



# School of Geological Disposal

## - Basis for developing safe geological disposal

Äspö Hard Rock Laboratory, Sweden  
Oct.14-18, 2019

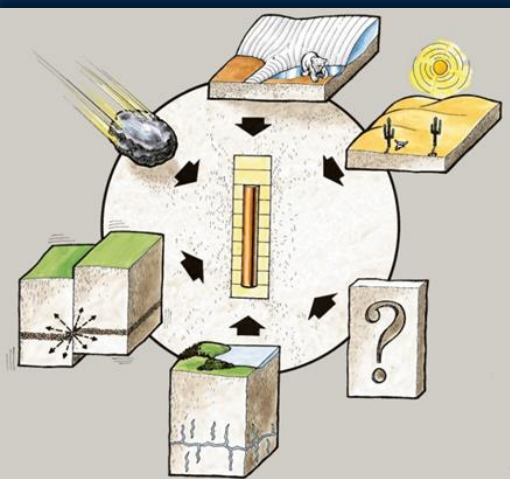
SKB International and SKB are delighted to once again offer a scientific training course covering important issues governing a national nuclear waste disposal programme. The course from last year has been slightly updated based on last year's experiences and feedback.

Based on the experiences gained by SKB during the past 40 years the course will present the planning and execution of a successful programme. The starting point being a strategic and graded approach with an early safety prediction via detailed understanding of processes, research achievements and gains in correctly defined targets and how this leads to a communicative safety case based on a solid and well defined safety assessment.



## Final Registration and Schedule

In the following package you will find the updated final schedule, detail programme description and information about recommended accommodation, transport and invoice details and registration form.



The course is given by senior experts from SKB, many with world renowned reputation in their field, and will cover the relevant topics for geological disposal of nuclear waste. The course programme will launch from the fundamentals of safety assessment and its defined safety functions. We will present SKB's experiences and knowledge based on selective research, successful experiments confirming assumptions and share experiences gained from failures. The lectures and discussions will provide extensive, profound information coupled to cutting edge applications when applicable. We aim to transfer theoretical knowledge and practical experience to the course participants efficiently and effectively all in an informal and inclusive atmosphere encouraging open discussions and networking.

Attendants will obtain course material (English), information material about SKB, and general information on Oskarshamn such as map, tourist information, etc. during the welcome reception to further enhance the positive experience of the course.

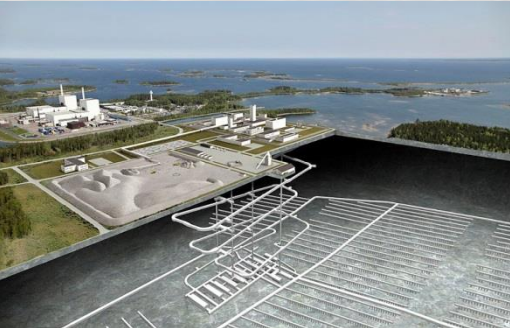
Full course details and a registration form are available at SKB web site:  
[www.skb.se/SGD2019](http://www.skb.se/SGD2019)

Further information contact:  
[erik.moller@skb.se](mailto:erik.moller@skb.se)



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When: October 14<sup>th</sup> -18<sup>th</sup>, 2019  
Time: One full workweek, 08:00-17:00  
Location: Äspö Research village, accommodation in Oskarshamn  
Price: €4000, including lunches & local transport, one dinner  
Registration: Full registration form to be submitted by **2019-08-01**

### Important information:

#### Registration:

- Full registration must be submitted by 2019-08-01.
- Registration form is attached to this information packages or can be downloaded from the web site: [www.skb.se/SGD2019](http://www.skb.se/SGD2019)
- A brief presentation of the participant is requested, will be used to adapt the presentations.

#### Accommodation:

- A discounted price of 1290 SEK/night & room is available at the Clarion Collection Hotel Post for all participants:  
[www.nordicchoicehotels.com](http://www.nordicchoicehotels.com),  
Phone: +46 491 160 60

E-mail [cc.post@choice.se](mailto:cc.post@choice.se)

- ✓ Participants arrange with reservation via telephone or e-mail, submitting event code: **SGD2019**
- ✓ Discounted price valid until the 2018-08-31.
- ✓ Included in the price of the room, Hotel Post offers breakfast and light evening meals.
- Other accommodations are available in Oskarshamn.
  - ✓ Transports will be arranged from/to Hotel Post.
  - ✓ Please inform secretariat of your accommodation plans.

#### Transportation:

- All local transportations between Hotel Post and SKB facilities, Monday through Friday is arranged.
- Further travel information is found on the last page.

#### Payment:

- Invoice will be sent to each participants affiliation after final registration.
  - ✓ Non-refundable registration fee of €4000, shall be payed within 30 days.

Participants must make their own travel and hotel arrangements.

- SKB International offers a reduced rate at the Clarion Collection Hotel Post.
- SKB International also offers a transfer bus on Sunday the Oct. 13<sup>th</sup>, see last page (€50 extra).

#### Study visits to:

- Central Interim Storage of Spent Nuclear Fuel - Clab
- Canister Laboratory
- Äspö Research Village;
  - ✓ Chemistry laboratory,
  - ✓ Multipurpose test facility,
  - ✓ Material science laboratory &
  - ✓ Hard Rock Laboratory (URL)

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### Schedule

Time	Day 1 - 14 <sup>th</sup> Oct.	Day 2 - 15 <sup>th</sup> Oct.	Day 3 - 16 <sup>th</sup> Oct.	Day 4 - 17 <sup>th</sup> Oct.	Day 5 - 18 <sup>th</sup> Oct.
08:00 - 10:00	<ul style="list-style-type: none"> <li>➤ <b>Introduction</b></li> <li>➤ Participants presentation &amp; expectations</li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>The role of the Äspö HRL</b> in the Swedish nuclear waste management programme.</li> <li>➤ Study visit to <b>the Äspö Research Village</b> incl.: <ul style="list-style-type: none"> <li>➤ Safety instructions</li> <li>➤ Tunnel visit</li> <li>➤ Bentonite &amp;</li> <li>➤ Chemical Laboratory</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Engineered Barrier system (EBS) Criteria and demands</b></li> <li>➤ Canister</li> <li>➤ Cementitious materials</li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>The siting process</b> in Sweden: <ul style="list-style-type: none"> <li>➤ Selection</li> <li>➤ Investigations</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Towards radioactive waste disposal world wide</b></li> <li>➤ Early political discussion</li> <li>➤ The RD&amp;D process</li> <li>➤ Application process for licence to construct</li> </ul>
30 min	BREAK		BREAK	BREAK	BREAK
10:30 - 12:00	<ul style="list-style-type: none"> <li>➤ <b>Overview of Nuclear Waste and Repository concepts</b> in different geological environments</li> <li>➤ <b>Regulation, IAEA, national requirements</b></li> </ul>		<ul style="list-style-type: none"> <li>➤ <b>Engineered Barrier system (EBS) Criteria and demands</b></li> <li>➤ Clay barrier (Buffer &amp; Backfill)</li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>The siting process</b> in Sweden, continued. <ul style="list-style-type: none"> <li>➤ Comparison and decision</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Social aspects of nuclear waste disposal</b></li> <li>➤ Public acceptance</li> <li>➤ Confidence building</li> </ul>
1h.	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
13:00 - 15:00	<ul style="list-style-type: none"> <li>➤ <b>Safety assessment fundamentas</b></li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>The Geological Barrier:</b> Rock types, Structural geology, Rock Mechanics, Hydrogeology, Chemistry</li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Biosphere and Climate</b></li> <li>➤ Ecosystem</li> <li>➤ Transport in biosphere</li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Knowledge management</b></li> <li>➤ Data handling</li> <li>➤ Quality assurance</li> <li>➤ Competence</li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Stepwise licensing of repositories in Sweden</b></li> <li>➤ Interaction between implementer and regulators.</li> <li>➤ Future plans</li> </ul>
30 min	BREAK	BREAK	BREAK	BREAK	BREAK
15:30 - 17:00	<ul style="list-style-type: none"> <li>➤ <b>Waste matrix, criteria and inventory (SNF, ILW, LILW)</b></li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Site Descriptive Modell (SDM)</b> – a systematic way of collecting all data to give an optimal description of the rock volume</li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Study visit to Canister laboratory.</b></li> <li>➤ Non-destructive testing</li> <li>➤ Friction stir welding</li> <li>➤ <b>Instrumentation workshop</b></li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Presentation and visit to the Central Interim Storage facility (Clab)</b></li> </ul>	<ul style="list-style-type: none"> <li>➤ Summary and course evaluation.</li> <li>➤ Examination and certificate of completion of the School of Geological Disposal.</li> </ul>
Evening activity	Sunday 13 <sup>th</sup> Oct.: Welcome Reception	Course Dinner			



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### Detailed programme description

#### Sunday evening, October 13<sup>th</sup>:

- A school representative will be available at the **Hotel Post** reception from 17:00.
- Registration package including local information, list of participants, name tags, and a full course documentation will be distributed to all participants.
- **Welcome Reception** between 18:00-20:00 at the **Hotel Post** hosted by SKB International, including snacks and drinks.

#### Monday, October 14<sup>th</sup>:

- Buss transfer to Äspö Research Village depart the **Hotel Post** main entrance at 07:30.

##### Monday Technical Programme:

- ✓ Introduction and Background to the course by Erik Möller. This section includes a presentation of the waste management company SKB, responsibilities, working procedures and financing. It includes a presentation of geological disposal concepts and its relation to waste forms/waste acceptance. We also expect a short presentation by each of the participants on their background and expectations from the course (max. 1 min).
  - ✓ Overview of Nuclear Waste and Repository concepts in different geological environments by Johan Andersson. This section presents disposal options which are tailored for different geological media (crystalline rock, clay formations and salt). The focus is to present the similarities and differences which are due to the geological properties of the different media. A brief description of the KBS-3 concept is given. Regulation, IAEA and national requirements will also be discussed.
  - ✓ Safety Assessment Fundamentals by Allan Hedin. This section presents the through safety assessment methodology which has been developed by SKB ever since the presentation of the KBS-3 disposal system in 1983. This systematic assessment is presented as:
    - 1) Background
      - SKB's licence application to construct the repository for Spent Nuclear Fuel (SNF)
      - The KBS-3 concept and its safety functions
      - The Forsmark site
      - Regulations
    - 2) Overview of the safety assessment SR-Site
      - Methodology
      - Safety functions
      - Reference evolution and scenarios
      - Conclusions
  - ✓ Characteristics of Radioactive waste forms by Klas Källgren. This section starts with the criteria and demands to be put on different waste forms. It presents the outcome of more than thirty years of experimental investigations and experiences of radionuclides in the conditions relevant in a geological repository.
- Buss transfer to Oskarshamn and Hotel Post at 17:00



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### Detailed programme description

#### Tuesday, October 15<sup>th</sup>:

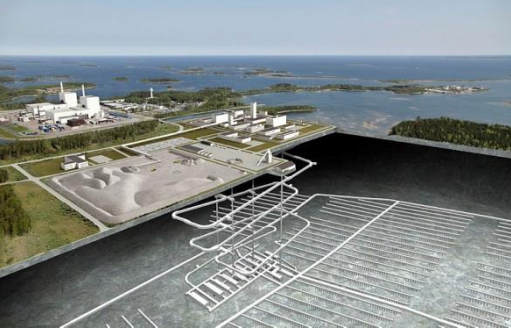
- Buss transfer to Äspö Research Village depart the **Hotel Post** main entrance at 07:30.

##### Tuesday Technical Programme:

- ✓ The role of the Äspö HRL in the Swedish nuclear waste management programme by Pär Grahm and Peter Wikberg. This section includes the presentation of Äspö and the underground research laboratory, the history and aim of the facility (both the past and present activities).
  - ✓ A comprehensive visit in the underground laboratory and surface based supporting facilities and laboratories.
    - Registration and identification control – **Bring Passport!**
  - ✓ The Geological Barrier is presented by Assen Simeonov. This section starts with a presentation of the safety functions and criteria expected for the geological barrier. In contrast to the engineered barriers this barrier cannot be manufactured and therefore its properties must be assessed carefully. In addition to the solid (rock)material the properties and aspects of the groundwater flow, chemical composition and potential to transport of dissolved species is highlighted. The geological barrier will provide the long-term stable conditions needed for the engineered barriers to function properly.
  - ✓ Site Descriptive Models (SDM) is presented by Johan Andersson. The SDM is developed as a result of careful investigation of the bedrock at sites potentially suitable for the construction of a nuclear waste repository. SDM work is a systematic assessment of all data and information useful for describing the properties and function of the host rock. Even though the modelling starts with disciplinary assessment of data, geology, hydrogeology, hydrogeochemistry the very core of SDM is the total integration of all data. In a fractured crystalline rock the existence of fractures and the network of fractures have an important impact on the outcome of flow and transport of dissolved species. Therefore the development of Discrete Fracture Network Models (DFM) is one of the most important components in preparation for the safety assessment.
- Buss transfer to Oskarshamn and Hotel Post at 17:00

#### Tuesday evening, October 15<sup>th</sup>:

- SKB International invites all participants and lecturers to the **Course Dinner!**
  - ✓ Time: 19:00
  - ✓ Location: To be decided, either walking distance from Hotel Post or transportation will be arranged.



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#### Wednesday, the 16<sup>th</sup> of October:

- Buss transfer to Äspö Research Village depart the **Hotel Post** main entrance at 07:30.

#### Wednesday Technical Programme:

- ✓ Engineered Barrier systems (EBS) by Johannes Johansson, Per Mårtensson and Patrik Sellin. This section is divided into three sessions (Canister, Cementitious and Clay materials) starts with a presentation of the criteria and demands that are put on the engineered barriers and which are dependent on one another and on the bedrock properties. The main points of the lectures are:
  - Iterative Development of Design
  - Requirements
  - Reference evolution and scenarios
  - Development of EBS design
  - Laboratory and full scale testing
  - Production and installation of EBS
  - The road ahead, building a repository
- ✓ Biosphere and climate is presented by Ulrik Kautsky. This section covers SKB's development of models of the biosphere and the climate changes from using generic data to site specific data. It includes site investigations, site descriptive models for the ecosystem, landscape development, development of biosphere and climate models in the safety assessment.
- Buss transfer to Canister Laboratory in Oskarshamn harbour at 15.00
  - ✓ Study visit including:
    - Non-destructive testing of Canister
    - Friction stir welding technology
- Short walk (max 15min) back to Hotel Post around 17:00



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#### Thursday, the 17<sup>th</sup> of October:

- Buss transfer to Äspö Research Village departs the **Hotel Post** at 07:30.

##### Thursday Technical Programme:

- ✓ Siting, Site Investigation and Selection is presented by Kaj Ahlbom using the Forsmark site as example. During the period 1992 to 2011 this was the most resource intensive work within SKB. Pre-studies were conducted in a total of 8 municipalities in Sweden. Out of these two were selected for detailed site investigations.
  - ✓ The selection of the repository site (Forsmark) was based on the outcome of the investigations, which proved the bedrock properties of Forsmark to be superior in comparison to the other investigated site (Laxemar). Thereby the actual selection of Forsmark was a simple task, but it required an intensive amount of investigations and modelling (SDM, DFN) before the choice could be made. The procedure to do the site selection is presented by Johan Andersson.
  - ✓ Within the organisations in charge of the Site Investigations was also the responsibility to handle the acceptance by the local politicians, neighbours and other stakeholders. Information and study visits to the SKB facilities was arranged weekly during the site investigation stage. Then and afterwards information activities are made for the students in the secondary school in those municipalities where SKB is located.
  - ✓ Knowledge Management by Johan Andersson, Karin Pers and Ebbe Eriksson. This section presents the importance and key factors of a knowledge management including routines, data handling, formulation of requirements, quality assurance and quality control of the working processes for a safety assessment, site investigations, manufacturing of EBS components being parts of procedures and strategies for maintaining and transferring competence within a waste management organisation.
- Buss transfer to Clab – the Central Interim Storage Facility for Spent Nuclear Fuel – departs Äspö Research Village at 15:00.
    - ✓ Registration and identification control – **Bring Passport!**
    - ✓ Study visit including:
      - Area for Reception and control of Spent Nuclear fuel
      - Interim Storage pool
  - Buss transfer to Oskarshamn and Hotel Post at 17:00



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### Detailed programme description

#### Friday, the 18<sup>th</sup> of October:

- Buss transfer to Äspö Research Village departs the **Hotel Post** at 07:30.

#### Friday Technical Programme:

- ✓ Hans Forsström reflects on the back-end issues from a international and historical viewpoint. With more than 40 years of experience in the field, starting with the foundation of the Swedish programme via the work done in European Commission and IAEA, Hans guides us down "The long and winding road" towards a radioactive waste disposal. The second half of this presentation deals with the interaction between the implementer and the regulator. There has been a constant interaction since the first KBS-3 report was presented to the regulator in 1984. In this process the RD&D reports issued by SKB have had an important role in presenting the latest results and the present plans to the regulator every three years. According to the Swedish law, these reports have to be approved by the government, based on the recommendation by the regulator.
- ✓ The importance of confidence building and public acceptance issues are discussed and experiences from the Swedish programme are presented by Kaj Ahlbom.
- ✓ In the final session Johan Andersson will present the stepwise licensing process of repositories in Sweden. Experiences and lessons learnt from the interaction between implementer and regulators and environmental court. Sweden has during the last few years experiences from two application processes, similarities and differences are shown. Only a few weeks before the SGD2019, the environmental court hearing regarding the extension of SFR will be done – comments and reflexions will be made. Also a status update of the application to construct the Spent Nuclear Fuel repository in Forsmark will be given.
- ✓ Summing up of the course is done by Johan Andersson and Peter Wikberg. This includes an oral examination and certificate of completion of the School of Geological Disposal 2019.
- ✓ The School will end no later than 17:00, and a transfer bus from Äspö to Kalmar will be arranged, see below.





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## Information how to get to and from Oskarshamn

Unfortunately the options to travel to Oskarshamn are somewhat limited.

Therefore SKB International will arrange with one transfer in each direction between Kalmar and Oskarshamn, see below.

SKB International offers to arrange a bus transfer from Kalmar Airport and Kalmar Centralstation(Train) to Clarion Collection Hotel Post in Oskarshamn on Sunday October 13th.

The buss transfer will connect to the following two means of transportation to Kalmar:

1. By air from Stockholm Arlanda Airport (ARN) to Kalmar Airport(KLR):  
Flight: SK195 (WX195), Departure (ARN) 13:45 – Arrival (KLR) 14:35
  2. By train from Copenhagen Airport (CPH) to Kalmar Central Station:  
SJ Train: #1042 Departure (CPH) 11:22 – Arrives 14:59
- Buss departure from Kalmar Airport at 15:00, with a pick-up stop at Kalmar Centralstation at 15:15. Arriving Hotel Post around 16:30. The schedule is fixed!
  - Notification must be done on the final registration form.
  - A fee of € 50 will be added to the invoice.

SKB International will arrange with buss transfer from Äspö to Kalmar Airport (KLR) and Kalmar Central Station (Train) on Friday October 18 afternoon which connects to earliest flight/train:

1. Flight:SK198 (WX198)  
Departure Kalmar Airport (KLR) 19:25 Arrival to Stockholm Arlanda (ARN) 20:15
  2. SJ Train: #1113  
Departure Kalmar Central Station 19:06 Arrival Copenhagen (CHP) 22:33
- By courtesy of SKB International, this transfer is free of charge.

Other options from Kalmar to Oskarshamn are:

- Taxi, approx. 1600SEK one way Kalmar airport – Hotel Post, Oskarshamn  
E.g.:<http://www.flygtaxi.se/>
- Public transportation, Buss 160, or local train+buss. Approx. 100SEK, 1.5h  
Travelplaner: <https://www.kalmarlanstrafik.se/>

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