
Amended by:
Problem of VOC Emissions at Petrol Service Stations

- Petrol vapour is displaced from a car’s fuel tank when it is refuelled at service stations.
- This vapour is vented to the atmosphere unless otherwise controlled.
- This vapour contains benzene and other volatile organic compounds (VOCs) which contribute to local, regional and global air pollution problems.

Goal of Petrol Stage II Directive:
- Ensure the recovery of petrol vapour that would otherwise be emitted to the air during the refuelling of vehicles at service stations.
- The Member States have until 31 December 2011 to transpose the Directive into national law.
Solution of VOC Emissions at Petrol Service Stations

• **Vapour Recovery** reduces the amount of toxic and smog-forming pollutants released at service stations.
• Service stations emit a large amount of VOCs (volatile organic compounds)
• This pollution is created by petrol vapours escaping from vehicle fuel tanks and underground petrol storage tanks at service stations.
• Petrol evaporates inside these tanks to create vapours which fill the empty space above the fuel.
• As a vehicle or storage tank is refuelled, these vapours are pushed out by the incoming petrol and escape through the top of the vehicle filler pipe or storage tank vents.
• Once in the atmosphere, petrol vapours contribute to the formation of smog in cities as well as localised air pollution immediately adjacent to service stations. Both types of pollution can directly affect our health.
• **Vapour Recovery** is a clean technology which drastically cuts the amount of these vapours escaping into the air.
Key points in the Petrol Stage II Directive are:

- by end-2018 all petrol stations with a petrol throughput of >3000 m³ must have PVRII vapour recovery fitted
- from January 2012, any new service station with an actual or intended annual throughput of >500 m³ must be equipped with PVRII vapour recovery
- from January 2012, any existing service station with an actual or intended annual throughput of >500 m³ must be equipped with PVRII if they undergo “major refurbishment”
- petrol vapour capture efficiency must be 85% or more
- where the recovered petrol vapour is transferred to a storage tank at the service station, the vapour/petrol ratio must be equal to or greater than 0.95 but less than or equal to 1.05.
## Structure of Petrol Stage II Directive

### Article

1. Subject matter
2. Definitions
3. Service stations
4. Minimum level of petrol vapour recovery
5. Periodic checks and consumer information
6. Penalties
7. Review
8. Technical adaptations
9. Committee procedure
10. Transposition
11. Entry into force
12. Addressees
Art. 1 Subject matter:
Reducing the amount of petrol vapour emitted to the atmosphere during the *refuelling of motor vehicles at service stations*
Technical details: Examples of pistols

Eleflex video vapour recovery

http://www.elaflex.de/nc/mediathek/videos/videos/?video=EHT-Stage-2-Vapour-Recovery&width=720&height=400

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Technical Norms and Standards

CEN/TC 393 - Equipment for storage tanks and for filling stations

CEN/TC 393 Published Standards

Reference, Title | Publication date | Sales Points
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European Technical Norms for Petrol Stations


German country experience – Petrol Service Stations

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**Technical Norms and Standards**

**EN 16321-1:2013:**
Petrol vapour recovery during refuelling of motor vehicles at service stations - Part 1: Test methods for the type approval efficiency assessment of petrol vapour recovery systems

**EN 16321-2:2013:**
Petrol vapour recovery during refuelling of motor vehicles at service stations - Part 2: Test methods for verification of vapour recovery systems at service stations

**DIN EN 13012: 2010**
Petrol filling stations – Construction and performance of automatic nozzles for use on fuel dispensers
Art. 3 Service stations

new service station shall be equipped with a Stage II petrol vapour recovery system:

• its actual or intended throughput is greater than 500 m$^3$/year; or
• its actual or intended throughput is greater than 100 m$^3$/year and it is situated under permanent living quarters or working areas.

existing service station which undergoes a major refurbishment shall be equipped with a Stage II petrol vapour recovery system at the time of the refurbishment:

• its actual or intended throughput is greater than 500 m$^3$/year; or
• its actual or intended throughput is greater than 100 m$^3$/year and it is situated under permanent living quarters or working areas

existing service station with a throughput in excess of 3 000 m$^3$/year shall be equipped with a Stage II petrol vapour recovery system by no later than 31 December 2018.
Art. 4 Minimum level of petrol vapour recovery

- Petrol vapour capture efficiency of such systems is equal to or greater than 85 % as certified by the manufacturer in accordance with Standard EN 16321-1:2013

- Where the recovered petrol vapour is transferred to a storage tank at the service station, the vapour/petrol ratio shall be: $0.95 \leq x \leq 1.05$

Note: 
≤ 1.05 to avoid excessive pressure build up and consequent release through the pressure relief valves.
Art. 5 Periodic checks and consumer information

- **In-service petrol vapour capture efficiency** of Stage II petrol vapour recovery systems is tested at least once each year either by checking that the vapour/petrol ratio in accordance with Standard **EN 16321-2:2013**

- **automatic monitoring system:**

  petrol vapour capture efficiency is tested at least once every three years. Any such automatic monitoring system shall automatically detect faults in the proper functioning of the Stage II petrol vapour recovery system and in the automatic monitoring system itself, indicate faults to the service station operator and **automatically stop the flow of petrol** from the faulty dispenser if the fault is not rectified **within seven days.**
Article 5 No 3: Labelling

Service station with Stage II petrol vapour recovery system:
Display by a sign, sticker or other notification on, or in the vicinity of, the petrol dispenser, informing consumers of that fact.
Technical Solutions for Controlling the VOC Emissions at Petrol Service Stations

Two types of vapour recovery systems

• passive system

• active system with automatic monitoring system
Generally used:

**Active Vapour Recovery with Return of Vapours to Underground Storage Tank**

When petrol enters the vehicle tank, an active vapour recovery system (open active petrol vapour recovery system) uses a *vacuum pump to suck a corresponding volume of vapours back into a storage tank*.

**Components** of an open active petrol vapour recovery system may include:
- A vapour recovery nozzle;
- A hose through which vapours are collected (coaxial or similar) and a pipe through which the vapours are returned (this may be separate from the fuel line or may be inserted into the fuel line);
- A vacuum pump;
- A system to control the ratio of the volume of vapour recovered to the volume of petrol dispensed into the vehicle tank;
- A vapour storage tank (i.e. the petrol storage tank).
Automatic monitoring systems according to EU Directive

- EU Directive 2009/126/EC demands no automatic monitoring system
- But if such a system is installed:
  The petrol vapour capture efficiency has to be tested at least once every three years according to Standard EN 16321-2:2013
  Any such automatic monitoring system shall automatically detect faults in the proper functioning of the Stage II petrol vapour recovery system and in the automatic monitoring system itself, indicate faults to the service station operator and automatically stop the flow of petrol from the faulty dispenser if the fault is not rectified within seven days.
**Technical Norms and Standards**

**EN 16321-1:2013:**
Petrol vapour recovery during refuelling of motor vehicles at service stations - Part 1: Test methods for the type approval efficiency assessment of petrol vapour recovery systems

**EN 16321-2:2013:**
Petrol vapour recovery during refuelling of motor vehicles at service stations - Part 2: Test methods for verification of vapour recovery systems at service stations

**DIN EN 13012: 2010**
Petrol filling stations – Construction and performance of automatic nozzles for use on fuel dispensers
Einundzwanzigste Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (Verordnung zur Begrenzung der Kohlenwasserstoffemissionen bei der Betankung von Kraftfahrzeugen - 21. BImSchV)

21. BImSchV
Ausfertigungsdatum: 07.10.1992
Vollzitat:

Stand: Neugefasst durch Bek. v. 18.8.2014 I 1453
Geändert durch Art. 7 V v. 28.4.2015 I 670
Country Study: German Permission Situation for service stations

The local authority (provincial directorate or municipalities) will issue construction licences and/or operating licences on condition that the new service stations will meet the required provisions of technical standard.

This also applies to modification of existing service stations.
Service station with Stage II petrol vapour recovery system:
Display by a sign, sticker or other notification on, or in the vicinity of, the petrol dispenser, informing consumers of that fact.

Reference: http://tokheim.com/de/dispenser/gasruckfuhrung/

German Country Experience

1. Requirements

• Requirements on filling of vehicles from service station in 21th BlmSchV from 07.10.1992, new version from 18.08.2014, amended 28.04.2015

• Before start of operation the operator has to notify the petrol station to the competent authority (§ 5 (1))

• Detailed requirements for passive vapour recovery systems (without vacuum) on tightness (§ 3 (3))

• Service station may only be operated if the manufacturer of vapour recovery confirms an efficiency of minimum 85% (§ 3 (2)). This efficiency must be tested by an authorized technical expert referring on special requirements in Annex 1
§ 3 (2): Check of efficiency of vapour recovery of of 85 %

• **Confirmation of manufacturer** that efficiency is $\geq 85\%$ verified by an **authorized inspection body** under conditions described in Annex 1 No 1

• The confirmation has to be stored at site of operation and must be shown to the competent authority on demand.

• Verification is proceeded according to Technical Note “System check on active gas recovery systems”
Certificate: **System check** of active gas vapour recovery systems:

Pistol: ........ [type]
Tube:............[type]
Control valve:......[type]
Gas recovery pump:....[type]

The following conditions have to met on installation:

- maximum volume flow of petrol: ..... [l/min]
- maximum counter pressure in recovery tube:........ [mbar]
- correction factor for system alignment with air: ..[mbar]

**The required efficiency of minimum 85 % has been verified.**

The vapour recovery system refers to the Best Available Techniques in meaning of 21. BlmSchV.

[Place] [Signatur of authorized expert]
Example of a certificate

- Petrol vapour capture efficiency of such systems is equal to or greater than **85 %** as **certified by the manufacturer in accordance with Standard EN 16321-1:2013**
Automatic control of gas balance system - § 3 (4)

**Automatic control** of gas balance system for all petrol stations installed after 01.04.2003

**Transition time periods for stations installed before 01.04.2013**

- > 5000 m³
  - From 01.01.2005

- 2500 m³ - 5000 m³ and site in polluted area
  - From 01.01.2005

- 2500 m³ - 5000 m³
  - From 01.01.2006

- 1000 m³ - <2500 m³
  - From 01.01.2007

- <1000 m³
  - From 01.01.2008

- <1000 m³ and installed before 01.01.1993
  - No up-grade necessary

**New:**

- 500 – 1000 m³ and installed before 01.01.1993
  - 01.01.2019

- or 1000 m³ - >100 sited in permanent living or working area
• Because of difficulties in automatic monitoring -> amendment of Ordinance in 2002: -> in case of signals on faults of function of vapour recovery system or in the automatic monitoring system itself > 72 h:
  -> automatically stop of petrol (§ 3 (5) No 2)

Faults of self-function must be automatically determined and signalized to petrol station staff (§ 3 (5) No 1)

If during a valid period (fuel flow ≥ 25 l/min for more than 20 sec.) faults are recognized (§ 3 (5):
• counting of those faults
• if number of faults > 10 -> clock starts in combination with a warning optical signal to show problems -> if > 72 hours -> programme stops Fuel dispenser side where the faults occurred

Different systems on market e.g.
• Fafnir – Vaporix (http://www.fafnir.de/Tankstellen-Umweltschutz-Sensorik/VAPORIX/VAPORIX-Gasrueckfuehung.php)
• Tokheim – ECVR-SCS: http://www.tokheim.com/de/p2.htm
• TST Electronics
Definition what a fault of function of vapour recovery is (§ 3 (5)):

A fault shall be deemed to be present where continuous monitoring during filling of vehicle petrol tanks indicates

- that the V/P ratio averaged over the duration of filling has fallen < 85%

or

- has exceeded 115% for ten consecutive filling operations.

This only applies to filling operations:

- of at least 20 seconds duration and

- where the rate of petrol dispensed reaches at least 25 litres per minute.
Volume ratio of fuel volume flow and gas flow:

- Control of gas recovery pumps by an electronic regulation proportional to fuel flow
- Gas recovery is influenced by ambient air conditions like temperature
- In case of ratios $< 95\%$: efficiency decreases and less vapours are captured
- In case of ratios $> 105\%$: more vapours are captured but there will be emissions at ventilation stack outlet
§ 5 Inspection:

• (1) Operator has to prove compliance to requirements on vapour recovery system (§ 3 (3) – passive system - or § 3 (4) – active system latest 6 weeks after taking into operation and then every 5 years by an authorized technical body. By a minimum of 3 single individual measurements the compliance to permitted V/P ratios have to be demonstrated over the time period of refuelling. Operator has to send report to competent authority within 4 weeks after expert inspection latest.

• In Annex I No 1 of Ordinance: Requirements on determination of efficiency relevant for manufacturers of vapour recovery systems.

• Annex I No 2 of Ordinance: Obligatory proceeding to check of tightness of total petrol vapour recovery system by authorized technical expert.
§ 5 Inspection:

(9) The operator has to register the annual dispensed quantity of petrol with deadline 01.02. of each year.
The documentations have to be stored at least 3 years at site of operation and must be presented to the competent authorities on demand.
These requirements are obsolete if requirements according to § 3 are complied.
Inspection confirmation on gas vapour recovery systems according to 21. BlmSchV: Periodic inspection according to § 5 (2)

Following checks have been carried out:

• Formal (e.g. certifications available) and technical check
• Consistence with system description
• Measurement of volume rates
• Check of tightness of gas balance tubes
• Function checks of gas vapour recovery system
• Check of automatic monitoring system

Requirements according to 21. BlmSchV and VdTÜV Technical Note 908 are complied. No faults have been detected.

Next periodic check:......

Date of check:
Annex of inspection report

Pulsing rate for the vapour recovery control, pulses/litre: ... impulses/litre

Used measurement instruments: Manual control unit......

Checks on Tightness: Tubes from feets of petrol station up to the tanks, proportional valves

Function checks:

Gas recovery: Functional test with petrol flow

Monitoring system:

a) Test of fault triggering after 10 faulty refuellings

b) Test of switch-off after 72 hours

Results of measurements:
Pulsing rate set on the handheld control: ...pulses/litre

Ambient air temperature during measurement: ..
EN 16321-2:2013
Measurement and test methods for the assessment of vapour recovery systems on filling stations – Dry method

• Dry measurement method for checking and adjusting the volume ratio on vapour recovery systems, with simulation of the petrol flow
• A measuring adapter is usually slipped over the vapour spout and connected with a connecting hose to a bellows-type gas meter
• A handheld control directly acts on the control of the vapour recovery system.
• The handheld control is connected to the vapour recovery control in the fuel dispenser.
• Two-way signal transmission between the handheld control and the vapour recovery control.
• The simulated petrol volumetric flow programmed in the handheld control causes the vapour recovery system to deliver a corresponding air volumetric flow. At the start of simulation of the petrol flow, the vapour recovery system receives electrical signals from the handheld control and starts operating.
• The bellows-type gas meter connected to the petrol spout measures this volumetric flow and compares it with the petrol volumetric flow programmed in the handheld control.
§ 5 (6): **Inspection by a specialized person**

- The operator of a petrol station with a passive vapour recovery has to check the functioning of at least quarterly.
- The operator of a petrol station with an active vapour recovery and automatic control has to check the **functioning of at least every 2,5 years**.
- In case of faults the system has to be repaired immediately.
- The results of the tests as well as faults and repair works have to be documented.
Check on tightness: Annex I in combination with § 3 (4) No 3 and § 6

2.1 **Before taking into operation** of a gas recovery system, after **each significant change** of the system as well as **every 5 years** a test of tightness has to be carried out of **complete gas recovery system**

2.2 To test of the tightness of gas recovery hoses the complete hose system between base point of fuel dispenser and storage tank has to be charged with an **excess pressure of 200 kPa** in an appropriate way. Within **30 minutes** a **maximum drop pressure of 100 hPa** is permitted.

2.3 The tightness of the gas recovery system between base point and nozzle has to be checked by excess or low-pressure dependent from system on the hand of the specifications of manufacturer. The check before taking into operation has not to be applied if a confirmation of the manufacturer of the fuel dispenser or of the specialist company on test of tightness is available.
Check on tightness: Annex I No 2 in combination with § 3 and § 5

Leakage tests:

- Vapour recovery lines between nozzle and vapour recovery pump
- Vapour recovery lines between vapour recovery pump and fuel dispenser base
- Vapour recovery lines from fuel dispenser base to tank
- On/Off valves

Specialist company

Company having the necessary equipment and trained personnel to ensure the risk-free and correct construction, maintenance and repair of vapour recovery systems and that is inspected annually by an authorized test organization
Directive 1994/63/EC storage of petrol and its distribution from terminals to service stations

EUROPEAN PARLIAMENT AND COUNCIL DIRECTIVE 94/63/EC
of 20 December 1994

on the control of volatile organic compound (VOC) emissions resulting from the storage of petrol and its distribution from terminals to service stations


Petrol Stage Ib
Scope of Petrol Stage I Directive ("Ib"): 

Delivery by road tankers → Storage in underground tanks
Petrol Stage I B – Best Practice on Article 6 – Loading into storage installations at service stations

Loading of storage tanks of a service station:

gas balance system at service stations

Annex III:

• Vapour-tight connection line for returning the displaced vapours from the storage tank to the road tanker during the filling the storage tank
• Loading operations may not take place unless the arrangements are in place and properly functioning
Ensuring the “vapour-tightness” of the gas balance line:

**German 20th BImSchV:**

Vapour balancing systems shall be deemed to comply with the state-of-the-art if in particular

1. the flow of fuel is only released if the vapour balancing system is connected using an electronic locking device, and

2. the vapour balancing system and the connected installations do not permanently release vapours into the atmosphere during the vapour displacement, apart from releases which occur for safety reasons.

**Example:**

[NoMix System](http://www.fmctechnologies.com/en/MeasurementSolutions/Technologies/LiquidProducts/TruckMeterPkgs/NoMix.aspx)
[NoMix MN](http://www.fmctechnologies.com/en/MeasurementSolutions/Technologies/LiquidProducts/TruckMeterPkgs/NoMixMN.aspx)
Ensuring the “vapour-tightness” of the gas balance line:

**German 20th BImSchV:**

**Verification by an approved inspection agency or by a publicly appointed and sworn expert:**

**Total system check including functioning and tightness**

- First time before putting system into operation and
- than every 5 years

-> report of expert body has to be submitted to competent authority by operator
Who carries out the technical control?

Approved inspection agency: inspection agency which, in accordance with Appliances and Product Safety Act (Produktsicherheitsgesetz) in each case in conjunction with Industrial Safety Ordinance (Betriebssicherheitsverordnung) has been designated as an inspection agency by the competent Land authority for the testing of facilities requiring supervision in accordance with Industrial Safety Ordinance to the Federal Ministry of Labour and Social Affairs, and has been published by the latter in the Joint Ministerial Gazette (Gemeinsames Ministerialblatt);

publicly appointed and sworn expert: a publicly appointed and sworn expert in accordance with section 36 of the Industrial Code (Gewerbeordnung)
German 20\textsuperscript{th} BlmSchV: Basis for the verification and regularly inspection:

VDI 2291 (June 2016): Emission control: Test criteria for monitoring vapour recovery systems

This standard also applies to the storage and filling of storage tanks at service stations pursuant to Section 6 Subsection 1 Sentence 1 of the 20th BlmSchV. This standard describes the inspection of relevant components for the unloading of petrol into service station storage tanks, including their associated entities such as interlocking devices, as well as for the filling of vehicle tanks on the forecourt, including adapters and connecting hoses.
VDI 2291 (June 2016): Emission control: Test criteria for monitoring vapour recovery systems

Formal check:

• Description of system existing?
• System is according system description?
• Confirmation on tightness check available?
• Confirmation on correct installation available?
• Confirmation on correct functioning available?
• Confirmation on check of electrical installations available?
• Marking of system correct?
• Check on leakages of connection hoses carried out regularly by operator?
VDI 2291 (June 2016): Emission control: Test criteria for monitoring vapour recovery systems

The inspection includes the vapour balancing system from vapour balance coupling at gantry via corresponding lines up to an existing vapour storage tank as well as components of inter-locking device, as far as existing. The check includes following control steps:

• Visual check of connectors and components of vapour recovery as well as interlocking device especially according to correct installation and damages
• Check of compliance of incidental provisions of permits, licences etc.
• As part of inspection before taking into operation check of tightness of lines with an overpressure of 1 bar
• As part of periodical inspections tightness checks of detachably joining lines
• Check on system according to specification of manufacturer
VDI 2291 (June 2016): Emission control: Test criteria for monitoring vapour recovery systems

**Inspection report**

An inspection report must include following information:

- Name and address of operator
- Site of operation
- Occasion of inspection
- Initial inspection, periodically inspection or re-inspection
- Inspection with consecutive number as well as number of manufacturer of tank, the content in m³ and type of stored liquid
- Control steps
- Data on check of tightness (control of lines with 1 bar as well of detachably joining connections), list of deficits, remarks
VDI 2291 (June 2016): Emission control: Test criteria for monitoring vapour recovery systems

**Inspection report**

Data on interlocking device of vapour balance system existing

Manufacturer: 

Type: 

Check of interlocking device in case of electronic systems according provisions of manufacturer (measured values)

Function test carried out: yes  no

Result of inspection:

Declaration of deficits

Declaration if re-inspection necessary

Remarks

Point of time for next inspection

Site, date, name and signature of responsible for inspection
EU Petrol Stage I Directive regulates only loading of the storage tank of the service station

But

not the breathing of the storage tank!

There are pressure/vacuum valves for the underground tanks. For the correct functioning of the whole “vapour” system the P/V valves must work correctly.
Petrol Stage I B – Service Stations: Best Practice
Petrol Stage I B – Service Stations: Best Practice

Germany:

- The requirements according to the pressure values of the P/V valves are not given by air pollution control regulations like EU Petrol Stage II or German 21th of BImSchV but generally by occupational health and safety regulations:
- In Germany: TRBS 3151. Due to the occupational health and safety regulations there are regularly checks

According to German TRBS 3151 following rules have to be complied:

„4.2.1.3 Ventilation Installation
(8) Storage tanks and containers for storage of fuel must be operated in such way that dangerous under- and overpressure cannot occur, e.g., by aeration and ventilation equipment or safety devices to prevent excess pressure.
(9) Ventilation ducts must be dimensioned so that dangerous under- or overpressures in the tank cannot occur. …. 
(10).
The displaced vapours during filling of storage tanks for liquid fuels and containers for the storage of fuel vapour and air mixture must be discharged in such way that risks to employees and other persons cannot arise.
(11) The ventilation lines must discharge in that way to the atmosphere that risks to employees and other persons cannot arise by discharging fuel vapour and air mixtures.
This is exemplified satisfied when the ventilation mast is at least 4 m above ground level and ending carryover of escaping steam-air mixtures or gases to adjacent areas, which are intended for residence of persons is not possible.
(12) Paragraph 9, sentence 1 during the filling of storage tanks for liquid fuels using the vapor recovery technique shall be considered to be met if the ventilation takes place only via the vapour recovery line and vents of storage tanks are closed to the outside during the vapour recovery process. Excepted are safety required openings. This requirement is to be regarded in underground storage tanks to be met if the ventilation pipe is fitted with a pressure / vacuum valve or a throttle, which is sufficient as a throttle an opening of 10 mm internal diameter or a tubular section with a comparable flow resistance.”

The integrated pressure/vacuum valve limits the storage tank pressure up to the adjusted pressures.

Switch pressure setting

Over pressure: + 30 mbar

Under pressure: - 5 mbar

Example: Flammer
Influence of temperature: see http://www.flammergmbh.de/englisch/videosection/8Erwaermung_mp4.mp4
Breathing lines with over/underpressure valves

Standard vacuum - 2.5 mbar
Standard pressure + 35 mbar
Arrester element 10 mm / 90 mm
width/diameter


Breathing lines with over/underpressure valves

Breathing lines with over/underpressure valves

P/V valves should be checked once a year on function according to instruction of manufacturer

Recommendation: Check documentation of P/V maintenance (function check) + certificate EN-16852
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