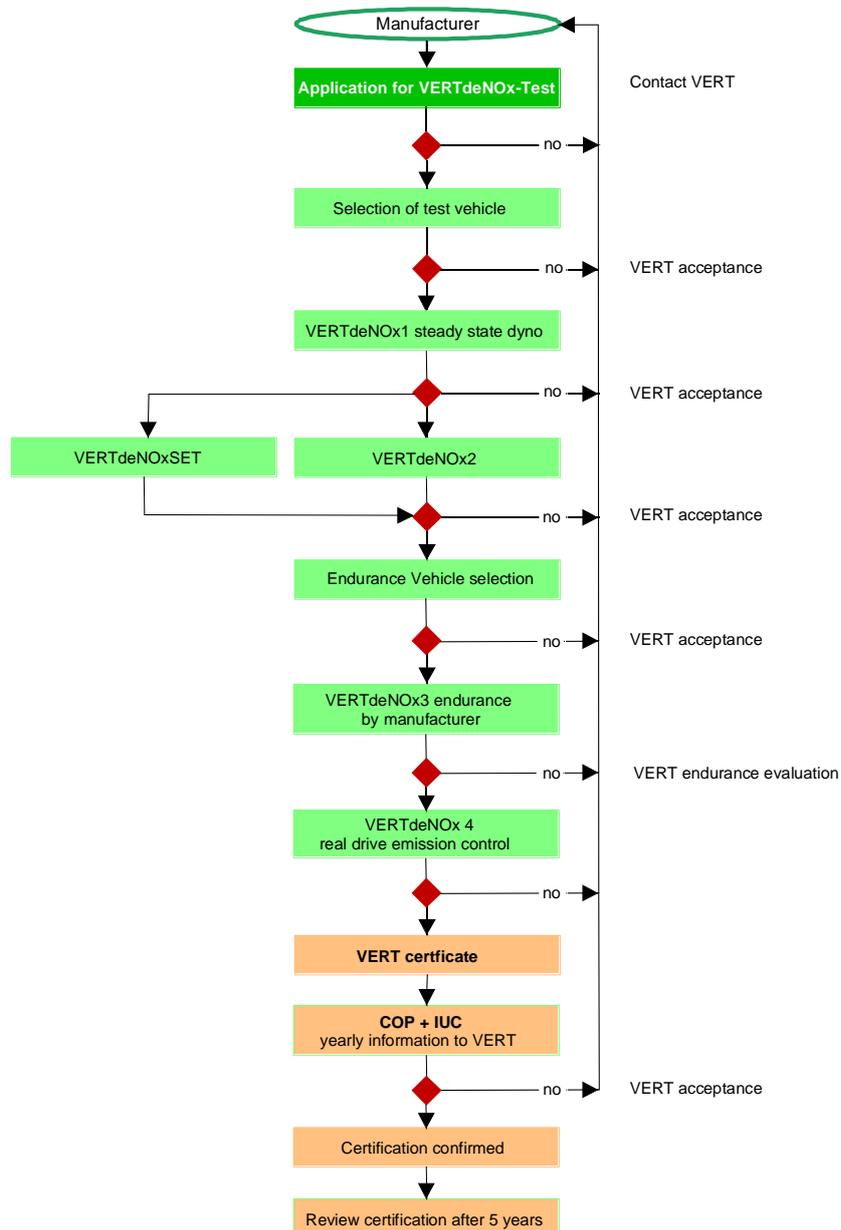


VERT - CERTIFICATION of deNO_x - EAS



Background and Trigger

In the past 8 years VERT has performed extensive research on SCR and SDPF-Systems on engine test benches and on HDV vehicles as well as supervised a pilot test fleet in Switzerland. Most of this work has been published. VERT has also established a VERTdePN certification method and has listed one certified SCR-system in 2012 with > 75% NOx-conversion. However, no large scale applications followed since public/legal pressure did not materialize.

Now time seems to change: following the Diesel Scandal and due to stricter EU-enforcement of NO2 limits many cities are planning to use the chances of SCR-retrofit for public fleets. However, no list of independently tested Exhaust Aftertreatment Systems EAS is available, from which the cities can select appropriate systems according to their performance and quality criteria. VERT will use the opportunity to fill this gap and help to build up confidence in this technology in Europe and as well in Korea, China, India and Latin America. For this reason the VERT deNOx certification procedure as well as the certification procedure for combined systems with SCR and DPF in combination with DOC is described here.

This VERTdeNOx certification protocol reflects the VERT BAT-principles and is structured in such a way that cities will feel confident to select from this list mature technology with highest possible performance to clean the air from toxic contaminants like solid particles, volatile hydrocarbon substances as well as NO + NO2 without creating additional toxic so-called secondary substances.

These EAS systems shall be available at prices which are low compared to the health cost avoided.

The elements of in-use compliance IUC, independent supervision/auditing and Periodic Technical Inspection PTI shall be also be included as confidence building elements for this new market.

Pre-Condition

This VERT-Certification has been developed for EAS ready for sale and retrofit installations. It is assumed that the manufacturer has already successfully performed all state of the art tests with respect to functionality, mechanical and thermal stress and failure modes, aging, pollution and poisoning properties. It is also assumed that he has developed the dosing strategies to achieve a certain deNOx target as well as maintenance strategies to be able to guarantee two years operation without maintenance and six years useful life prior to submit a representative sample of this EAS family for certification testing.

Test Object

Test object is a vehicle, which according to the declaration of the manufacturer is representative for the vehicle family the manufacturer intends to apply. This might be HDV or LDV and within these families it might be limited to city bus application or coaches or waste transporters – this remains up to the manufacturer commitment.

The vehicle can be of any EU emission class but must be equipped with a VERT certified DPF and a complete SCR system in a technically final and ready-to-sell form including an on board control unit (OBC) with telemetry features.

It must be perfectly maintained regarding safety and emission relevant elements, degreened and operated with the system for not more than 10'000 km but not less than 1000 km and the manufacturer must provide his maintenance data on emissions relevant elements at the time the vehicle is presented to the testing laboratory.

For the emission testing the vehicle must be equipped with access ports for emission measurement (gases and particles) upstream and downstream of the after-treatment emission control elements, which are designed such that measurement during real world operation (RDE) of the vehicle is possible. Electronic access to the system sensor signals and the OBC must be provided for the testing direct at the vehicle and via the telemetric path on internet.

Manufacturer Data to be Disclosed

The manufacturer must disclose to the VERT-certification officer

- physical structure of the system – drawings, catalyst materials.
- DeNOx-process strategy
- control and alert strategy
- operation and maintenance procedures
- target performance
- target life
- DPF-certification data
- system experience: number of systems retrofitted in the selected vehicle family
- hours (km) tested so far

Testing Protocol

The tests consists of 4 phases:

A. VERTdeNOx1: Steady state test on vehicle dynamometer

- Test on chassis dynamometer
- engine load ramp at two engine speeds in order to determine the exhaust temperature at which AdBlue injection starts and at which 80% conversion is reached
- full load and low idle should also be tested
- each operation point during 15 mins or until thermal stability is reached
- Measured operation data: velocity, RPM, power, temperatures of exhaust gas, engine water and lube oil, exhaust mass flow
- Measurement of emissions: CO, HC, CO₂, O₂, NO, NO₂, PN
- Measurement of NH₃ at tailpipe only
- Download system sensors data for NO, NO₂ at all operation points

B. VERTdeNOx2: Real drive emission (RDE)

- RDE-conform trajectory
- 3 repetitions on different days
- Log operation data: velocity, RPM, ambient climate data
- PEMS-conform measurement of emissions: : CO, HC, CO₂, O₂, NO, NO₂, PN, NH₃
- Download system sensors data for NO, NO₂ during whole test, compare with PEMS

C. VERTdeNOx3: 10'000 km with telemetric data transfer to VERT laboratory

- System checked and sealed by the VERT certification inspector
- Operation of the vehicle under supervision of the manufacturer who must supply a logbook on all relevant observations to the VERT-laboratory
- Continuous access to OBC via internet telemetry
- AdBlue consumption to be measured
- Fuel consumption to be measured
- NOx upstream and downstream continuously measured and stored
- Further measurements of: temperatures, pressures, RPM, vehicle speed,
- Monitor ambient temperature, humidity, pressure
- Monitor vehicle position by GPS

The System must be checked by the VERT-inspector before release for VERTdeNOx4

Any system problem, maintenance or repair must be immediately transmitted to the VERT inspector.

D. VERTdeNOx4: Real Drive Emission Control

Download all System OBS data stored during VERTdeNOx3
Repetition of VERTdeNOx2

E. VERTdeNOxSET, the Secondary Emission Test

It can be waived, if all relevant data is already available from technically similar systems. If the system however uses a catalyst formulation or catalyst concentration or catalyst morphology which is new and not yet VERT-tested, a VERT Secondary emission test similar to VSET for DPF must be performed to make sure that no additional toxic substances are generated in significant concentrations.

This test and the related analytics will be performed according to SN 277206 and expected secondary toxic nitrogen substances like N₂O, NH₃, HNCO, CH₂O₂, HCN, HCHO shall be included.

In all cases however, a size specific metal analysis for all catalyst materials must be performed in order to make sure that no metal emission happens with the new and the aged system in the whole operation range; this shall also follow SN 277206.

Metrology

Measurement “upstream/downstream”
and with/without AdBlue injection only during VERTdeNOx1

Metrology is in accordance with

- SN 277206
 - PMP/PEMS-Protocol
 - RDE-Protocol
 - Noise acc. to VTS, SR 741.41 and EU-70/157/EWG
- Noise measurement before installation by the manufacturer

Testing Conditions

- Testing at ambient conditions >10 °C
- Engine warmed up
- Engine maintained
- Air filter replaced
- Fuel: EN 590 – Swiss market quality
- Lubrication oil: changed, manufacturer specified quality
- DPF regenerated at start of the test
- AdBlue tank full, filled by the VERT inspector who will take an AdBlue sample

Testing Time

- A. Dynamometer test: one day
- B. Road Test on 3 different days
- C. Maybe one month depends on the applicants organization
- D. 1 day
- E. One week

Reporting

- All data measured and downloaded
- Interpretation of all important findings
- Conclusions with respect to conformity criteria, operation and findings
- Document system design and strategy

- Compare OBC sensors data and test data
- Physical observation, pictures

VERT-Conformity Criteria

Certification is limited to the defined vehicle family and must fulfill the following criteria:

- PN filtration efficiency > 98% for solid particles 10-500 nm in all operation points
- Backpressure max during endurance test < 200 mbar
- NO_x-conversion during RDE: 3 classes > 85% / 75-85 % / 65-75 %; < 65% rejected
- Light off (50% NO_x-conversion) below 230°C after SCR
- NH₃ < 20 ppm at all operation points
- CO, HC according to the EU emission class of the vehicle
- Fuel economy deterioration < 3 %
- Noise emission: no deterioration after replacement of muffler by AEC
- Aging for NO_x-reduction during 10'000 km < 5%
- Aging for particle filtration: none

VERT Certification is valid for 5 years if yearly failure rate remains < 3%

Accredited Testing Laboratories

VERT accredited Testing Organizations (see VERT-Filter list)

Overall Testing Cost

- to be confirmed by a detailed cost calculation
- cost for endurance test, which will be organized by the applicant, are covered by the applicant
- Transfer of finances by the VERT finance department
- Payment in advance

Confidentiality of Data and Reports

All data and reports are confidential between the manufacturer, VERT and the testing laboratory. A respective NDA shall be signed

Harmonization with Political Bodies

VERT shall try to get approval for this procedure from political bodies

reviewed
16.06.2019
VERT Certification Committee