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TUNNEL PERFORMANCE TEST

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ABSTRACT

The life cycle of a tunnel structure over 500 m officially begins for operation with the first opening in accordance with the Road Tunnel Safety Act (STSG) and thus after acceptance by the tunnel management authority. In the course of such an acceptance with an officially appointed and sworn expert, the tunnel is structurally and technically inspected for functionality and conformity with regulations.

After the first opening, the tunnel is not tested any more across all trades until the next refurbishment according to STSG §§ 7 and 8 STSG. ASFINAG Performance Tests have been working against this since 2018. With the voluntary internal ASFINAG tests of the entire system, conclusions can be drawn about the life cycle of a tunnel system and traffic and tunnel safety can be increased. The aim of these tests is to check systems between partial and general refurbishment and to initiate any necessary measures to restore the approved system condition.

Keywords: Tunneltest, Life Cycle, Commissioning, Recommissioning, Performance Test, system-wide

1. FIGURES, DATA AND FACTS LIFE CYCLE

At present, 166 tunnel systems are in operation on Austrian motorways and expressways, 87 of which are over 500 m long and therefore subject to the Road Tunnel Safety Act. (STSG)

With the entry into force of the Road Tunnel Safety Act 2006, all tunnel installations more than 500 m before being opened for the first time (new construction) or reopened (refurbishment) must undergo an acceptance or test procedure by the tunnel management authority and an external expert. The official acceptance procedure takes place after a cross-system test and trial run by the contractor, which can last up to 12 weeks, depending on the size of the facility. On the basis of the official acceptance procedure, a notice of initial opening or reopening of the tunnel is issued.

Before opening or reopening tunnels run through several test procedures until they are open to traffic in accordance with §§ 7, 8. After that, partial or general refurbishments with closure of the tunnels are planned every 15 to 20 years. Between opening or reopening and the refurbishments, only maintenance and repair work at the maintenance intervals in accordance with the guidelines can be carried out by external contractors and/or the operating technology department of ASFINAG.

For tunnels under 500 m length, no official acceptance procedure with cross-trade inspections is provided.

2. TUNNEL PERFORMANCE TEST

Due to the lack of cross-system tests between the refurbishment phases, ASFINAG started with the first performance tests in 2018.

A performance test aims to check the tunnel for approved functionality and guideline conformity (status of the guidelines at the time of the first opening or last refurbishment). A target-actual comparison is carried out in order to derive measures for operation from it if necessary.

2.1 GENERAL CONDITIONS

In order to ensure a reasonable and efficient planning of the systems to be tested, 5 parameters were identified which can trigger a performance test in tunnel systems:

- Age of the system (year of first opening or last reopening)
- Safety assessment (year of the last external safety assessment carried out)
- Exchange of the tunnel head computer
- Implementation of a notification procedure according to § 10 STSG
- Partial or general refurbishment (year of the next planned refurbishment)

The above mentioned parameters flow into the planning matrix and thus support the selection of the systems to be tested and the preparation of the annual planning.

Currently, a test interval of max. 5 years is planned.

2.2 SCOPE AND PROCEDURE OF THE TEST

A performance test looks at the tunnel holistically and across all the different trades. The technical function of the individual field devices on site, visual inspections of the system status and the integral automated processes according to the event and incident matrix and traffic matrix are documented in the tunnel and in the traffic management centre. In addition, the equipment of the tunnel is checked for compliance with planning and guidelines.

- Video detection incl. correct video image switching and text insertion (ghost drivers, slow drivers, standstill/congestion)
- Occupied, counting and double counting loops (triggering parameters, reflexes)
- Traffic programs according to traffic matrix
- Emergency call (voice quality, door contacts and reflexes)
- Fire alarm system incl. ventilation control (reflexes, plausibility check ventilation control, fire extinguishing niches, extinguishing equipment)
- Sound reinforcement (FM or loudspeakers, free text or canned music)
- Lighting (step switching and control in case of an event)
- Automated processes according to event and incident matrix (if available)
- Visual inspection of all system components (incl. pictograms) for damage
- Doors and gates (contacts, door opening forces)
- Inspection of signage and inscriptions conforming to guidelines and planning

A minimum of 3 persons (excluding operating personnel for setting up the barrier) must be scheduled for the tests. When setting up the barrier, care must be taken to ensure that it is kept as short as possible and that it takes place during periods of low traffic. Especially in urban areas, these factors are an enormous challenge in planning the test procedures.

Visual inspections and functional tests of the emergency call system can in principle be carried out during lane closures. Testing of counting and double counting loops, and here especially the detection of wrong-way drivers, is only permitted with a blocking of the affected tube. Integral and thus cross-tube tests are only possible in the course of stops on both sides or during the blocking of both tunnel tubes. Experience has shown that cross-system tests during or after exercises and/or tunnel washing are not useful due to the time factor and the simultaneous work to be carried out in the tunnel. As a rule, the tests take place during exclusive night closures.

The tests carried out are documented in pre-prepared sheets with the date, time, tunnel tube and the name of the tested component and the reflex triggered by it. In order to ensure traceability and, if necessary, to reconstruct defects, test sheets per trade must be filled in for each trade for the documentation of the test activities/triggers in the tunnel and for the documentation of the resulting visualisation of the reflexes in the traffic management centre. In addition, photos are taken in case of deviations from the target state as well as videos of the ventilation tests.

After the tests, all test activities carried out must be listed in a protocol, if necessary with a list of the deviations from the target state and the measures to be derived from them.

3. EXAMPLE OF A TUNNEL PERFORMANCE TEST IN THE GANZSTEIN TUNNEL

The almost 2 km long, longitudinally ventilated Ganzstein Tunnel on the S 6 Semmering Expressway was tested in 2019 as part of a performance test. The first tube of the Ganzstein tunnel was completed in 1980 and the second in 2009. Since the opening of the second tube, no refurbishment procedure and therefore no official acceptance has been carried out. The start of the next refurbishment is planned for 2025 at the earliest.

The inspections/tests were carried out or accompanied by 8 persons (excluding operational staff for the closure). Two employees documented the procedures from the traffic management centre in Bruck; 5 employees carried out the visual inspections and releases on site in the tunnel. Furthermore, the operators on duty supported the operation of the system.

The tests took place during a 7-hour night closure from 20:00 to 03:00 in the morning. A total of 36 SOS manual hazard alarms were pressed, 74 niche doors and 10 escape route doors were tested, the fire alarm centre and the fire programme were activated 12 times, 36 emergency calls were made via the emergency call receivers, 39 cameras and 16 double counting and occupancy loops were tested. Table 1 shows an overview of the size of the system, the time required and the documented deviations.

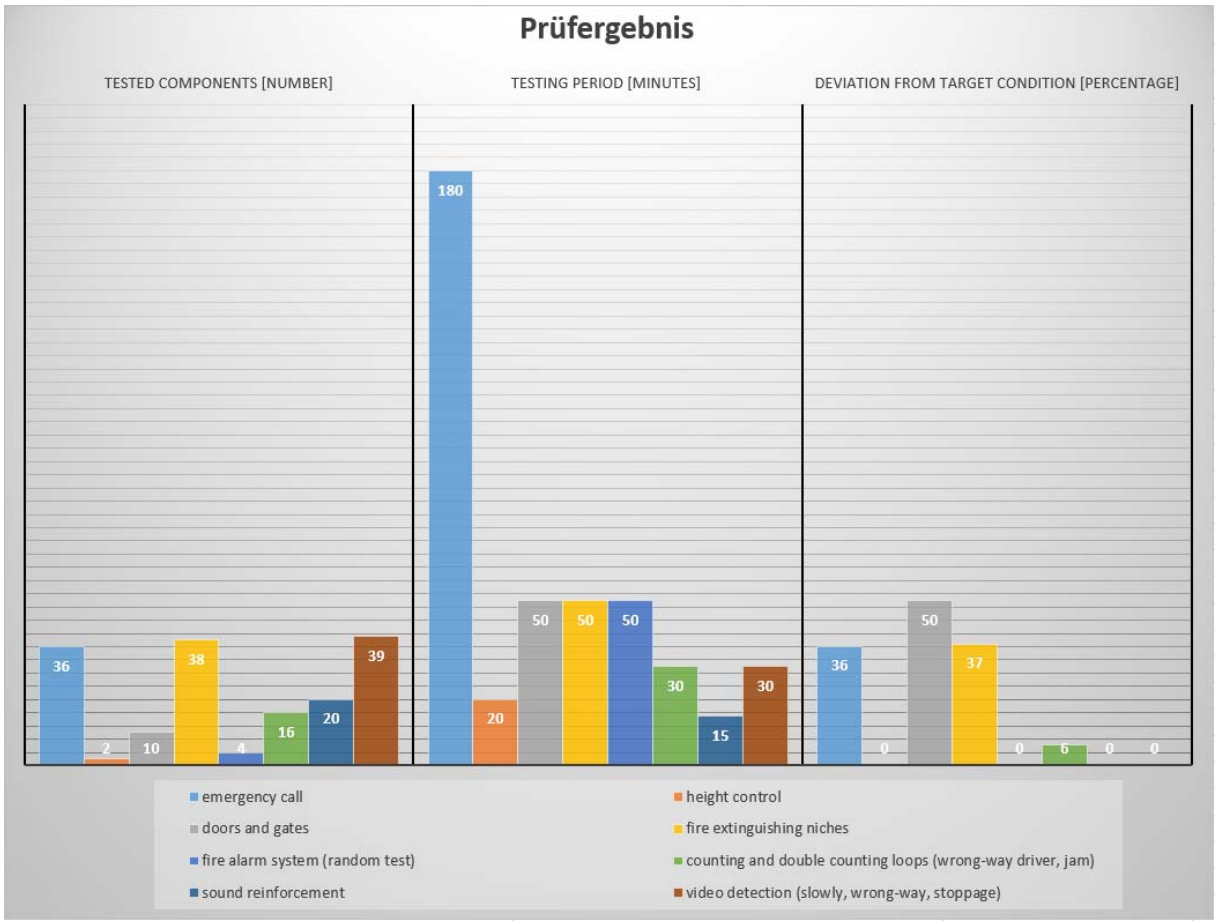

Table 1: Total expenditure for Tunnel Ganzstein test procedure

Finally, a very good plant condition was documented. Nevertheless, over 30 deviations from the target condition were detected. Safety-critical deviations were not determined. Corrective action could be taken promptly by taking appropriate measures.

4. EXPERIENCES AND FINDINGS

Since 2018, about 50 tunnels were tested. Experience shows that the time required for tunnels under 3 km can be calculated as 7 hours (one night). For the remaining tunnels, night closures, lane closures or stops lasting several days had to be planned.

The deviations are divided into three categories, firstly deviations of the technical function, then deviations of the system condition and deviations from the approved technical regulations (RVS, planning manuals, etc.). Deviations from the state of the system include all visual inspections (pictograms, escape route orientation boards, etc.).

A large part of the deviations concern the general condition of the system. This is followed by technical deviations in the area of control technology, video detection and loop detection. Insignificant faults can usually be rectified by the plant engineering department during the tests.

The measures are recorded in a results or measures list and assigned to the responsible departments. A priority ranking according to short, medium and long-term measures as well as clear responsibilities can be read from this list. The monitoring of the fulfilment of these measures is ensured by the tunnel management.

Fig. 1: Example of a faulty display WVZ

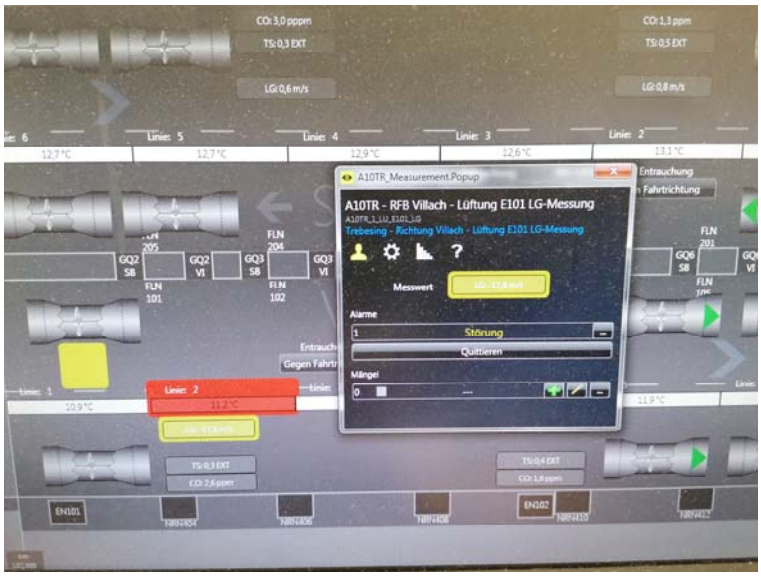

Fig. 2: Example: LG measuring device malfunction during fire simulation

Fig. 3: Example of a faulty escape route indication sign

The system tests between the planned refurbishments ensure that the tunnel systems function perfectly and comply with the planning and guidelines, thus actively contributing to tunnel safety.

5. SUMMARY

The performance tests that have been carried out voluntarily by ASFINAG since 2018 ensure a high level of safety in Austrian tunnels. They provide support in fault rectification and are in the meantime a fixed component of a tunnel life cycle. The aim is to test up about 20 tunnels (STSG and short tunnels) per year.

Similar to the performance tests, the Road Tunnel Safety Act provides for inspections by the tunnel administration authority according to § 3 (5). In order to minimize traffic disruptions for road users the tunnel administration authority and ASFINAG decided to carry out joint inspections and tunnel performance tests. In 2022, 14 tunnel performance tests and additional 14 joint inspections and tunnel performance tests are planned.

Such tests are preventive measures to maintain and increase safety standards in tunnels. Furthermore, conclusions can be drawn about the life cycle of the operation and safety facilities and refurbishment measures can be adapted accordingly.