**TED 26 (18375) F**

***भारतीय मानक***

***Indian Standard***

 **IS 15718: 2024**

 **सड़क वाहन – संपीड़ित प्राकृतिक गैस (सीएनजी)/जैव-संपीड़ित प्राकृतिक गैस (जैव-सीएनजी) – ईंधन प्रणाली के घटक – सीएनजी उच्च दाब ईंधन लाईन (नम्य होज) सिरे कनेक्शन सहित [2.15 मैगापास्कल (21.5 बार) से अधिक दाब की]**

*( पहला पुनरीक्षण )*

**Road Vehicles — Compressed Natural Gas (CNG) / Bio- Compressed Natural Gas (Bio- CNG) — Fuel System Components — High Pressure Fuel Line (Flexible Hose) with End Connections [Having Service Pressure Exceeding 2.15MPA (21.5 Bar)]**

*( First Revision )*

ICS 43.060.40

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भारतीय मानक ब्यूरो

BUREAU OF INDIAN STANDARDS

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 **October 2024 Price Group**

Automotive Vehicles Running on Non-Conventional Energy Sources Sectional Committee, TED 26

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Automotive Vehicles Running on Non-Conventional Energy Sources Sectional Committee had been approved by the Transport Engineering Division Council.

This standard was first published in 2006 to specify definitions, test methods and requirements of high-pressure fuel line (flexible hose) with end connections having service pressure exceeding 2.15 MPa (21.5 bar) of CNG on-board fuel system component intended for use on motor vehicles defined in IS 14272. In this revision, bio-CNG is added to the scope of this standard keeping in view the technological advancements that have taken place since its last publication.

In the formulation of this standard considerable assistance has been derived from the following AIS Standards issued by the Automotive Research Association of India:

AIS 024 (Rev. 1) (Part A) — Safety and procedural requirements for type approval of gaseous fuelled vehicles — Part A (Automotive application)

AIS 024 (Rev. 1) (Part B) — Safety and procedural requirements for type approval of gaseous fuel agricultural tractors — Part B (Agricultural tractors application)

AIS 024 (Rev. 1) (Part C) — Safety and procedural requirements for type approval of gaseous fuel vehicles — Part C (CEV’s application)

AIS 028 (Rev. 1) (Part A) — Code of practice for use of gaseous fuels in internal combustion engine vehicles — Part A (Automotive application)

AIS 028 (Rev. 1) (Part B) — Code of practice for use of gaseous fuels in internal combustion engine agricultural tractors — Part B (Agricultural tractors application)

AIS 028 (Rev. 1) (Part C) — Code of practice for use of gaseous fuels in internal combustion engine construction equipment vehicles (CEV’s) — Part C (CEV’s application)

SAE J 517 : 1998 — Hydraulic hose

This standard is one of the series of Indian Standards published on CNG/bio-CNG onboard fuel system components. Other standards in the series are:

| *IS No.* | *Title* |
| --- | --- |
| IS 15710 : 2024  | Road vehicles — Compressed natural gas (CNG)/bio-compressed natural gas (bio-CNG) fuel system components — General requirements and definitions |
| IS 15711 : 2024 | Road vehicles — Compressed natural gas (CNG)/bio-compressed natural gas (bio-CNG) fuel system components — Performance and general test methods (*first revision*) |
| IS 15712 : 2024 | Road vehicles — Compressed natural gas (CNG)/bio-compressed natural gas (bio-CNG) fuel system components — Automatic valve (solenoid valve) (*first revision*) |
| IS 15713 : 2024 | Road vehicles — Compressed natural gas (CNG)/bio-compressed natural gas (bio-CNG) fuel system components — Pressure regulator (*first revision*) |
| IS 15714 : 2024 | Road vehicles — Compressed natural gas (CNG)/bio-compressed natural gas (bio-CNG) fuel system components — Gas air mixer (*first revision*) |
| IS 15715 : 2024 | Road vehicles — Compressed natural gas (CNG)/bio-compressed natural gas (bio-CNG)/ Liquefied petroleum gas (LPG) fuel system components — CNG/bio-CNG/LPG conduit (ventilation hose/pipe) (*first revision*) |
| IS 15716 : 2024 | Road vehicles — Compressed natural gas (CNG)/bio-compressed natural gas (bio-CNG) fuel system components — CNG/bio-CNG high pressure fuel line (rigid) with end connections [having pressure exceeding 2.15 MPa (21.5 bar)] |
| IS 15717 : 2024 | Road vehicles — Compressed natural gas (CNG)/bio-compressed natural gas (bio-CNG)/ Liquefied petroleum gas (LPG) fuel system components — Petrol valve (automatic/manual) |
| IS 15719 : 2024 | Road vehicles — Compressed natural gas (CNG)/bio-compressed natural gas (bio-CNG)/ liquefied petroleum gas (LPG) fuel system components — Electrical wiring kit |
| IS 15720 : 2024 | Road vehicles — Compressed natural gas (CNG)/bio-compressed natural gas (bio-CNG) /liquefied petroleum gas (LPG) fuel system component — Compartments/ sub-compartments |
| IS 15721 : 2024 | Road vehicles — Compressed natural gas (CNG)/bio-compressed natural gas (bio-CNG)/ liquefied petroleum gas (LPG) fuel system components — Fire retardant material for seat, upholstery, roof and side lining |
| IS 15722 : 2024 | Road vehicles — Compressed natural gas (CNG)/bio-compressed natural gas (bio-CNG) fuel system components — CNG/bio-CNG flexible fuel line with or without end connections (having pressure not exceeding 2.15 MPa) |
| IS 15723 : 2024 | Road vehicles — Compressed natural gas (CNG)/bio-compressed natural gas (bio-CNG) /Liquefied petroleum gas (LPG) fuel system components — Current limiting devices (*first revision*) |

The composition of the Committee responsible for the formulation of this standard is given in Annex B.

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 test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second 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.

*Indian Standard*

ROAD VEHICLES — COMPRESSED NATURAL GAS (CNG)/BIO-COMPRESSED NATURAL GAS (BIO-CNG) FUEL SYSTEM COMPONENTS — HIGH PRESSURE FUEL LINE (FLEXIBLE HOSE) WITH END CONNECTIONS [HAVING SERVICE PRESSURE EXCEEDING 2.15MPa (21.5 BAR)]

*( First Revision )*

**1 SCOPE**

**1.1** This standard specifies definitions, test methods and requirements of CNG/bio-CNG high pressure fuel line (flexible hose) with end connections having service pressure exceeding 2.15 MPa (21.5 bar) of CNG/bio-CNG on-board fuel system component intended for use on motor vehicles defined in IS 14272.

**1.1.1** This standard is applicable to CNG/bio-CNG fuel system components intended to be used on vehicles using Compressed natural gas/bio-compressed natural gas in accordance with IS 15320 (Part 1) (mono-fuel or bi-fuel applications or dual fuel applications).

**1.1.2** This standard is not applicable to the following:

1. Liquefied natural gas (LNG) fuel system components located upstream of, and including, the vaporizer;
2. Fuel containers;
3. Stationary gas engines;
4. CNG/bio-CNG fuel systems components for the propulsion of marine craft; and
5. Hydrogen natural gas blend (HCNG) fuel system components.

**1.1.3** This standard is based upon a service pressure for compressed natural gas/bio-compressed natural gas as a fuel at 20 MPa (200 bar) settled at 15 °C. Other service pressures could be accommodated by adjusting the pressure by the appropriate factor (ratio). For example, a 25 MPa (250 bar) service pressure system will require pressures to be multiplied by 1.25. All references to pressure are to be considered gauge pressures unless otherwise specified.

**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 edition of these standards.

**3 DEFINITIONS**

For the purpose of this standard definitions given in IS 15710 shall apply.

**4 TYPES**

CNG/bio-CNG high pressure fuel line (flexible hose) shall be of following types:

1. Type A — This hose shall consist of an inner tube of oil-resistant synthetic rubber, single wire braid reinforcement and an oil-and weather resistant synthetic rubber cover. A ply or braid of suitable material may be used over the inner tube and/or over the wire reinforcement to anchor the synthetic rubber to the wire; and
2. Type AT — This hose shall be of the same construction as Type A, except having a cover designed to assemble with fittings which do not require removal of the cover or a portion thereof.

**5 TYPE TESTS**

**5.1 Dimensions**

Dimensions and tolerances applicable to this hose are given in Table 1.

**Table 1 Dimensions of Flexible Hose**

(*Clause* 5.1)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sl No.**(1) | **Nominal** **Size,** in mm (inch) (2) | **Hose3) Dash** **Size**(3) | **Hose** **ID,**in mm (4) | **Tolerance on ID,**in mm (5) | **Reinforcement Diameter,**in mm (6) | **Hose OD Type A,**in mm (7) | **Hose OD****Type** **AT,**in mm (8) | **Cover4) Thickness Type AT,** in mm (9) |
| + | - | *Max* | *Min* | *Max* | *Min* | *Max* | *Max* | *Min* |
| i) | 4(3/16) | - 3 | 4.8 | 0.6 | 0.2 | 10.1 | 8.9 | 13.5 | 11.9 | 12.5 | 1.52 | 0.76 |
| ii) | 6(1/4) | - 4 | 6.4 | 11.7 | 10.6 | 16.7 | 15.1 | 14.1 |
| iii) | 8(5/16) | - 5 | 7.9 | 13.3 | 12.1 | 18.3 | 16.7 | 15.7 |
| iv) | 9(3/8) | - 6 | 9.5 | 15.7 | 14.5 | 20.6 | 19.0 | 18.1 |
| v) | 10(13/32) | - 6.5 | 10.3 | 0.8 | 0.4 | 16.4 | 15.3 | 21.4 | 19.8 | 18.9 |
| vi) | 12(1/2) | - 8 | 12.7 | 19.0 | 17.5 | 23.8 | 22.2 | 21.5 |
| vii) | 16(5/8) | - 10 | 15.9 | 22.2 | 20.6 | 27.0 | 25.4 | 24.7 |
| viii) | 18(3/4) | - 12 | 19.0 | 26.2 | 24.6 | 31.0 | 29.4 | 28.6 |
| ix) | 22(7/8) | - 14 | 22.2 | 29.4 | 27.8 | 34.1 | 32.5 | 31.8 |
| x) | 25(1) | - 16 | 25.4 | 1.0 | 34.1 | 32.5 | 39.3 | 36.9 | 36.6 |
| xi) | 32(1-1/4) | - 20 | 31.8 | 1.2 | 41.7 | 39.3 | 47.6 | 44.4 | 44.8 | 2.03 | 1.02 |
| xii) | 38(1-1/2) | - 24 | 38.1 | 48.0 | 45.6 | 54.0 | 50.8 | 52.0 | 2.54 | 1.27 |
| xiii) | 50(2) | - 32 | 50.8 | 61.9 | 58.7 | 68.3 | 65.1 | 65.9 |

NOTES

1. Superscript ‘**3)**’ indicates ‘For information only’.
2. Hose dash size = Nominal size, in inch x 16.
3. Superscript ‘**4)**’ indicates cover thickness shall be measured by means of a dial indicator depth gauge having a round foot placed parallel to the hose bridging a groove obtained by stripping a 12.5 to 25.4 width of cover from the hose. A mandrel should be placed in the hose bore to insure freedom from misalignment.

The inside diameter of hose shall be concentric with outside diameter of hose and the outer surface of the reinforcement within the limits given in Table 2.

**Table 2 Hose Concentricity**

(*Clause* 5.1)

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl No.** | **Nominal Hose ID,**in mm (inch) | **Concentricity, FIR ID to OD,** in mm | **Concentricity, FIR ID to Reinforcement,** in mm |
|  |  |  |  |
|  | Up to and including 6 (1/4) | 0.8 | 0.4 |
|  | Over 6 (1/4) to 22 (7/8) inclusive | 1.0 | 0.6 |
|  | Over 22 (78) | 1.3 | 0.8 |

**5.2 Proof Pressure Test**

When tested as per **5** of IS 15711 flexible hose shall not leak at the proof pressure test specified in Table 3.

**5.3 Change In Length Test**

Shall not exceed + 2 percent to - 4 percent change when pressurized to operating pressure specified in Table 3.

**5.4 Burst Test**

One 460 mm free hose length assembly shall not leak or fail below the minimum burst pressure specified in Table 3 when tested as per **5** of IS 15711.

**5.5 Leakage Test**

Two 300 mm free hose length assemblies shall not leak or fail when tested as per **5** of IS 15711 at 1.5 times of operating pressure as specified in Table 3.

**5.6 Cold Bend Test**

One hose assembly shall exhibit no cover cracks or leakage when bent at a minimum bend radius specified in Table 3 and exposed at - 20 °C.

**5.7 Oil Resistance Test**

When tested as per IS 3400 (Part 6) the specimens prepared from the inner tube and the cover shall show a volume increase of not more than 100 percent when measured after removal from oil No. 3 in which it has been immersed for 70 h at 100 ± 2 °C.

**Table 3 Specifications of Flexible Hose**

(*Clauses* 5.2, 5.3, 5.4, 5.5 *and* 5.6)

| **Sl No.**  | **Nominal** **Size,** in mm (inch) | **Burst Pressure MPa,** *Min* | **Proof Pressure,** MPa | **Operating****Pressure,** MPa  | **Min Bend Radius5),**in mm |
| --- | --- | --- | --- | --- | --- |
| (1) | (2) | (3) | (4) | (5) | (6) |
| i) | 4(3/16) | 82.7 | 41.4 | 20.7 | 89 |
| ii) | 6(1/4) | 75.8 | 37.9 | 19.0 | 102 |
| iii) | 8(5/16) | 68.9 | 34.5 | 17.2 | 114 |
| iv) | 9(3/8) | 62.0 | 31.0 | 15.5 | 127 |
| v) | 10(13/32) | 62.0 | 31.0 | 15.5 | 140 |
| vi) | 12(1/2) | 55.2 | 27.6 | 13.8 | 178 |
| vii) | 16(5/8) | 41.2 | 20.7 | 10.3 | 203 |
| viii) | 18(3/4) | 34.5 | 17.2 | 8.6 | 241 |
| ix) | 22(7/8) | 31.0 | 15.5 | 7.8 | 279 |
| x) | 25(1) | 27.6 | 13.8 | 6.9 | 305 |
| xi) | 32(1-1/4) | 17.2 | 8.6 | 4.3 | 419 |
| xii) | 38(1-1/2) | 13.8 | 6.9 | 3.4 | 508 |
| xiii) | 50 (2) | 10.3 | 5.2 | 2.6 | 635 |

**5)** indicates ‘bend radius measured at inside of bend’.

**5.8 Ozone Resistance Test**

When tested as per IS 3400 (Part 20) for ozone resistance test to an atmosphere comprised of air and ozone with an ozone partial pressure of 50 MPa (50 parts ozone per 100 million parts of air at standard atmospheric conditions) at an ambient temperature of 40 °C for 70 h exposure, specimens shall not show evidence of cracking or deterioration when viewed with seven-power magnification while still in a stressed condition.

**5.9 Ageing Test**

When hose is aged for 72 h at 125 ± 2 °C in accordance with IS 3400 (Part 4) the change in tensile strength and elongation at break of the lining and cover when tested in accordance with IS 3400 (Part 1) shall not vary from the corresponding pre-determined un-aged values by more than 40 percent.

**6 ACCEPTANCE TEST**

For the purpose of acceptance test, CNG/bio-CNG high pressure fuel line (flexible hose) having pressure exceeding 2.15 MPa (21.5 bar) approved under this standard shall be so manufactured as to conform following test requirements as specified in relevant clauses of this standard:

1. Proof pressure test;
2. Burst test;
3. Leakage test;
4. Cold bend test;
5. Ozone resistance test; and
6. Ageing test.

**7 MARKING**

**7.1** CNG/bio-CNG high pressure fuel line (flexible hose) with end connections shall be permanently marked with:

1. Manufacturers name, trade-mark or symbol;
2. Part No. or unique identification mark;
3. Type;
4. Nominal size;
5. Working pressure;
6. Date of manufacture or batch number, and
7. CNG/bio-CNG;

**7.2 BIS Certification Marking**

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act,* 2016 and the Rules and Regulations made thereunder. The details of conditions under which the license for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

**8 TECHNICAL INFORMATION TO BE SUBMITTED BY THE COMPONENT MANUFACTURER**

Technical information to be submitted by the component manufacturer for component type approval/type test shall contain at least following information:

1. Name of the hose manufacturer;
2. Manufacturing plant address;
3. Part No.;
4. Type No. (Type A or Type AT);
5. Nominal inner diameter (ID);
6. Nominal outer diameter (OD);
7. Maximum operating pressure; and
8. Drawings with relevant dimensions and materials.

**9 NUMBER OF SAMPLES FOR TESTING**

Samples of free hose length of CNG/bio-CNG high pressure hose assembly with or without end connections having preferably BSP threading shall be submitted as per Table 4 for complete testing as per this standard:

**Table 4 Number of Samples for Testing**

(*Clause* 9)

|  |  |  |
| --- | --- | --- |
| **Sl No.** | **Free Hose Length Sample** | **Minimum Quantity** |
|  |  |  |
| i) | 460 mm length with end connections | 3 |
| ii) | 460 mm length without end connections | 1 |
| iii) | 300 mm length with end connections | 2 |
| iv) | 300 mm length without end connections | 2 |
| v) | 150 mm × 150 mm slabs of cover and lining material | 4 |

**10 CHANGES IN TECHNICAL SPECIFICATIONS OF A TYPE APPROVED COMPONENT AND EXTENSION OF APPROVAL**

Any modification in technical specification of already type approved component shall require re-type test/extension of approval at the discretion of certification authority, based on the justification provided by the component manufacturer and reviewed by the certification authority, which has granted type approval.

**ANNEX A**

(*Clause* 2)

**LIST OF REFERRED STANDRADS**

|  |  |
| --- | --- |
| *IS No.* | *Title* |
| IS 3400 (Part 1) : 2021/ISO 37 : 2017 | Methods of test for vulcanized rubber — Part 1 Tensile stress-strain properties (*fourth revision*) |
| IS 3400 (Part 4) : 2012/ ISO 188 : 2011 | Methods of test for vulcanized rubber — Part 4 Accelerated ageing and heat resistance (*third revision*) |
| IS 3400 (Part 6) : 2018/ISO 1817 : 2015 | Methods of test for vulcanized rubbers — Part 6 Determination of the effect of liquids (*fourth revision*) |
| IS 3400 (Part 20) : 2018/ISO 1431-1 : 2012 | Methods of test for vulcanized rubbers — Part 20 Resistance to ozone cracking — Static strain test (*second revision*) |
| IS 14272 : 2011 | Automotive vehicles — Types — Terminology |
| IS 15710 : 2024  | Road vehicles — Compressed Natural Gas (CNG)/bio-compressed natural gas (bio-CNG) fuel system components — General requirements and definitions |
| IS 15711 : 20242) | Road vehicles — Compressed natural gas (CNG)/bio-compressed Natural gas (bio-CNG) fuel system components — Performance and general test methods |

**ANNEX B**

(*Foreword*)

**COMMITTEE COMPOSITION**

Automotive Vehicles Running on Non-Conventional Energy Sources Sectional Committee, TED 26

| *Organization* | *Representative(s)* |
| --- | --- |
| Automotive Research Association of India (ARAI), Pune | Dr S. S. Thipse **(*Chairperson*)**  Shri A. D. Dekate  |
| A B Process Technologies, Pune | Shri Kunal Chopde |
| Ashok Leyland Ltd, Chennai | Shrimati Suchismita C.  Shri Muthukumar N. (*Alternate*) |
| Automotive Component Manufactures Association of India, New Delhi | Shri Sanjay Tank  Miss Seema Babal (*Alternate*) |
| Bajaj Auto Ltd, Pune | Shri Milind J. Pagare  Shri Arvind V. Kumbhar (*Alternate*) |
| Bosch Limited, Bengaluru | Shri Bharadwaj M. Krishnamurthy  Shri Vikram K. (*Alternate*) |
| Central Institute of Road Transport, Pune | Shri Samir Sattigeri  Shri V. V. Joshi (*Alternate*) |
| Central Pollution Control Board, New Delhi | Shri A. Sudhakar Shri Suneel Dave (*Alternate* I) Shri Kedarnath Das (*Alternate* II) |
| CLH Gaseous Fuel Applications Ltd, Gurugram | Shri Shishir Agrawal  Shri Gagan Agrawal (*Alternate*) |
| Delhi Transport Corporation, New Delhi |  Shri Vikas Batra  |
| GAIL (India) Limited, New Delhi | Shri Ashish Kumar Mittal  Shri Lokesh Mehta (*Alternate*) |
| Indian Auto LPG Coalition, Faridabad | Shri Shishir Agrawal  Shri Suyash Gupta (*Alternate*) |
| Indian Institute of Petroleum, Dehradun | Shri Wittison Kamei  Shri Robindro Lairenlakpam (*Alternate*) |
| Indian Institute of Science, Bengaluru | Prof R.V. Ravikrishna  |
| Indian Institute of Technology Ropar, Rupnagar | Shri Dhiraj Kumar Mahajan  Dr Debaprasad Mandal (*Alternate*) |
| Indian Oil Corporation Ltd, (R & D Centre), Faridabad | Dr M. Sithananthan  |
| Indian Rubber Manufacturers Research Association, Thane, Mumbai | Dr K. Raj Kumar  Dr Bharat Kapgate (*Alternate*) |
| International Centre for Automotive Technology (ICAT), Manesar | Shri Vaibhav Prashant Yadav  Shri Vijayanta Ahuja (*Alternate*) |
| Mahindra & Mahindra Ltd, Mumbai | Shri Rajamani Parthiban  Shri Shailesh Kulkarni (*Alternate*) |
| Mahindra & Mahindra Ltd (Truck and Bus Division), Pune | Shri V. G. Kulkarni  |
| Maruti Suzuki India Limited, Gurugram  | Shri Gururaj Ravi Shri Arun Kumar (*Alternate*) |
| Minda Emer Technologies Limited, Gurugram  | Shri Vivek Jain  Shri Bibhuti Kumar (*Alternate*) |
| Ministry of New and Renewable Energy, New Delhi | Shri Dipesh Pherwani  |
| Petroleum and Explosive Safety Organization, Nagpur | Shri D. K. Gupta  Shri Vivek Kumar (*Alternate*) |
| Petronet LNG Ltd, New Delhi | Shri Pankaj Wadhwa (*Alternate*) |
| Prodair Air Products India Private Ltd, Pune | Shri Ravi Subramanian  Shri Arun Kuruvangattil (*Alternate*) |
| Renault India Private Limited, Mumbai | Shri Rajendra Khile  Shri Vijay Dinakaran (*Alternate*) |
| Rohan BRC Gas Equipment Pvt Ltd, Ahmedabad | Shri Stefano De Carolis  Shri Parthiv Shukla (*Alternate*) |
| Society of Indian Automobile Manufacturers, New Delhi | Shri P. K. Banerjee  Dr Sandeep Garg (*Alternate*) |
| Swagelok – Bombay Fluid System components Pvt Ltd, Mumbai | Shri Sachin Koulgi  Shri Harish Takke (*Alternate*) |
| Tata Motors Ltd, Pune | Shri P. S. Gowrishankar  Shri Shailendra Dewangan (*Alternate*) |
| TVS Motor Company Ltd, Hosur | Shri V. Pattabiraman  Shri K. M. Srikanth (*Alternate*) |
| Vanaz Engineers Ltd, Pune | Shri S. J. Vispute  Shri J. S. Dhumal (*Alternate*) |
| Volkswagen India Pvt Ltd, Mumbai | Shri Joreg Bouzek  Shri Pankaj Gupta (*Alternate*) |
| BIS Directorate General | Shri Deepak Agarwal, Scientist ‘F’/ Senior Director and Head (Transport Engineering) [Representing Director General (*Ex-officio*)] |
| *Member Secretary*Shri Gaurav JayaswalScientist ‘C’/Deputy Director(Transport Engineering), BIS |