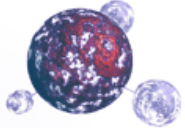


IRSN

INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

RISKAUDIT - GRS - IRSN

Safety assessment of the BELENE NPP



Bulatom Conference 2010

*Bulgarian Nuclear Energy – National, Regional and World
Energy Safety*

9th -11th June 2010, Riviera complex, Varna



Systeme de management
de la qualite IRSN certifie

*G.B. Bruna,
IRSN/DSR/Dir*

The SAFETY ASSESSMENT of NPPs 1/5

- **The aim of the Safety Assessment of Nuclear Power Plants (NPPs) is the evaluation (and when possible, the quantification) of all potential risks, including those originated by either voluntary changes in design and operation (such as refurbishment, fuel loading) or involuntary ones (such as ageing, degradation of materials and fuel ...).**

The SAFETY ASSESSMENT of NPPs 2/5

- **To achieve such an ambitious objectives it is worth:**

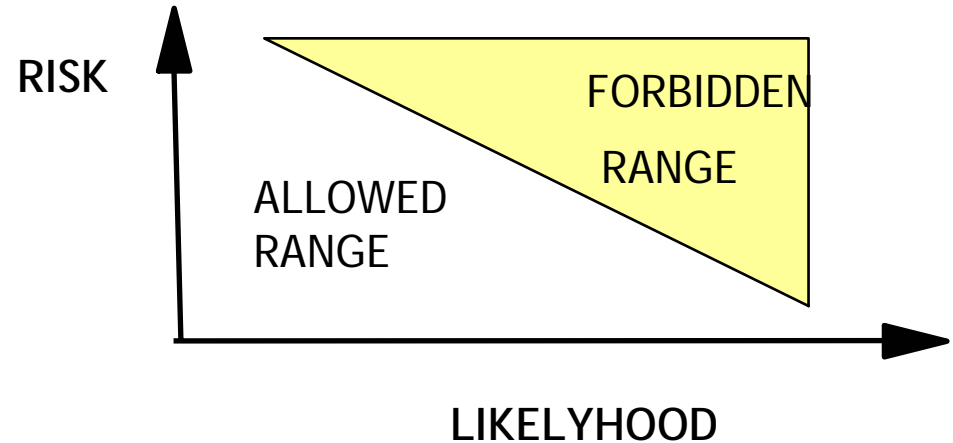
- ◆ Identifying all the potential risk-sources through suitable probabilistic approaches (PSA),
- ◆ Understanding the physical phenomena generating such risks,
- ◆ Mastering the component and system design features and operating modes; as well as their failure modes;

- **That is done, accounting for**

- The capitalization and increase of knowledge through operating experience, studies and R&D,
- The change in the rules (new topics such as Aggressions, Ageing)
- The evolution of the socio-economical context (public acceptance, media coverage ...).

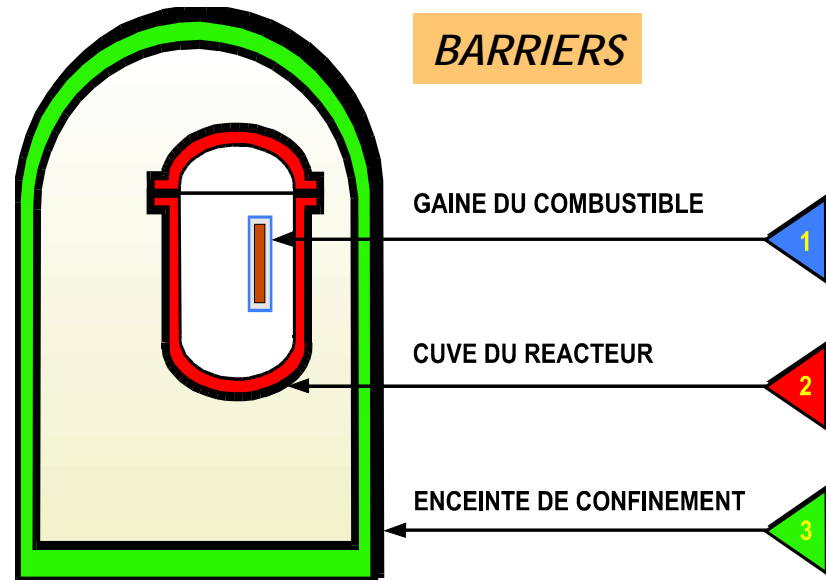
The SAFETY ASSESSMENT of NPPs 3/5

Principles & Tools of the SAFETY APPROACH



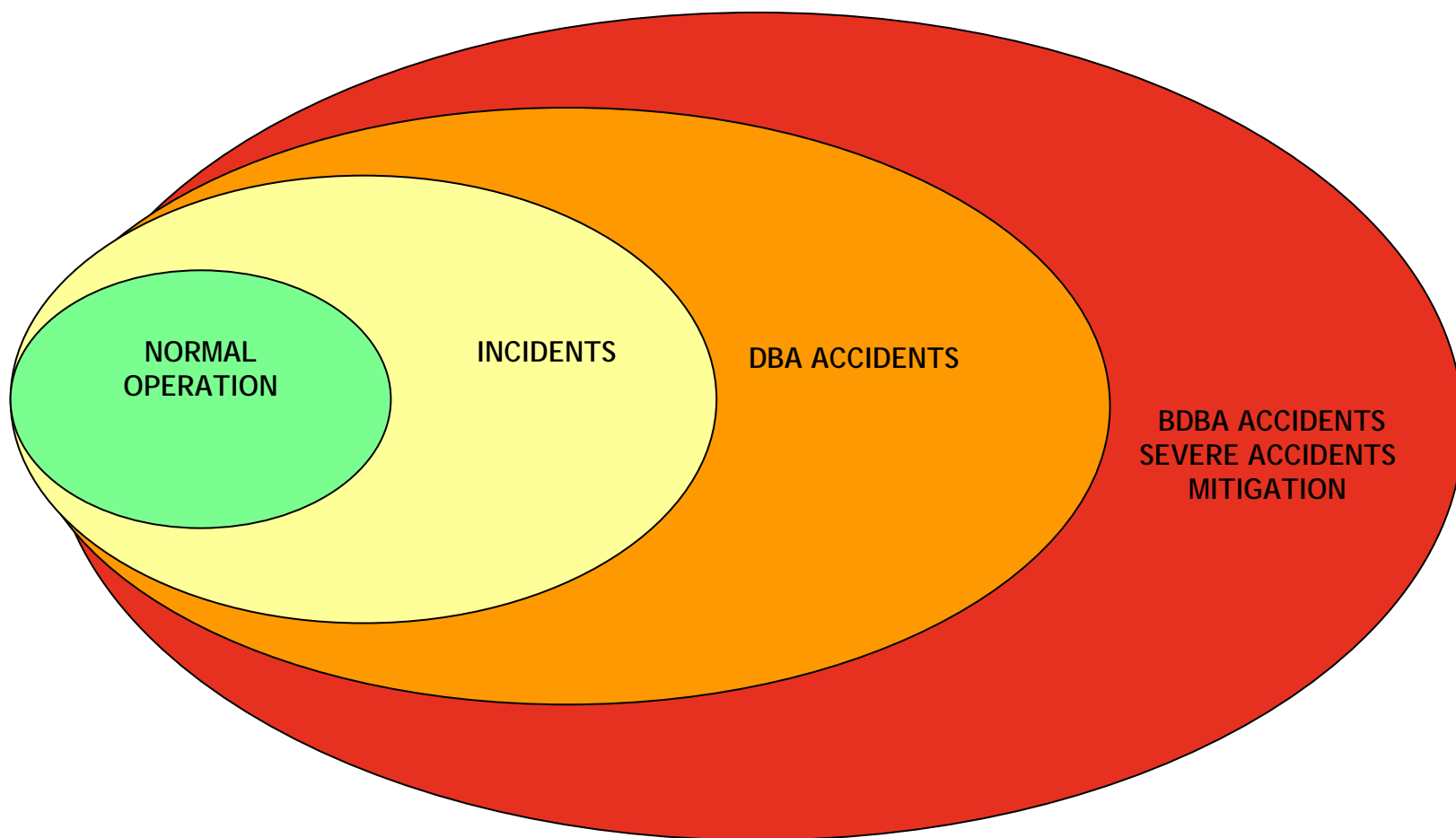
- **Control of nuclear chain-reaction (Reactivity – Criticality)**
- **Fuel and Core-cooling-down (Coolability)**
- **Confinement of radioactive contaminants**

SAFETY FUNCTIONS



The SAFETY ASSESSMENT of NPPs 4/5

DEFENCE IN DEPTH



During the whole Plant Life (From Construction to Decommissioning)

The SAFETY ASSESSMENT of NPPs 5/5

□ The safety assessment applies to all stages in the plant life

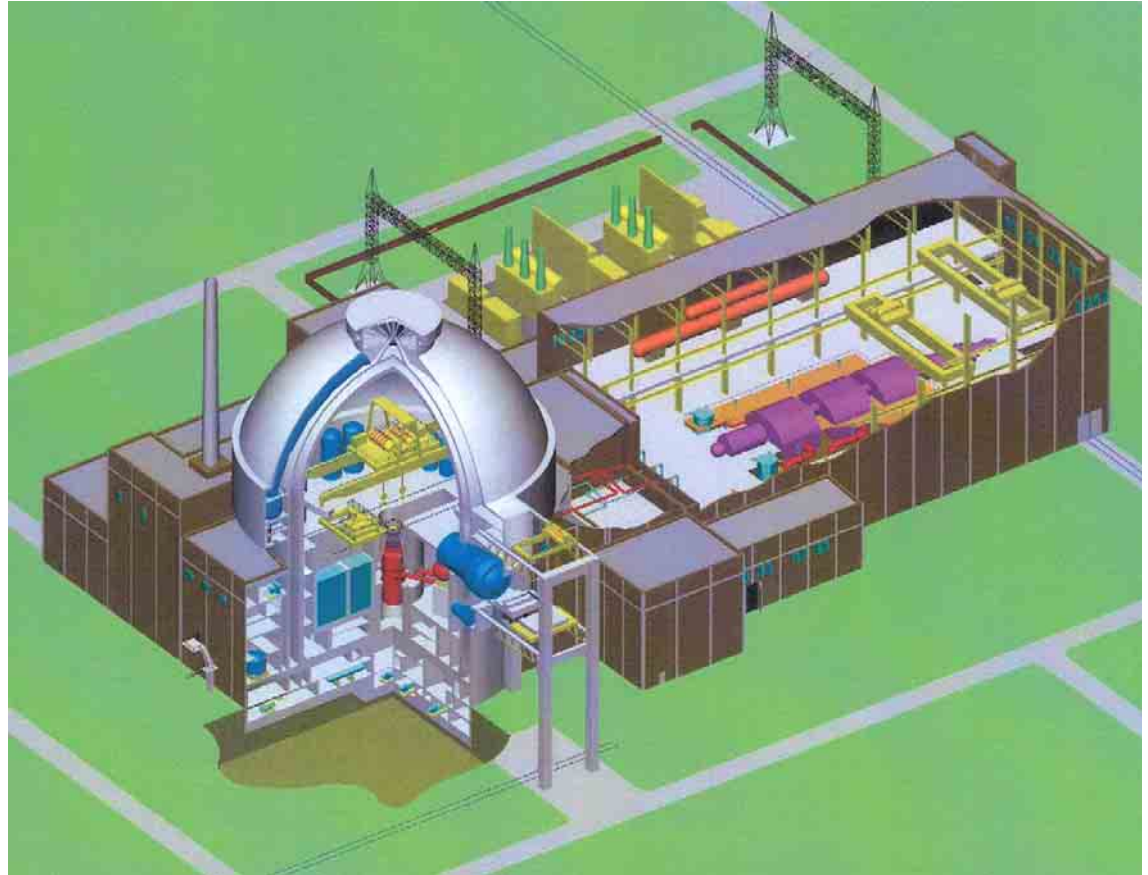
- **From the initial design,**
- **To dismantling,**
- **Through operation and decommissioning;**

Including:

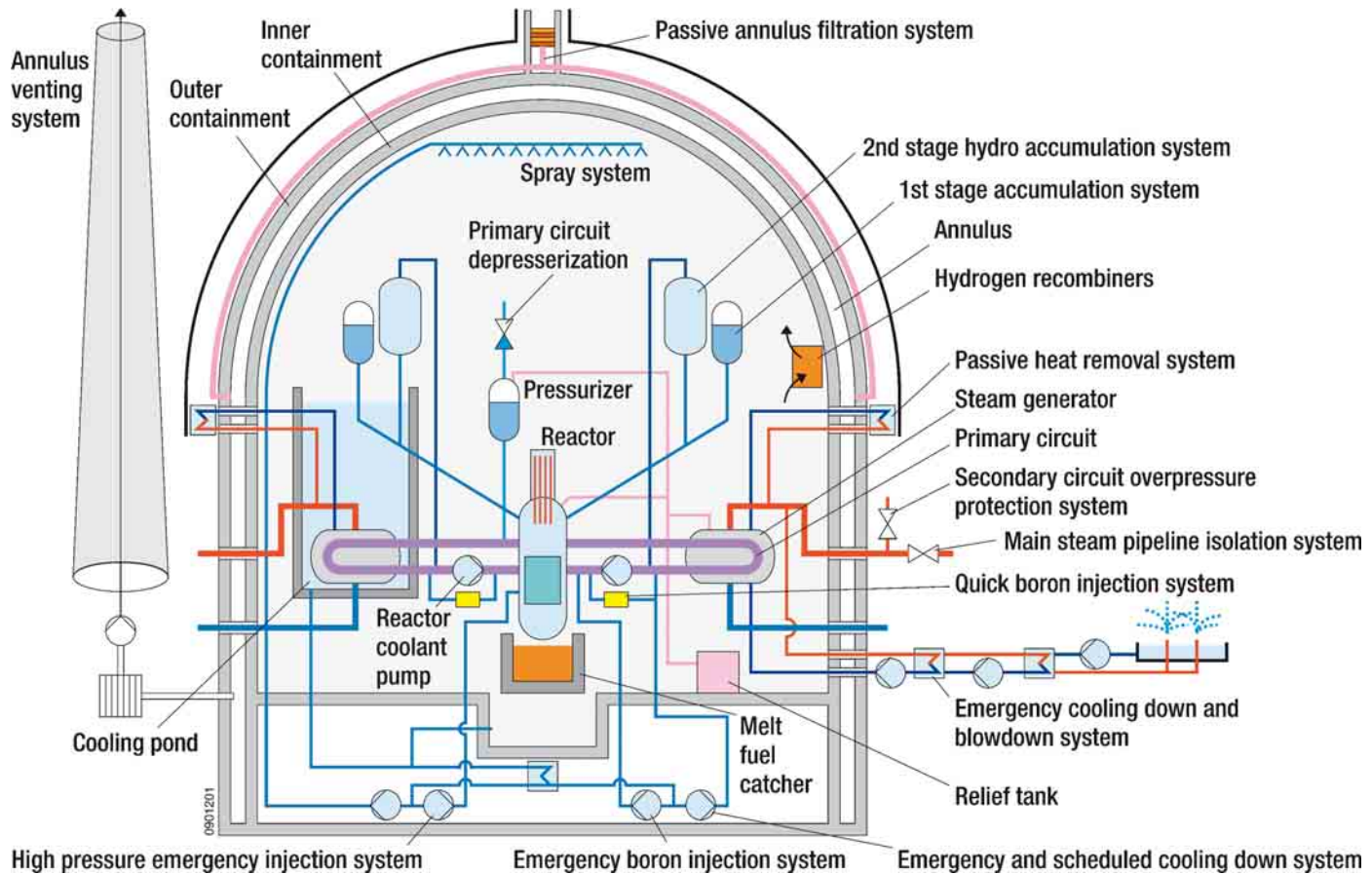
- **Construction,**
- **Commissioning,**
- **Operation,**
- **Modifications of plant design and operation , such as fuel features, loading strategy, operation modes,**
- **Final shutdown.**

The BELENE NPP 1/4

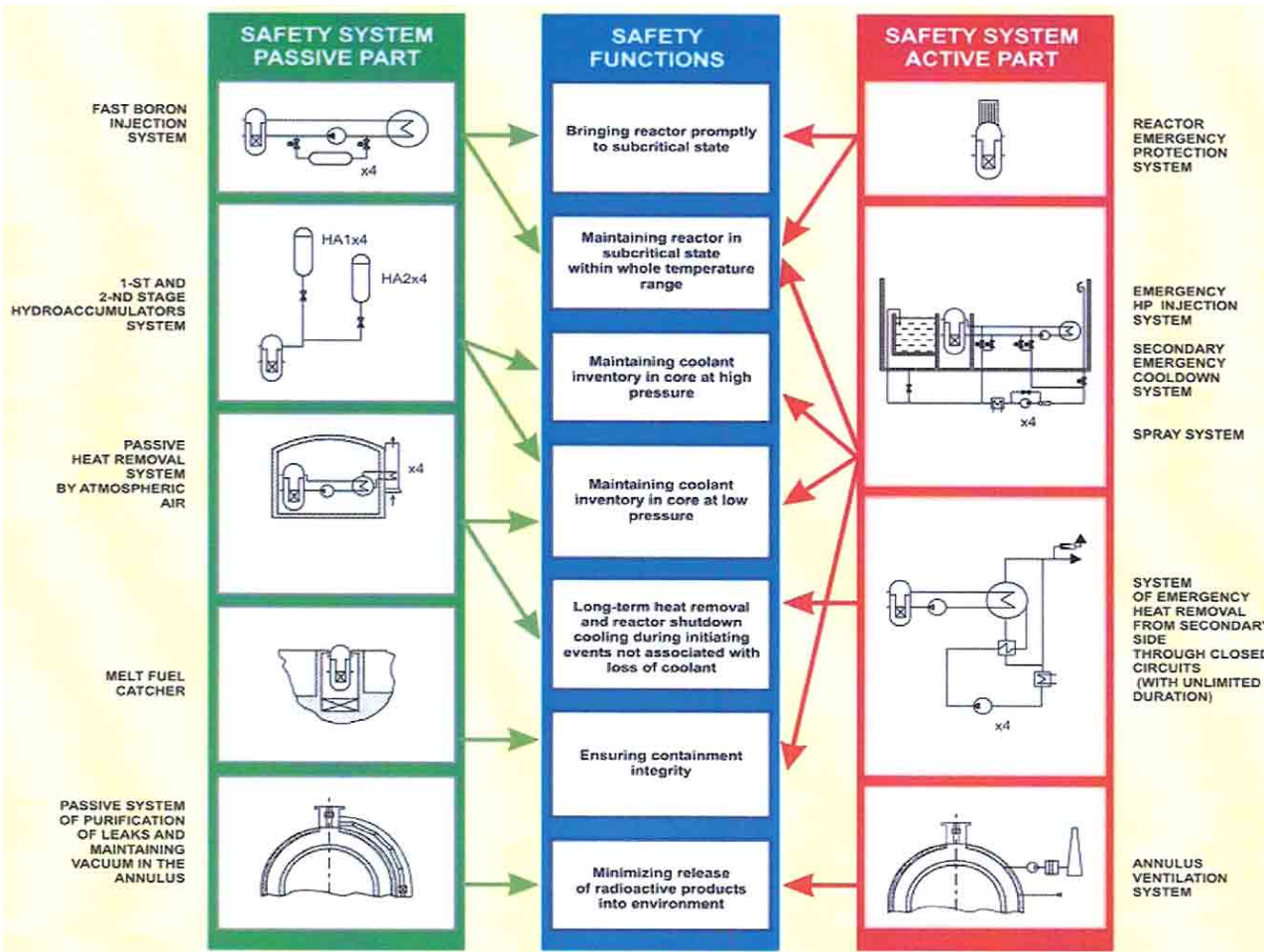
The reactor type selected for the BELENE NPP (BNPP) is the **A-92 (V-466)**. It has been developed as an evolutionary concept featuring all well-known VVER-1000 safety systems with addition of some innovative semi-complementary passive safety systems.



The BELENE NPP 2/4

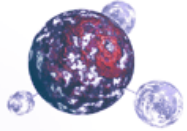


The BELENE NPP 3/4



The adopted safety philosophy is to complement each **active safety function** with an additional **passive safety function**

The BELENE NPP 4/4



BULATOM about BELENE NPP

Is BELENE NPP Project Necessary and Profitable?

Those two major questions were treated many times immediately after the parliamentary elections in June this year in Bulgaria by those elected to govern this country during the next 4 years. BELENE NPP is of utmost concern and it's quite normal keeping in mind that this project is and will be the largest investment project of this decade.

What is Characteristic of Belene NPP?

From technical point of view it is a third generation nuclear power plant, i.e. this project implies all the major state-of-the-art technologies in the field of nuclear energy.

The European Commission expressed positive attitude to the construction of this nuclear power plant.

Reviewing the BELENE NPP's ISAR – Interim Safety Analysis Report – 1/12

Historical Background 1/2

- 1. 2005: the Council of Ministers of Republic of Bulgaria approved the construction of two 1000 MW PWR units at a site located near the town of BELENE.**
- 2. 2006: selected reactor type has been the AES-92 (V-466B), an upgraded variant of the new generation VVER AES-92 (V-412) presently under construction at *Kudankulam* (India).**
- 3. According to Bulgarian law, the holder of the design permit has to make a comprehensive and systematic safety assessment of the unit to demonstrate compliance of the design solutions with the applicable safety requirements and to reflect this assessment in the interim safety analyses report (ISAR). The information contained in ISAR shall enable possibility for verification the sufficiency of the design technical means and organizational measure.**

Reviewing the BELENE NPP's ISAR – 2/12

Historical Background 2/2

- 1. 2008: cooperation between BNRA and RISKAUDIT IRSN/GRS International in view of ensuring a high level of nuclear safety in the Belene Nuclear Power Plant (BNPP) by implementing the regulatory review process in conformity with international safety standards (IAEA, e.g.), additional specific safety requirements defined by BNRA and best safety assessment practices.**
- 2. The assessment and in-depth analysis work were carried out from November 2008 to November 2009.**

Reviewing the BELENE NPP's ISAR – 3/12

The Assessment Procedure : TWO TASKS

TASK 1 – “Review of the ISAR”,

The work carried out by RISKAUDIT and its subcontractors GRS and IRSN in the review and assessment of the ISAR consisted of two phases:

- **PHASE I** :The review of the Belene ISAR for **comprehensiveness and completeness** against the **Safety Standards of the IAEA**, additional specific safety requirements defined by BNRA and best safety assessment practices.

This review was based on IAEA DS348 “*Safety Assessment for Facilities and Activities*”.

Reviewing the BELENE NPP's ISAR – 4/12

The Assessment Procedure : TWO TASKS

TASK 1 – “Review of the ISAR”.

- **PHASE II** : The review of the Belene ISAR for **compliance** with the Safety Standards of the International Atomic Energy Agency (IAEA), additional specific safety requirements defined by BNRA and best safety assessment practices.

This review was based on IAEA NS-R-1 “*Safety of nuclear power plants: design*”

More than 40 experts from GRS and IRSN participated in the review process of the more than 8000 pages of the ISAR

Reviewing the BELENE NPP's ISAR – 5/12

The Assessment Procedure : TWO TASKS

TASK 2 – “In-depth analyses”

The objective of Task 2 is to perform in depth-studies of selected safety issues in support to assessment of the safety demonstration.

Seven technical reports have been issued in Task 2 by the end of November 2009.

Reviewing the BELENE NPP's ISAR – 6/12

1. **Large Break Loss of Coolant Accident (LOCA) Study**
2. **Core-Catcher Features and Performance Investigation**
3. **Analysis for a BDBA LOCA DN80 calculations with the coupled ATHLET-COCOSYS in NPP BELENE (WWER-1000/466B)**
4. **Analysis of Small Break DN80 and total loss of power for 24 hours with ATHLET BDBA**
5. **Accident analyses with COCOSYS for BELENE NPP**
6. **Structure mechanical analyses of the BELENE NPP containment behaviour**
7. **Analysis of the resolution of IAEA Safety Issues for WWER-1000/W-320 Nuclear Power Plants for BELENE NPP**

TASK 2

“In-depth analyses”

Reviewing the BELENE NPP's ISAR – 7/12

TASK 1:

ORGANIZATION: SHARING and PERFORMING

The safety design regulations for generation III reactors have been documented in the **Technical Guidelines**, issued as a common work by IRSN and GRS.

This document, as well as the relevant-to-safety design features of the *Olkiluoto* EPR have been adopted as reference for the best international practice in the framework of the current project of the BELENE safety assessment.

The work has been performed by more than 40 experts from GRS and IRSN who shared 50-50 the review of more than 8000 pages of the ISAR.

Reviewing the BELENE NPP's ISAR – 8/12

TASK 1:

ORGANIZATION: SHARING and PERFORMING

Two TPLs (Technical Project Leaders), one from GRS and one for IRSN, have:

- a. distributed the activity among individual contributors,**
- b. coordinated and conducted the work relying on a few-member group of wide-spectrum safety experts acting both as advisers and first-rank contributors.**

The work has been organized in a matrix-structured way;

Each chapter has been analyzed in crossed referenced to Requirements and specific sheet provided to BNRA under the form of *Working Material*.

Reviewing the BELENE NPP's ISAR – 9/12

The assessment work has been organized in a **matrix-structured**

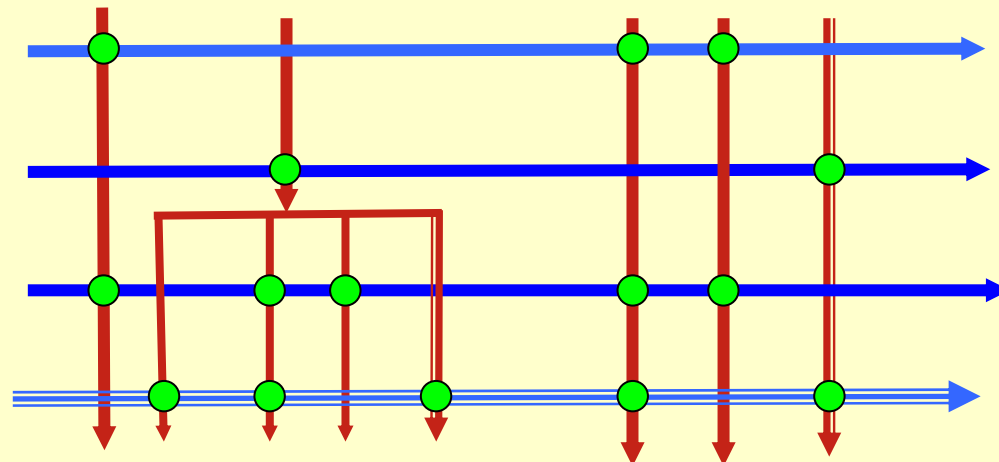
- 1. Each ISAR's chapter has been analyzed by at least two experts operating together - sharing that way, responsibility between the two Institutes - making reference to the Requirements in a crossed matrix-like approach.**
- 2. The material has been systematically reanalyzed, rearranged per chapter and summarized in two *Interim Reports*, structured in such a way that the questions to the applicant and the recommendations are clearly addressed.**

Reviewing the BELENE NPP's ISAR – 10/12

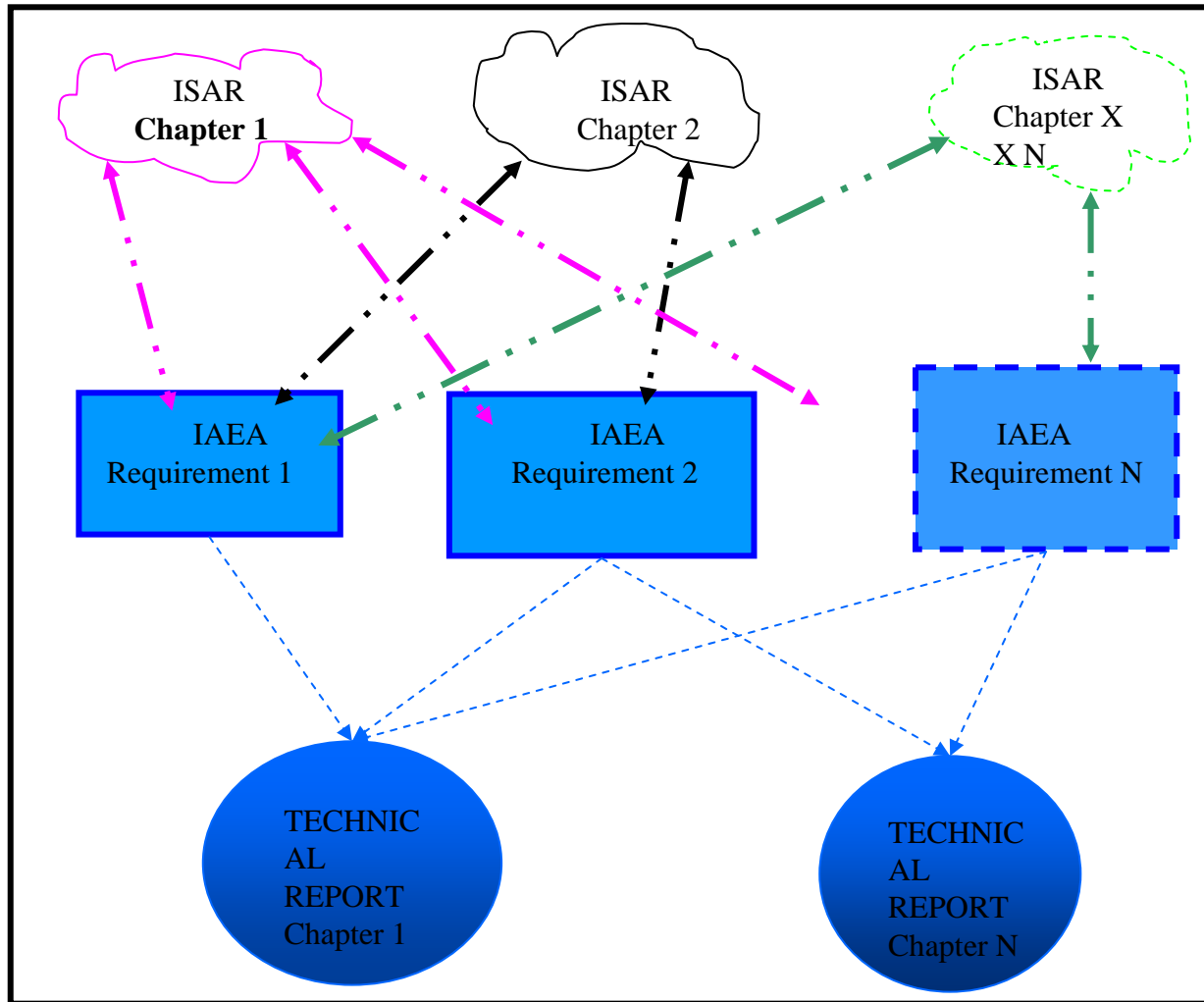
Matrix organization of the Review

ISAR Chapters and Sub-chapters

Requirements



Reviewing the BELENE NPP's ISAR – 11/12



Reviewing the BELENE NPP's ISAR – 12/12

The Kick-off meeting of the Contract was held in Sofia, November 24th 2008.

Topical meetings have been organized when milestones of the Contract have been matched.

Two specialists meeting have provided the opportunity for wide and open technical exchanges among BNRA's, RISKAUDIT's and Vendor's specialists. They have originated a contributed list of questions and preliminary answers collected in the *Minutes*.

SUMMARY & CONCLUSION - 1/4

The Reviewers has provided BNRA with recommendations (more than 250), classified in class 1 “must do”, class 2 “should do” and class 3 “nice to have”, and specific technical questions to be submitted to the Vendor.

This material has been systematically arranged and summarized in technical reports and Working Material per Chapters, providing recommendations and their justification.

These reports have been delivered to BNRA by a web-based information exchange site.

SUMMARY & CONCLUSION – 2/4

- 1. The most important outcome of the RISKAUDIT's review of the BELENE's ISAR was that the design of the plant is in general conformity with the applied requirements, the Bulgarian regulation and the international practice. No substantial design flaws have been identified and no major issues are found as missing.**
- 2. However, the ISAR should be significantly improved before issuing the construction permit. The improvements should take into account both the recommendations in the *Interim Reports* and in the *Working Material* made available to BNRA in a secured web-based information exchange system. The improvements should also address all questions posed to during the specialists' meetings.**

SUMMARY & CONCLUSION – 3/4

- 1. This positive appreciation on the ISAR relied also on the results of the seven in-depth analyses conducted by RISKAUDIT in support of the safety assessment, which, in general, have confirmed the claims made in the ISAR.**
- 2. Nevertheless, some complementary investigations have been recommended before final conclusions. Moreover, two reports have provided some additional recommendations**
- 3. In conclusion, RISKAUDIT asked for elaboration of a revised version of the ISAR, in which all the recommendations, the requests for information as well the questions should be comprehensively addressed, and explicitly referenced to facilitate their assessment.**

SUMMARY & CONCLUSION – 4/4

- 1. The satisfactory accomplishment of this duty has been considered as a prerequisite for the issuance of the construction permit,**
- 2. The REV 2 of the ISAR have been issued at the beginning of this year, BNRA and RISKAUDIT signed on a new collaboration under the above-mentioned Contract, which has the following main objectives:**
 - a. Assessing the implementation of the above-mentioned recommendations,**
 - b. Verifying and integrating the answers provided to the questions,**
 - c. Performing additional in-depth analysis aimed at completing and finalizing the previous investigations as well as addressing some complementary relevant safety issues.**
- 3. The inception meeting of this Contract is planned June 17 – 18 in Sofia. Details on the planning have to be defined, but, tentatively, the assessment activity should be completed by the end of current year and the accompanying in-depth analysis at the latest at the beginnings of 2011.**
- 4. The issuance of those Reports is an important technical support to the process for granting the construction permit.**