# APPLICATION OF HLS AT THE REACTORS OF THE NUCLEAR POWER PLANT AT TEMELIN, CZECH REPUBLIC

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## 1. ABSTRACT

Application of automated Hydrostatic Levelling System HYNI for monitoring of vertical deformations of foundation slabs of the reactor room and of the technological part of the turbo-generator at the Nuclear Power Station TEMELIN. The vertical deformations are monitored at real time by means of a static measurement procedure. The results are not influenced by temperature changes of the liquid at individual sensors. The system enables interconnection of hydrostatic levelling networks at different levels of the monitored construction. Several series of observation results and their comparison with results obtained by high precision optical levelling are presented and commented.

## 2. INTRODUCTION

Health protection against ionisating radiation represents an actual problem which should result in forming of an efficient and independent system of nuclear security management. The State Office for Nuclear Security cannot secure supervision over production and operation of all technical installations and objective responsibility for facilities remain on producer or operator. This is valid also in the case that the facility is a subject of state inspection according to legal regulations.

The security principle of newly introduced technical instalments to service at the Temelín Nuclear Plant are periodic controls of most important components of its technical solution, plan of service controls and other legal obligations of operator. The reactor hall (HVB) and engine hall of turbogenerator belong to objects requiring periodic monitoring of vertical stability.

Namely the turbogenerator machine set (Fig. 1) and bearing mounting between high pressure part and the first low pressure part represents the facility that determines the required high accuracy of vertical movement measurement.

The own bearing mountings are firmly installed on concrete girders. There is only one radial multi-wedge shaped bearing in every connecting field of the turbine. Two radial bearing are only in the connecting field between the turbine and the generator. Any changes in height of machine set placing will be manifested namely by wear of bearing parts of turbine and thus in periods between general repairs. This will be reflected negatively in operational economy of the whole facility complex. The full steam turbine 1000 MW is namely an installation to covering

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not only basic devices of energetic network during condensation running, but also to combined production of electricity and heat of centralized distant heating by the electric generator as well as heat exchangers.

## 3. MEASURING SYSTEM HYNI

The Research Institute of Geodesy, Topography and Cartography devised an authorised stationary hydrostatic measuring system (HYNI) to monitoring of vertical displacements of above mentioned objects. This system enables in connection with invar gauges control measurements in more high levels related to the basic level of HYNI (Fig 1,2) system distribution. Evolution in this area attained many innovation until now. The actual version is characterized by technical parameters given in the part describing the sensor.

Automated stationary hydrostatic measuring systems are projected on the HVB object also at the levels of –3,60 / - 4,20 m of the foundation plate of the reactor hall. There are two systems with 21 position sensors and one control computer.

At the object of turbogenerator (level – 5,20 and 15,0 m), there are installed two systems with one control computer placed in central control room. There are totally 71 measuring sensors (Fig 3).

The design of sensor connection to measuring system at different levels as placed on the object of turbogenerator and on the plate of turbogenerator table is shown at Fig 4, 5, 6. The importance of the whole problem regarding monitoring vertical displacements on the turbogenerator object gave rise to connecting of automated measuring system to diagnostic system of turbine that represents a part of consignment of the general supplier of the technological part.

The stationary hydrostatic measuring system consists of HYNI hydrostatic sensors that are interconnected by hose with liquid, hose with air or to compensating of atmospheric air pressure at the measuring system and four-wire cable to data transfer and power supply.

Number of sensors in measuring system is determinated case by case and into the system there could be included $A \times 32$ sensors where $A$ is the number of busses or number of ports at the control computer.

To enable vertical displacements at various height levels, it is possible to include into the system the INVA sensors. Thanks to such sensors individual areas could be connected. It is also possible to monitor continually difference changes in distances of levels interconnected in such way. Evaluation of individual displacements is done automatically on the base of determining reference points and also on the base of measured data analyse the vertical stability of the reference point is tested, too.

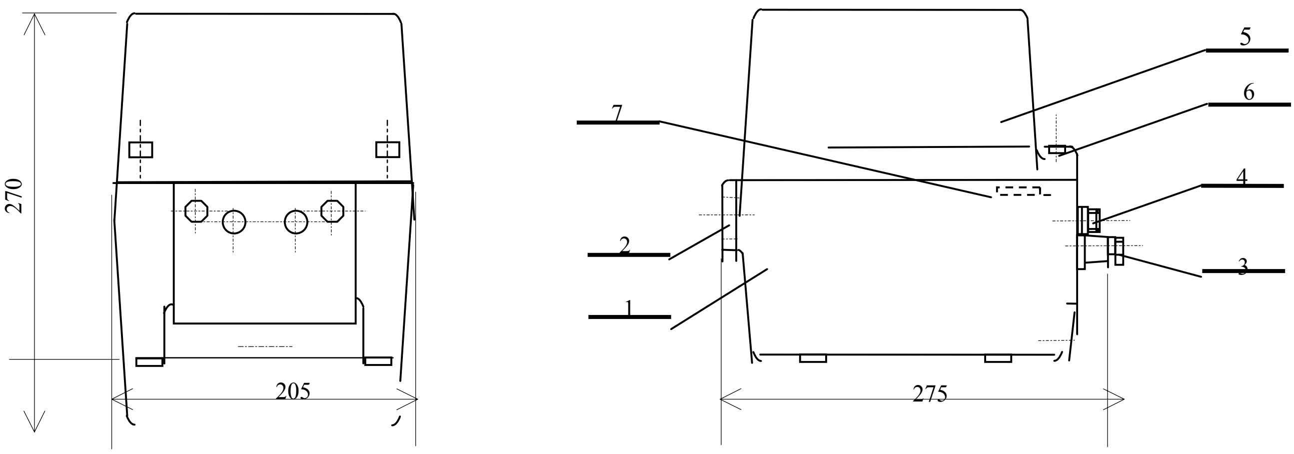
An important property of the metrical system is the continual measurement without any interference of the operator. The data acquisition takes place at pre-programmed time intervals and obtained values may be seen any time during automatic performance of measuring programme.
Data scanning uses the characteristic of so called exact branch, i.e., it preferes the slower measurement in the case of "static" measuring system. Time needed to data measuring from one sensor is approximately 250 ms, but the average time of measurement of one channel is approximately 15 s in the praxis (due to measurement sampling minimally 10×, software treatment of all communication regimes with sensor) and due to the nature of the whole system (hydrostatics).

On the base of preferential requirements to stability (in the vertical sense) of the technologic instalments and building parts HYNI and INVA measuring sensors were developed. Their accuracy can be characterised by standard sampling error of measurement in the complex of the measuring system (up to the distance of 100 m) as $\sigma \leq \pm 0.05$ mm.

The service activity at the measuring system can be secured at the system supplier. Conditions of such activity will be derived during specification input data, eventual malfunction will be removed to 5 working days since obtaining the notice.

### 3.1. Technical parameters of HYNI sensors

| | | |
|---|---|---|
| Dimensions of sensor: | height : | 270 mm |
| | wide : | 205 mm |
| | depth : | 275 mm |
| Span of holes on collar : | | 185 mm |
| Fasting screws : | | M 10 |
| Cable grommets : | | P16 |
| Threaded joint to fluid delivery: | | 1/2″ |
| Threaded joint to air delivery: | | 1/2″ |
| Sensor mass (without fluid): | | 13 kg |
| Sensor supply: | | 18 – 30 Vss; 0,5 A |
| Applied fluid: | | according to demands on reaction speed and external conditions (temperature) |
| Sensor accuracy of displacement measuring: | | ± 0,05 mm |
| Resolution of reading: | | 0,001 mm |
| Range of measurement: | | appr. up to 80 mm – 100 mm |
| Communication | | RS 485 – double-wire circuitry |
| Working temperatures: | | +5 až +50ºC |
| | | -20 až +50°C |




1 – lower part of sensor case
2 – adjusting collar
3 – cable grommets
4 – treated joinnts to fluid and air supply
5 – upper part of sensor case
6 – connecting screws
7 – terminal plate

## 4. FIGURES

**Fig 1: Sensors HYNI**

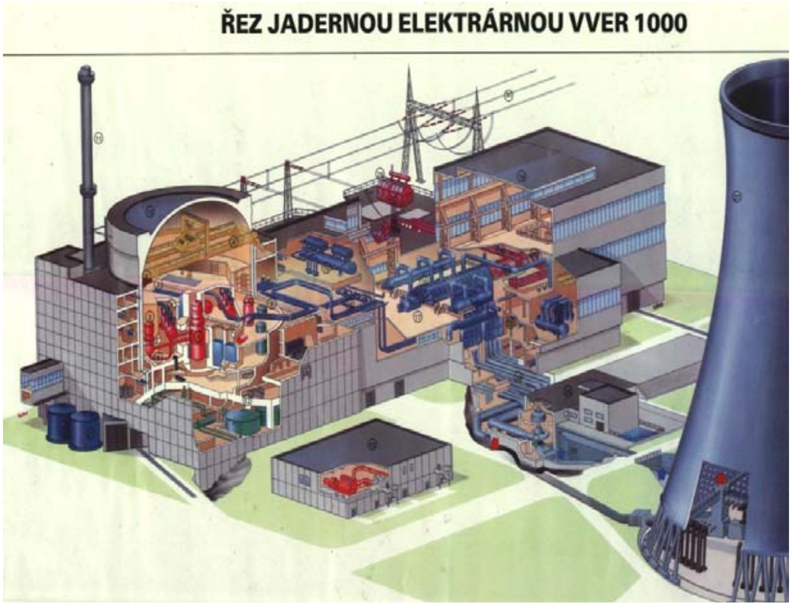



**Fig 2: Section through the Power Plant**

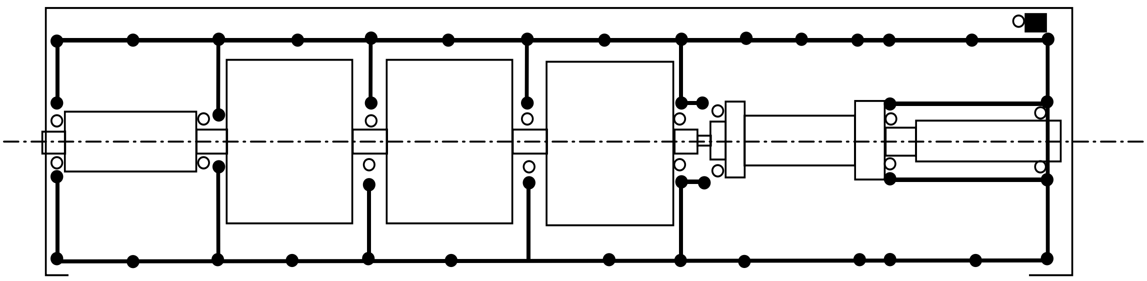


**Fig 3:Chart of HYNI and INVA on Table of TG +15,2m**

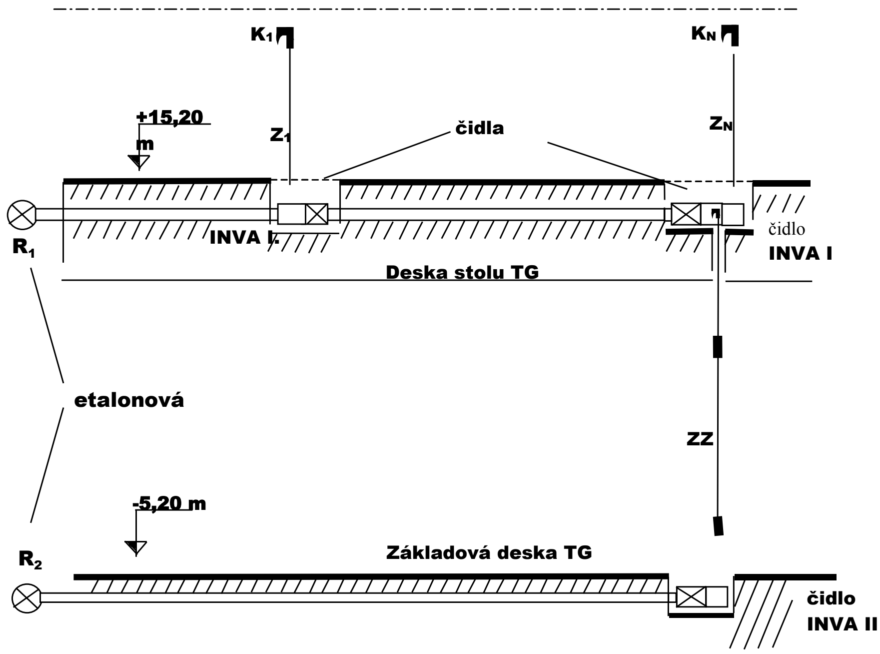



**Fig 4: Coupling HYNI and INVA Sensors at TG**

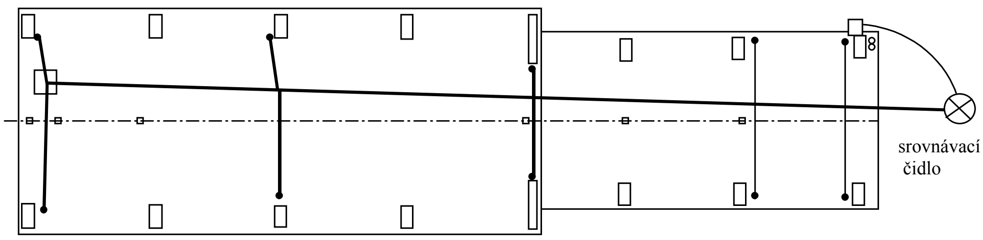



**Fig 5: System HYNI at Level -5,2 m of the Engine Hall**

**Fig 6: View of the TG from the Exciter -Couplin of INVA Sensor to HYNI**