

## State of the Evaluation of Measurements and Observations in Connection with Cavity Control of Liquid Filled Storage Caverns

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On the basis of an evaluation with regard to the specific behavior of liquid filled caverns a new concept for cavity monitoring was developed in order to reduce technical interference with long-term storage operation caused by workovers for regular sonar surveys.

### 1. CAUSE

According to legal regulations in Germany solution mined caverns are submitted to down-hole surveys in regular terms to determine position, extension and volume of the cavity. Prior to a sonar survey the internal pressure of the liquid filled storage cavern has to be released to hydrostatic conditions and the variable storage pipings have to be removed from the cavity by aid of an workover rig. The cavern decompression over a period of 2 to 4 weeks results in an irreversible convergence thrust and puts strain on the surrounding salt and overburden. Exceptional behavior of caverns (e.g. salt exfoliation, damage to storage pipings) is provoked and higher subsidence rates have been observed in conjunction with workover campaigns for sonar surveys.

The arguments for a revision of the to date procedure are not only of geomechanical origin but are also economically and technically motivated (service life of cavern, operational costs, health, environment, safety).

### 2. NEW CONCEPT FOR CAVITY CONTROL

In order to reduce stress to the rock and negative consequences to cavern operation caused by cavern decompression a new concept of cavity monitoring applicable to

caverns under long term storage conditions was developed.

#### 2.1 Evaluation on specific cavity behavior

In 1991 IVG introduced a computer aided mine plan management system (DIKAB) for the Etzel caverns. Based on this platform an information system was organized that on one side took advantage of the processing and illustration abilities of the digital mine plan and on the other side included data resources from cavern operation and monitoring documented over more than 20 years.

In order to achieve a register on specific cavity behavior rating parameters were set up, such as

- contour match (based on sonar surveys)
- long term convergence
- natural pressure build-up
- sump rise
- interface variation
- chemistry of brine
- subsidence (related to wellhead elevation).

In the course of evaluation each cavern was subsequently checked on these parameters considering all measurements and observations available, e.g. sonar surveys, pressure build-up, storage volumes, brine discharge volumes, temperature and interface measurements, sump rise, levelling (Fig. 1). The register on specific cavity behavior was completed in 1998. The characteristic rating parameter values for a cavern drawn from this reference represent the

individual normal behavior during storage operation. For control purposes the register is consequently kept up to date.

## 2.2 Evaluation results

The analysis proved that under long-term storage conditions caverns show a typical and constant behavior pattern. Hence, it appears justifiable to maintain cavity control by means of indirect (surface) measurements and down-hole logs that do not require cavern decompression. As long as the cavity shows the defined normal behavior pattern *term-oriented* complete sonar surveys become unnecessary. In the event of exceptional behavior or in case of cavern operation that causes a change in cavity geometry or volume subsequent *cause-oriented* sonar surveys have to be performed for inspection (Fig. 2).

## 2.3 Course of approval

The modified procedure for cavity control was verified in course of an expert judgement which was demanded by the mining authority. Therein the stability of the relevant liquid filled caverns was proved by historical and prognostic analyses using finite element

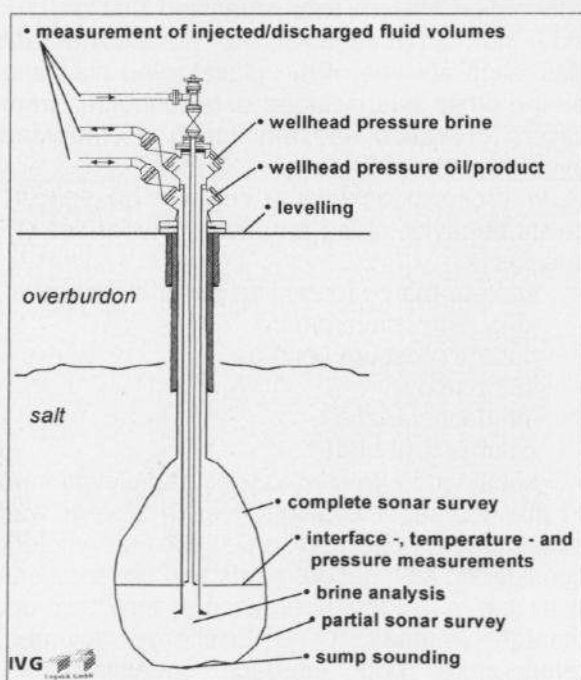


Figure 1. Measurements and observations on liquid filled caverns.

calculations. The expert came to the conclusion to be able to follow the operators proposal for reduction of term-oriented sonar surveys.

The application to alter the operation plan concerning cavity control of the Etzel caverns was approved by the mining authority in April 1999.

## 3. PERSPECTIVE

In future, cavern surveys by innovative means of wireline logging equipment will likewise remain the fundamental method of cavity control in respect to the determination of position, extension and volume.

But information systems on the other hand, which arise from a digital cavern plan, will take an indispensable position as a process tool and management instrument when practicing specific cavity control. Evaluations on measurements and observations will help to reduce cavern decompressions for downhole surveys. Thus, new monitoring procedures will contribute to preserve caverns and the surrounding salt deposit for storage purposes.

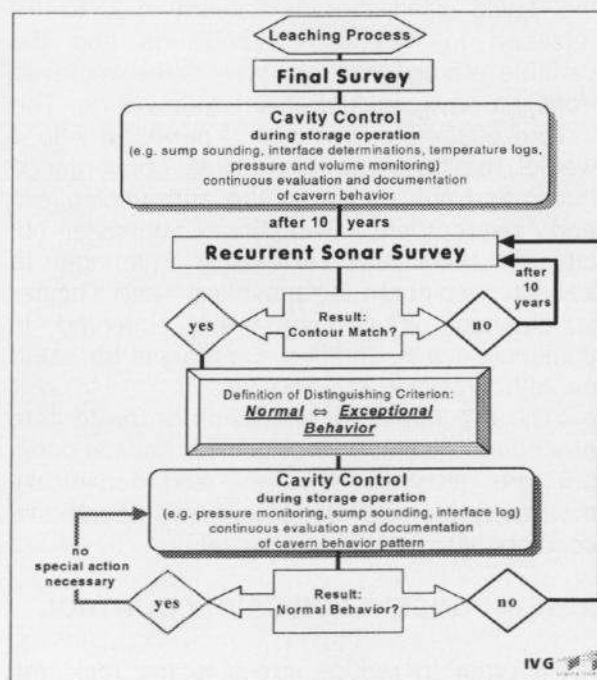


Figure 2. Flow scheme for cavity control of liquid filled caverns.