



### Main field of application

LNG storage tanks on import and export terminals (liquefaction and regasification)



1-Delayed deformations pose a risk for long term performance of prestressed concrete infrastructure

2-The Ageing monitoring process allows controlling and reducing this risk to warranty the expected life span of the infrastructure

### Contact:

[sophie.crouigneau@oxand.com](mailto:sophie.crouigneau@oxand.com)  
[norbert.badez@edf.fr](mailto:norbert.badez@edf.fr)  
[info@geo-instrumentation.com](mailto:info@geo-instrumentation.com)

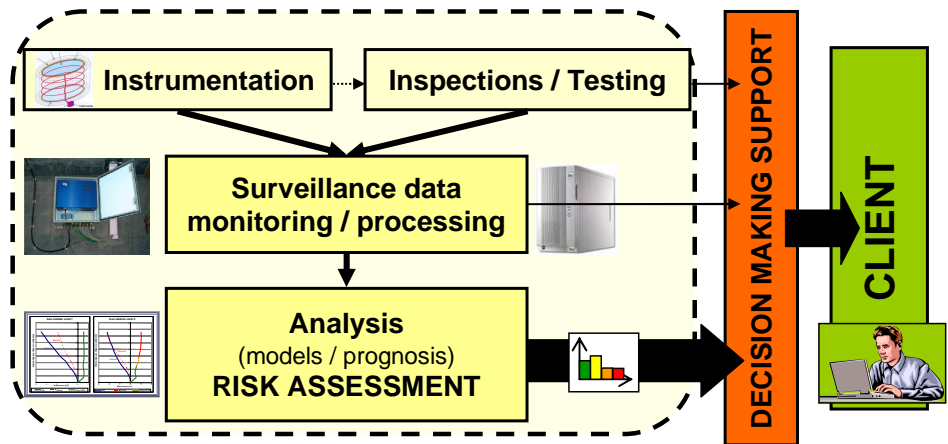
# Ageing monitoring: Managing the lifespan of LNG reservoirs

## Context

Risk analyses undertaken on LNG reservoirs show that the **loss of tension** in the prestressing cables of the external confining wall could be a **critical factor** influencing the expected lifespan of these structures. This phenomenon is mainly due to the **long-term deformation** of material such as creep and shrinkage of concrete or relaxation of prestressing cables.

It is therefore highly recommended that operators monitor the long-term changes in the behaviour of their structure in order to be able to predict the impact of such phenomenon on their performance.

The ageing monitoring process provides decision-making indicators which help in determining whether or not maintenance works are needed, as well as their priority.



*The Ageing Monitoring Process allows sustainable management of risks during the expected lifespan of infrastructure*

## Value added for the operator

The ageing monitoring process enables the operator:

- To **record and store** the behaviour of the infrastructure during its expected life span ;
- To obtain a **realistic prognosis** of the ageing of the prestressed concrete confining walls (more accurately than with standard design models);
- To obtain **regular updates** for this prognosis;
- To have **clear decision-making indicators** in order to justify and anticipate the actions if needed (maintenance, decommissioning...);
- To **plan the appropriate actions** to carry out, if needed, in order to control the risks.

→ Ageing monitoring facilitates the optimization of current maintenance costs and the **prevention of exceptional maintenance costs**

→ Ageing monitoring helps **managing the operational risks** and is a strong argument for **safety demonstration**, especially if **lifespan extension is foreseen**

3- Ageing Monitoring integrates the analysis of all the available surveillance data

4- Treatment of complementary data will also help in detecting other time related phenomena like global settlements

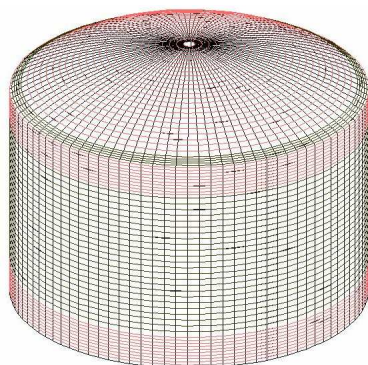
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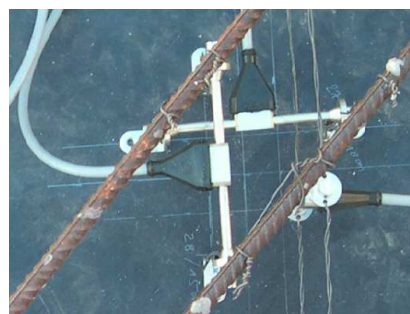
## Ageing Monitoring: methodology

The ageing monitoring process includes:

- ✚ **Appropriate well-tried systems** (e.g.: wire strain gauges, invar wire, pendulums, fibre optics, etc.);
- ✚ **Data acquisition, safe and long-term storage** in a dedicated **database**, and **analysis**;
- ✚ Specific **modelling of structural behaviour** based on a **realistic approach** (including up to date **creep and shrinkage models**, taking into account concrete type, actual climatic conditions etc.);
- ✚ Data treatment and **update of diagnosis/prognosis** regarding both **experimental** (measures) and **theoretical** (modelling) results.
- ✚ Evaluation of **intervention criteria regarding required functions of the structure** (integrity under service and accidental loads, tightness, acceptable residual compression in concrete, etc.);
- ✚ **Recommendation and planning** of necessary **preventive or curative actions** regarding the diagnosis/prognosis results and the intervention criteria.



*FE 3D modelling of the confining prestressed concrete wall*



*Fitting of a strain gauge on the steel reinforcement*

## Deliverables for the client

- ✚ **Set up and control of an appropriate sustainable instrumentation** for the monitoring of confining prestressed walls of LNG tanks;
- ✚ **Delivery of a database containing all the validated raw measures** (temperature, structure deformations...);
- ✚ **Summary reports** concluding on **diagnosis and prognosis** of the state of the structure (expected reports frequency: about one report per year during the first years and one every three to five years later on);
- ✚ **Risk estimation** concerning both integrity and tightness of the structure, statement and planning of recommendations if required.