

Gas Industry Standard

GIS/V9-1:2006

Specification for

Slamshut valves for governor installations with inlet pressures in the range greater than 75 mbar to not greater than 7 bar

Part 1: Spring-operated diaphragm type slamshut valves

nationalgrid

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Foreword

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Compliance with this engineering document does not confer immunity from prosecution for breach of statutory or other legal obligations.

Mandatory and non-mandatory requirements

For the purposes of a GIS the following auxiliary verbs have the meanings indicated:

- can** indicates a physical possibility;
- may** indicates an option that is not mandatory;
- shall** indicates a GIS requirement;
- should** indicates best practice and is the preferred option. If an alternative method is used then a suitable and sufficient risk assessment needs to be completed to show that the alternative method delivers the same, or better, level of protection.

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Brief history

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1 Scope

This Gas Industry Standard (GIS) specifies general design, materials and performance testing of spring-operated diaphragm slamshut valves of both stand-alone and integral types with inlet pressures in the range greater than 75 mbar to not greater than 7 bar, and temperatures in the range $-20\text{ }^{\circ}\text{C}$ to $60\text{ }^{\circ}\text{C}$ inclusive.

2 Normative references

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

Formal standards

BS 21, *Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions)*.

BS EN 485 Series, *Aluminium and aluminium alloys — Sheet strip and plate*.

BS EN 515, *Aluminium and aluminium alloys — Wrought products — Temper designations*.

BS EN 573 Series, *Aluminium and aluminium alloys*.

BS EN 682, *Elastomeric seals — Materials requirements for seals used in pipes and fittings carrying gas and hydrocarbon fluids*.

BS EN 755 Series, *Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles*.

BS EN 1092-1, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 1: Steel flanges*.

BS EN 1092-2, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 2: Cast iron flanges*.

BS EN 1092-4, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 4: Aluminium alloy flanges*.

BS EN 1559-1, *Founding — Technical conditions of delivery — Part 1: General*.

BS EN 1559-4, *Founding — Technical conditions of delivery — Part 4: Additional requirements for aluminium alloy castings*.

BS EN 1561, *Founding — Grey cast irons*.

BS EN 1562, *Founding — Malleable cast irons*.

BS EN 1563, *Founding — Spheroidal graphite cast iron*.

BS EN 1676, *Aluminium and aluminium alloys — Alloyed ingots for re-melting — Specifications*.

BS EN 1706, *Aluminium and aluminium alloys — Castings — Chemical composition and mechanical properties*.

BS EN 1982, *Copper and copper alloys — Ingots and castings*.

BS EN 10028 Series, *Specification for flat products made of steels for pressure purposes*.

BS EN 10029, *Specification for tolerances on dimensions, shape and mass for hot rolled steel plates 3 mm thick or above*.

BS EN 10088-1, *Stainless steels — List of stainless steels*.

BS EN 10213-1, *Technical delivery conditions for steel castings for pressure purposes — Part 1: General*.

BS EN 10213-3, *Technical delivery conditions for steel castings for pressure purposes — Part 3: Steels for use at low temperatures.*

BS EN 10222-3, *Steel forgings for pressure purposes — Part 3: Nickel steels with specified low-temperature properties.*

BS EN 10269, *Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties.*

BS EN 10272, *Stainless steel bars for pressure purposes.*

BS EN 10273, *Hot rolled weldable steel bars for pressure purposes with specified elevated temperature properties.*

BS EN 12165, *Copper and copper alloys — Wrought and unwrought forging stock.*

BS EN 12420, *Copper and copper alloys — Forgings.*

BS EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories.*

Gas Industry Standards

GIS/C5, *Specification for distribution pipe fittings cast in grey cast iron for use up to 7 bar maximum operating pressure.*

GIS/PL4-1, *Specification for elastomeric diaphragms — Part 1: Homogeneous diaphragms.*

National Grid standards

T/SP/CW6-1, *Specification For The External Protection Of Steel Line Pipe And Fittings Using Fusion Bonded Powder And Other Coating Systems — Part 1: Requirements For Coating Materials And Methods Of Test.*

T/SP/CW6-2, *Specification For The External Protection Of Steel Line Pipe And Fittings Using Fusion Bonded Powder And Other Coating Systems — Part 2: Factory applied coatings.*

T/SP/PA10, *Specification for new and maintenance painting at works and site for above ground pipeline and plant installations.*

3 Terms and definitions

For the purposes of this GIS the following definitions apply.

3.1

allowable leakage

amount of test gas so small that no bubbles are observed breaking loose from the slamshut valve when fully immersed in water during the test specified

3.2

flow coefficient C_v

$$C_v = \frac{Q}{416} \left\{ \frac{GT}{(P_1 - P_2) P_1 \text{ absolute}} \right\}^{0.5}$$

where:

Q is the flowrate (m³/h) at 15 °C, 1013.25 mbar

G is the specific gravity of gas

T is the inlet temperature (K)

P_1 is the inlet pressure (bar)

P_2 is the outlet pressure (bar)

3.3

low pressure (LP)

gas pressure not exceeding 75 mbar

3.4

repeatability

estimate of the percentage deviations from the mean set pressure within which the slamshut valve will operate 95 times out of 100 calculated in accordance with Annex B

3.5

slamshut valve

spring operated diaphragm emergency shut-off valve whose body is either stand-alone or an integral part of either an active or monitor governor

3.6

trip pressure

observed pressure at the instant the closure device shuts off for the defined rate of pressure rise

4 Materials

4.1 All materials used for components shall be suitable for use with natural gas and shall not be adversely affected by any gas constituents or additives.

4.2 Grey cast iron shall conform to BS EN 1561, minimum grade EN-GJL-200 and GIS/C5.

4.3 Spheroidal graphite cast iron (ferritic ductile iron) shall conform to BS EN 1563, grade EN-GJS-400-18-LT.

4.4 Malleable cast iron shall conform to BS EN 1562, grades EN-GJMW-360-12 or EN-GJMB-350-10.

4.5 Carbon steel castings shall conform to BS EN 10213-1 and BS EN 10213-3, grades G17Mn5 or G20Mn5.

4.6 Carbon steel forgings shall conform to BS EN 10222-3, grades 13MnNi6-3, 15NiMn6, or 12Ni14.

4.7 Carbon steel plates shall conform to BS EN 10028 and BS EN 10029, grade P275NL1.

4.8 For steel compositions of welding grades, the ladle analysis shall be checked to ensure that the carbon equivalent (CE) does not exceed 0.40 based on the formula:

$$CE = C + \frac{Mn}{6}$$

4.9 Austenitic stainless steel components shall be BS EN 10088-X grades 1.4401 (X5 Cr Ni Mo 17-12-2), 1.4436 (X3 Cr Ni Mo 17-13) or 1.4571 (X6 CrNiMoTi 17-12-2). The specific steel grade for a product form (e.g. casting, plate) and the British Standard to which it conforms shall be approved by the gas transporter. Standards for product forms are BS EN 10028, BS EN 10029, BS EN 10088-X, BS EN 100269, BS EN 100272 and BS EN 100273.

4.10 Copper alloy castings shall conform to BS EN 1982:

- bronze shall conform to grades CC491K or CC492K;
- brass shall conform to grades CuZn38Al-C, CuZn39Pb1Al-C or G-CuZn40Pb;
- aluminium bronze shall conform to grade CuAl10Fe5Ni5-C.

4.11 Copper alloy forgings shall conform to BS EN 12165 and BS EN 12420, grades CuZn39Sn1, CuZn39Pb3, CuZn40Pb2 or CuZn36Pb2As.

4.12 The magnesium content of aluminium alloys shall not exceed 6%. Aluminium alloys shall conform to BS EN 1559, BS EN 1676 and BS EN 1706:

- castings shall conform to grades EN AC 45200, EN AC 42100, AC44200 or AC46600;
- plate, sheet and strip shall conform to BS EN 485 (all parts), BS EN 515 and BS EN 573 (all parts), grades EN AW-5251, EN AW-5454, EN AW-5154A or EN AW-5083;
- bars and sections shall conform to BS EN 1020, BS EN 515, BS EN 573 (all parts) and BS EN 755 (all parts), grades EN AW-5251, EN AW-5154A or EN AW-508.

4.13 Elastomeric components of slamshut valves (e.g. seals) shall conform to BS EN 682. The material and testing of rubber used in the manufacture of diaphragms shall conform to GIS/PL4-1.

5 General design requirements

5.1 Slamshut valves shall be designed to operate in gas and ambient temperatures in the range $-20\text{ }^{\circ}\text{C}$ to $60\text{ }^{\circ}\text{C}$ inclusive.

5.2 The design and construction of slamshut valves shall of such a standard that a minimum working life of five years can be expected without overhaul maintenance.

5.3 Slamshut valves shall be capable of operating when mounted at any angle. Associated control mechanisms that can be rotated independently of the main body may be used.

5.4 Slamshut valves shall be fitted with an external visual device that clearly indicates whether the closure device has been released or reset.

5.5 The relatching mechanism shall be protected from overload or failure due to stresses applied during relatching. Where such protection is provided by the fitting of equalizing valves, these shall be of the type that cannot be left in the open position.

5.6 Slamshut valves shall shut off the flow of gas in one direction only.

NOTE The direction of gas flow is cast or similarly permanently marked directly on the slamshut valve body (see **10.1**), to ensure that the slamshut valve is not fitted in the gas stream the wrong way round.

5.7 Manufacturing tolerances shall be such that replacement parts are interchangeable.

5.8 All critical fastenings shall be locked to prevent vibrational loosening and be re-lockable during maintenance. All free moving/loose components shall remain so during service and shall not be capable of being inadvertently locked.

5.9 Slamshut valves shall operate satisfactorily when upstream filters are employed with elements which are no finer than 200 μm .

5.10 Breathers shall be so designed and located that they do not block and cannot be painted over and shall resist water ingress under adverse weather conditions. The opening in the body/housing to which the breather is connected shall be threaded internally in conformance to BS EN 10226-1 and 10226-2. If the breather is substituted for a vent pipe, performance shall not be affected.

5.11 External impulse connections shall be internally threaded in conformance with BS EN 10226-1 and BS EN 10226-2, $R_{1/4}$ (for taper external threads), $R_c^{1/4}$ (for taper internal threads) or $R_p^{1/4}$ (for parallel internal threads) as a minimum.

5.12 Flanged ends shall be used on slamshut valves greater than 50 mm diameter nominal size. The dimensions for flanged ends shall conform to BS EN 1092.

5.13 For slamshut valves up to 50 mm diameter nominal size threaded or flanged connections may be used. Threaded connections shall conform to BS EN 10226-1 and 10226-2.

5.14 Slamshut valves with a nominal diameter equal to or greater than 200 mm shall incorporate lifting lugs appropriate to both the horizontal and vertical positions. Each lug shall be capable of taking the full weight of the slamshut valve. Tapped holes and eyebolts shall not be used.

5.15 Springs shall not be overstressed when fully compressed in their housings and shall allow sufficient free movement for satisfactory operation. Spring adjusters shall not be capable of operation by interference from other components.

5.16 Where external reset/adjustment levers are detachable, they need not be provided with every slamshut valve, but shall be available as extra items.

5.17 Where the slamshut valve is integral with the governor, its operating mechanism shall be independent from that of the governor.

5.18 The latching/trip mechanism shall not rely on magnetic forces for its operation.

6 Type approval

6.1 General

6.1.1 Implementation of the tests in this GIS shall be the responsibility of the contractor.

6.1.2 The testing may be carried out by the contractor and witnessed by the gas transporter, or carried out by an independent laboratory accredited to BS EN ISO/IEC 17025.

6.1.3 The test programmes for stand-alone slamshut valves and for integral slamshut valves are specified in Annex C.

6.2 Dimensions

The contractor shall check the dimensions of the slamshut valve components against the drawings lodged with the gas contractor at the time of type testing and subsequently during production.

6.3 Additional testing to cover external devices (where fitted)

Where telemetry switches or other external devices are available as optional extras to the standard slamshut valves, the appropriate type tests shall be repeated with those items fitted.

7 Production testing

7.1 General

Each production slamshut valve shall be tested by the contractor in accordance with the tests specified in **7.2** and **7.3**. Failure to meet the requirements of any of the tests shall be cause for rejection of the slamshut valve.

7.2 Tests prior to assembly

7.2.1 General

The pressure-containing components shall be tested for leakage and strength, in accordance with **7.2.2** and **7.2.3** respectively, after all machining has been completed but prior to the application of any paint or synthetic protective coating.

7.2.2 Leakage test

The leakage test applied to the body, diaphragm casing and other pressure-containing parts shall be carried out at a pressure of either 0.5 times the maximum rated pressure or 3.5 bar, whichever is the lesser, for not less than 60 s during which time allowable leakage shall not be exceeded.

7.2.3 Strength test

The strength test applied to all pressure-containing parts shall be carried out at a minimum of 1.5 times the maximum rated pressure for the times given in Table 1. Allowable leakage shall not be exceeded.

Table 1 — Duration of strength test

Body size mm	Duration of test min
≤30	0.5
>30 to <50	1
>50 to <80	2
>80 to <150	3
>150 to <250	5
>250 to <450	7
>450	8

7.3 Tests after assembly

7.3.1 General

The tests specified in **7.3.2**, **7.3.3** and **7.3.4** shall be carried out on fully assembled slamshut valves prior to packaging. Paints and synthetic protective coatings may be applied prior to these tests.

7.3.2 External leakage test

7.3.2.1 A pneumatic pressure test shall be carried out on the assembled slamshut valve to check for external leaks.

7.3.2.2 The slamshut valve shall be tested in the open position, first at a pneumatic pressure of 20 mbar for a period of 30 s and then at the maximum rated pressure for a period of 30 s, during which periods allowable leakage shall not be exceeded.

7.3.2.3 The maximum rated pressure test on integral slamshut valves shall be carried out with the governor in the closed position.

7.3.2.4 The diaphragm sense chamber shall also be tested for external leakage at a pressure nominated by the manufacturer, which shall be at least 1.1 times the maximum trip pressure.

7.3.3 Internal leakage test

7.3.3.1 A pneumatic pressure test shall be carried out to check for internal leakage past the closure device and/or seat and into the diaphragm sense chamber.

7.3.3.2 The slamshut valve shall be tested in the fully closed position, first at a pneumatic pressure of 20 mbar for a period of 30 s and then at the maximum rated pressure for a period of 30 s.

7.3.3.3 The pressure shall be applied to the inlet side of the slamshut valve.

7.3.3.4 The leakage past the closure device and/or seat shall not exceed $1 \text{ m}^3 \text{ (st) h}^{-1}$ or $0.0024C_v \text{ m}^3 \text{ (st) h}^{-1}$, whichever is the lesser.

7.3.3.5 Allowable leakage into the diaphragm sense chamber shall not be exceeded.

7.3.3.6 The test on integral slamshut valves shall be carried out with the governor in the “open” position.

7.3.4 Functional test

7.3.4.1 The assembled slamshut valve shall be tested for repeatability either with the specified spring installed, or using a nominal mid-range spring.

7.3.4.2 Whichever spring is used, it shall be set at the mid-point and the following procedure undertaken:

- a) The initial trip point shall be within ± 2 % of the nominal trip pressure.
- b) Without further adjustment to the slamshut valve, the actual trip pressures for the next nine consecutive slamshut valve closures shall be checked with a rate of pressure rise corresponding to approximately 100 % of set pressure per minute (commencing at 80% of set point), with zero body pressure, and shall be within -5 % of the nominal trip pressure.

8 Repair of castings

8.1 Castings shall not be repaired unless the repairs are permitted in the relevant standard for the material, as given in Clause 5. Such repairs shall be carried out to a standard procedure.

8.2 Repairs shall only be carried out on defects that do not reduce the casting thickness to a level that fails to conform to this GIS.

8.3 Grey iron castings shall not be repaired by welding.

8.4 Cosmetic repairs by welding shall be allowed on ductile iron castings if weld procedures have been agreed with the gas transporter.

8.5 Micro-porosity may be repaired by impregnation if the leak path does not reduce the mechanical/structural strength of the casting. Leaks on flange surfaces may not be repaired by impregnation. Resin-based fillers shall be used for all impregnation repairs.

8.6 All repaired castings, except those specified in 8.7, shall be subjected to the pneumatic pressure tests given in Clause 7 after completion of the repairs.

8.7 Metal fillers, used to enhance the appearance of castings, shall only be used after completion of all pressure testing.

9 Painting

9.1 The external surfaces of the slamshut valve shall be painted in accordance with the requirements of T/SP/PA10 unless the gas transporter specifies the application of a holding primer for storage protection compatible with T/SP/PA10.

9.2 Corrosion protection systems for buried slamshut valve bodies shall conform to T/SP/CW6-1 and T/SP/CW6-2.

10 Marking

10.1 Slamshut valves shall have the direction of gas flow (see 5.6) cast or similarly permanently marked directly on the slamshut valve body.

10.2 Slamshut valves manufactured to the requirements of this GIS shall be permanently marked with the following information in a manner that does not detract from their mechanical strength or service requirements:

- a) the contractor's name or trademark;
- b) the batch number and serial number of the individual slamshut valve;

NOTE A code may be used for this item.

- c) the slamshut valve type;
- d) the number and date of this standard, i.e. GIS/V9-1:2006¹⁾;
- e) Maximum inlet pressure;
- f) The name or trademark of the manufacturer or their appointed agent;
- g) The manufacturer's contact details;
- h) Where authorized, the product conformity mark of a third party certification body e.g. BSI Kitemark;

NOTE Attention is drawn to the advantages of using third party certification of conformance to a standard.

- i) the size of the slamshut valve;
- j) maximum sense pressure;
- k) trip range of spring;
- l) date of manufacture.

NOTE A code may be used for this item.

10.3 The marking shall remain legible under the handling, storage and installation procedures. The method of marking shall not prevent the slamshut valve from meeting the requirements of this GIS.

10.4 For integral slamshut valves, markings that appear elsewhere in the governing system need not be repeated on the slamshut valve.

11 Packing and shipping

11.1 All slamshut valves shall be stored with the closure device in the closed position.

11.2 All slamshut valve openings shall be protected with a non-metallic material and using recognized means, such as plastic plugs or caps, immediately after the production tests in Clauses **6** and **7** have been completed and the slamshut valves are free of water and cleaned. Such protection shall prevent ingress of dirt or moisture. End protection on flanged slamshut valves shall allow them to stand upright.

11.3 Shipping containers shall protect each slamshut valve against damage.

¹⁾ Marking GIS/V9-1:2006 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Annex A (normative)
Calculation of repeatability

A.1 This Annex gives the percentage deviations from the mean set pressure within which the slamshut valve shall operate 95 times out of 100.

A.2 From the test points at each pressure condition, the arithmetic mean (\bar{p}) and the standard deviation (s) shall be calculated using the following equations:

$$\bar{p} = \frac{1}{n} \sum_{i=1}^n P_i$$

$$s = \sqrt{\frac{\sum_{i=1}^n (P_i - \bar{p})^2}{n-1}}$$

where:

n is the number of tests

P_i is the each individual test result.

A.3 The repeatability shall be obtained by multiplying the standard deviation (s) by a factor (t) depending on the number of tests, i.e.:

$$\text{Repeatability} = \frac{\pm ts}{\bar{p}} .100\%$$

For 95 % confidence limits:

n	=	2	3	4	5	6	7	8	9	10
t	=	12.71	4.30	3.18	2.776	2.571	2.447	2.365	2.306	2.262

Annex B (normative)

Test schedules for type approval

B.1 General

B.1.1 The test schedules for stand-alone slamshut valves are specified in **B.2**, and for integral slamshut valves in **B.3**. The schedules may be carried out in any order but the sequence of tests and any other requirements shall be as given within each schedule.

B.1.2 Where slamshut valves are manufactured to the same nominal design for a range of sizes, it will generally only be necessary to test one or two sizes from the range (see **B.2** and **B.3**).

B.1.3 Where slamshut valves are available as pressure variants of the same nominal design, it will sometimes only be necessary to test the LP type (see Tables **B.1** to **B.6** inclusive).

B.1.4 Type tests shall only be carried out on slamshut valves which have been previously subjected to the strength test specified in **7.2.3**.

B.1.5 Failure of any slamshut valve shall constitute a failure of the type tests.

B.1.6 Details of the tests are specified in Annex C.

B.2 Stand-alone slamshut valves

As a minimum requirement, the largest and smallest sizes in the contractor's range of stand-alone slamshut valves shall be tested according to the schedules given in Tables **B.1**, **B.2** and **B.3**. Satisfactory completion of the tests shall also qualify intermediate sizes.

NOTE 1 The gas transporter reserves the right to require intermediate sizes to be tested where performance is not considered to be representative.

NOTE 2 Full test schedules are generally only applicable to the LP types.

Table B.1 — Schedule 1 for stand-alone slamshut valves

Test		Requirement
No.	Title	
B.3	Leakage	All slamshut valves tested shall undergo this test
B.4	Repeatability	All types shall be tested using the maximum and minimum spring ranges. Springs shall meet their stated pressure range and not become coil-bound at the maximum position of the spring adjuster
B.5	Dynamic response	All types shall be tested
B.6	Vibration	LP type only to be tested. Test pressure shall be 75 mbar (or the minimum set point, whichever is greater) using the appropriate spring
B.7	Pressure loss	LP type only to be tested but for all body sizes
B.8	Rapid flow change	Test not required
B.9	Closure	LP type only to be tested but for all body sizes
B.10	Body flow effects	Test not required
B.11	External impact	LP type only to be tested. Trip pressure shall be 75 mbar (or the minimum set point, whichever is greater) and the pressure in the sense chamber shall be 75 % of the trip point
B.12	Temperature effects	All types shall be tested so that different diaphragms can be tested) NOTE The repeatability requirement for this test is 5 %.
B.13	Environmental effects	LP type only to be tested
B.3	Leakage	All slamshut valves tested shall undergo this test
B.14	Inspection	All slamshut valves tested shall undergo this test

Table B.2 — Schedule 2 for stand-alone slamshut valves

Test		Requirement
No.	Title	
C.15	Sense pressure versus trip mechanism characteristics	All types shall be tested but for one body size only. Each spring range shall be tested but at maximum pressure only NOTE An initial diaphragm movement of not greater than 0.1 mm is allowable for "settling in".
C.16	Dust test	LP type only to be tested
C.14	Inspection	All slamshut valves tested shall undergo this test

Table B.3 — Schedule 3 for stand-alone slamshut valves

Test		Requirement
No.	Title	
C.3	Leakage	All slamshut valves tested shall undergo this test
C.4	Repeatability ^{a)}	All types shall be tested
then	250 repeated closure cycles	All types shall be tested
C.3	Leakage	All types shall be tested
C.4	Repeatability ^{a)}	All types shall be tested
then	750 repeated closure cycles	All types shall be tested
C.3	Leakage	All types shall be tested
C.4	Repeatability ^{a)}	All types shall be tested
C.14	Inspection	All slamshut valves tested shall undergo this test
^{a)} This test is only performed with the minimum range spring installed. NOTE Where the closure spring (torsion or otherwise) varies with size, each design of closure spring shall be tested.		

B.3 Integral slamshut valves (not greater than 50 mm nominal bore)

B.3.1 Where integral slamshut valves are manufactured to the same design for different sizes, consideration may be given to a reduced series of tests, provided that the test programme is agreed in advance with the gas transporter, and clearly indicates the size and type of slamshut valve or governor cartridge.

NOTE The largest size slamshut valve will normally be the size tested, unless otherwise agreed with the gas transporter.

B.3.2 In drawing up the test programme, particular attention shall be given to:

- a) nominal size and flow capacity of the regulator;
- b) slamshut valve pressure range;
- c) spring ranges: consideration may only be given to tests using maximum/minimum spring ranges, provided that the dimensions of the slamshut valve spring housing allows the spring to operate across its full range without becoming coil-bound.

NOTE Test C.15 (see **C.15**) requires each spring range to be tested.

B.3.3 As a minimum requirement, the slamshut valve shall be tested according to the schedules given in Tables B.4, B.5 and B.6. Satisfactory completion of the tests shall also qualify all other sizes.

NOTE The gas transporter reserves the right to require additional tests, or additional sizes to be tested, where performance is not considered to be representative.

B.3.4 Where a slamshut valve is available in either external or internal impulse, the version that fulfils the worst case shall be tested. The result shall count for both versions.

B.3.5 Integral slamshut valves with a nominal size of greater than 50 mm shall be subject to the tests specified in Tables B.4, B.5 and B.6 except that in the tests given in **C.6**, **C.9** and **C.12** the test procedures and performance requirements for stand-alone slamshut valves shall apply.

Table B.4 — Schedule 1 for integral slamshut valves

Test		Requirement
Clause	Title	
C.3	Leakage	All slamshut valves and governor bodies that are to be tested shall undergo this test
C.4	Repeatability	Largest size of governor body/slamshut valve from each type shall be tested, using the maximum and minimum spring ranges. Springs shall meet their stated pressure range and not become coil-bound at the maximum position of the spring adjuster. Either external or internal impulsed version of slamshut valve shall be tested
C.5	Dynamic response	Largest size of governor body/slamshut valve from each type shall be tested, using the maximum and minimum spring ranges. Either external or internal impulsed version of slamshut valve shall be tested – unless impulse ports are different diameters, in which case the slamshut valve with the smallest port shall be tested
C.6	Vibration	Largest size of governor body/slamshut valve – LP type only – shall be tested. Test pressure shall be 75 mbar (or the minimum set point, whichever is the greater). Either external or internal impulsed version of slamshut valve shall be tested. A pressure of 60% of set pressure shall be maintained in the sense chamber. This test shall be carried out once only
C.7	Pressure loss	Test not required
C.8	Rapid flow change	Largest size of governor body/slamshut valve – LP type only – shall be tested. External impulsed governor cartridge shall be tested if available, otherwise internal impulsed version shall be tested. The minimum spring range only shall be tested, with the maximum orifice fitted. The internal impulsed version of the slamshut valve shall be tested
C.9	Closure	Largest size of governor body and largest orifice sizes to suit 2 bar and 7 bar inlet pressures – LP type only – shall be tested. External impulsed governor cartridge shall be tested if available, otherwise internal impulsed version shall be tested. The largest size of slamshut valve – either externally or internally impulsed – shall be tested, together with the minimum spring range
C.10	Body flow effects	Largest size of governor body and largest orifice sizes to suit 2 bar and 7 bar inlet pressures – LP type only – shall be tested. External impulsed governor cartridge shall be tested if available, otherwise internal impulsed version shall be tested. Internally impulsed governor cartridge shall be tested if available, otherwise internal impulsed version shall be tested. Internally impulsed slamshut valve shall be tested, together with the minimum spring range. NOTE Two configurations of outlet pipework shall be tested, i.e.: a) standard outlet pipework with maximum governor cartridge and maximum orifice size; b) largest outlet pipework recommended by the manufacturer with maximum governor cartridge and maximum orifice size

Table B.4 — Schedule 1 for integral slamshut valves *(continued)*

Test		Requirement
Clause	Title	
C.11	External impact	Minimum size of governor body/slamshut valve – LP type only – shall be tested at an inlet pressure of 2 bar. External impulsed governor cartridge shall be tested if available, otherwise internal impulsed version shall be tested, with maximum orifice to suit 2 bar inlet pressure. Test pressure shall be 75 mbar (or the minimum set point, whichever is the greater), and the pressure in the sense chamber shall be 75% of the trip point. Either external or internal impulsed version of slamshut valve shall be tested
C.12	Temperature effects	Largest size of governor body/slamshut valve for each type shall be tested at maximum inlet pressure only. Either external or internal impulsed version of slamshut valve shall be tested, together with the minimum spring range NOTE The repeatability requirement for this test is 7.5%.
C.13	Environmental effects	Largest size of governor body/slamshut valve – LP type only – shall be tested. Either external or internal impulsed version of slamshut valve shall be tested, together with the minimum spring range
C.3	Leakage	All slamshut valves tested shall undergo this test
C.14	Inspection	All slamshut valves tested shall undergo this test

Table B.5 — Schedule 2 for integral slamshut valves

Test		Requirement
No.	Title	
C.15	Sense pressure versus trip mechanism characteristics	Largest size of governor body/slamshut valve for each type shall be tested. Either external or internal impulsed version of slamshut valve shall be tested. Each spring range shall be tested, but at maximum inlet pressure only NOTE An initial diaphragm movement of not greater than 0.25 mm is allowable for “settling in”.
C.16	Dust	Largest size of governor body/slamshut valve – LP type only – shall be tested. Internal impulsed version of slamshut valve shall be tested, together with the minimum spring range
C.14	Inspection	All slamshut valves tested shall undergo this test

Table B.6 — Schedule 3 for integral slamshut valves

Test		Requirement
Clause	Title	
C.3	Leakage	All slamshut valves tested shall undergo this test
C.4	Repeatability ^{a)}	All types shall be tested
then	250 repeated closure cycles	All types shall be tested
C.3	Leakage	All types shall be tested
C.4	Repeatability ^{a)}	All types shall be tested
then	750 repeated closure cycles	All types shall be tested ^{b)}
C.3	Leakage	All types shall be tested ^{b)}
C.4	Repeatability ^{a)}	All types shall be tested ^{b)}
C.14	Inspection	All slamshut valves tested shall undergo this test
^{a)} This test is only performed with the minimum range spring installed.		
^{b)} The internal impulse slamshut valve shall not be tested if it is only available on governors with a nominal bore not greater than 50 mm and a design flow rate $\leq 200 \text{ m}^3$ (st) per h.		

Annex C (normative) Tests

C.1 General

C.1.1 This Annex details the tests in the schedules specified in Annex B.

C.1.2 All pressures are gauge pressures unless otherwise specified.

C.2 Test requirements

C.2.1 Instrumentation accuracy requirements

The instrumentation used in the tests specified in **C.3** to **C.16** inclusive shall have the following accuracy:

Inlet pressure (P_1)	: ±0.5% nominal value
Differential pressure ($P_1 - P_2$)	: ±0.2 mbar nominal value
Flowrate (Q)	: ±2.5 % nominal value
Valve travel (X)	: ±1 % nominal value
Temperature (T)	: ±2 °C
Relative humidity	: ±5 % nominal value
Dynamic pressure	: ±0.5 % nominal value with frequency response flat to 50 Hz
Resolution of ultra violet (UV) recorder:	±1 % nominal value

C.2.2 Test apparatus

Unless otherwise specified for the tests given in **C.4** to **C.13** inclusive, **C.15** and **C.16** (see Annex B), the slamshut valve shall be installed in the apparatus as specified in:

- a) Figure C.1: for stand-alone slamshut valves and integral slamshut valves that are externally impulsed.
- b) Figure C.4: for integral slamshut valves that are internally impulsed.

C.2.3 Orientation of slamshut valves in apparatus

C.2.4 Unless otherwise specified, tests shall be carried out with the axis of flow through the slamshut valve body horizontal and the axis of the setting spring vertical.

C.2.5 Where the procedure calls for the slamshut valve to be installed in an alternative plane, the slamshut valve shall be positioned so that the axis of flow is vertical, with the inlet to the body beneath the outlet and the axis of the setting spring horizontal.

C.2.6 Integral slamshut valves

Unless otherwise specified:

- a) The maximum sized common governor/slamshut valve body to which the slamshut valve may be attached shall be used in the test.
- b) The maximum sized orifice shall be fitted into the common governor/slamshut valve body. Where the procedure calls for a blank orifice to be fitted, the design of the blank orifice shall be such that the orifice outlet is sealed whilst the orifice inlet retains its normal seating arrangement, e.g. knife-edge.

- c) A blank cover shall be fitted to seal the opening in the common governor/slamshut valve body to which the governor cartridge is normally affixed. Where the procedure specifies that the governor cartridge shall be fitted, it shall be the largest available for the body size and include an internal (integral) relief where this option is available.

NOTE The appropriate size of orifice and governor body for each test is given in Tables B.4, B.5 and B.6.

C.3 Leakage test

C.3.1 Apparatus

C.3.1.1 Slamshut valve, set up as described in **C.2.2** to **C.2.4**.

C.3.1.2 Flow measuring device, accurate as described in **C.2.1**.

C.3.2 Procedure

C.3.2.1 Subject the slamshut valve to an inlet pneumatic pressure of 200 mbar and test it for leakage past the closure device in the closed position using a standard flow measuring device.

C.3.2.2 Subject the slamshut valve to an inlet pressure equal to its maximum rated working pressure or 7 bar, whichever is the lesser, and test it as specified in **C.3.2.1**.

C.3.2.3 For integral slamshut valves that are internally impulsed, replace the orifice with a blank orifice.

C.3.2.4 Subject the slamshut valve to an inlet pressure of 200 mbar and test it for:

- a) Leakage past the body gasket, reset shaft, bypass valve or other body sealing device using the soap bubble technique.
- b) Pressure build-up in the sense chamber using a standard pressure gauge for a minimum period of 3 min.

C.3.2.5 Subject the slamshut valve to an inlet pressure equal to its maximum rated working pressure or 7 bar, whichever is the lesser, and test it as specified in **C.3.2.4 a)** and **b)**.

C.3.2.6 Subject the slamshut valve sense chamber to a pressure equal to the maximum trip pressure and tested for leakage to atmosphere using the soap bubble technique.

C.3.3 Requirements

C.3.3.1 There shall be no external leakage.

C.3.3.2 There shall be no internal leakage into the sense chamber.

C.3.3.3 Internal leakage past the closure device shall not exceed $1 \text{ m}^3 \text{ (st) h}^{-1}$ or $0.0024C_v \text{ m}^3 \text{ (st) h}^{-1}$, whichever is the lesser, where C_v is the measured flow coefficient of the valve.

C.4 Repeatability test

C.4.1 Apparatus

C.4.1.1 Slamshut valve, set up as described in **C.2.2** to **C.2.4**.

C.4.1.2 Pressure measuring device, accurate as described in **C.2.1**.

C.4.2 Procedure

C.4.2.1 Fit integral slamshut valves that are internally impulsed with a blank orifice.

C.4.2.2 With the minimum range spring installed, set the spring to within ± 2 % of the mid-point setting of that spring.

C.4.2.3 Without further adjustment, record the actual trip pressure for 10 consecutive slamshut valve closures with a rate of pressure rise corresponding to approximately 10 % of trip pressure per minute commencing at 80 % of trip point. Ensure that the pressure in the valve body is atmospheric throughout these tests.

C.4.2.4 Repeat the test specified in **C.4.1.3** using each spring specified for the slamshut valve, having adjusted it as specified in **C.4.1.2**. Carry out one of these tests with the slamshut valve positioned in an alternative plane (see **C.3.3**).

C.4.3 Requirements

The calculated repeatability for the slamshut valve shall be within ± 5 % for each spring at each test pressure (see Annex A).

C.5 Dynamic response test

C.5.1 Apparatus

C.5.1.1 *Slamshut valve*, set up as described in **C.2.2** to **C.2.4**.

C.5.1.2 *Pressure measuring device*, accurate as described in **C.2.1**.

C.5.2 Procedure

C.5.2.1 Fit integral slamshut valves that are internally impulsed with a blank orifice.

C.5.2.2 With the minimum range spring installed, set the spring to within ± 2 % of the mid-point setting of that spring and determine the repeatability band width at a rise rate of 10 % of nominal trip pressure per min. Without further adjustment, record the response time and trip pressure for 10 consecutive slamshut valve closures with a rate of pressure rise corresponding to approximately 2 000 % of nominal trip pressure per min commencing at 10 % of trip pressure. Ensure that the pressure in the valve body is atmospheric throughout these tests.

C.5.2.3 Repeat the test specified in **C.5.2.2** with the maximum range spring installed.

C.5.2.4 Determine the response time for each trip in accordance with Figure C.2.

C.5.3 Requirements

C.5.3.1 The response time for each trip of the slamshut valve shall be not greater than 1 s for each spring.

C.5.3.2 The calculated repeatability of the trip pressure determined in accordance with Figure C.2 shall be within ± 5 % for each spring.

C.6 Vibration

C.6.1 Apparatus

C.6.1.1 *Slamshut valve*, set up as described in **C.2.2** to **C.2.4**.

C.6.1.2 *Pressure measuring device*, accurate as described in **C.2.1**.

C.6.2 Procedure

C.6.2.1 For integral slamshut valves, attach the regulator to slamshut valve.

C.6.2.2 Blank off the internal impulse for integral slamshut valves that are internally impulsed and connect the sense chamber directly to the impulse line from the pressure vessel (see Figure C.4.).

C.6.2.3 With the minimum range spring installed, set the spring to within $\pm 2\%$ of 75 mbar (or the minimum setpoint, whichever is the greater). Do not further adjust the spring adjuster during the test.

C.6.2.4 Test the slamshut valve by dropping it freely on to a firm, solid test surface from a height of X mm or 50 mm, whichever is the lesser, where:

$$X = 4\ 600/w; \text{ and}$$

w = weight of slamshut valve in kg.

C.6.2.5 Lift the slamshut valve and drop it five times whilst a pressure of 75 % of set pressure (stand-alone slamshut valves) or 60 % of set pressure (integral slamshut valves) is maintained in the sense chamber for the whole period commencing before the first drop and finishing after the fifth drop.

C.6.2.6 Increase the she sense chamber pressure at a rate of pressure rise corresponding to approximately 10 % of trip pressure per minute and actual trip pressure recorded.

C.6.2.7 Repeat the test specified in **C.6.2.3** a further four times (only for stand-alone slamshut valves).

C.6.2.8 Repeat the tests specified in **C.6.2.3** and **C.6.2.4** using each spring specified for the slamshut valve, each having been adjusted as specified in **C.6.2.2**. Carry out one of these tests with the slamshut valve positioned in an alternative plane (see **C.2.3**).

C.6.3 Requirements

C.6.3.1 The slamshut valve shall not operate at any time whilst the pressure is maintained in the sense chamber, for each spring.

C.6.3.2 Each trip pressure shall be within $\pm 5\%$ of the nominal set pressure.

C.7 Pressure loss test

C.7.1 Apparatus

C.7.1.1 *Slamshut valve*, set up as described in **C.2.2** to **C.2.4**.

C.7.1.2 *Pressure measuring device*, accurate as described in **C.2.1**.

C.7.2 Procedure

C.7.2.1 Install the slamshut valve in the apparatus shown in Figure C.3.

C.7.2.2 With an inlet pressure of 25 mbar, P_1 absolute, $(P_1 - P_2)$, record T and Q for values of $(P_1 - P_2)/P_1$ absolute in steps of 0.002 over a range of 0.002 to 0.02.

C.7.2.3 Calculate the flow coefficient, C_v , of the valve.

C.7.3 Requirements

The calculated C_v shall be within $\pm 5\%$ of the contractor's claimed value.

C.8 Rapid flow change test

C.8.1 Apparatus

C.8.1.1 *Slamshut valve*, set up as described in **C.2.2** to **C.2.4**.

C.8.1.2 *Inlet pressure measuring device*, accurate as described in **C.2.1**.

C.8.2 Procedure

C.8.2.1 Install the internally impulsed governor cartridge.

C.8.2.2 With the slamshut valve minimum range spring installed, set the spring adjuster to within $\pm 2\%$ of the mid-point setting of that spring. Do not further adjust the spring adjuster during the test.

C.8.2.3 At an inlet pressure of 350 mbar and a flowrate of 5 % of governor design capacity, set the governor outlet pressure to 40 % below the slamshut valve setting.

C.8.2.4 Increase the flowrate until the governor is fully open then reduce to zero in a period of 1 s by closing the relevant outlet valve V_2 (see Figure C.1 or C.4, as applicable).

C.8.2.5 Where an external control line for the governor is available, repeat all the tests specified in **C.8.2.1** to **C.8.2.4** inclusive with the governor in the external mode and impulse them in the largest outlet pipe diameter recommended by the manufacturer.

C.8.2.6 Repeat the tests specified in **C.8.2.1** to **C.8.2.5** inclusive for each body size to which the slamshut valve can be fitted.

C.8.3 Requirements

The slamshut valve shall not trip throughout the test unless the recorded pressure, P_2 (see Figure C.4), exceeds 95 % of slamshut valve set point.

C.9 Closure test

C.9.1 Apparatus

C.9.1.1 *Slamshut valve*, set up as described in **C.2.2** to **C.2.4**.

C.9.1.2 *Inlet pressure measuring device*, accurate as described in **C.2.1**.

C.9.2 Procedure

C.9.2.1 Install the governor cartridge in integral slamshut valves.

C.9.2.2 Blank off the internal impulse to integral slamshut valves that are internally impulsed and connect the sense chamber directly to the impulse line from the pressure vessel (see Figure C.4).

C.9.2.3 With the slamshut valve minimum range spring installed, set the spring adjuster to within ± 2 % of the mid-point setting of that spring. Do not further adjust the spring adjuster during the test.

C.9.2.4 At an inlet pressure of 2 bar and a flow rate of $7000 \text{ m}^3 (\text{st})\text{h}^{-1}$ or a velocity of 80 m s^{-1} at the orifice, whichever is the lesser for stand-alone slamshut valves, or the maximum fault capacity of the governor for integral slamshut valves, record the actual trip pressure and inlet pressure for five consecutive slamshut valve closures with a rate of pressure rise corresponding to approximately 100 % of trip pressure per minute starting at 80 % of trip point.

C.9.2.5 Determine the leakage rate past the closure device.

C.9.2.6 Determine the time taken for the pressure to equalize by the operation of the pressure equalizing valve (where fitted) with V_3 and V_4 closed and a pressure of 2 bar between V_3 and the slamshut valve and atmospheric pressure between the slamshut valve and V_4 at the start of the test.

C.9.2.7 Repeat the tests specified in **C.9.2.3.** and **C.9.2.4.** at an inlet pressure equal to the maximum rated working pressure or 7 bar, whichever is the lesser.

C.9.3 Requirements

C.9.3.1 Each trip pressure shall be within ± 5 % of the nominal set pressure for each test pressure.

C.9.3.2 The internal leakage past the closure device shall not exceed $1 \text{ m}^3 (\text{st}) \text{ h}^{-1}$ or $0.0024 C_v \text{ m}^3 (\text{st}) \text{ h}^{-1}$, whichever is the lesser.

C.9.3.3 Where a pressure equalizing valve is fitted, the inlet and outlet pressures shall be within ± 5 % of being equal within the minimum practical time.

C.10 Body flow effects test

C.10.1 Apparatus

C.10.1.1 *Slamshut valve*, set up as described in **C.2.2** to **C.2.4**.

C.10.1.2 *Inlet pressure measuring device*, accurate as described in **C.2.1**.

C.10.2 Procedure

C.10.2.1 Install the internally impulsed governor cartridge. Install the largest orifice size.

C.10.2.2 With the slamshut valve minimum range spring installed, set the spring adjuster to within ± 2 % of the mid-point setting of that spring. Do not adjust the spring adjuster again during the test.

C.10.2.3 At an inlet pressure of 2 bar and a flowrate of 5 % of governor design capacity, set the governor outlet pressure to 40 % below the slamshut valve setting.

C.10.2.4 Increase the flowrate by increments until the governor is fully open. Record P_1 , P_2 and P_s at each point. Use these measurements to plot graphs of pressure versus flowrate.

NOTE The number of increments by which the flowrate is increased provide the points to be plotted on the graphs; for this reason there should ideally be 10 increments.

C.10.2.5 Repeat the tests specified in **C.10.2.2**, **C.10.2.3** and **C.10.2.4** with an inlet pressure equal to the maximum rated working pressure or 7 bar, whichever is the lesser.

C.10.2.6 Repeat the tests specified in **C.10.2.2** to **C.10.2.5** inclusive with the minimum size orifice fitted.

C.10.2.7 Where an external control line for the governor is available, repeat the tests specified in **C.10.2.1** to **C.10.2.6** inclusive with the governor in the external mode and impulse it in the largest outlet pipe diameter recommended by the contractor.

C.10.2.8 Repeat the tests specified in **C.10.2.1** to **C.10.2.7** inclusive for each body size to which the slamshut valve may be fitted.

C.10.3 Requirements

C.10.3.1 With the governor under flow, P_s shall not exceed 75 % of the slamshut valve set pressure (as in **C.10.1.2**) nor be less than 90 % of P_2 or 10 mbar below P_2 (whichever is the lower pressure), at all flowrates for each orifice, body and governor control option.

C.10.3.2 The internal (integral) relief shall not operate during these tests.

C.11 External impact test

C.11.1 Apparatus

C.11.1.1 *Inlet pressure measuring device*, accurate as described in **C.2.1**.

C.11.1.2 *Slamshut valve*, set up as described in **C.2.2** to **C.2.4**.

C.11.1.3 *Steel bar*, 50 mm diameter, 150 mm long

C.11.2 Procedure

C.11.2.1 Install the governor cartridge in integral slamshut valves.

C.11.2.2 Blank off the internal pressure in integral slamshut valves that are internally impulsed and connect the sense chamber directly to the impulse line from the pressure vessel (see Figure C.4).

C.11.2.3 With the minimum range spring installed, set the spring to within ± 2 % of 75 mbar (or the minimum set point, whichever is the greater). Do not further adjust the spring adjuster during the test.

C.11.2.4 At an inlet pressure of 2 bar and a flow rate of approximately half of the maximum as defined in **C.9.2.3**, increase the pressure in the sense chamber to 75 % of trip point.

C.11.2.5 Apply an impact load to the inlet connection of the slamshut valve body by dropping a steel bar, end on, from a height of 80 mm, 10 times.

C.11.2.6 Increase the sense chamber pressure at a rate of pressure rise corresponding to approximately 100 % of trip pressure per minute and record the actual trip pressure.

C.11.2.7 Repeat the tests specified in **C.11.1.3**, **C.11.1.4** and **C.11.1.5** a further four times.

C.11.2.8 Repeat the tests specified in **C.11.2.3** to **C.11.2.6** with the maximum range spring installed, having adjusted it as specified in **C.11.2.2**.

C.11.2.9 For integral slamshut valves, repeat the tests specified in **C.11.2.2** to **C.11.2.7** inclusive with smallest body and smallest governor but with largest orifice size.

C.11.3 Requirement

C.11.3.1 With 75 % of trip pressure in the sense chamber, the slamshut valve shall not trip when impacted.

C.11.3.2 Each trip pressure shall be within ± 5 % of the nominal set pressure for each spring.

C.12 Temperature effects test

C.12.1 Apparatus

C.12.1.1 *Inlet pressure measuring device*, accurate as described in **C.2.1**.

C.12.1.2 *Slamshut valve*, set up as described in **C.2.2** to **C.2.4**.

C.12.1.3 *Environmental chamber*.

C.12.2 Procedure

C.12.2.1 Seal the inlet and outlet connections of the slamshut valve. Make provision to pressurize the slamshut valve body via the inlet seal and, on integral slamshut valves that are internally impulsed, also via the outlet seal in order to pressurize the sense chamber during the repeatability test.

C.12.2.2 Fit integral slamshut valves that are internally impulsed with a blank orifice.

C.12.2.3 Install the slamshut valve, but not necessarily the apparatus, in an environmental chamber. The test apparatus need not be situated inside the chamber.

C.12.2.4 With the slamshut valve minimum range spring installed, and at a temperature in the range 15 °C to 20 °C inclusive and with atmospheric pressure maintained in the body, set the spring adjuster to within ± 2 % of the mid-point setting of that spring.

C.12.2.5 Subject the slamshut valve to the repeatability test (see **C.4.2.3**). Relatch the slamshut valve and make no further adjustment.

C.12.2.6 Adjust the temperature to (-20 ± 2) °C with a pressure of 2 bar maintained in the body. After a minimum period of 24 h at that temperature, subject the slamshut valve to the repeatability test (see **C.4.2.3**) with a body pressure of 2 bar. Do not operate the slamshut valve during the conditioning period.

C.12.2.7 Isolate the pressurizing supply and record any pressure decay in the body over a period of 30 min.

C.12.2.8 Repeat the tests specified in **C.12.2.5** and **C.12.2.6** at a body pressure equal to the maximum rated working pressure or 7 bar, whichever is the lesser.

C.12.2.9 Repeat the tests specified in **C.12.2.5**, **C.12.2.6** and **C.12.2.7** at a temperature of (50 ± 2) °C.

C.12.3 Requirements

C.12.3.1 There shall be no binding or sticking of moving parts at any temperature.

C.12.3.2 The calculated repeatability for the slamshut valve shall be within $\pm 5\%$ at each temperature (stand-alone slamshut valves) or within $\pm 7.5\%$ at each temperature (integral slamshut valves).

C.12.3.3 There shall be no pressure decay.

C.12.3.4 The variation of mean trip pressure with temperature and body pressure from that determined in **C.12.1.4** shall be not greater than that given in Table C.1.

Table C.1 — Variation of mean trip pressure

Trip pressure range bar	Maximum allowable variation of mean trip pressure %
≤ 2	± 10
> 2 to < 3.5	± 7.5
> 3.5 to < 7	± 5

C.13 Environmental effects test

C.13.1 Apparatus

C.13.1.1 *Slamshut valve*, set up as described in **C.2.2** to **C.2.4**.

C.13.2 Procedure

C.13.2.1 Seal the inlet and outlet connections of the slamshut valve. Make provision to pressurize the sense chamber of integral slamshut valves that are internally impulsed via the outlet seal.

C.13.2.2 Fit integral slamshut valves that are internally impulsed with a blank orifice.

C.13.2.3 Install the slamshut valve in an environmental chamber. The test apparatus need not be situated inside the chamber.

C.13.2.4 With the slamshut valve minimum range spring installed, and at a temperature in the range $15\text{ }^{\circ}\text{C}$ to $20\text{ }^{\circ}\text{C}$ inclusive, set the spring adjuster to within $\pm 2\%$ of the mid-point setting of that spring. Do not further adjust the spring adjuster during the test.

C.13.2.5 Subject the slamshut valve in the latched open position to 100 cycles of temperature and relative humidity, where a cycle takes a minimum period of 5 h, from $(50 \pm 2)\text{ }^{\circ}\text{C}$ at a minimum of 90% relative humidity to $(-20 \pm 2)\text{ }^{\circ}\text{C}$ at a minimum of 90% relative humidity to $(50 \pm 2)\text{ }^{\circ}\text{C}$ at 90% relative humidity.

C.13.2.6 After completion of the 100 cycles, adjust the temperature to a point in the range $15\text{ }^{\circ}\text{C}$ to $20\text{ }^{\circ}\text{C}$ inclusive and, after a minimum period of 24 h at that temperature, subject the slamshut valve to the repeatability test (see **C.4.e.3**). Do not operate the slamshut valve during the cyclic or the minimum 24 h conditioning periods.

C.13.2.7 With the seals removed from the inlet and outlet of the slamshut valve, repeat the test specified in **C.13.e.5** for 20 cycles.

C.13.3 Requirements

The calculated repeatability for the slamshut valve shall be within $\pm 5\%$.

C.14 Inspection

C.14.1 Procedure

C.14.1.1 Dismantle the slamshut valve and examine all moving parts for damage, wear, binding, evidence of corrosion and other defects.

C.14.1.2 At each stage of dismantling, note any binding of moving parts and any difficulties encountered in dismantling the slamshut valve, together with the presence of any foreign bodies.

C.14.2 Requirements

Undue wear, binding, corrosion, damage or other defects which can affect the long term performance of the slamshut valve shall be a cause for the slamshut valve failing the test schedule.

C.15 Sense pressure versus trip mechanism characteristics test

C.15.1 Apparatus

C.15.1.1 *Inlet pressure measuring device*, accurate as described in **C.2.1**.

C.15.1.2 *Slamshut valve*, set up as described in **C.2.2** to **C.2.4**.

C.15.2 Procedure

C.15.2.1 Fit integral slamshut valves that are internally impulsed with a blank orifice.

C.15.2.2 With the slamshut valve minimum range spring installed, set the spring adjuster to within $\pm 2\%$ of the specified minimum setting of that spring.

C.15.2.3 Ensure that the body pressure is equal to atmospheric pressure and the pressure in the sense chamber is 60 % of the trip pressure and is increased at a rate of approximately 10 % of the trip pressure per minute. Record the sense pressure when the diaphragm begins to move. Increase the pressure in the sense chamber to 90 % of set point then reduce it to 60 % of set point. Repeat this a further four times.

C.15.2.4 Repeat the test specified in **C.15.2.3** with a body pressure equal to the maximum working pressure.

C.15.2.5 Repeat the tests specified in **C.15.2.3** and **C.15.2.4** for each spring specified for the slamshut valve, having adjusted it as specified in **C.15.1.2**.

C.15.3 Requirements

C.15.3.1 The diaphragm shall not begin to move before the percentage trip pressure given in Table C.2 is reached; initial movement of 0.1 mm (stand-alone slamshut valves) or 0.25 mm (integral slamshut valves) can be accepted due to settling in under pressure.

Table C.2 — Percentage trip pressure

Trip pressure range	Maximum allowable variation of mean trip pressure
bar	%
≤ 2	75
> 2 to < 3.5	80
> 3.5 to < 7	85

C.15.3.2 At not more than 5 % below the minimum percentage trip pressure before movement figures specified in **C.15.2.1** are reached, the mechanism shall return to the fully latched position.

C.16 Dust test

C.16.1 Apparatus

C.16.1.1 *Inlet pressure measuring device*, accurate as described in **C.2.1**.

C.16.1.2 *Slamshut valve*, set up as described in **C.2.2** to **C.2.4**.

C.16.2 Procedure

C.16.2.1 Fit integral slamshut valves with a blank orifice.

C.16.2.2 With the minimum range spring installed, set the spring adjuster to within ± 2 % of the mid-point setting of that spring.

C.16.2.3 Without further adjustment, record the actual trip pressure for 10 consecutive slamshut valve closures with a rate of pressure rise corresponding to approximately 10 % of trip pressure per minute, commencing at 80 % of trip point. Ensure that the pressure in the slamshut valve body is atmospheric during these tests.

C.16.2.4 Remove the slamshut valve from the apparatus.

C.16.2.5 Place a sample of Sepiolite 400 or equivalent weighing 250 g or of a volume equivalent to one tenth of the body volume, whichever is the lesser, in the inlet side of the slamshut valve body. Seal the inlet body connection (and outlet on stand-alone slamshut valves).

C.16.2.6 With the slamshut valve in the closed position, rotate it to ensure complete contamination of the inner parts.

C.16.2.7 Refit the slamshut valve in the apparatus and subject it to 50 repeated closure cycles.

C.16.2.8 Repeat the tests specified in **C.16.2.6** and **C.16.2.7** a further four times.

C.16.2.9 Repeat the test specified in **C.16.1.3**.

C.16.3 Requirements

The calculated repeatability for the slamshut valve shall be within ± 5 %.

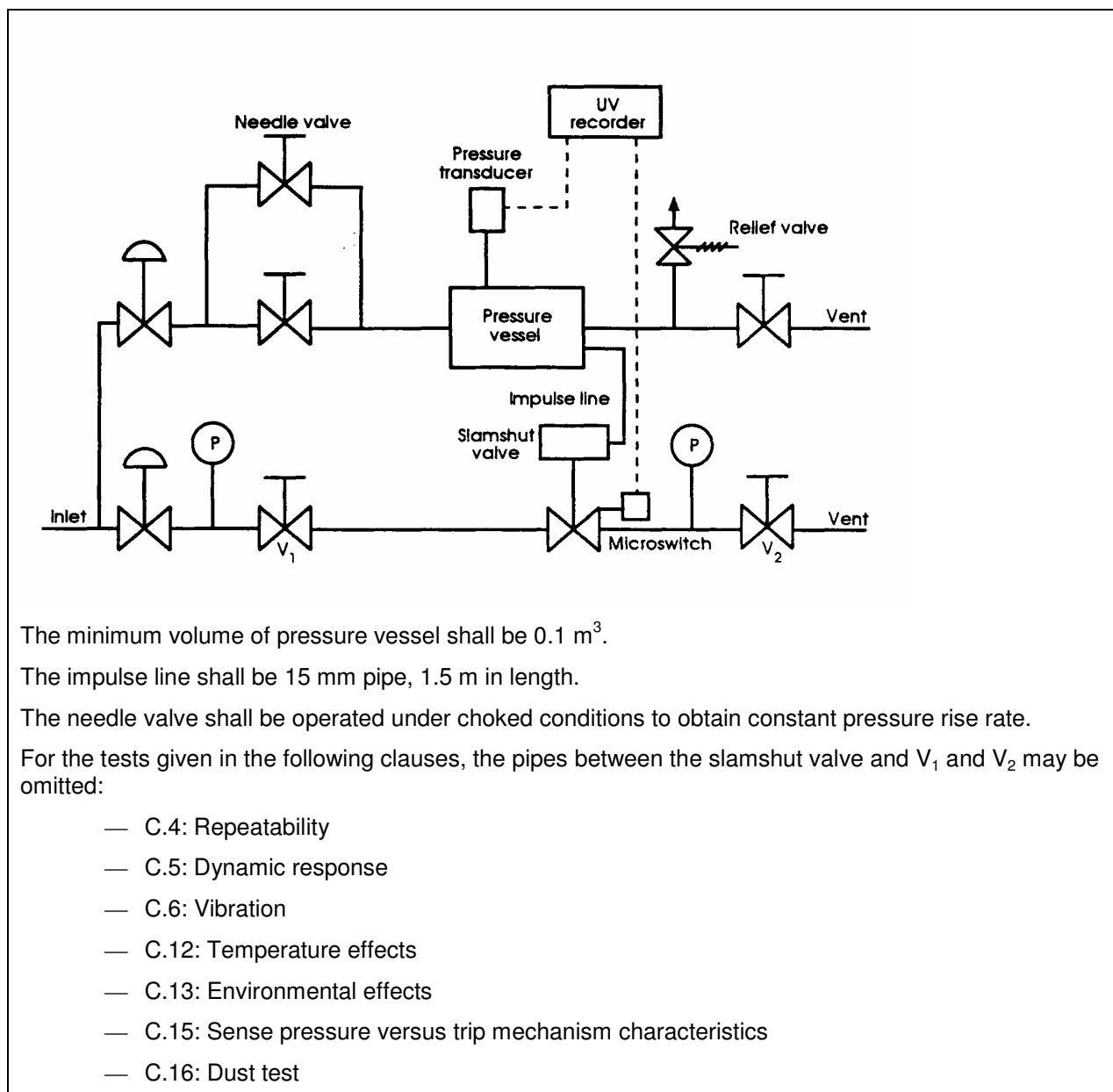


Figure C.1 —Test configuration: slamshut valve that is externally impulsed

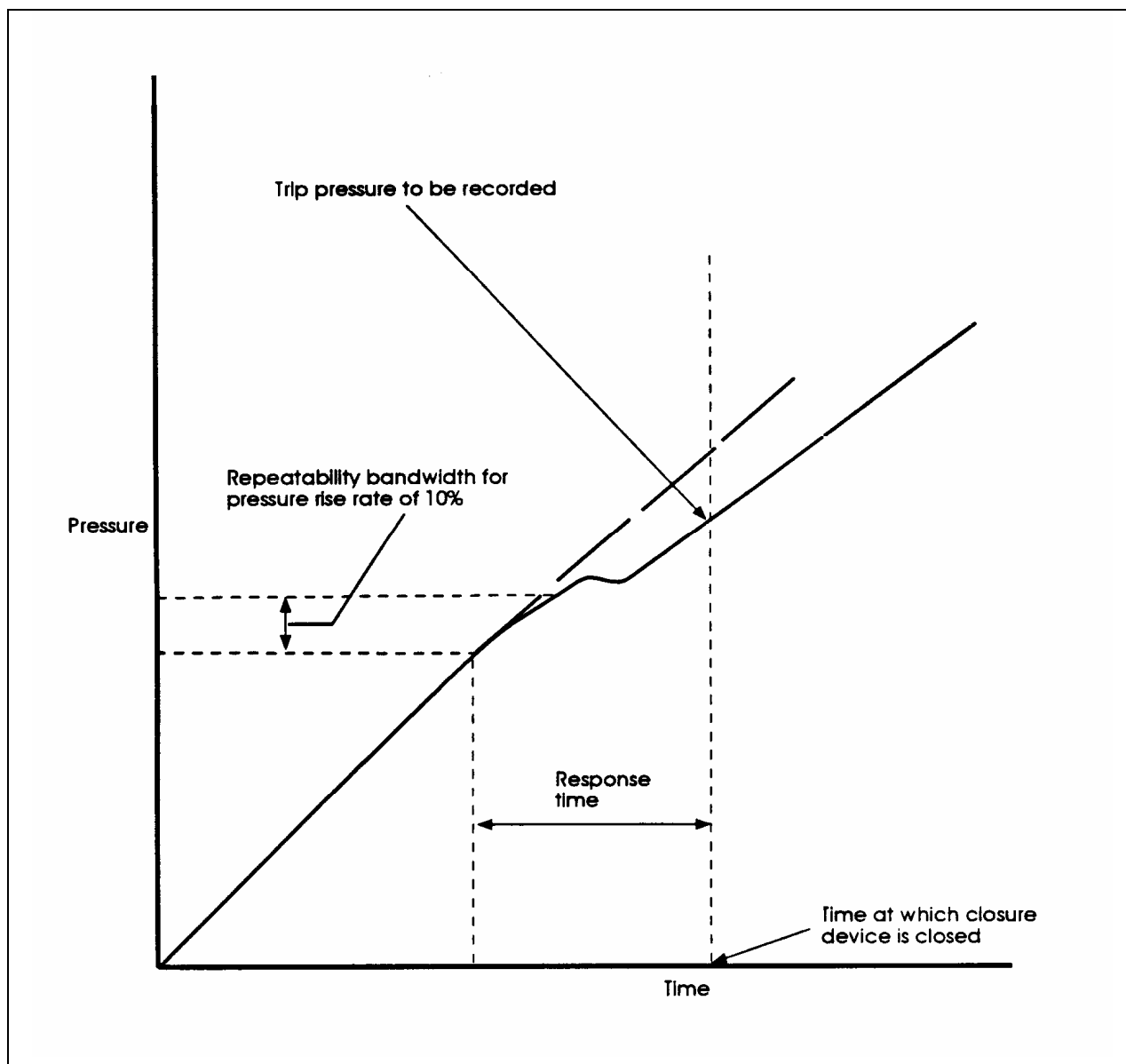


Figure C.2 — Determination of response time

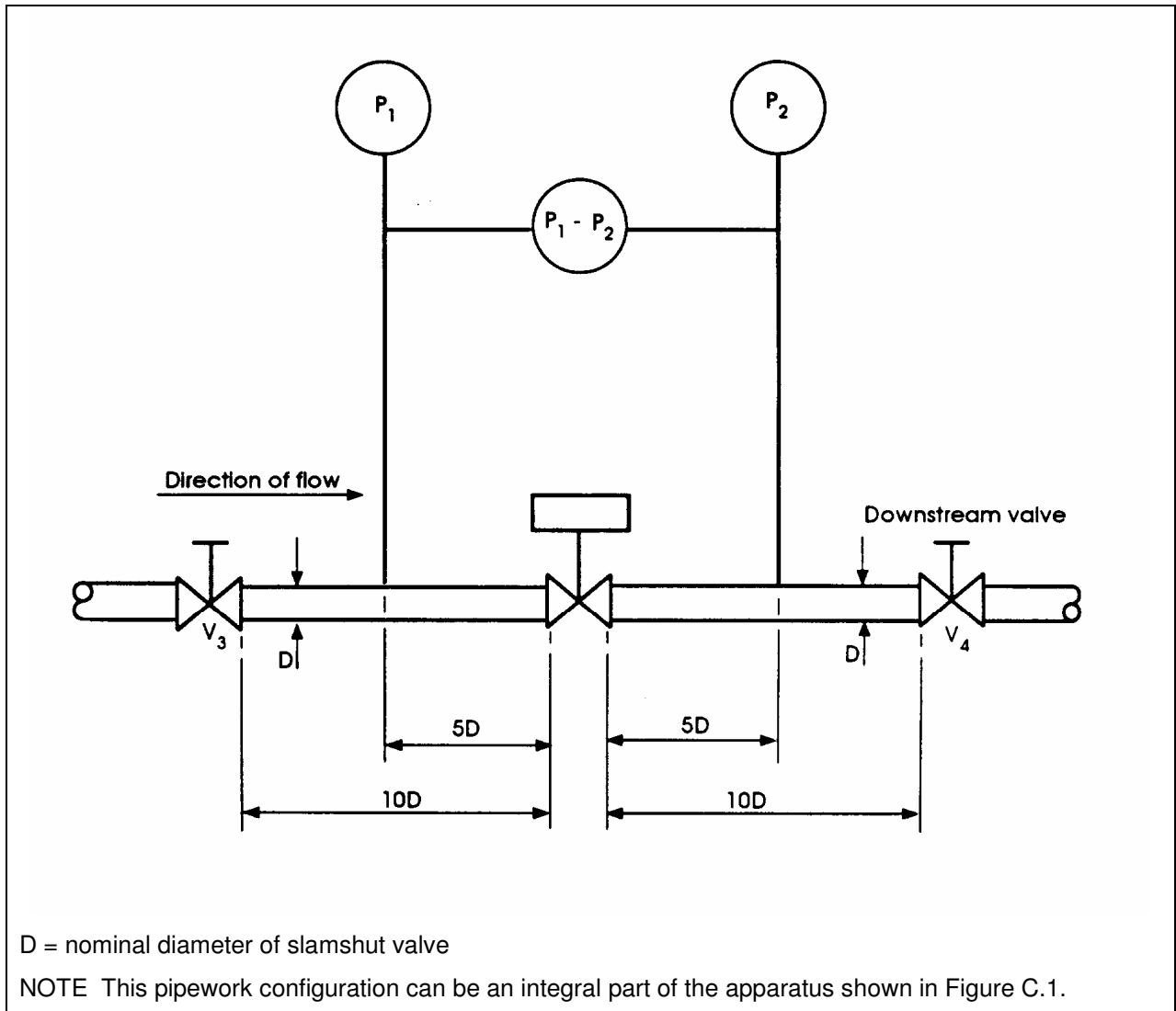
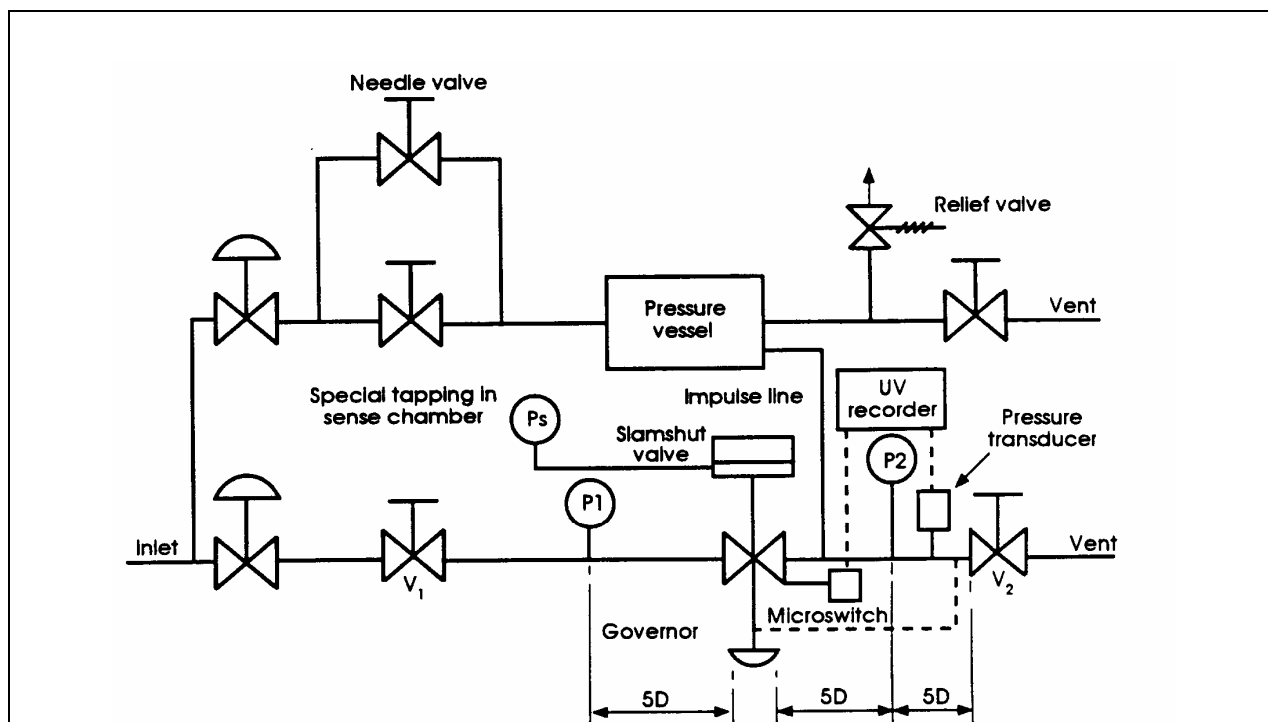


Figure C.3 — Flow test configuration - slamshut valve that is externally impulsed



D = nominal diameter of slamshut valve

The minimum volume of pressure vessel shall be 0.1 m^3 .

The impulse line shall be the same diameter as the slamshut valve/governor outlet pipe up to a maximum of 25 mm.

The needle valve shall be operated under choked conditions to obtain constant pressure rise rate.

The outlet pipe diameter shall be the largest recommended by the contractor.

For the tests given in the following clauses, the pipes between the slamshut valve and V_1 and between the pressure transducer and V_2 may be omitted provided the pipe is sealed after the pressure transducer:

- C.4: Repeatability
- C.5: Dynamic response
- C.6: Vibration
- C.12: Temperature effects
- C.13: Environmental effects
- C.15: Sense pressure versus trip mechanism characteristics
- C.16: Dust test

Figure C.4 — Integral slamshut valve that is internally impulsed