BELGIAN STRESS TESTS

FANC
federal agency for nuclear control

National progress report for nuclear power plants

This national progress report is provided by the Belgian regulatory body to the European Commission, as part of the stress tests program applied to European nuclear power plants in response to the Fukushima-Daiichi accident.

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Document History Log

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1. Introduction

Belgium has always been a pioneering country in the development of nuclear sciences and technologies for peaceful purposes. As such, the country is endowed with seven pressurized water reactors currently in operation on two distinct sites:

- The Doel site, located on the Scheldt river close to Antwerp (Flanders), home of four reactors:

    - Doel 1/2: twin units of 433 MWe each, commissioned in 1975,
    - Doel 3: single unit of 1 006 MWe, commissioned in 1982,
    - Doel 4: single unit of 1 039 MWe, commissioned in 1985.

- The Tihange site, located on the Meuse river close to Liège (Wallonia), home of three reactors:

    - Tihange 1: single unit of 962 MWe, commissioned in 1975,
    - Tihange 2: single unit of 1 008 MWe, commissioned in 1983,
    - Tihange 3: single unit of 1 054 MWe, commissioned in 1985.

Both sites are operated by the same licensee, namely ELECTRABEL, a company of the GDF-SUEZ energy and services Group.

For all nuclear safety related matters, the licensee's activities are under the control of the Belgian regulatory body[1], which is composed of:

- the Federal Agency for Nuclear Control (FANC),

- and Bel V, its technical subsidiary.

Following the accident that occurred on 11 March 2011 at the Japanese Fukushima-Daiichi nuclear power plant, a wide-scale targeted safety reassessment program was set up among the member states of the European Union operating such facilities on their soil. This "stress tests" program is designed to re-evaluate (based on technical studies, calculations and engineering judgment) the safety margins of the European nuclear power plants when faced with extreme natural events, and to take relevant action wherever needed. Upon demand of the Belgian Federal Government, terrorist attacks (aircraft crash) and other man-made events (cyber attack, toxic and explosive gases, blast waves) were also included in the Belgian stress tests as possible triggering events.

Upon completion of the stress tests program, and depending on the results, four options will be open for each unit:

1. the safety margins are sufficient and operation of the unit can be continued with no modifications,

2. the safety margins are sufficient and operation of the unit can be continued while appropriate improvements are implemented,

3. the safety margins are not sufficient and operation of the unit must be temporarily interrupted until appropriate improvements are effectively implemented,

4. the safety margins are not sufficient and operation of the unit must stop permanently.

The scope of the Belgian stress tests covers all seven reactors operated by Electrabel, including the dedicated spent fuel storage facilities at both sites, namely:

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[1] Additional information about the Belgian regulatory body and nuclear facilities is available on the FANC website (http://www.fanc.fgov.be), specifically in the 2010 report for the Convention on Nuclear Safety

- "SCG" building at Doel (dry cask spent fuel storage facility),
- "DE" building at Tihange (wet spent fuel storage facility).

In accordance with the European methodology, the stress tests of the nuclear power plants are performed in three stages:

1. The licensee carries out the stress tests in its facilities in accordance with the specifications developed and agreed by ENSREG, complemented by the specific requirements of the Belgian regulatory body (see § 4.2.3). A stress test report is to be sent by the licensee to the Belgian regulatory body. In this report, the licensee describes the reaction of the facilities when facing the different extreme scenarios, and indicates, where appropriate, the improvements that could be implemented to reinforce safety.

2. The regulatory body examines the licensee's report and evaluates the approach and the results. Based on these data, the regulatory body writes its own national report.

3. The report of all national regulatory bodies is subject to an international peer review: the national reports are examined by other regulatory bodies representing 27 European independent national Authorities responsible for the nuclear safety in their country. This method increases consistency in the whole process and ensures the sharing of experience between regulatory bodies.

From that stage, the European Commission will establish a final report that will be presented to the European Council, so as to provide an overall view of the current situation in the European power plants.

One of the major milestones in that process is the publication by each national Authority of a progress report describing the current status of the national stress tests program. Due by 15 September 2011, this progress report is intended for Belgian Parliament and the European Commission. A summary progress report will be prepared by the European Commission for the European Council of 9 December 2011.

The present progress report is issued by the Belgian regulatory body to fulfill this requirement. It provides the following information on the ongoing Belgian stress tests program:

- the chronology and milestones of the stress tests program up to the publication of the report,
- the main achievements to date,
- and the perspectives for the future.

In order to increase readability, the key data presented in this progress report are highlighted in **bold** fonts.
Similarly, where appropriate, the position of the regulatory body regarding the licensee's activities is marked in ***bold italic*** fonts.

As part of the Authorities' transparency policy, this national progress report is made available to the public and media on the Belgian regulatory body's website (http://www.fanc.fgov.be).

2. Conclusions

The current status of the Belgian stress tests program applicable to power reactors is satisfactory.

The licensee has mobilized the necessary qualified human resources and has set up an appropriate organization to fit the requirements within the allocated timeframe.

So far, several major achievements have been completed in time, namely:

- **the development of a compliant stress tests methodology,**
- **the publication of the licensee's progress report,**
- **the proposal for a table of content for its stress tests final reports.**

The preparation of the licensee's final reports has also reached a satisfactory progress.

The Belgian regulatory body is closely involved in the stress tests program. A project organization has been defined to prepare the framework of the stress tests and to ensure a thorough follow-up of the licensee's activities and progress.

The next major steps to be completed in the stress tests program are as follows:

- **the completion of the licensee's final stress tests reports, due by 31 October 2011,**
- **the evaluation of the licensee's stress tests reports by the regulatory body, and the transmission of the Belgian stress tests report to the Belgian Parliament and the European Commission, due by 31 December 2011,**
- **the implementation of the peer reviews of the national stress tests reports at the European scale, due by 30 April 2012.**

The Belgian regulatory body is confident in the fulfillment of its international commitments in due time.

3. Chronology and milestones

3.1. Licensee's timeline

The main milestones related to the licensee's involvement in the stress tests program (up to 15 September 2011) are listed hereafter.

The most important items are developed in § 4.1.

The key items marked in **bold** are also placed in an overall timeline shown in appendix 1.

March 2011:

- Since the Fukushima-Daiichi accident, collaboration with the European Nuclear Industry Safety Standards (ENISS), and interaction (through ENISS) on a regular basis with other European utilities

- Meeting with the regulatory body about the re-evaluation of the seismic hazard at Doel and Tihange

- Initial meeting with the regulatory body about the stress tests initiative

April 2011:

- Analysis of the stress tests specifications (version of 21 April 2011) proposed by the Western European Nuclear Regulators' Association (WENRA)

- Contacts with the Royal Observatory of Belgium (ROB) to discuss the re-evaluation of the seismic hazard at Doel and Tihange

- Organization of the Belgian Stress Tests project ("BEST" project, see §4.1.1)

May 2011:

- **Kick-off meeting of the "BEST" project**

- Analysis of the first feedback of the Fukushima-Daiichi accident through the Significant Operating Experience Report (SOER) 2011-02 questionnaire distributed by the World Association of Nuclear Operators (WANO)

- Follow-up committee with the regulatory body

- Preliminary re-evaluation of the seismic hazard at Doel and Tihange by the ROB

June 2011:

- Presentation to the regulatory body of the different scenarios to be studied as part of the "BEST" project

- Extensive inspections ("walkdowns") in several buildings at Doel and Tihange by American experts, as part of the review of earthquake scenarios, and presentation of the results to the regulatory body

- Follow-up committee with the regulatory body

- Implementation of first post-Fukushima safety improvements at Doel and Tihange

July 2011:

- Presentation of the "BEST" project to the FANC Scientific Council
- Presentation of the stress tests methodology to the regulatory body
- Follow-up committee with the regulatory body
- Production of the first stress tests technical documents

August 2011:

- **Transmission of the progress report to the regulatory body, including a proposal of a table of content for the final stress tests reports**
- Presentation of the progress report to the regulatory body
- Presentation to the regulatory body of the work progress related to earthquake as a triggering event
- Presentation to the regulatory body of the work progress related to flooding as a triggering event

September 2011:

- Extensive inspections in several reactor buildings at Doel and Tihange by American experts, as part of the assessment of earthquake scenarios
- Continuation of the stress tests project

3.2. Regulatory body's timeline

The main milestones related to the regulatory body's involvement in the stress tests program (up to 15 September 2011) are listed hereafter.

The most important items are developed in § 4.2.

The key items marked in **bold** are also placed in an overall timeline shown in appendix 1.

March 2011:

- Meeting with the licensee about the re-evaluation of the seismic hazard at Doel and Tihange
- Participation to the meeting organised by the Commission and Commissioner Oettinger where the principle of the stress test was launched (and later approved by the Council)
- Participation to the Euratom Atomic Question Group
- Involvement in the Western European Nuclear Regulators' Association (WENRA) steering group for an independent regulatory technical definition of stress tests and associated methodology
- Initial meeting with the licensee to present the stress tests initiative

April 2011:

- Involvement in WENRA task force to define the technical content of stress tests ("stress tests specifications")

- Presentation of the stress tests initiative to the FANCScientific Council

May 2011:

- Kick-off meeting of the "BEST" project between the licensee and Bel V
- Organization of the follow-up of the licensee
- Participation in the Nuclear Energy Agency (NEA) task group on the implications of the Fukushima-Daiichi accident
- Involvement in WENRA presentation of technical stress tests specifications to the European Nuclear Safety Regulators Group (ENSREG)
- Active participation to ENSREG who reached a consensus on the content of the European stress tests as required by the European Council.
- **Publication of the Belgian preliminary stress tests specifications applicable to power reactors**
- **Presentation of the Belgian preliminary stress tests specifications applicable to power reactors to the Belgian Parliament's Subcommittee for nuclear safety**
- Follow-up committee with the licensee

June 2011:

- Participation in the NEA Forum on the Fukushima-Daiichi accident and related insights and approaches
- Meeting with the licensee about the different scenarios to be studied as part of the stress tests project
- Meeting with the licensee about the methodology for seismic margin assessments (including walkdowns at Doel and Tihange by American experts)
- Participation in the International Atomic Energy Agency (IAEA) international conference on the implications of the Fukushima-Daiichi accident
- Follow-up committee with the licensee

July 2011:

- **Publication of the Belgian final stress tests specifications applicable to power reactors**
- **Publication of the Belgian stress tests specifications applicable to other class I nuclear facilities [2] currently in operation**
- Presentation of the stress tests program to the FANC Scientific Council
- Meeting with the licensee about its stress tests methodology
- Follow-up committee with the licensee

[2] Major nuclear facilities (other than power reactors) such as research reactors, nuclear fuel production plants, radioactive waste processing plants, radioactive waste storages…

August 2011:

- Meeting with the representatives of class I nuclear facilities (other than power reactors) to present the stress tests program applicable to their activities

- Progress meeting with the licensee (nuclear reactors) to discuss its progress report (in presence of the Dutch and French nuclear safety Authorities)

- Meeting with the Dutch and French nuclear safety Authorities about the respective stress tests activities and perspectives

- Progress meeting with the licensee about earthquake as a triggering event

- Progress meeting with the licensee about flooding as a triggering event

September 2011:

- Targeted inspections on the first post-Fukushima safety improvements implemented by the licensee at Doel and Tihange

- Involvement in WENRA task force to define the process of the peer review of the national stress tests reports

- **Presentation of the conclusions of the national progress report to the FANC Scientific Council**

- Participation as observer in the extensive inspections carried out in several reactors building at Doel and Tihange by American experts in presence of the licensee, as part of the assessment of earthquake scenarios

- **Publication and transmittal to the European Commission of the national progress report**

4. Main achievements

4.1. Licensee

The following paragraphs comprise information from the licensee's progress report (see § 4.1.4).

4.1.1. Project organization and resources

The licensee mobilized substantial internal and external resources soon after the Fukushima-Daiichi accident occurred.

As part of a large industrial group, the licensee can rely on qualified human capacities among its own personnel, but also in the parent company and in a specialized engineering subsidiary within the group (Tractebel Engineering).
In addition, the licensee has requested the assistance of several national and international key experts and organizations (Royal Observatory of Belgium, International Air Transport Association, University of Liège,…) to contribute to specific technical assessments and reviews wherever needed.

At this stage, the personnel currently involved in the management and technical studies of the stress tests program includes:

- high level managers,
- experienced project managers,
- qualified senior experts,
- international experts.

Besides, the licensee defined and established a full organization in the early phases of the stress tests program.

This organization is composed of:

- a steering committee,
- a project group,
- and six workgroups.

The steering committee is periodically convened to assure a high level steering and follow-up of the "BEST" project, as well as a timely and adequate decision-making and approval process. Participants in this steering committee are representatives of the management of the different entities contributing to the "BEST" project, namely:

- both nuclear sites operators,
- the corporate nuclear projects department,
- the corporate nuclear safety department,
- the engineering subsidiary.

A project group has also been established to handle the day-to-day management of the "BEST" project. This group is composed of five experienced project managers, representing the different entities contributing to the "BEST" project as defined above. By means of weekly meetings, project progress is tracked, bottlenecks are identified, and corrective actions are defined, if necessary.

In addition, six workgroups were formed to carry out the different tasks required by the stress tests specifications:

- workgroup 1: triggering event "earthquake",
- workgroup 2: triggering events "flooding" and "other extreme natural events",
- workgroup 3: loss of safety functions "loss of electrical power" and "loss of the ultimate heat sink",
- workgroup 4: severe accident management,
- workgroup 5a: triggering events "terrorist attacks" (aircraft crash…) and "other man-made events" (toxic and explosive gases and blast waves),
- workgroup 5b: triggering event "external attacks on computer-based controls and systems" ("cyber-attacks").

These workgroups are also composed of experts from the same entities as mentioned above. The workgroups meet weekly as well, and back-up participants are assigned to guarantee continuity. Approximately forty experts are active in the "BEST" project workgroups.

Overall, the regulatory body considers that the human resources mobilized by the licensee are well suited in qualification and number, considering the technical challenge and the stringent time-frame allocated for the completion of the stress tests program. Also, the organization built up by the licensee seems appropriate given the complexity of the project and the need for thorough follow-up along time.

4.1.2. Short-term actions undertaken after the Fukushima-Daiichi accident

Shortly after the Fukushima-Daiichi accident, the licensee started to evaluate possible improvements related to hardware, organization and procedures, to better cope with the extreme scenarios that would be studied later as part of the stress tests program. The aim was to benefit soon from the already available feedback of the accident, without waiting for the detailed stress tests results.

For that purpose, a report from WANO, including an initial analysis of the accident and a number of recommendations, was used as one of the input data.

By the end of June 2011, several short-term improvements had already been implemented at both sites, to immediately enhance the robustness of the facilities. For example:

- complementary means and procedures were developed to refill the spent fuel pools in case of loss of water inventory during a long-lasting total station blackout;
- complementary means and procedures were developed to refill certain water reservoirs using newly installed additional equipment in case of a total station blackout;
- some parts of the facilities were reinforced to guarantee their correct functioning in case of an earthquake.

This process was presented to the regulatory body.

The regulatory body considers that the licensee's initiative is beneficial to the nuclear safety of the facilities as it reinforces in the short term its capability to face extreme Fukushima-like scenarios, pending the completion of the detailed stress tests studies and the achievement of further actions that will eventually be identified thereafter.

4.1.3. Development of the licensee’s stress tests methodology

As requested by the regulatory body, a specific methodology for the stress tests was prepared by the licensee and officially communicated on 15 July 2011 for review and comments.

It was amended by the licensee taking into account the regulatory body’s remarks and recommendations.
Some selected items of the licensee’s methodology were further detailed to better fit the expectations and avoid any misunderstanding or discrepancy with the Belgian stress tests specifications (see § 4.2.3).
The licensee also agreed on specific justifications that shall be developed in its final stress tests reports, regarding particularly:

- the safe-shutdown objectives to reach, depending on the different accidental scenarios considered,

- the initial state of the units on a single plant when the accidental scenarios occur.

An updated version of the licensee’s methodology was communicated to the regulatory body.

The following topics are covered by the proposed methodology:

- the scope of the assessment:
    - nuclear facilities included in the assessment,
    - initial operating states of the facilities, for a single unit and for the whole site,
    - initiating events conceivable at the plant sites,
    - loss of safety functions,
    - and severe accident management issues;

- the key points to be reported:
    - the provisions taken in the design basis and the physical conformity of the plant regarding its design basis,
    - the robustness of the plant beyond its design basis,
    - the potential modifications and studies to improve the robustness of the plant;

- the assessment method regarding:
    - earthquake,
    - flooding,
    - extreme weather conditions,
    - aircraft crash,
    - other man-made events (toxic gases, explosive gases and blast waves, cyber attacks),
    - loss of electrical power supply and loss of ultimate heat sink,
    - severe accident issues.

The final licensee’s methodology was reviewed by the regulatory body in August 2011, and it showed compliance with the Belgian stress tests specifications. Besides, the licensee acknowledged the expectations of the regulatory body regarding the content and level of details of its final stress tests report. Therefore, the licensee was allowed to go further in his assessment.

4.1.4. Publication of the licensee's progress report

The licensee's progress report was communicated to the regulatory body on 15 August 2011, in conformity with the deadline prescribed by the regulatory body.
It was published on the regulatory body's website on the following day.

The licensee's progress report provides a comprehensive description of the following topics:

- the organization of the project that was set up by the licensee in order to carry out the Belgian stress tests (see § 4.1.1);

- the methodology that the licensee is implementing in order to fulfill the requirements expressed by the regulatory body in its Belgian stress tests specifications (see § 4.1.3);

- the state of progress, at the date of the report, of:

    - the activities undertaken by the licensee in order to achieve the required stress tests reports,
    - the various improvement actions that were launched, in parallel with the stress tests assessment;

- a proposal for the table of content of the licensee's stress tests report for each nuclear site (see § 4.1.5).

The licensee's progress report fulfills the regulatory body's expectations and was accepted by the regulatory body. Part of its content is used for the writing of the present national progress report provided by the regulatory body to the European Commission.

4.1.5. Proposal for a table of content for the final licensee's stress tests reports

The licensee proposed a preliminary version of the stress tests reports' table of content, as part of its progress report published on 15 August 2011.

The licensee has adopted the table of contents as established by the ENISS organization and submitted to ENSREG. This proposal might be adjusted later since the detailed definitive ENSREG requirements regarding the table of content to be used in the (licensee's and national) stress tests reports have not been finalized yet.

The proposed table of content is composed of two parts to suit the Belgian stress tests specifications frame:

- the first part aims at fulfilling the ENSREG requirements of the specifications,

- the second part is specifically dedicated to the complementary "Belgian" requirements of the specifications that were not in the scope of the ENSREG requirements (i.e. aircraft crashes and other man-made events).

The preliminary table of content, as proposed by the licensee on 15 August 2011, is reproduced in appendix 2.

The regulatory body considers that the table of content of the stress tests reports proposed by the licensee is sufficiently detailed and is consistent with the expectations of the Belgian stress tests specifications. Unless minor adjustments are applied later to meet further ENSREG harmonization requirements, the proposed preliminary table of content can be used as a main frame for the writing of the licensee's stress tests reports.

4.1.6. Preparation of the licensee's stress tests reports

The licensee intends to provide one stress tests report for each of the two Belgian nuclear power plant sites. The report for the Doel site will be written in Dutch, and the one for the Tihange site will be written in French.

Each report will be composed of two different parts, both based on the national stress tests specifications. The first part will meet the "ENSREG" requirements, and the second one will be dedicated to the specific "Belgian" requirements of the specifications. In this second part, some topics related to man-made events will remain confidential for security matters (Law of 11 December 1998).

To prepare its reports, the licensee chose to firstly write a number of individual technical documents ("deliverables") that will eventually be gathered and merged into the final reports.

This process, which was decided to allow workload distribution among the workgroups and facilitate subsequent follow-up, was divided into three consecutive phases:

- Phase 1: Development of the deliverables.
  Based on the stress tests specifications, a distinction is made between the design basis of the power plants, the robustness of the power plants beyond their design basis (evaluation of the margins), and the severe accident management strategies.
  According to the licensee, the technical information to be included in the final reports should be available in written form (for all three parts) at the end of phase 1, but not necessarily with the correct level of detail.

- Phase 2: Merge of the individual deliverables to get a first draft of the final reports, collection of comments and integration of these comments in the texts.
  According to the licensee, the full report texts should be internally consistent at the end of phase 2, but not necessarily in a suitable format.

- Phase 3: Editing of the reports in their final forms, with attention to readability and ease of understanding.

The development of the deliverables (phase 1) was the main task of the workgroups from May 2011 till August 2011.

First of all, all the requirements contained in the Belgian stress tests specifications were highlighted individually and one deliverable document was assigned to each requirement. Thus, each deliverable will provide a specific answer to a specific requirement issued from the specifications.
Then, for each individual deliverable, a thorough independent "second level" review was organized within the workgroups. Each deliverable was reviewed by another expert in the field, before validation by the workgroup. In this step of the process, emphasis was set particularly on consistency (between units, between plants, etc.) for the considered topic.

In their analysis of the Belgian stress tests specifications, all workgroups also discussed possible improvements related to hardware, organization and procedures, which would potentially be valuable in the management of Fukushima-type severe accident scenarios.

These possible improvements were categorized according to their benefit, implementation complexity and potential realization schedule as short-term, medium-term or long-term improvement actions. Results of this continuous process were regularly communicated to the project group for further analysis and validation.

Overall, the regulatory body considers that the process engaged by the licensee to prepare its stress tests reports is appropriate and efficient. So far, the planned tasks are performed on schedule and a substantial amount of technical data is now available for synthesis in the licensee's final stress tests reports.

4.2. Regulatory body

4.2.1. Project organization and resources

In Belgium, the safety of the nuclear activities is under the control of:

- the Federal Agency for Nuclear Control (FANC),
- and its technical subsidiary (Bel V).

The FANC is the Belgian independent safety Authority, responsible for the protection of the workers, the population and the environment against the hazards of ionizing radiations. It is under the supervision of the Federal Minister of Internal Affairs, who is not in charge of the national energy policy.
Among other missions, the Agency:

- contributes to the preparation of the national regulations related to nuclear safety and radiological protection,
- evaluates license applications from the nuclear operators,
- and carries out on-site inspections.

The main initiatives and achievements of the Agency are presented periodically for information and advice to a FANC Scientific Council composed of independent specialists within the field of nuclear energy, safety and radiological protection.. The Scientific Council advises the FANC on various aspects related to major nuclear facilities such as licence applications or licence renewals as well as for some aspects of nuclear safety regulations.

Bel V is a subsidiary created by the FANC to act as an expert body. It carries out, on behalf of the FANC, the on-site regulatory control of the main Belgian nuclear activities. Bel V also provides technical support to the FANC for all nuclear projects needing high level expertise, thanks to several specialized technical resource centers.

The FANC and Bel V established a dedicated organization to manage the Belgian stress tests program.

Within the FANC, a team of experts and inspectors was designated, including one coordinator who was involved early in the international talks and working meetings about the stress tests program. These experts have experience in the licensing and inspections of the nuclear power plants.

Within Bel V, the Nuclear Projects Department has designated a project leader for the stress tests program. This coordinator relies on Bel V's on-site controllers and technical experts who have a thorough knowledge of the licensee's facilities.
For the purpose of the stress tests program, senior experts have also been named in all Bel V's technical resource centres as points of contact to the technical working groups established by the licensee in its own organization (see § 4.1.1).

This team of FANC and Bel V experts is in charge of:

- the international collaboration (see § 4.2.2),
- the preparation of the Belgian stress tests specifications (see § 4.2.3),
- the follow-up of the licensee (see § 4.2.4),
- the inspection programs (see § 4.2.5 and 5.2.1),

- the evaluation of the licensee's progress and final reports, and the writing of the Belgian progress and final reports (see § 4.2.6 and 5.2.2).

The Senior management of the FANC and Bel V is also member of the follow-up committee established to monitor the progress of the licensee's stress tests program (see § 4.2.4).

The FANC Scientific Council is informed during the whole process. In this context, information sessions were organized by the FANC to present:

- the stress tests initiative (8 April 2011),
- the "BEST" project (5 July 2011),
- and the conclusions of the national progress report (9 September 2011).

4.2.2. International collaboration

The Belgian regulatory body is actively involved in a number of international organizations (such as WENRA, ENSREG, IAEA, NEA) in view of defining the stress test policy and developing collaboration, mutual information and harmonization of practices.

This ongoing process intensified immediately after the Fukushima-Daiichi accident occurred, particularly with:

- an assiduous participation in supranational works and debates through WENRA/ENSREG meetings on the stress tests, and NEA/IAEA meetings on the implications of the accident,
- a reinforcement of bilateral collaboration with regulatory bodies from neighboring countries.

The Belgian regulatory body is an active permanent member of WENRA and ENSREG, and as such, a Belgian representative participated in all working meetings related to the accident in Japan and the subsequent construction of the stress tests program.

The main meetings attended so far are the following:

- 23 March 2011 at Helsinki: WENRA statement to provide stress tests specifications,
- 6 and 7 April 2011 at Paris: WENRA task force to define the stress tests specifications,
- 12 May 2011 at Brussels: Presentation of WENRA's proposal of stress tests specifications to ENSREG,
- 5 September 2011 at Helsinki: ENSREG task force to define the methodology of the upcoming peer reviews of national stress tests reports.

The close participation of the Belgian regulatory body in the entire international process is beneficial as it facilitates subsequent implementation of the national stress tests program and ensures overall consistency with the European expectations.

The Belgian regulatory body also strengthened its bilateral relationships with the Dutch and French nuclear safety Authorities (respectively Ministerie van Economische Zaken, Landbouw en Innovatie / KernFysische Dienst (EL&I/KFD) and Autorité de Sûreté Nucléaire (ASN)), given that each of the three countries operates nuclear power plants in border areas, namely:

- the Dutch site of Borssele and the Belgian site of Doel on either sides of the border with the Netherlands,

- the French sites of Chooz and Gravelines and the Belgian site of Tihange on either sides of the border with France.

The collaboration is aimed at comparing and matching wherever possible the way the stress tests are implemented and supervised by the national regulatory bodies on these facilities. Official contacts between the Belgian, Dutch and French ministers in charge were undertaken for that purpose.

In practice, the process implies exchange of information (technical data, methodologies, action plans…) in full transparency between the regulatory bodies and with the concerned licensees.

So far, the licensees' progress reports have been shared between the regulatory bodies, and so will be the licensees' final reports.
Several meetings with the licensees have also been attended by third-party regulatory bodies as external observers:

- on 6 July 2011, representatives of the Belgian regulatory body attended a nuclear reactors experts committee in Paris, during which the French licensee presented its methodology and progress,

- on 2 and 16 August 2011, a representative of the Belgian regulatory body attended meetings in Den Haag, during which the Dutch licensee presented its progress report,

- on 19 August 2011, Dutch and French regulatory bodies' representatives attended a meeting in Brussels during which the Belgian licensee presented its progress report.

In the same perspective, on-site cross-inspections are organized in which observers from third-party regulatory bodies can evaluate the implementation of the stress tests program on the licensees' facilities in Belgium, France, and the Netherlands.
To date, the following cross-inspections have been attended by the Belgian regulatory body:

- on 6 July 2011, at the Gravelines nuclear power plant, about flooding,

- on 18 July 2011, at the Chooz nuclear power plant, about heat sink,

- on 1 August 2011, at the Chooz nuclear power plant, about earthquake,

- on 5 September 2011, at the Chooz nuclear power plant, about accident management.

The process will be continued and further cross-inspections related to stress tests are already scheduled in the next months.

4.2.3. Publication of the Belgian stress tests specifications

The Belgian regulatory body participated in the earliest initiatives dedicated to the preparation of a common stress tests program at the international level, including the definition of stress tests specifications through WENRA (see § 4.2.2).

Following these works, and pending their validation by the European Authorities, the Belgian regulatory body prepared and published on 17 May 2011 a preliminary version of the Belgian stress tests specifications applicable to power reactors, based on the WENRA proposal, which was transmitted to the licensee to allow work to start.

Compared to the WENRA proposal, the scope of the Belgian stress tests specifications was extended by including also terrorist attacks and other man-made events (e. g. aircraft crashes, cyber attacks…).

This preliminary version was submitted to the Belgian Parliament's Subcommittee for nuclear safety on the 18 May 2011, and was then subject to a resolution of the Belgian Parliament on 16 June 2011 in which it was recommended to:

- use the preliminary version of the stress tests specifications for the Belgian power reactors;
- include the other class I nuclear facilities in the Belgian stress tests program.

These recommendations are in accordance with an earlier decision of the Belgian Federal Government on the scope of the Belgian stress tests.

Consequently, the regulatory body published its final stress tests specifications applicable to power reactors (identical to the preliminary version published previously) on 4 July 2011, and formally communicated these requirements to the licensee.
This document is shown in appendix 3.

On 4 July 2011, the regulatory body also published its stress tests specifications applicable to other class I nuclear facilities currently in operation, and formally communicated these requirements to the concerned licensees. The following class I nuclear facilities are included in this second part of the Belgian stress tests program:

- Franco-Belge de Fabrication du Combustible International (FBFC International), a nuclear fuel fabrication plant located at Dessel (Flanders),
- Belgoprocess, two radioactive waste treatment and storage facilities located at Dessel and Mol (Flanders),
- Institute for Radioelements (IRE), a radioisotope production facility located at Fleurus (Wallonia),
- Studiecentrum voor Kernenergie - Centre d'études de l'Energie Nucléaire (SCK-CEN), a nuclear research centre located at Mol (Flanders),
- Institute for Reference Materials and Measurements (IRMM), a research centre located at Geel (Flanders).
- "Water en Afvalbehandelingsgebouw" (WAB), a waste treatment and storage facility at the Doel Site

The specifications aimed at the other class I facilities are inspired by those applicable to power reactors, with relevant modifications and simplifications given the nature of these installations.

Note: The Belgian stress tests program for the other class I nuclear facilities is outside the scope of the present progress report.

4.2.4. Follow-up of the licensee

Given the stringent timeframe allowed to perform the stress tests, the regulatory body has emphasized the need for a close follow-up of the licensee's activities, in order to ensure the availability in due time of both the progress report and the final report.

Several contacts and information meetings were held between the regulatory body and the licensee soon after the Fukushima-Daiichi accident.

From May 2011, as the stress tests program was entering its early phases, a formal follow-up committee was established by the regulatory body and attended by the representatives of the licensee.

This committee aims at monitoring the progress and results of the licensee and providing assistance for any query related to the stress tests specifications and other relevant matters.

The follow-up committee is convened on a monthly to two-monthly basis.

Several technical meetings between the regulatory body and the licensee were also organised in parallel with the follow-up committee, in order to present and discuss in details specific topics from the licensee's stress tests program (e.g. the scenarios to be studied, or the triggering events like earthquake and flooding). This follow-up process will be continued over the entire stress tests program.

4.2.5. Inspection of the post-Fukushima short-term on-site improvements

A number of on-site inspections at Doel and Tihange were conducted by the regulatory body to check the short term improvements set up by the licensee after the Fukushima-Daiichi accident (see § 4.1.2).

The scope of the inspections was as follows:

- genesis of the improvements by the licensee, internal decision process, internal check of the potential impact of the modifications;
- incorporation of new hardware in procedures, information and training of the personnel;
- on-site verification of a selection of improvements evoked by the licensee in its progress report (see § 4.1.4);
- judgment on the usability and relevance of the improvements.

Regarding the first topic, the inspections showed that the safety improvements were proposed and selected by the licensee for their added value to safety, global contribution to safety (i.e. ability of one improvement to cope with several different situations), and short-term feasibility (implementation times, availability of equipment…). The proposals were made by teams of experienced designers and independently challenged by other teams of experienced experts.
The analysis, decision and implementation process is fully formalized (through the applicable modification process) for the improvements related to the flooding risk at Tihange, as the analysis was already in an advanced state in the framework of the periodic safety review initiated before the Fukushima-Daiichi accident occurred.

Regarding the second topic, the inspections confirmed that some of the new hardware is already incorporated in new or existing procedures, with information of the concerned personnel. In general, training (including the validation of the related procedures) still needs to be performed.
A notable exception is the treatment of the flooding risk at Tihange, for which all procedures were created or adapted, and the involved personnel was informed and trained.

Regarding the third topic, the inspections confirmed that all improvements that were presented previously to the regulatory body were in place as indicated.
For some of those improvements, the exact date of achievement is not clearly defined by the licensee, as they represent the first steps of a continuous process in the stress tests exercise.

Regarding the fourth topic, the inspections showed that several improvements still need to be tested in order to evaluate their actual availability and efficiency. On the other hand, many short-term improvements consist of additional emergency equipment which are usable in the different reactor units and can be considered as a response to multiple-unit accidents.

The regulatory body considers that some of the short term improvements undertaken by the licensee are already operational. The formal implementation of the other

improvements (including incorporation in procedures, testing, and training of the personnel) is still ongoing.

4.2.6. Publication of the national progress report

The present national progress report was prepared jointly by the Federal Agency for Nuclear Control and Bel V, and was transmitted to the European Commission on 15 September 2011 (European deadline).

The Belgian progress report includes information provided mostly by the FANC and Bel V experts involved in the stress tests program.
Wherever relevant, it also contains quotes from the licensee's progress report that was transmitted to the regulatory body on 15 August 2011 (see § 4.1.4).

The structure of the national progress reports may vary from one country to another, as there is no imposed template at the European level.
However, in the framework of our international collaboration, the table of content of the Belgian progress report was presented to several third-party regulatory bodies for information and feedback.

The national progress report is accessible on the Belgian regulatory body's website (http://www.fanc.fgov.be).

5. Perspectives

5.1. Licensee

5.1.1. Completion of the licensee's stress tests reports

In the process adopted by the licensee to write its stress tests reports (as described previously in § 4.1.6), phases 2 and 3 still need to be completed.

In phase 2, the licensee has to merge the individual deliverables produced in phase 1 to a complete text, which will represent the draft version of a single stress tests report. Both drafts (one for each site) will then be reviewed by other internal experts who have not participated in their preparation. After these reviews, the texts will be ready for edition.
The implementation of phase 2 is scheduled by the licensee in August and September 2011.

In phase 3, both reports will be edited, with special attention to their readability.
The implementation of phase 3 is scheduled by the licensee in September and October 2011.

At this stage, the regulatory body considers that the schedules proposed by the licensee for phases 2 and 3 of its stress tests reports are compatible with the applicable deadlines. Meanwhile, the regulatory body will check the current status of these phases during the next follow-up meetings in order to ensure that no delay is likely to occur.

Note: As mentioned previously in § 4.1.6, the licensee will resume several technical on-site visits after the publication of the final stress tests reports. These visits will be synchronized with the outage planning of the units that were in operation during early phases of the project. The results of these walkdowns will be compared with the terms of the final reports so as to check that the conclusions are not questioned.

5.1.2. Implementation of the licensee's stress tests action plan

A number of modifications and improvements were already decided and planned by the licensee prior to the Fukushima-Daiichi accident, as part of the continuous safety upgrade process.

Depending on the conclusions of its stress tests and the subsequent evaluation by the regulatory body, the licensee may have to update a full action plan to treat potential weak points and to improve the robustness of its plants, based on the defence-in-depth approach:

- prevent the loss of a safety function after an initiating event,
- prevent a severe accident situation,
- manage a severe accident.

The conclusions of the licensee's stress tests are not yet known at this stage of the program, and hence the exact complementary improvements to be considered cannot be defined at the date of publication of the present national progress report.

In case action is needed after the assessment is achieved, the following options will be explored by the licensee:

- proposal for design improvements in the facilities (new modifications, anticipation of already planned modifications…),
- proposal for organizational measures (e.g. emergency management),
- proposal for additional studies.

As a main achievement of the entire stress tests program, the regulatory body will pay special attention to the licensee's action plan (including implementation times) to ensure that it is adapted and sufficient regarding the issues.

5.2. Regulatory body

5.2.1. Development and implementation of a targeted inspection program

In the continuity of the first on-site inspections that were conducted in September 2011 (see § 4.2.5), the regulatory body intends to develop and implement a comprehensive targeted inspection program as part of the assessment of the licensee's final stress tests reports.

The inspection program will focus on selected facts and hypotheses (physical description, technical features, organization…) valued in the final reports that appear to have a critical importance in the licensee's safety demonstrations. The aim is to check in the field the reality, relevance and robustness of the key data used by the licensee in order to build its arguments and draw its conclusions.

The following aspects might be included in the inspection program (non-exhaustive list):

- availability of redundant safety equipment in various scenarios,
- autonomy of batteries, fuel tanks, water tanks in various scenarios,
- availability of emergency equipment on-site and off-site,
- lead times before emergency equipment is actually operational,
- lead times before emergency organization is actually operational.

The regulatory body will carry out inspections in November and/or early December 2011, so as to include its results in the Belgian final stress tests report (due by 31st December 2011) (see § 5.2.2).

Dedicated site inspectors will be implied in the process. Other experts and institutions might also be consulted by the regulatory body in some specialized areas.

5.2.2. Preparation of the national final stress tests report

The national stress tests report will include relevant information from the licensee's stress tests reports, and also give the position of the regulatory body regarding the approach and results of the stress tests.

Its preparation will start as early as the licensee's final reports are officially transmitted to the regulatory body (due by 31 October 2011). The assessment of the licensee's reports, including the inspections planned on that occasion (see § 5.2.1), will be performed in November and December 2011.

The regulatory body will write the national stress tests report in parallel and communicate it to the Belgian Parliament and the European Commission by 31 December 2011.
The national stress tests report will also be accessible to the public and media through the regulatory body's website (http://www.fanc.fgov.be).

As far as possible, the table of content will be consistent with the structure adopted by the licensee in its own stress tests reports (as communicated in its progress report, see § 4.1.5).

However, future adjustments may also be decided in the meantime to allow harmonization, at the request of ENSREG or through the continuous dialog with third-party regulatory bodies, in the perspective of the coming peer reviews.
In all cases, the national stress tests report will be composed of two independent parts:

- **a first part aimed at the European Commission, dealing with the common requirements of the European Commission,**

- **a second part dealing with the complementary requirements of the Belgian stress tests specifications.**

5.2.3. Preparation of the international peer reviews of national stress tests reports

After all the national stress test reports are submitted to the European Commission, an international peer review will be held which will last until 30 April 2012. The reviews will imply all national regulatory bodies in reciprocal evaluation groups aimed at assessing the national stress tests reports at the European scale. The peer review process can include topical review meetings to evaluate specific topics (e.g. severe accident management) in all national reports. Site visits by a peer review team can also be planned as part of the peer review process.

The Belgian regulatory body is already preparing its active contribution to the peer review process.

In practice, a representative has been designated to take part in the ENSREG task force dedicated to the definition of the peer review methodology at the European level.

In parallel, a number of experts from the FANC and Bel V have already been identified to participate in the peer review teams from early January 2012, and all measures will be taken to ensure their full availability along the peer review period.

5.2.4. Follow-up of the licensee’s stress tests action plan

In case the licensee proposes an action plan to reinforce the safety of his facilities, the regulatory body will prepare and implement a dedicated follow-up, including:

- the regular update of the action plan progress by the licensee, and its communication to the regulatory body,

- periodic information meetings between the regulatory body and the licensee,

- on-site inspections by the regulatory body, on a periodic basis and also after the main achievements.

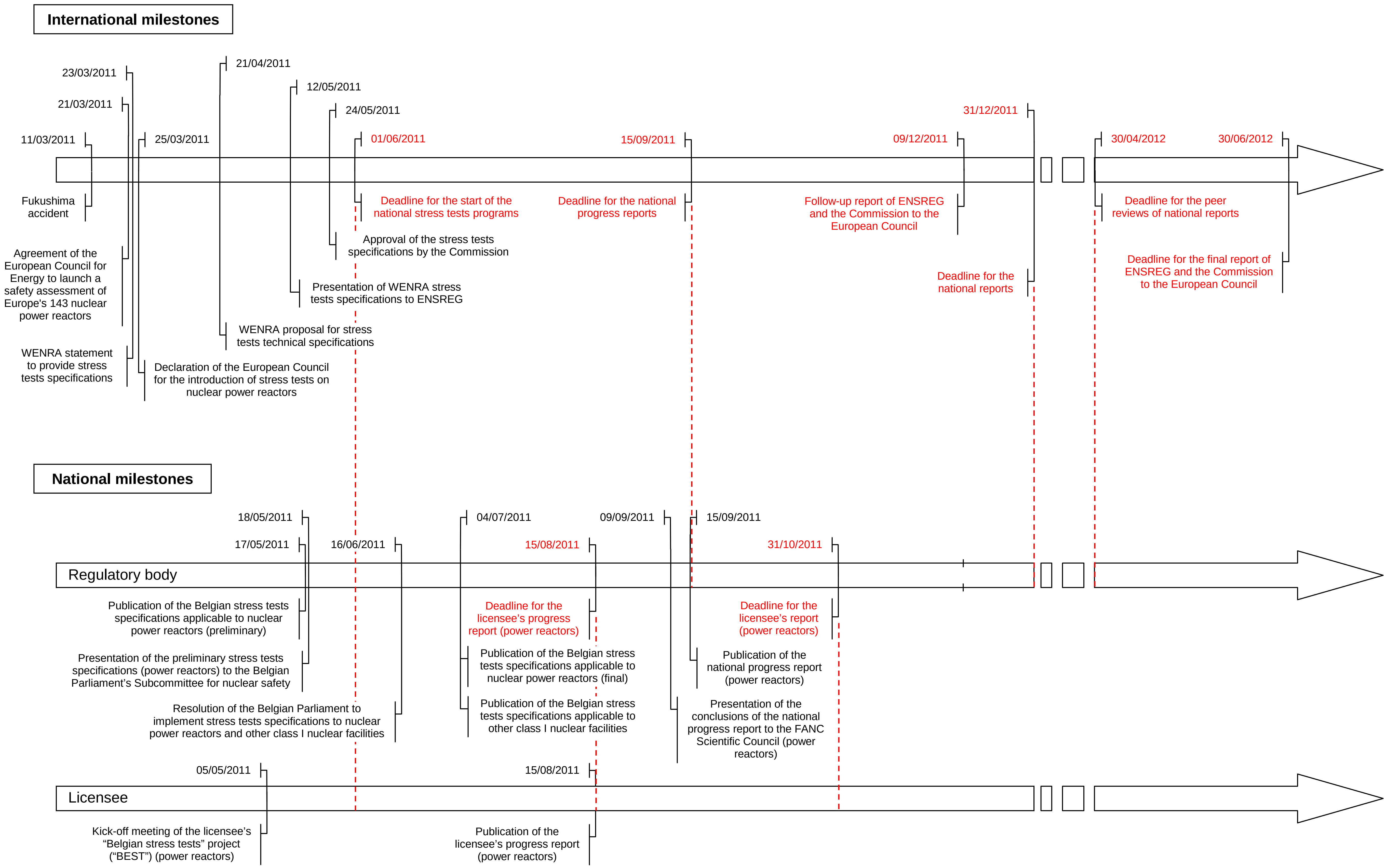
This follow-up will allow the regulatory body to control the proper implementation of the licensee’s action plan, and ensure that the licensee’s commitments are fulfilled in due time.

The dedicated site inspectors from the FANC and Bel V will be involved in this process.

6. Abbreviations

ASN	Autorité de Sûreté Nucléaire (French Nuclear Safety Authority)
BEST	Belgian Stress Tests
DE	Bâtiment de Désactivation (Deactivation building)
EL&I / KFD	Ministerie van Economische Zaken, Landbouw en Innovatie / KernFysische Dienst (Dutch Nuclear Safety Authority)
ENISS	European Nuclear Industry Safety Standards
ENSREG	European Nuclear Safety Regulators Group
FANC	Federal Agency for Nuclear Control
FBFC	Franco-Belge de Fabrication du Combustible (Nuclear fuel fabrication plant)
IAEA	International Atomic Energy Agency
IATA	International Air Transport Association
IRE	Institute for Radioelements
IRMM	Institute for Reference Materials and Measurements
NEA	Nuclear Energy Agency
ROB	Royal Observatory of Belgium
SCG	Splijtstof Container Gebouw (Fuel container building)
SCK-CEN	Studiecentrum voor Kernenergie - Centre d'études de l'Energie Nucléaire (Belgian nuclear research centre)
SOER	Significant Operating Experience Report
WAB	Water en Afvalbehandelingsgebouw
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators' Association

Appendix 1: Timelines of main events



Appendix 2: Licensee's stress tests reports preliminary table of content

A. Answer to ENSREG specifications

NOTE: The following table of content should be considered as *preliminary*, since the detailed definitive ENSREG requirements with regard to the table of contents to be used in the stress tests reports are not yet finalized.

0. Executive summary

The licensee will:

- *Remind briefly the main hypothesis taken into account (e.g. all operational states considered in the plant technical specifications, realistic assessments in case of severe accidents…)*
- *Point out for the different topics (earthquake, flooding, loss of electrical supply and heat sink, Severe Accident Management) the main results about design basis, margin analyses, robustness, adequacy of provisions, management measures and the main proposed improvements.*

1. General data about site/plant

1.1 Brief description of the site characteristic
- *location (sea, river)*
- *number of units*
- *license holder*

1.2 Main characteristics of the units/nuclear installations
- *reactor type*
- *thermal power*
- *date of first criticality*
- *existing spent fuel storage (or shared storage)*

1.3 Significant differences between units

1.4 Scope and main results of Probabilistic Safety Assessments

2. Earthquake

2.1 Design basis

2.1.1 Earthquake against which the plant is designed

2.1.1.1 Characteristics of the design basis earthquake (DBE)

2.1.1.2 Methodology used to evaluate the design basis earthquake

2.1.1.3 Conclusion on the adequacy of the design basis for the earthquake

2.1.2 Provisions to protect the plant against the design basis earthquake

2.1.2.1 Key structures, systems and components (SSC) including main associated design/construction provisions required for achieving safe shutdown state and supposed to remain available after the earthquake

2.1.2.2 Main operating provisions

2.1.2.3 Indirect effects of the earthquake taken into account

2.1.3 Compliance of the plant with its current licensing basis

2.1.3.1 Licensee's general organisation / process to ensure compliance

2.1.3.2 Licensee's organisation for mobile equipment and supplies

2.1.3.3 Potential deviations from licensing basis and remedial actions in progress

2.1.3.4 Specific compliance check already initiated by the licensee

2.2 Evaluation of margins

2.2.1 Range of earthquake leading to severe fuel damage

2.2.1.1 Weak points and cliff edge effects

2.2.1.2 Measures which can be envisaged to increase robustness of the plant

2.2.2 Range of earthquake leading to loss of containment integrity
2.2.3 Earthquake exceeding the design basis earthquake for the plant and consequent flooding exceeding design basis flood
2.2.3.1 Physically possible situations and potential impacts on the safety of the plant
2.2.3.2 Weak points and cliff edge effects
2.2.3.3 Measures which can be envisaged to increase robustness of the plant

3. Flooding

3.1 Design basis
3.1.1 Flooding against which the plant is designed
3.1.1.1 Characteristics of the design basis flood (DBF) flooding
3.1.1.2 Methodology used to evaluate the design basis flood
3.1.1.3 Conclusion on the adequacy of the design basis for flooding
3.1.2 Provisions to protect the plant against the design basis flood
3.1.2.1 Key structures, systems and components (SSC) required for achieving safe shutdown state and supposed to remain available after the flooding
3.1.2.2 Main associated design/construction provisions
3.1.2.3 Main operating provision
3.1.2.4 Other effects of the flooding taken into account
3.1.3 Plant compliance with its current licensing basis
3.1.3.1 Licensee's general organisation to ensure conformity
3.1.3.2 Licensee's organisation for mobile equipment and supplies
3.1.3.3 Potential deviations from licensing basis and remedial actions in progress
3.1.3.4 Specific compliance check already initiated by the licensee

3.2 Evaluation of margins
3.2.1 Additional protective measures which can be envisaged in the context of the design, based on the warning lead time
3.2.2 Weak points and cliff edge effects
3.2.3 Measures which can be envisaged to increase robustness of the installation

4, Extreme natural events

4.1 Very bad weather conditions (storm, heavy rainfalls…)
4.1.1 Events and any combination of events – reasons for a selection (or not) as a design basis event
4.1.2 Weak points and cliff edge effects
4.1.3 Measures which can be envisaged to increase robustness of the plant

5. Loss of electrical power and loss of ultimate heat sink

5.1 For nuclear power reactors
5.1.1 Loss of off-site power
5.1.1.1 Design provisions taking into account this situation, back-up power sources provided, capacity and how to implement them
5.1.1.2 Autonomy of the on-site power sources
5.1.1.3 Provisions taken to prolong the time of on-site power supply
5.1.1.4 Measures which can be envisaged to increase robustness of the plant
5.1.2 Loss of off-site power and of on-site back-up power sources
5.1.2.1 Design provisions
5.1.2.2 Battery capacity and duration
5.1.2.3 Autonomy of the site before fuel degradation
5.1.2.4 (External) actions foreseen to prevent fuel degradation
5.1.2.5 Measures which can be envisaged to increase robustness of the plant
5.1.3 Loss of off-site power and loss of the ordinary back up source, and loss of any other diverse back up source
5.1.3.1 Design provisions
5.1.3.2 Battery capacity and duration

5.1.3.3 Autonomy of the site before fuel degradation
5.1.3.4 (External) actions foreseen to prevent fuel degradation
5.1.3.5 Measures which can be envisaged to increase robustness of the plant

5.1.4 Loss of primary ultimate heat sink (access to water from the river or the sea)
5.1.4.1 Design provisional autonomy of the site before fuel degradation
5.1.4.2 (External) actions foreseen to prevent fuel degradation
5.1.4.3 Measures which can be envisaged to increase robustness of the plant

5.1.5 Loss of the primary ultimate heat sink and "alternate heat sink"
5.1.5.1 Design provisional autonomy of the site before fuel degradation
5.1.5.2 (External) actions foreseen to prevent fuel degradation
5.1.5.3 Measures which can be envisaged to increase robustness of the plant

5.1.6 Loss of the primary ultimate heat sink, combined with station black out
5.1.6.1 Design provisional autonomy of the site before fuel degradation
5.1.6.2 (External) actions foreseen to prevent fuel degradation
5.1.6.3 Measures which can be envisaged to increase robustness of the plant

5.2 For the spent fuel pits of the fuel building

5.2.1 Loss of offsite power
5.2.1.1 Design provisions taking into account this situation, back-up power sources provided, capacity and how to implement them
5.2.1.2 Autonomy of the on-site power sources
5.2.1.3 Provisions taken to prolong the time of on-site power supply
5.2.1.4 Measures which can be envisaged to increase robustness of the plant

5.2.2 Loss of off-site power and loss of the ordinary back-up source
5.2.2.1 Design provisions
5.2.2.2 Battery capacity and duration
5.2.2.3 Autonomy of the site before fuel degradation
5.2.2.4 (External) actions foreseen to prevent fuel degradation
5.2.2.5 Measures which can be envisaged to increase robustness of the plant

5.2.3 Loss of off-site power and loss of the ordinary back-up source, and loss of any other diverse back up source
5.2.3.1 Design provisions
5.2.3.2 Battery capacity and duration
5.2.3.3 Autonomy of the site before fuel degradation
5.2.3.4 (External) actions foreseen to prevent fuel degradation
5.2.3.5 Measures which can be envisaged to increase robustness of the plant

5.2.4 Loss of the primary ultimate heat sink
5.2.4.1 Design provisional autonomy of the site before severe accident
5.2.4.2 (External) actions foreseen to prevent fuel degradation
5.2.4.3 Measures which can be envisaged to increase robustness of the plant

5.2.5 Loss of the primary ultimate heat sink and loss of the alternative ultimate heat sink
5.2.5.1 Design provisional autonomy of the site before severe accident
5.2.5.2 (External) actions foreseen to prevent fuel degradation
5.2.5.3 Measures which can be envisaged to increase robustness of the plant

5.2.6 Loss of the primary ultimate heat sink, combined with station black out
5.2.6.1 Design provisional autonomy of the site before severe accident
5.2.6.2 (External) actions foreseen to prevent fuel degradation
5.2.6.3 Measures which can be envisaged to increase robustness of the plant

5.3 Dependence of one unit on the functions of other units

6. Severe accident management

6.1 Organisation of the licensee to manage the accident and the possible disturbances

6.1.1 Organisation planned
6.1.1.1 Organisation of the licensee to manage the accident
6.1.1.2 Possibility to use existing equipment

6.1.1.3 *Provisions to use mobile devices (availability of such devices, time to bring them on site and put them in operation)*

6.1.1.4 *Provisions for and management of supplies (fuel for diesel generators, water, etc.)*

6.1.1.5 *Management of radioactive releases, provisions to limit them*

6.1.1.6 *Communication and information systems (internal and external)*

6.1.2 *Possible disruption with regard to the measures envisaged to manage accidents and associated management*

6.1.2.1 *Extensive destruction of infrastructure around the installation including the communication facilities*

6.1.2.2 *Impairment of work performance due to high local dose rates, radioactive contamination and destruction of some facilities on site*

6.1.2.3 *Feasibility and effectiveness of accident management measures under the conditions of external hazards (earthquakes, floods)*

6.1.2.4 *Unavailability of power supply*

6.1.2.5 *Potential failure of instrumentation*

6.1.2.6 *Potential effects from the other neighbouring unit(s) at site*

6.2 *For nuclear power reactors*

6.2.1 *Loss of core cooling: Accident management measures currently in place before occurrence of fuel damage in the reactor pressure vessel*

6.2.1.1 *Preventive actions to prevent fuel damage and to eliminate high pressure fuel damage*

6.2.1.2 *Risks of cliff edge effects and deadlines*

6.2.1.3 *Adequacy of the existing management measures and possible additional provisions*

6.2.2 *Loss of cooling: Accident management measures currently in place after occurrence of fuel damage in the reactor pressure vessel*

6.2.2.1 *Mitigative measures*

6.2.2.2 *Risks of cliff edge effects and deadlines*

6.2.2.3 *Adequacy of the existing management measures and possible additional provisions*

6.2.3 *Accident management measures and installation design features for protecting containment integrity after occurrence of fuel damage*

6.2.3.1 *Management of hydrogen risks (inside and outside the containment)*

6.2.3.2 *Prevention of overpressure of the containment*

6.2.3.3 *Prevention of re-criticality*

6.2.3.4 *Prevention of basemat melt through: retention of the corium in the pressure vessel*

6.2.3.5 *Need for and supply of electrical AC and DC power and compressed air to equipment used for protecting containment integrity*

6.2.3.6 *Risks of cliff edge effects and deadlines*

6.2.3.7 *Adequacy of the existing management measures and possible additional provisions*

6.2.4 *Accident management measures currently in place to mitigate the consequences of loss of containment integrity*

6.2.4.1 *Design, operation and organisation provisions*

6.2.4.2 *Risks of cliff edge effects and deadlines*

6.2.4.3 *Adequacy of the existing management measures and possible additional provisions*

6.3 *For the spent fuel storage*

6.3.1 *Measures for managing the consequences of a loss of cooling function for the pool water*

6.3.1.1 *Before and after losing adequate shielding against radiation*

6.3.1.2 *Before and after uncovering of the top of fuel in the fuel pool*

6.3.1.3 Before and after occurrence of fuel degradation in the fuel storage facility
6.3.1.4 Risks of cliff edge effects and deadlines
6.3.1.5 Adequacy of the existing management measures and possible additional provisions
6.3.2 Specific points
6.3.2.1 Adequacy and availability of the instrumentation
6.3.2.2 Availability and habitability of the control room
6.3.2.3 Potential for hydrogen accumulation

B. Answer to FANC specifications

This paragraph covers the (draft) Electrabel Stress Test Report Table of Contents, pertaining to the FANC "Belgian Stress tests specifications – Applicable to power reactors" of May 17, 2011, in particular the attachment with the List of Triggering events, paragraphs D and E, since these are in addition to the ENSREG specifications.

1. Terrorist attacks

1.1 Review of maintenance of vital functions in case of an aircraft crash or a direct hit by an object
1.1.1 Crash scenarios
1.1.2 Provisions to satisfy the defence in depth principle, keeping the plant away from a SBO or the loss of UHS
1.2 Weak points and cliff edge effects
1.3 Main provisions to protect the unit against fuel fire effects

2. Other man-made events

2.1 Site specific impacts caused by toxic and explosive gases and blast waves
2.1.1 Events and combination of events and reasons for the selection (or not) as a design basis
2.1.2 Provisions to prevent the loss of control by the operator of the plant
2.2 Site specific impacts caused by external attacks on computer-based controls and systems
2.2.1 Events and combination of events and reasons for the selection (or not) as a design basis
2.2.2 Provisions to prevent the loss of control by the operator of the plant

Appendix 3: Regulatory body's stress tests specifications (power reactors)

"Belgian Stress tests" specifications
Applicable to power reactors
17 May 2011

Introduction

Considering the accident at the Fukushima nuclear power plant in Japan, the European Council of March 24th and 25th declared that "*the safety of all EU nuclear plants should be reviewed, on the basis of a comprehensive and transparent risk assessment ("stress tests"); the European Nuclear Safety Regulatory Group (ENSREG) and the Commission are invited to develop as soon as possible the scope and modalities of these tests in a coordinated framework in the light of the lessons learned from the accident in Japan and with the full involvement of Member States, making full use of available expertise (notably from the Western European Nuclear Regulators Association); the assessments will be conducted by independent national authorities and through peer review; their outcome and any necessary subsequent measures that will be taken should be shared with the Commission and within the ENSREG and should be made public; the European Council will assess initial findings by the end of 2011, on the basis of a report from the Commission*".

Considering the important work performed by the WENRA members in providing *"an independent regulatory technical definition of a "stress test" and how it should be applied to nuclear facilities across Europe."*

Considering the political view that man-made events, f.i. terrorist attacks should be considered as triggering the loss of important systems to safety as well.

Definition of the "stress tests"

For now we define a "stress test" as a targeted reassessment of the safety margins of nuclear power plants in the light of the events which occurred at Fukushima: extreme (natural) events challenging the plant safety functions and leading to a severe accident.

This reassessment will consist

- in an evaluation of the response of a nuclear power plant when facing a set of extreme situations envisaged under the following section "technical scope" and
- in a verification of the preventive and mitigative measures chosen following a defence-in-depth logic: initiating events, consequential loss of safety functions, severe accident management.

In these extreme situations, sequential loss of the lines of defence is assumed, in a deterministic approach, irrespective of the probability of this loss. In particular, it has to be kept in mind that loss of safety functions and severe accident situations can occur only when several design provisions have failed. In addition, measures to manage these situations will be supposed to be progressively defeated.

For a given plant, the reassessment will report on the response of the plant and on the effectiveness of the preventive measures, noting any potential weak point and cliff-edge effect, for each of the considered extreme situations. A cliff-edge effect could be, for instance, exceeding a point where significant flooding of plant area starts after water overtopping a protection dike or exhaustion of the capacity of the batteries in the event of a station blackout. This is to evaluate the robustness of the defence-in-depth approach, the adequacy of current accident management measures and to identify the potential for safety improvements, both technical and organisational (such as procedures, human resources, emergency response organisation or use of external resources).

By their nature, the stress tests will tend to focus on measures that could be taken after a postulated loss of the safety systems that are installed to provide protection against accidents considered in the design. Adequate performance of those systems has been assessed in connection with plant licensing. Assumptions concerning their performance are re-assessed in the stress tests and they should be shown as provisions in place. It is recognised that all measures taken to protect reactor core or spent fuel integrity or to protect the reactor containment integrity constitute an essential part of the defence-in-depth, as it is always better to prevent accidents from happening than to deal with the consequences of an occurred accident.

Process to perform the "stress tests" and their reviews

The licensees have the prime responsibility for safety. Hence, it is up to the licensees to perform the reassessments, and to the regulatory bodies to independently review them.

The timeframe is as follows:

The national regulator will initiate the process at the latest on July 4 2011 by sending requirements to the licensees.

	Progress report	**Final report**
Licensee report	August 15	October 31
National report	September 15	December 31

- The final national reports will be subjected to the peer review process described below.
- The European Commission, with the support of ENSREG, will present a progress report to the EU Council for the meeting scheduled on 9th December 2011 and a consolidated report to the to the EU Council for the meeting scheduled for June 2012.

Due to the timeframe of the stress test process, some of the engineering studies supporting the licensees' assessment may not be available for scenarios not included in the current design. In such cases engineering judgment is used.

During the regulatory reviews, interactions between European regulators will be necessary and could be managed through ENSREG. Regulatory reviews should be peer reviewed by other regulators. ENSREG will put at the disposal of all peer reviews the expertise necessary to ensure consistency of peer reviews across the EU and its neighbours.

Peer review process

In order to enhance credibility and accountability of the process the EU Council asked that the national reports should be subjected to a peer review process. The main purpose of the national reports will be to draw conclusions from the licensees' assessment using the agreed methodology. The peer teams will review the fourteen national reports of Member States that presently operate nuclear power plants and of those neighbouring countries that accept to be part of the process.

- **Team composition.** ENSREG and the Commission shall agree on team composition. The team should be kept to a working size of seven people, one of whom should act as a chairperson and a second one as rapporteur. Two members of each team will be permanent members with the task to ensure overall consistency. The Commission will be part of the team. Members of the team whose national facilities are under review will not be part of that specific review. The country subject to review has to agree on the team composition. The team may be extended to experts from third countries.
- **Methodology.** In order to guarantee the rigor and the objectivity of any peer review, the national regulator under review should give the peer review team access to all necessary information, subject to the required security clearance procedures, staff and facilities to enable the team, within the limited time available.
- **Timing.** Reviews should start immediately when final national reports become available. The peer reviews shall be completed by the end of April 2012.

Transparency

National regulatory authorities shall be guided by the "principles for openness and transparency" as adopted by ENSREG in February 2011. These principles shall also apply to the EU "stress tests".

The reports should be made available to the public in accordance with national legislation and international obligations, provided that this does not jeopardize other interests such as, inter alia, security, recognized in national legislation or international obligations.

The peer will review the conclusions of each national report and its compliance with the methodology agreed. Results of peer reviews will be made public.

Results of the reviews should be discussed both in national and European public seminars, to which other stakeholders (from non nuclear field, from non governmental organizations, etc) would be invited.

Full transparency but also an opportunity for public involvement will contribute to the EU "stress tests" being acknowledged by European citizens.

Technical scope of the "stress tests"

The existing safety analysis for nuclear power plants in European countries covers a large variety of situations. The technical scope of the stress tests has been defined considering the issues that have been highlighted by the events that occurred at Fukushima, including combination of initiating events and failures, and further enlarged to take into account other events. The following situations will be addressed, corresponding to steps of more and more severe situations:

Initiating events conceivable at the plant site

- Earthquake
- Flooding
- Other extreme natural events
- Terrorist attacks
- Other man made events

Those initiating events conceivable at the plan are further detailed in an appendix to this document.

Loss of safety functions

- Loss of electrical power, including station black out (SBO)
- Loss of the ultimate heat sink (UHS)
- Combination of both

Severe accident management issues

- Means to protect from and to manage loss of core cooling function
- Means to protect from and to manage loss of cooling function in the spent fuel storage pool
- Means to protect from and to manage loss of containment integrity

The review of the severe accident management issues focuses on the licensee's provisions but it may also comprise relevant planned off-site support for maintaining the safety functions of the plant. The experience feedback from the Fukushima accident may include the emergency preparedness measures managed by the relevant off-site services for public protection (fire-fighters, police, health services….) as defined and implemented following the Fukushima event before the end of the first quarter of 2012.

The next sections of this document set out:

- general information required from the licensees;
- issues to be considered by the licensees for each considered extreme situation.

It remains a national responsibility to take any appropriate measures resulting from the reassessments.

General aspects

Format of the report

The licensee shall provide one document for each site, even if there are several units on the same site. Sites where all NPPs are definitively shutdown but where spent fuel storages are still in operation shall also be considered.

In a first part, the site characteristics shall be briefly described:

- location (sea, river);
- number of units;
- license holder

The main characteristics of each unit shall be reflected, in particular:

- reactor type;
- thermal power;
- date of first criticality;
- presence of spent fuel storage (or shared storage).

Safety significant differences between units shall be highlighted.

The scope and main results of Probabilistic Safety Assessments shall be provided.

In a second part, each extreme situation shall be assessed following the indications given below.

Hypothesis

For existing plants, the reassessments shall refer to the plant as it is currently built and operated on June 30, 2011. For plants under construction, the reassessments shall refer to the licensed design.

The approach should be essentially deterministic: when analysing an extreme scenario, a progressive approach shall be followed, in which protective measures are sequentially assumed to be defeated.

The plant conditions should represent the most unfavourable operational states that are permitted under plant technical specifications (limited conditions for operations). All operational states should be considered. For severe accident scenarios, consideration of non-classified equipment as well as realistic assessment is possible.

All reactors and spent fuel storages shall be supposed to be affected at the same time when it can be reasonably assumed that the initiating event or the subsequent accident could give cause to common mode failures at the other units at the same site.

Possibility of degraded conditions of the site surrounding area shall be taken into account.

Consideration should be given to:

- automatic actions;
- operators actions specified in emergency operating procedures;
- any other planned measures of prevention, recovery and mitigation of accidents;

Information to be included

Three main aspects need to be reported:

- Provisions taken in the design basis of the plant and plant conformance to its design requirements;
- Robustness of the plant beyond its design basis. For this purpose, the robustness (available design margins, diversity, redundancy, structural protection, physical separation, etc) of the safety-relevant systems, structures and components and the effectiveness of the defence-in-depth concept have to be assessed. Regarding the robustness of the installations and measures, one focus of the review is on identification of a step change in the event sequence (cliff edge effect[3]) and, if necessary, consideration of measures for its avoidance.
- any potential for modifications likely to improve the considered level of defence-in-depth, in terms of improving the resistance of components or of strengthening the independence with other levels of defence.

In addition, the licensee may wish to describe protective measures aimed at avoiding the extreme scenarios that are envisaged in the stress tests in order to provide context for the stress tests. The analysis should be complemented, where necessary, by results of dedicated plant walk down.

To this aim, the licensee shall identify:

- the means to maintain the three fundamental safety functions (control of reactivity, fuel cooling, confinement of radioactivity) and support functions (power supply, cooling through ultimate heat sink), taking into account the probable damage done by the initiating event and any means not credited in the safety demonstration for plant licensing;
- possibility of mobile external means and the conditions of their use;
- any existing procedure to use means from one reactor to help another reactor;
- dependence of one reactor on the functions of other reactors on the same site.

As for severe accident management, the licensee shall identify, where relevant:

- the time before damage to the fuel becomes unavoidable. For PWR and BWR, if the core is in the reactor vessel, indicate time before water level reaches the top of the core, and time before fuel degradation (fast cladding oxidation with hydrogen production);

[3] Example: exhaustion of the capacity of the batteries in the event of a station blackout

– if the fuel is in the spent fuel pool, the time before pool boiling, time up to when adequate shielding against radiation is maintained, time before water level reaches the top of the fuel elements, time before fuel degradation starts;

Supporting documentation

Documents referenced by the licensee shall be characterised either as:
– validated in the licensing process;
– not validated in the licensing process but gone through licensee's quality assurance program;
– not one of the above.

Specific Aspects

Loss of electrical power and loss of the ultimate heat sink

Electrical AC power sources are:
- off-site power sources (electrical grid);
- plant generator;
- ordinary back-up generators (diesel generator, gas turbine…);
- in some cases other diverse back-up sources.

Sequential loss of these sources has to be considered (see a) and b) below).

The ultimate heat sink (UHS) is a medium to which the residual heat from the reactor is transferred. In some cases, the plant has the primary UHS, such as the sea or a river, which is supplemented by an alternate UHS, for example a lake, a water table or the atmosphere. Sequential loss of these sinks has to be considered (see c) below).

a) Loss of off-site power (LOOP[4])
- Describe how this situation is taken into account in the design and describe which internal backup power sources are designed to cope with this situation.
- Indicate for how long the on-site power sources can operate without any external support.
- Specify which provisions are needed to prolong the time of on-site power supply (refuelling of diesel generators…).
- Indicate any envisaged provisions to increase robustness of the plant (modifications of hardware, modification of procedures, organisational provisions…).

For clarity, systems such as steam driven pumps, systems with stored energy in gas tanks etc. are considered to function as long as they are not dependent of the electric power sources assumed to be lost and if they are designed to withstand the initiating event (e.g. earthquake)

b) Loss of off-site power and of on-site backup power sources (SBO)
Two situations have to be considered:
- LOOP + Loss of the ordinary back-up source;
- LOOP + Loss of the ordinary back-up sources + loss of any other diverse back-up sources.

For each of these situations:
- Provide information on the battery capacity and duration.
- Provide information on design provisions for these situations.
- Indicate for how long the site can withstand a SBO without any external support before severe damage to the fuel becomes unavoidable.
- Specify which (external) actions are foreseen to prevent fuel degradation:
  - equipment already present on site, e.g. equipment from another reactor;
  - assuming that all reactors on the same site are equally damaged, equipment available off-site;
  - near-by power stations (e.g. hydropower, gas turbine) that can be aligned to provide power via a dedicated direct connection;
  - time necessary to have each of the above systems operating;

[4] All offsite electric power supply to the site is lost. The offsite power should be assumed to be lost for several days. The site is isolated from delivery of heavy material for 72 hours by road, rail or waterways. Portable light equipment can arrive to the site from other locations after the first 24 hours.

- availability of competent human resources to make the exceptional connections;
- identification of cliff edge effects and when they occur.

- Indicate if any provisions can be envisaged to prevent these cliff edge effects or to increase robustness of the plant (modifications of hardware, modification of procedures, organisational provisions…).

c) Loss of primary ultimate heat sink (UHS[5])

- Provide a description of design provisions to prevent the loss of the UHS (e.g. various water intakes for primary UHS at different locations, use of alternative UHS, ...)"

Two situations have to be considered:

- Loss of primary ultimate heat sink (UHS), i.e. access to water from the river or the sea;
- Loss of primary ultimate heat sink (UHS) and the alternate UHS.

For each of these situations:

- Indicate for how long the site can withstand the situation without any external support before damage to the fuel becomes unavoidable.
- Provide information on design provisions for these situations.
- Specify which external actions are foreseen to prevent fuel degradation:
  - equipment already present on site, e.g. equipment from another reactor;
  - assuming that all reactors on the same site are equally damaged, equipment available off-site;
  - time necessary to have these systems operating;
  - availability of competent human resources;
  - identification of cliff edge effects and when they occur.
- Indicate if any provisions can be envisaged to prevent these cliff edge effects or to increase robustness of the plant (modifications of hardware, modification of procedures, organisational provisions…).

d) Loss of the primary UHS with SBO

- Indicate for how long the site can withstand a loss of "main" UHS + SBO without any external support before severe damage to the fuel becomes unavoidable
- Specify which external actions are foreseen to prevent fuel degradation:
  - equipment already present on site, e.g. equipment from another reactor;
  - assuming that all reactors on the same site are equally damaged, equipment available off site;
  - availability of human resources;
  - time necessary to have these systems operating;
  - identification of when the main cliff edge effects occur.
- Indicate if any provisions can be envisaged to prevent these cliff edge effects or to increase robustness of the plant (modifications of hardware, modification of procedures, organisational provisions…)

Severe accident management

This chapter deals mostly with mitigation issues. Even if the probability of the event is very low, the means to protect containment from loads that could threaten its integrity should be assessed. Severe accident management, as forming the last line of defense-in-depth for the operator, should be consistent with the measures used for preventing the core damage and with the overall safety approach of the plant.

a) Describe the accident management measures currently in place at the various stages of a scenario of loss of the core cooling function:
   - before occurrence of fuel damage in the reactor pressure vessel/a number of pressure tubes;
     - last resorts to prevent fuel damage
     - elimination of possibility for fuel damage in high pressure
   - after occurrence of fuel damage in the reactor pressure vessel/a number of pressure tubes;
   - after failure of the reactor pressure vessel/a number of pressure tubes.

b) Describe the accident management measures and plant design features for protecting containment integrity after occurrence of fuel damage
   - prevention of H_2 deflagration or H_2 detonation (inerting, recombiners, or igniters), also taking into account venting processes;

[5] The connection with the primary ultimate heat sink for all safety and non safety functions is lost. The site is isolated from delivery of heavy material for 72 hours by road, rail or waterways. Portable light equipment can arrive to the site from other locations after the first 24 hours.

- prevention of over-pressurization of the containment; if for the protection of the containment a release to the environment is needed, it should be assessed, whether this release needs to be filtered. In this case, availability of the means for estimation of the amount of radioactive material released into the environment should also be described;
- prevention of re-criticality;
- prevention of basemat melt through;
- need for and supply of electrical AC and DC power to equipment used for protecting containment integrity.

c) Describe the accident management measures currently in place to mitigate the consequences of loss of containment integrity.

d) Describe the accident management measures currently in place at the various stages of a scenario of loss of cooling function in the fuel storage (the following indications relate to a fuel pool):
  - before/after losing adequate shielding against radiation;
  - before/after occurrence of uncover of the top of fuel in the fuel pool;
  - before/after beginning of fuel degradation (fast cladding oxidation with hydrogen production)in the fuel pool.

For a), b), c) and d) at each stage:
- identify any cliff edge effect and evaluate the time before it;
- assess the adequacy of the existing management measures, including the procedural guidance to cope with a severe accident, and evaluate the potential for additional measures. In particular, the licensee is asked to consider:
  - o the suitability and availability of the required instrumentation;
  - o the habitability and accessibility of the vital areas ot the plant (the control room, emergency response facilities, local control and sampling points, repair possibilities)
  - o potential H_2 accumulations in other buildings than containment.

The following aspects have to be addressed:
- Organisation of the licensee to manage the situation, including:
  - o staffing, resources and shift management;
  - o use of off-site technical support for accident management (and contingencies if this becomes unavailable);
  - o procedures, training and exercises;
- Possibility to use existing equipment;
- Provisions to use mobile devices (availability of such devices, time to bring them on site and put them in operation, accessibility to site);
- Provisions for and management of supplies (fuel for diesel generators, water…);
- Management of radioactive releases, provisions to limit them;
- Management of workers' doses, provisions to limit them;
- Communication and information systems (internal, external);
- Long-term post-accident activities.

The envisaged accident management measures shall be evaluated considering what the situation could be on a site:
- Extensive destruction of infrastructure around the plant including the communication facilities (making technical and personnel support from outside more difficult);
- Impairment of work performance (including impact on the accessibility and habitability of the main and secondary control rooms) due to high local dose rates, radioactive contamination and destruction of some facilities on site;
- Feasibility and effectiveness of accident management measures under the conditions of external hazards (earthquakes, floods);
- Unavailability of power supply;
- Potential failure of instrumentation;
- Potential effects from the other neighbouring plants at site.

The licensee shall identify which conditions would prevent staff from working in the main or secondary control room as well as in the plant emergency/crisis centre, and what measures could avoid such conditions to occur.

Attachment to Belgian Stress test specifications
List of triggering events
17 May 2011

A. Earthquake

I. Design basis

- Earthquake against which the plant is designed :
  - o Level of the design basis earthquake (DBE) expressed in terms of peak ground acceleration (PGA) and reasons for the choice. Also indicate the DBE taken into account in the original licensing basis if different;
  - o Methodology to evaluate the DBE (return period, past events considered and reasons for choice, margins added…), validity of data in time;
  - o Conclusion on the adequacy of the design basis.

- Provisions to protect the plant against the DBE:
  - o Identification of the key structures, systems and components (SSCs) which are needed for achieving safe shutdown state and are supposed to remain available after the earthquake;
  - o Main operating provisions (including emergency operating procedure, mobile equipment…) to prevent reactor core or spent fuel damage after the earthquake;
  - o Were indirect effects of the earthquake taken into account, including:
    - Failure of SSCs that are not designed to withstand the DBE and that, in loosing their integrity, could cause a consequential damage of SSCs that need to remain available (e.g. leaks or ruptures of non seismic pipework on the site or in the buildings as sources of flooding and their potential consequences);
    - Loss of external power supply;
    - Situation outside the plant, including preventing or delaying access of personnel and equipment to the site.

- Plant compliance with its current licensing basis:
  - o Licensee's general process to ensure compliance (e.g., periodic maintenance, inspections, testing);
  - o Licensee' process to ensure that off-site mobile equipment/supplies considered in emergency procedures are available and remain fit for duty;
  - o Any known deviation, and consequences of these deviations in terms of safety; planning of remediation actions;
  - o Specific compliance check already initiated by the licensee following Fukushima NPP accident.

II. Evaluation of the margins

- Based on available information (which could include seismic PSA, seismic margin assessment or other seismic engineering studies to support engineering judgement), give an evaluation of the range of earthquake severity above which loss of fundamental safety functions or severe damage to the fuel (in vessel or in fuel storage) becomes unavoidable.
  - o Indicate which are the weak points and specify any cliff edge effects according to earthquake severity.
  - o Indicate if any provisions can be envisaged to prevent these cliff edge effects or to increase robustness of the plant (modifications of hardware, modification of procedures, organisational provisions…).

- Based on available information (which could include seismic PSA, seismic margin assessment or other seismic engineering studies to support engineering judgement), what is the range of earthquake severity the plant can withstand without losing confinement integrity.

- Earthquake exceeding DBE and consequent flooding exceeding DBF
  - o Indicate whether, taking into account plant location and plant design, such situation can be physically possible. To this aim, identify in particular if severe damages to structures that are outside or inside the plant (such as dams, dikes, plant buildings and structure) could have an impact on plant safety.
  - o Indicate which are the weak points and failure modes leading to unsafe plant conditions and specify any cliff edge effects. Identify which buildings and equipment will be impacted.
  - o Indicate if any provisions can be envisaged to prevent these cliff edge effects or to increase robustness of the plant (modifications of hardware, modification of procedures, organisational provisions…)

B. Flooding

I. Design basis

- Flooding against which the plant is designed :
  - Level of the design basis flood (DBF) and reasons for choice. Also indicate the DBF taken into account in the original licensing basis if different;
  - Methodology to evaluate the DBF (return period, past events considered and reasons for choice, margins added…). Sources of flooding (tsunami, tidal, storm surge, breaking of dam…), validity of data in time;
  - Conclusion on the adequacy of the design basis.

- Provisions to protect the plant against the DBF
  - Identification of the key SSCs which are needed for achieving safe shutdown state and are supposed to remain available after the flooding, including:
    - Provisions to maintain the water intake function;
    - Provisions to maintain emergency electrical power supply;
  - Identification of the main design provisions to protect the site against flooding (platform level, dike…) and the associated surveillance programme if any;
  - Main operating provisions (including emergency operating procedure, mobile equipment…) to warn of, then to mitigate the effects of the flooding; and the associated surveillance programme if any;
  - Were other effects linked to the flooding itself or to the phenomena that originated the flooding (such as very bad weather conditions) taken into account, including:
    - Loss of external power supply;
    - Situation outside the plant, including preventing or delaying access of personnel and equipment to the site.

- Plant compliance with its current licensing basis:
  - Licensee's general process to ensure compliance (e.g., periodic maintenance, inspections, testing);
  - Licensee's process to ensure that off-site mobile equipment/supplies considered in emergency procedures are available and remain fit for duty;
  - Any known deviation and consequences of these deviations in terms of safety; planning of remediation actions;
  - Specific compliance check already initiated by the licensee following Fukushima NPP accident.

II. Evaluation of the margins

- Based on available information (including engineering studies to support engineering judgement), what is the level of flooding that the plant can withstand without severe damage to the fuel (core or fuel storage)?
  - Depending on the time between warning and flooding, indicate whether additional protective measures can be envisaged/implemented.
  - Indicate which are the weak points and specify any cliff edge effects. Identify which buildings and which equipment will be flooded first.
  - Indicate if any provisions can be envisaged to prevent these cliff edge effects or to increase robustness of the plant (modifications of hardware, modification of procedures, organisational provisions…).

C. Other extreme natural events

Very bad weather conditions (storm, heavy rainfalls…)

- Events and combination of events considered and reasons for the selection (or not) as a design basis.
- Indicate which are the weak points and failure modes leading to unsafe plant conditions and specify any cliff edge effects. Identify which buildings and equipment will be impacted.
- Indicate if any provisions can be envisaged to prevent these cliff edge effects or to increase robustness of the plant (modifications of hardware, modification of procedures, organisational provisions…).

D. Terrorist Attacks

- Review of maintenance of vital functions in case of an aircraft crash or a direct hit by an object
  i. Crash scenarios (aircraft type, speed; worst case location of impact zone, etc…)
  ii. Indicate if any existing provisions, layout, etc.., are available to satisfy the defence in depth principle, keeping the plant away from a SBO or the loss of UHS
- Indicate which are the weak points and failure modes leading to unsafe plant conditions and specify any cliff edge effects. Identify which buildings and equipment will be impacted.

- Identification of the main provisions to protect the unit against fuel fire effects.

E. <u>Other man-made events</u>

- Site specific impacts caused by toxic and explosive gases and blast wave
  i. Events and combination of events and reasons for the selection (or not) as a design basis
  ii. Indicate if provisions exist or can be envisaged to prevent the loss of control by the operator of the plant.
- Site specific impacts caused by external attacks on computer-based controls and systems
  i. Events and combination of events and reasons for the selection (or not) as a design basis
  ii. Indicate if provisions exist or can be envisaged to prevent the loss of control by the operator of the plant.