DEVELOPMENT OF THE PERFORMANCE OF THE LOENHOUT UGS (ANTWERP - BELGIUM)

DRILLING THROUGH A HIGHLY KARSTIFIED AND FISSURED LIMESTONE RESERVOIR UNDER GAS STORAGE OPERATION



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- ❑ Characteristics & Performances of the Loenhout UGS
- ❑ Reservoir geological conditions : Karstified gas reservoir
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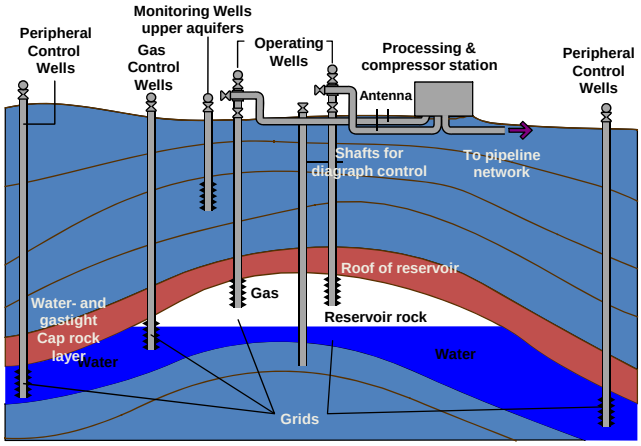
Aquifer UGS Principle



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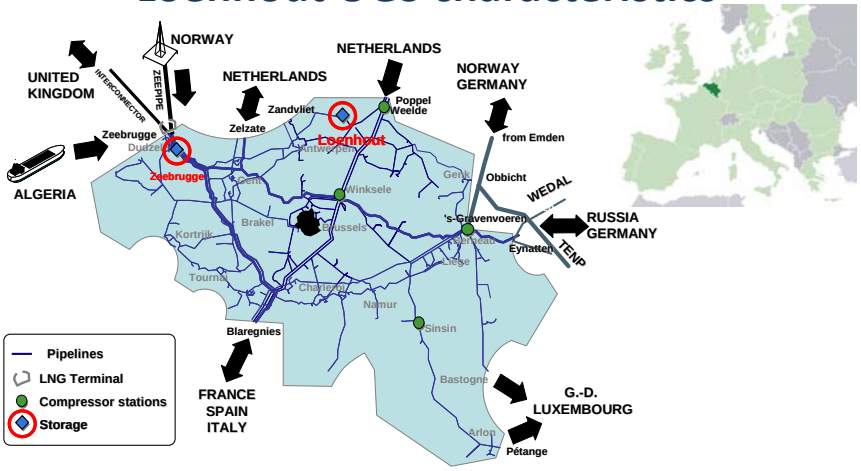
Loenhout UGS characteristics



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Loenhout UGS Characteristics

- **Storage depth :**
  - Top : - 1.080 meter
  - Authorized depths : - 1295 / -1340 meter
- **Surface covered :**
  - Surface : 19 ha
  - Underground : 2.810 ha
- **Storage Capacity :**
  - Current capacity : 1.4 billion Nm^3 (52 BSCF)
  - Working gas : 0.7 billion Nm^3 (26 BSCF)

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Loenhout UGS Characteristics

- **Working pressures :**
  - Max BHP : 150 bar g
  - Min BHP : 90 bar g
- **Production :**
  - Send out : 625 000 Nm^3/h (560 MSCF/D)
  - Injection : 325 000 Nm^3/h (290 MSCF/D)
- **Operation Wells network :**
  - Inject./Prod. : 12
  - Platforms : 4

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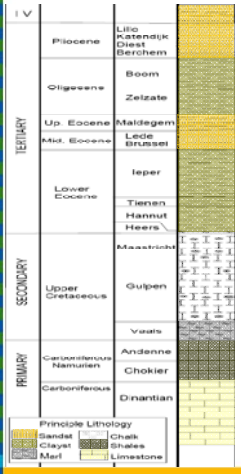
Loenhout UGS Geological Characteristics



The Reservoir (top @ -1080 m) :

- Tight and compact carbonated rocks matrix
- Fissured and karstified rockmass.

The Caprock :

- Impermeable Namurian shales
- hundred meters thick .

Upper formations (Aquifers & Aquitards) :

- 300 meters thick Cretaceous layers
- Alternation of 650 meters of clay and sand layers of Tertiary and Quaternary ages.

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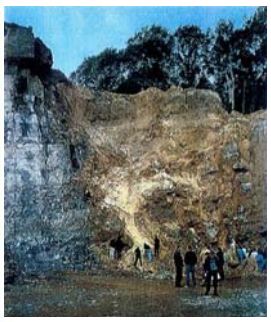
Loenhout UGS Geological Characteristics



The reservoir porosity comes from complex interconnected caves network created by the dissolved carbonates (karst):

- **Karsts filled with sediments** rich in uranium, composed of detritic material and carbonated fluid deposits coming from upper Namurian cap rock formation.

- **Opened karsts exhibiting very high local permeability values**, which are revealed during drilling phases by total or partial losses of drilling mud or even by free falls of drilling tool by some meters.

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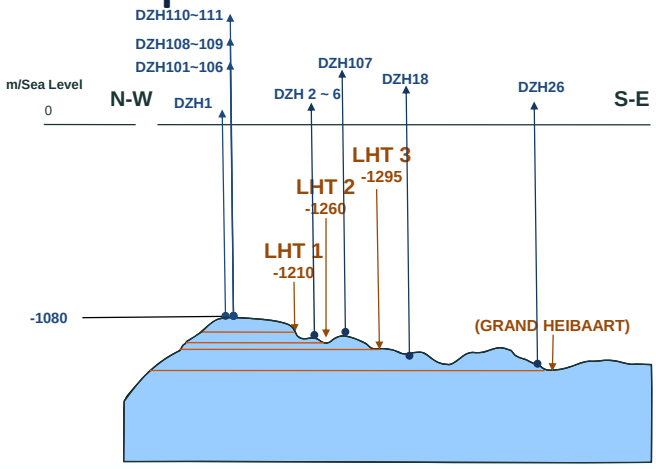
Development of Loenhout UGS



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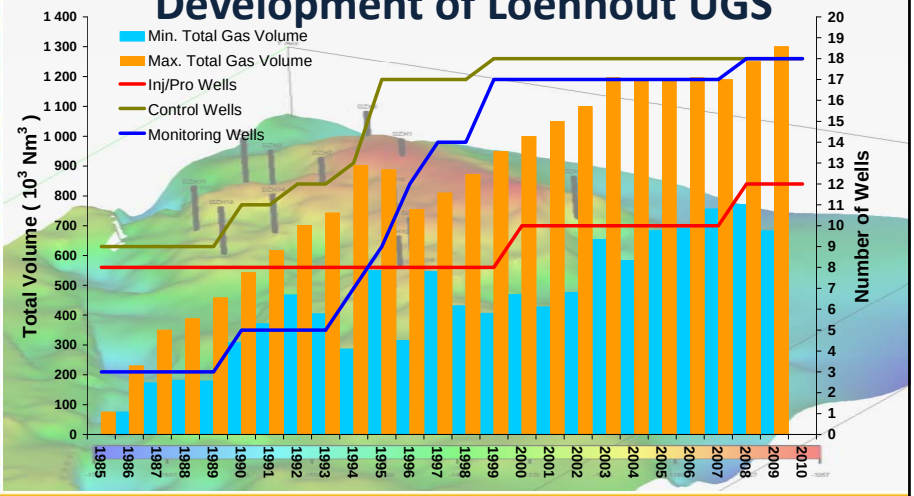

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Drilling works Methodology

Loosing of mud circulation through the highly permeable fissured and karstified reservoir is frequent.

The chance to recover circulation is very low when intersecting opened karsts

How to manage in fully safe conditions, the drilling and then the setting of a final completion in a karstic zone where the well is likely to intersect vacuums and highly permeable fissures, constantly supplied in pressurized gas ?

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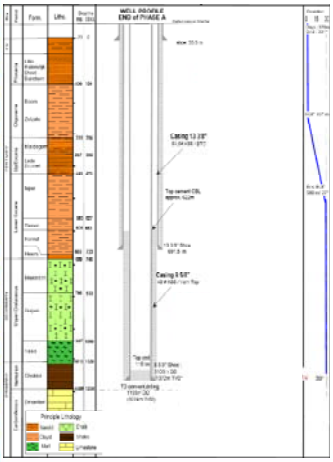
Drilling works Methodology



- **The first phase :**
  - Drilling through all the upper aquiferous formations down to the caprock formation,
  - Casing the holes and cementing the production casing into the caprock.

Since there is no gas involved in this phase the well is drilled with a conventional drilling rig equipped with a standard Blowout Preventer.

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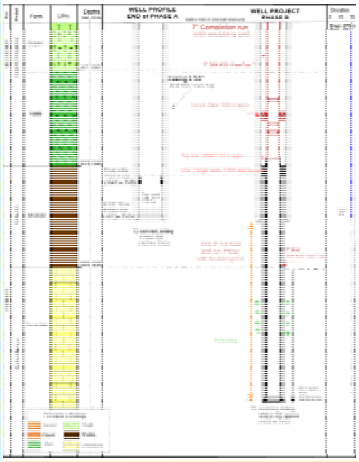

- **The second phase :**
  - Drilling through the caprock and trough the karstic reservoir formation under gas pressure,
  - Run in the liner into the reservoir,
  - Setting the liner packer in the production casing,
  - Cementing the liner.

This phase is carried out with a snubbing unit to allow complete control of operations with gas pressure at the wellhead.

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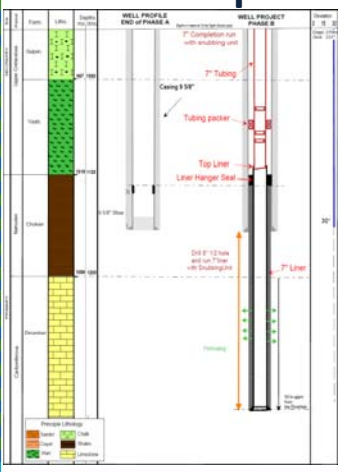
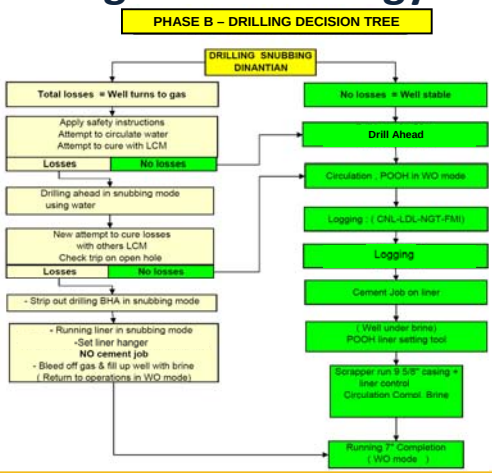
Adapted drilling works strategy





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Liner running and setting in gas conditions

- **Design Requirements :**

– **Liner elements have to be strippable;** i.e. length and diameter of assemblies have to be compatible with HWO characteristics,

– **The liner shoe has to be equipped with a double check valves system** in order to be run in hole for any possible wellhead pressure condition,

– **The liner packer has to be tightly set** in the cemented production casing, in order to be able to install the gas well completion in workover mode, under hydrostatic conditions,

– **The liner can be cemented,** if reservoir permeability conditions allows to.

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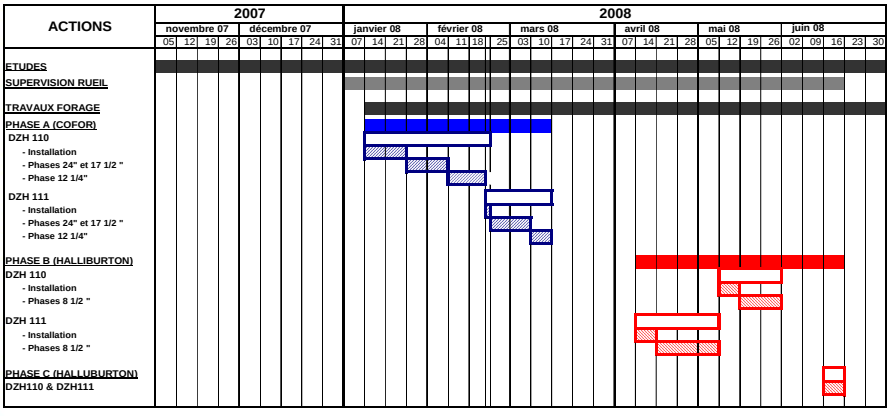
Case History : Drilling works of live gas wells in Loenhout



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Case History : Drilling works of live gas wells in Loenhout

PHASE A – CONVENTIONAL DRILLING

(Rig COFOR MR7000)

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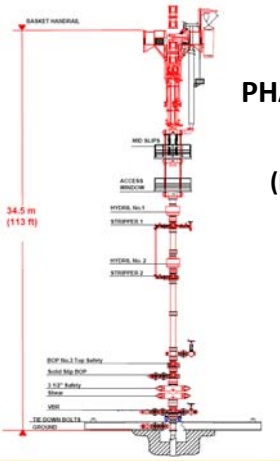
Case History : Drilling works of live gas wells in Loenhout



PHASE B – Snub-drilling and completion

(Halliburton HWO Unit)

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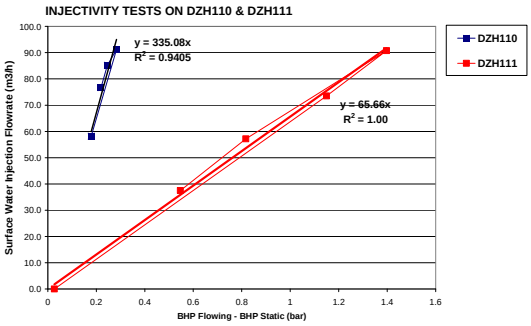
Case History : Drilling works of live gas wells in Loenhout

PHASE C – Perforations and injectivity tests

(Halliburton)



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Conclusions

The development of an Underground Gas Storage is a continuous development process, which necessitates a reasoned scheduling and design of the drilling of new wells into gas reservoir zone, without any interruption of the storage operation activities.

The locally extremely high permeability of the karstified reservoir of the Loenhout UGS which is very favorable for the performances of an underground gas storage facility, is constraining for the realization of new gas wells.

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Conclusions

The methodology and strategy designed and developed for the drilling of live wells in the karstic gas reservoir of Loenhout, has demonstrated its full effectiveness during the drilling campaign of 2008, and validated the technical options selected at design stage.

It has been demonstrated that an optimal combination of a conventional drilling rig with an adapted snubbing unit allows to successfully satisfy the safety requirements, while maintaining the control of the work schedule.

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