Convention on Nuclear Safety
7th Review Meeting – 2017

International Atomic Energy Agency IAEA, Vienna

Country Review Report for

SWEDEN

Drafted by Country Group 2

(Armenia, Bahrain, EURATOM, France, Kuwait, Montenegro, Niger, Portugal, Slovakia, Slovenia, Sweden, Tunisia)

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Version: **FINAL**

DISCLAIMER: Per INFCIRC 571, Revision 7, Para. 16-19 and Annex IV, Contracting Parties were invited to comment on the implementation of the CNS reporting guidance. Contracting Parties were also encouraged to submit proposed Good Practices, Challenges, and Suggestions prior to the Review Meeting. The draft Country Review Report documents the preliminary observations identified by the Contracting Parties. The Country Review Report is the result of the CNS Review Process and was agreed by consensus by the Country Group.

Glossary

The Glossary provides here the definitions of "Challenges", "Suggestion" and "Good Practice" according to Annex IV of INFCIRC/571/Rev. 7. The definition of "Area of Good Performance" was agreed upon by the Officers of the 7th CNS Review Meeting at the CNS Officers' Meeting on 3-4 October 2016.

A **Challenge** is "a difficult issue for the Contracting Party and may be a demanding undertaking (beyond the day-to-day activities); or a weakness that needs to be remediated."

A **Suggestion** is "an area for improvement. It is an action needed to improve the implementation of the obligations of the CNS."

A **Good Practice** is "a new or revised practice, policy or programme that makes a significant contribution to nuclear safety. A Good Practice is one that has been tried and proven by at least one Contracting Party but has not been widely implemented by other Contracting Parties; and is applicable to other Contracting Parties with similar programmes."

An **Area of Good Performance** is "a practice, policy or programme that is worthwhile to commend and has been undertaken and implemented effectively. An Area of Good Performance is a significant accomplishment for the particular CP although it may have been implemented by other CPs."

Executive Summary

Sweden has 10 Reactors in operation (7 boiling water reactors (BWR) and 3 pressurized water reactors (PWR)). Three (3) are in a permanent shutdown state (one pressurized heavy-water reactor and two BWRs). In 2015, plant owners decided to phase out the four oldest reactors (2 at Ringhals NPP and 2 at Oskarshamn NPP) over the period 2017 to 2020 based on business and energy market considerations. In 2012, Vattenfall AB submitted a request to replace one or two existing reactors with new ones, but, in late 2014, Vattenfall put the work on hold.

All actions from the EU Stress Test National Action Plan (NAcP) were reported as completed in the review period. Several of the actions required further evaluations and some of the decided measures still remain to be implemented. All measures resulting from the NAcP are expected to be implemented, by end of 2020.

A major review of existing SSM regulations was initiated in 2013 at the request of the Swedish government to enable building of new nuclear reactors and to address a recommendation from the 2012 IRRS mission. In 2015 the assignment was given the additional aim of developing up to date regulations also for existing reactors. The update is performed in parallel with the transposition of the Amended EU Nuclear Safety Directive (EURATOM/2014/87) and the EU Basic Safety Standard (EURATOM/2013/57) and will also implement the updated WENRA safety reference levels.

New regulations were issued in 2015 in the area of emergency response, which feature increasing the robustness of emergency response organizations and introduction of off-site emergency logistical centres. A National contingency plan for dealing with nuclear emergencies was compiled in 2014/2015.

The Nuclear Power Phase Out Act was abolished in 1997 and since 2010 the national framework allows for new reactors to be built on existing sites to replace reactors being decommissioned.

A National Government review of energy strategy is underway – the starting point being a focus on replacement of nuclear energy with renewables and energy efficiency but in a manner sustainable in the long term.

Power uprates are ongoing with three reactors in trial operation at increased power levels.

7 out of 8 Challenges and 1 out of 1 Suggestions from the 6th Review Meeting have been closed

The Country Group highlights the following measures to improve safety in Sweden's national nuclear programme:

- The modernization programs (reference regulation SSFMS 2008:17) were completed in all NPPs in 2016.
- In 2014, SSM requested that all Swedish power plants operating after 2020 have a fully independent emergency core cooling system in place before 2021 and interim measures in place by 2017.
- Sweden continued to progress reviews of the robustness of electrical power supplies based on experiences from both national and international programs.

The Country Group highlights the following results of international peer review missions of Sweden:

- Sweden hosted an IRRS mission in 2012 and a follow-up mission in April 2016. Results from the follow-up mission indicated:
    - 20 of 22 recommendations were closed
    - 2 remained open
    - All 17 Suggestions were closed
    - 4 additional Suggestions and 2 additional Good Practices were generated in the follow-up mission

The Country Group identified the following Challenges for Sweden:

- **Challenge SE-2014-05**: Ensuring safe long-term operation of Swedish NPPs requires additional safety improvements and licensee applying an effective ageing management (remained open)
- **Challenge SE-2017-01:** Implementing an approach, consistent with the government assignment, to sustain and develop capability in both the regulatory body and licensee (including sustaining support such as R&D and suppliers) given the plan to shut down some NPPs and the need to develop additional capability in technical and radiological aspects of the decommissioning area
- **Challenge SE-2017-02:** Maintaining and overseeing safety culture during the transition from operation to decommissioning
- **Challenge SE-2017-03:** Completion of the remaining work to update the set of regulations, including consideration of the requirements from EU Directives and WENRA reference levels

In addition the country group identified 0 Suggestions, 4 Areas of Good Performance, and 0 Good Practices.

The Country Group concluded that Sweden:

- Submitted a National Report on 11 August 2016, and therefore complies with Article 5 and in time following Rule 39 of INFCIRC/573
- Attended the 7th CNS Review Meeting, and therefore complies with Article 24.1
- Held a national presentation and answered questions, and therefore complies with Article 20.3

1. Basic Information on Sweden's Nuclear Programme

Sweden has 10 reactors in operation (7 BWR and 3 PWR) and has 3 in a permanent shutdown state (one PHWR and 2 BWR). In 2015, plant owners decided to phase out the four oldest reactors (2 at Ringhals NPP and 2 at Oskarshamn NPP) over the period 2017 to 2020 based on business and energy market considerations. A request had been submitted earlier (2012) by Vattenfall AB to replace old reactors with new ones but in late 2014, Vattenfall put this work on hold. Associated activities at the authority have also been suspended.

2. Follow-Up from Previous CNS Review Meeting

2.1 Challenges

Sweden provided the following updates on Challenges identified during the 6th CNS Review Meeting:

Challenge SE-2014-01: To manage the Vattenfall AB application for replacing 1 or 2 old reactors by new ones

Status: **Closed**

Basis: In late 2014 the project to replace 1 or 2 old reactors with new ones was put on hold. There are currently no plans to restart this project

Challenge SE-2014-02: The review of SSM's regulatory framework, i.e. regulations and general advice, for nuclear and radiation safety

Status: **Closed** (see Challenge SE-2017-03)

Basis: Sweden reported that a major review of the regulatory framework and all of the regulations was initiated in 2013 and is in progress. This involves a large effort (15 to 20 person-years per year) for several years.

Challenge SE-2014-03: The implementation of the Swedish National Action Plan aiming on improving robustness and safety, including an update of dimensioning values related to external hazards and additional independent core cooling system

Status: **Closed**

Basis:

- Interim measures have been put in place at operating NPPs
- In 2016, licensees submitted site specific action plans to SSM for safety enhancement measures identified by the analyses and evaluations from the National Action Plan (from the stress tests)
- Measures focus on:
  - Strengthening plant protection against extreme external hazards
  - Improving emergency preparedness and response
- The required completion date for these additional measures has been set as 2020.

Challenge SE-2014-04: Licensees are finalizing the update of safety analysis reports in order to comply with new safety requirements

Status: **Closed** (based on progress and clear plan)

Basis:

- Work ongoing to address changes needed as a consequence of power uprates and performed modifications.
- There will be a need for further revisions given planned modifications at the plants and coming updates of the regulations.

Challenge SE-2014-05: Ensuring safe long-term operation of Swedish NPPs requires additional safety improvements and licensee applying an effective ageing management

Status: **Open**

Basis:

- Requirements for having aging management programs in place for long term operation have been expressed more explicitly in new regulations
- IAEA pre-SALTO missions have been completed at Ringhals and Forsmark NPPs and one is planned for the Oskarshamn NPP.
- In 2014, SSM requested that all Swedish power plants operating after 2020 have a fully independent Emergency Core Cooling system in place before 2021.
    - Interim measures have been put in place at operating NPPs
- Sweden plans to participate in the EU topical peer review in 2017/ 2018. A clear set of requirements is in place for this work. However, the task is still considered a challenge and important progress is needed during the coming years.

Challenge SE-2014-06: 9 of the overall 10 reactors will be subject of long-term operation evaluation in the upcoming PSRs

Status: **Closed**

Basis: Regulations have been revised to provide additional clarity for PSR work. Focus on aging management will be a key focus for upcoming PSRs for the six reactors planned to remain in operation after 2020.

Challenge SE-2014-07: The ambitious and concentrated in time Swedish programmes for modernization, safety upgrading and power uprating of operating power reactor units impose additional challenges on safety management, since the operating organizations may become overloaded and lose focus on operational safety

Status: **Closed**

Basis:

- Given the change in plan regarding new plant construction, one of the sizeable work programs has lessened
- Power uprate work is at the point where work is in the final stages for 3 reactors – a trial operation at elevated power is in progress
- The extensive modernization programs introduced in 2005 (reference regulation SSMFS 2008:17) was completed in 2016

Challenge 2014-8: The CP should inform on results of special supervision of Oskarshamn NPP

Status: **Closed**

Basis: The oral presentation included an overview of the results of the special supervision. Specifically:

- Oskarshamn NPP was placed under special supervision by SSM in December 2012
- The oversight activities showed that Oskarshamn NPP continued to strengthen and develop its organization since 2014.
- In June 2016 SSM concluded that there was no longer a need to continue the special supervision at Oskarshamn

2.2 Suggestions

Suggestion SE-2014- 01: Ensure that the RB gets a legal basis for performing vendor inspections

Status: **Closed** (based on progress)

Basis:

- The suggestion was reported to the Government
- SSM has proposed an amendment to the Nuclear Activities Act that would allow SSM to conduct oversight of licensees' quality assurance activities at vendor and supplier sites
- The Government bill was presented to Parliament on 16 March 2017

3. Measures to improve safety

3.1 Changes to the regulatory framework and the national nuclear programme

Since the last Review Meeting, the Country Group took note of the following changes to the regulatory framework and the national nuclear programme:

- SSM issued new regulation concerning nuclear emergency preparedness at nuclear facilities (SSFMS 2014:2 replacing SSFMS 2008:15)
- Two EU Directives are being transposed into national regulation
  - Amended Nuclear Safety Directive 2014/87/EURATOM
  - Basic Safety Standards for Radiation (2013/59/EURATOM)
- A major review of the regulatory framework and regulations has been underway since 2013
  - Effort involved is 15 to 20 person-years each year
  - Main NPP regulations are being prepared for final consultation
- A National Contingency Plan for nuclear accidents was compiled over 2014/2015

3.2 Safety improvements for existing nuclear power plants

The Country Group took note of the following implemented and planned safety measures for existing nuclear power plants in Sweden:

- The modernization programs (reference regulation SSFMS 2008:17) were completed in all NPPs in 2016.
- In 2014, SSM requested that all Swedish power plants operating after 2020 have a fully independent emergency core cooling system in place before 2021 and interim measures in place by 2017.
- Sweden continued to progress reviews of the robustness of electrical power supplies based on experiences from both national and international programs.
- SAMG or equivalent is in place at all NPPs
- Main control rooms and emergency command centers are equipped with filtered air intakes and can be placed in recirculation mode
- Flexible emergency mitigation equipment is in place at all NPP sites
- Transmission of crucial NPP status information to SSM in connection with an emergency
- New radiological monitoring station are providing information on dose rates at 90 positions around Swedish NPPs (completed in autumn 2016)

3.3 Response to international peer review missions

The Country Group took note of the following implemented or planned measures in response to the results of international peer review missions:

Sweden hosted an IRRS mission in 2012 and a follow-up mission in April 2016. Results from the follow-up mission indicated:

- 20 of 22 recommendations were closed
- 2 remained open
- All 17 Suggestions were closed
- 4 additional Suggestions and 2 additional Good Practices were generated in the follow-up mission

4. Implementation of the Vienna Declaration on Nuclear Safety (VDNS)

On 9 February 2015, the Contracting Parties adopted INFCIRC 872, "Vienna Declaration on Nuclear Safety," which is a commitment to certain principles to guide them in the implementation of the CNS' objective to prevent accidents and mitigate their radiological consequences, should they occur. The Contracting Parties agreed to discuss the principles of the Vienna Declaration on Nuclear Safety in their National Reports and in the subsequent Review Meetings.

4.1 Implementation of the VDNS's principle on new nuclear power plants

The first principle of the VDNS is:

> New nuclear power plants are to be designed, sited, and constructed, consistent with the objective of preventing accidents in the commissioning and operation and, should an accident occur, mitigating possible releases of radionuclides causing long-term off site contamination and avoiding early radioactive releases or radioactive releases large enough to require long-term protective measures and actions.

Sweden has no new plant in the sense of the VDNS, and no new plants are being considered in Sweden at this time. Any new plant built would need to be in compliance with the VDNS according to legislation and regulations being introduced to take account of the amended EU Nuclear Safety Directive (EURATOM/2014/87). Sweden reports that its national requirements and regulation incorporate appropriate aspects and that modernization of requirements is still in progress.

- In its oral presentation content, Sweden indicated that:
  - it would consider a new NPP as one that is initiated (licencing process) in accordance with new regulations
  - NPPs are designed in accordance to the defence in depth principle and design extension conditions

4.2 Implementation of the VDNS's principle on existing nuclear power plants

The second principle of the VDNS is:

> Comprehensive and systematic safety assessments are to be carried out periodically and regularly for existing installations throughout their lifetime in order to identify safety improvements that are oriented to meet the above objective. Reasonably practicable or achievable safety improvements are to be implemented in a timely manner.

Sweden reports that its national requirements and regulation address the application of the principles and safety objectives of the Vienna Declaration to existing NPPs in the following way:

- The Act on Nuclear Activities requires that a periodic safety review is carried out at least once every 10 years for each nuclear facility.
- In addition, existing facilities are required to analyse operational experience and new

knowledge and through use of living PSAs identify and implement changes that as far as reasonably achievable, make the facility level of safety comparable to that of a new facility.

- Specifically:
  - Periodic safety reviews:
    - Performed since the 1980s (originally ASAR reviews (As Safe As Operated Reviews)); in the fourth round of 10 year period
    - Affected by amended EU NSD 2014/87/EURATOM, and included in updated Swedish legislation and SSM regulations
    - The PSR provide an overall view of safety and identify needs and possibilities to improve safety further
    - The conclusions are put into an action plan
  - Level of safety is assured and improved:
    - Safety improvements are identified through analysis operational experience, research and development, and evaluation of new knowledge
    - Sweden applies the concept of "Living PSA" which means the PSAs are up to date and continuously used in enhancing and understanding plant safety status. PSAs are required to include Levels 1 and 2, all initiating event categories, and all operating states.
    - R&D, new knowledge, and technology change affects what is reasonable and justifiable over time. This is basically a continuous adaptation to the concepts "acceptable level of safety" and "reasonable and justifiable." Risk informed approaches can be used to support assessments.
  - The principles of the VDNS will also be covered through the planned update of the Act on Nuclear Activities, as well as by the implementation of the Nuclear Activities Act (implementing the amended EU Nuclear Safety Directive Euratom 2014/87):
    - According to Government decisions in the 1980s, large releases and long-term contamination of soil shall be prevented
    - Starting in the 1990's further major safety upgrades were required for all operating reactors (current regulations SSMFS 2008:1, SSMFS 2008:17)
    - The Nuclear Activities Act requires an overall assessment of a nuclear facility's safety and radiation protection (PSR) shall be conducted at least every ten years
- Requirements focusing on preventing accidents were and are managed as follows:
  - Strengthening of DiD and independency between DiD levels
  - Addressing Design Extension Conditions
  - Avoidance of high pressure core melt scenarios
  - Use of detailed PSA models to verify low core-melt frequencies
  - Design basis further reviewed in connection with EU stress tests
  - Requirement to install a fully independent core cooling system
- Measures for mitigation of radionuclides causing long term offsite contamination:
  - Filtered containment venting system with decontamination factor of at least 500

- Independent containment spray system
- Automatic filling of lower drywell with water (some BWRs)
- Containment pressure relief in events of LOCA and degraded pressure-suppression function (BWR)
- Containment instrumentation qualified for severe accidents (activity, temperature, pressure, water level, hydrogen content)
- Follow up and evaluation of new research results and experiences (APRI programme on-going since 30 years)
- Severe accident management guidelines, protection of staff during the accident
  - SAMG procedures or similar are in place
  - Main control room and command and control centre are equipped with filtered air intake and self- circulating mode
- Provision and resilience of Emergency Mitigation Equipment (EME)
- Implementation of on-line transmission to SSM of crucial plant data in connection with an emergency (ETAPP project)
  - Recent co-operation project between SSM and the licensees
  - Agreement on MMI interfaces, parameters to follow and technical solution

4.3 Taking into account IAEA Safety Standards and other international Good Practices in the national requirements and regulations addressing the VDNS principles

Principle 3 is addressed since Swedish national requirements are developed in consideration of relevant IAEA Safety Standards, EU legislation, WENRA reference levels, as appropriate and other good practices.

In SSM's management system, it is stated that IAEA Safety Standards shall be reflected in SSM regulations. This is also applied in the ongoing process of preparation of a new set of regulations.

4.4 Issues faced by Sweden in the implementation of the VDNS

Based on EU stress tests, no urgent issues were identified related to the VD principles.

- The early introduction of filtered venting systems and accident mitigation measures as well as on-going modernisation projects were positive aspects in this respect.
- The stress tests and the resulting national action plan resulted in a number of additional analyses and actions.
- Dependence of core cooling on electric power supply in case of SBO or emergency; this was known to be an important issue and already under discussion before the Fukushima accident.

Sweden does not expect to face any issues in applying the VDNS principles to its existing fleet or to potential new builds of nuclear power plants

5. Results of the Review

5.1 General Quality of the National Report

Contracting Parties and officers were invited to provide general comments on Sweden's implementation of the obligations of the CNS (e.g., report submitted on time); the extent to which it addressed all articles, addressed the Vienna Declaration on Nuclear Safety, and addressed all Challenges and Fukushima lessons learned; the general quality of its National Report; transparency issues; and the compliance with the CNS guidance documents and special peer review topics identified in the previous CNS Review Meeting or specified by the President of the CNS (use of the templates for articles 17 and

18 and reporting on the management of spent fuel on site and radioactive waste on site - especially for CPs not signatories of the Joint Convention)..

With regards to the general quality of the National Report and transparency issues, the members of the Country Group made the following observations:

- Sweden did make voluntary use of the National Report template for Articles 17 and 18
- Several Contracting Parties commented on the well written, extensive national report from Sweden and the excellent job responding to questions

With regards to the compliance with the requirements of the CNS and its Guidelines, the members of the Country Group made the following observations:

- The Report was submitted on time before the deadline of 15 August 2016.
- The content and structure of Sweden's National Report complies with the CNS guidance.
- The directions of the Summary Report of 6th Review Meeting were taken into consideration.
- The directions given by the President of the 7th Review Meeting were mostly followed.

5.2 Participation in the Review Process

With regard to Sweden's participation in the review process, Sweden:

- posted questions to Contracting Parties (166 questions posted)
- delivered answers to the questions of Contracting Parties on time (response to 115 questions)
- delivered its national presentation

5.3 Challenges

The Country Group identified the following Challenge(s) for Sweden.

- **Challenge SE-2017-01:** Implementing an approach, consistent with the government assignment, to sustain and develop capability in both the regulatory body and licensee (including sustaining support such as R&D and suppliers) given the plan to shut down some NPPs and the need to develop additional capability in technical and radiological aspects of the decommissioning area
- **Challenge SE-2017-02:** Maintaining and overseeing safety culture during the transition from operation to decommissioning
- **Challenge SE-2017-03:** Completion of the remaining work to update the set of regulations, including consideration of the requirements from EU Directives and WENRA reference levels

5.4 Suggestions

The Country Group did not identify any Suggestions for Sweden.

5.5 Good Practices and Area of Good Performance

During the peer review of Sweden's National Report, the Contracting Parties were invited to recommend Good Practices and to highlight Areas of Good Performance.

The Country Group did not identify any Good Practices for Sweden.

The following Areas of Good Performance of Sweden were commended by the Country Group:

- **Area of Good Performance SE-2017-01:** Development of the legal framework in an extensive and focused effort addressing EU Directives as well as state of the art requirements from IAEA, WENRA, etc.
- **Area of Good Performance SE-2017-02:** Finalization of an extensive modernization program in 2016 aimed at bringing the NPPs in line with modern safety requirements

- **Area of Good Performance SE-2017-03:** The inclusion of the requirement to have immediate compensatory measures in place to enhance the independence of emergency core cooling by 2017 as an early, intermediate step, toward installation of a fully independent core cooling system by 2020.
- **Area of Good Performance SE-2017-04:** Efficient, cooperative approach (industry and SSM) to implement online transmission to SSM of crucial plant data in connection with an emergency (ETAPP project)

6. Fulfilment of CNS Review Requirements

The Country Group concluded that Sweden:

- Submitted a National Report, and therefore complies with Article 5 and in time following Rule 39 of INFCIRC/573 Rev. 6
- Attended the 7th CNS Review Meeting, and therefore complies with Article 24.1
- Held a national presentation and answered questions, and therefore complies with Article 20.3