Gasunie Technical Standard

Design Specification Instrumentation

OSM-03-E

Control valves
General requirements and sizing

External

Version 6 *08-11-2018*

N.V. Nederlandse Gasunie

Gasunie Technical Standard

Design Specification Instrumentation
OSM-03-E

Control valves
General requirements and sizing

This specification has been drawn up by the Gasunie department "Operations & Projects; Technology - E&I Installations".

The specification may be distributed to suppliers and contractors.

Issued by the Gasunie department "Document Management".

N.V. Nederlandse Gasunie
Postbus 19, 9700 MA Groningen (Netherlands)
Telephone +31 50 5219111, Fax +31 50 5211999

FOREWORD

This specification supersedes the fifth version of OSM-03-E.

With respect to the former version the following has been changed:
- The maximum permissible sound level has been changed from 85 dB(A) to 80 dB(A).
- New electrically operated actuators have been added.
- Attention points for renovation have been added.

Alterations are marked with a left margin line.

CONTENTS

1. SCOPE AND APPLICATION

This specification gives requirements and design considerations for control valves and for the application of control valves, mainly in natural gas systems.

This specification also provides guidelines for the sizing and selection of control valves.

Sizing formulas and definitions are based on NEN-EN-IEC 60534 publications.

2. REFERENCES

This specification is subject to the requirements of the documents mentioned in this clause. If the documents in this specification are mentioned with a date, this specific edition is applicable.

2.1 Gasunie documents

In this specification reference is made to the following Gasunie documents:

MSW-03-E/6	Control valves.
OSA-14-E	Noise control.

2.2 Standards

Reference is made in this specification to the standards mentioned in this subclause. Any supplements and errata notices are also applicable.

NEN-EN-IEC 60534-1[1]	Industrial-process control valves; Part 1: Control valve terminology and general considerations;
NEN-EN-IEC 60534-2-1	Industrial-process control valves; Part 2-1 Flow capacity - Sizing equations for fluid flow under installed conditions.
NEN-EN-IEC 60534-2-4	Industrial-process control valves; Part 2-4: Flow capacity - Inherent flow characteristics and rangeability.
NEN-EN-IEC 60534-2-5	Industrial-process control valves; Part 2-5: Flow capacity - Sizing equations for fluid flow through multistage control valves with interstage recovery.
NEN-EN-IEC 60534-3-1	Industrial-process control valves; Part 3-1: Dimensions - Face-to-face dimensions for flanged, two-way, globe-type, straight pattern and centre-to-face dimensions for flanged, two-way, globe-type, angle pattern control valves.
NEN-EN-IEC 60534-3-2	Industrial-process control valves; Part 3-2: Dimensions – Face-to-face dimensions for rotary control valves except butterfly valves.
NEN-EN-IEC 60534-3-3	Industrial-process control valves; Part 3-3: Dimensions - End-to-end dimensions for buttweld, two-way, globe-type straight pattern control valves.
NEN-EN-IEC 60534-4	Industrial-process control valves; Part 4: Inspection and routine testing.
NEN-EN-IEC 60534-5	Industrial-process control valves; Part 5: Marking.
NEN-EN-IEC 60534-6-1	Industrial-process control valves; Part 6-1: Mounting details for attachment of positioners to control valves - Section 1: Positioner mounting on linear actuators.
NEN-EN-IEC 60534-6-2	Industrial-process control valves; Part 6-2: Mounting details for attachment of positioners to control valves - Positioner mounting on rotary actuators.

[1] Applicable for all NEN-EN standards: Depending on the country where the standard will be applied, DIN-EN or BS EN, for example, shall be chosen.

NEN-EN-IEC 60534-8-3	Industrial-process control valves; Part 8-3: Noise considerations - Control valve aerodynamic noise prediction method.
NEN-EN-IEC 60534-8-4	Industrial-process control valves; Part 8-4: Noise considerations - Prediction of noise generated by hydrodynamic flow.

2.3 Software package

In this specification reference is made to the following software package:

Conval[1)]	Software programme from Engineered Software, Inc., managed by the Gasunie department "Operations & Projects; Techniek - Multidisciplinair". A request for access to Conval can be sent to Gasunie department "ICT".

1) Conval is an engineering tool for the calculation and optimisation of common plant components such as control valves and throttle elements, piping system components, heat exchangers, integrated property calculations and pump motor output.

3. DEFINITIONS, PARAPHRASE AND SYMBOLS

3.1 Definitions

In this specification the following definitions are applicable:

Control valve	A power device which changes the flow rate as the final control element of a process control system. It consists of a valve connected to an actuator that is capable of changing the position of a closure member in the valve in response to a signal from the process control system.
C_v of a control valve	The quantity of water, at a temperature of between 40 °F to 100 °F, in US gallons per minute, that will flow through the valve at a specified travel with a pressure drop of 1 lbf/in^2 (psi).
Flow coefficient	The flow capacity of a control valve, commonly expressed by the C_v-factor or K_v-factor.
Inherent equal percentage characteristic	A characteristic for which equal increments of relative travel yield equal percentage changes of the relative flow coefficient.
Inherent linear characteristic of a control valve	A characteristic for which equal increments of relative travel yield equal increments of relative flow coefficient.
K_v of a control valve	The quantity of water in m^3/h, at a temperature of between 5 °C and 40 °C, that will flow through the valve at a specified travel with a pressure drop of 1 bar ($K_v = 0{,}865 \cdot C_v$).
Medium mixture	A mixture of various gases, a mixture of various liquids, a mixture of liquid with gas or a mixture of a liquid with its saturated vapour.

3.2 Paraphrase

In this specification the following paraphrase is applicable:

Flashing (for liquids only)	Flashing occurs when the pressure in the valve body falls below the liquid vapour pressure. The bubbles thus formed remain as vapour in the fluid, owing to the fact that the downstream pressure of the control valve is below its vapour pressure.

3.3 Symbols

In this specification the following symbols are applicable:

Symbol	Description	Unit
C_v	flow coefficient	US gal/min
P_A	system A pressure	bar (abs)
$P_{A,B}$	pump outlet pressure	bar (abs)
P_B	system B pressure	bar (abs)
$P_{B,C}$	system B pressure without (differential) static head (P_B-P_h)	bar (abs)
P_h	(differential) static head	bar (abs)
$P_{p,d}$	pump dynamic pressure loss under design condition	bar
$P_{s,d}$	system dynamic pressure loss under design condition	bar
P_t	total dynamic pressure difference	bar (abs)
Q	mass flow rate	kg/s
Q_-	minimal controllable flow rate - use $Q_- = 0{,}5 \cdot Q_d$ if unknown	kg/s
Q_+	maximal controllable flow rate - use $Q_+ = 1{,}1 \cdot Q_d$ if unknown	kg/s
Q_0	mass flow rate under normal conditions	kg/s
Q_d	mass flow rate under design conditions	kg/s
Q_s	system flow rate without control valve	kg/s
ΔP	differential pressure between the control valve inlet and outlet	bar
ΔP_v	pressure drop across control valve	bar (abs)

4. REQUIREMENTS

Control valves shall only be used for throttling purposes and shall not be part of a shutdown system.

Control valves for general purpose shall have leakage class IV according to EN 60534-4. If a tight shut-off control valve is required, the leakage rate shall be specified in accordance with EN 60534-4 leakage class VI.

Unless otherwise specified, the maximum allowable sound pressure level at 1 metre distance from the piping and 1 metre downstream of the valve shall not exceed 80 dB(A) and shall be guaranteed by the control valve manufacturer (see OSA-14-E).

If the allowable sound pressure level is exceeded, sound insulation of the control valve body may be considered (see OSA-14-E).

4.1 Valve type

Control valves (choke valves) used in liquid drain systems (e.g. scrubbers) shall be operated open/close only in order to avoid damage to the trim. Hardened trim materials shall be applied for this service.

Application of restriction orifice plates downstream of control valves shall be avoided.

Direct operating pressure-reducing regulators shall be applied only for non-contaminated media.

Three-way globe valves shall only be applied for instrument air driers and lubrication oil cooling systems where a constant flow is required or cold spots are to be avoided.

For natural gas applications, ball valves or axial operated control valves shall be used.

4.2 Body construction

Body sizes of DN 25 up to and including DN 600 shall only be considered; for larger body sizes, care shall be given to the stroking time in relation to the required speed of control. If a required stroking time cannot be reached with a large size valve, smaller sizes shall be applied in parallel.

Body sizes smaller than DN 25 shall not be applied; if smaller capacities are required, reduced trims shall be used.

Control valves shall have either flanged ends or flangeless bodies. If they are unavailable, screwed connections up to and including DN 50 may be applied.

Body material shall be selected based on the relevant piping class specification (see also MSW-03-E/6).

Seal and/or packing rings shall be made of asbestos-free material and, if they come in contact with the medium, suitable for the specified process conditions.

4.3 Trim design

Control valves in a throttling service shall have linear characteristics when, under all operating conditions, the pressure drop over the control valve is more than $^2/_3$ of the pressure drop across the valve in the closed position. An equal percentage characteristic shall be specified for all other cases, with the exception of valves for the following applications (see annexes A and B for examples of typical sketches):

- surge control of a compressor;
- split-range control;
- two valves in parallel for increased rangeability;
- minimum flow protection for pumps.

A reduced trim shall be selected when flashing is predicted.

4.4 Actuators

Control valves shall be electrically operated or pneumatically operated by instrument air or nitrogen.

A control valve action can be spring-returned (open or closed) or fixed depending on the process safety conditions.

The required stroking time of a control valve shall be based on the process control requirements.

The actuator shall be sized in accordance with the required:

- stroking time;
- process conditions (pressure drop);
- minimum hysteresis effect.

4.4.1 Electrically operated actuators

Electrically operated actuators shall be powered by the emergency power supply.

4.4.1.1 Accessories

The actuator shall be equipped with smart positioners with an input signal of 4 mA – 20 mA, HART protocol and position indication 0 % - 100 %.

The control valve shall be fitted with limit switches for fully open and closed.

4.4.2 Pneumatically operated actuators

Where stroking time requirements cannot be met, volume boosters shall be considered.

Note:
One stroke is from fully open to fully closed, or the reverse.

4.4.2.1 Accessories

All control valves shall be equipped with smart electropneumatic positioners with an input signal of 4 mA – 20 mA, loop-powered, HART protocol and position indication 0 % - 100 %.

The control valve shall be fitted with limit switches for fully open and closed.

The positioner output shall be direct. Attention shall be given to the "safe" failure action of the control valve in the event of signal failure.

Limit stops are intended to prevent the valve from fully closing or opening. The limit/travel stop setting(s) shall be specified in the requisition.

Lock-up valves shall be provided for control valves which shall remain in the position immediately prior to a failure of the instrument air system or gas system. For control valves with a positioner, the lock-up valve shall be installed between the positioner output and the actuator. Where lock-up valves are applied on valves operated by a(n) (emergency) solenoid valve, this solenoid valve shall be installed between the lock-up device and the actuator.

If instrument air systems are used, separate air filter regulators shall be installed in the instrument air supply lines to the actuator and/or positioner. The air filter regulator shall be of the reducing relief valve type, with drainage facilities and bolt adjustment, and provided with a locking device to prevent tampering.

5. RENOVATION OR REVISION

Considerations for renovation or revision of control valves are given in this clause.

When a period of time has elapsed, control valves shall be overhauled or renovated.

If the control valve is not obsolete, preference is given to overhauling unless there are important reasons for deviating from this, such as:
- operational changes;
- environmental reasons (sound), or
- scheduled technical reasons.

If replacement of the control valve is necessary, take account of the following points:
- Check if the control valve is working properly by testing the control valve.
- Check whether the process parameters have remained unchanged, such as: in- and outlet pressure, flow conditions and quality schemes.
- Check whether the station has undergone any modifications.
- The hook up still meets the current specification.
- If the existing control valve is equipped with power gas, check whether it can be transferred to an electrically actuated actuator or one powered by instrument air.
- Use calculation program Conval to calculate and validate the parameters. Verify whether the new configuration can be applied.

6. SIZING OF CONTROL VALVES

6.1 Introduction

Gasunie uses the "Conval" software package to size control valves. This software package shall be used for sizing, noise calculations, trim design and actuator design. Most control valve manufacturers can supply data for making specific valve calculations with the Conval programme.

The formulas and definitions in Conval are based on NEN-EN-IEC 60534.

6.2 Data required for calculation

The data required for sizing each control valve shall be shown on the relevant data sheet.

Each calculation shall include a simplified sketch of the process system in which the control valve is to be installed (see annexes A and B for examples of typical sketches).

The following criteria shall be taken into account when sizing a control valve:

- The data used for sizing the control valve shall be unambiguous with regard to the required maximum flow, minimum controllable flow and design flow.
- Unless otherwise specified, the calculation of the C_v value shall be based on the design flow, with its relevant process data.
- Unless otherwise specified, the following shall apply:

  In order to be able to control around the design point, the maximum required flow rate through a control valve shall be at least 10 % greater than the design flow, i.e.: $Q_+ \geq 1{,}10 \cdot Q_d$.
- The geometry of the surrounding piping and the control valve shall be taken into consideration for the C_v value calculation.

For ball-type control valves, the following rules shall be applied:

- The minimum opening shall be 15° under all operating conditions.
- The maximum opening shall be 85° with design flow and minimum ΔP.

6.3 Selection of a C_v value

A control valve shall be selected with a C_v value which is equal to, or the next highest value to, the calculated C_v value. However, the control valve shall be able to handle at least the maximum required flow rate at the minimum required pressure drop.

ANNEXES

A INSTALLED CONTROL VALVE AND LINE SYSTEM WITHOUT PUMP

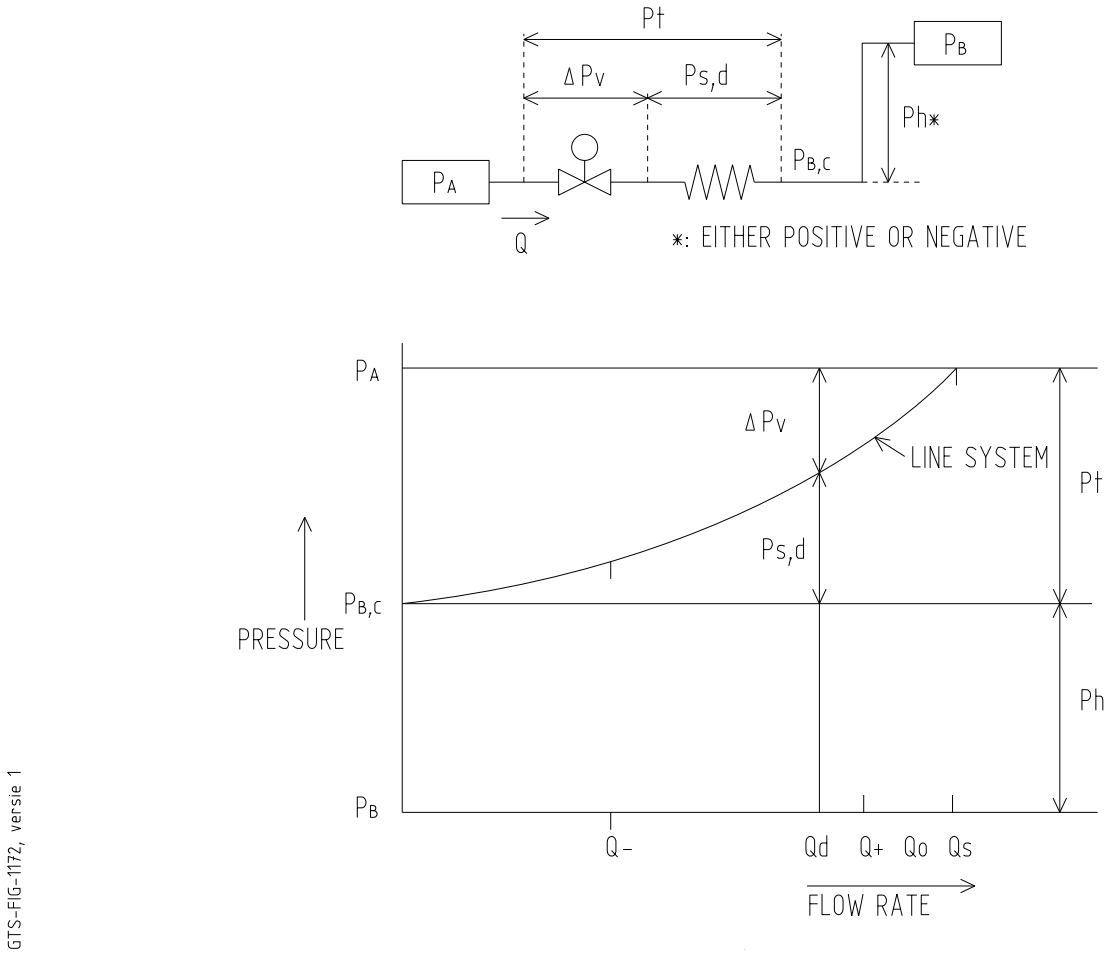

Figure 1: Process system without pump

B INSTALLED CONTROL VALVE AND LINE SYSTEM WITH PUMP

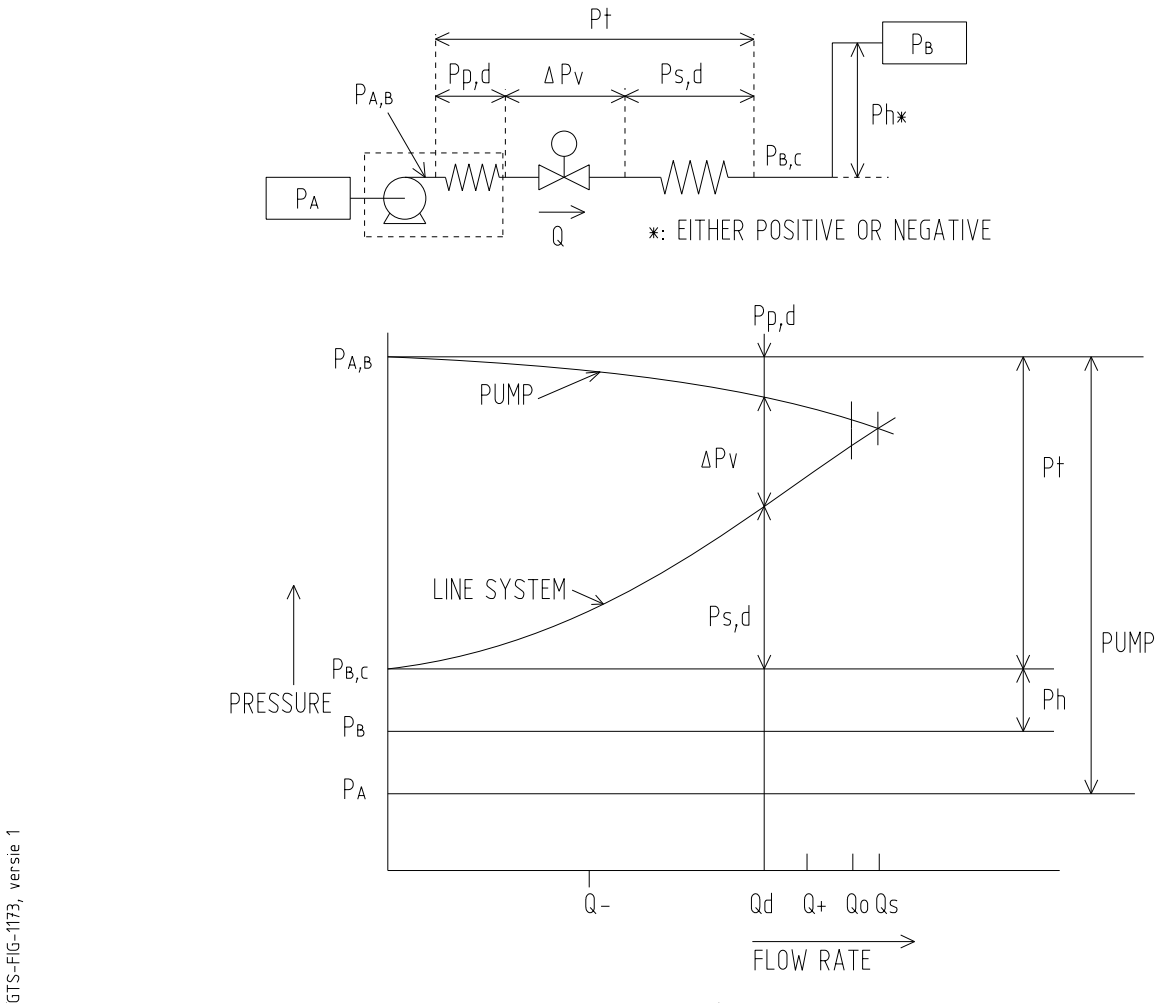

Figure 2: Process system with pump