

## Review meeting LOT experiments (i)

- (i) **Management system & project management**
- (ii) Retrieval, sampling, handling of samples & analysis
- (iii) Interpretation of results.

# Question 1 – Longterm mangement LOT



*If retrieval and analysis of S2 and A3 is managed via a dedicated project, how has the LOT project as a whole been managed (i.e. through conception, set-up and long-term running of LOT)?*

Test plans were written in the late 1990s.

Installation and dismantling activities have been carried out in the project form.

Monitoring and data deliveries to SICADA was managed by Clay Technology AB up to 2012, after which the experiment was transferred to SKBs (Äspö HRL) administration and included in yearly activity plans.

# Question 2 – Milestones, tollgates



*Were additional milestones added for this project? Were the tollgate decisions and/or criteria revised for this project? Gates T0 to T3 should have taken place according to the PMP programme. Is it possible to see the milestone reports prepared to support tollgates T0 to T3? What decisions were made at each tollgate for this project? Where are the outcomes of the tollgate decisions recorded?*

Two updates were made:

- The project time schedule was updated and TG4/5/6 were put forward 2 years due to limitations in the availability of internal resource for bentonite analyses. These analyses are not time critical and thus it is deemed acceptable. It should be noted, that bentonite analyses with a direct connection to copper were prioritised and reported in October 2020.
- In the first project charter, dedicated studies to measure survival and microbial activity was included. Microbial survival was studied in LOT A2, but the results gave no new information compared to other tests. Microbial activity, in the form of sulfate reduction, cannot be studied in the LOT setup. The conclusion during planning was that these questions are better addressed in other dedicated experiments and the studies were thus removed from the project.
- The tollgate decisions are recorded in protocols from LOT steering group meetings .

# Question 3 – Risk assessment



*How were risks identified at project initiation? How was learning from previous LOT retrievals and analyses accounted for when planning the project (e.g. risk of damaging parcels during retrieval, any issues in preparation of coupons and tubes for copper corrosion analysis, and possible mitigation measures)? How often is the risk register reviewed and have any risks been added since the start of the project? Have any of the risks been realised?*

Risk identification started with PM reading documentation from previous dismantling's which provided a basic list of risks. The project group then sat down together and started to list risks as well as discussing those prepared by the PM. The project group includes several resources with experience from both earlier LOT dismantling's as well as other Äspö installations and dismantling's.

Risks are additionally assessed in the risk assessment included in each Activity plan. The authors also take the main risk list into account when writing activity plans.

Top risks are also included in Antura where they are included and reported to the client in each monthly report.

The risk list, which is handled as a living document, includes a short risk handling plan for each risk. Risks were reviewed and added at working meetings and PGMs.

Two risk were realised:

- For the first parcel there was edges between the holes of the seam drilling and the risk handling plan to drill core drilling holes had to be implemented. This caused some delays; however, water could be pumped away according to plan and there were no implications for the parcel. The seam drilling equipment was repaired between the parcels and the problem was avoided in the second parcel.
- Another risk relating to the ordering of Mössbauer analysis was also realised and the order was delayed, meanwhile the samples were stored in vacuum sealed bags in order to keep the samples stable.

# Question 4 – Tollgate review & lessons learnt



*What are the findings of the project assurance reviews undertaken for the tollgates so far? Is a record of lessons learnt during the course of the project so far maintained?*

Four high risks were highlighted in the TG3 decision PM (1867780):

- 1) availability of internal resources,
- 2) times schedule,
- 3) cost risks
- 4) packages could be damaged by water during dismantling.

With the schedule updated and increased budget which was approved at TG3 these risks have not been realised and both schedule and costs are expected to be kept. The key technical risk of water damaging the parcels is closed and the implemented risk handling with suction of water and alarms worked as intended.

Lessons learnt will be reported in the experience report at the end of the project. No formal notes are kept at this stage, although the PM has some key once written down, like the challenges with the seam drilling of the first parcel and the tight fit of the crane when lifting the parcels which will be even tighter for the final parcel, likely requiring a modified lifting procedure.

# Question 5 – Stakeholders/impartial observers



*The project charter notes that there are a number of external stakeholders that want to observe the project (including potential collaboration with Posiva) and that this needs to be taken in to account when planning the project. How were stakeholder needs accounted for in planning the project? Were collaboration activities explored with Posiva before TG1, as required? Was any consideration given to the inclusion of an impartial observer at different stages of the project (e.g. during parcel recovery and analysis) and what was the outcome of such considerations?*

The project has had a discussion with Posiva and samples have been sent which are of high interest for them due to the relatively long high temperature exposure. Additional samples will be sent upon request.

SKB did consider impartial observers in the early planning stages. Different alternatives were presented and discussed in the steering group for the project. SKB's final decision was to film the retrieval of the experiment and impartial observers were thereby not invited/included. Normally, SKB have not invited impartial observers for the retrieval of other long term experiments, but we have made exceptions in the past.

# Question 6 – Extraction of the Cu coupons



***What procedures were applied to the dismantling of parcels to ensure that there was no damage to the Cu coupons when they were extracted from the bentonite blocks?***

The dismantling of the blocks was planned in detail and carried out according to *AP RD KBP1019-19-010 – Grovdelning och paketering av material. LOT-paket S2 och A3.*

The Copper WP leader also participated in person to ensure the safe extraction of the coupons.

A metal detector was used to carefully identify the coupons positions and to minimise the risk of scratching the coupons, hand tools made of wood were used to remove the surrounding bentonite clay and extract the coupons.

Coupon retrieval was successful and any scratches or damages would also have been clearly noticed in the gravimetrical analysis and/or in the microscopic examination.

# Question 7 – Transport of coupons/tubes



*What procedures are used to protect the condition of the Cu coupons and Cu tubes during transport to and storage at laboratories?*

The samples (coupons and pipe sections) were directly placed in vacuum bags and transported to the external laboratory, where they were immediately placed in a plastic tent purged with nitrogen gas. The total exposure to dry air is estimated to less than 1 hour.



# Question 8 – Deviations during retrieval, transport & analysis



*Were any problems encountered or deviations from the activity plans for retrieval of the parcels and their transport and analysis identified?*

The preferred way to dismantle the LOT packages is seem drilling, however, seem drilling has commercially been basically replaced by wire sawing and seem drilling tools are not readily available any more. It turned out that there was some play in the reused tool which lead to the holes not being perfectly straight, and thus leaving edges between them. These edges had to be core drilled away (as described in the risk handling plan). Dry conditions were maintained and there were no implications other than a time delay and increased costs and the equipment was updated to the second parcel.

Two risk observations were written, one was a risk observation written relating to the contractor's helmets lacking straps and one recourse being unsure of how to operate the elevator. There was also a risk observation written relating to a door not being locked after the parcels were removed but before the area was formally stated as free from radiation (all Co-60 had been removed together with the parcels). The noted risk observations were addressed directly.

# Question 9 – Suppliers QA



*How do you ensure that, before work is undertaken, suppliers have appropriate QA processes in place that are at least equivalent to SKB's?*

ISO certified suppliers are preferred and all contracts written by SKB allows for SKB to audit the suppliers. A audit was done for Swerea KIMAB AB in 2017, Audit report SKBdoc Id 1610897 . And a supplier evaluation was done on Clay Technology AB in 2017, SKBdoc Id 1590042

# Question 10 – Separate/independent contractors



*To what extent are contractors regarded as separate/independent of SKB?*

All contractors are regarded as capable companies with the major ones in the LOT project all being ISO certified. It is clear that the contractors are independent companies.

Most of the bentonite analyses related to corrosion were performed by SKB staff using scientific equipment available at SKB.

SKB's experts were engaged in assessing results and thus the conclusions are SKB's.

# Question 11 – Laboratory audits



*Were audits done of the management/QA procedures used by laboratories? Are there records of audits?*

No specific audits were carried out during the LOT project.

- Swerea KIMAB was audited in 2017.
- A supplier evaluation was done on Clay Technology AB in 2017, SKBdoc Id 1590042

# Question 12 – Agreement with suppliers



*Were the specific QA procedures, measurement methods, and techniques to be applied in the project discussed and agreed with the suppliers before the analysis was undertaken?*

The project asked for offers including what should be measured. This was done in an iterative way through discussions between SKB staff and the supplier. The orders then refer to the offers, what should be done, and delivered.

# Question 13 – Implications evolving management system



*How has the management process evolved over the course of the LOT programme and what are the implications of the changing QA system (e.g. if improved quality management systems have been introduced, are there implications with regard to the reliability of previous parcel analyses)?*

SKB is continuously improving its management system and with 20 years past, it is clear that some procedures have been improved.

With that said, earlier LOT work has also been carried out in the project form which has been a way to assure a systematic and effective methodology/way of working for achieving high quality results for a long time.

In some respects, experiences from earlier installations and dismantling's, both within the LOT project and other experiments, plays a more central role in avoiding potential issues that can really affect the quality of the work. It is thus clear that a risk list from 2019 predicts and lowers a greater number of risks than a 1999 version.

# Question 14 – Handling of data



*The project charter and PMP require that all data generated during the project's implementation, and which form the basis for the project's results, must be traceable and stored in SKB's databases. How do you ensure this is undertaken? What data have been submitted to the databases as a result of this project so far (all primary data or just results of analyses)? What QA procedures are applied before data are accepted for inclusion in SICADA? What records are kept on the project file for data submitted to SKB's databases?*

Work carried out at Äspö; the activity plans includes an activity table, that lists all separate activities, including steering documents, the deliveries/data they generate and how they are to be stored. This table (physical table) is filled in when the work is done and when deliveries/data is delivered and finally when it is stored and approved.

Work done by contractors; as defined in offers/orders data shall be delivered to SICADA and signed by the WP leader.

1863807 - AP RD KBP1019 – 19 - 009 – Friborring och upptag av LOT-paket S2 och A3

1866317 - AP RD KBP1019 – 19 – 010 – Grovdelning och paketering av material. LOT-paket S2 och A3

1866344 - AP RD KBP1019 – 19 – 011 – Bestämning av vattenkvots- och densitetsfördelning. LOT- paket S2 och A3

# Question 15 – FEBEX experiences



*To what extent was SKB involved in the FEBEX experiment and the copper coupon measurements for that experiment? Was any learning from FEBEX brought into this project, including the analysis methods and understanding of conditions and corrosion mechanisms?*

The retrieval and examination of Febex was a collaboration between Nagra, SKB and other organisations.

Since copper was not a material of particular focus in Febex, only two copper specimens were included and initially these were examined very briefly using SEM. SKB saw a value in extending the SEM-EDS analysis to examine a larger part of one of the copper coupons in order to get a better understanding of the corrosion morphology observed and to determine corrosion products. In addition, SKB ordered gravimetric analysis of a second copper coupon, in order to quantify the extent of corrosion.

No particular learning from Febex was brought into this project, however, the Febex corrosion results are discussed in both TR-20-14, as in SKBs upcoming safety assessment PSAR.