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भारतीय मानक **मसौदा**

इलेक्ट्रॉनिक विस्तार वाल्व — विशिष्टता

DRAFT *Indian Standard*

ELECTRONIC EXPANSION VALVE (EXV) — SPECIFICATION

ICS 23.060.99

Refrigeration and Air Conditioning Sectional Committee, MED 03	Last date for receipt of comments is **12 July 2024**

FOREWORD
(*Formal clause to be added later*)

This Indian Standard is applicable for electronic expansion valves used in refrigeration and air conditioning purposes which are either direct acting or small gear driven.

The committee responsible in preparation of this standard focused upon the technological advancement in design, construction methodologies, and testing of electronic expansion valves.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (s*econd revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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June 2024

DRAFT *Indian Standard*

ELECTRONIC EXPANSION VALVE (EXV) — SPECIFICATION

1 SCOPE

1.1 This standard specifies the performance, safety requirements, and test method for electrically driven type electronic expansion valves with nominal supply voltage not more than 36 V d.c., with orifice diameter up to 8 mm used in refrigeration and air conditioning cycle. This standard also specifies marking, packing, storage condition, and transportation requirements.

1.2 This standard does not specify the requirements for toxic refrigerants [refrigerants with higher toxicity (B1, B2L, B2, and B3) as per IS 16656 like ammonia].

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed in Annex A.

3 TERMS AND DEFINITIONS

For the purpose of this standard, the definitions given in IS 3615 and the following are applicable:

3.1 Capacity of Electronic Expansion Valves — It is the refrigerating effect produced by the evaporation of refrigerant flowing through the valve under the following specified conditions:

a) Liquid refrigerant temperature at the valve inlet, ^{o}C;
b) Saturated evaporating temperature, ^{o}C; and
c) Pressure drop across the valve, kPa.

3.2 Electronic Expansion Valve (EXV)— It is an electrically driven metering device used in refrigeration and air conditioning system for expansion of liquid refrigerant.

3.2.1 Direct Driven Electronic Expansion Valve — It is a control valve with an electric motor directly controlling the spindle to open or close orifice to meter refrigerant flow by moving clockwise or counter clockwise.

3.2.2 Gear Driven Type Electronic Expansion Valve — It is a control valve with an electric motor indirectly controlling the spindle through gear drive to open or close orifice to meter refrigerant flow by moving clockwise or counter clockwise.

3.3 External Leakage — It is the extent of tightness for in service requirements of a final assembly, a specific system, or a respective component that will not leak liquid or has a defined maximum gas leak requirement.

3.4 Flow Characteristics — It is the relationship between the flow of air through the expansion valve at the corresponding open position of the orifice. The characteristic is captured for the entire working range of the valve when it is opening and closing at 1 bar pressure across the valve orifice.

3.5 Internal Leakage — It is the leakage observed at valve port when it is fully closed.

3.6 Maximum Working Pressure — It is the maximum pressure for which system or component is designed, as declared by the manufacturer.

3.7 Maximum Working Temperature — It is the highest temperature that can occur during operation and standstill of refrigeration and air conditioning system or during testing at maximum temperature condition.

3.8 Nominal Capacity — Under the specified test conditions when the expansion valve is at its maximum opening to adjust refrigerant flow, nominal capacity is the product of the mass flow rate of refrigerant that flows through expansion valve and the enthalpy difference between saturated vapor with vaporizing temperature and sub-cooled or vapor-free liquid from expansion valve inlet.

3.9 Pressure Drop across the Valve — It is the net pressure difference between the valve inlet and outlet.

3.10 Vapour-free (Sub-cooled) Liquid Refrigerant — It is the refrigerant which has been cooled below the bubble point temperature for a given pressure.

4 CLASSIFIACTION

The electronic expansion valves are classified based on the following:

a) Valve port diameter;
b) Type of refrigerant;
c) Nominal input voltage; and
d) Bipolar or Unipolar coil.

5 CONSTRUCTION

5.1 General

Expansion valves shall meet the requirements specified in this standard.

5.2 Appearance

There shall not be bumps, deformations, and other defects on the surface of the valve, which affect the working of expansion valve.

5.3 Opening Pulse

The minimum opening pulse (when the valve starts to open for flow) shall be defined on drawings or documentation, as agreed to between the manufacturer and purchaser.

5.4 Flow Characteristics

The shapes and values of flow characteristics curves of expansion valves as defined on documentation, shall be as agreed to between the manufacturer and purchaser. Flow characteristics are usually performed for small orifice valves using air/nitrogen up to 8 mm in diameter.

5.5 Internal Leakage – Small Valves (up to 8 mm Orifice)

The leakage of the expansion valve orifice in both directions of flow or as indicated on the valve shall be within the values as specified in the Table 1 when tested as per **7.6** of ISO 21922.

Table 1 Internal Leakage
(*Clauses* 5.5 *and* 6.9)

Sl No.	**Valve Port Diameter** mm	**Leakage Rate** ml/min
(1)	(2)	(3)
i)	≤ 2.4	≤ 600
ii)	> 2.4 to ≤ 3.2	≤ 1 000
iii)	> 3.2 to ≤ 8	≤ 1 500
NOTE — The above rates are not applicable for valves made for shutoff function		

5.6 Maximum Working Pressure

It shall conform to the values specified for various refrigerants as defined in IS 16678 (Part 1) and IS 16678 (Part 2).

NOTE — Safety precautions shall be provided in instructions for mildly flammable and flammable refrigerants.

5.7 Maximum Operating Pressure Differential – For Small Valves up to 8 mm Orifice Diameter (MOPD)

When a valve operates at 90 percent of nominal voltage, specified excitation mode and excitation speed; the maximum operating pressure difference that can act reliably shall be as defined in the Table 2 for small valves up to 8 mm diameter.

NOTE - For special valves designed for specific application and bigger valve with orifice greater than 8 mm, MOPD is dependent on application and specification as agreed to between the manufacturer and purchaser. In this case, MOPD is defined by drawings or documentation.

Table 2 Maximum Operating Pressure Differential
(*Clause* 5.7)

Sl No.	**Application**		**Low Pressure**	**Medium pressure**	**High pressure**
(1)	(2)	(3)	(4)	(5)	(6)

i)	Valve port diameter ≤ 2.4 mm	Maximum Operating Pressure Differential (MPa)	2.3	2.5	3.5
ii)	Valve port diameter > 2.4 mm to ≤ 8 mm		2.3	2.3	3.2

NOTE –
Low Pressure : Condensing pressure is lower than 1.7 Mpa at 54.4 °C condensing temperature
Medium Pressure : Condensing pressure is between 1.7 to 2.5 Mpa at 54.4 °C condensing temperature
High Pressure : Condensing pressure is more than 2.5 Mpa at 54.4 °C condensing temperature

5.8 Maximum Opening Pressure Difference – Reverse direction (MOPD-RD)

The maximum opening valve pressure difference in reverse direction of expansion valve shall be as defined in Table 3 for small valves up to 8 mm diameter.

NOTE - For special valves designed for specific application and bigger valve with orifice greater than 8 mm, MOPD-RD is dependent on application and specification as agreed to between the manufacturer and purchaser. In this case, MOPD-RD is defined by drawings or documentation.

Table 3 Maximum Opening Pressure Differential— Reverse direction (MPa)
(*Clause* 5.8)

Sl No.	**Application**		**Low Pressure**	**Medium pressure**	**High pressure**
(1)	(2)	(3)	(4)	(5)	(6)
i)	Valve Port Diameter ≤ 2.4 mm	Maximum Operating Pressure Differential (MPa)	1.5	1.5	2.1
ii)	Valve Port Diameter > 2.4 mm to ≤ 3.2 mm		1.5	1.5	1.5

NOTE –
Low Pressure : Condensing pressure is lower than 1.7 Mpa at 54.4 °C condensing temperature
Medium Pressure : Condensing pressure is between 1.7 to 2.5 Mpa at 54.4 °C condensing temperature
High Pressure : Condensing pressure is more than 2.5 Mpa at 54.4 °C condensing temperature

Those special products without shut-off capability and products whose valve port diameters are larger than 3.2 mm, are defined by drawings or specification.

5.9 Electrical Requirement

5.9.1 The operating voltage for unipolar valves used for refrigeration capacity of up to 150 kW, shall not exceed 36 V d.c.

NOTES
1 The d.c. supply wave shall be rectangular wave, and the pulse-rate shall be as declared by the manufacturer.
2 For refrigeration capacity above 150 kW the operating voltage shall be as declared by the manufacturer.

5.9.2 Bipolar valves shall use current control drive which can provide needed current as required by the valve.

NOTE — The d.c. supply wave shall be rectangular wave, and the pulse-rate shall be as declared by the manufacturer.

5.9.3 *Voltage Driver* — The EXV shall operate at the input voltage range of 90 percent to 110 percent of the rated voltage.

5.9.4 *Current Controller* — The EXV shall operate at the current range of ± 10 percent of rated current.

5.10 Nominal Capacity Test Condition

The nominal capacity of the EXV shall be tested under the following conditions:

a) refrigerant condensation temperature of 38 °C;
b) at expansion valve inlet, liquid refrigerant temperature of 34 °C; and
c) vaporizing temperature of 4 °C.

NOTE — The nominal capacity at different condensing temperature shall be published as standard operating performance rating.

6 PERFORMANCE REQUIREMENT

6.1 External leak

A leak rate shall be maximum 3 grams/year when the valve body is tested at 0.25 times of Maximum Working Pressure (MWP) or 0.25 times of design pressure for 1 minute. (*see* **7.2.8.1**)

When Helium is used to test, at test pressure 1.1 × MWP, the leakage of expansion valve body shall not be larger than 2.83 grams/year (*see* **7.2.8.2**).

For safety and environment reasons, equivalent helium test may be used according to **7.4** of ISO 14903. However, the tightness control level shall be defined based on applied Helium percentage and pressure. It is allowed to reduce the testing pressure of helium test, but the test pressure shall not be lower than 1.0 MPa, and the leakage rate needs to be interpolated to reflect values corresponding to 1.1 × MWP.

6.2 Sound Pressure Level

Using semi-anechoic chamber test mode, the valve shall be tested as per **7.2.9** and the operating sound pressure level of expansion valve shall be as follows:

Operation Mode	≤ 60 dB
Overdrive Mode	≤ 70 dB
Indoor application	≤ 45 dB

6.3 Coil Temperature

Expansion valve coil temperature when tested as per **7.2.10** shall not be higher than the specified value in Table 4 which is applicable for valves with orifice size up to 8 mm.

Table 4 Coil Temperature
(*Clause* 6.3)

Sl No.	Insulation Class	E	B	F
(1)	(2)	(3)	(4)	(5)
i)	Coil Temperature	≤ 120 °C	≤ 130 °C	≤ 155 °C

NOTE— If a higher value of coil temperature is required then IEC 62114 may be referred.

6.4 Low Temperature Resistance

Expansion valves shall be tested as per **7.2.11** for low temperature resistance at low temperature specified. After the test, it shall meet the requirements stated in **5.4**, **5.5**, **5.7**, **6.1**, **6.14**, and **6.15**.

6.5 High Temperature Resistance

Expansion valves shall be tested as per **7.2.12** for high temperature resistance at high temperature specified. After the test, it shall meet the requirements stated in **5.4**, **5.5**, **5.7**, **6.1**, **6.14**, and **6.15**.

6.6 Temperature Variation Resistance

Expansion valves tested as per **7.2.13** for temperature variation resistance between low and high temperatures. After the test, it shall meet the requirements stated in **5.4**, **5.5**, **5.7**, **6.1**, **6.14**, and **6.15**.

6.7 Vibration Resistance

Expansion valves shall be tested for random vibrations per IEC 60068-2-64. Alternatively, the expansion valve shall be subject to the vibration tests with the acceleration of 43.1 m/s^2 and the vibration frequency of 10 Hz to 150 Hz for 4 h in up-down directions, and 2 h in front-back directions and left-right directions respectively (*see* **7.2.14**). After the test, the expansion valve shall be able to work normally, components shall not be loose and shall meet the requirements specified in **5.4**, **5.7**, **6.1**, **6.14**, and **6.15**.

6.8 Corrosion resistance

The expansion valves shall be tested for corrosion test for 72 hrs as per **7.2.15**. After the test, it shall meet the requirements stated in **6.1**, **6.13**, **6.14**, and **6.15**.

6.9 Life

Expansion valve shall be tested as per **7.2.16** for 100 000 open and close cycles. After the test, it shall operate normally; meet the requirements stated in **5.4**, **5.7**, **6.1**, **6.14,** and **6.15;** and the leakage shall not be larger than 2 times the specified value in Table 1.

6.10 Durability of Spindle Stopper Mechanism

Expansion valves shall be tested as per **7.2.17** for 50 000 valve closing cycles to evaluate durability. After the test, it shall operate normally and meet the requirements stated in **6.9**.

6.11 Individual Strength–Pressure Test

Expansion valves shall be tested as per **4.4.2** of IS 16678 (Part 2) at 1.43 × MWP (*also see* **7.2.18**). The valve shall not crack, break or show permanent deformation during the test.

6.12 Burst Test

Expansion valves when tested for burst/type approved strength pressure test as per **4.4.2.3** of IS 16678 (Part 2), shall not have external leak and rupture (*see* **7.2.19**).

6.13 Fatigue Strength

Expansion valves tested for fatigue as per **4.4.2.4** of IS 16678 (Part 2), shall meet requirements stated in **6.1** (*see* **7.2.20**).

6.14 Insulation Resistance

When tested as per **7.2.21**, the insulation resistance between coil lead and body of expansion valve shall be minimum 100 MΩ.

6.15 Electric Strength

When tested as per **7.2.22** for electric strength, valves shall not breakdown or flashover at setting leakage current of 5 mA.

6.16 Pulse Voltage Resistance

When tested as per **7.2.23** for pulse voltage resistance, valves shall meet the requirements stated in **6.14** and **6.15**.

6.17 Steady Damp-Heat

When tested as per **7.2.24** for steady damp-heat, valves shall meet the requirements stated in **6.14** and **6.15.**

6.18 Lead Strength

The X, Y, and Z directions of each lead of the fixed test sample shall be subject to the force of 19.6 N for 1 min. After the tension test, no lead may fall, and the resistance in each phase of the coil shall meet the requirements as agreed to between the manufacturer and purchaser (*see* **7.2.25**).

6.19 Assembly Strength

Coil assembly torque on valve body shall not be less than 0.4 Nm, and the axial pullout force of coil in relation to valve body shall not be smaller than 50 N. (*see* **7.2.26**).

6.20 Nominal Capacity

Manufacturer shall declare the nominal capacity of the expansion valve. The capacity which is measured as per **7.2.27,** shall not be lower than 90 percent of declared value. One of the published capacity shall be at the standard rating condition, publication of additional capacities at application ratings is optional.

7 TESTS

7.1 Test Equipment Instrumentation–Accuracy

Instruments and accuracy requirements shall be as specified in Table 5.

Table 5 Instruments and Accuracy Requirements
(*Clause* 7.1)

Sl No.	Name	Accuracy/ Rating Requirement
(1)	(2)	(3)
i)	Temperature measurement	± 1 °C
ii)	Pressure measurement	± 1.0 % of measured pressure
iii)	Air tightness test instrument	Minimum detectable leak rate < 1×10^{-6} mbar·l/s
iv)	Voltage measurement	± 5.0 % of measured value
v)	Voltage measurement (coil drive voltage)	± 1.0 % of measured value
vi)	Resistance measurement	± 0.2 % of measured value of coil resistance ± 5.0 % of measured value of insulation resistance
vii)	Noise measuring instrument	Level 1
viii)	Tension meter	± 0.6 N
ix)	Time measurement	± 1.0 % of measured time
x)	Caliper	MPE0.02
xi)	Torque wrench	Not lower than level 3
xii)	Pressure gauge	Level 0.25

7.2 Test Methods

Tests from **7.2.1** to **7.2.2** and **7.2.8** to **7.2.27** shall be done to conform to the requirements in this standard. The tests from **7.2.3** to **7.2.7** are optional and for information only.

7.2.1 *Shape and Size Check*

Using calipers and special measuring tools to check, expansion valves shall meet the requirement stated in **5.1**.

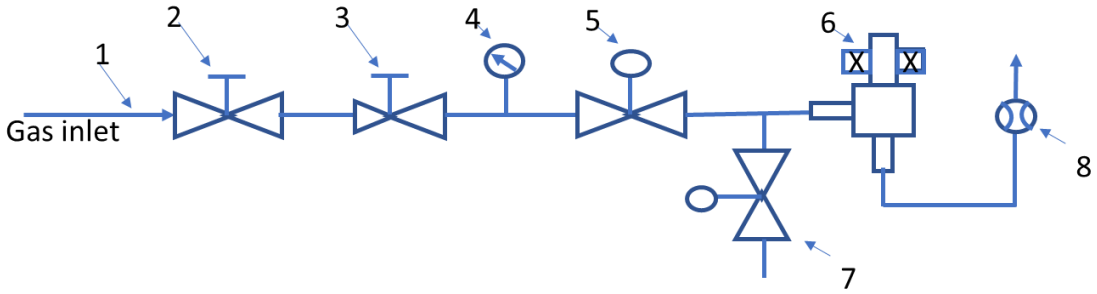
7.2.2 *Appearance Check*

Using visual method to check, expansion valves should meet the requirement stated in **5.2**.

7.2.3 *Open Valve Pulse Test (Applicable only for Valves up to 8 mm Orifice) (Optional)*

The open valve pulse test of expansion valve shall be conducted in accordance with the following procedure:

a) The tested expansion valve is connected according to the Fig. 1;
b) Dry air or nitrogen is used as test gas;
c) Connect expansion valve coil with power supply according to the drawings/specification as declared by the manufacturer;
d) Set the power supply: nominal voltage, specified excitation mode and excitation speed;
e) Set the expansion valve as tight closing position by adjusting the power supply;
f) Open stop valve (2), and adjust pressure-reducing valve (3) in order that pressure gauge (4) shows 1.0 MPa;
g) Open Solenoid valve (5), and let the gas of which the pressure is 1.0 MPa flows through expansion valve body;
h) According to the excitation sequence specified in drawings/specification as declared by the manufacturer, operate the power supply and open the expansion valve with the unit of one pulse, until there exists inflection point of mutation of flow in the outlet end, and this input pulse is the opening valve pulse. The special products without shut-off capability use the sudden increasing inflection as decision requirement. The opening valve pulse shall meet the requirement stated in **5.3**.



Key

1	Gas inlet	5	Solenoid valve
2	Stop valve	6	Expansion valve under test
3	Pressure–reducing valve	7	Solenoid valve
4	Pressure gauge	8	Flow meter

FIG.1 SETUP FOR OPEN VALVE PULSE TEST

7.2.4 *Airflow Characteristic Test–For Small Size Valves up to 8 mm Orifice (Optional)*

The airflow characteristic test of expansion valve shall be conducted in accordance with the following procedure:

a) Connect the tested expansion valve according to Fig. 1. Dry air or nitrogen is used as test gas;
b) Connect coil with power supply according to the specified drawings/specification as declared by the manufacturer;
c) Set the power supply: nominal voltage, specified excitation mode, and excitation speed;
d) Set the expansion valve as tight closing position by regulating power supply and determine the origin;
e) According to the open excitation sequence, enter the specified pulse and open expansion valve;
f) Open stop valve (2) and solenoid valve (5), then adjust pressure-reducing valve (3) in order that the indicated pressure of pressure gauge (4) rises to 0.1 MPa; and
g) Gas flow rate value is measured from outlet end, and it shall meet the requirement stated in **5.4**.

7.2.5 *Internal Leak Test (Optional)*

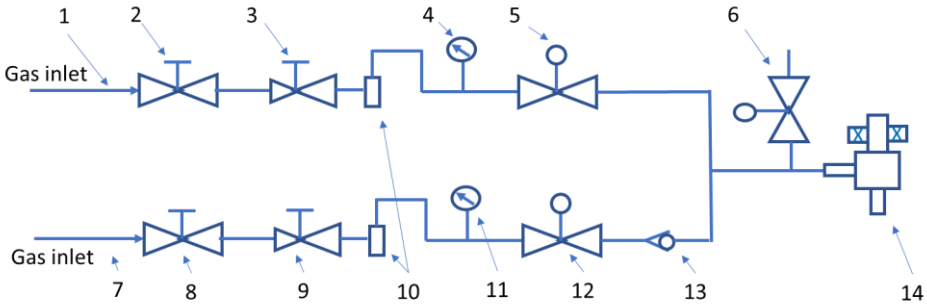
The internal leak test of expansion valve shall be conducted in accordance with the following procedure:

a) Connect the expansion valve according to Fig. 1. Dry air or nitrogen is used as test gas;
b) Connect coil with power supply according to the specified drawings/specification as declared by the manufacturer;
c) Set the power supply: nominal voltage, specified excitation mode, and excitation speed;
d) Open stop valve (2), and adjust pressure-reducing valve (3) in order that the indicated pressure of pressure gauge 4 is 1.0 MPa;
e) Open solenoid valve (5), and let the gas of which the pressure is 1.0 MPa flows through expansion valve body; and
f) Gas leakage is measured from outlet end, and it shall meet the requirement stated in **5.5**.

7.2.6 *Maximum Opening Pressure Differential (Optional)*

The maximum opening pressure difference test of expansion valve shall be conducted in accordance with the following procedure:

a) Connect the tested expansion valve according to Fig. 2. Dry air or nitrogen is used as test gas;
b) Connect coil with power supply according to the declared drawings/specification as declared by the manufacturer;
c) Set the power supply: nominal voltage, specified excitation mode, and excitation speed;
d) Set the expansion valve as tight closing position by regulating power supply and determine the origin;
e) According to the open excitation sequence, for both direct driven expansion valves and gear driven expansion valves – enter specified pulses to open within specified opening degree;
f) Open stop valve (8) and solenoid valve (6, 12) then adjust pressure-reducing valve (9) in order that the indicated pressure of pressure gauge (11) rises to 0.1 MPa;
g) Gas flow rate is measured from outlet end as Q_1;
h) Close stop valve (8) and solenoid valve (6, 12);
j) Set the expansion valve as tight closing position by regulating power supply and determine the origin;
k) Open stop valve (2) and solenoid valve (5);
m) Set the power supply: 90 percent of nominal voltage, specified excitation mode, and excitation speed, and then according to the open excitation sequence, for both direct driven expansion valves and gear driven expansion valves– enter specified pulses to open within specified opening degree;
n) Close stop valve (2) and solenoid valve (5) then open stop valve (8) and solenoid valve (6, 12). Adjust pressure-reducing valve (9) in order that the indicated pressure of pressure gauge (11) rises to 0.1 MPa;
p) Gas flow rate is measured from outlet end as Q_2;
q) Compare gas flow rate Q_1 with Q_2, and the variation of $(Q_1 - Q_2)/Q_1$ should within 5 percent.



Key

1	Gas inlet	8	Stop valve
2	Stop valve	9	Pressure-reducing valve
3	Pressure-reducing valve	10	Air cylinder
4	Pressure gauge	11	Pressure gauge
5	Solenoid valve	12	Solenoid valve
6	Solenoid valve	13	One-way valve
7	Gas inlet	14	Expansion valve under test

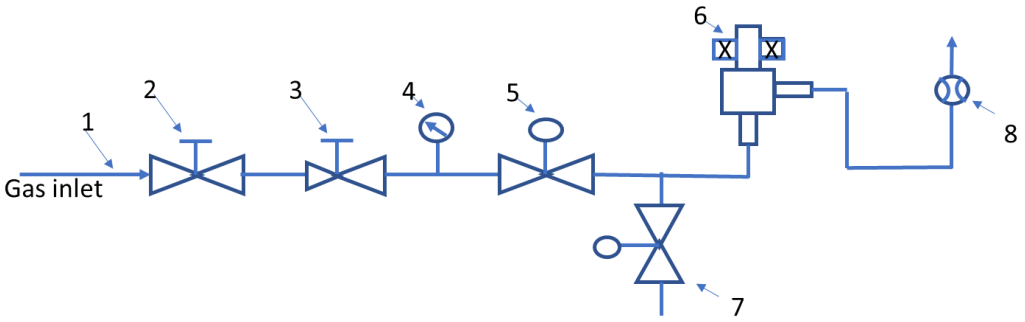
FIG. 2 SETUP FOR MAXIMUM OPERATING PRESSURE DIFFERENTIAL TEST

7.2.7 *Maximum Opening Pressure Difference–Reverse Flow Direction (Optional)*

The maximum opening valve pressure difference test of expansion valve in reverse flow direction shall be conducted in accordance with the following procedure:

a) Connect the tested expansion valve according to Fig. 3. Dry air or nitrogen is used as test gas;
b) Connect coil with power supply according to the specified drawings/specification as declared by the manufacturer;
c) Set the power supply: nominal voltage, specified excitation mode, and excitation speed;
d) Set the expansion valve as tight closing position by regulating power supply and determine the origin;
e) Open stop valve (2) then adjust pressure-reducing valve (3) in order that the indicated pressure of pressure gauge (4) rises from 0 MPa gradually, until there exists inflection point of mutation of flow in the outlet end, and this indicated pressure of pressure gauge (4) is the reverse opening valve pressure difference; and
f) The reverse opening valve pressure difference shall meet the requirement stated in **5.8**.

NOTE — Those special products without shut-off capability and products whose valve port diameters are larger than 3.2 mm are specified by drawings or specification.



Key

1	Gas inlet	5	Solenoid valve
2	Stop valve	6	Expansion valve under test
3	Pressure–reducing valve	7	Solenoid valve
4	Pressure gauge	8	Flow meter

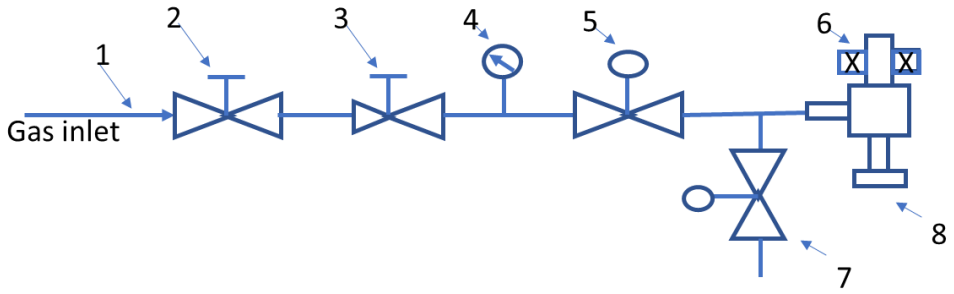
FIG. 3 SETUP FOR REVERSE OPENING VALVE PRESSURE DIFFERENCE TEST

7.2.8 *Gas (Air/Nitrogen/Helium) – Tightness Test*

7.2.8.1 *Bubble test under water*

The bubble test under water of expansion valve shall be conducted in accordance with the following procedure:

a) Connect the tested expansion valve according to Fig. 3. Dry air or nitrogen is used as test gas;
b) Connect coil with power supply according to the drawings/specification as declared by the manufacturer;
c) Set the power supply: nominal voltage, specified excitation mode, and excitation speed;
d) Set the expansion valve as tight closing position by regulating power supply and determine the origin. According to the open excitation sequence, for both direct driven expansion valves and gear driven expansion valves – enter specified pulses to open within specified opening degree;
e) Remove the expansion valve coil, and block the outlet end of expansion valve body, then connect it according to the gas line requirements in Fig. 4. Dry air or nitrogen is used as test gas. Open stop valve (2) then adjust pressure-reducing valve (3) in order that the indicated pressure of pressure gauge (4) is 1.1 × MWP;
f) Open solenoid valve (5) and let the gas of which the pressure 1.1 × MWP flows through expansion valve body. Then immerse valve body in the water for 1 min, and it shall meet the requirement stated in **6.1**.



Key

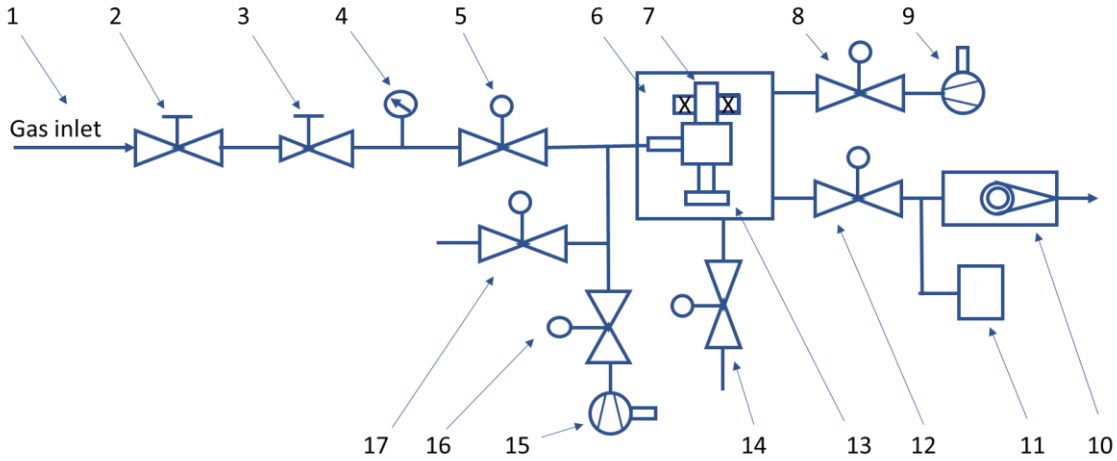
1	Gas inlet	5	Solenoid valve
2	Stop valve	6	Expansion valve under test
3	Pressure–reducing valve	7	Solenoid valve
4	Pressure gauge	8	Flow meter

FIG. 4 SETUP FOR OPEN VALVE PULSE TEST

7.2.8.2 *Helium gas leak test*

The Helium leak test of expansion valve shall be conducted in accordance with the following procedure:

a) Connect the tested expansion valve according to Fig. 3. Dry air or nitrogen is used as test gas;
b) Connect coil with power supply according to the specified drawings/specification as declared by the manufacturer;
c) Set the power supply: nominal voltage, specified excitation mode, and excitation speed;
d) Set the expansion valve as tight closing position by regulating power supply and determine the origin. According to the open excitation sequence, for direct driven expansion valves – enter 300 pulses to open and for gear driven expansion valves–enter 1 000 pulses to open;
e) Remove the expansion valve coil, and block the outlet end of expansion valve body, then connect it according to the gas line requirements in Fig. 5. Helium or mixed gas of helium and nitrogen is used as test gas, and the combination of helium ratio and gas pressure may satisfy the precision requirements. Open stop valve (2) then adjust pressure-reducing valve (3) in order that the indicated pressure of pressure gauge (4) is 1.1 × MWP;
f) Close solenoid valve (5, 17) and open solenoid valve (16) open vacuum pump (15) and pump the expansion valve into vacuum. The vacuum degree shall be lower than 100 Pa;
g) Close solenoid valve (16) and open solenoid valve (5). Test gas is introduced into the expansion valve;
h) Close solenoid valve (12, 14) and open solenoid valve (8). Open vacuum pump (9) and pump the airtight container into vacuum. The vacuum degree shall be lower than 100 Pa;
j) Close solenoid valve (8) and open electron magnetic valve (12). Open leak detection pump (10) and detect leakage by leak detector. The leakage of expansion valve body shall meet the specified leakage rate requirements in **6.1**; and
k) Open solenoid valve (14, 17) then return airtight container and valve body to normal atmospheric pressure. Remove the expansion valve body.



Key

1	Helium gas-inlet	10	Leak detection pump
2	Stop valve	11	Leak detector
3	Pressure-reducing valve	12	Solenoid valve
4	Pressure gauge	13	Plug
5	Solenoid valve	14	Solenoid valve
6	Air tight container	15	Vacuum pump
7	Expansion valve under test	16	Solenoid valve
8	Solenoid valve	17	Solenoid valve
9	Vacuum pump		

FIG. 5 SETUP FOR HELIUM LEAKAGE TEST

7.2.9 *Sound Test*

The noise test of expansion valve shall be conducted in accordance with the following procedure:

a) Expansion valve is suspended in the air inside noise test laboratory which complies with the background noise not greater than 25 dB(A) as per ISO 3740;
b) Connect coil with power supply according to the specified drawings/specification as declared by the manufacturer;
c) Set the power supply: nominal voltage, specified excitation mode, and excitation speed;
d) Set the expansion valve as tight closing position by regulating power supply and determine the origin.
e) Regulate power supply to conduct opening and closing action in cycle with specified pulses for opening and specified pulses for closing with specified pulses of overdrive and measure the stop motion noise 15 m away from the surface of expansion valve. The measured noise should correspond to the requirement stated in **6.2**.

NOTE - The specified pulses as indicated in e) above shall be declared by the manufacturer.

7.2.10 *Coil Temperature Test*

a) The coil temperature test of expansion valve shall be conducted in accordance with the following procedure;
b) Place the expansion valve into a thermostatic chamber with 40 °C ± 2 °C for coils used in direct driven valves and 60 °C ± 2 °C for coils used in gear driven valves;
c) After the 2 h temperature equilibrium, measure and record the initial resistance of coils;
d) Set the power supply: 110 percent of nominal voltage, specified excitation mode and excitation speed. The expansion valve coil is connected to power supply according to the specified specification.
e) Regulate power supply to conduct opening and closing action in cycle between + 100 to + 300 pulses for 2 h and measure the resistance of coils. Use the electrical resistivity method to measure the temperature increase of coils and calculate according to equation (1) and equation (2).
f) Coil temperature after the test shall meet the requirement stated in **6.3**.

$$\Delta t = \frac{R_2 - R_1}{R_1} \times (234.5 + t_1) + t_1 - t_2 \qquad \ldots(1)$$

$$T = \Delta t + t_2 \qquad \ldots(2)$$

where

Δt = Temperature increase of coils, °C;
R_1 = The resistance of coils with temperature t_1, Ω;
R_2 = The resistance of coils with temperature t_2, Ω;
t_1 = The ambient temperature when test starts, °C;
t_2 = The ambient temperature at the end, °C; and
T = Coil temperature , °C.

7.2.11 *Low Temperature Test*

Test the valve without power connected, at specified low temperature within tolerance of ± 3 °C for 96 h. Take it out and soak it for 2 h at room temperature. Valve after the test shall meet the requirement stated in **6.4**.

7.2.12 *High Temperature Test*

Test the valve without power connected, at specified high temperature within tolerance of ± 3 °C for 96 h. Take it out and soak for 2 h at room temperature. Valve after the test shall meet the requirement stated in **6.5**.

7.2.13 *Thermal Shock Test*

Test the valve without power connected, expansion valve is tested for 10 cycles at temperature cycling between low temperature − 30 °C ± 3 °C for 1 h and + 100 °C ± 3 °C for 1 h. Temperature ramp up/down time shall not be higher than 3 min. Take the valve out and soak it for 2 h at room temperature. Valve after the test shall meet the requirement stated in **6.6**.

7.2.14 *Vibration Test*

The vibration test of expansion valve shall be conducted in accordance with the following procedure:

a) Set the power supply: nominal voltage, specified excitation mode, and excitation speed;
b) The expansion valve coil is connected to power supply. Set the expansion valve in tight closing position by regulating power supply and determine the origin;
c) According to the open excitation sequence, for direct driven expansion valves − enter 300 pulses to open and for gear driven expansion valves – enter 1 000 pulses to open;
d) The frequency, acceleration and amplitude depend upon the application (*see* Note below).
e) After experiencing vibration test with up and down for 4 h, forward and backward as well as left and right for 2 h respectively, the expansion valve should meet the requirements stated in **6.7**.

NOTE - For generic guideline, use the information presented as follows. The direct expansion valve is conducted with vibration of which the frequency is 33.3 Hz and the total amplitude is 2 mm. Gear driven expansion valve is subjected to vibration tests with the acceleration of 43.1m/s^2 and the vibration frequency of 10 Hz to 150 Hz.

7.2.15 *Corrosion Test*

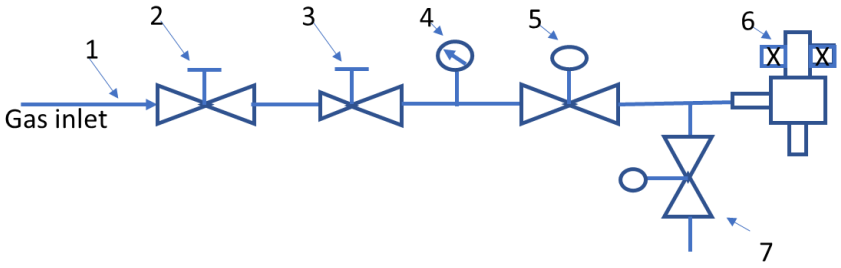
Expansion valve is tested with neutral salt spray for 72 h as per the test method specified in IS 9844. After the test, it shall meet the requirement stated in **6.8**.

7.2.16 *Life Test*

The life test of expansion valve shall be conducted in accordance with the following procedure:

a) Connect the tested expansion valve as shown in Fig. 6. Dry air or nitrogen is used as test gas;
b) The expansion valve coil is connected to power supply according to the specification as declared by the manufacturer;
c) Open solenoid valve (5) and let the gas with the pressure is 1.5 MPa flows through expansion valve body;
d) Set the power supply: nominal voltage, specified excitation mode, and excitation speed;
e) Set the expansion valve in tight closing position by regulating power supply and determine the origin;

f) Conduct opening and closing action in cycle with 0 to 500 pulses for direct driven valves and 0 to 2 000 pulses for gear driven valves;
g) In the process of test, the appropriate amount of frozen oil shall be added in the inlet end of valve with the frequency of 30 mg/min;
h) Check the leakage and maximum operating pressure difference after every 20 000 cycles. The values observed shall meet the requirements for leakage rate and MOPD as stated in **6.9**.
j) After completion of 100 000 cycles, the valve shall meet the requirements as stated in **6.9**.



Key

1	Gas inlet	5	Solenoid valve
2	Stop valve	6	Expansion valve under test
3	Pressure–reducing valve	7	Solenoid valve
4	Pressure gauge		

FIG. 6 SETUP FOR OPEN VALVE PULSE TEST

7.2.17 *Test for Durability of Spindle Stop Mechanism – Applicable for Unipolar Valves of Small Size up to 8 mm Orifice*

The test for durability of spindle stop mechanism of expansion valve shall be conducted in accordance with the following procedure:

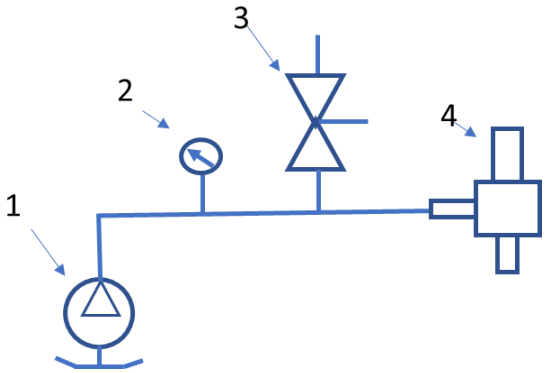
a) Set the power supply: 110 percent of nominal voltage, specified excitation mode and excitation speed;
b) The expansion valve coil is connected to power supply according to the specification as declared by the manufacturer.
c) Set the expansion valve as tight closing position by regulating power supply and determine the origin. Then conduct opening and closing action in cycle with + 50 to + 150 pulses for direct driven valve and 0 to + 1 000 pulses for gear driven valve;
d) In the process of test, before the test starts and after each 10 000 cycles, 30 mg frozen oil should be added in the inlet end of valve; and
e) After completion of 50 000 cycles, the expansion valve shall meet the requirement stated in **6.10**.

7.2.18 *Hydraulic Strength Test*

The hydraulic strength test of expansion valve shall be conducted in accordance with the following procedure:

a) Set the power supply: nominal voltage, specified excitation mode and excitation speed;
b) The expansion valve coil is connected to power supply according to the specification as declared by the manufacturer;

c) Set the expansion valve as tight closing position by regulating power supply and determine the origin. According to the open excitation sequence, enter 300 pulses to open expansion valve;
d) Remove the expansion valve coil, and block the outlet end of expansion valve body, then connect it according to Fig. 7; and
e) Fill the expansion valve body with water at room temperature. Add up pressure to 1.5 times the maximum work pressure, and hold pressure for 3 min. There shall be no leakage and no permanent deformation at surface of expansion valve body during the test.



Key

1	Gas supply	3	Stop valve
2	Pressure gauge	4	Expansion valve under test

FIG. 7 TEST SETUP FOR HYDRAULIC STRENGTH

7.2.19 *Burst Strength Test*

The burst strength test of expansion valve shall be conducted in accordance with the following procedure:

a) Set the power supply: nominal voltage, specified excitation mode, and excitation speed;
b) The expansion valve coil is connected to power supply. Set the expansion valve in tight closing position by regulating power supply and determine the origin;
c) According to the open excitation sequence, for direct driven expansion valves − enter 300 pulses to open and for gear driven expansion valves – enter 1 000 pulses to open;
d) Remove the expansion valve coil, and block the outlet end of expansion valve body, then connect it according to Fig. 7; and
e) Fill the expansion valve body with water at room temperature. After exhausting air, add up pressure to 4 times the maximum work pressure, and hold pressure for 1 min.
f) During the test, there shall be no cracking and breakage at surface of expansion valve body. Also, after the test it shall meet the requirement stated in **6.12**.

7.2.20 *Fatigue Test*

The fatigue test of expansion valve shall be conducted in accordance with the following procedure:

a) Set the power supply: nominal voltage, specified excitation mode, and excitation speed;
b) The expansion valve coil is connected to power supply. Set the expansion valve in tight closing position by regulating power supply and determine the origin;
c) According to the open excitation sequence, for direct driven expansion valves−enter 300 pulses to open and for gear driven expansion valves–enter 1 000 pulses to open;

d) Remove the expansion valve coil and connect expansion valve according to gas line requirements in Fig. 4. Dry air or nitrogen is used as test gas;
e) Open stop valve (2) then adjust pressure-reducing valve (3) in order that the indicated pressure of pressure gauge (4) is MWP; and
f) Open solenoid valve (5) for 1.5 s [when solenoid valve (5) opens, solenoid valve (7) closes], in order that the indicated pressure of pressure gauge (4) is MWP. Open solenoid valve (7) for 1.5 s [when solenoid valve (7) opens, solenoid valve (5) closes]. On completion of 200 000 cycles, the valve shall meet the requirement stated in **6.13**.

7.2.21 *Insulation Resistance Test*

Use 500 V d.c. insulation resistance meter to measure insulation resistance between expansion valve lead and body, which shall meet the requirement stated in **6.14**.

7.2.22 *Electric Strength Test*

Electric strength shall be tested as per **13.3** of IEC 60335-1. During the test, it shall meet the requirement stated in **6.15**.

7.2.23 *Pulse Voltage Test*

1.2/50 μs wave of which peak voltage is 5 kV is applied to expansion valve lead and body, and after 5 consecutive shocks, the valve shall meet the requirement stated in **6.16**.

7.2.24 *Steady Damp-Heat Test*

Under the condition of no power, valve shall be subject to high temperature of + 40 ℃ and relevant humidity of 93 percent for 48 h. After 2 h recovery at room temperature, the valve shall meet the requirement stated in **6.17**.

7.2.25 *Lead Strain – Applicable for Valve Sizes with Orifice up to 8 mm*

The X, Y, and Z directions of each lead of the fixed test sample shall be subject to the force of 19.6 N for 1 min. After the tension test, no lead may fall, and the resistance of the coil in each phase, shall meet the requirements stated in **6.18**.

7.2.26 *Assembly Strength Test – Applicable for Valve Sizes with Orifice up to 8 mm*

Under the condition of no power, assemble valve bodies and fix coils. Use torque wrench to test the torque between valve body and coil. Use peeling measure meter to test disengage tension of valve body.

Valve tested as above, shall meet the requirements stated in **6.19**.

7.2.27 *Nominal Capacity*

Nominal capacity measurement of expansion valve shall be conducted as per Annex B or as per agreed between manufacturer and customer. The capacity shall meet the requirement stated in **6.19**.

8 TESTS

8.1 Classification of Tests

Test shall be classified into the following three groups:

a) Production routine tests;
b) Type tests; and
c) Acceptance tests.

8.2 Production Routine Tests

The routine tests shall consist of routine tests that would be conducted on each unit after completion at the manufacturer's works. The following shall constitute acceptance tests:

a) External leak Test (*see* **7.2.8**);
b) Insulation Resistance Test (*see* **7.2.21**); and
c) Electrical Strength Test (*see* **7.2.22**).

8.3 Type test

The type tests shall consist of the tests that would be necessary to check up the performance and characteristics of the units and components. The following shall constitute type tests:

a) Life test (*see* **7.2.16**);
b) Durability of Spindle stopper mechanism (*see* **7.2.17**);
c) Individual Strength pressure test (*see* **7.2.18**);
d) Burst test (*see* **7.2.19**);
e) Fatigue Strength test (*see* **7.2.20**);
f) Pulse Voltage resistance (*see* **7.2.23**);
g) Steady Damp- Heat Test (*see* **7.2.24**);
h) Lead Strength (*see* **7.2.25**); and
j) Assembly Strength Test (*see* **7.2.26**).

8.4 Acceptance tests

lf the purchaser desires any of the production routine tests to be repeated at the time of purchase, then, where agreed to between the purchaser and the manufacturer, the tests may be carried out at the manufacturer's works; alternatively, the tests may be repeated at the place specified by the purchaser provided that all the arrangements for tests are made by the purchaser at the specified place. The following shall constitute acceptance tests:

a) Sound Pressure Level (*see* **7.2.9**);
b) Coil temperature test (*see* **7.2.10**);
c) Low temperature resistance test (*see* **7.2.11**);
d) High temperature resistance test (*see* **7.2.12**);
e) Temperature variation Resistance test (*see* **7.2.13**);
f) Vibration Resistance (*see* **7.2.14**);
g) Corrosion resistance Test (*see* **7.2.15**); and

h) Nominal capacity (*see* **7.2.27**).

9 LABELING, MARKING, PACKING, TRANSPORT, AND STORAGE

9.1 Marking

Each valve shall be legibly and indelibly marked with the following:

a) Manufacturers name /brand /trademark/identification mark;
b) Country of manufacture/origin;
c) Model number and serial number;
d) Product type;
e) Nominal voltage;
f) Nominal capacity;
g) Connector Size;
h) Maximum Working Pressure; and
j) Flow Direction.

9.2 Packing and Packaging

There may be the following information on the packing box of expansion valve:

a) Name or trademark of a manufacturer;
b) Product name, type and quantity;
c) Net weight or gross weight; and
d) Size (length × width × height).

Packing of product shall not affect the performance specified in this standard.

9.3 Transport and Storage

9.3.1 In the transport process, expansion valves should be avoided with heavy pressure, damp, exposure, rain and snow attacks. They should not be placed upside down or on their side.

9.3.2 Expansion valves should be stored in a well ventilated, clean, dry, and noncorrosive gas surrounding environment.

9.4 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the product(s) may be marked with the Standard Mark.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS/ISO No.	*Title*
IS 3615 : 2020	Glossary of terms used in refrigeration and air conditioning (*second revision*)
IS 16656 : 2017/ ISO 817 : 2014	Refrigerants — Designation and safety classification
IS 16678 (Part 1) : 2018/ ISO 5149-1 : 2014	Refrigerating systems and heat pumps — Safety and environmental requirements: Part 1 Definitions, classification and selection criteria
IS 16678 (Part 2) : 2018/ ISO 5149-2 : 2014	Refrigerating systems and heat pumps — Safety and environmental requirements — Part 2 Design, construction, testing, marking and documentation
ISO 3740 : 2019	Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards
ISO 14903 : 2017	Refrigerating systems and heat pumps — Qualification of tightness of components and joints
ISO 21922 : 2021	Refrigerating systems and heat pumps — Valves — Requirements, testing and marking
IEC 60068-2-64 : 2008	Environmental testing — Part 2-64: Tests — Test Fh: Vibration, broadband random and guidance
IEC 60085 : 2007	Electrical insulation - Thermal evaluation and designation
IEC 60335-1 : 2020	Household and similar electrical appliances - Safety - Part 1: General requirements

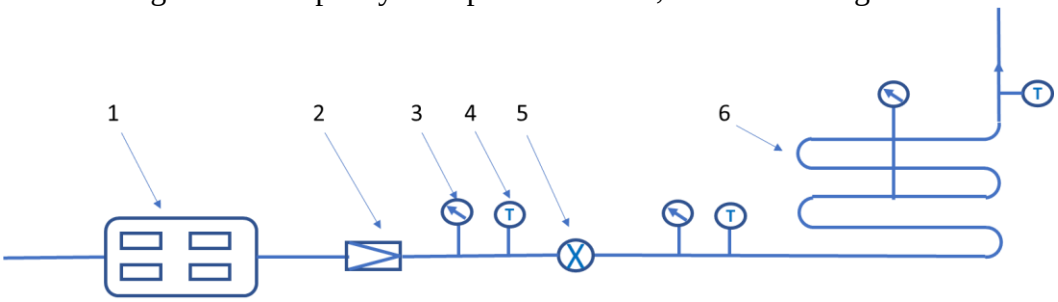
ANNEX B

(*Clause* 7.2.27)

TEST METHOD OF NOMINAL CAPACITY FOR EXPANSION VALVES

B-1 TYPE REPRESENTATION METHOD

The apparatus for testing nominal capacity of expansion valves, is shown as Fig. 8.



Key

1	Sub-cooler	4	Temperature meter
2	Mass flow meter	5	Expansion valve under test
3	Pressure sensor	6	Evaporator

FIG. 8 TEST SETUP FOR NOMINAL CAPACITY OF EXPANSION VALVES

B-2 LOCATION AND REQUIREMENTS FOR MEASURING POINTS

B-2.1 Pressure Hole Measurement Position

B-2.1.1 Inlet pipe pressure hole of expansion valve shall be set on main pipeline, and the ideal location is twice times the inside diameter of main pipe from the inlet tube end.

B-2.1.2 Outlet pipe pressure hole of expansion valve shall be set on main pipeline, and the ideal location is 10 times the inside diameter of main pipe from the inlet tube end.

B-2.2 Fluid Temperature Measurement Position

Measuring points of fluid temperature before and after the expansion valve shall be close to pressure measuring point of pressure sensor (the distance shall not be larger than 3 times the diameter of main pipe).

B-2.3 Size of Main Pipe

Size of main pipe shall correspond to the size of pipe connecting inlet and outlet of expansion valves.

B-3 TEST PROCEDURE

B-3.1 Start the refrigeration system test bed, and set operating parameters according to the nominal capacity testing conditions specified in **4.3**.

B-3.2 Adjust the opening of expansion valve gradually until reach its maximum opening of refrigerating capacity regulation. Adjust the system so that the system is gradually stabilized to the nominal capacity testing condition as specified in **4.3**.

B-3.3 Measure the mass flow rate m_n under the normal condition.

B-4 CALCULATION OF NOMINAL CAPACITY OF EXPANSION VALVE

The nominal capacity of expansion valve shall be calculated according to equation (3).

$$Q_n = m_n (h_2 - h_1) \qquad \ldots(3)$$

where

Q_n = Nominal capacity of expansion valve, kW;

m_n = mass flow rate of refrigerant that flows through expansion valve under the normal condition, kg/s;

h_2 = specific enthalpy of saturated refrigerant vapor at the pressure of evaporating temperature under the normal condition, kJ/kg; and

h_1 = enthalpy of inlet refrigerant of expansion valve under the normal condition, kJ/kg.

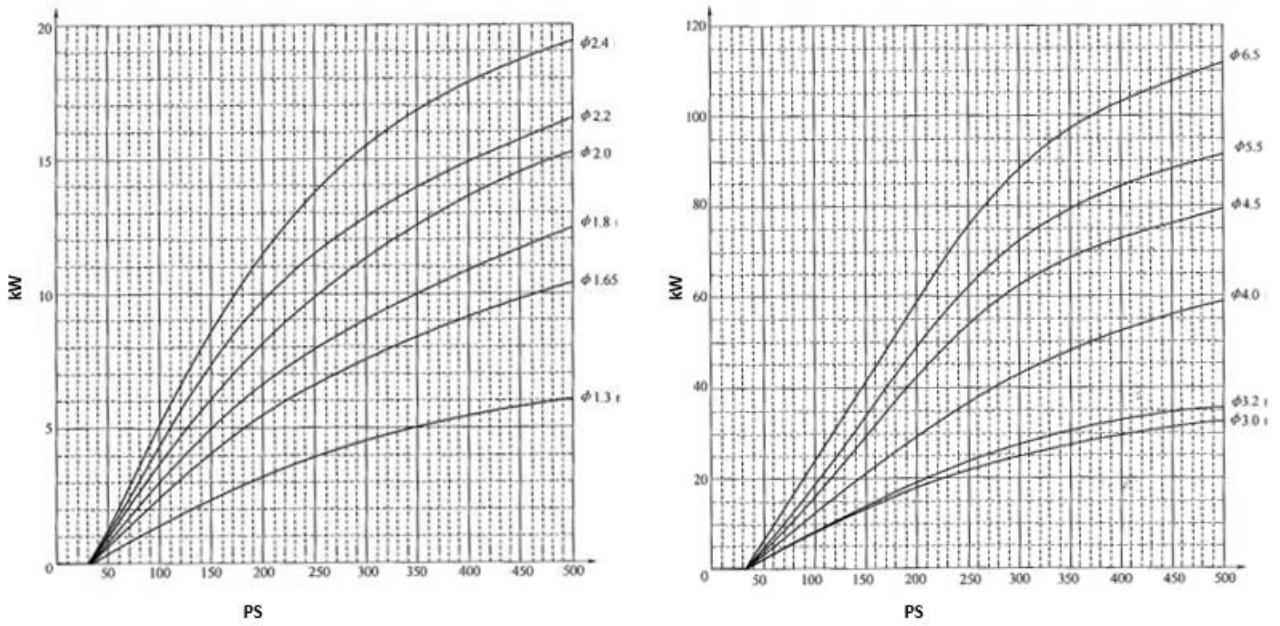
B-5 RECOMMENDED NOMINAL CAPACITY TABLE

In the system with refrigerant R410A, nominal capacity of expansion valve is recommended in Table 6.

Table 6 Nominal Capacity of Expansion Valve
(*Clause* B-5)

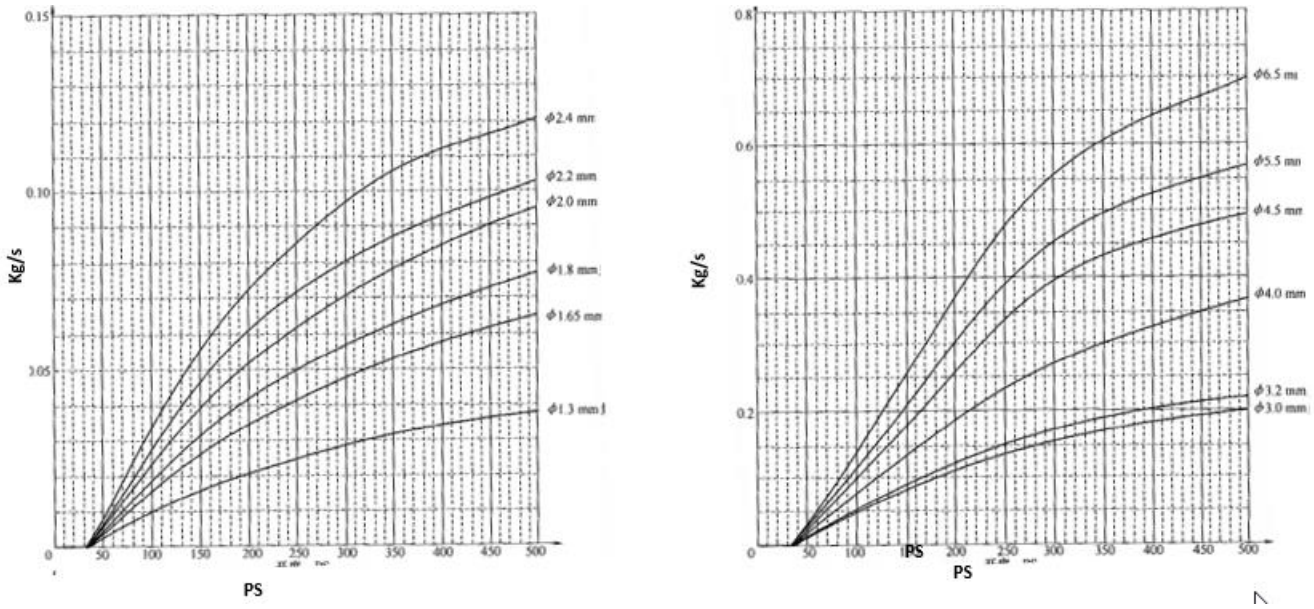
Sl No.	**Valve Port Diameter** mm	**Nominal capacity** kW
(1)	(2)	(3)
i)	1.3	6.1
ii)	1.65	10.4
iii)	1.8	12.4
iv)	2	15.3
v)	2.2	16.5
vi)	2.4	19.4
vii)	3	32.5
viii)	3.2	35.5
ix)	4	59
x)	4.5	79.3
xi)	5.5	91.5
xii)	6.5	111.8

B-6 Examples of opening- refrigeration capacity curve and opening- refrigerant mass flow rate curve are shown as Fig. 9 and Fig. 10.



Y axis- Refrigeration capacity, kW
X axis- Opening

FIG. 9 EXAMPLES OF OPENING – REFRIGERATION CAPACITY CURVE



Y axis- Refrigerant mass flow rate, kg/s
X axis- Opening

FIG. 10 EXAMPLES OF OPENING – REFRIGERANT MASS FLOW RATE CURVE