CONCLUSIONS OF THE SEMINAR ON UNDERGROUND GAS STORAGE, BIOGAS AND LNG SITES

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GIES - ROMANIA

- 14th May 2019 – Sibiu, Romania - 7th meeting of the Commission Expert Group on the control of major accident hazards involving dangerous substances („Seveso Expert Group")
- Wednesday 15th May 2019 – Seminar on underground gas storage, biogas and LNG sites
- Site visit on Seveso implementation challenges - Thursday 16th May 2019 - Medias - Natural Gas Museum visit

SEMINAR

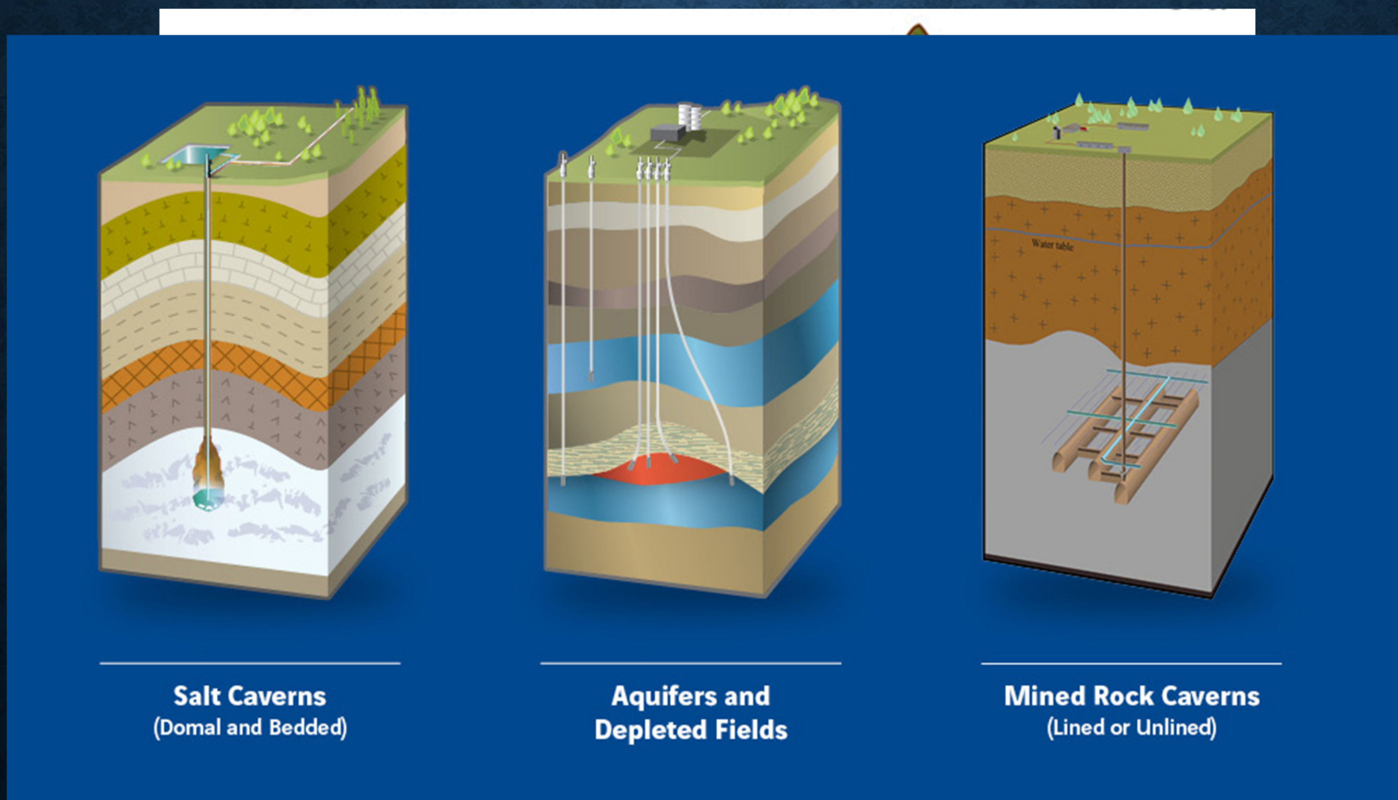
- I – Underground storage of natural gas
- II –LNG bunkering, storage and distribution
- III – Production and storage of biogas

SESSION I - UNDERGROUND STORAGE OF NATURAL GAS

- Underground gas storage in natural strata - Differences between gas extraction from natural strata and gas storage into natural depleted strata
- **Challenges related to risk assessment for land use planning related to natural gas storage in naturally depleted strata**
- Underground gas storage/extraction in natural cavities and / or salt / coal mines Storage of natural gas in caverns in a former uranium mine / crystalline structures (cavern reservoir Háje) in the Czech Republic
- Underground gas storage in excavated caverns cavities – Norway
- Challenges in risk assessment and the development of risk assessment guidelines for competent authorities for underground gas storage activities in Italy

Underground gas storage

- There are three principal types of underground storage methods: *depleted oil or gas reservoirs*, *aquifers* and *caverns.*



Source: PB-KBB, inc., enhanced by EIA.

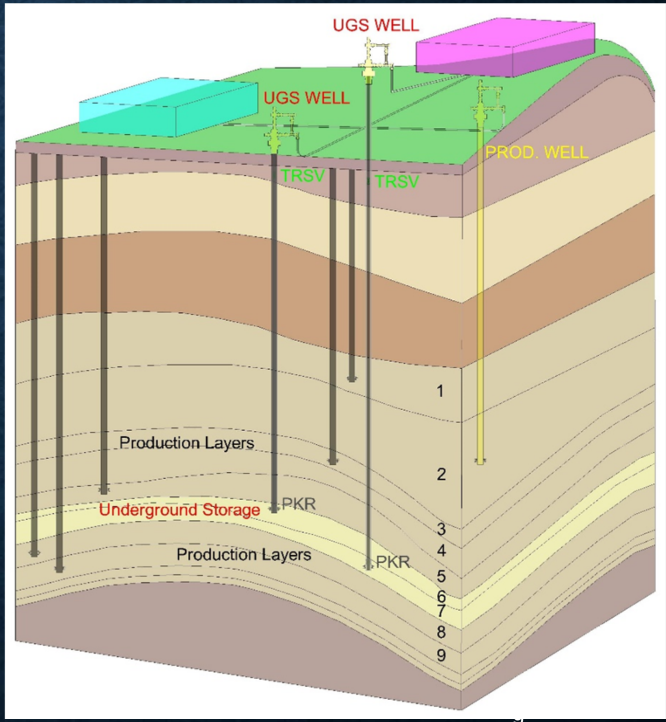
UNDERGROUNG STORAGE IN THE NATURAL STRATA

- The operating storage sites are *depleted gas reservoirs -* natural structures in which gas was trapped and which, once the primary exploitation phase was completed, were converted into storage
- Composition of the storage site
  - Reservoirs (deposits - natural storage systems)
  - Wells (connecting the reservoir with surface plants)
  - Interconnecting flow-lines
  - Surface plants (compressor and treatment units)

UNDERGROUNG STORAGE IN THE NATURAL STRATA

- Hazardous installations: injection / extraction wells; adduction and collector pipelines; common manifold for total and calibration; measuring panels; collector ramps; separation units; drying unit.
- Hazardous activities: injection and extraction of gases; transportation; separation from impurities; drying of gas; interventions in case of malfunctioning wells; maintenance procedures at wells and central station;
- Many accident scenarios – most of them involving fire (wells, adduction or collector pipelines, measurements station) and explosion (crack in the mantle of the separation unit or of the absorption unit) due to both human errors or natural causes (IT).

- possibility of a major technical accident - specific for RO
  - Gas migration from the horizons of the storage facility through behind the columns of the storage wells;
  - Gas migration from the storage strata through behind the columns of extraction wells that cross the horizons associated with the storage activity;
  - Loss of the storage well control through one of the storage wells columns .



CONCLUSIONS

- the underground gas storage activities in gas depleted fields are similar to the gas production activities,
- operational difference:
  - the bidirectional flow in the case of UGS
  - pressure: - less than 20 bar for the production horizon

    - max 45 bar for storage horizon
- the level of wells safety completion in the case of UGS is higher.
- the mining legislation has included special safety distances to objectives from the oil and gas industry which impose slightly longer distances than the distances resulting from SEVESO risk analyses.

RISK ASSESSMENT GUIDELINES FOR COMPETENT AUTHORITIES FOR UNDERGROUND GAS STORAGE ACTIVITIES

1. define a validated methodology of integrated risk analysis in order to quantify the effect of the safety management system and also establish the procedures which are necessary both to reduce the probability of occurrence and to reduce the extent of the consequences of major accidents
2. systematize the risk analysis experience gained over the years in the different regions
3. investigate rules and methodologies applicable to underground gas storage facilities
4. identify credibility thresholds for accident events
5. recognize ways to carry out Na-Tech risk analyses
6. put in place measures to contain methane emissions (greenhouse gas) in conditions other than normal operation
7. create shared guidelines in order to have uniform evaluation throughout the national territory of the risk analyses produced

STORAGE IN THE ROCK CAVERNS

- **Storage space created by excavation and mining of underground rock.**
  - Caverns with steel tanks located inside the cavern.
  - Caverns lined with with concrete and steel
  - Unlined rock caverns (most common)

ADVANTAGES COMPARED TO SURFACE STORAGE

- An underground storage is better protected against oil spills and fire disasters.
- Environmentally better because of lower discharges to air and water.
- The underground facilities are also much better protected against sabotage
- In many cases possible to build below existing facilities, even process areas, and thereby getting double use of the land.
- The product quality is better maintained for long time storage because of stable temperatures inside the caverns.
- The costs for construction, management and maintenance are lower for underground storage.
- Reduced maintenance compared to overground tank storage, winter maintenance is minimised.

CHALLENGES

- Underground storage of LNG in unlined caverns is more complicated , amongst others because of rock stability problems and the extreme temperatures.
- Vapor pressure for propane is at about 6 barg at 10 °C.
- The top of a propane cavern must therefore be located at least 80 m below the ground water table.
- In a warmer climate, the vapour pressure is higher (about 8 barg at 20 °C gives a location of at least 100 m below the ground water table).
- Refrigerated storage of gases - the cooling of the cavern down to operation temperature is a critical and very complicated operation - Important to keep the volume of ice in the cavern at a minimum.
- Too much moisture causes hydrate formations in the coolings-system and problems with loading pumps

SESSION II – LNG BUNKERING, STORAGE AND DISTRIBUTION

POLAND – GAZ-SYSTEM ACCIDENT

- Gas emission in LNG terminal in the port of Swinoujscie on the Baltic Sea – end of October 2017 - due to strong winds (up to 150 km/h) - Upper-Tier Site Natech event - damage to property: ~1,8 mln EUR
- Reccomandation of CA
  - detailed analysis of the impact of atmospheric factors (strong winds, other extreme weather events) on the entire infrastructure of the LNG Terminal – updating the SR
  - gantry cranes on the roofs of LNG storage tanks – design and construction solution for taking into account extreme weather conditions
  - update the instructions and procedures for inspections and maintenance of installations to ensure that defects and faults can be identified at an early stage and corrective action taken.

FRANCE - JONQUIÈRES ACCIDENT

- Series of explosions of the gas cylinders during nearly 5 hours, mid February 2017 - full destruction up to 50 m around the site and impact up to 300 m away
  - Other effects – population evacuated and roads blocked in a 400 m radius, a railway in a nearby shut for a few hours, wildfire in the vineyards nearby

MEASURES IMPLEMENTED TO REDUCE THE RISK

- Reduction of the authorization threshold : from 50 tons to 35 tons.
- Sites must prepare a specific hazard assessment study above 35 tons stored
- To prevent intrusions - making accessibility to the storage area more difficult (anti-intruder devices)
- To detect ignitions – more focus on monitoring and checking
- To minimize the spread of an incident – size of the storage areas, separation distances
- To put out an ignition – imediat reaction to fire
- To protect the population – increase distances between storages and populated areas

SESSION III - PRODUCTION AND STORAGE OF BIOGAS

BIOGAS INSTALATION OVERVIEW IN GERMANY

- Biogas Installations – increse in a exponential way in the last 15 years
- Three types are used – fermentation of waste / agricultural residues / agricultural products (corn)
- Different licensing process – according to size – special one for the establishments under Seveso
- Using of a excel – tool for determine if come under Seveso
- Developed a Technical Rule on Process Safety for Biogas Installations - state of the art of safety technology
- In preparation - Model Piping and Instrumentation Diagrams for Biogas Installations

THANK YOU FOR ATTENTION!