



WSP
Future Tunnels Today



Protecting Future tunnels today

WSP provides support of the highest calibre to prestigious and complex projects around the world. Our Swedish and international teams have significant experience in delivering innovative and code compliant life safety solutions around the world.

Our global reach and local knowledge delivers the highest in international standards and local regulations.

WSP provides a wide range of services in tunnel planning, design and construction. In this brochure the areas of Fire and Risk Engineering, Automation, Lighting and Ventilation will be presented.

We pride ourselves on a proactive and committed approach to projects, striving to deliver innovation while maintaining common sense and client focus. ■



WSP Fire and Risk Engineering

Throughout the various stages of the road and railway processes, there are numerous requirements on consideration and analysis of risks. WSP works with risk management in all planning and design stages and with numerous kinds of services in both the consultant and the client organisation.

In a feasibility study, the focus is generally on identifying which risk factors need closer attention in the work ahead and whether these factors pose a threat to the implementation of the project. Thereafter, the amount of detail gradually increases and the focus during the investigation stage is on evaluating risk-related difference between the proposed

alternatives. During the planning stage of layout design, the route is defined and the risk analysis becomes a key tool for investigating whether the proposed structure meets current requirements for safety and for defining prerequisites and design conditions for other engineering disciplines.

A whole range of protective systems are called for during the tunnel design stage and these are evaluated and a safety concept is derived for the final proposal. This concept has to be validated by means of a risk analysis which contains all the risks of accidents that may affect a tunnel, so that relevant safety standards are met. Furthermore, essential parts of the fire safety documentation are generally based on risk analyses. Fire safety documentation presents strategies, as well as passive and active protection and safety systems, for ensuring robust and effective fire protection.

Design of escape routes and fire resistance of load-bearing structures are included as key components in the fire safety documentation. Computational

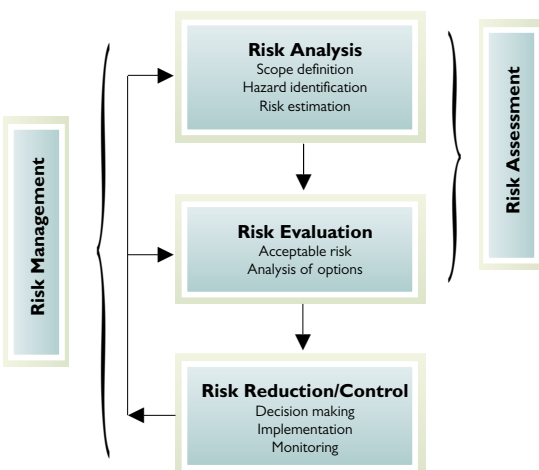


Photo: Per-Erik Adamsson

The City Line Link, Stockholm.

Fluid Dynamics(CFD) models are used for the advanced computation of the fire and smoke spread along with evacuation simulations designed to calculate walking speeds, identify bottlenecks and validate evacuation strategies. Advanced temperature calculations are used when designing and validating the fire resistance of load-bearing structures.

Proposals for action plans are discussed for possible extreme accident scenarios in tunnels involving hazardous materials. It is often necessary to study risk exposure with regard to both road-users and third parties.



A series of special investigations also have to be carried out, either because they are directly required by legislation or in order to find solutions that are more functional and cost-effective than prescribed ones. Some illustrations of this are:

- EX-classification of water and wastewater facilities in tunnels,
- opportunities and weaknesses involved in using sprinklers in tunnels
- cost benefit analyses of different concept solutions or system options.

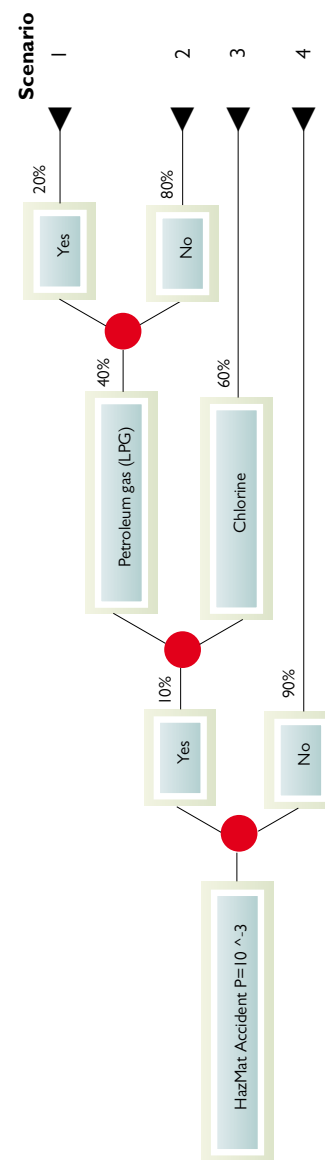
In addition to planning and design of safety systems, WSP works actively with risk analyses as an integral part of the design work. Technical supervisors from different engineering disciplines are involved in this work, contributing with information and know-how about risks in their particular fields of technology so that the risks can then be managed early and efficiently in the planning process.

Risks that are identified and dealt with are systematically documented in a risk-register, i.e. a database of risks. A plan is

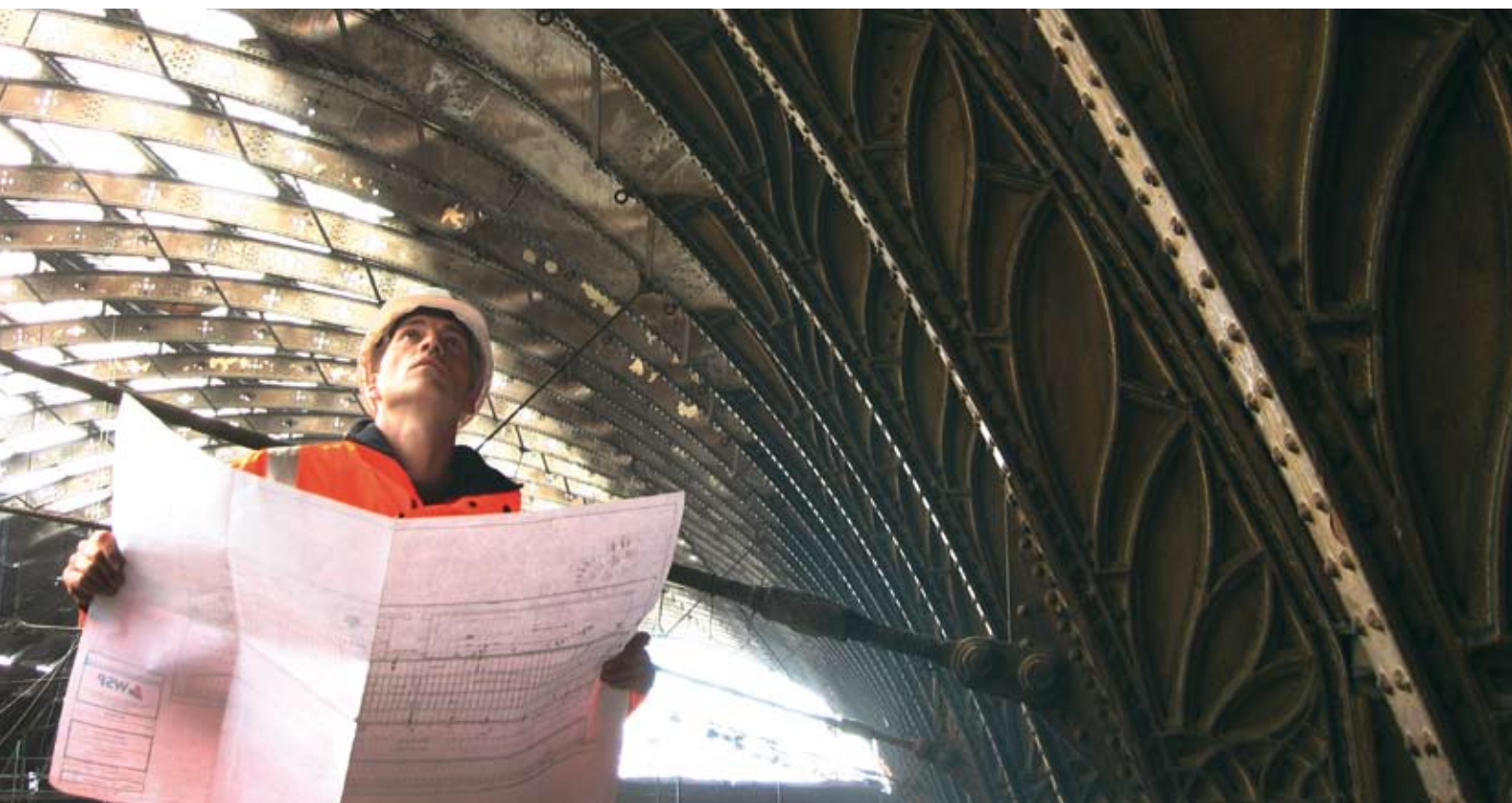
built around each risk that has been identified to ensure that the risk is avoided or properly controlled. If this is not possible, a further analysis is performed or the risk is escalated and communicated to the appropriate parties.

The status of the risks is updated so that, on completion of each stage, it is easy to see which risks remains and who is responsible for them. The risk register is a vital component in the client's tender documentation and forms part of the report on how the client manages its risks, e.g. when purchasing insurance.

WSP also works as a project risk co-ordinator and manages and co-ordinates risk management procedures in project planning work in order to methodically go through, document and deal with risks for its own undertakings together with the project management group. Personnel from WSP may also form part of the client's organisation, in which case they act as project managers in the areas of safety, consultation co-ordination, and so on.



An event tree can be used in a risk analysis in order to systematically identify scenarios.



WSP Automation, Ventilation and ITS

A tunnel is made up of a mass of different systems, designed to work together to maintain a high level of utility for the traffic and to ensure that safety is sustained at all times. The requirements for each subsystem and for the control and monitoring of the entire site are high.

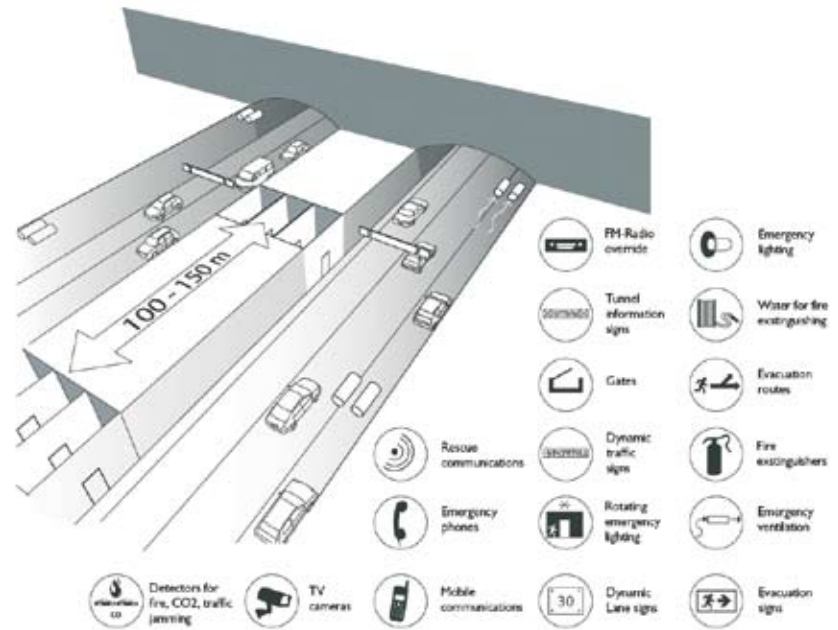
These systems detect whatever happens in the tunnel and the operators who monitor the tunnel are notified of any events by a control and monitoring system.

Should an accident occur, like a fire, many measures have to be taken. The control and monitoring system can then support operators in their decisions as they work through numerous measures. The various subsystems then perform the measures via the control and monitoring system.

WSP has the expertise for each subsystem and the overall knowledge needed to coordinate all systems. Using the risk analyses as our starting point, we plan the various installations so that maximum safety is achieved.

WSP can supply an extensive range of services throughout the various phases of a project:

- Project management
- Feasibility studies

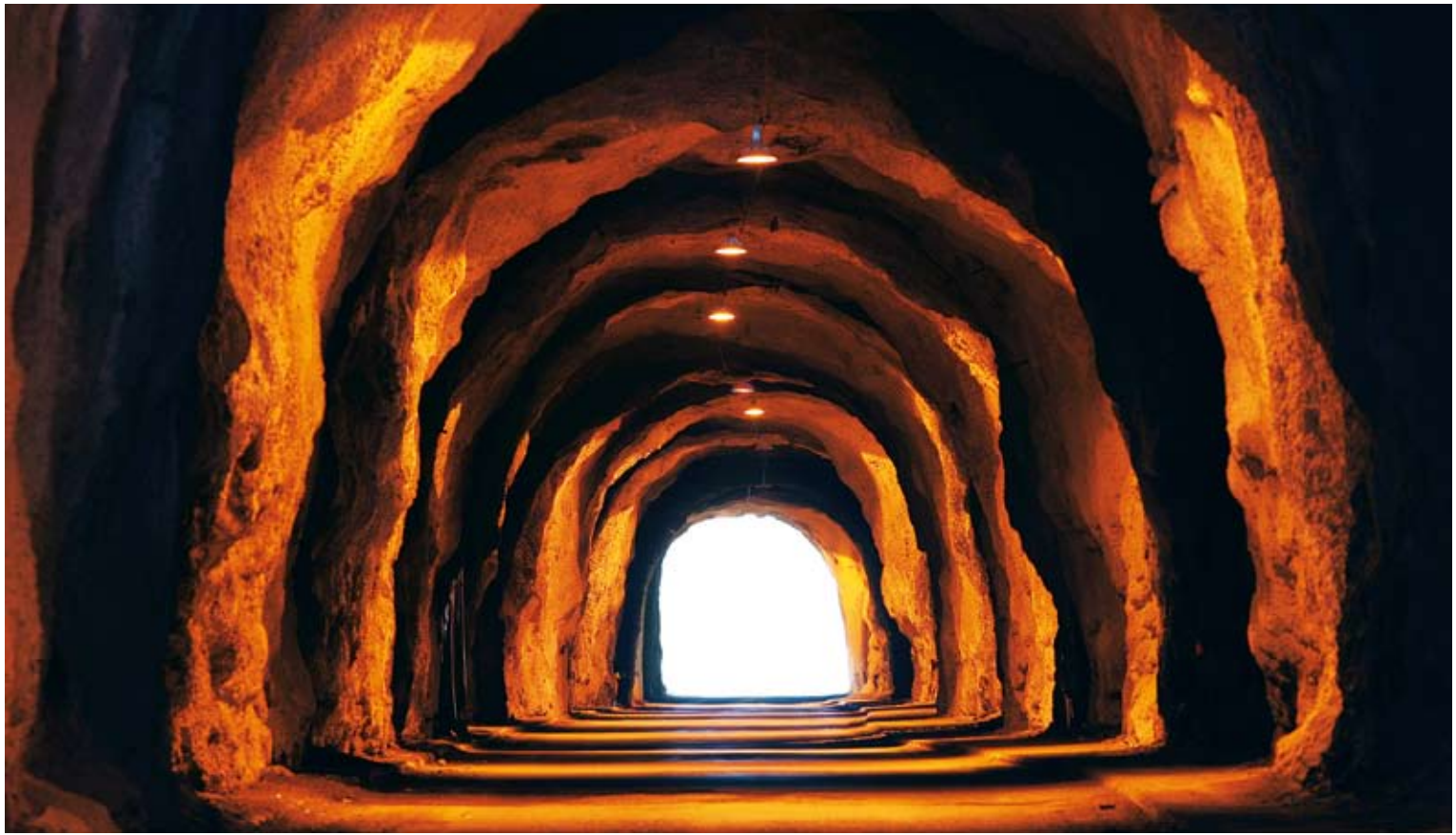


The Nothern Link has an extensive safety concept tailored by WSP.

- Investigations
- Project planning
- Testing
- Technical advisor services
- Cost benefit analysis
- Interface with equipment suppliers to ensure integrated design solutions
- Commissioning and whole site witness testing
- Audit of operational facilities to identify system limitations and enhancements

Variable message signing, Closed Circuit Television and interactive public information points are part of the range of communication methods provided by our world-class electrical and electronic engineering specialist Intelligent Transportation Systems(ITS) team. Their innovative information, monitoring and control-based systems and products inform travellers of choices before and during travel.





WSP Lighting

WSP Lighting provides infrastructure lighting for projects like highways, airports and major installations. In Sweden, WSP specialises in interior and exterior lighting for architecture projects and in the UK we provide lighting advice in four key areas:

- Policy, strategy and regulation
- Management and procurement
- Design and construction supervision
- Operation and maintenance

Our clients include: The Highways Agency, the National Roads Authority, Network Rail and Gatwick Airport.

In Sweden, WSP Lighting employs 40 specialists from different business areas and with different experience, including light planners, light designers, architects, technical consultants and structural engineers.

Our company in the US, Flack + Kurtz provides lighting services for high-rise building projects.

WSP Lighting offers light planning for all categories of interior and exterior projects. Our services cover all aspects, from counselling and feasibility studies to complete work documentation. Our client list includes local authorities, real estate owners, construction companies and architects.

The focus in lighting projects has been on creating a good visual line for increased safety.

In particular, efficient light sources with good colour rendering have been used. The light is perceived as being whiter and renders colours more accurately. The lighting control system not only includes the aspects of safety but also optimises energy efficiency.



The Tingstad tunnel in Gothenburg.

Examples of WSP's tunnel projects in Sweden

The Svealand Rail Line

The project consists of improving the capacity of the line by expanding it to a double-track line. WSP conducted a general and an in-depth risk analysis including a fire and evacuation investigation for the Strängnäs station tunnel. The work also involved the production of proposals for a safety concept of the station design, based on CFD-models.



Overbuild at the Northern Station area, Stockholm

The Swedish National Road Administration has commissioned WSP to conduct a feasibility study of the E4/E20 motorway at Norra Station. This road section is used heavily by hazardous goods vehicles and it has been decided to overbuild the road and the railway. A new city district will be constructed on the overbuild. WSP has analyzed the following risk factors: the temporary road network, design of the tunnel profile, the safety concept, the traffic redirection network, capacity-strengthening measures and the number of tunnel pipes.



Bypass Stockholm

WSP is one of three partners in a consortium that was bought by the Swedish National Road Administration to develop two work plans for the continued development of the Bypass Stockholm motorway project. Just over 16 kilometres of this 20 kilometre long motorway will lead through tunnels. WSP is solely responsible for tunnel safety and has 40% of the whole project. The other partners in the consortium are SWECO and Tyréns.



The Northern Link, Stockholm

Through close collaborative work between all its fields of technology, WSP has developed the general safety concept and fire safety strategy for the Northern Link. The eleven kilometres of traffic tunnels have been analysed for risks, hazardous goods transportation, technology, construction, evacuation safety, EX-classification under the ATEX Directive, etc.

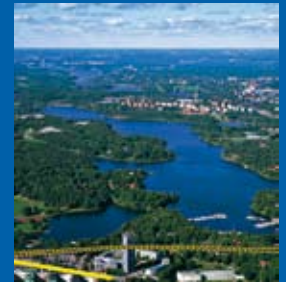


Photo: Per-Erik Adamsson

The Marieholm Link Road, Gothenburg

The purpose of the Marieholm Link Road is to provide relief to Tingstad Tunnel and enhance safety and access in an area of Gothenburg that has experienced major traffic problems over the years. WSP has performed fire and risk investigations, environmental engineering analyses of soil conditions, landscape architecture and water and wastewater technology for all sections of the planned Marieholm Link Road.



Photo: Vägverket

The City Line Link, Stockholm

The City Line leads through the heart of Stockholm and is a double-track railway line with underground stations, running about six kilometres from south to west. WSP is conducting risk and safety studies which are primarily concerned with personal safety and accident management. The work involves safety during the construction period and safety of the finished structure. This is one of WSP's largest ever projects in Sweden and we have many disciplines involved.



WSP Group plc is a global design, engineering and management consultancy, specialising in projects for the property, transport and environment sectors. With over 250 offices in 35 countries and more than 9,500 employees, WSP is one of the largest consultancy companies in Europe and among the top ten in the world. Operations are mainly based in England and Sweden, but also in other European countries, the USA, Africa, Asia, Middle East, Australia and New Zealand.

WSP's vision and core values help to define the culture of the group, motivating our staff to give their best and instilling in our clients confidence that we will deliver solutions of the very highest quality.

Our vision is:

“To be the outstanding supplier of specialist and integrated services in the built and natural environment”