Visibility Monitoring: VisGuard Field Test in Gotthard Road Tunnel

Objective

At the beginning of March, a several-month field test was started with the new VisGuard visibility monitor and its associated control equipment SIREL, SIBUS and SITRA. The objective was to try out the equipment in various configurations under actual tunnel conditions and to determine:

- whether all of the equipment works flawlessly in continuous operation
- whether the different control units work as they should with the VisGuard
- how the VisGuard performs with regard to:
  - fouling and corrosion
  - zero-point drift
  - stability over several months (checking rod)
  - comparability of the measurement results obtained with the different installation configurations
  - pressure surges caused by trucks (especially the in-situ instruments)
- whether the VisGuard results agree with those of previous instruments (UP, CTN)

Field test venue

The instruments are placed in the emergency shelter/niche 10, about 500 m from the northern portal of the Gotthard road tunnel. The extractive instruments are located in the emergency shelter and draw the tunnel air right from the tunnel wall about 1.5 m above the roadway. The in-situ instruments are mounted on the tunnel wall about 2.2 m above the roadway.

Instruments used

Six VisGuard instruments were employed in all types of configurations, such as extractive/in situ, short/long extraction lengths, single/multiple sampling, with SIREL and also SITRA control units. For comparison purposes, the results from a CTN and a (permanently installed) UP instrument were also plotted. In detail, the following instruments are involved:

1. 2 x VisGuard In-situ, mounted right in the tunnel, controlled by SIBUS/SITRA. One of the Visguards also has a temperature sensor connected to its analog input.
2. 2 x VisGuard Extractive with small blower SE12 (extraction length 25m), controlled with SIREL
3. 1x VisGuard Extractive with large blower SD4n (extraction length 25m, a thin hose being used to simulate greater extraction length with correspondingly high resistance), controlled with SIREL
4. 1x VisGuard Extractive with large blower SD4n (same as above), but with additional double valve switching system, controlled with SIREL
5. 1x CTN, extractive with small blower SE12 (extraction length 25m), controlled with SIPRO
6. 1x extractive UP instrument (extraction length about 50m), used by tunnel operator

Data acquisition

The readings from all instruments were picked off about once per second by means of the SIBUS control unit (serial bus in the case of SITRA, current output in the case of SIREL). An average over 10 seconds was then recorded on a PC.

Every 1-2 weeks the checking rod and zero-point figures were recorded as well.

Results

Comparability of the readings

Fig. 1 shows the hourly average over a full week, as measured with the different configurations. Except for averaging, the data was not processed in any way. Obviously losses had a noticeable effect on the extractive measurements, but such losses can of course be corrected for with a scaling factor determined using a comparative measurement in the tunnel upon installation. After this correction was made, the readings ran parallel (see also Fig. 2).

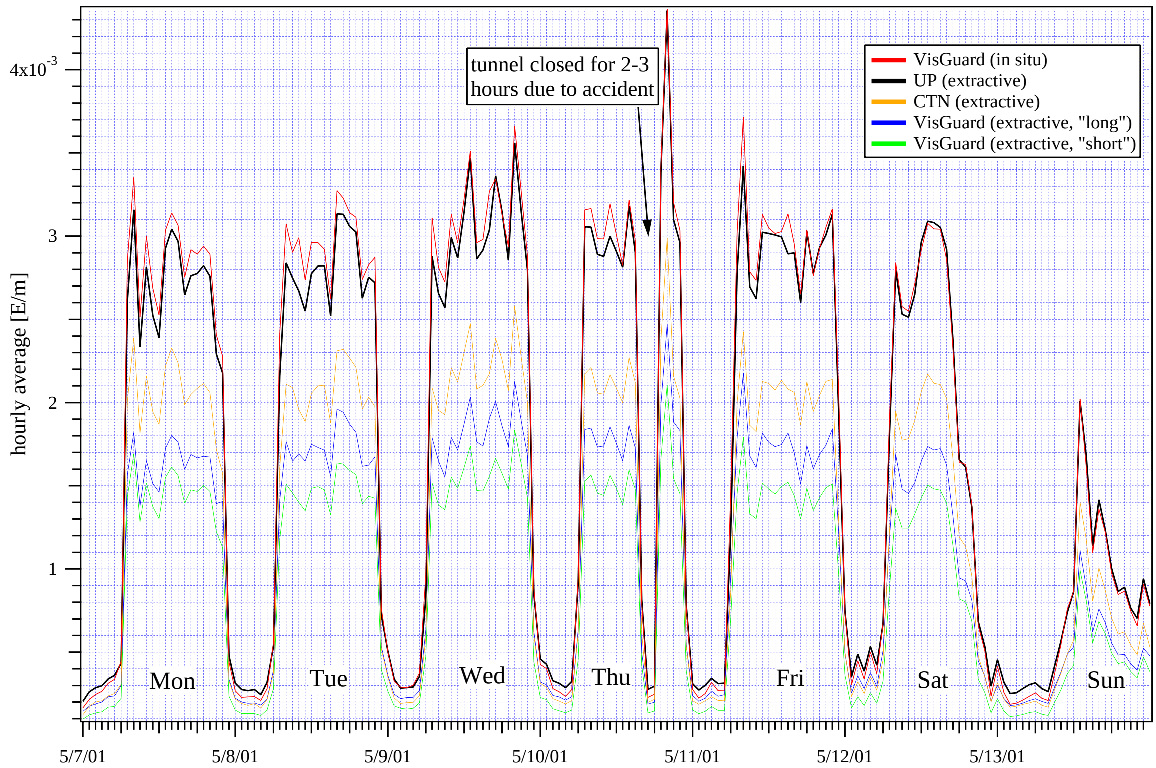

Fig. 1: Hourly average of visual turbidity, Calendar Week 19 (uncorrected reading)

Fig. 2 shows that the instruments run parallel over very short periods as well. In this case no averaging was done over time. Unlike Fig. 1, the losses caused by the hoses used for the extractive alternatives were compensated with a constant factor.

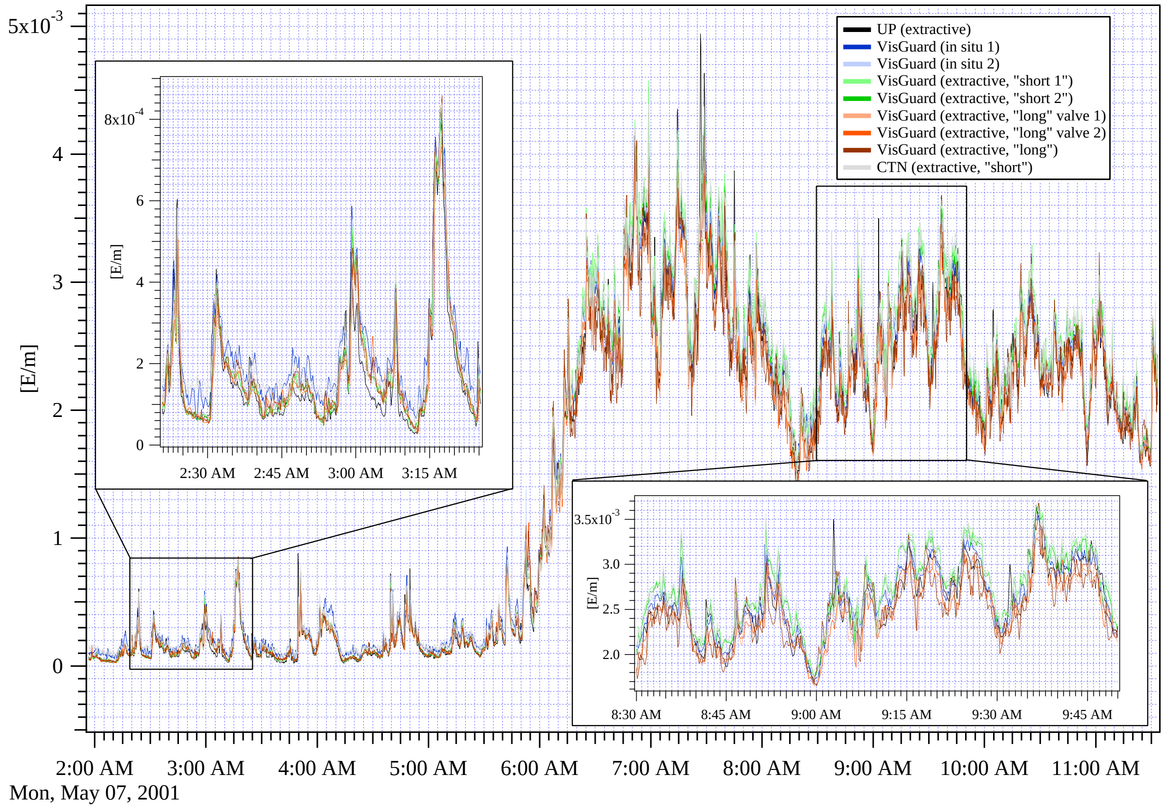

Fig. 2: Visual turbidity readings on 7.5.01, with scaling correction

General operation

No significant malfunctions occurred during the three-month field tests. The same was true for the two-month test conducted previously with a prototype in the Seelisberg Tunnel.

Fouling and corrosion

Only minor fouling was found inside the instrument. There were no signs of corrosion damage, but of course this would not be expected after only three months. Nevertheless, for regular production the electronics will receive additional encapsulation and the deflecting mirror will be housed in a protective enclosure. The instrument enclosure itself will be made entirely of stainless steel 1.4435.

Filter contamination

The particulate air filters of the in-situ instruments are the most heavily loaded, because all of the sample air (about 7 l/min) is filtered. The measured filter contamination shows that service life of a year or more is certainly achievable, even if traffic is heavy.

Zero point and reference point drift

In terms of the two checking rods used, the VisGuards are relatively stable (see Fig. 3), especially in comparison with CTN operated in parallel. After four months, the maximum reference point deviation was 4%.

During the test period, the zero point of the different instruments rose by a negligible (hardly measurable) amount.

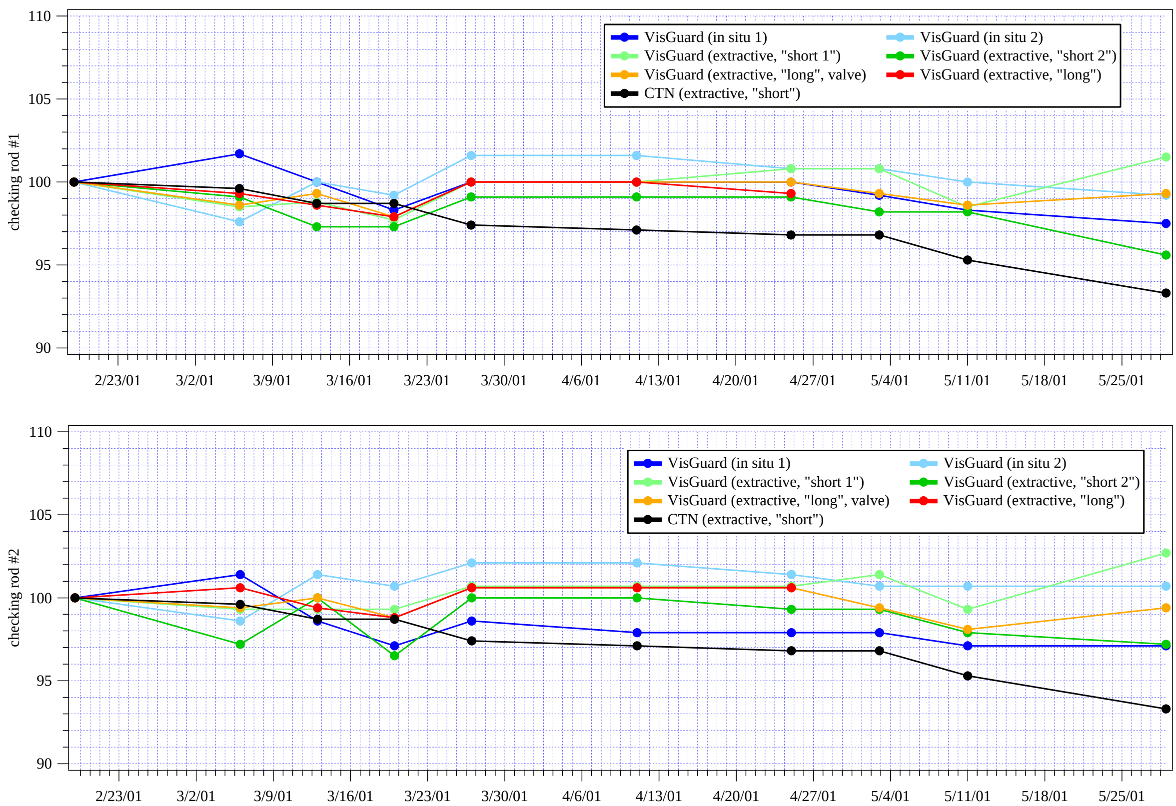

Fig. 3: Reference point drift, as measured with two different checking rods

Summary

The results can be summarized as follows:

- All of the instruments ran without any note-worthy malfunctions over the entire test period.
- The readings produced are comparable both among the individual VisGuards and vis-à-vis the predecessor types UP and CTN. Dust losses resulting from extraction can be corrected with a constant factor as in the past.
- The data indicate that reference point drift of less than 10% p.a. is to be expected. This means it will be sufficient to service the instruments once a year .