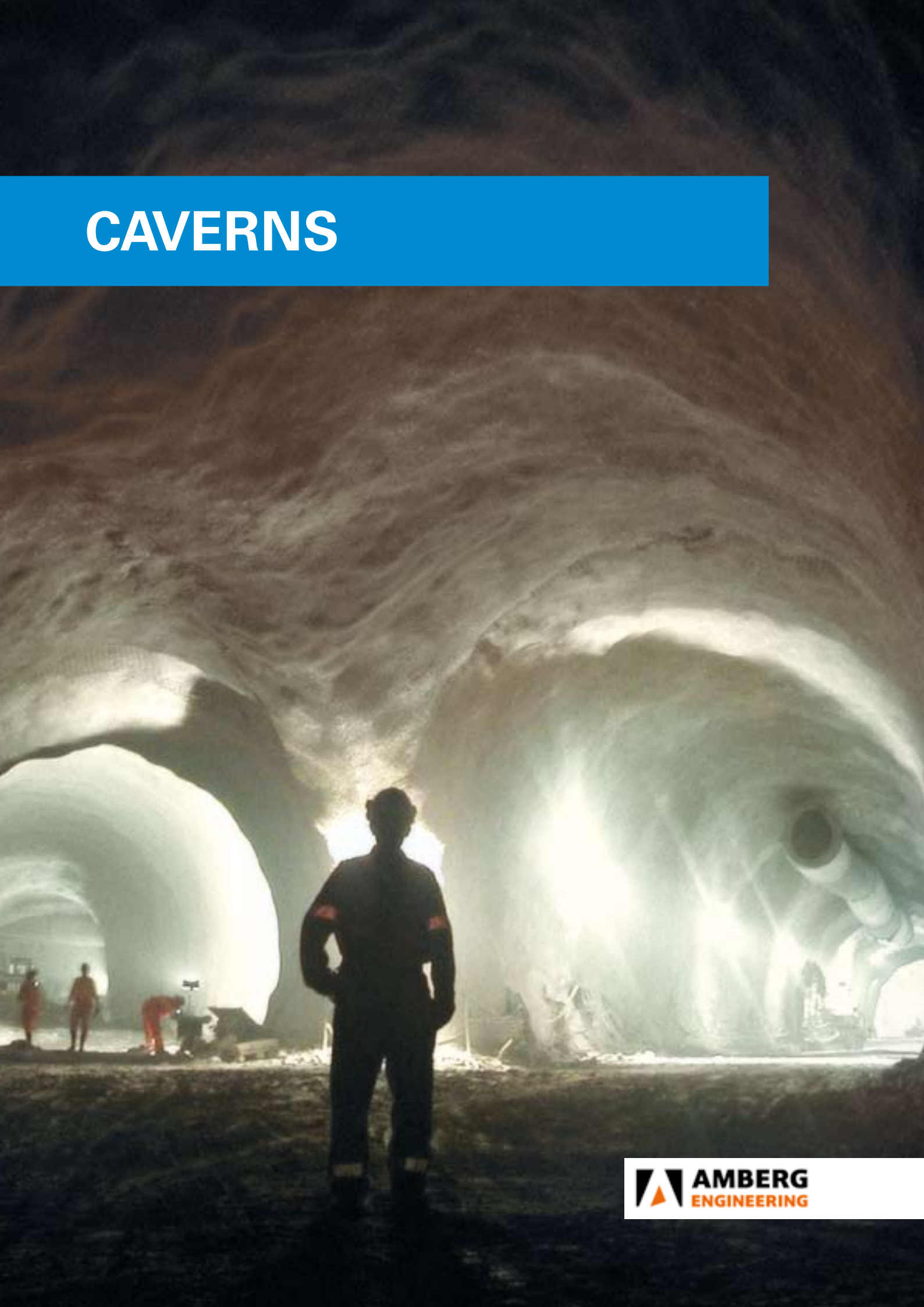
CAVERNS



AMBERG ENGINEERING

CAVERNS AS A SOLUTION

Infrastructure systems, industrial plants, research facilities, hydroelectric power stations, recreational facilities, protective structures, storage facilities, waste disposal facilities and quarries have some joint characteristics. They need large areas, which are becoming ever scarcer. The consequence is significant acquisition costs. If situated near residential areas, resistance to the facility is likely, leading to new obligations and delays. Conditions placed on the environmental compatibility of facilities, such as reducing emissions, lead to expensive measures. Some of the facilities listed need an increased level of protection for the material or processes inside. Finally, some require uniform environmental conditions with respect to climate and low vibrations.

Building a facility in an underground cavern can be the optimal solution to meet these characteristics and requirements – underground facilities need less land, have less impact on the surrounding countryside, prevent some objections and obligations, offer uniform environmental conditions, lead to fewer emissions and offer very high levels of protection.

What should be taken into account?

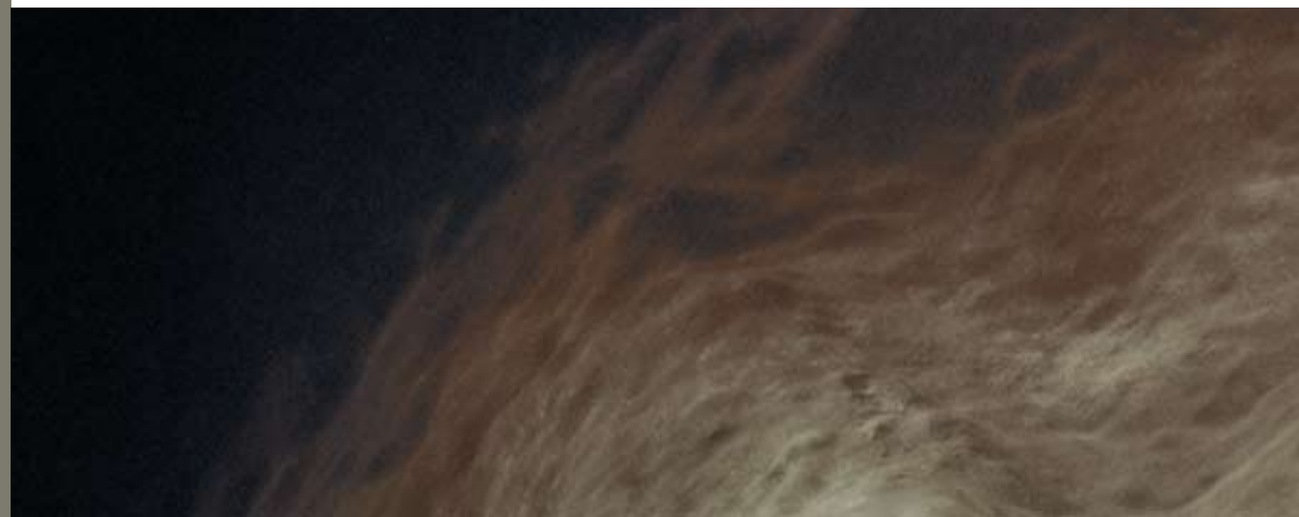
The use of the facility determines the location and the layout of the cavern. Usually, large dimensions are necessary, which are always a challenge to build. Underground caverns require careful analysis of the rock mass behaviour and the support installed, especially in poor ground conditions.

For underground structures, access, supply and disposal, ventilation, cooling and safety systems must be designed differently than for structures above ground. Equally, the maintenance and upkeep of underground caverns have different characteristics. A further challenge of building facilities underground is to correctly recognise the requirements resulting from the purpose and the technical equipment in the system, so that a technically sound but cost-effective solution can be found. This is an iterative process.

Professionals with the necessary overview and vision

Amberg Engineering has many years of experience and in-depth knowledge of all types of underground cavern construction. This experience has been gathered over decades, especially in the construction of complex military underground installations – where we are one of the leading engineering design companies in the world. This, combined with our continuous search for innovative solutions, allows us to take into account the latest developments when delivering our services and to create cost-effective, needs-oriented solutions.

Underground caverns must be adjusted to meet specific requirements. For this reason, it is important to us to understand the needs of the client, user and operator, in order to reach the best solution. Therefore, we develop the facility in co-operation with the customer and his planners and specialists.



SERVICES IN DETAIL

Amberg Engineering realises innovative, customised solutions for caverns. From planning and realisation to operation, our specialists will support you throughout the entire lifecycle of a structure.

Phase 1 – Planning

– Geological survey
– Feasibility study
– Preliminary and schematic design
– Invitation to tender, tender documents
– Geotechnical and structural analysis
– Stability analysis and evaluation
– Dynamic analysis
– Fire protection concepts and evaluation
– Safety concept
– Evacuation planning

Phase 2 – Realisation

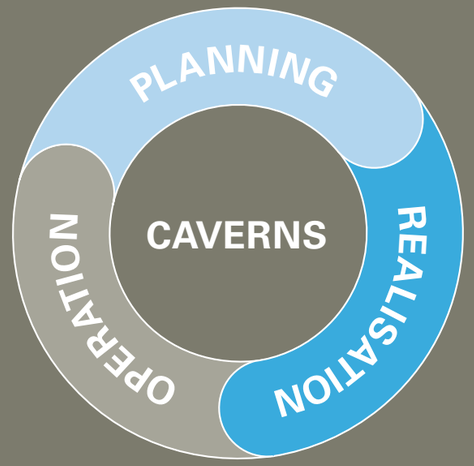
– Detailed design
– Construction supervision
– Project direction
– Control surveying
– Vibration and shock monitoring
– Resource planning
– Quality management

Phase 3 – Operation

– Facility inspection
– State assessment
– Conservation of value planning
– Maintenance planning
– Renewal and refurbishment
– Modification

Services in all phases

– Project review
– Project management as the client representative
– Controlling
– Risk management
– Consulting
– Training
– Safety evaluation



Underground quarry, Läntigen – Switzerland

OPENING A NEW EXCAVATION AREA

In Läntigen, at Lake Lucerne, an underground quarry for limestone is developed. The excavation volume is around 15 million tonnes. The excavated rock is processed as ballast for railway track or gravel for road construction. The plant has been designed for an annual excavation volume of 0.5 million tonnes. Amberg Engineering carries out the feasibility and commercial viability study as well as the preliminary design and the design for regulatory approval for the underground work.

The challenge

Underground excavation of construction material is only commercially viable with optimisation of the underground cavern geometry and the applied rock support. An overburden of several hundred metres must be taken into account. In the excavation area, attention should be paid to existing and planned tunnels. Transport of limestone from the quarry as well as the required supply to the site can not be done by road due to lack of space and environmental concerns.

The solution

The caverns, placed systematically across several levels, are aligned favourably with the main stresses in the strata. They are designed around the necessary rock columns between the chambers. The chamber width and height is 13 m. The rock columns in between are 17 m thick. The existing and planned tunnels and the optimum internal access of the excavation levels are included in a concept for the arrangement of the underground excavation. Transports to and from the excavation area are solved via access tunnels and loading facilities for either ship or train.

JTC Oil Terminal – Singapore

UNDERWATER OIL STORAGE

As part of the construction of a new port facility, the Jurong Town Corporation (JTC) in Singapore builds a new oil terminal. Parts of this terminal are oil storage caverns with a capacity of 1,470,000 m^3. This facility should be built ready for use by a contractor. For the bid of one of the contractors, Amberg Engineering designed the underground caverns. Eventually, Amberg Engineering will take over detailed design and the supervision of construction for the caverns.

The challenge

Since the entire facility will be built below sea level, the geological and hydro-geological conditions are very demanding. The zone, in which the facility will be situated, has a considerable number of rock joints and fault zones.

The solution

Two shafts permit access to the caverns, each with a diameter of 25 m and a depth of approximately 130 m. From these shafts, access tunnels lead to the rock chambers. The support, a single shell type, must be designed to withstand exposure to seawater. The strata and joint system will be pre-consolidated with grout injection from the access tunnel. To prevent oil from seeping into the ground a curtain of groundwater flowing towards the cavern is maintained.

Further references for caverns:

– Wafer Fab, microchip factory (Switzerland)
– Military facilities (Switzerland)
– Underground quarry, Schollberg (Switzerland)
– Underground quarry, Zirl (Austria)
– Multifunction stations, Gotthard Base Tunnel (Switzerland)
– Underground visitor and event cavern, Gonzen Bergwerk (Switzerland)
– Underground research facility, Hagerbach Test Gallery Ltd. (Switzerland)

AMBERG ENGINEERING

Amberg Engineering Ltd.
Trockenloostrasse 21
P. O. Box
CH-8105 Regensdorf-Watt
Switzerland

Phone +41 44 870 91 11
Fax +41 44 870 06 20
info@amberg.ch, www.amberg.ch

Branches: Regensdorf, Berne, Sargans, Chur, Brno (CZ), Bratislava (SK) Singapore (SG), Madrid (ES)
Associated companies: Amberg Technologies AG (CH), Hagerbach Test Gallery Ltd. (CH)