L-Surf - Large Scale Underground Research Facility for Safety and Security

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ABSTRACT

Security and stability rank among the most important aspirations in everybody's life. Mobility of people and reliable transport of goods are key issues in our society. Both economic growth and societal development rely heavily upon safe and secure infrastructure, in which road, rail and metro tunnels besides other enclosed spaces of infrastructures are important elements.

To date, the increasing awareness of safety and security caused by severe heavy accidents with partly enormous damage on health and goods and terrorist attacks in underground infrastructures, leads to the necessity of R&D projects that work on safety and security and make an improvement of both existing and projected infrastructure in enclosed spaces possible. This also finds its expression in the description of the 7th framework programme of the EC where safety and security is explicitly addressed as an individual topic for R&D activities.

The necessity for large scale test and R&D on safety and security in enclosed spaces - and correspondingly for adequate R&D facilities - was identified during the programmes of the 5th EU framework programme. In order to answer these questions and to overcome the identified shortcomings a basic analysis of all relevant aspects was needed. A design – study seemed to be the most appropriate tool to do so. The L-surF project is running within the 6th EU framework programme and will propose a solution to define a European wide R&D approach and a real scale research facility to cover safety and security aspects in enclosed spaces.

1. LARGE SCALE TESTING REQUIREMENTS – OR WHY L-SURF?

At the given stage we are able to conduct large scale tests for research and development in the field of safety and security underground. Several test facilities spread all over Europe are available for real scale tests dealing with fire safety, fire propagation, smoke distribution, but also for training and education of users, operators, special forces as first responders like fire fighters etc. The Hagerbach Test Gallery for example which I am representing is such an underground research facility offering both the infrastructure and consultancy in the planning phase of test activities and support during the preparation phase and during the tests. One of our big projects was the testing of a water mist system carried out as a validation test required for the implementation into a new constructed tunnel being part of the A86 in the south – west of Paris. Being able to carry out such extensive test procedures we think we are a really strong partner for our clients, even if we know – or maybe because of that – where our limits are.

Flexibility in size and the shape of contours of subsurface spaces is one of the major requirements future test facilities will have to meet. Especially for validation tests scaled 1:1 it is necessary to provide a potential client with shapes, cross sections and slopes of tunnels, e.g., which is either quite challenging to construct or in the end good or bad luck, if the required spaces are available or not. To satisfy this need with a CCSS – Convertible Contour Size and Shape scheme – is one of the two
technical priorities of our L-surF project. More detailed information will be provided in the following section dedicated to an introduction to the project itself.

**Simulation** of surface properties close to reality as possible is one of the core criteria in conducting tests, making research, or performing training. Depending on the testing or training focus, different properties of the shell have to meet the corresponding requirements. While fire protection of the lining is certainly the most important criterion regarding surface properties when carrying out fire tests, there are completely different needs for the research in human behaviour, where colours or the surface texture e.g. are the properties to be focussed on. Testing in the field of blasting or distribution of toxic gases in connection with ventilation require further properties. Either to combine some of these properties or to define separate areas dedicated to some special testing activity may be a satisfactory solution a research facility could offer to potential clients.

![Fig. 1. Preparation for water mist tests at Hagerbach Test Gallery (Source: VSH Ltd.).](image)

**Environmental protection** today resounds throughout the land as climate change and the global warming at the given stage are more and more identified as the biggest problems we will face in the near future. For that reason we must be aware of the fact that waste water treatment and waste air treatment in case of fire tests for example must fulfil very strong directives in order to avoid pollution while doing research. Having a closer look at a large scale test facility and given the requirements to cross sections, air velocity, and the duration and number of tests for the validation of a water mist system in a tunnel, e.g., it is quite easy to get an idea of the amount of polluted air resulting from such test activities. Depending on what is burnt in the frame of testing different means of cleaning and filters are necessary for the waste air treatment. These amounts of smoke are asking for really huge purification equipment and accordingly causing high expenses.

**Measuring equipment** and its development is the second technical focus regarding requirements to a large scale test facility - besides the flexibility of the construction - and therefore part of our L-surF project, too. Some measurement instrumentation is meanwhile well proved to be applied in tunnel safety testing. But against the background of recommendations for the harmonisation of tests both the accuracy and the range of the broad variety of measurement equipment available has to be taken into consideration. Thinking about research methodology requires delving into the relation between several important parameters and further to discuss and suggest scenarios and the corresponding relevant
parameters. Data acquisition of these parameters may be done with a broad diversity of measurement technology. Several technologies are frequently used in fire research but not in tunnels and have therefore to be adapted to the special requirements. Another sounding term in the same respect is Technology Transfer. More dimensional pressure measurement or the air velocity distribution are two examples for potential know how transfer from other fields of research to the scope of safety and security underground. The corresponding contacts we were able to establish in the course of our project.

Harmonisation of test procedures will allow setting the benchmark and make comparison between tests possible. Today there is no European regulation regarding testing for safety and security in enclosed spaces but several national guidelines and regulations. But results of tests and of course the test procedure itself must not depend on where and by whom tests are carried out. Even the parameters which are focussed on are to be harmonised and clearly defined, e.g. the fire load, the temporal extension of a test, air velocity etc. In order to harmonise the test procedure also the measurement equipment regarding range and accuracy, the property of surfaces regarding temperature resistance and the ignition have to be defined. In the frame of L-surF some recommendations are worked out aiming in a harmonisation of the test activities.

2. THE DESIGN STUDY “L-SURF”

L-surF, which is the acronym for Large Scale Underground Research Facility on Safety and Security, is a feasibility study in the frame of the Sixth EU Framework Programme for Research and Technological Development implemented as a specific support action. Five European institutes leading in the field of safety and security research of underground spaces are collaborating in order to find an answer to open questions, problems and shortcomings identified during several FP5 programmes in this research area. The main objectives of L-surF are fourfold and will be achieved by our work distributed in 6 Work Packages which will later be explained.

L-surF’s first main objective is to carry out a feasibility study for the establishment of a pan European research facility for large scale tests in underground spaces. The development and design of the constructional layout goes hand in hand with the identification and definition of R&D activities based on research needs which are screened in the frame of an own Work Package. Additionally, potential clients and partners strongly influence the development of the design study as a whole.

L-surF’s second main objective covers scientific and technological research on both the constructional properties of the infrastructure and the measurement equipment to guarantee technical equipment according to the latest state of the art and based on the newest technology available. As far as constructional properties of testing areas are concerned L-surF is developing an entirely new system called CCSS (Convertible Contour and Shape Scheme) to ensure best possible flexibility regarding cross sections, contours, slopes, in other words to provide test areas with every geometrical property required by the clients. Depending on the test activities carried out in the corresponding areas, the properties of the surface will exactly meet the specific requirements, i.e. fire resistance up to several degrees in the locations for fire tests according to special needs, stability and resistance against dynamic loads to allow research on and with explosives, air tightness for ventilation and smoke distribution tests etc. As far as the measurement equipment of the test areas is concerned, the technology transfer through which we try to facilitate the development of innovative 2D and 3D measurement sensors is an important issue. In some parts large scale testing for tunnel safety and security requires measurement of similar parameters or even the same (but maybe in another range or with different accuracy) as in aeronautic research. As mentioned above, the measurement of air velocity distribution with PIV (Particle Image Velocimetry) or 3-dimensional measurement of pressure distribution with PSP (Pressure Sensitive Paint) are available technologies from other fields of research which might be transferred and adapted for the use in the scope of L-surF. Besides these
scientific aspects environment protection has to be dealt with in a very careful way, too. Caused by the fact that large scale fire testing in tunnels always goes together with tunnel ventilation, it is easily imaginable that enormous amounts of smoke resulting from the test have to be treated besides the waste water from the fire mitigating or extinguishing system.

**L-surF’s third main objective** is a business plan comprising information about users, customers, markets and of course financial issues for the realisation of the research facility. In the frame of “Work Package 5 - Research, Training and Experimental Activities” we are working on a definition of R&D activities carried out in the scope of L-surF in the future, based on a survey of research and market needs (Work Package 2) and on our own capabilities and knowledge. But at the same time we are developing an integration process (Work Package 1) for both existing and projected national facilities with their competences and researchers thus restructuring and improving the relevant EU competence while simultaneously showing ways for using R&D funds more economically. In our understanding added value to the European research community is compulsory and absolutely necessary to enable the realisation of L-surF. The question of the construction site and the registered seat of the legal entity is highly depending on political support, either from regional governments or from the EC and / or the different strategic and decision making institutions. Where the Large Scale Underground Research Facility on Safety and Security can be erected remains therefore to be seen.

![Fig. 2. Beginning of water mist tests at Hagerbach Test Gallery (Source: VSH Ltd.).](image)

But the base will be a legal entity called L-surF established in the course of the project (by February 2008 at the latest) which is stipulated in the contract and therefore **L-surF’s fourth main objective**.

So this might be a speciality of L-surF that the end of the project itself is definitely not the end of L-surF but actually a starting point for a new era of research and development on safety and security of confined and subsurface spaces.

### 3. POLITICAL AND STRATEGIC SUPPORT

Research infrastructures of pan European interest and excellence do not arise overnight. Even they do not come into reality if political and strategic support is lacking. It is one of our biggest challenges that research on underground safety and security has a really poor publicity and lobby in comparison to
other fields of scientific research, fundamental research of physicists e.g. with their need for a particle accelerator. The need of such a research infrastructure is well known and accepted in public.

**The realisation** of L-surF will only be possible, if the need of such a large scale research infrastructure is identified in the specific strategic groups such as ESFRI, the European Strategy Forum on Research Infrastructure, or in those institutions supporting the decision making on a political high level as the ETPs and their working groups. At the time being we have been in contact with the ESFRI Roadmap Working Group for “Physical Sciences and Engineering” in order to find entrance into the ESFRI Roadmap. Further we had the opportunity to present our project to the Working Group on Research Infrastructure of the ECTP. Through these activities we hope to create the certain momentum necessary for the realisation of L-surF. In addition to that we were up to now able to establish contacts with several Eastern European countries and we hope that one or some of them will support the erection of L-surF on its territory. This would also be very helpful for the financing via the European Investment Bank or the European Bank for Reconstruction and Development including new facilities like the RSFF (Risk Sharing Finance Facility).

4. **DO WE REALLY NEED L-SURF?**

Screening the European landscape of large scale research facilities you will find several infrastructures carrying out research and testing in the field of underground safety and security. As a matter of course the question is arising if there would be not enough infrastructures available to cover this field of R&D and training. Who will pay for that? Is there really any need for first response services e.g. to travel several hundreds of kilometres for training and education purpose only?

**At the present time** a couple of research infrastructures are doing research and training for underground safety issues. The need is obviously given and certainly increasing having in mind several bad incidents in recent years as identified in the course of some FP5 projects dealing with underground safety. Furthermore there is always somebody paying for the running activities. Who would do so without any need? Due to the fact that large scale tests in this field are always linked to enormous expenses we believe that bundling the forces and sharing costs for infrastructure will facilitate carrying out real scale tests in the future. Flexibility to exactly meet users’ requirements is too expensive to be borne on a national level. And last but not least, testing on European level will significantly increase the worldwide competitiveness and strengthen the global position of the European Research Area which we believe is a valuable contribution to the European Community.