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Technical Conference Paper

Gas - Technical Completion of New Salt Caverns at the Epe Underground Gas Storage-RWE WWE Netzservice GmbH

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Fall 2005 Conference
2-5 October
Nancy, France

Gas – Technical Completion of New Salt Caverns at the Epe Underground Gas Storage

RWE WWE Netzservice GmbH

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Gas – Technical Completion of New Salt Caverns at the Epe Underground Gas Storage of RWE WWE N

Content:

Gas – Technical Completion of New Salt Caverns at the Epe Underground Gas Storage of RWE WWE N

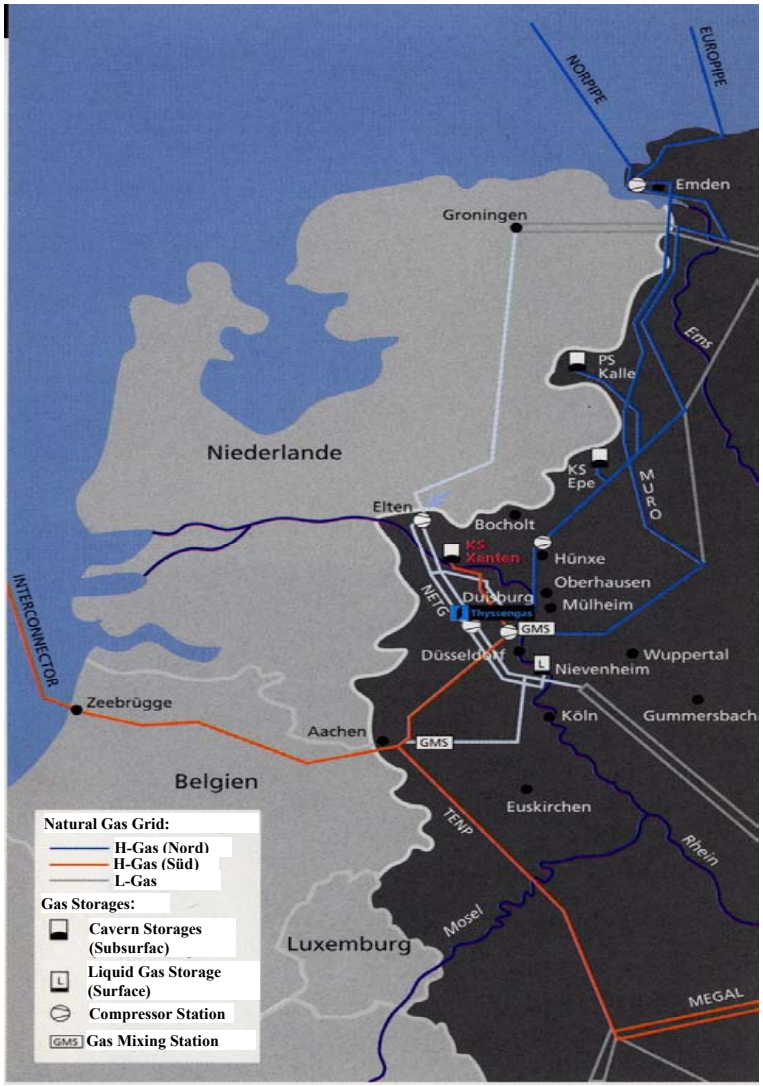
Situation of the Storage Epe:

→ North – West of Germany

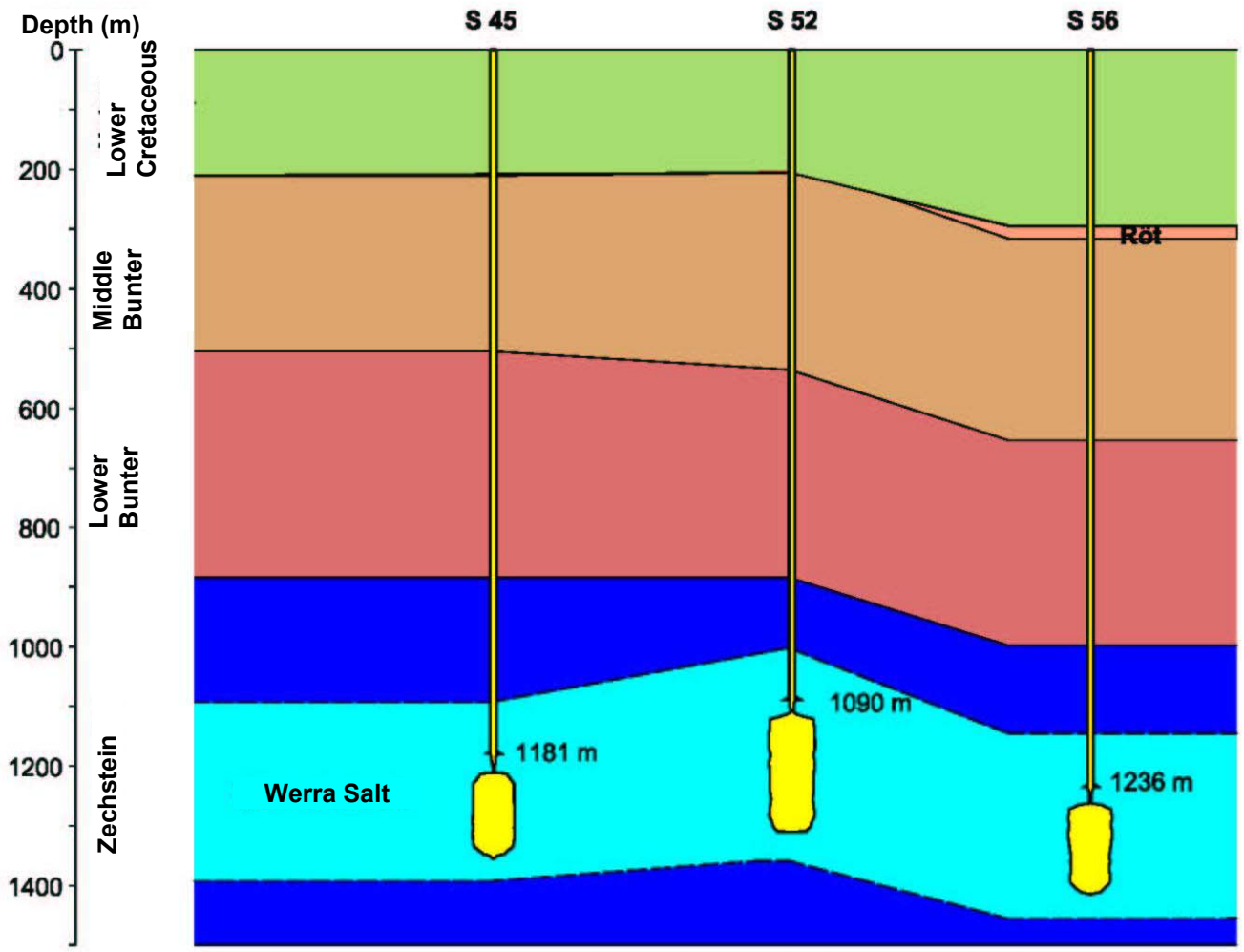
Tie-in to the Gas Grid:

→ Tie-in to the RWE Net East

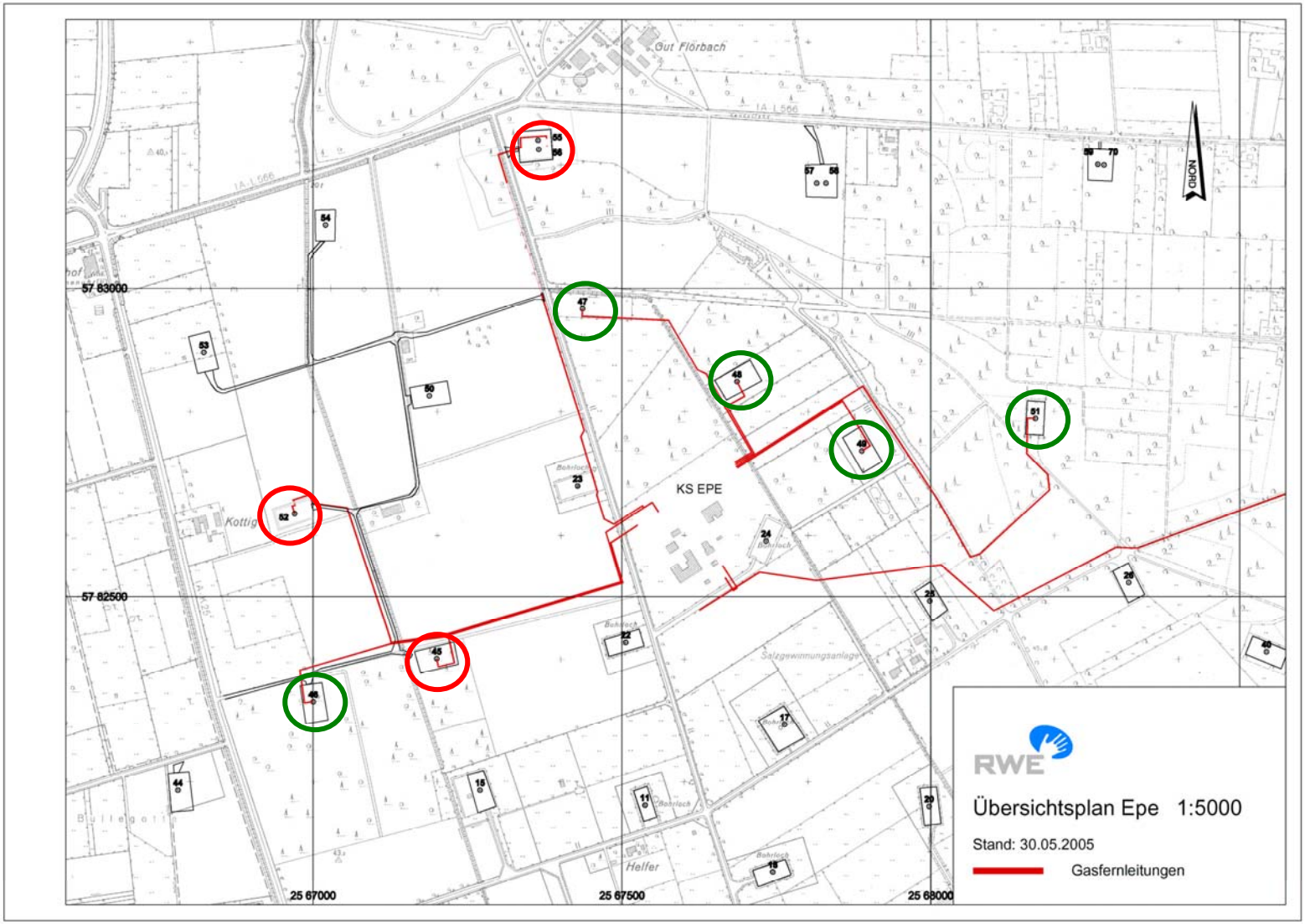
→ Tie-in to the RWE Net West (former Thyssengas)



Gas – Technical Completion of New Salt Caverns at the Epe Underground Gas Storage of RWE WWE N



Volume of Extension of the Gas Storage of RWE WWE in Epe (I)



Existing

Extension

Structure:
- Zechstein

Depth:
- av. 1100 – 1400 m

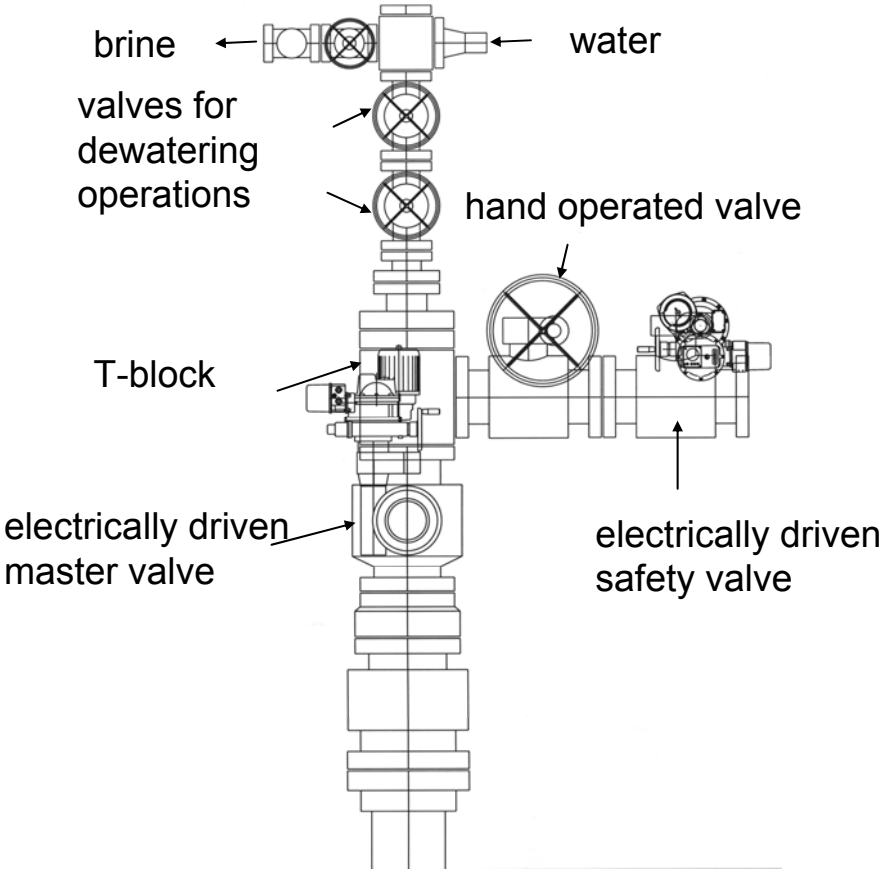
Volume of Extension of the Gas Storage of RWE WWE in Epe (II)

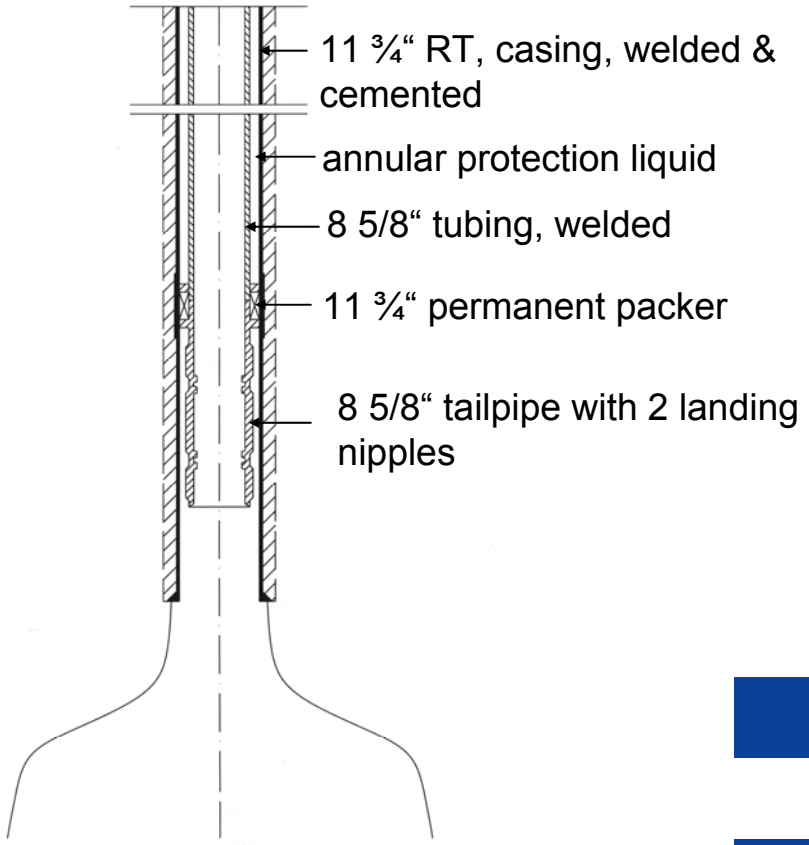
	Number of Single Caverns	Cavern Volume [m³]	Gas in Place [Mio. m³]	Working Gas Volume [Mio. m³]
Stock before Extension (State 10/2002)	5	960.000	215	167
Volume of Extension	3	1.100.000*	245*	193*
Stock after Extension (State 05/2005)	8	2.060.000*	460*	360*

* figures subject to sonar survey in gas

→ **since 04/2005 the next step of extension with one cavern is under construction**

Completion of new Caverns (I)

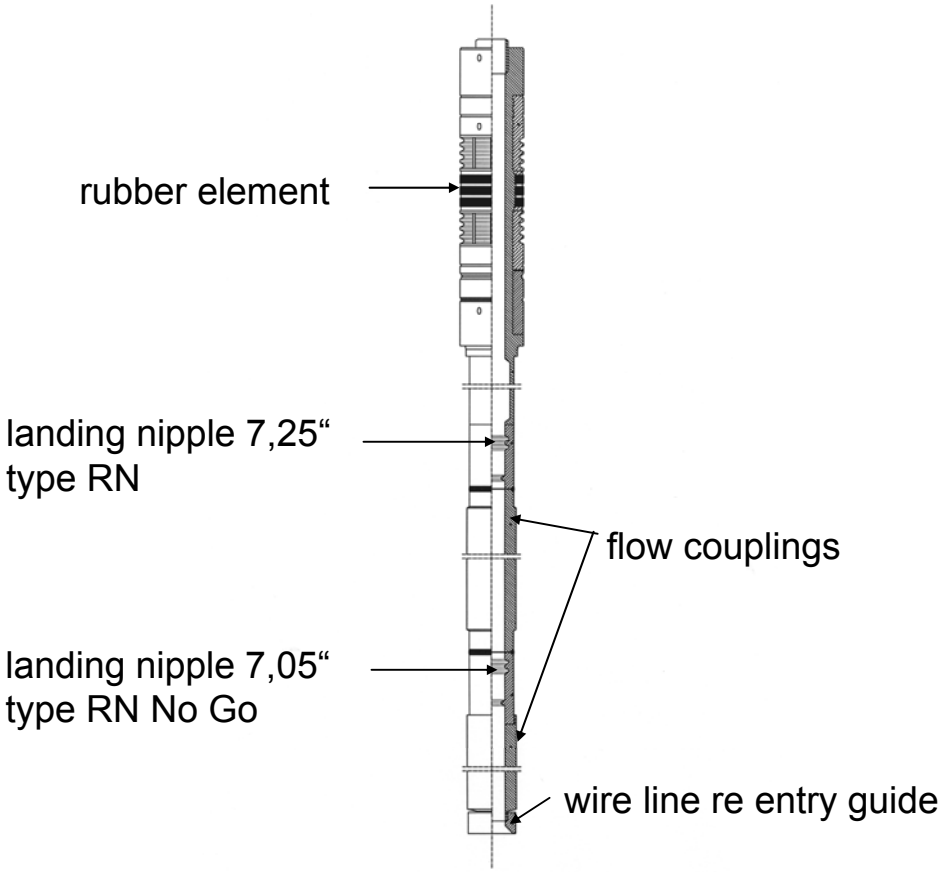


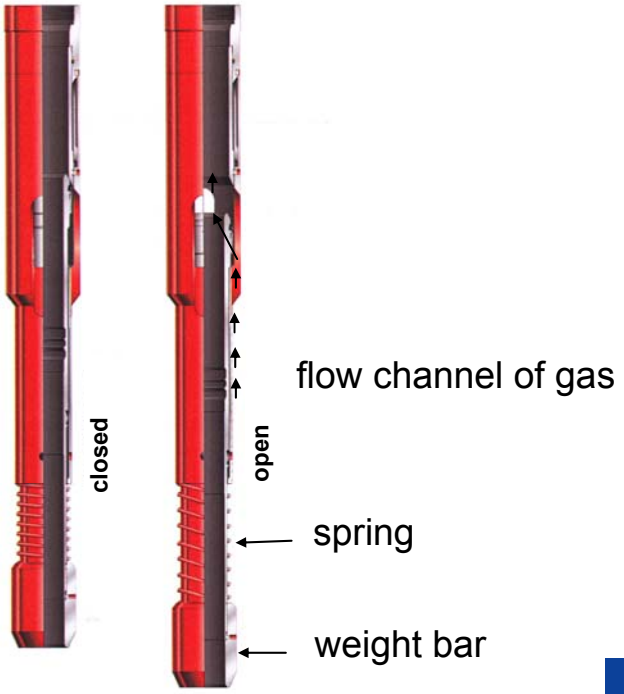


- Well Head
  T-Block Type

- Subsurface Completion

Completion of new Caverns (II)





- 11 ¾“ Permanent Packer
- Tailpipe with 2 x Landing Nippels

- Subsurface Saftety Valve
  Storm Choke Type

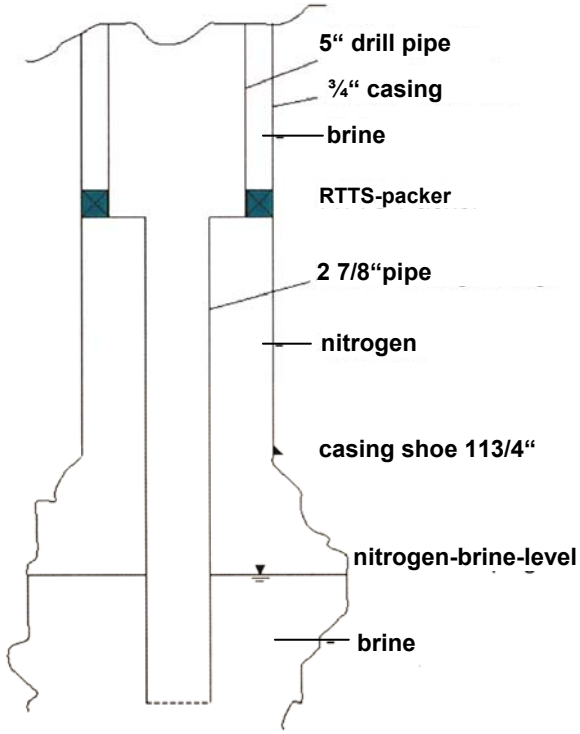
Completion Technology (I)

1. Assessment of 11 ¾“ Casing by USIT-Survey

2. Integrity Test of 11 ¾“ Casing Shoe

3. Setting of Packer and Tailpipe and Running-in of welded Tubing

4. Injection of Annular Protection Liquid



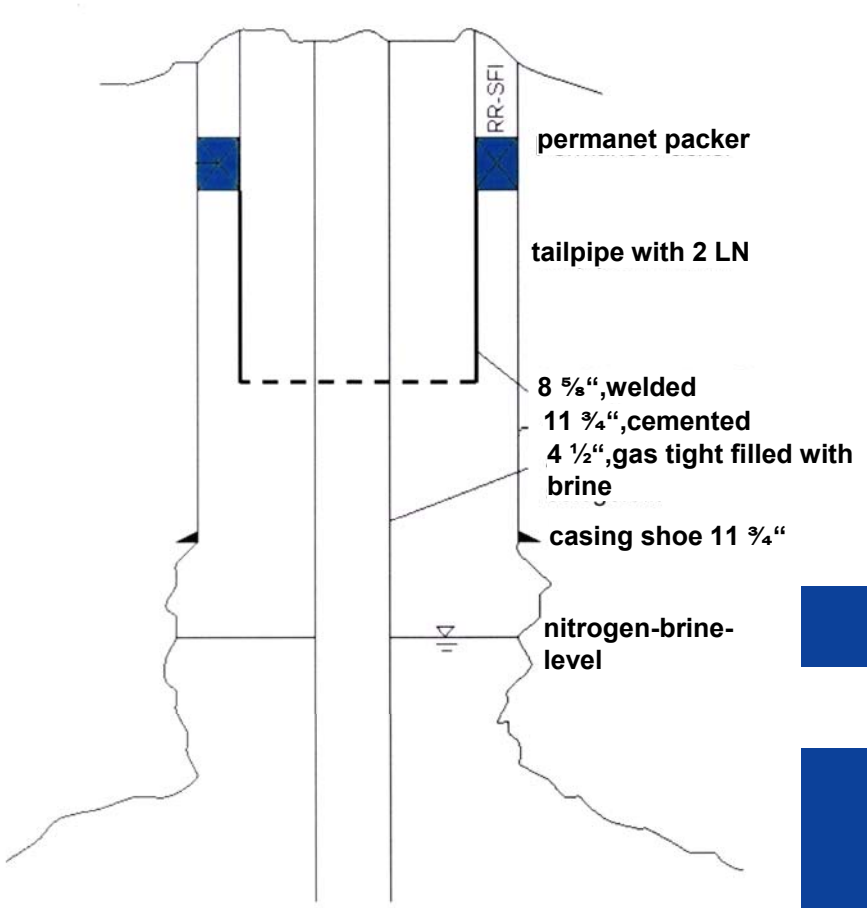
Completion Technology (II)

5. Assessment of 8 5/8“ Tubing by USIT-Survey
   → inadmissible Reduction in Wall Thickness at S 45

6. Completion of Wellhead

7. Running-in of Dewatering String and Final Completion of Wellhead

8. Integrity Test of Final Completion incl. Casing Shoe of Last Cemented Casing



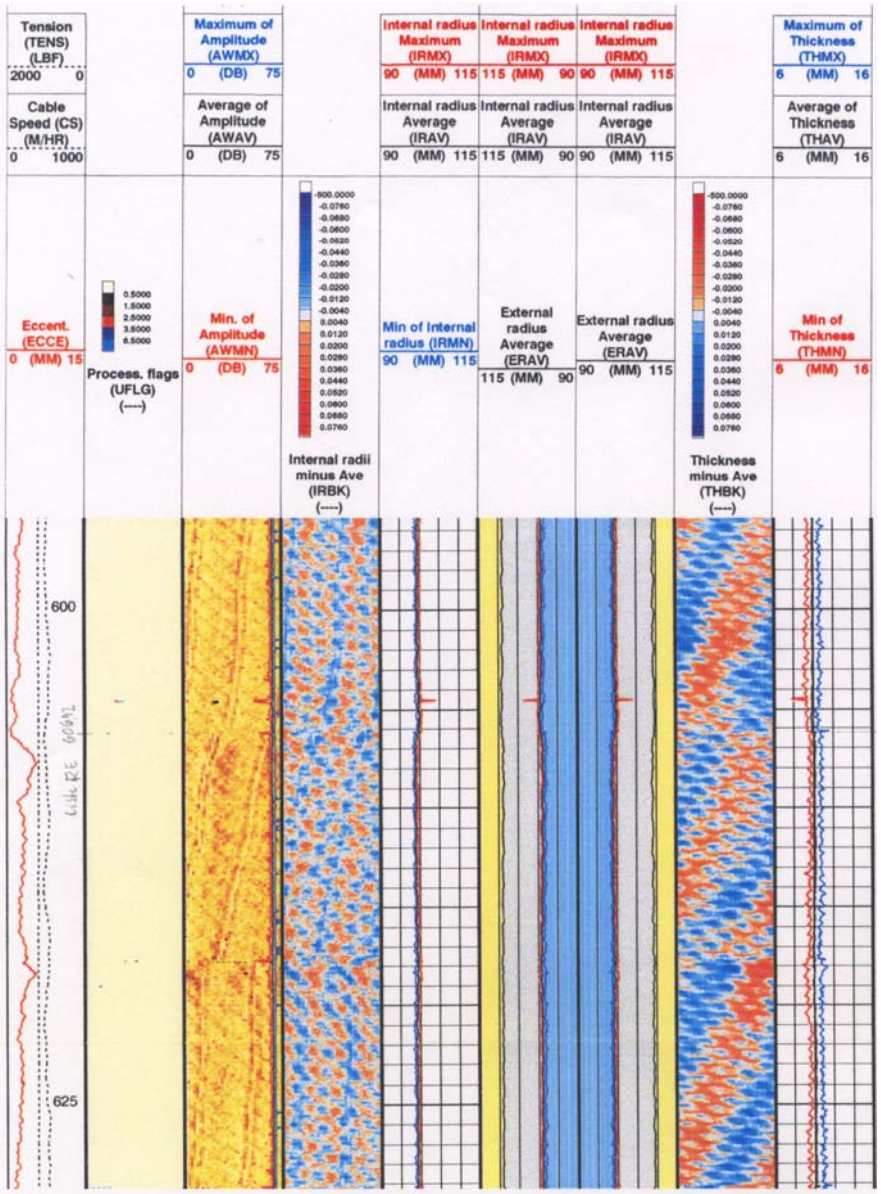
Additional Tests of 8 5/8“ Production String (I)

Starting Situation:

- design of production string in accordance to WEG-guideline
- tubing material ordered according to terms of delivery of API 5 CT
- supply of tubings with 3.1 C certificates (independent assessor)
- inspections before running-in: visual inspection, calibration
- inspections after running-in: USIT survey as correlation log (first log)

  for a later corrosion assessment

Additional Tests of 8 5/8“ Production String (II)



➡ •Inner Tubing:

strong roughness

•Internal Radius:

unsteady, only a little oval

• Wall Thickness:

variation from 9,5 ... 11,0 mm

reduction in wall thickness at a depth of 604,5 m: 7,68 mm

repeat run: 8,26 mm

➡ Inadmissible Reduction in Wall Thickness!

➡ • Conclusion:

further assessment of reduced wall thickness is necessary – possibly tubing needs to be pulled out of hole ?!

Additional Tests of 8 5/8“ Production String (III)

Analysis of the Problem:

- check with video runs

➡ confirmation of rough internal wall

➡ a defect in wall thickness is complicate to dedect by internal wall structure

➡ by some video runs a possible defect was detected which correlates with USIT results

➡ kind of defect: Overlap !

- check with multifinger tool

➡ no confirmation of wall defect

➡ problem: distance and shape of multifinger arms

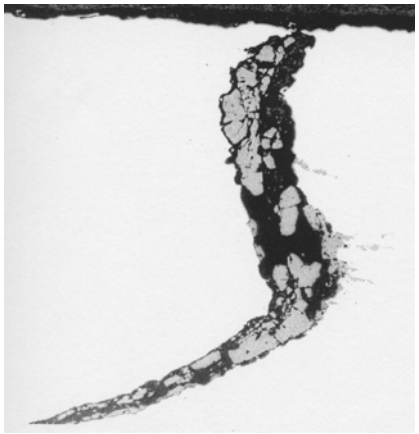
Conclusion:

• It wasn`t possible to determine the defect clearly by the additional subsurface investigations.

Additional Tests of 8 5/8“ Production String (IV)

Further Steps:

- detailed analysis of the remaining tubings regarding material properties and kind of defects:

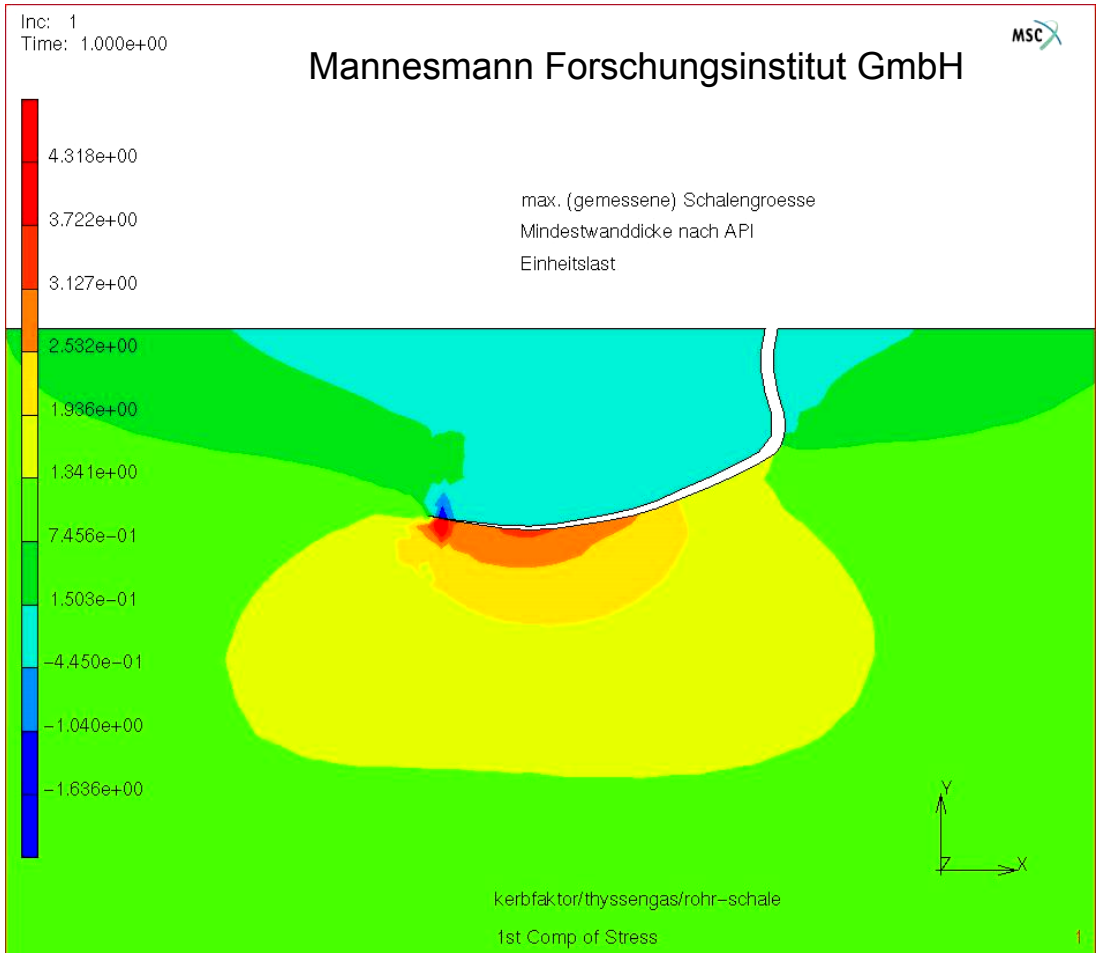


→all defects were OVERLAPS

- calculation of tubing strength by „Worst-Case-Scenario“
  - apply of max. possible defect regarding wall thickness
  - consideration of long defects
    (in case of short defects the material strain is lower)

Additional Tests of 8 5/8“ Production String (V)

Distribution of Longitudinal Stress (Notch Factor) under Maximum Load:



- stress maximum at the end of the defect
- nominal stress developes in parallel to the crack
- no rip up of the crack must be expected
- no growth of the crack

<u>Danger:</u>

- development of a new vertical crack caused by local stress maximum (material fatique)
- break down of the tubing
- determination of maximum possible load changes until break down

Additional Tests of 8 5/8“ Production String (VI)

Estimation of Lifetime according to AD-Merkblatt S2:

- in case of measured minimal local wall thickiness without defects (notches, **overlaps**)

  → creep strength is given by calculation

- in case of measured minimal local wall thickness plus defects

  → creep strength is not given
  → plastic deformation

- determination of allowable load changes according to the „Merkblatt“

  → calculated number of load changes to the break down is 65.470
  → allowable for operation are 10% of these load changes: 6.547

  → SUFFICIENT FOR THE LIFETIME OF THE CAVERN !!!

There is no increased risk for the tubing strength under the given operating conditions

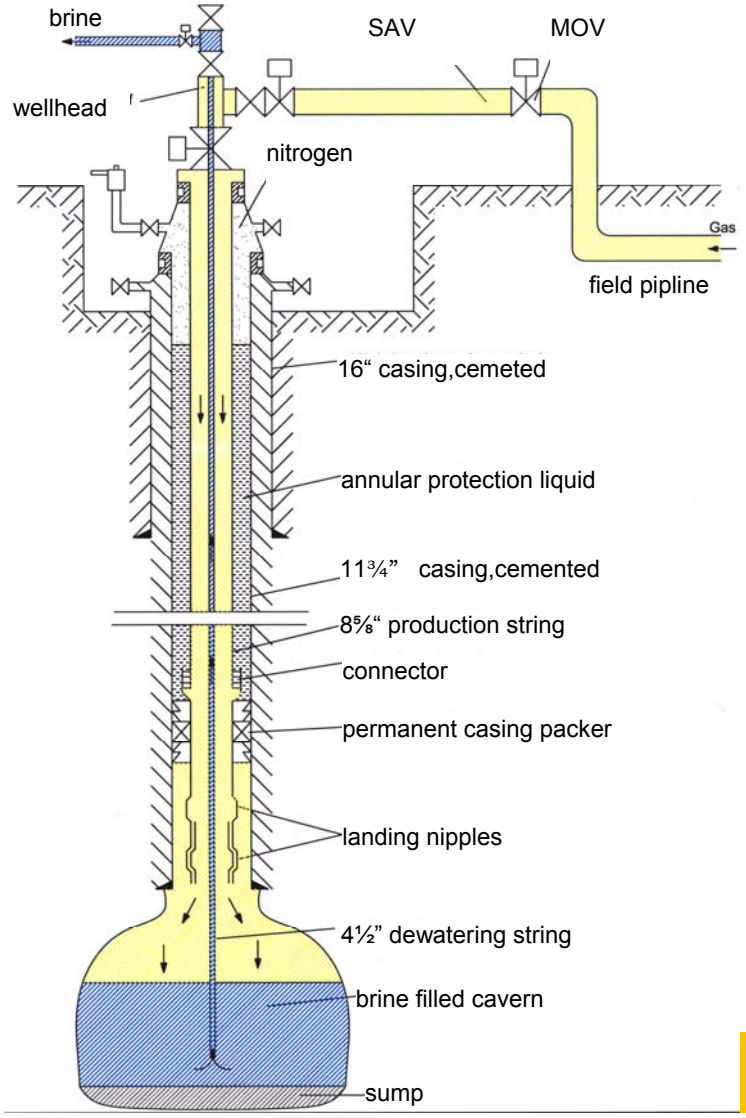
Dewatering Technology (I)

- utilisation of a standing alone plant with intrinsic safety shut off system
  - own power supply (generator)
  - own safety facilities

- data transfer to a control centre (permanently occupied) and engineering office

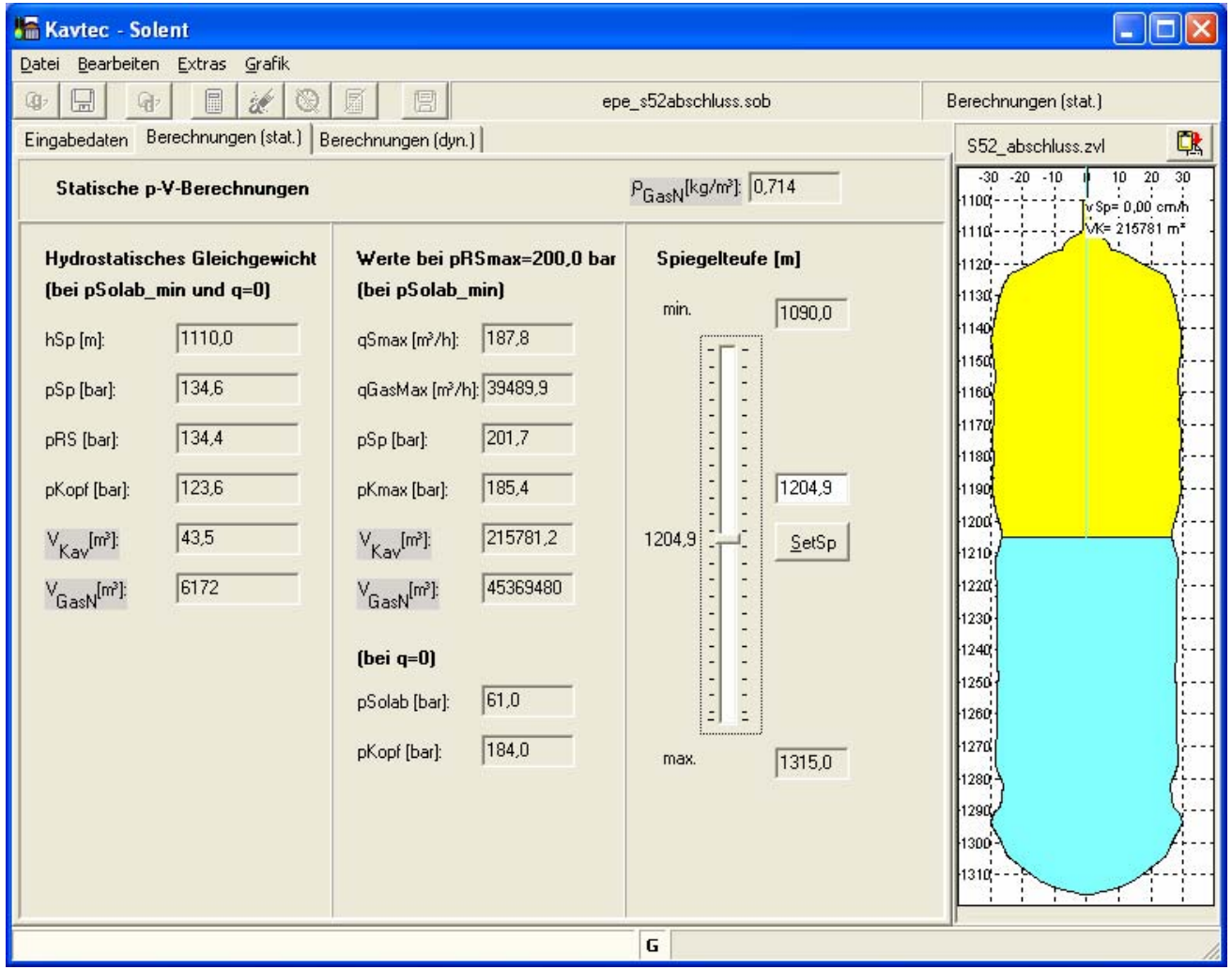
- remote control of the dewatering process

- daily control of the plant by standby staff and execution of purge process



Dewatering Technology (II)

- accompanying of dewatering process applying special software products



New Concepts (I)
- Wellhead -

- Former Layout of the Wellheads:

double completed wellhead Y-block type

single completed wellhead Y-block type

- New Layout of the Wellheads:
  - compact design in T-Shape
  - better access
  - reduction of potential leakages to a minimum
  - discharge of all condensates to the cavern
    → reduction of hydrate formation danger
  - cost reduction

New Concepts (II)
- Safety Concept -

- Former Concept of Safety Valves:

  → utilization of hydraulic actuators (spring mechanism)

- New Concept of Safety Valves:

  → utilization of electrical actuators

- Demand of Mining Authorities to the Safety Valves with electrical Actuators :

  → redundancy in design

  → in case of power failure the valve has to be closed

  → emergency power supply has to be guaranteed

  → in case of doubts the valve has to be closed

New Concepts (II)
- Safety Concept -

- Realisation of the new Safety Concept

→ use of new developed electrical actuators with profibus application

→ use of two single components in non fail-safe technique, in order to obtain a reliable and safe process

→ installation of two programmable control systems, each with its own process interface

→ in case of predefined limit values are exceeded, each PLC system moves its own actuators into a safe direction

→ both systems are monitored synchronically; safety bits will be triggered in case of deviation or synchronisation errors

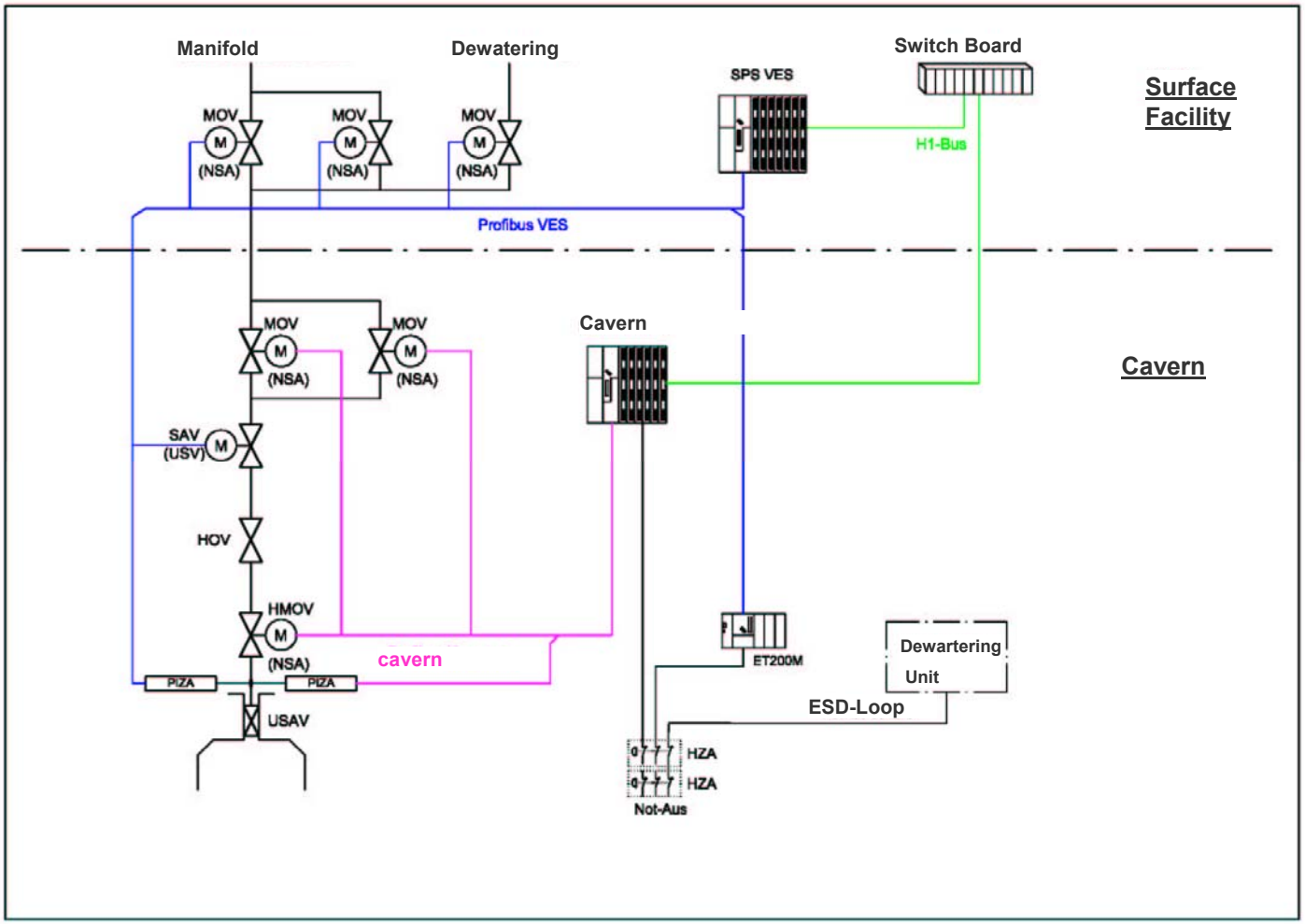
→ two electrical power supply systems are connected

- 400 V low voltage system

- 400 V uninterruptible power supply system

New Concepts(II)
- Safety Concept -

- Configuration



New Concepts(II)
- Safety Concept -

- Advantages of the new Concepts

→ reduction in necessary equipment (no hyraulic unit, smaller container)

→ standard in process and safety engineering regarding to actuators/ sensors

→ simplification of spare part storage

→ centralized data management

→ reduction in maintenance (no vessel inspection of hydraulic unit, leakage control etc.)

→ reduction in costs

→ improvement of environmental compatibility (no hydraulic oil)

Summary

• doubling of storage capacity of the RWE WWE N Storage Epe in this step of extension

• presently, the completion of a further cavern is going on which will increase the working gas volume by approx. 20% once again

• at the production string of the cavern S 45 a defect in wall thickness was determined by USIT-Logging- a standard logging method at the storage site Epe

• The operational safety of the production string was demonstrated by the application of additional calculation methods regarding problems in wall thickness

• under current market conditions a careful production and delivery control is very important and recommendable

• better working conditions and reduction in cost were achieved in this step of extension by development of new concepts.