

Oskarshamn 1 Reactor Containment

Deformation Test



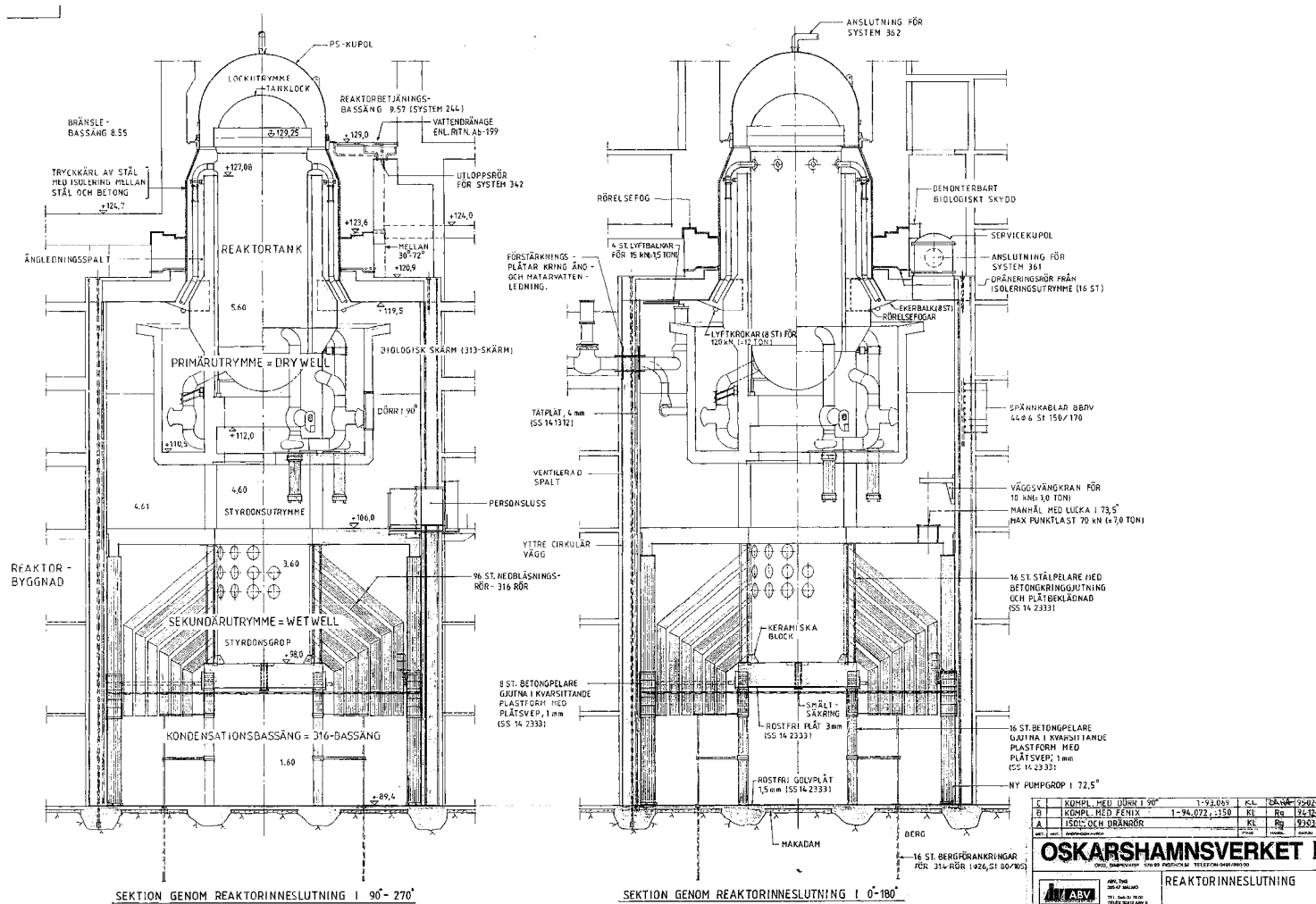
General Information

- **Asea – Atom reactor, the first commercial in Sweden**
- **Reactor power 490MW**
- **Thermal power 1375 MW**

- **Commercial operation since 1972**
- **Shut down in 2017**

Reactor containment

- **The Reactor Containment is constructed and erected by Armerad betong, today NCC between 1966 and 1969**
- **Concrete quality 1, K30/K40, Limhamn LH water-cement ratio - 0,5**
- **Reinforcement Ks40, Ks40s, mostly Φ 16**



Prestressed tendons/liner

- **Prestressed tendon type - BBRV Φ 6 mm, Yield limit - 1500 Mpa, Tensile strength - 1750 Mpa**
- **All tendons are grouted**
- **Both full- and half turn tendons exist**

- **The liner is 4 mm thick, at local strengthening the thickness is 8 mm**

Design Criteria

- **Non-stressed structure:**
 - **General Swedish civil criteria 1960**
 - **Swedish concrete criteria 1946**
- **Prestressed structure:**
 - **Swedish national bridge criteria 1965**
 - **Swedish civil regulatory guides for prestressed structures**

Construction requirement

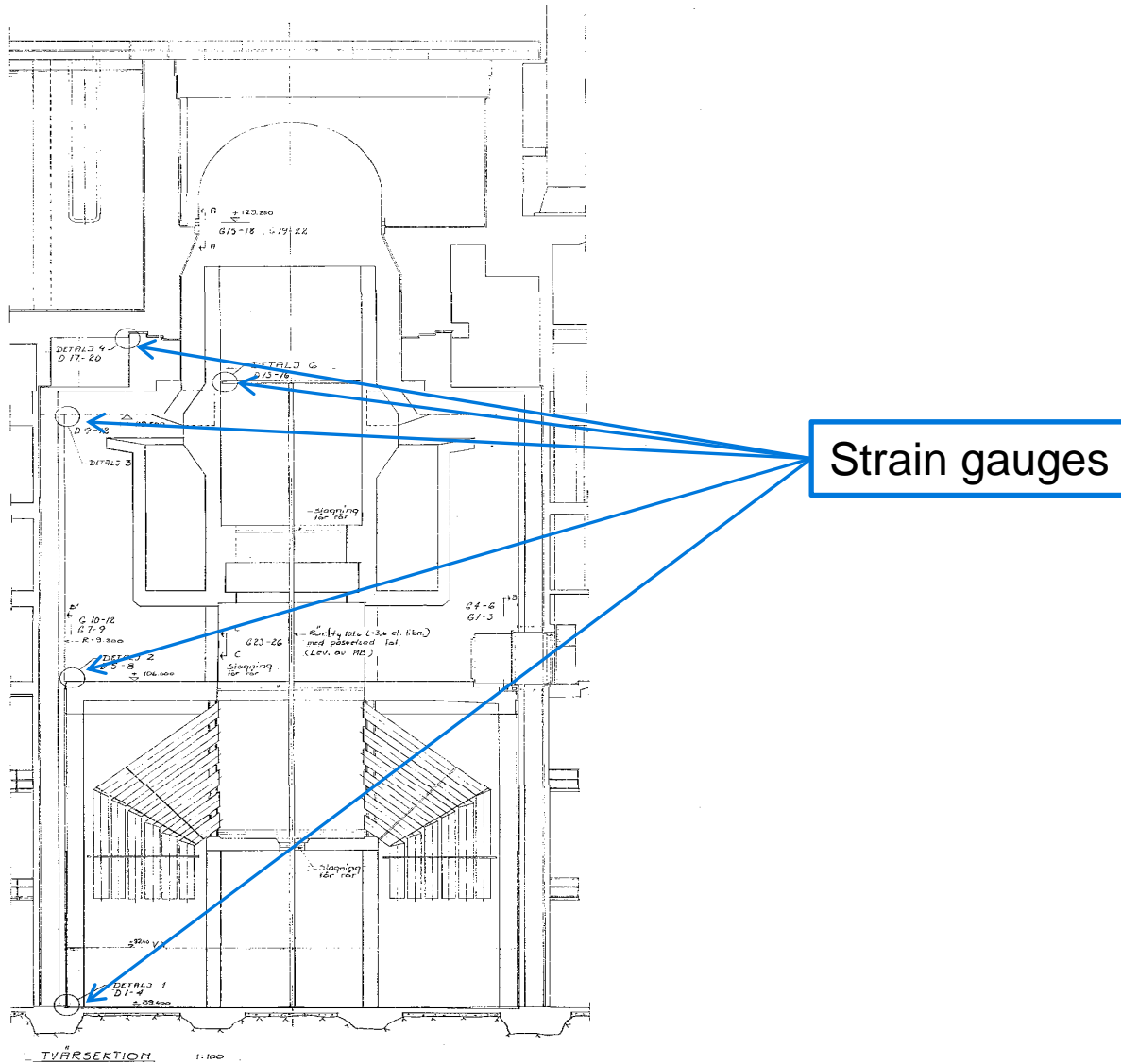
- **No tensile forces shall exist in the tendons at a pressure up to 4,5 bar(a)**
- **At 100% overload of the design pressure (4,5 bar) 8,0 – 9,0 bar(a), the containment must be leak tight**

Original deformation test

- **Performed in 1968**
- **44 strain gauges**

- **Test pressure at 450 kPa(a)/4,5 bar(a)**
- **Readings were done in intervals of 0,5 bar**

- **The conclusion was that the Containment behaved as expected from the calculations**

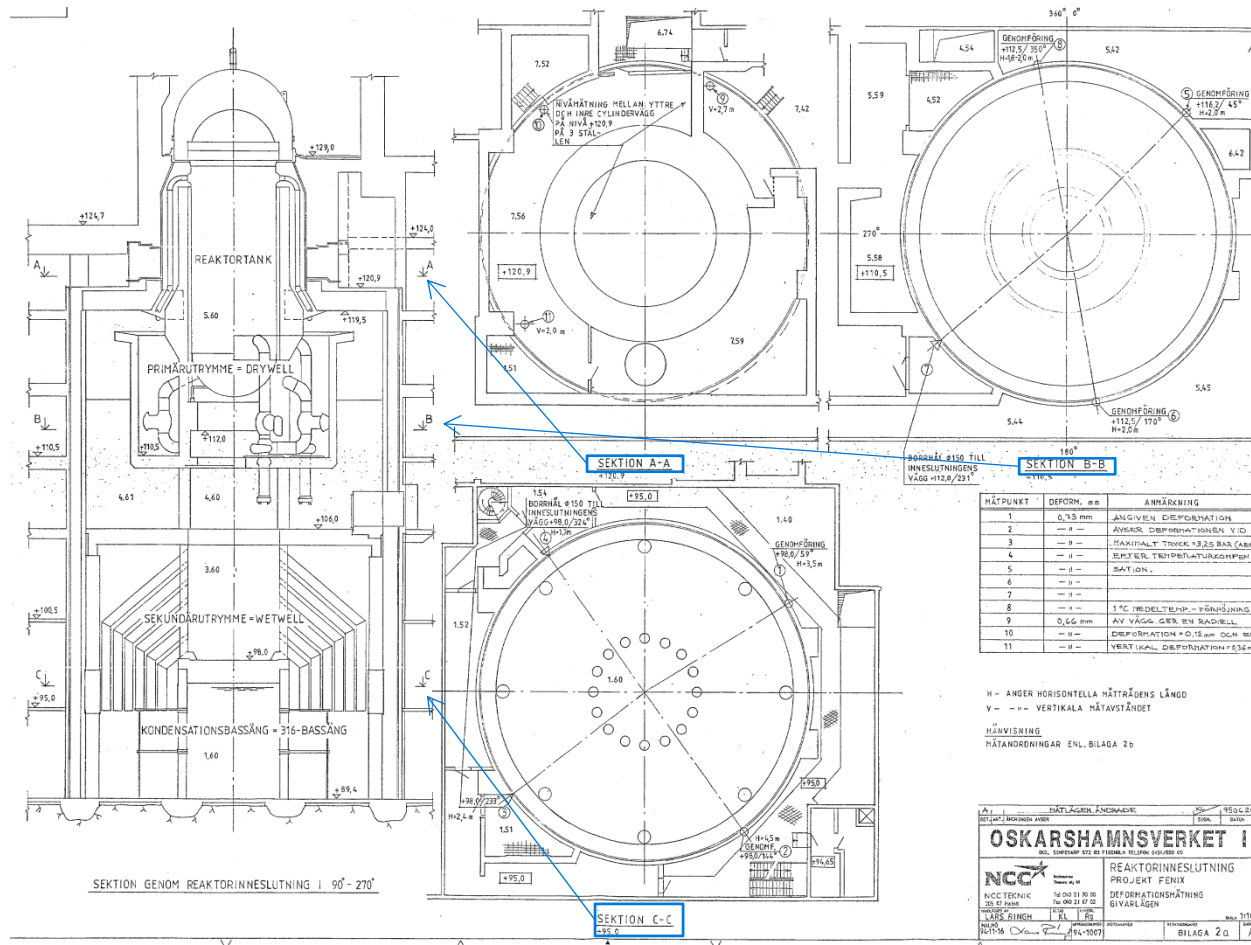


Follow up deformation test

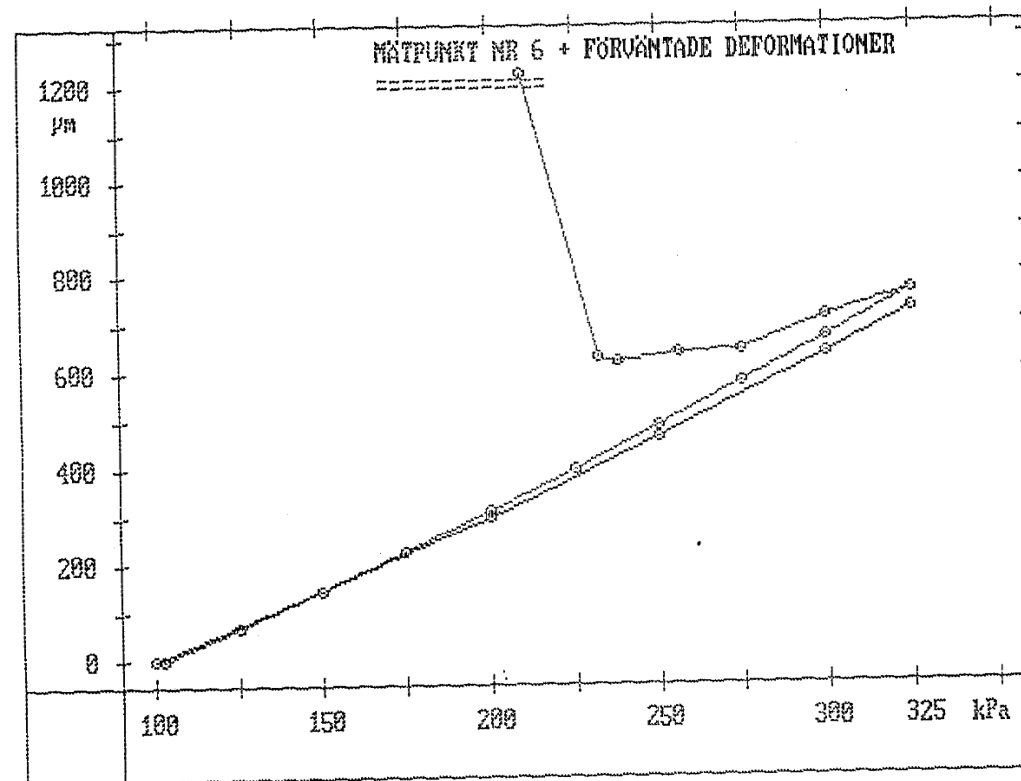
- **Performed in 1995 after 24 years of operation**
- **11 control points, with strain gauges (8 radial and 3 vertical)**
- **Test pressure at 325 kPa(a)/3,25 bar(a)**

- **Maximum radial deformations of 0.413 mm at level +98 and 0.607 mm at +112**
- **The modulus of elasticity during deformation test were measured to 36.32 GPa**
- **The containment behaved better than expected, the defomation was lower and the tendon forces were higher**
- **The drying of the concrete is estimated to be slower, this is positive for the tendon forces**

Strain gauges



The strain gauges in point 6 loose after 32 h of measuring, it fall down after 48 h



Summary

- **The containment and its tendons are after the original and the follow up deformation tests in good condition**
- **Measurements of moisture in concrete are important to validate the drying process of the concrete**