The ODOBA project aims at understanding better concrete ageing pathologies within the context of extending the service life of nuclear facilities. The effect of these phenomena on the mechanical and containment properties of concrete structures - like reactor containments and waste disposal facilities - needs to be studied in depth so as to assess on their durability.

The project comprises both modelling activities and experimentation in the ODE¹ facility. ODOBA is led by IRSN in collaboration with Bel V (Belgian technical support organisation), CNSC (Canadian regulator), NSC (Chinese technical support organisation), VTT (Finnish research centre), NRC (US regulator), and several French academic partners: Ecole normale supérieure de Cachan, IFSTTAR², the University of Aix-Marseille, and the university of Toulouse.

Context and objectives
The nuclear power plants (NPPs) currently in operation throughout the world were initially designed to run for 40 years. Operators in France would like to extend their service life to 60 years, while other countries are considering 80 years or more. In this context, we need to assess how well non-replaceable components can guarantee their safety functions over such extended periods.

Two types of ageing phenomena have been identified for reactor containments: 1) shrinkage & creep of pre-stressed concrete, and 2) concrete pathologies. The ODOBA project is focused on studying concrete pathologies, determining the impact of these pathologies on the behaviour of structures, developing and validating detection & diagnostic methods, and developing and validating predictive ageing models.

Concrete ageing pathologies
These studies cover:
• Corrosion of reinforced concrete structures due to carbonation (effect of CO₂ in air) or chloride ion attack (effect of sea spray on coastal facilities).
• Internal swelling: alkali-silica reactions (ASR) and delayed ettringite formation (DEF).

These chemical reactions lead to the formation of gels that swell, causing the concrete to crack and its properties to change.

ODE: an experimental platform dedicated to the ODOBA project
The crux of the ODOBA project is to perform experiments on large concrete blocks (2 x 1 x 4 m) using the ODE platform at the Cadarache centre. Ultimately, about 60 blocks will be manufactured to investigate several types of concrete that have been used to build reactor containments. The different conditions under which these containments were built and are operated will be studied. Most of these blocks will be subjected to accelerated ageing processes to simulate operating periods from around 60 to 80 years.

These highly instrumented blocks will undergo a programme of non-destructive and destructive tests, after which the data collected will be used to define a monitoring programme for reactor containments. Additionally, lab-scale tests and studies will be carried out to refine further our understanding of the phenomena.

The experimental results will be used to develop and validate models that can predict the behaviour of reactor containments based on an initial diagnosis, which will help experts to make their judgements in each periodic safety review.