HYDROSTATIC LEVELLING OF A NPP (NUCLEAR POWER PLANT) FLOOR DURING THE PRESSURE TEST OF THE SURROUNDING WALL EXPERIMENTAL MEASUREMENT

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The stability of the floor of a nuclear Plant (NPP) is continuously checked with existing levelling systems. In January 1999, the NPP of Flamanville (North-West of France) which is not equipped with such a system, decided to carry out an experimental measurement with a "**H**ydrostatic **L**evelling **S**ystem" (HLS), during the pressure test (for inspection air-tightness) of the surrounding wall.
This paper will describe the conception, the installation of such a system and the results of the measurement.

Figure 1 : Hydrostatic Levelling Sensor

The Hydrostatic Levelling System is dedicated to high accuracy levelling between two different points which can be several hundred meters apart. Based on the communicating vessels principle, the system uses the free surface of a liquid as an absolute measurement reference. Each point of the network is equipped with a sensor (see figure 1) which measures the vertical distance between the electrode and the altimetric reference plane (see figure 2). Measurement quality and accuracy are obtained thanks to the capacitive sensors and electronics.

This equipment is available in two versions, one "high accuracy" version and one version which allows high amplitude measurements.

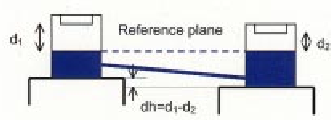

Figure 2 : Principle

⇨ Network definition

The first task for such an experiment is the definition of the network considering the area concerned and the expected values of deformation ; this determines the position of the sensors and specifies the global system accuracy.
For this application a number of 8 HLS sensors was established with respect to the network geometry shown in Figure 3.
As the deformations expected were of the order ± 1 mm, it was decided to aim for an accuracy of ± 0.1 mm.

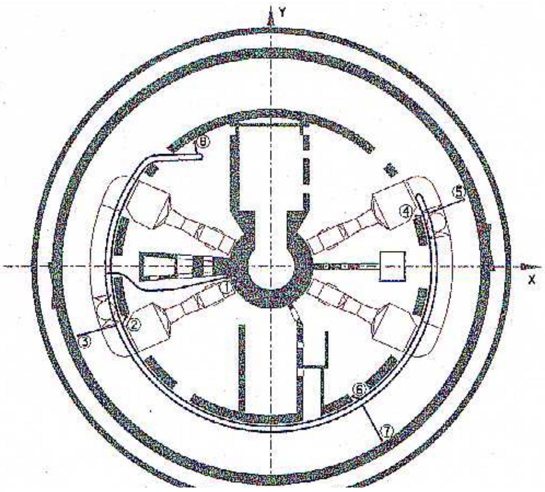

Figure 3 : HLS Network

⇨ **System installation**

The installation of such a system is carried out through the three following steps :

first step : ***interfaces installation***

Each sensor is fixed on a mechanical plate, screwed into the floor. The sensor is isolated from the plate to avoïd any mass problems and all the sensors are adjusted to a common level, using optical levelling.

second step : connection

All the sensors are connected to a PC computer, via a rack, and the pipes are installed and connected between all the sensors.

third step : starting-up

Once all the connections are made, the system is filled up with water. After a short period of stabilization (about 12 hours in this case), measurement can begin.

The measurement from each sensor is an average value of 60 successive measurements (period of frequency). It also takes into account the calibration results and the linearity error of each sensor and the temperature adjustment.

Finally the measurement process is checked by putting under one sensor a block of known thickness which is compared to the measurement value given by the sensor. In this case the system indicated a value of 2.50 mm for a known thickness of 2.52 mm (after only 8 minutes of stabilization time).

Another test is carried out by taking out some water, and checking the similarity of each sensor measurement (during this test it was also established that all the values were inside a range of 10µm after only 4 minutes of stabilization time).

⇨ **System operating**

Before any deformation measurements during the pressure test it was necessary to run the system for few days, to get a "characterization" of the site. This way, all the deformations having no relationship with the pressure test were identified : - especially the influence of the oceanic masses (!) (see figure 4).

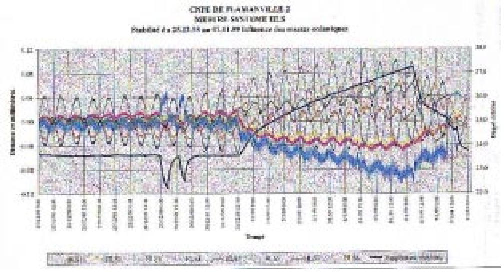

Figure 4

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Then the pressure test was carried out over six days from 0 bar to 3.8 bars back to 0 bar. The measurements were taken each second and the average value of 60 measurements was recorded. The main measured deformation was 0.71 mm at a pressure of 3 824 mbars (see results in figures 5, 6 and 7).

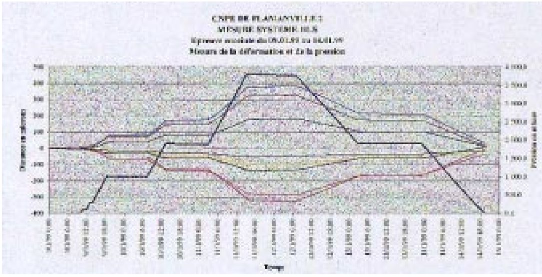

Figure 5: deformation and pressure

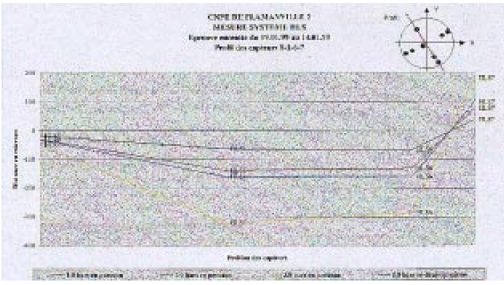

Figure 6 : Sensor moving

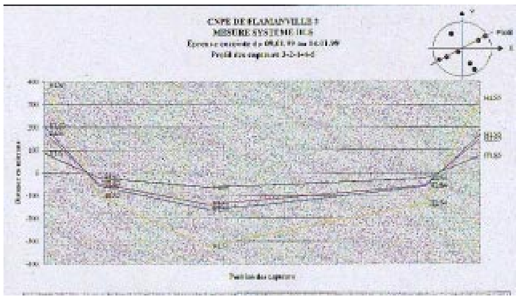

Figure 7 : Sensor moving

Results were available in real-time on the PC computer (see figure 8).

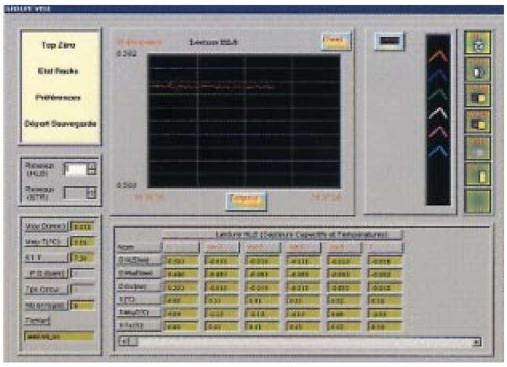

Figure 8 : Realtime display

At the end of the pressure test, the system was checked once again using a block of known thickness (measured value after 4 minutes of 2.50 mm for a known thickness of 2.52 mm) and taking out some water to check the similarity of each sensor measurement.

All the measurements showed a global system accuracy estimated at ± 10 µm.

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⇨ **Conclusion / perspectives**

The **Hydrostatic Levelling System** allows measurement of deformations in **real-time** with a **very high accuracy**.

Usually installed for the monitoring of equipment over a long period, it can also be installed for a short period for specific tests and works very well even in a "hard" environment such as a Nuclear Power Plant.

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