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BSI Standards Publication

Thermal spraying — Safety requirements for thermal spraying equipment

Part 4: Gas and liquid fuel supply

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National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

This document (CEN/TR 15339-4:2014) has been prepared by Technical Committee CEN/TC 240 “Thermal spraying and thermally sprayed coatings”, the secretariat of which is held by DIN.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

CEN/TR 15339, *Thermal spraying - Safety requirements for thermal spraying equipment* is composed of the following parts:

— *Part 1: General requirements*

— *Part 2: Gas control units* (published as a European Standard)

— *Part 3: Torches for thermal spraying and their connection and supply units*

— *Part 4: Gas and liquid fuel supply*

— *Part 5: Powder and wire feed units*

— *Part 6: Spray booth, Handling system, Dust collection, Exhaust system, Filter*

1 Scope

This Technical Report specifies safety requirements of equipment for thermal spraying, in this case of gas supply including supply of liquid fuels. It deals with safety requirements for storage and the high pressure piping system from storage to the gas control unit or pressure regulator equipment. Safety requirements for gas hoses, hose assembly and torches are presented in CEN/TR 15339-3.

This document should be used in conjunction with CEN/TR 15339-1, which deals with general aspects of designing, manufacturing, and/or putting into service of machines or equipment and with the responsibility to issue the CE Conformity Declaration.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 657, *Thermal spraying — Terminology, classification*

EN 15339-2, *Thermal spraying — Safety requirements for thermal spraying equipment — Part 2: Gas control units*

EN ISO 3821, *Gas welding equipment — Rubber hoses for welding, cutting and allied processes (ISO 3821)*

CEN/TR 15339-1, *Thermal spraying — Safety requirements for thermal spraying equipment — Part 1: General requirements*

CEN/TR 15339-3, *Thermal spraying — Safety requirements for thermal spraying equipment — Part 3: Torches for thermal spraying and their connections and supply units*

CEN/TR 15339-6, *Thermal spraying — Safety requirements for thermal spraying equipment — Part 6: Spray booth, Handling system, Dust collection, Exhaust system, Filter*

3 Function of thermal spraying equipment

3.1 General

Thermal spraying processes are described and schematically represented in EN 657.

Thermal spraying processes as flame, plasma or HVOF (high velocity oxygen fuel) spraying use inert, flammable and oxidizing gases which possess a significant potential of danger. Oxygen is considered as a dangerous gas because hardly inflammable material will burn in the presence of a certain concentration of oxygen.

Pressurised air, nitrogen, or carbon dioxide (CO_2) are applied for cooling the substrate's surface or the part to be sprayed. Fuel gases and oxygen are used for fusing of sprayed coatings made out of self fluxing alloys.

For such applications, an appropriate and safe supply shall be ensured by gases from manifold cylinder banks, cryogenic gas tanks or public piping systems (natural gas).

The installation of the gas delivery system, taken in conjunction with control measures, such as gas detection flow rates, and interlocking of the thermal spray equipment, forms a crucial part of the HAC. The respective class shall be considered. For details, see CEN/TR 15339-1 and CEN/TR 15339-6.

3.2 Gases for thermal spraying

Table 1 — Gases for thermal spraying

Thermal spraying process	Gases and mixtures used - Remarks
Flame spraying	acetylene (C_2H_2) propane (C_3H_8)[a] propylene (C_3H_6) hydrogen (H_2) oxygen (O_2) air carbon dioxide (CO_2)[c]
High Velocity Oxygen Fuel spraying (HVOF)	acetylene (C_2H_2) ethene (C_2H_4) propane (C_3H_8)[a] CNG (natural gas)[b] hydrogen (H_2) oxygen (O_2) nitrogen (N_2) air carbon dioxide (CO_2)[c]
Cold spraying	helium (He) nitrogen (N_2) and their mixtures air
Detonation spraying	acetylene (C_2H_2) propylene (C_3H_6) oxygen (O_2) nitrogen (N_2) air carbon dioxide (CO_2)[c]
Arc spraying	argon (Ar) nitrogen (N_2) argon or nitrogen mixtures air carbon dioxide (CO_2)[c]
Plasma spraying	argon (Ar) helium (He) hydrogen (H_2) nitrogen (N_2) and their mixtures air carbon dioxide (CO_2)[c]
Laser spraying, Laser cladding	helium (He) nitrogen (N_2) argon (Ar)

Thermal spraying process	Gases and mixtures used - Remarks
	and their mixtures air carbon dioxide (CO_2)[c]

[a] Propane is applied as a liquid gas containing >=95 % C_3H_8 and remnants or traces of butane (C_4H_{10}), ethane (C_2H_6), ethene (C_2H_4) or butane-isomers

[b] CNG (natural gas) contains mainly methane (CH_4), however its content varies between 80 and more than 95 %. Further constituents are inert gases, ethane, propane, butane, pentane (C_5H_{12}). The PCI (BTU) can be kept constantly adjusted by the N_2 content.

[c] CO_2 can be applied beside of pressurized air or nitrogen for cooling the substrate or the coating itself.

3.3 Safety related features of gas, liquid fuel, and cooling water supply

— Storage of burnable and inflammable gases.

— Storage of liquid fuels.

— Supply of high pressure gases in the high pressure gas supply system (> 20 bar) running from the storage to the spraying equipment, e.g. to the gas control cabinet (for details, see EN 15339-2) or to the stop and control fitting of the torch hose (for details, see CEN/TR 15339-3).

— Supply of liquid fuel from the storage to the control cabinet (for details, see EN 15339-2).

— Supply of oxygen or air for acceleration the combustion of the spray jet.

— Storage, supply and distribution of cooling media for thermal spraying.

4 Potential hazards

For a safe operation and supply of gaseous and liquid fuels, the following hazards shall be considered for normal operation or foreseeable abnormal circumstances.

— Risk of fire or explosion:

  — if leakage occurs on the connections in the piping system;

  — if the distance between gas cylinders or bundles of different gases is not appropriate;

  — if leakages are produced when changing the connections.

— Risk of over-heating or damage by impairment of ice, snow, direct sunlight to the gas supply.

— Release of gases or liquids under high pressure.

— Impairment of the environment by gases and/or liquids.

— Risk of anoxia in the spray cabin by release of inert gases (e.g. Ar) or CO_2, if the ventilation is not working, or if the operator enters the cabin before sufficient venting occurred (refer to 5.7)

— Risk and increase of fire by release of oxygen.

— Risk of flashback, if the stop valve or the gas pressure reducing fitting does not operate sufficiently.

5 Safety requirements – Protection measures

5.1 General requirements and measures

Specific safety conditions and protective measures are required by European, national or local regulations. These requirements shall be fulfilled predominantly. The following equipment is covered by this Technical Report.

Gas cylinders, manifold cylinder bundles and cryogenic gas tanks, storage receptacle for liquid fuel, piping systems for gases, liquid fuel and cooling media.

Appropriate devices and equipment to fulfil the requirements are:

— gas stop valves;

— gas pressure regulator;

— shutt-off valve;

— gas pressure control;

— pressure reducing valves;

— pipes for the connection of the gas cylinders from the storage receptacle to the control cabinet, or within the control cabinet;

— fittings, connecting parts;

— pressure gauges;

— flashback arresters;

— non-return valves.

5.2 Safety requirements and protection measures for gas storage

Wherever possible, stores for cryogenic liquid gas tanks, bulk supply of gases and/or tanks for liquid fuels shall be located outside the work area, in purpose-built bays that can be locked.

The storage area shall be well ventilated, kept clean and the cylinders shall be protected against ice and snow and direct sunlight. Access shall be given for the delivery and removal of bundles or cylinders by lorries.

Fuel gases and oxygen shall be stored separately, either by a distance or by a fire resistant wall. The limits of the permissible quantity of LPG, propane and acetylene stored together shall be considered.

Heating and/or gasification of the LPG piping may be necessary to avoid liquefaction of the LPG in the piping and/or feeding the spraying system. This phenomenon may appear at high pressures and low temperatures

Annex A represents schematically layouts for gas and liquid fuel supply for several thermal spraying processes.

5.3 Safety requirements and protection measures for high pressure gas supply

A fixed installation of this gas supply system (more than 20 bar gas pressure) shall be applied for thermal spraying using solid piping as far as possible. Hoses of suitable material and pressure range shall be used in order to reduce the risk of damages and leakage. A sufficient flow shall be available.

A solid piping shall be routed on the outside and inside of the building as far as possible and shall contain a minimum number of connections. Any connections shall either be welded or brazed (for pipes made out of copper). Soft soldered joints or crimp connectors are not permitted.

The piping shall be visible and accessible for inspection and maintenance purposes. Installation in ducts, roof spaces and enclosed spaces should be avoided. All pipes and hoses shall be suitably marked, indicating the type of gas and its direction of flow.

To avoid the risk of fire or explosion, no organic materials such as oil or grease shall come into contact with oxygen.

Flashback arresters and non-return valves shall be used to protect the piping and storage system against flashbacks.

Gas stop valves, automatically or manually operated, pressure reducing valves and gas pressure control devices shall be applied on the cylinder, bundle, or tank.

5.4 Safety requirements and protection measures for liquid fuel supply

For systems based on liquid fuels, e.g. kerosene, the possibility of producing an explosive mixture exists although the flash point of kerosene is higher than the one of gaseous fuels such as acetylene or propane, but the flash point varies widely depending upon the specific product. An atomized kerosene spray can explode in the presence of an ignition source.

Usually, the fuel is fed via a pressurized line to the console. A leakage in this system can create an explosive atmosphere. Thus, the high-pressure side shall be equipped with an all-metal pipe or a metal reinforced rubber hose designed for the liquid fuel, its pressure and pressure peak load conditions, for example according to EN ISO 3821.

The barrels should be placed on a collecting container according to national rules.

The installation shall be leak tested. For details, see 5.8.

5.5 Safety requirements and protection measures for cooling media supply

Cooling media are applied for cooling the part to be sprayed, the coating and the spray torches. Usually, pressurized air or water is applied for cooling the spray torch, while pressurized air or carbon dioxide (CO_2) are applied for cooling the part and/or the coating.

Considering the safety requirements, the storage and supply system shall be operated or equipped with

— suitable storage of liquid carbon dioxide (CO_2) in cylinders, bundles or a tank,

— protection from hot cooling water exit,

— controlled distribution of cooling media in the HVOF or plasma spray torch,

— leak test. For details, see 5.8.

5.6 Gas detection

Leaks can occur on any connections. Small leaks can be dispersed by an adequate general ventilation system. Unintentional escaping of flammable gases shall be detected, generally. If safety limits are exceeded, a monitoring and control system shall stop the further gas supply.

An appropriate positioning, accurate calibration, and regular inspection of gas detectors and testing for their effectiveness shall be performed. Instructions given by the supplier of the devices shall be considered.

A suitable risk assessment shall be performed before a gas detection equipment is installed. For details to the risk assessment, see CEN/TR 15339-1. The appropriate location of the detectors can be limited to the working area of the spray process, the gas control cabinet and inside the spray cabin.

5.7 Measures in the case of a gas leakage

The function of the detector shall be integrated into the process control of the thermal spray system (inclusive ventilation system and gas and electric power supply). An interlock shall be introduced, the electric power supply shall be separated and gas/fuel supply stopped before a critical level is reached. The ventilation shall continue to function or a ventilation emergency system shall be activated and shall operate until any flammable gas is below a critical level.

5.8 Leak test – Pressure test

In any case, a pressure test has to be carried out following installation or a repair. Likewise, a leak test should be carried out on the screw connections following a change of cylinders.

A pressure and leak test has to be performed after installation and repair work. After a change of gas cylinders the pressure and leak test can be focussed on the screw connections to the gas cylinder.

Periodical pressure and leak tests should be performed according to the local regulations.

For pressure testing, the test should be carried out according to the national or local regulations using an inert or a non-flammable gas with similar properties to the fuel gas used in the system. Thus, for instance helium can be used to test a hydrogen system. The pressure shall be held in the system without a drop for a period required by the national or local regulations (usually not less than 30 min).

5.9 Finishing the installation - Inspections

The inspector should issue an appropriate certificate of testing after the system is visually inspected and leak tested.

Equipment for use with oxygen shall be certified as clean for oxygen service.

6 Requirements for manufacture, supply, operation and maintenance

6.1 Requirements for the manufacturer

— Designing and manufacturing of the equipment according to the relevant directives of the European Union and the technical instructions of CEN/TR 15339-1 and of this Technical Report;

— presentation of an operation manual of the equipment;

— service plan providing instructions for measures and testing respectively replacement of worn parts at intervals;

— plan for training the operators.

In case of delivery of incomplete machinery, an additional notice of assembly shall be part of the documentation, see Directive 2006/42/EC [2].

6.2 Requirements for the integrator

— Installing and putting into service meeting the requirements of EU Directives and the instructions of CEN/TR 15339-1 and of this Technical Report;

— training of the operator;

— leak testing.

6.3 Requirements for the user

— Operating the equipment meeting the requirements of EU Directives and the instructions of CEN/TR 15339-1 and of this Technical Report;

— preparing the operation personnel;

— instruction of the operator;

— carrying out the service plan.

6.4 Requirements for the gas supplier

— Supply of the MSDS of the different gases supplied;

— provide necessary training for the handling and use of such gases;

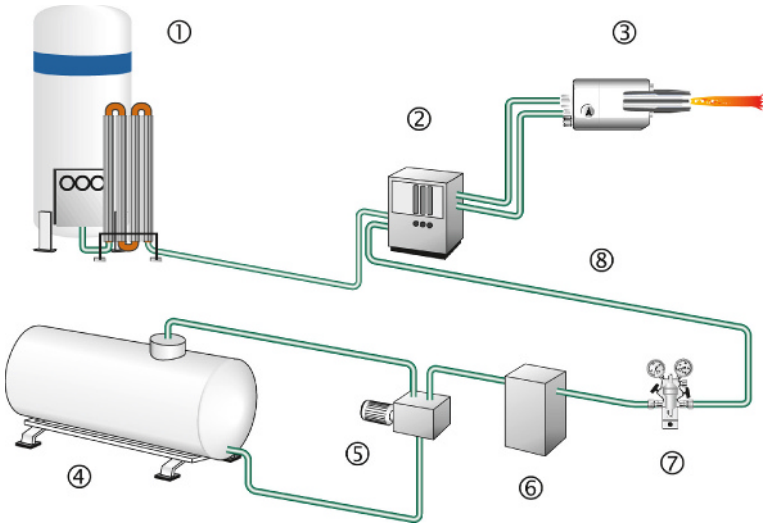
— provide the emergency numbers.

7 National rules

National laws or regulations shall be considered and can be added in the prevailing national foreword of this Technical Report, if applicable.

Annex A
(informative)

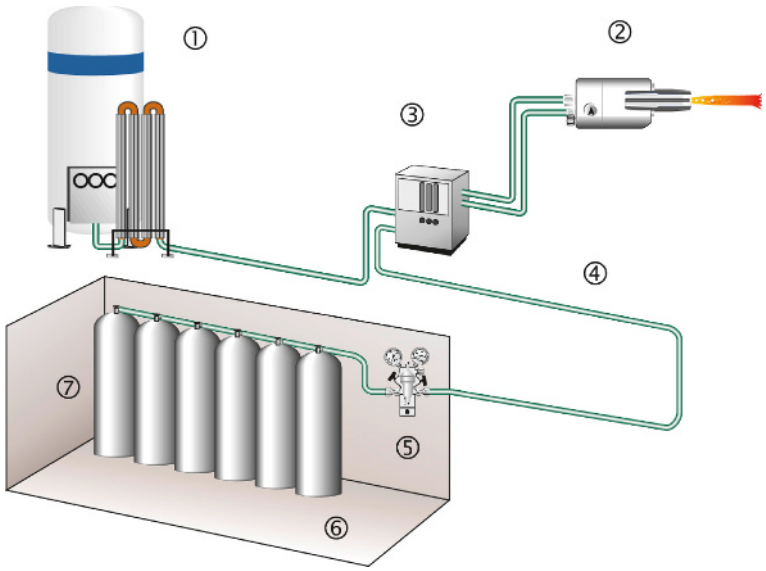
Schematic representations of equipment for supply of gas and liquid fuel



Key

1 oxygen tank
2 control cabinet
3 spray torch
4 LPG (liquid propane gas) tank
5 pump
6 evaporator
7 pressure regulator
8 heating

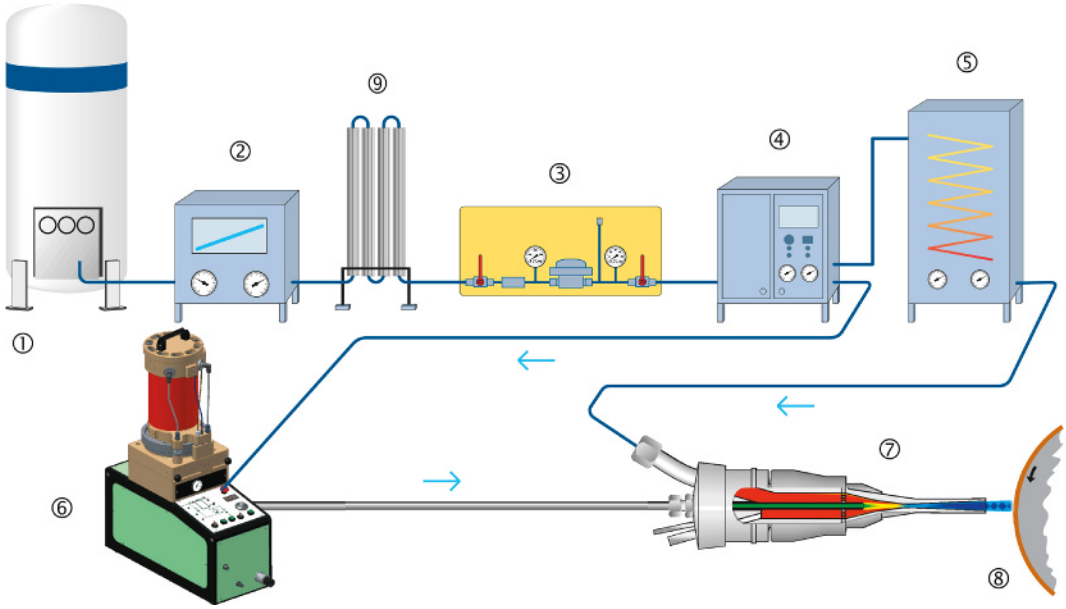
Figure A.1 — Gas supply for HVOF spraying with LPG and oxygen



Key

1	oxygen tank	5	pressure regulator
2	spray torch	6	heated room
3	control cabinet	7	propylene cylinders
4	heating		

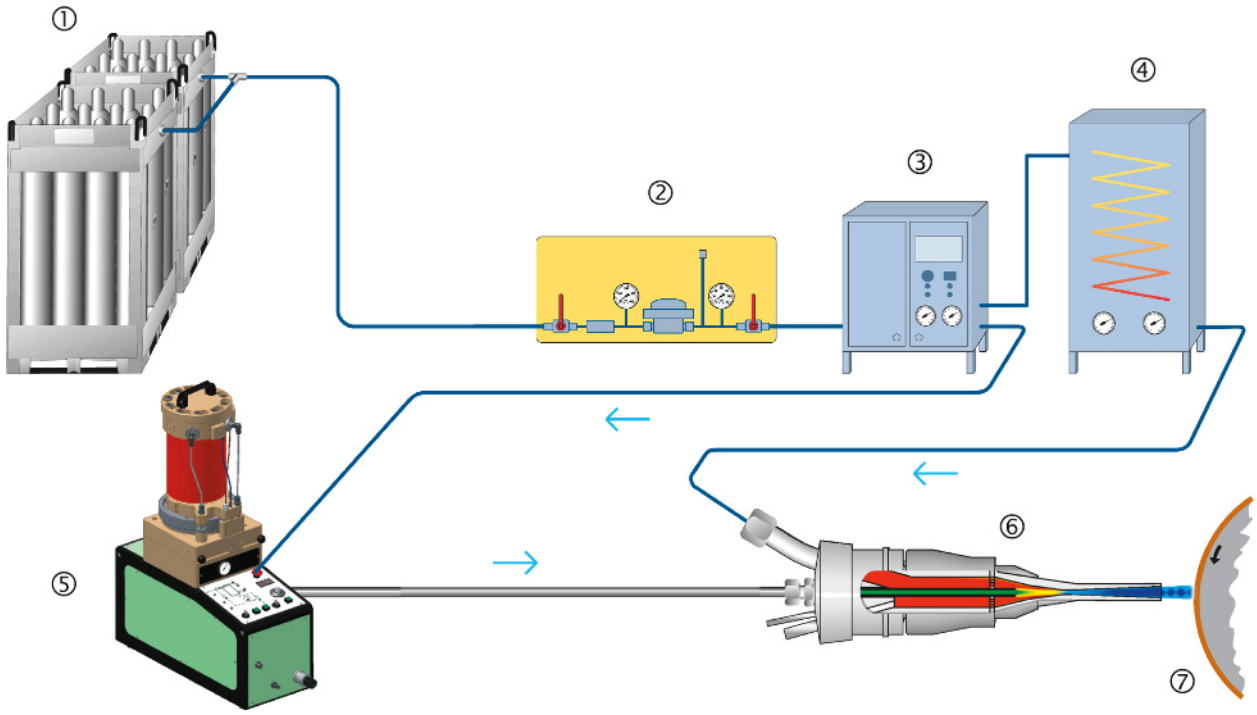
Figure A.2 — Gas supply for HVOF spraying with propylene and oxygen



Key

1	gas tank	6	powder feed unit
2	pressure booster	7	spray torch
3	pressure regulator with non-return valves	8	spray jet and substrate
4	control cabinet	9	evaporator
5	gas heater		

Figure A.3 — Gas supply with gas tank for cold spraying



Key

1 cylinder
2 pressure regulator with non-return valves
3 control cabinet
4 gas heater
5 powder feed unit
6 spray torch
7 spray jet and substrate

Figure A.4 — Gas supply with bundles for cold spraying

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