SURFACE MONITORING SYSTEM
FOR UNDERGROUND STORAGE RESERVOIRS
OF DANGEROUS CHEMICALS
OR GASES

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1. **Definition of the system**

The Surface Monitoring System for Underground Storage Reservoirs is the network of number "n" individual monitoring stations especially designed to continuously measure the leakage of product from the (pressurized) underground storage locations.

Such a reservoir is usually built in the deep subsurface location in the very compact rock - obviously granite, which is free of deep & large tectonic faults. Granite massive usually have the system of microfractions & microfaults which may tend to create ways for product leakage during the long time period. For this reason it is important to "watch" for the product leakage.

The proper location of individual monitoring stations of the network have to be carefully selected according to the precise tectonic survey of the massive. 7 to 12 individual stations are obviously enough to cover the whole area - depending of the fraction condition of the massive. A tectonic survey will point the most dangerous locations where we can expect the probable future leakage.

Often, the "watch" for product leakage is combined with microseismic 3-D measurement at the each monitoring station. We can provide all the stations with very sensitive 3-D seismic system combined with sophisticated evaluation software for simultaneous monitoring of seismic events and product leakage.

All individual monitoring stations communicate wireless. The completed system is operated from the central station which collects data from individual stations in regular preset interval and creates the maps of leakage/seismic situation of the reservoir. If ANY station register any event (event = leakage or seismic activity higher then defined alarm threshold) the data from all stations are immediately transferred to the central station regardless on the reading interval preset. All the individual measuring parameters of the individual measuring station may be remote-configured from the central station.

All the individual measuring stations are supplied via U.P.S. Power Supply to cover power-line faults.

2. **Description of the Measuring Station**

Each monitoring station consists of:

a) Surface sampling probe
b) Integration/Mixing chamber
c) Sensor unit
d) Vacuum pump
e) Evaluation electronic module
f) Data communication module
g) Control computer with monitoring & communication software
h) Wireless communicator

i) U.P.S. Power Supply with rechargeable batteries

a) Surface sampling probe

is especially designed to collect the contingent leakage from the largest possible surface area of the watched rock. Located at the output of the defined microfault it collects the all contingent leakage which may penetrate through the subsurface structure within it's sampling "bell". Usually, the sampling bell feature the diameter of 0.7 m what is enough for good surface sampling from the compact rock with microfaults. The sampling bell is connected with the rugged steel tube - usually 2.5 m long, which carries most of the monitoring technology (items b, c, d, e, f). The tube contains two copper tubes - one for sampling and second for the insertion of calibration gas to the sampling bell. The sampling tube is connected with the solenoid valve of the integration chamber via the automatic water valve which avoids the water to be pumped to the integration chamber.

b) Integration/Mixing Chamber

is a special part equipped with two solenoid valves and the measuring head of the sensor. First solenoid valve brings the fresh air for the system zeroing, the second one brings the measured gas from the sampling bell. The cylindrical chamber has a computer-tuned internal shape for the best possible homogenization of the measured media to achieve the best measured value. The chamber is made of machined aluminum.

c) Sensor Unit

According to the compound monitored we can offer wide range of sensing principles. The mainly used principle is high-tech IR for Methane, CO_2 and general petroleum products as well as various other chemicals, PID for mainly petroleum leakage from surface or underground storage tanks requiring extreme detection sensitivity.

d) Vacuum Pump

Standard system pump feature 4 liters per minute pumping speed. An alternative pump may be ordered. Pump is housed in the main frame and requires no maintenance.

e) Evaluation Electronic Module

EEM is housed in the main frame. It includes all the circuitry for controlling the sensor operation, pump operation, solenoid valves, analogue measurement, A/D conversion and heating (with regulation) of the frame for winter condition.

f) Data Communication Module

DCM is also housed inside the main frame. It provides the communication with the station control computer.

g) Control Computer with Monitoring & Communication Software

Provides the control of the completed monitoring station. Industrial PC heavy duty technology.

The Monitoring software has a number of presetable operational parameters - like an interval of sampling, the system of zeroing (automatic or preset), preintegration interval, measuring interval, threshold for first and other alarms, e.t.c.).

After starting of operation it samples automatically the earth gas in preset intervals and always stores the measured data to the file. After a signal from the control station it transfers the data for a central data acquisition.

Monitoring software is issued in two versions:
1. DOS version
2. UNIX (LINUX) version

The measuring software may be delivered in advanced version including seismic measurement and seismic data preacquisition. Issued in both DOS and UNIX version.

f) Wireless Communicator

WC is an optional selection. Both systems - cheap Radiomodem solution or Ethernet-by-wireless technology may be used. Depends on geographical conditions and system requests. We usually offer the Motorola technology.

g) U.P.S. Power Supply with Rechargeable Battery

A standard U.P.S. system is used for the back-up. The capacity depends on the clients order and represents the optional costs.

3. Seismic Station Integration

An advanced 3-D seismic station may be integrated to the each measuring station. Very high sensitivity in each channel and advanced pre-acquisition software allow to monitor the very delicate seismic events to predict & prevent the leakage of the reservoir. More info on request.

4. Operation & Maintenance

The both - the individual stations and the whole network are the completely self-sufficient systems with fully autonomous operation. Once the system is started it

automatically monitors the value of methane concentration at the each location and, in the case of combination with seismic measurement also the seismic activity of the subsurface massive. All the data are concentrated in the central station for later acquisition and mapping.

In the case of any event - regardless on the preset reading interval the data transfer is automatically activated and the measured data from the all stations (including the "pre-event" record) are automatically transferred to the central station and various levels of alarm are activated.

Maintenance

The regular check of zero & calibration of the each individual station is recommended. The suggested interval is 1 or 2 month. The pressurized cylinder with calibration gas is an optional accessory of the system. ESS staff recommended.

5. Delivery & Installation, Maintenance

Basic delivery time for the completed system is usually two or three month, in the case of individual special request one month more. Cooperation with local dealer posssible.