RESULT OF QUESTIONNAIRE ON UNDERGROUND STORAGE OF NATURAL GAS

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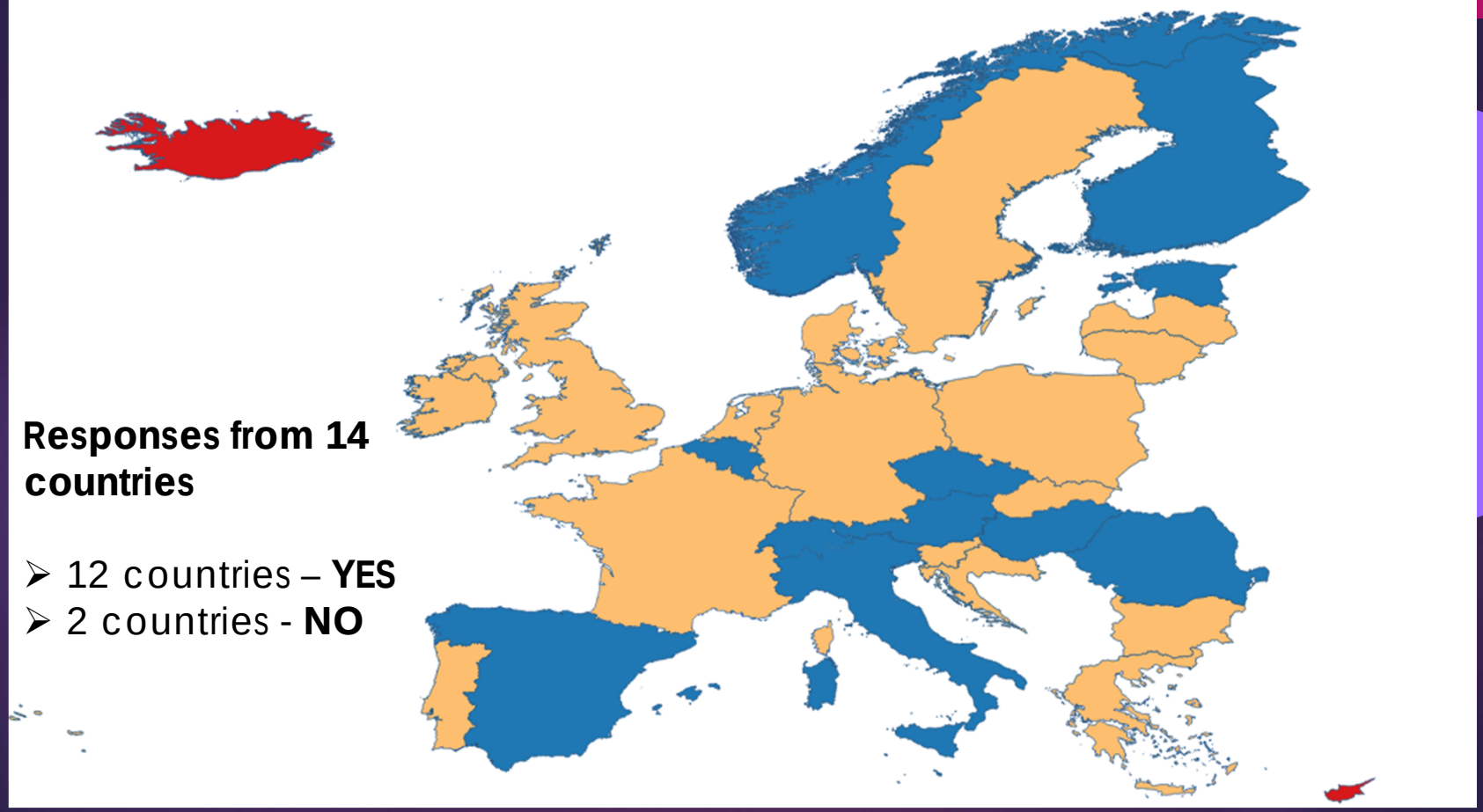
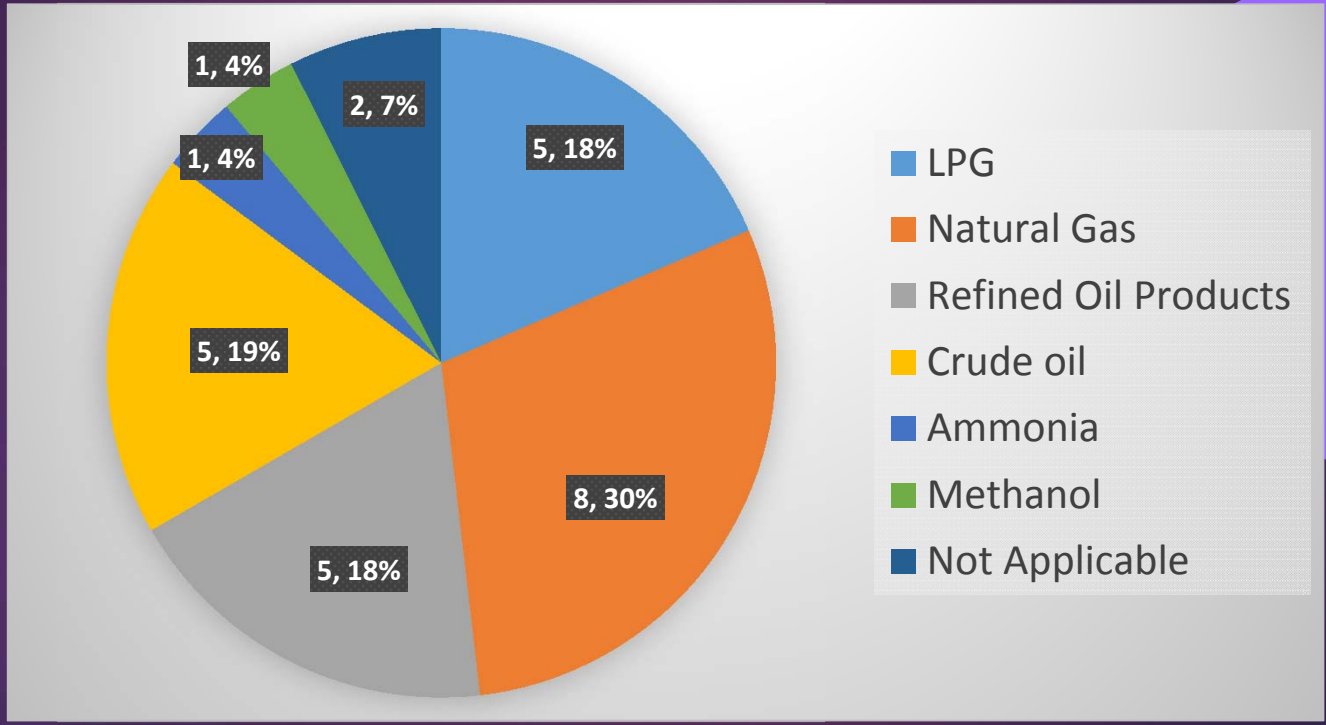
Q2 - Underground storage in operation



Responses from 14 countries

- 12 countries – **YES**
- 2 countries - **NO**

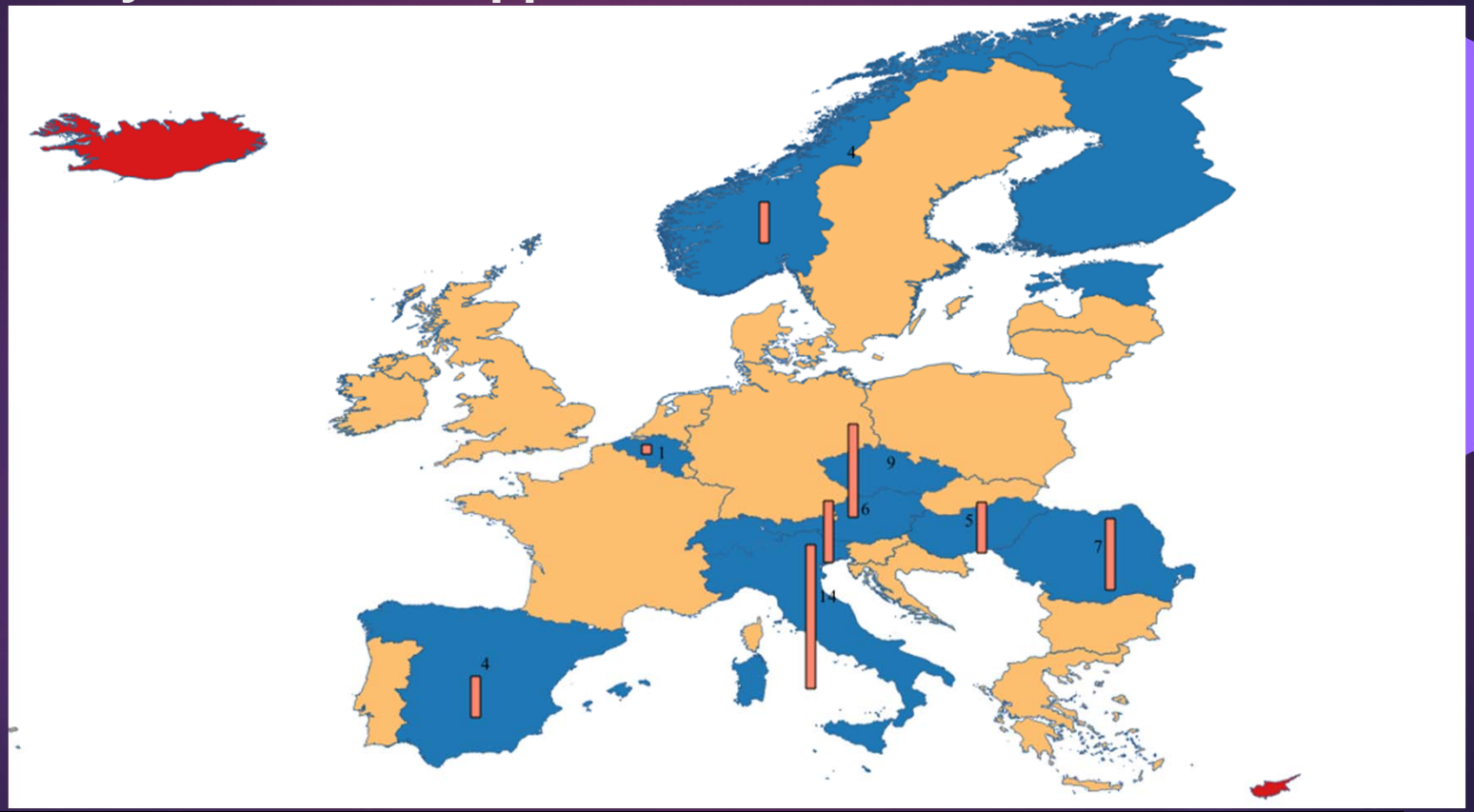
Q3: dangerous substances stored



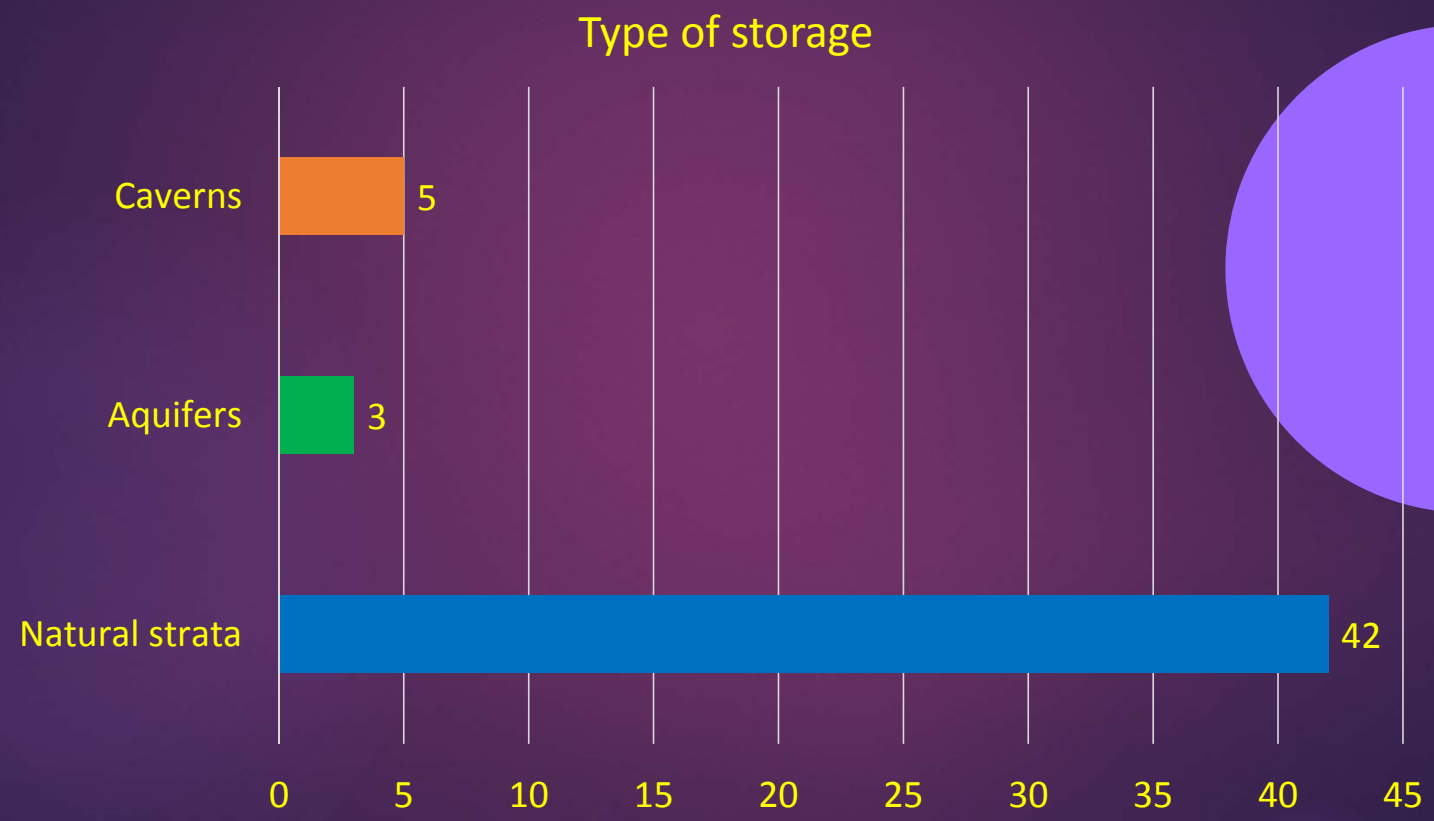
Q4 - How many underground gas storage covered by Seveso Directives exist in your country?

Q5 - How many of them are upper tier?

All of them are upper tier with exception of AT (only 1 / 6)



Q6 – How is natural gas stored?



Q7 - the most challenging issues in implementing/enforcing the Law in an underground storage establishment?

- Land use planning considerations.
- Definition of the establishment
- Connecting pipelines for refined oil products that are located in underground caverns.
- Align existing processes and legislation with the requirements of the Directive / transition from the legislation belonging to the extractive industry sector to the Seveso regulation
- Differences between existing legislation and the new legislation regarding safety distances between establishments covered by the Directive and residential areas, buildings and areas of public use, and major transport routes
- Selecting credible accident scenarios and quantifying their consequences and likelihood
- Analyze the integrity of the natural strata.
- Adequate containment in case of spill (environmental concern)
- Detection of leaks / Safety devices
- Evacuation of personnel
- Access for emergency services in case of an accident

Q8 - Which are the relevant installations from the point of view of safety in an underground natural gas storage establishment?

- Well heads
- Gas pipelines at high pressure (up to 100 bar)
- Desulfurization towers
- Drying towers
- High pressure compressors / pumps
- Mining deposit

- In relation to accident prevention and emergency response, following installations are essential:
  - Distributed Control System, that manages all process control signals
  - Gas leak detection system in compressors
  - Fire detection system
  - Heat detection
  - Fire fighting equipment
  - In terms of well completions: packers and TRSV valves; Inside the gas compressors stations and GTPs: plants Shut Down Valves

Q9 - the main operational causes which may play a role in triggering an accident

- Operational errors / human factors:
  - Most likely accidents could occur during the gas transfer and treatment operations
  - Wrong manipulation (neglecting the instructions),
  - Influences of third parties (accidents on near rail or road)
  - Open ignition sources
- Power failure / Failure of instrumentation and control devices
- Process deviations (such as high pressure), degradation of piping and vessels, maintenance and modification works on the installation.
- Disruption of the integrity of the mentioned equipment and subsequent leakage of flammable gas due to: defect in material, defects in structure, dislocation, mechanical damage
- Poor maintenance, fatigue and aging of material (flange, fittings and valves management, sealing, pipe corrosion/erosion)
- Earthquakes could be a risk since rock layers can deform / other natural disasters
- Loss of integrity of the mining deposit;
- Wells LOC;
- Formation of hydrates;
- release from connecting flow-lines

Q 10 - differences and similarities between exploitation and storage for underground storage of natural gas?

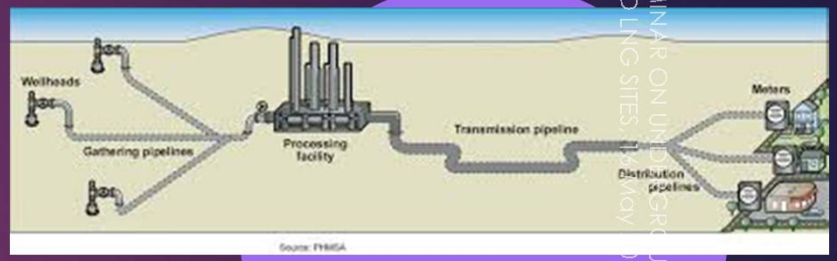
- Comparing to a gas field exploitation plant, the reinjection process occurs more technological complexity with a significant number of added installations. The higher number of vulnerable elements means higher risk.
- Because of the necessary compression (in order to reinject the gas into the gas field) it is possible to measure higher gas pressures in the aboveground installations.
- In both cases, exploitation and storage, are mainly the same so from our point of view there are not significant differences regarding the safety between exploitation and storage in depleted natural strata. Even if when injecting the natural gas the pressure is higher than at extraction/exploitation, the installations are designed for much higher pressures.

Q 11 - What means establishment in case of underground storage in natural strata, caverns, salt and coal mines, aquifers?

- Establishment means central area and fenced areas around individual probes including connecting pipes.
- Only on the installations above ground / the territory at the surface, under the control of the operator. Legally the owner can only be made accountable (in the sense of implementing safety measures) for the installations on his property. But if the natural strata will release “his” gas he will be liable for the consequences.
- An establishment contains:
  - the fenced areas of the wellheads;
  - the fenced area of the main plant (high-pressure gas unit and the support facilities);
  - and the route of the (underground) pipelines between them. Usually, the pipelines are not surrounded by fences but laying under a layer of infield. Even in this case, the pipelines are the part of the establishment, have got their own protection zones (based on their risk contours).

Q 11 - What means establishment in case of underground storage in natural strata, caverns, salt and coal mines, aquifers?

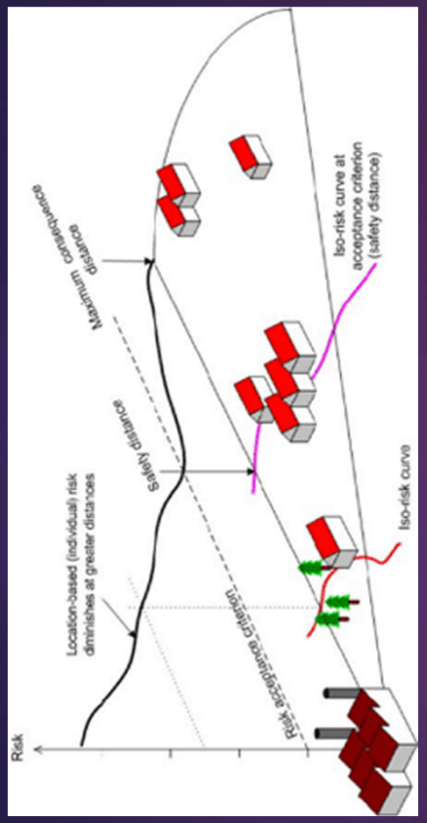
- The whole area covered by the underground storage including the area around the wells, compressor station and pipelines.
- Seveso establishment: Mining deposit; Clusters (wells + processing unit, included compressor stations); Connecting flow-lines.
- As establishment is considered all the installations under the control of the operator and within the limits of property. That means wells, installations at the wells heads and process plant. Pipelines that connect the wells with the process plant <u>are not considered as a part of the establishment</u>. The underground natural strata is only considered for the purposes of applying Annex I of Seveso III



Q12 - What are the main challenges for elaboration and putting into practice the external emergency plans for underground gas storages?

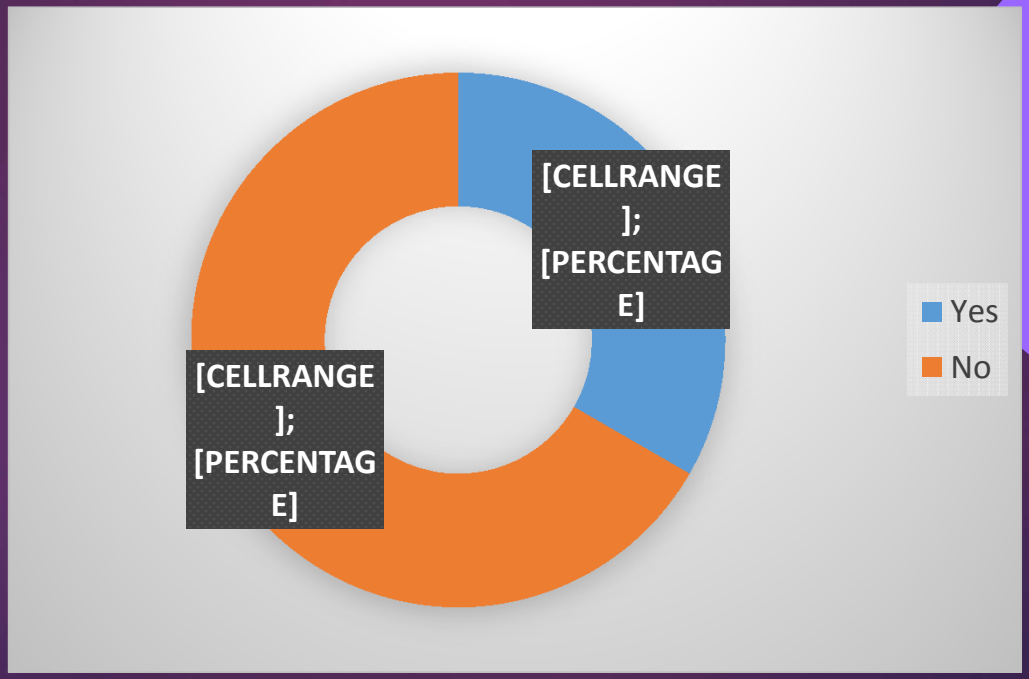
- Having a sufficient amount of water for fire-fighting.
- Because of the large size and long distances between the wellheads and other units, it is close to impossible to ensure extensive automatic gas detection. Therefore the observation of leakage is difficult, many times done by residents. (Who they will call?)
- To identify the area and estimate what area that can be affected by an accident, determine the evacuation and safety zones
- The deposits occupy a vast underground area, which involves several regional, provincial and municipal areas. The connecting flow-lines cross these areas (above ground), with relative impacts on a vast territory.
- Selection of accident scenarios. They are defined with substances and equipment located over ground. None of the accident hypothesis consider the underground stored gas, except for the event called ‘blow out’ (uncontrolled outbreak from well)
- Collaboration and coordination of intervention in case of an accident (when are involved more than one county/administrative region)

Q13- Does Article 13 apply to buildings, public buildings, residential and recreational areas, etc. on the land above the underground gas deposits?



- In general the consideration zones will not reflect the underground storage.
- In the safety report, for the calculation of external risks only scenario's involving the above ground installations are taken into account.
- No. The ground area outside the fence of establishment is not considered.
- Article 13 does apply to buildings, public buildings, residential and recreational areas if they are in the vulnerable zones of the establishment, but not because of they are on the land above the underground gas deposits.
- Yes. Risk assessment shall be the base for the application of Article 13.
- Article 13 applies to buildings, public buildings, residential and recreational areas, on the land above the underground gas deposits. The damage areas must be compared with LUP, defined by municipal administration, through overlaying of risk curves and contours
- Yes, based on the risk assessment from the SR is determined the territorial compatibility based on the potentially affected vulnerable elements and scenario frequency.
- Article 13 is only applied in areas around well-heads and process plants. Decisions in land use planning are made based on reference scenarios in these over ground installations.

Q14 - When you perform the inspection of these sites do you use check lists?



Q15 - the most important aspects on which you focus during the inspection of an underground storage

- Maintenance programs and corrosion issues (for underground storage of steel tanks located in caverns)
- The follow up and maintenance of the connected overground equipment, and the control-systems monitoring the operation of the cavern
- Controlling degradation of piping
- Controlling degradation of process vessels
- Accident scenario's in the safety report,
- Alarm management, shift management, training
- Operation instructions
- Work permit system
- Internal emergency planning / trainings and drills
- Safety valves function on operating probes
- Management of monitoring integrity of installations and detection systems,
- Integrity of the storage instalations (storage space and loading/off-loading)
- Emergency shut down systems, overfilling, communication, security, pressure relief systems, maintenance, fire safety
- SMS, preventive measures and equipment, measures and equipment relevant for the reduction of the impact of a major accident

Thank you for attention!