics with conservative input data was used. It can be assumed that for the configuration of breaks in neighbouring loops the criterion of intact fuel (the criterion for an event of category II in accordance with ANSI) will be met with respect to the reserves in DNBR values in the case of calculations performed to date.

The NPP Temelín steam- and feed-water pipelines system is split to two safety classes - 2 and 3 (SUJB Decree No. 214/1997Coll.) - up to the complex of valves class 2 and from this point up to the turbine hall class 3. As such they must fulfil following safety function: *"To remove residual heat during normal and abnormal operation and under emergency conditions when the integrity of the pressure circuit of the reactor coolant is not disturbed."*

There is no doubt that this design basis safety function is guaranteed even in the case of a multiple break of the steam lines if the steam outlet from at least one steam generator remains under control. At the same time the existing layout of steam lines assures that for the inseparable parts of the steam lines (the part up to the quick-acting separating valves) the possibility of a simultaneous break of all four steam lines can be excluded. The steam generator feed water is assured with the system of emergency feed water supply the lines of which are located outside the above mentioned critical junction near the A 820 room.

As it has been proved, the scenario of a simultaneous break of two or four steam lines in the case of Temelín NPP is a matter of the beyond design basis events with the frequency of occurrence lower than 10^{-9}/reactor year (hereinafter "ry" only). If the criteria from the IAEA "Accident analysis of the Nuclear Power Plants" Safety Report are applied (summary of the practices in the world) for the evaluation of the event of a simultaneous break of more than one steam line, the results would show that the design events are taken into account with the occurrence probability between 10^{-2}/ry to 10^{-4}/ry. The beyond design basis events are within the range of 10^{-4}/ry to10^{-6}/ry and the criterion of acceptability is that the limits for radiation consequences outside the emergency-planning zone must not be exceeded. For events with the occurrence 10^{-6}/ry the criterion of acceptability is the emergency preparedness. Results of the CSCR fully comply with these criteria and this is why such a scenario was not analysed in detail within this CSCR in compliance with the world practices. However, the Temelín NPP has means and alternative measures of the accident management ready that make it possible to

provide for the above mentioned safety function even in the case of this very improbable beyond design basis event. They are contained in the emergency operating procedures (EOP). One of these can be used for the parallel break of all four steam pipelines if the delivery of emergency feed water to at least one steam generator is ensured. The strategy consists in the controlled management of the size of the heat-exchanging surface in the steam generator so that the removal of the residual heat transferred from the primary circuit (I.O.) can be controlled. If there is a complete loss of heat removal from the steam generator (loss of all sources of feed water), it can be applied the "feed and bleed" procedure when the residual heat removal from the primary circuit is ensured only through the safety systems of the primary circuit (lines of high-pressure deaeration system YR or the pressurizer relief valve => pressurizer relief => containment => TQ emergency cooling exchangers => TQ pumps => I.O.).

Further, operational and accident modes were determined and selected for TH analyses for subsequent PTS calculations which when finished will prove that the integrity of the reactor vessel as well as primary circuit as a significant physical barrier against the release of radioactive substances will not be endangered.

On the top of the assessment results presented above, **a combination of three layers of protection is proposed** for energy pipe breaks, and consequential failures of the steam- and feed-water lines.

For the first layer of protection - whip restraints:

Analyses performed within the CSCR project confirm both correct whip restraint capability to eliminate pipe whip, based on the fact that:

- Both analysis i.e. pipe break postulations and "no break zone/super-pipe" confirmed that most stressed areas are welds with containment pipe penetrations and anchor support area. Position of the pipe whip restraint is this fully justified;
- Pipe whip restraint design allows limit the pipe movement at the point of break postulation, e.g. at the penetration or at the closing weld with the check valve (steam) or gate valve (feed water). This result is supported by calculations using Finite Element Method and the results of fixation elements weld examinations. Load values used for these calculations were determined by TH analyses and follow-up stress state analyses;

- All circumferential welds covered by the pipe whip restraints (including the fixation element welds) were inspected by qualified UT mechanised examination designed in accordance with European Network on Inspection Qualification (ENIQ)**.** The requirement on compatibility with EU practices is therefore met for qualification and application of examinations.

SUJB considers the CSCR results under this item as sufficient to prove restraints as one of the measures to protect high energy piping against consequential failures of the steam- and feed-water lines after break.

For the second layer of protection - application of integrity proof:

For the second level of protection the CSCR results propose application of the „no break zone/super-pipe" concept on the pipelines segment from containment penetration to anchoring supports – see Figure 3. Successful application of this concept provides for exclusion of sudden break in specified pipe segment if all prerequisites are in place. Feasibility of „no break zone/super-pipe" concept application is in the CSCR Final Report justified by following:

- Most conservative values of stresses calculated by the U.S.N.R.C. certified PIPESTRESS program are used;
- Thermal expansion results are evaluated. Displacement measurements confirmed validity of calculation model used ;
- Allowable values of stresses are determined using the lower bound curves from validated material properties database;
- Validated material database involves all used types of materials including weld material and welding consumables. The results also respect the influence of dynamic deformation ageing;
- Results of calculations performed by the PRAISE code show that the probability of a guillotine break (DEGB) for both the steam pipeline and feed water pipeline is lower than 10^{-10}/ry, i.e. is extremely low.

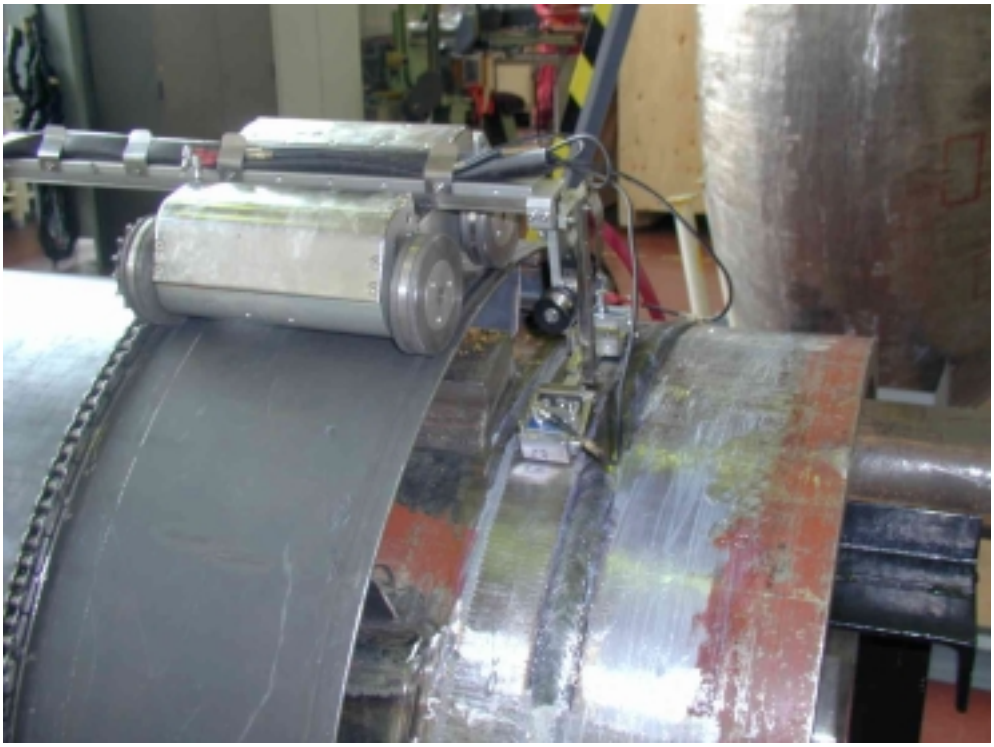
An inevitable requirement for the application of the „no break zone/super-pipe" concept is implementation of 100% volumetric qualified UT examinations for all welds in high energy pipe system. Implementation will be gradual on top of the 100% X-ray examinations

performed during the manufacturing and erection phase. Regulatory consideration on this subject was supported by evidence of:

- 100 % volumetric UT method qualification file developed in compliance with best EU practice (ENIQ) – see Figure 4;
- Results of examinations performed with the use of this qualified method at unit 2 (all together 21 welds);
- Detailed plan for full steam line (TX70 code) inspection during the unit one refuelling outage at the beginning of 2003;
- Draft proposal for inspection plan of all remaining welds in both units.

SUJB accepts the concept of “no break zone/super-pipe” discussed above as second layer of protection against pipe break with the condition of completion examinations of all piping systems under consideration performed till the end of trial operation of individual units.

Figure 4: Scanner with probe holder on steam line



For the third layer of protection - steam- and feed-water lines monitoring

Following steam and feed-water lines monitoring and inspections are proposed as additional measures for protection:

- Flow accelerated corrosion prediction by calculation and follow-up detail wall thickness and chemical composition measurement;
- Qualified 100% volumetric UT in-service inspection of all welds by mechanised system – see “no break zone/super-pipe” text;
- Displacement measurement performed on selected cross sections of the steam- and feed water lines during commissioning tests with possibility to repeat it after refuelling outages (if needed).

Physical separation possibilities

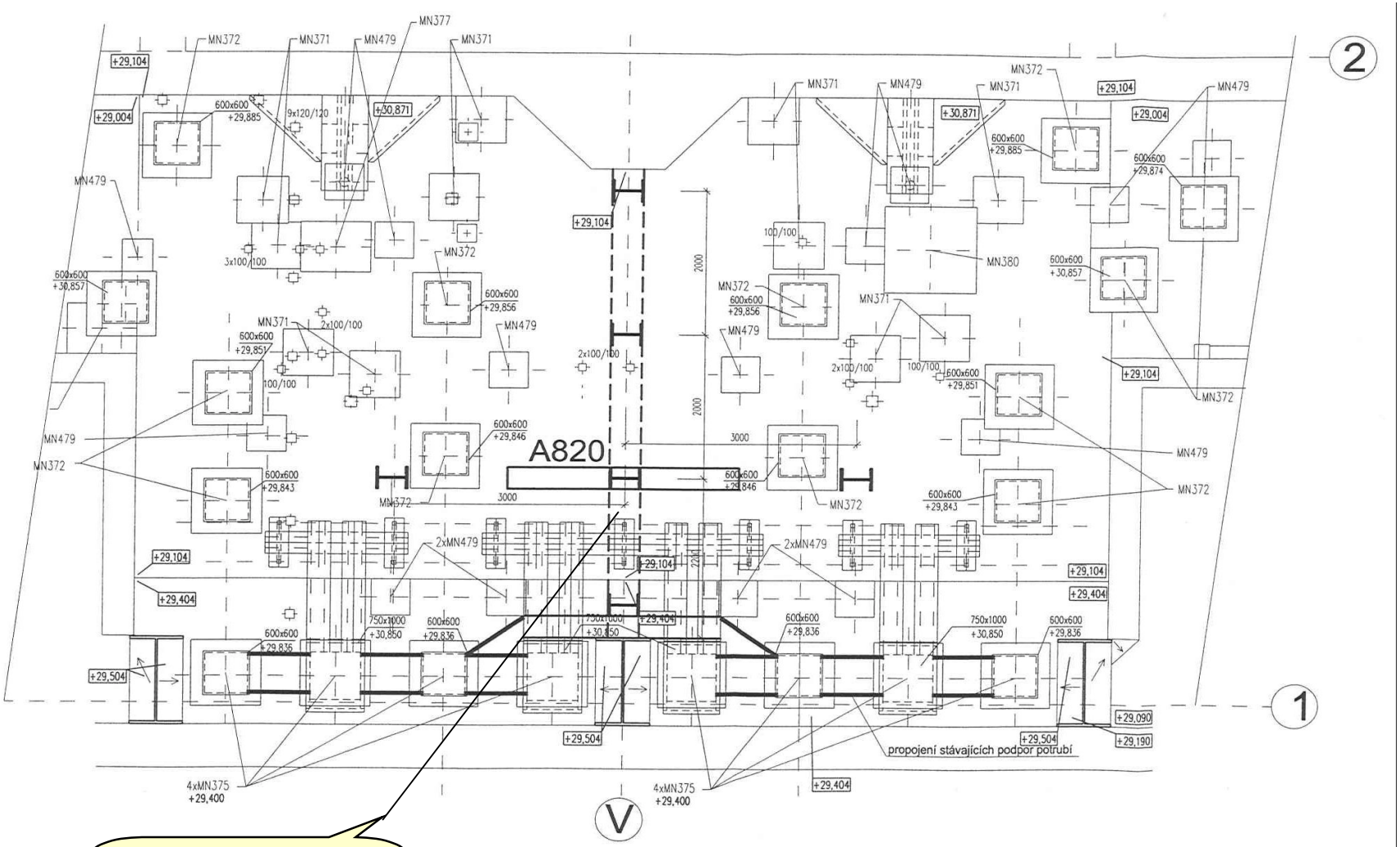
Qualified calculations of forces due to pipeline break induced dynamic effects are presented in the CSCR to allow for the feasibility study of the separating wall – for possible location see Figure 5. Analysis results prove that the wall can be supported and anchored in a way that it can transfer calculated dynamic effects. This level of protection is presented in the CSCR Final Report as reserve/redundant level of protection in case that combination of previously mentioned measures cannot be justified. On the other hand the report stress out that this solution is at limit from the safety benefit point of view, mainly due to possible prevailing negative effects in significant restriction of maintenance and in-service inspection work.

Based on safety assessment the SUJB do not consider incorporation of separation wall as a credible measure to be combined in order to protect consequential steam- and feed-water lines due to the pipe break for following reasons:

- Adverse effect for in-service inspection of safety-related components housed in discussed location;
- Above mentioned whip restraints, “no break zone/super-pipe” definition and periodic piping system monitoring offers justifiable combination of well-developed measures.

Figure 5

+ 28.8000m level



Safety and relive valves qualification

Evidence of the functional capability of the relief valves (BRU-A) and safety valves of the steam generator in the conditions of the flow of water and steam-water mixture in the case of a primary-secondary leak is given in the CSCR documents. Evidence includes the functional capability of the electric actuator of the BRU-A in conditions of the surrounding environment postulated for an event of the HELB type in the A 820 room:

- Design similarity requirements are followed according to the ASME Standard QME-1, 1994 and confirmed with manufacturer;
- Qualification of the SG and main steam relief valves for two-phase and water flow has been demonstrated by meeting the requirements for extension of qualification from qualified parent valves;
- EQ for the BRU-A actuator was confirmed for 30 years of normal operation and postulated DBE.

SUJB accepted the above-mentioned demonstration of reliable function of key steam safety and relief valves under dynamic load with mixed steam-water flow. Qualification procedures applied in this case comply with practice in most of the EU countries. Regardless of the CSCR Final Report conclusions the SUJB requested:

- Replacement of relief valves (BRU-A) electric actuators on both units;
- Replacement of steam generator pilot valves on both units.

This regulatory decision is based on evaluation of experience feedback data and regulatory surveillance results related to in-service inspection, maintenance and commissioning tests. Replacement shall be done during nearest refuelling outages.

G/ Final Conclusions

Based on thorough evaluation of the Comprehensive Safety Case Revisit documentation and additional information gained from the regulatory surveillance of the commissioning tests and in-service inspection programme at the NPP Temelín units 1 and 2, the SUJB concluded following:

On the high energy pipe break protection – a combination of:

- **Extremely low likelihood of a sudden break of the pipeline under normal or abnormal operation conditions or safe shutdown earthquake.**
- **Application of "no break zone/super-pipe" concept that precludes sudden pipe break for the area from containment penetration to anchoring point (supported by periodic 100% UT NDE monitoring qualified in accordance with the best European practice – ENIQ);**
- **Existing pipe whip restraints installed at break zones postulated in accordance with international standards to eliminate pipe whip and consequential damage of adjacent pipes or safety related equipment;**
- **Implementation of high energy lines surveillance systems additional to 100% UT NDE: corrosion-erosion monitoring (validated by use in the NPP Dukovany monitoring system) and possible follow-up displacement measurement (if needed);**
- **Results of safety analyses, performed in accordance with best European practices and using validated codes and methods, demonstrating for the NPP Temelín VVER-1000 sufficient safety margins for sequences induced by credible initiating events;**

is well above requirements set forth in Czech national standards and satisfy recommendation defined by the WPNS (as its technical meaning was interpreted by the SUJB).

This SUJB conclusion was supported, among others, by completed qualification for UT NDT examination method (mechanised – with use of manipulator), 21 weld examinations performed at unit No. 2 up to this time with no indication discovered and positive results of independent material properties database review contracted by the regulator.

<u>On the key relief and safety valves reliable function demonstration for two-phase flow</u> – the qualification of respective valves was re-confirmed by development of new qualification files in accordance with international standards also widely applied in the EU. The principle is in extension of parent valve (same manufacturer, comparable characteristic) full scope test results to valve under review.

Despite of positive qualification results, the SUJB requested to replace steam generator pilot safety valves and in case of steam relief valves (BRU-A) to replace their electric motor drives (actuators) in order to increase the reliability of this equipment. Both replacements shall be finished in course of nearest refuelling outage.

Steam generator pilot safety valves at Unit 2 have been already replaced.