AG 52 FSW

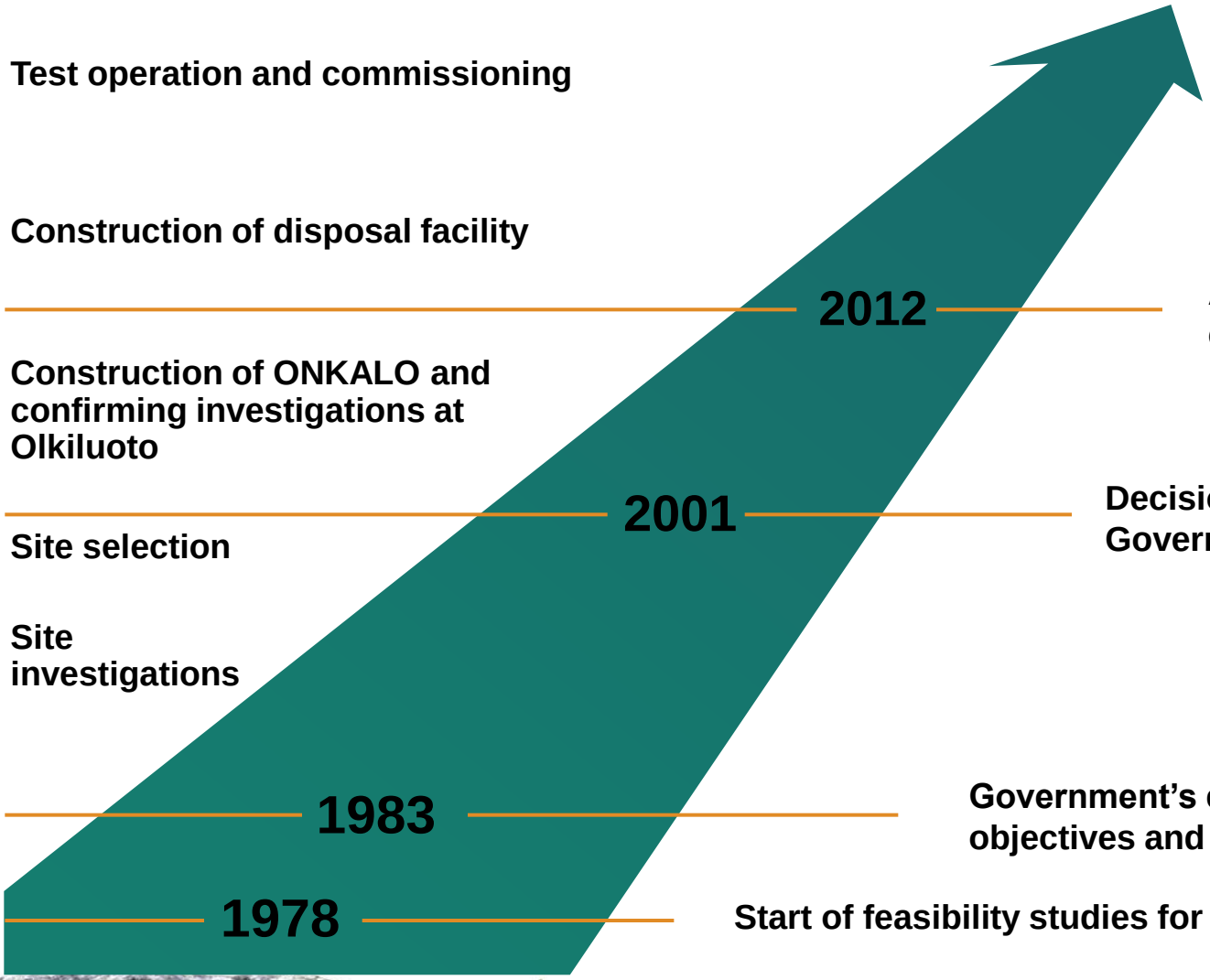
Posiva’s welding method selection for sealing copper canister

POSIVA

Presentation

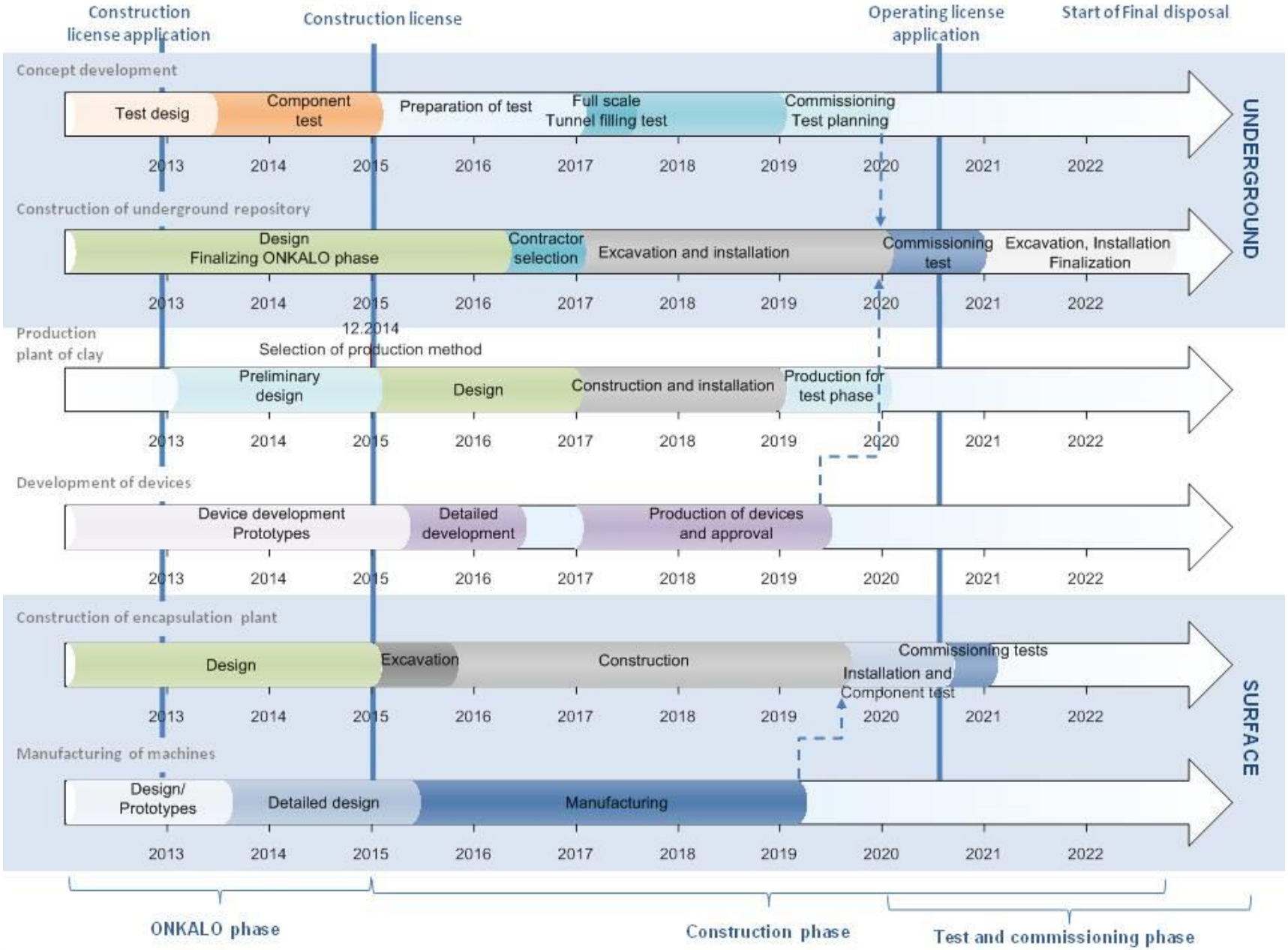
- Overall information about Posiva's timetable concerning starting final disposal and concept
- Basics of the Posiva's choosing process of the welding method for sealing copper canister
- Demands for the canister weld set by VAHA
- Welding tests during year 2013 with SKB

40 years' effort



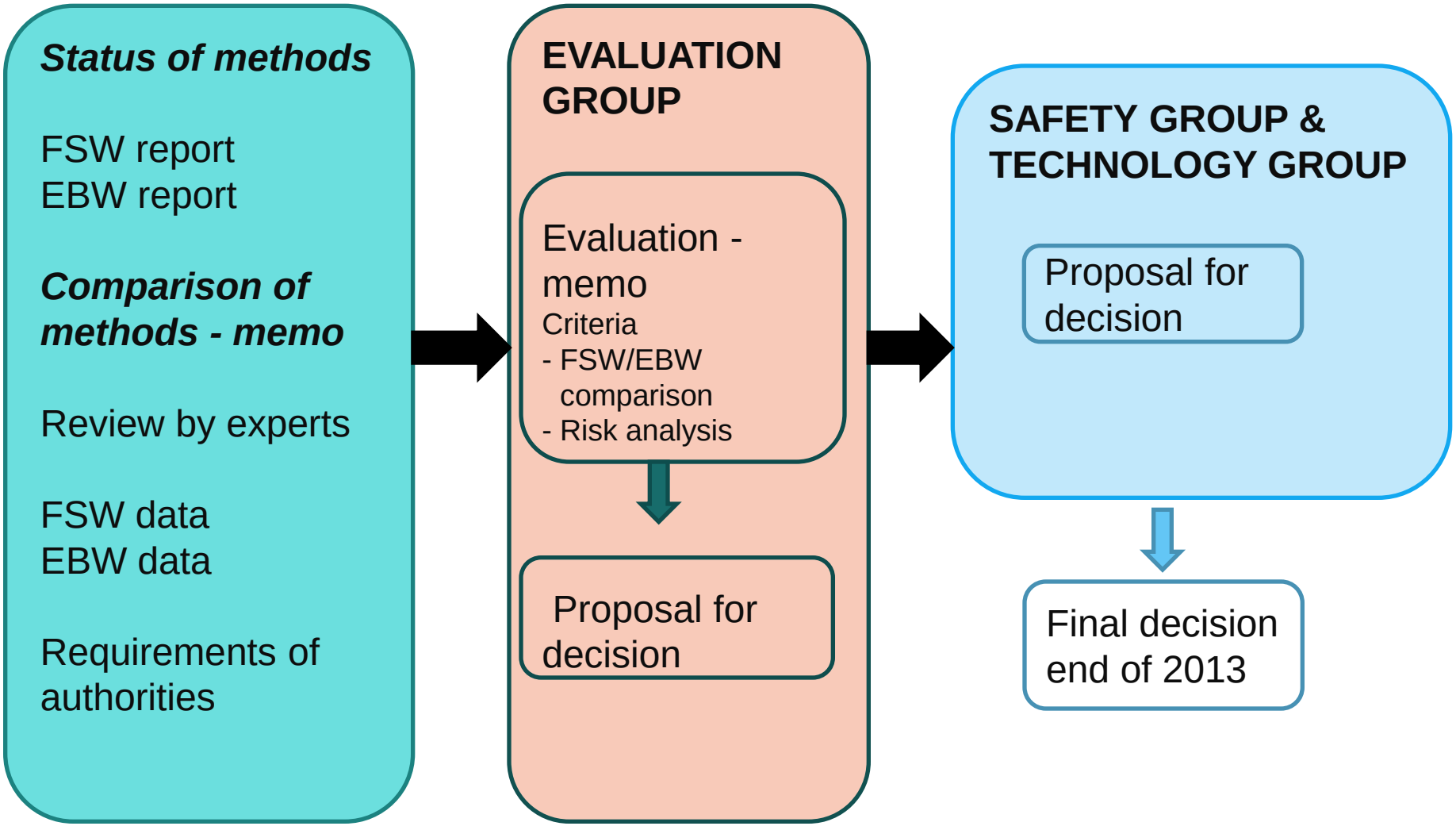
Status of the Application

- Posiva submitted 29.12.2012 the construction license application for TEM's (ministry) review
  - application and associated (18) app's
  - TEM requested statement's from ~ 20 organisations
  - STUK has promised to give it's statement within about 18 months
  - application has been translated in Swedish
- Construction license is expected to be granted within about 2 years

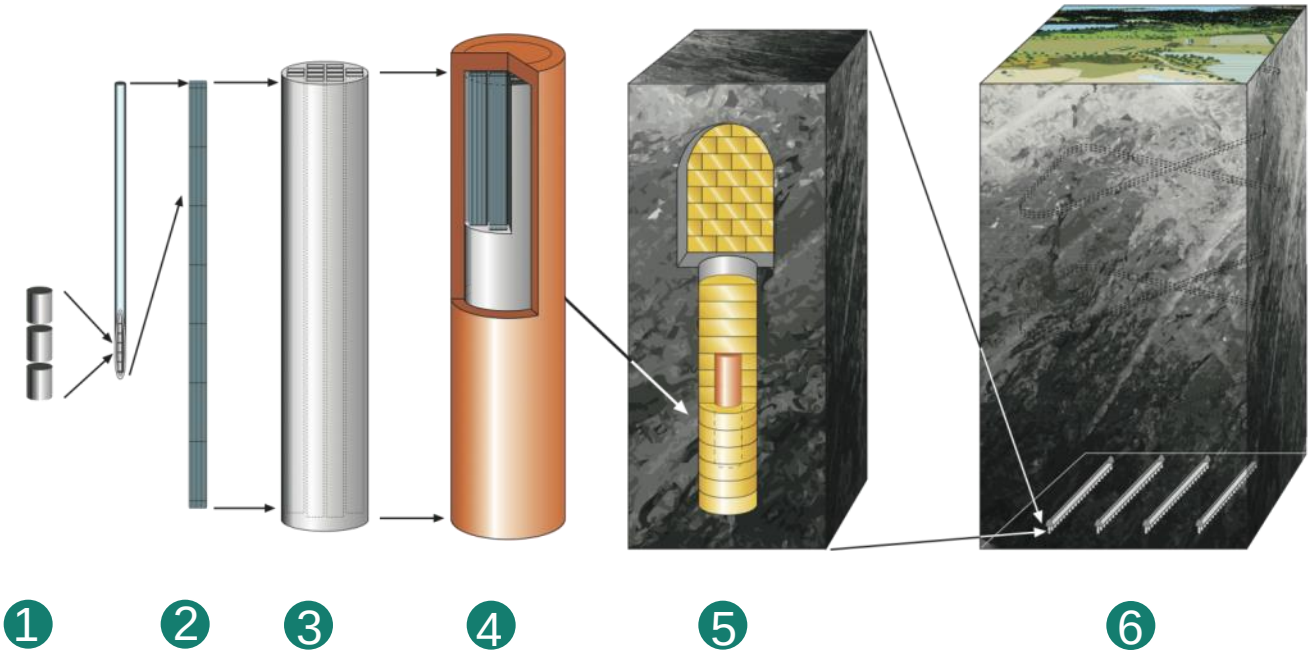

Construction license application
Construction license
Operating license application
Start of Final disposal
Concept development
Test desig
Component test
Preparation of test
Full scale Tunnel filling test
Commissioning Test planning
UNDERGROUND
Construction of underground repository
Design Finalizing ONKALO phase
Contractor selection
Excavation and installation
Commissioning test
Excavation, Installation Finalization
12.2014
Selection of production method
Production plant of clay
Preliminary design
Design
Construction and installation
Production for test phase
Development of devices
Device development Prototypes
Detailed development
Production of devices and approval
Construction of encapsulation plant
Design
Excavation
Construction
Commissioning tests
Installation and Component test
SURFACE
Manufacturing of machines
Design/ Prototypes
Detailed design
Manufacturing
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
ONKALO phase
Construction phase
Test and commissioning phase

Background of the choosing process

- SKB chose the reference welding method during years 2005 – 2006. Selection was done between FSW and EBW.
- Posiva will choose the welding method at the end of year 2013. Selection will be made between FSW and EBW


Status of methods
FSW report
EBW report
Comparison of methods - memo
Review by experts
FSW data
EBW data
Requirements of authorities
EVALUATION GROUP
Evaluation - memo
Criteria
- FSW/EBW comparison
- Risk analysis
Proposal for decision
SAFETY GROUP & TECHNOLOGY GROUP
Proposal for decision
Final decision end of 2013

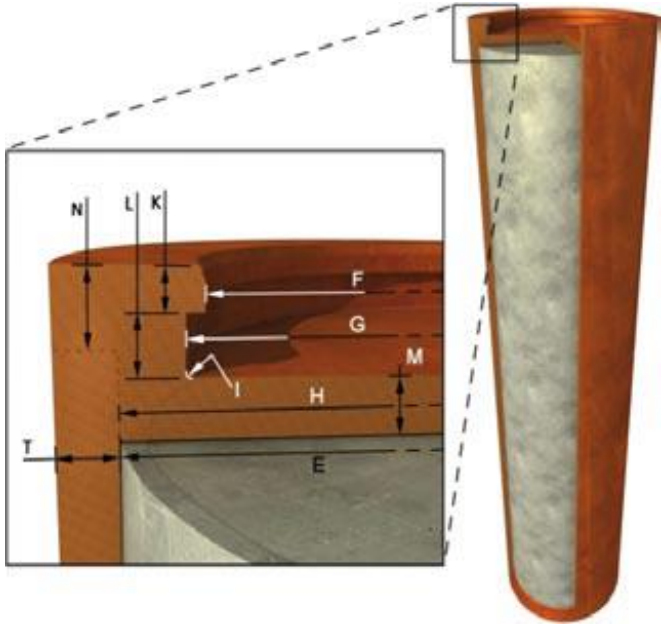
The principle of final disposal (KBS-3V)

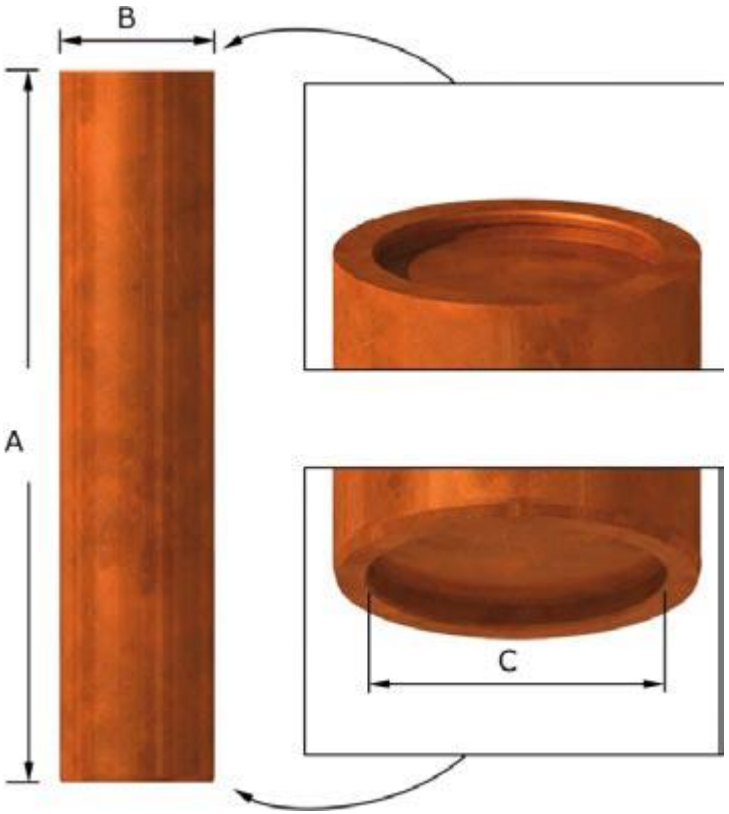


Several release barriers back up each other and ensure long-term safety.

1. Fuel pellet
2. Fuel assembly
3. Canister insert
4. Canister overpack
5. Bentonite and tunnel backfill
6. ~420 metres of bedrock

Dimensions of the canister

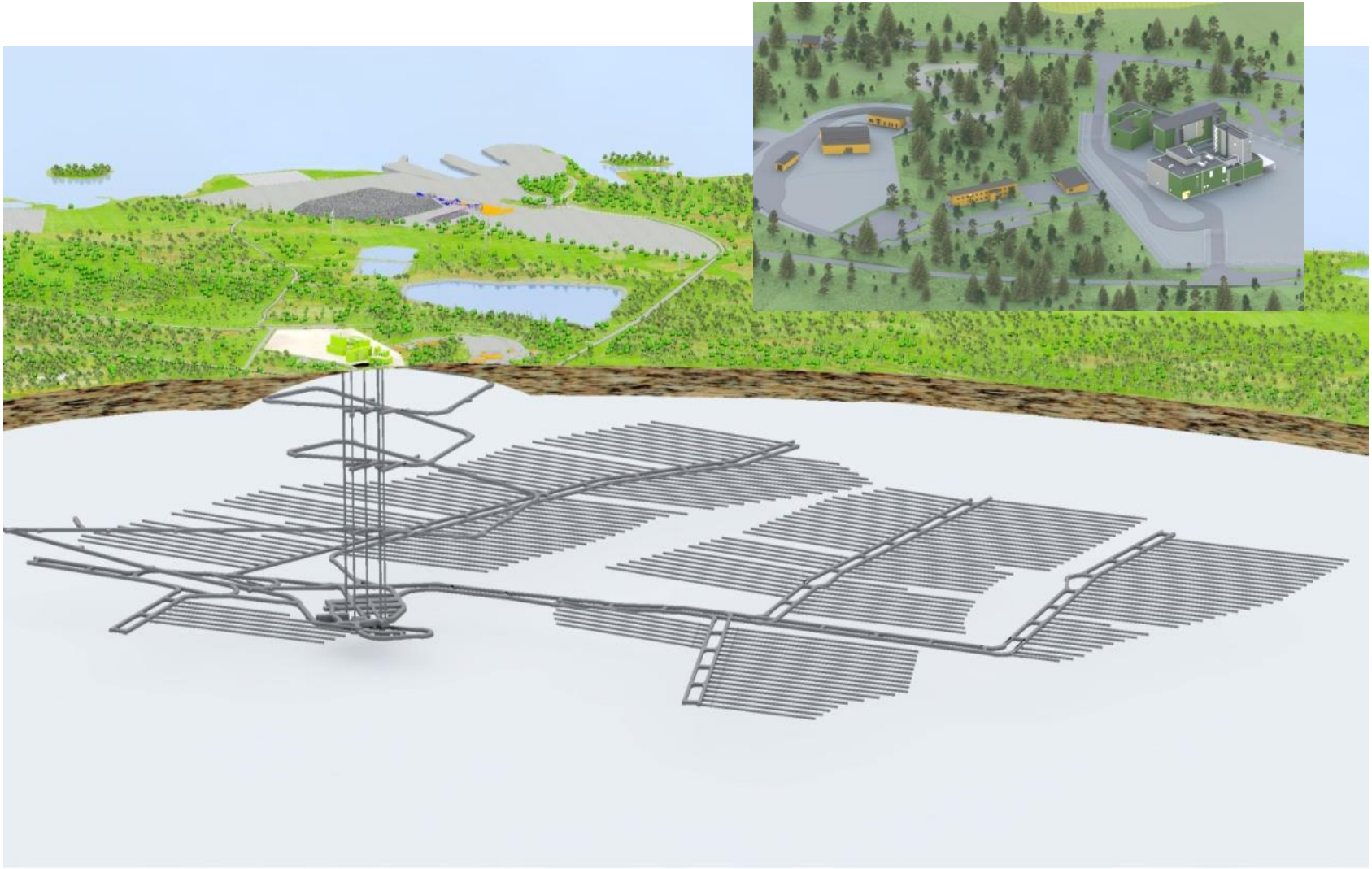




A = 3552 – 5223 mm
B = 1050 mm

mass of the copper = 5.6 – 8 ton
total canister mass = 18.8 – 29 ton

Final repository around 2120's (9000 tU)



VAHA - Posiva's requirement management system.

Requirements for the initial state and the long-term safety of the canister welds

- nominal thickness of the overpack is 49 mm
- minimum intact copper thickness is 35 mm and 40 mm in 99% of the canisters' wall thicknesses
- components shall not have macroscopic defects larger than 15 mm in depth
- chemical composition shall fulfil the specification in EN 1976:1998 with the following additional requirements: O < 5 ppm, P = 30 - 100 ppm, H < 0.6 ppm, S < 8 ppm
- elongation at rupture shall be > 40%
- creep ductility of the overpack shall be > 15%

VAHA - Posiva's requirement management system.

Requirements set by NDT, manufacturing and handling in encapsulation and disposal plant

- Capacity of the welding process has to be 40 to 60 canisters per year.
- Maximum grain size of the weld and base material has been set to 360 µm to enable sufficient material properties concerning ultrasonic
- Because of high radiation level near canister, system has to be remote controlled.
- Welding system has to produce a weld, which fulfils the acceptance criterions. Reliability of the welding system has to be good and yield of the production has to be high enough to minimize quality costs

Chemical composition of weld material

Chemical composition of the weld material should be such that creep ductility and corrosion properties don't impact long term safety of the copper canister.

	P, [ppm]	S, [ppm]	H, [ppm]	O, [ppm]
VAHA	30 - 70	< 8	< 0.6	< 5
Base material	44 – 52	4 - 5	0.2 – 0,5	1 - 2
FSW weld material	48 - 56	< 5	0,2 – 0,4	2
EBW weld material	50 - 52	4.9 - 5.2	0.2 – 0.4	1.5 – 2.7

Mechanical properties – FSW vs EBW

		Temp. [º C]	Rp0.2, [MPa]	Rm, [MPa]	A, [%]
	Demand set by VAHA				> 40
EBW	Base material	20	49	201	58
	Weld, transversal	20	48	193	34
	Weld, longitudal	20	41	188	50
FSW	Base material	20	76	206	51
	Weld	20	75	207	51
	Weld	100	69	198	45

Creep properties – FSW vs. EBW

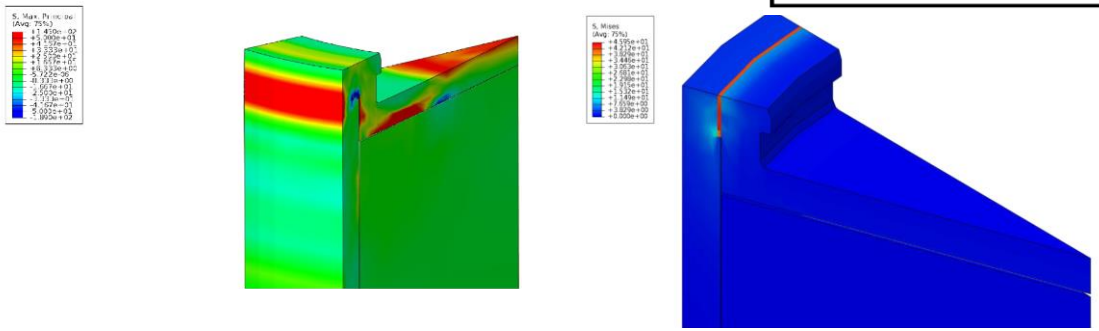
VAHA: Creep ductility of the overpack shall be > 15% at 80 - 90 º C

FSW:

Location of the tests specimen	T [˚C]	Stress [MPa]	Elongation [%]	Red. of area [%]	Time [h]
base material	175	145	38.9	85.7	163
cross-weld top	175	150	38.3	87.5	40
cross-weld bottom	175	147	35	85.6	45
cross-weld radial, test 1	175	136	13.5	48	7.8
cross-weld radial, test 2	175	136	10	41	11,2
cross-weld radial, test 3	175	126	16	75	14,9

EBW:

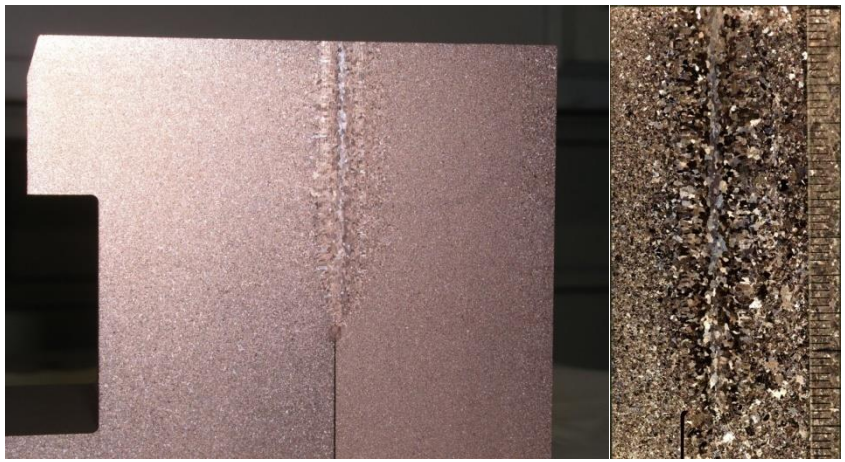
Speci-men ident	Tem-perature T	Nominal stress σ	Time	Engi-neering strain ε_f	Area reduc-tion Z	True stress σ_{true}	True strain e_{true}
	(°C)	(MPa)	(h)	(%)	(%)	(MPa)	(%)
8J	175	125	194	23	67	379	111
9J	175	120	471	25	59	305	89
9N	175	115	844	20	55	256	80
8N	175	100	4405	15	52	208	73
8I	175	100	4656	16	44	179	58
8C	225	95	210	10	34	144	42

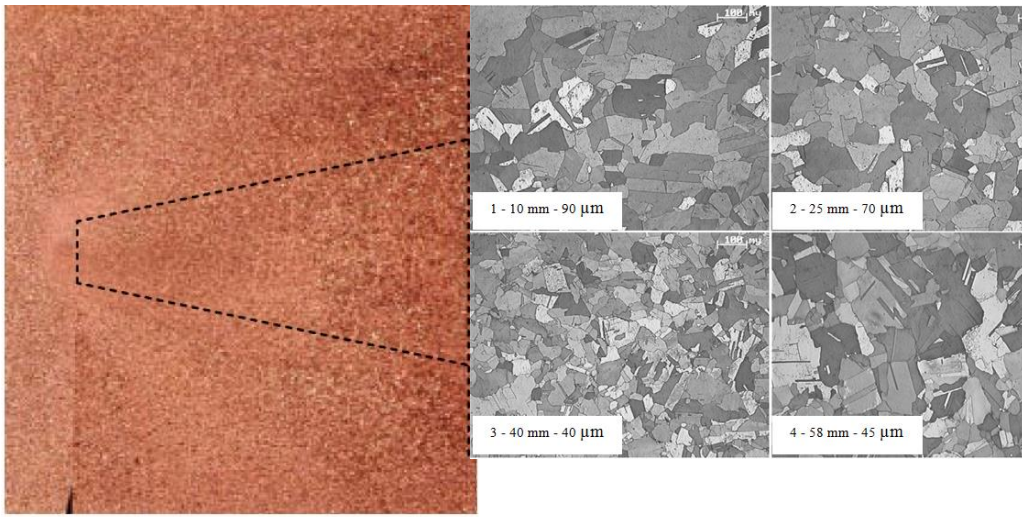


FEM-modelling of the initial state

Grain size – FSW vs. EBW

- EB-welds grain size at transversal direction is 0.5-1.5 mm and at longitudal 10 – 15 mm.
- Average grain size at FS weld is 75 µm.



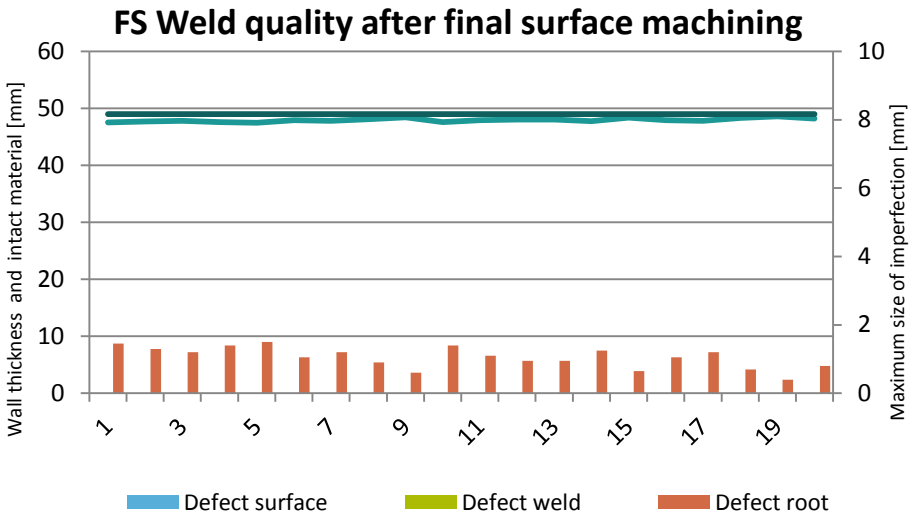


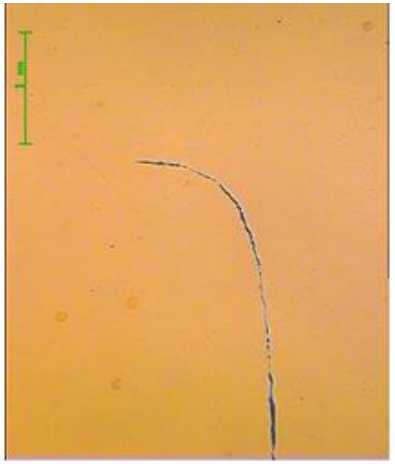
Corrosion

- Possible types of corrosion at final disposal enviroment:
  - Grain boundary corrosion -> impurities at weld material and grain size
  - Stress corrosion -> residual stresses
  - Galvanic corrosion -> possible impurities at weld material
  - Overall corrosion

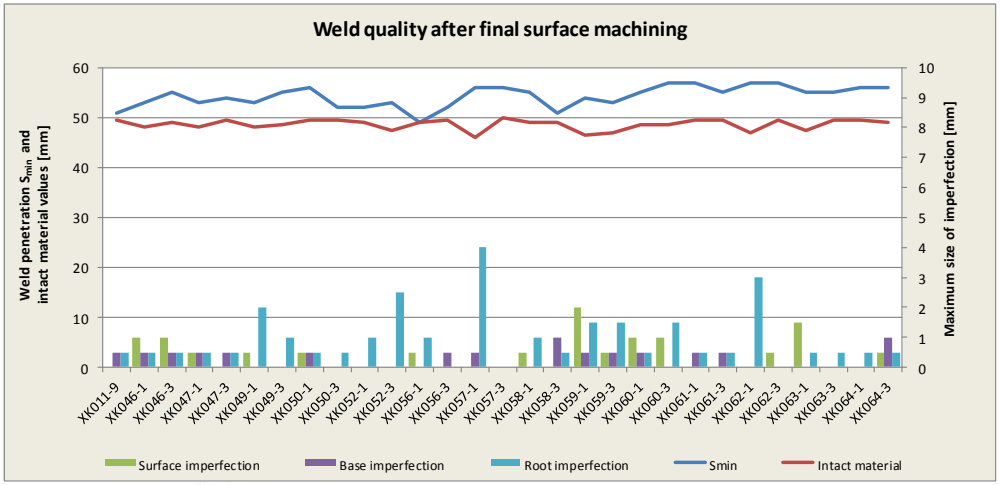
- The conclusion from made studies is that there is no evidence to indicate that the weld region should suffer higher corrosion rates than the rest of the canister shell
- Of the two techniques, it can be said that FSW provides better corrosion resistance than EBW welds, because of the lower residual stresses, the minimal grain growth and the absence of any resultant concentration of impurities at the grain boundaries for FSW

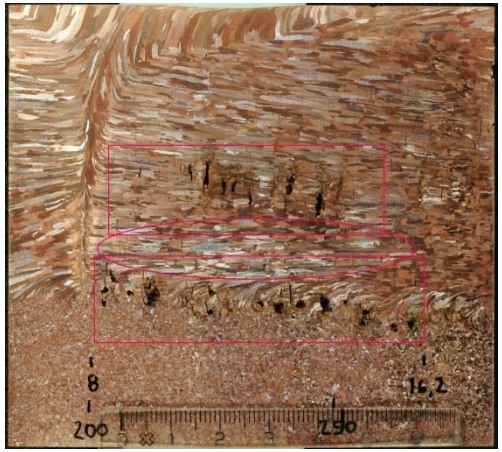
Intact material





JLH

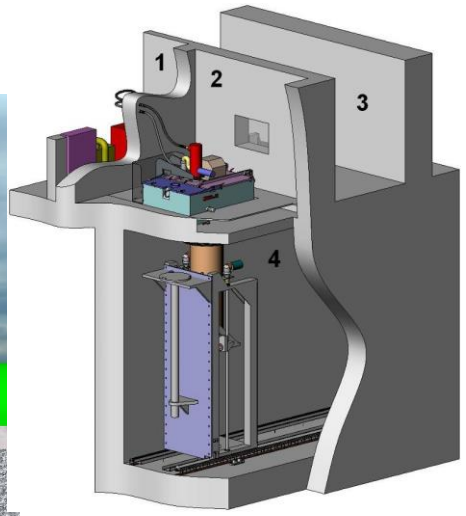




Cold shut

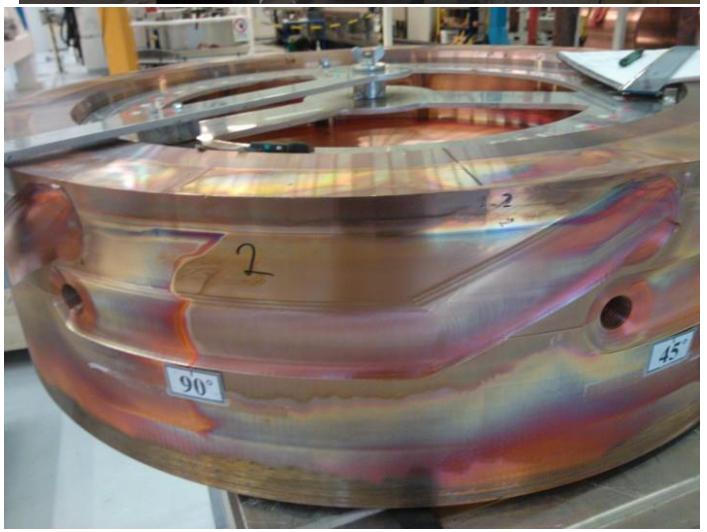
Implementation of the welding machine to the encapsulation plant

- There has been made comprehensive plans for implementation of the EBW-machine at encapsulation plant
- Basics concept of the welding operations is similar



FSW 2013 – welding tests of 5 lids

- During spring 2013 Posiva and SKB welded 5 lids at Oskarshamn.
- 3 tests lids were supposed to use for research that how much does manufacturing method of the components and S-content affects to welding
- lid nro. 4 is used to improve knowledge of Posiva's NDT-work for inspection of the FS-welds



Kiitos

Thank you

POSIVA