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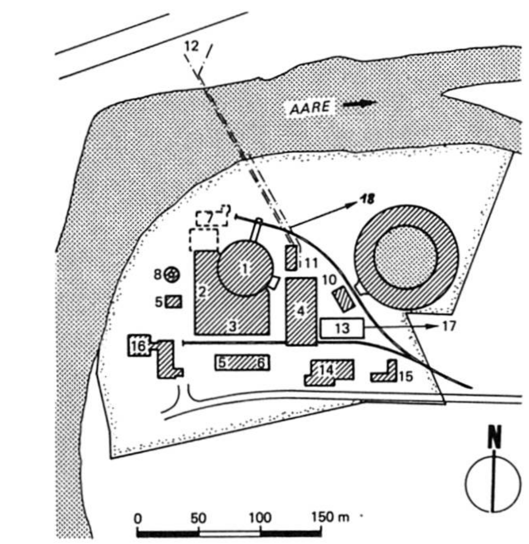
10. Nuclear Power Plant, Goesgen—Daeniken / SO

Owner: Kernkraftwerk Goesgen-Daeniken AG
General Contractor: Kraftwerk Union AG
Engineers: Motor-Columbus Consulting Engineers Inc.
Construction years: 1973 – 1979

Introduction

As it is well known, nuclear power plants all over the world have to fulfill very stringent safety requirements. In this respect, the buildings and the structural parts of the plant contribute an important part to the overall safety concept. They protect the plant against extreme external loads such as airplane crashes, severe earthquakes, and shock waves caused by external explosions. On the other hand they protect the environment and the population against any major consequences of internal incidents within the plant. Such improbable incidents may result in loads such as pressurization, temperature, pipe whip with corresponding restraint anchor forces and jet impringement forces. All such loads, which are to be borne by the buildings and structural parts of the plant are time dependent in most cases with complex time histories. This, combined with high reliability required for the design calculations and the construction, constitutes a new challenge to structural engineering.

In 1973 the utility company Kernkraftwerk Goesgen-Daeniken AG placed an order with Kraftwerk Union AG for the supply of a 900 MW pressurized water reactor system and at the same time Motor-Columbus Consulting Engineers Inc. have been commissioned with the structural design of the whole plant. The start of commercial operation is planned for Spring 1979.

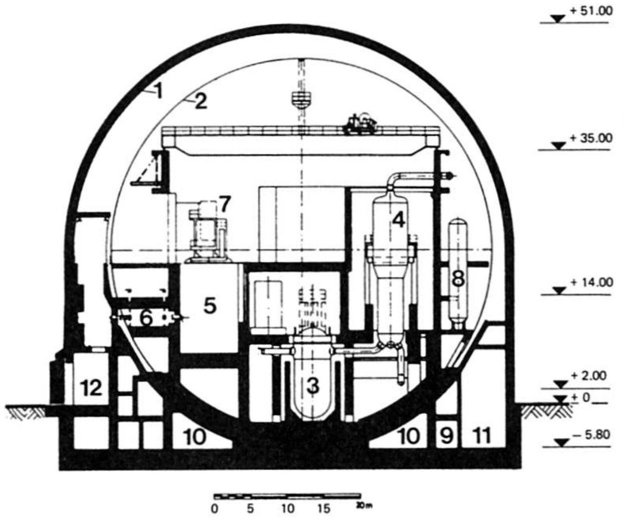


1 REACTOR BUILDING
2 REACTOR AUXILIARY BUILDING
3 ELECTRICAL BUILDING
4 TURBINE BUILDING
5 EMERGENCY POWER SUPPLY BUILDING
6 MAKE-UP WATER BUILDING
7 EMERGENCY FEEDWATER
8 OFF-GAS STACK
10 MAIN CIRCULATING WATER PUMP HOUSE
11 SERVICE WATER PUMP HOUSE
12 SERVICE WATER INTAKE
13 TRANSFORMER PLANT
14 WORKSHOP AND STORE BUILDING
15 GARAGES AND FIRE STATION
16 ADMINISTRATION BUILDING
17 SWITCHYARD
18 SERVICE WATER SYSTEM

Fig. 1

General Layout of the Plant

In the center of the plant is located the cylindrical reactor building which is surrounded by the auxiliary building, the building for the emergency feedwater system, ventilation chimney, the electrical building and the turbine building, other buildings such as the cooling tower, pumping stations, canteen, administration building, workshop, etc. are grouped around the main block of the plant (see fig. 1). The most important building of the plant is the reactor building; it houses the whole reactor system (see fig. 2).



1 REACTOR BUILDING
2 STEEL CONTAINMENT
3 REACTOR PRESSURE VESSEL
4 STEAM GENERATOR
5 FUEL POOL
6 FUEL TRANSFER MACHINE
7 FUEL MANIPULATOR
8 PRESSURIZER
9 EMERGENCY CORE COOLING SYSTEM PUMP
10 RESIDUAL HEAT REMOVAL PUMP
11 STORAGE TANK
12 MATERIAL ACCESS

Fig. 2

Foundation

All buildings are supported by mat foundations. Generally, the problems which occured in the course of the structural design exceeded those of common industrial buildings for the following reasons:

- Large dimensions and weights of the structures (dead load of the reactor building 160'000 t)
- High reliability required for the settlement analysis (out of plumb deviation of the reactor building is not allowed)
- Structure to structure interaction
- Consideration of extreme load cases (earthquake, airplane crash, shock waves due to external explosions)

Fig. 3

Taking all this into consideration, a slab thickness of 2,75 m with 1'700 t reinforcing steel has to be provided for the reactor building. A special steel supporting structure was needed for the upper layer of reinforcement (see fig. 3).

Design of the Buildings

As all major loads are time dependent, many dynamic analyses had to be performed. To withstand such loads, a great amount of reinforcement is usually required (sometimes up to 1'000 kg/m3). In turn, this requires considerable skill on the part of the engineers to successfully design the arrangement of reinforcing steel.

Design Impact and Masses of Material

During the structural design of the plant, 60 to 70 engineers and draftsmen were involved. They have produced about 20'000 pages of handwritten design calculations, a two meter high pile of computer outputs and execution drawings. For the buildings and structures 180'000 cubic meters of concrete have been poured, 26'000 tons of reinforcing steel have been put in place and 360'000 square meters formwork have been erected.

(Kurt Gähler)

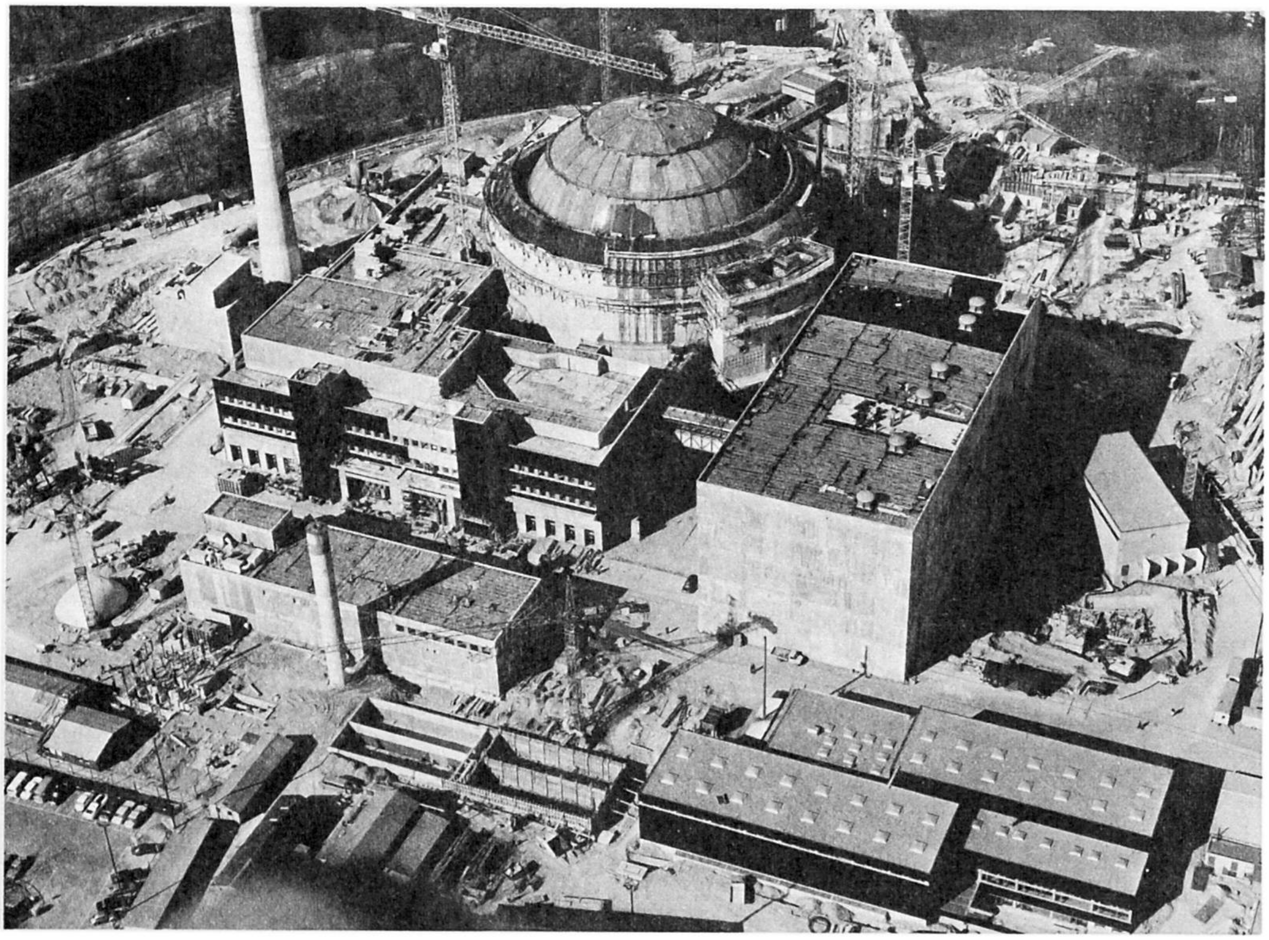


Fig. 4