INDIAN STANDARDS ON TRANSFORMERS

Shyam Kumar
Scientist C

BUREAU OF INDIAN STANDARDS – AN OVERVIEW

BIS is the **NATIONAL STANDARD BODY OF INDIA** established for the harmonious development of the **activities of standardization, marking and quality certification** of goods and for matters connected therewith or incidental thereto.

BIS has been providing traceability and tangibility benefits to the national economy in a number of ways – **providing safe reliable quality goods; minimizing health hazards to consumers; promoting exports and imports substitute; control over proliferation of varieties** etc. through standardization, certification and testing

ORIGIN OF BIS

1947 — Indian Standards Institution (ISI)

1986 — BIS Act 1986

2016 — BIS Act 2016

The Prime Minister Pt. Jawahar Lal Nehru performing the foundation stone laying ceremony of the Indian Standard Institution near Mathura Road Delhi on 21.8.1954 standing on his left are : Shri T. T. Krishnamachari the then Minister of Commerce and Industry and Shri Sri Ram alongwith Dr. Verman.

Shri C. Rajagopalachari President of ISI (1947-48) addressing a Calcutta conference on Standardization and quality control held on 8-14 Feb 1947

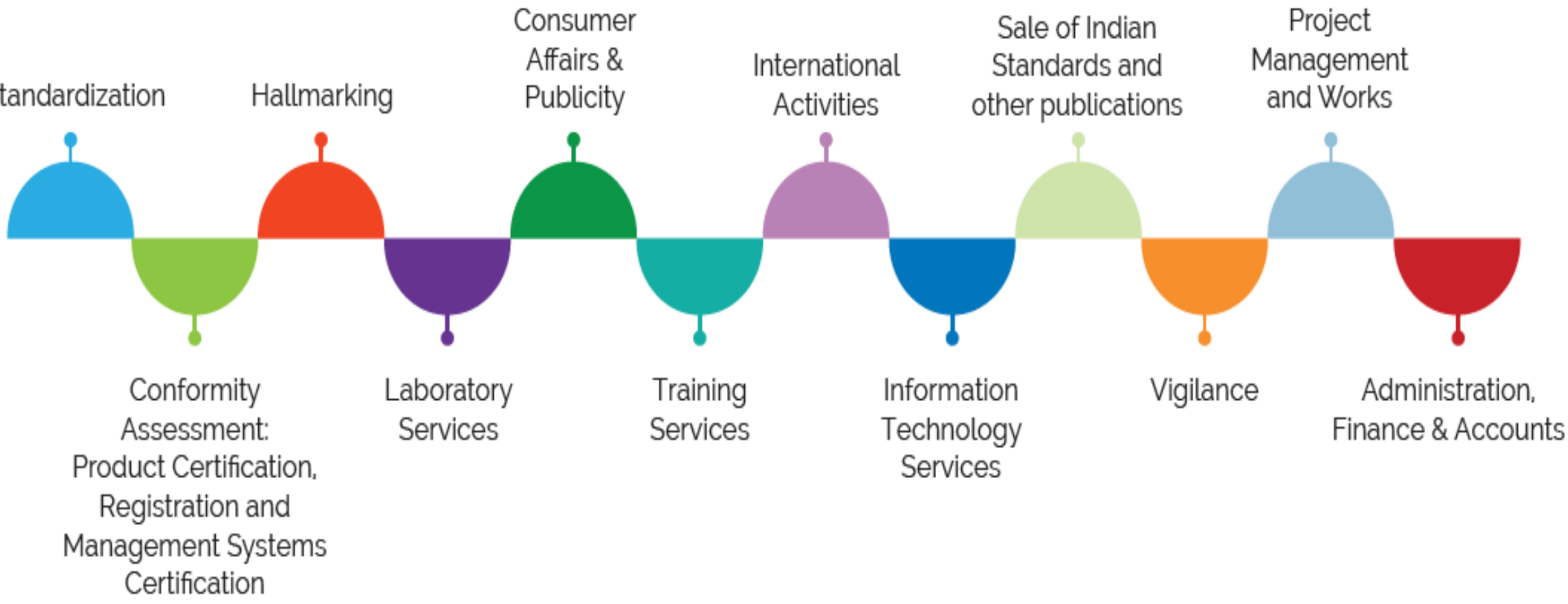
Dr. Lal C Verman as Director ISI and Vice-President ISO attending 4th ISO Council Meeting held from 3-7 July 1950.

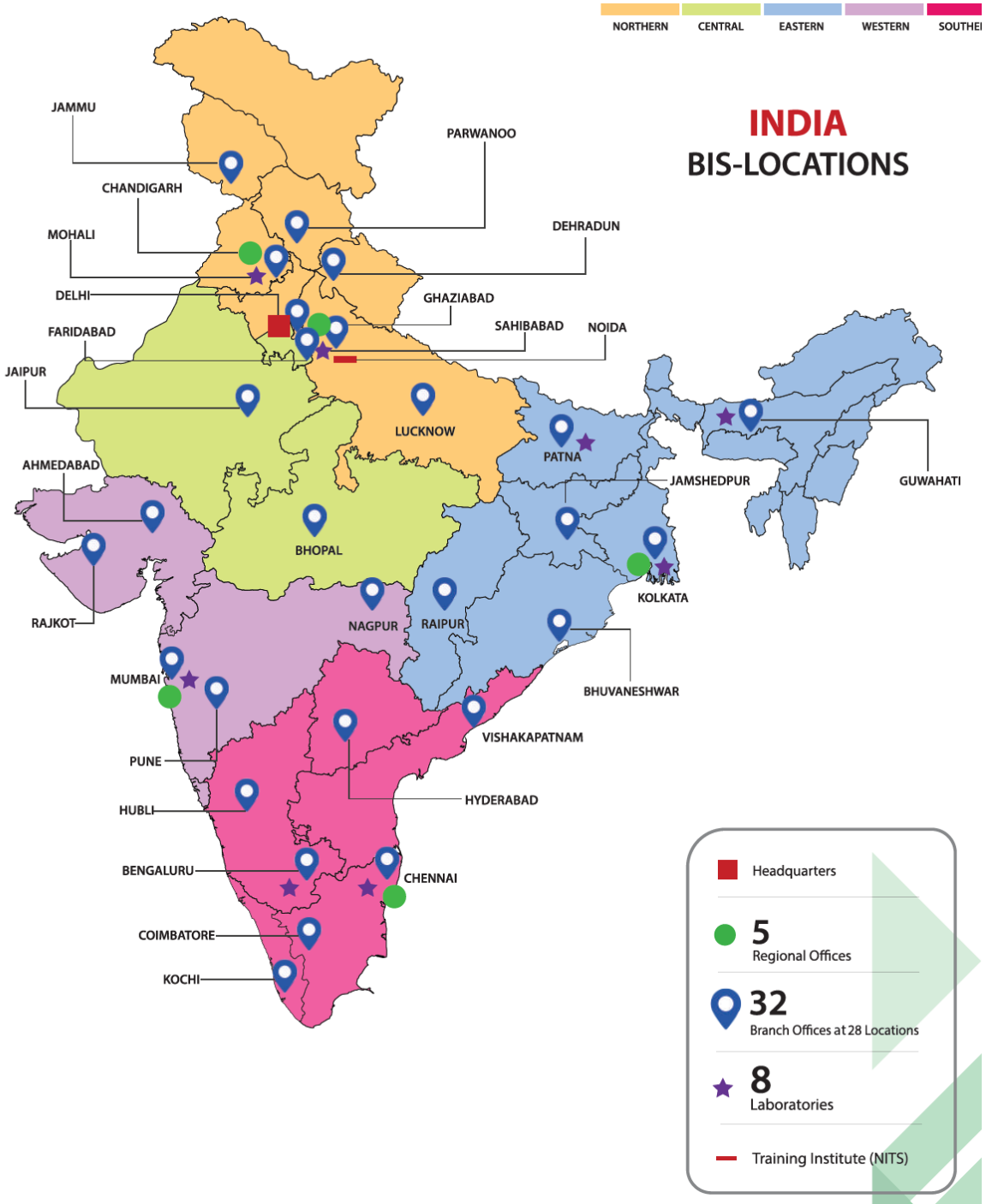
OBJECTIVES OF BIS

Harmonious development of the activities of standardization, conformity assessment and quality assurance of goods, articles, processes, systems and services and for matters connected therewith or incidental thereto.

To provide thrust to standardization and quality control for growth and development of industry on one hand and to meet the needs of consumers on the other.

ACTIVITIES


Standardization
Conformity Assessment: Product Certification, Registration and Management Systems Certification
Hallmarking
Laboratory Services
Consumer Affairs & Publicity
Training Services
International Activities
Information Technology Services
Sale of Indian Standards and other publications
Vigilance
Project Management and Works
Administration, Finance & Accounts



ORGANIZATIONAL NETWORK

BIS has its Headquarters at New Delhi. It has 5 Regional Offices (ROs). Under the Regional Offices are the Branch Offices (BOs).

To cater to the needs of testing of samples, BIS has eight laboratories in the country.

WHY DO WE NEED STANDARDS?


BS
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Safety
Interoperability
Performance
?
Sustainability
And Many more….
Reliability

ADVANTAGES OF STANDARDIZATION

- Rationalize different varieties of products.
- Reduced Operational Costs
- Facilitate the exportation and marketing of products.
- Simplify purchasing management.
- Establish quality and safety level to the service and products.
- Inform to the characteristic of the products.
- Establish quality, environmental and safety policies.
- Facilitate issuing of quality control orders.

Areas of Standardization

Chemical	Civil Engineering	Electronics and Information Technology	ELECTROTECHNICAL	Food and Agriculture
Management and Systems	Mechanical Engineering	Medical Equipment and Hospital Planning	Metallurgical Engineering	Petrochemical, Coal & Related Products
Production and General Engineering	Textiles	Transport Engineering	Water Resources	Services Sector

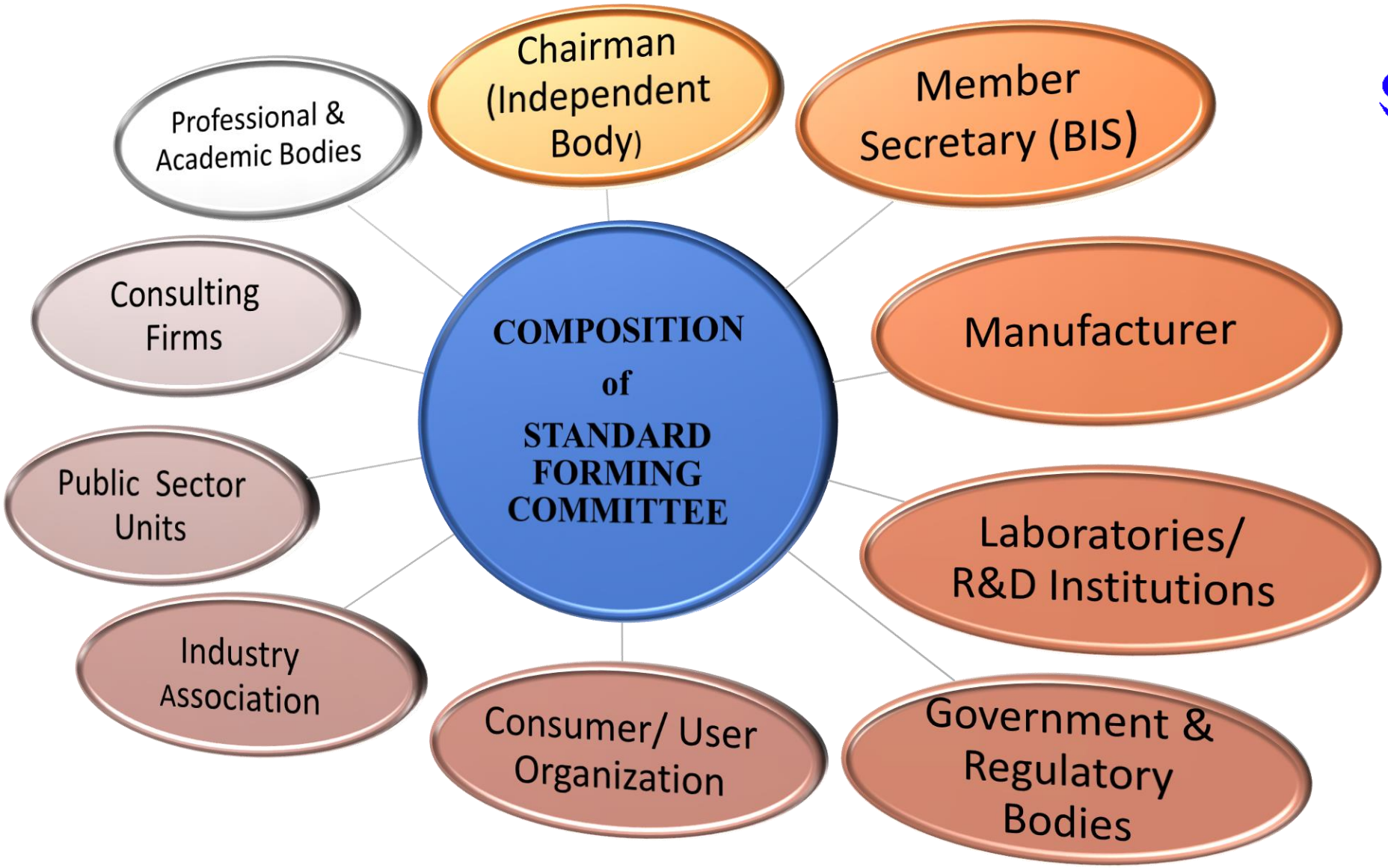
LIST OF SECTIONAL COMMITTEES

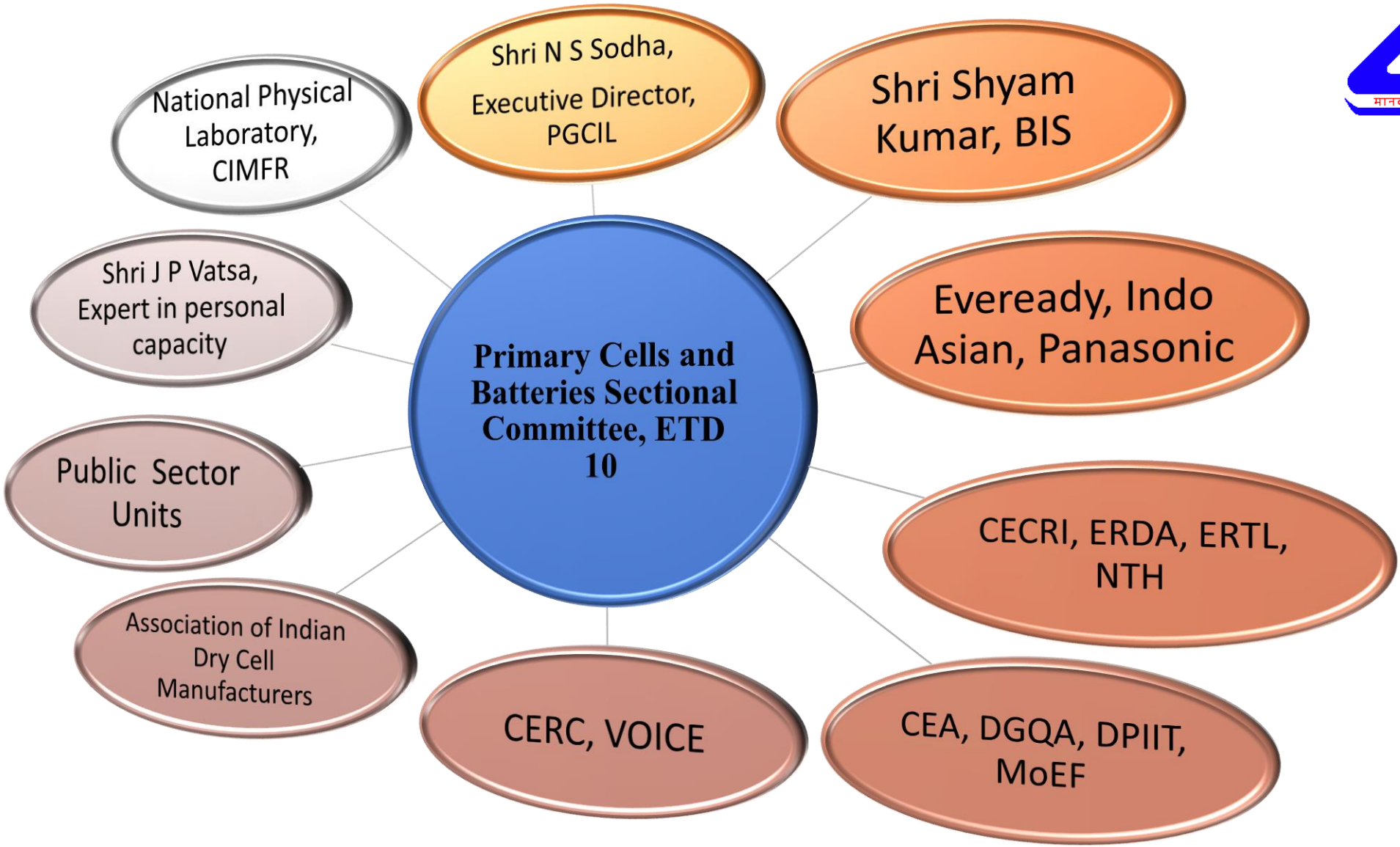
Sl. No	SC NO	SECTIONAL COMMITTEE NAME
1	ETD 01	BASIC ELECTROTECHNICAL STANDARDS AND POWER QUALITY
2	ETD 02	SOLID ELECTRICAL INSULATING MATERIALS AND INSULATING SYSTEMS
3	ETD 03	FLUIDS FOR ELECTROTECHNICAL APPLICATIONS
4	ETD 06	ELECTRICAL INSULATORS AND ACCESSORIES
5	ETD 07	LOW VOLTAGE SWITCHGEAR & CONTROLGEAR
6	ETD 08	HIGH VOLTAGE SWITCHGEAR AND CONTROLGEAR
7	ETD 09	POWER CABLES
8	ETD 10	PRIMARY CELLS AND BATTERIES
9	ETD 11	SECONDARY CELLS AND BATTERIES
10	ETD 12	MEASURING EQUIPMENT FOR BASIC ELECTRICAL QUANTITIES
11	ETD 13	EQUIPMENT FOR ELECTRICAL ENERGY MEASUREMENT AND LOAD CONTROL

Sl. No	SC NO	SECTIONAL COMMITTEE NAME
12	ETD 14	ELECTRICAL WIRING ACCESSORIES
13	ETD 15	ROTATING MACHINERY
14	ETD 16	TRANSFORMERS
15	ETD 18	INDUSTRIAL PROCESS MEASUREMENT AND CONTROL
16	ETD 19	HIGH VOLTAGE ENGINEERING
17	ETD 20	ELECTRICAL INSTALLATIONS
18	ETD 21	ELECTRIC WELDING EQUIPMENT
19	ETD 22	ELECTRICAL APPARATUS FOR EXPLOSIVE ATMOSPHERES
20	ETD 23	LAMPS AND RELATED EQUIPMENTS
21	ETD 25	LIFTS AND ESCALATORS
22	ETD 28	SOLAR PHOTOVOLTAIC ENERGY SYSTEMS
23	ETD 29	POWER CAPACITORS
24	ETD 30	SURGE ARRESTERS
25	ETD 31	POWER ELECTRONICS

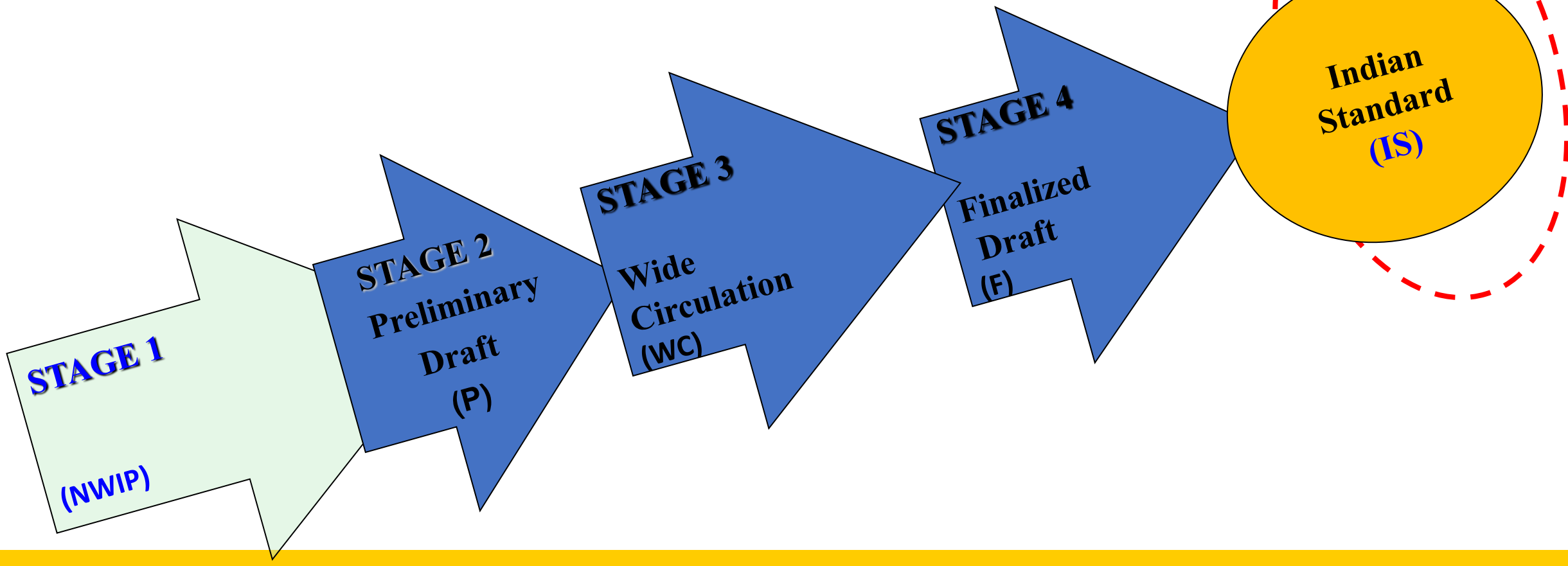
Sl. No	SC NO	SECTIONAL COMMITTEE NAME
26	ETD 32	ELECTRICAL APPLIANCES
27	ETD 33	WINDING WIRES
28	ETD 34	INSTRUMENT TRANSFORMERS
29	ETD 35	POWER SYSTEMS RELAYS
30	ETD 36	TOOLS AND EQUIPMENT FOR LIVE WORKING
31	ETD 37	CONDUCTORS AND ACCESSORIES FOR OVERHEAD LINES
32	ETD 39	FUSES
33	ETD 40	HVDC POWER SYSTEMS
34	ETD 42	WIND TURBINES
35	ETD 43	STANDARDIZATION OF ENVIRONMENTAL ASPECTS FOR ELECTRICAL AND ELECTRONIC PRODUCTS
36	ETD 44	SAFETY OF MACHINERY
37	ETD 46	GRID INTEGRATION
38	ETD 47	RAILWAY ELECTRIC TRACTION EQUIPMENT

Sl. No	SC NO	SECTIONAL COMMITTEE NAME
39	ETD 48	STANDARDIZATION IN THE FIELD OF UHV AC TRANSMISSION SYSTEMS
40	ETD 49	ILLUMINATION ENGINEERING AND LUMINAIRES (NEW COMMITTEE)
41	ETD 50	LVDC POWER DISTRIBUTION SYSTEMS
42	ETD 51	ELECTROTECHNOLOGY IN MOBILITY
43	ETD 52	ELECTRICAL ENERGY STORAGE SYSTEMS
44	ETD 53	STANDARDIZATION OF THE MANAGEMENT OF ASSETS IN POWER NETWORKS


COMPOSITION
of
STANDARD
FORMING
COMMITTEE
Chairman (Independent Body)
Member Secretary (BIS)
Professional & Academic Bodies
Consulting Firms
Manufacturer
Public Sector Units
Laboratories/ R&D Institutions
Industry Association
Consumer/ User Organization
Government & Regulatory Bodies

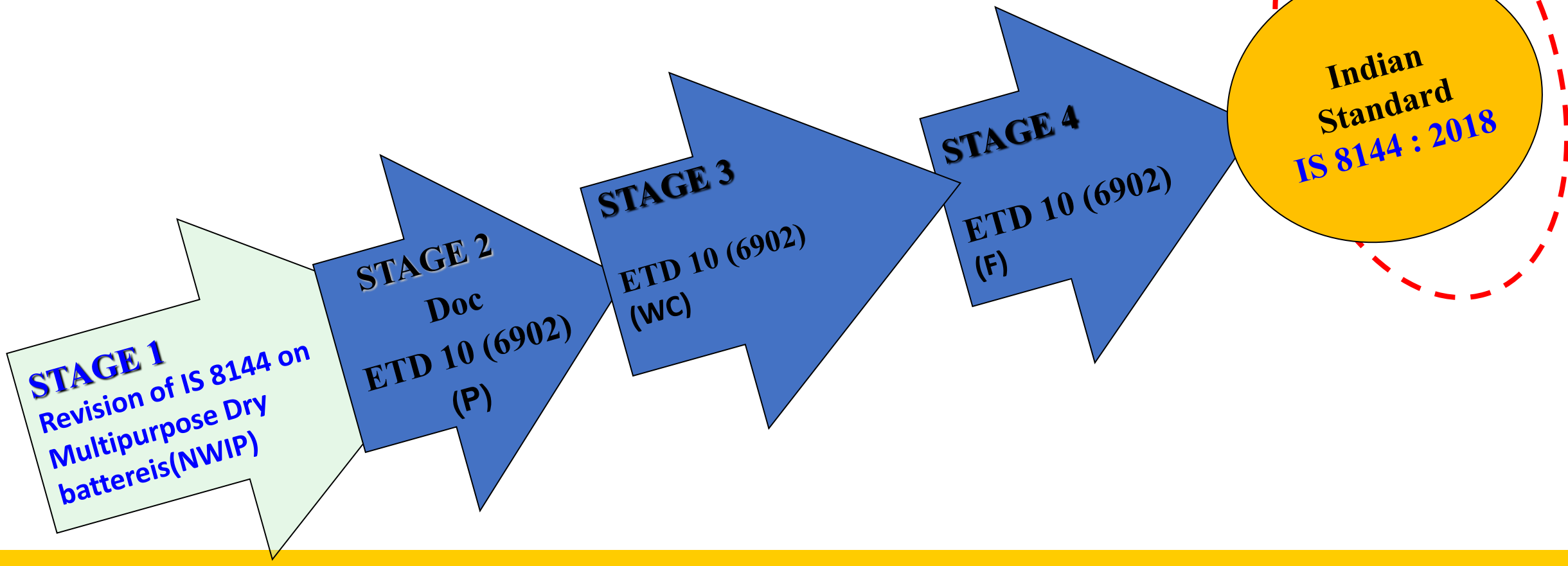

Primary Cells and Batteries Sectional Committee, ETD 10
Shri N S Sodha, Executive Director, PGCIL
Shri Shyam Kumar, BIS
National Physical Laboratory, CIMFR
Shri J P Vatsa, Expert in personal capacity
Eveready, Indo Asian, Panasonic
Public Sector Units
CECRI, ERDA, ERTL, NTH
Association of Indian Dry Cell Manufacturers
CERC, VOICE
CEA, DGQA, DPIIT, MoEF

STAGES OF STANDARD FORMULATION



Stage 2 : Building consensus among committee members
Stage 3: Building national consensus
Stage 4 – Collaboration of Science, Technology and Expertise

STAGES OF STANDARD FORMULATION



Stage 2 : Building consensus among committee members
Stage 3: Building national consensus
Stage 4 – Collaboration of Science, Technology and Expertise

INTERNATIONAL ACTIVITIES
(Membership of International Bodies)

- India is an active member of IEC/ISO.

- IEC Committees
  - Technical Committees

    Participating member – 102, Observer member – 69

- ISO Committees
  - Participating member – 489, Observer member – 185

INTERNATIONAL ACTIVITIES
(Membership of International Bodies - ETD)

- IEC Committees
- Technical Committees

Participating member – 47, Observer member – 15

- Sub Committees

Participating member – 23, Observer member – 16

- ISO Committees

Participating member – 02, Observer member – 01

INTERNATIONAL ACTIVITIES
(Membership of International Bodies)

- **Working Groups (WG)/Maintenance Team (MT) Project Team (PT)**

- More than 100 experts are contributing in the International Standardization work.

- Shri Vimal Mahendru: Chairman of SyC LVDC
- Shri Ritwik Anand : Member of SyC LVDC/WG1
- Shri Shyam Kumar : Member MT 60076-1, IEC TC 14

•National Institute of Training for Standardization (NITS)

•Quality training in the fields of standardization, quality assurance, management systems, certification, laboratory testing, etc.

•https://www.bis.gov.in/index.php/training-2/overview-of-nits/

EARLIER INDIAN STANDARDS ON DISTRIBUTION TRANSFORMERS

- **IS 1180(Part 1): 1989** - Outdoor type three phase distribution transformers upto and including 100kVA 11 kV Part 1: Non sealed type.

- **IS 1180(Part 2): 1989** - Outdoor type three phase distribution transformers upto and including 100kVA 11 kV Part 2: Sealed type.

- Scope was limited upto three phase 100 kVA, 11kV.

IS 1180 (PART 1) : 2014

- IS1180 (Part 1) has been revised by taking into account the needs of various stakeholders and technological developments taken place on transformer.

- Title of IS 1180 (Part 1) : 2014 — Outdoor/Indoor Type Oil Immersed Distribution Transformers Up to and Including 2 500 kVA, 33kV — Specification: Part 1 Mineral Oil Immersed (Fourth Revision).

- Four amendments have been published.

IS 1180 (PART 3) : 2021

- IS 1180 (Part 3) : 2021 — This standard specifies the requirements and tests including standard loss levels of natural/synthetic organic ester liquid immersed, natural air-cooled, outdoor/indoor type, double-wound distribution transformers for use in power distribution systems with nominal system voltages up to and including 33 kV and of following types and ratings:

- a) Three phase ratings up to and including 200 kVA both non-sealed and sealed type;
- b) Three phase ratings higher than 200 kVA, up to and including 2 500 kVA both non-sealed type and sealed type; and
- c) Single phase ratings up to and including 100 kVA sealed type.

SALIENT FEATURES OF
IS 1180 (Part 1): 2014 & IS 1180 (Part 3) : 2021

- Includes Outdoor type as well as Indoor type three phase Distribution Transformers upto and including 2500 kVA with nominal system voltage upto and including 33 kV (both sealed and non-sealed).

- Includes Single phase Distribution Transformers upto and including 100 kVA (sealed type).

- Following types of transformers are not covered:

a) Inverter duty transformers;
b) Traction transformers;
c) Instrument transformers;
d) Transformers for static converters;
e) Starting transformers;
f) Testing transformers;
p) Rectifier transformers; and
h) Earthing transformers;
g) Welding transformers;
j) Mining transformers;
k) Transformers for solar, wind power application;
m) Transformers for railways (locomotive and other applications);
n) Furnace transformers;
q) Dual ratio in primary/secondary windings transformers.

- relevant CEA guidelines must be followed while using mineral oil filled DT's indoor.

- In case of indoor transformers and transformers installed in an enclosure, suitable ventilation, if required, shall be provided to maintain service conditions as per IS 2026 (Part 1).

WHAT IS A DISTRIBUTION TRANSFORMER

A distribution transformer is a transformer that provides the final voltage transformation by stepping voltages down within a distribution circuit or from a distribution circuit to an end user or application.

NOTE — The distribution circuit voltages are 3.3 kV, 6.6 kV, 11 kV, 22 kV and 33 kV in the country. The power supply for the end users is 415 volt, 3 Phase (240 volt, 1 phase), 50 Hz. Transformers with primary voltages of 3.3, 6.6, 11, 22 or 33 kV and secondary voltage of 433 volt, 3 Phase (and 250 volt single phase) are called Distribution Transformers. The maximum rating of these transformers for the purpose of this standard is considered up to 2 500 kVA, 3 Phase.

SERVICE CONDITIONS

- Service conditions shall be as per IS 2026 (Part 1) : 2011.

- In case of indoor transformers and transformers installed in an enclosure, suitable ventilation, if required, shall be provided to maintain service conditions as per IS 2026 (Part 1).

RATINGS

a) Three phase distribution transformers

Sl No.	Standard Ratings (kVA)
1.	*6.3, *10,16, *20, 25, *40, 63, 100, 160, 200, 250, 315, 400, 500, 630, 800, 1 000, 1 250, 1 600, 2 000 and 2 500

b) Single phase distribution transformers

Sl No.	Standard Ratings (kVA)
1.	5, 10, 16, 25, *50, *75 & *100

BASIC INSULATION LEVEL

- Basic insulation level values given are MINIMUM VALUES.

NOTE: Insulation coordination of all relevant fittings and accessories corresponding to higher BIL values shall be ensured.

- a) For three phase DTs

Sl No. (1)	Nominal System Voltage (kV) (2)	Minimum BIL (kVp) (3)
1.	3.3	40
1.	6.6	60
1.	11	75
1.	22	125
1.	33	170

➢b) For single phase DTs

Sl No. (1)	**Nominal System Voltage (kV)** (2)	**Minimum BIL (kVp)** (3)
1.	11	75
1.	22	125
1.	33	170

TAPPINGS

➢No taps are generally required upto 100 kVA, unless specified.

➢Standard tapping range is given below:

Transformer range	No. of tap positions	Voltage variation
3 phase transformers upto and including 200 kVA	4	+2.5% to -5% of HV in steps of 2.5 percent
3 phase transformers higher than 200 kVA and upto and including 2500 kVA	7	+5% to -10% of HV in steps of 2.5 percent for variation of HV
NOTE: 1) For ratings 500 kVA and above, on load tap changers may be provided for variation of HV voltage from +5 percent to –15 percent in steps of 2.5 percent 2) Off-circuit tap-changing is permitted		

➢Provision of any other tapping range and tapping step is subject to agreement between the user and the supplier

LOSSES

- Losses given in Table 3, Table 6 and Table 9 are **MAXIMUM TOTAL LOSSES**

- These losses are only for transformers upto 11kV voltage class

- For 22 kV and 33 kV class higher losses values permitted (as given in the next slide)

- Losses for non-preferred ratings are as per agreement between user and supplier.

➢Maximum total losses for voltage class above 11 kV is given in table below:

Voltage class	Maximum total losses for 3 phase transformers upto and including 200 kVA	Maximum total losses for 3 phase transformers higher than 200 kVA and upto and including 2500 kVA	Maximum total losses for single phase transformers upto and including 25 kVA
Above 11 kV and upto and including 22 kV	Shall not exceed by 5% of the maximum total losses given in Table 3	Shall not exceed by 5% of the maximum total losses given in Table 6	Shall not exceed by 7.5% of the maximum total losses given in Table 9
Above 22 kV and upto and including 33 kV	Shall not exceed by 7.5% of the maximum total losses given in Table 3	Shall not exceed by 7.5% of the maximum total losses given in Table 3	Shall not exceed by 10% of the maximum total losses given in Table 3

LIMITS OF TEPERATURE RISE – IS 1180 (Part 1) : 2014

➢Limits are given as below:

Transformer class	Limits for temperature rise
3 phase transformers upto and including 200 kVA	For **transformer winding - 40°C** (when measured by resistance method) **For top oil - 35°C** (measured by thermometer)
3 phase transformers higher than 200 kVA and upto and including 2500 kVA	For **transformer winding - 45°C** (when measured by resistance method) **For top oil - 40°C** (measured by thermometer)
single phase transformers upto and includng 25 kVA	For **transformer winding - 40°C** (when measured by resistance method) **For top oil - 35°C** (measured by thermometer)

➢These are **maximum limits of temperature rise.**

LIMITS OF TEPERATURE RISE – IS 1180 (Part 3) : 2021

➢Limits are given as below:

Transformer class	Limits for temperature rise – Type A Insulation System	Limits for temperature rise – Type B Insulation System
3 phase transformers upto and including 200 kVA	For **transformer winding - 45°C** (when measured by resistance method) **For top oil - 40°C** (measured by thermometer)	For **transformer winding - 55°C** (when measured by resistance method) **For top oil - 50°C** (measured by thermometer)
3 phase transformers higher than 200 kVA and upto and including 2500 kVA	For **transformer winding - 50°C** (when measured by resistance method) **For top oil - 45°C** (measured by thermometer)	For **transformer winding - 60°C** (when measured by resistance method) **For top oil - 55°C** (measured by thermometer)
single phase transformers upto and includng 25 kVA	For **transformer winding - 45°C** (when measured by resistance method) **For top oil - 40°C** (measured by thermometer)	For **transformer winding - 55°C** (when measured by resistance method) **For top oil - 50°C** (measured by thermometer)

➢These are **maximum limits of temperature rise.**

% IMPEDENCE VALUES

- Values of % impedance given in IS 1180 series are only **RECOMMENDED VALUES**.

- Manufacturers can prefer other values while designing.

- Higher impedance values might lead to poor regulation, more stray losses and heating, therefore small variation in these values is suggested.

STANDARD MATERIALS

Major material used in the transformer shall conform to the following Indian Standards:

a) Cold rolled grain oriented electrical steel – IS 3024
b) Amorphous core material – IS 16585
c) Copper/Aluminum conductor – IS 191, IS 1897, IS 7404, IS 12444, IS 13730/IS 6162 series as given in Annex A.
d) Kraft paper – IS 9335 series as given in Annex A.
e) Press board – IS 1576
f) Mineral oil – IS 335
g) Synthetic Organic Ester – IS 16081
h) Natural Ester – IS 16659

MINIMUM CLEARENCES IN AIR

- Specified clearances values are MINIMUM values.

- Clearances above these values are acceptable

- Clearances between coils and no. of coils are not given as these are design parameters

MARKING PLATE DIMENSIONS

➢Dimensions of Rating Plate, Terminal Marking Plate and Combined Rating and Terminal Plate can be changed subject to agreement between the user and the supplier.

MOUNTING ARRANGEMENT

➢Mounting arrangement is given in cl 14:

a) Upto 200 kVA:

- two channels of minimum size 75 mm × 40 mm shall be provided.
- Note added under Fig. 6 – Any other mounting dimensions are subject to agreement between the user and the supplier.

b) Beyond 200 kVA

- Bidirectional rollers can also be used as per mutual agreement between the user and the supplier.
- Any other mounting dimensions are subjected to agreement between the user and the supplier.'

- Suitable pole mounting arrangement may be alternatively provided for 3 phase transformers upto 500 kVA, subject to agreement between user and supplier.

- Single phase transformers are pole mounted type and shall be provided with two mounting lugs suitable for fixing the transformer to a single pole by means of two bolts of 20 mm diameter. Both mounting lugs are made with steel of minimum 5 mm thickness.

PAINT THICKNESS

➢Measuring Paint Thickness is not a part of the tests specified in IS 1180

➢This is for guidance to the stakeholders. It is to be ensured by the Inspecting agencies at the time of factory visit.

CONSTRUCTION REQUIREMENTS FOR TRANSFORMER TANK

- Given under clause 15.

- Minimum thickness at the corrugations shall be 1.0 mm

STANDARD FITTINGS given under clause 20.1

➢These fittings shall be provided by the manufacturer.

a) Two earthing terminals with the earthing symbol ⏚;
b) Oil level gauge indicating oil level at minimum, 30°C and maximum operating temperature;

NOTES

1 Minimum and maximum positions correspond to the operating temperature of –5°C and 90°C respectively (for non-sealed type transformer).

2 Only minimum position corresponding to the operating temperature of 30°C (for sealed type transformers).

c) Air release device (for non-sealed type transformers);
d) Rating and terminal marking plates;
e) Dehydrating breather shall be provided for non-sealed type transformers;
f) Drain-cum-sampling valve preferably steel with plug for three phase transformers (for ratings above 500 kVA);

NOTE — Valve size shall be as per agreement between the user and the supplier.

g) Thermometer pocket with cap;

h) Oil/Nitrogen/Air filling hole having (1¼″ nominal size thread) with cover (for sealed type transformers without conservator);

j) Lifting lugs for the complete transformer as well as for core and winding assembly;

k) Pressure relief device or explosion vent [for sealed type transformers (for all ratings) and non-sealed type transformers (for ratings above 200 kVA)];

m) One filter valve on the upper side of the tank (for transformers above 200 kVA);

n) HV side neutral grounding strip (where one of the HV bushing terminal is connected to earth);

p) LV earthing arrangement for single phase transformers;

q) Buchholz relay for transformers above 1 000 kVA; and

r) Arcing horns for HT side (one number per phase).’

OPTIONAL FITTINGS given under clause 20.2:

➢These fittings may be provided at the option of the user wherever specified.

a) Dehydrating breather in lieu of plain breathing device for transformers up to 200 kVA;
b) Filter valve for transformers up to 200 kVA;

NOTE — Valve size shall be as per agreement between the user and the supplier.'

a) Suitable rating lightning arrestors for HT side (one number per phase);'
b) Bird guard;
c) Terminal connectors
d) Oil temperature indicator and winding temperature indicators for transformers above 200 kVA;
e) Jacking pads (for transformer above 1 600 kVA);
f) Buchholz relay (for transformers above 200 kVA);
j) Magnetic oil level gauge (for transformer above 1 600 kVA) with low oil level alarm contact;

k) Non return valve (for conducting pressure test);

m) Pressure relief device or explosion vent (upto 200 kVA for non-sealed type transformers);

‘n) Protection relay for sealed type transformers for internal parameters that is pressure, temperature, oil level and gas detection;’

p) 4 Nos anti-theft stainless steel fasteners with breakaway nut shall be provided at top cover (up to 200 kVA). NOTE — IS 3639 describes some of the fittings and accessories.

q) Unidirectional flat rollers (for transformers above 200 kVA);

r) Drain-cum-sampling valve preferably steel with plug for three phase transformers (for transformers upto 500 kVA); and NOTE — Valve size shall be as per agreement between the user and the supplier.

s) **Self protection/disconnection devices** subject to agreement between the user and the supplier:

1) Thermo-magnetic circuit breaker as self protection device on secondary side as per IS/IEC 60947-2 : 2003; and

2) Expulsion fuse as disconnection device on primary side as per IS 9385 (Part 2) : 1980.

NOTE— Additional requirements for transformers with self protection/disconnection devices are under preparation.

TEST REQUIREMENTS

All routine, type and special tests as described in 21.2 to 21.4 shall be performed as per relevant parts of IS 2026.

➢ ROUTINE TESTS (to be conducted on all units)

a) Measurement of winding resistance [IS 2026 (Part 1)].
b) Measurement of voltage ratio and check of phase displacement [IS 2026 (Part 1)].
c) Measurement of short-circuit impedance (principal tapping, when applicable) and load loss at 50 percent and 100 percent load [IS 2026 (Part 1)].
d) Measurement of no-load loss and current [IS 2026 (Part 1)].
e) Measurement of insulation resistance [IS 2026 (Part 1)].
f) Induced over-voltage withstand test [IS 2026 (Part 3)].
g) Separate-source voltage withstand test [IS 2026 (Part 3)].

Note: For single phase transformer with 11/√3 or 22 / √3 or 33/√3 kilo volts and with 1.0 kV neutral bushing, this test shall be conducted at test voltage of neutral (3 kV rms for one minute).'

h) Pressure test (see 21.5).
i) Oil leakage test (see 21.5).

'

➢TYPE TESTS (to be conducted on one unit)

a. Lightning impulse test [IS 2026 (Part 3)].
b. Temperature-rise test [IS 2026 (Part 2)].
c. Short-circuit withstand test [IS 2026 (Part 5)] (up to 200 kVA).

NOTE — Routine tests before and after short circuit test shall be conducted as per IS 2026 (Part 1).

a. Pressure test – requirements given for both single phase as well as three phase transformers.

i. Upto 200 kVA:

Test requirements for corrugated tanks added
Limits of deflection given.
Permanent deflection is not applicable for corrugations

ii. Beyond 200 kVA

Test requirements for corrugated tanks added
Limits of deflection given.
Permanent deflection is not applicable for corrugations

- Additional information on leakage test has been provided in ANNEX E

c) SPECIAL TESTS (to be conducted on one unit)

a) Determination of sound levels [IS 2026 (Part 10)]
b) Short-circuit withstand test [IS 2026 (Part 5)] (above 200 kVA) NOTE — Routine tests before and after short circuit test shall be conducted as per IS 2026 (Part 1).
c) No load current at 112.5 percent voltage (see 5.9.3).
d) Paint adhesion tests. The test is performed as per ASTM D3359 (Standard Test Methods for measuring adhesion by Tape test).
e) BDV and moisture content of oil/ester liquid in the transformer .

NOTE — Tests at (d) and (e) may be carried out on more than one unit subject to agreement between user and supplier.

➢These are subject to agreement between user and supplier

METHOD OF DECLARING EFFICIENCY

- The efficiency to be declared is the ratio of the output in kW to the input in kW and calculated as under.

- Efficiency = output/input = input- total losses/ input

- Total losses comprise:

  No-load loss, which is considered to be constant at all loads : and

  Load loss, which varies with load.

- The total loss, on load is the sum of above losses.

NORMAL INFORMATION

The following information should be given in all cases:

- Particulars of the specification to be complied with;
- Application of Transformer e.g. normal Distribution Transformer, Solar duty, wind application, Motor starting etc.
- Single or three phase unit;
- Number of phases in system;
- Frequency;
- Indoor or outdoor type;
- Type of cooling;
- Rated power (in kVA)
- Rated voltages (for each winding);
- State if tappings are required and if on-load or off-circuit tap-changers, or links are required.
- Highest voltage for equipment (for each winding);
- Method of system earthing (for each winding);
- Insulation level (for each winding), power frequency test level/impulse level;
- Connection symbol;
- Neutral terminals, if required (for each winding) and their insulation level to earth;
- Special requirements of installation, assembly, transport and handling;
- Fittings required and an indication of the side from which meters, rating plates, oil-level indicator, etc. may be readable.

ADDITIONAL INFORMATION

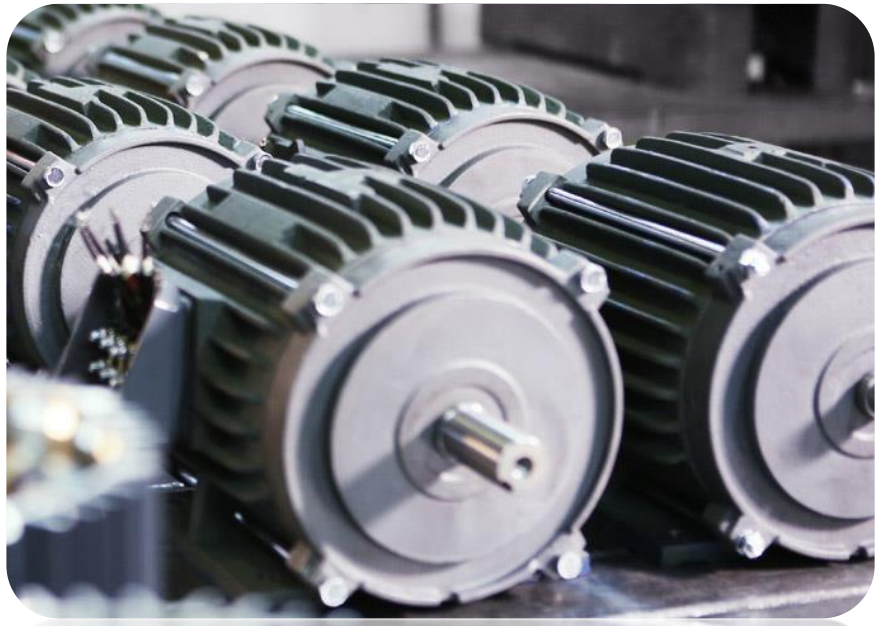
- The following additional information may be required to be given:
- If a lightning impulse voltage test is required, whether or not the test is to include chopped waves [see IS 2026 (Part 3)].
- Impedance voltage at rated current, if specific value is required;
- Altitude above mean sea-level, if in excess of 1 000 m;
- Whether transformers will be subjected to frequent overcurrent, for example, furnace transformers and traction feeding transformers;
- Any other exceptional service conditions;
- Whether noise level measurement is to be carried out;
- Vacuum withstand of the transformer tank, if a specific value is required;
- Type of Tap-changer controls required (if OLTC is provided);
- Type of mounting for example pole mounted, ground mounted etc.
- Any other appropriate information, including reference to any special tests not referred to above which may be required.

IS 2026 SERIES ON POWER TRANSFORMERS

IS 2026 : Part 1 : 2011	**Power transformers Part 1 General**
IS 2026 : Part 2 : 2010	Power transformers Part 2 temperature - Rise
IS 2026 : Part 3 : 2018	Power transformers Part 3 insulation levels dielectric tests and external clearances in air
IS 2026 : Part 4 : 1977	Specification for power transformers Part 4 terminal markings tappings and connections
IS 2026 : Part 5 : 2011	Power transformers Part 5 ability to with stand short circuit
IS 2026 : Part 6 : 2017	Power transformers Part 6 reactors
IS 2026 : PART 7 : 2009	Power transformers Part 7 loading guide for oil - Immersed power transformers
IS 2026 : Part 8 : 2009	Power transformers Part 8 application guide
IS 2026 : Part 10 : 2009	Power transformers Part 10 determination of sound levels

IS 2026 : Part 10 : Sec 1 : 2018	**Power transformers Part 10 determination of sound levels**
IS 2026 : Part 11 : 2021	Power Transformers Part 11 Dry-Type Transformers
IS 2026 : Part 12 : 2018	Power transformers Part 12 loading guide for dry - Type power transformers
IS 2026 : Part 14 : 2018	Power transformers Part 14 liquid - Immersed power transformers using high - Temperature insulation materials
IS 2026 : Part 15 : 2018	Power transformers Part 15 gas - Filled power transformers
IS 2026 : Part 16 : 2018	Power transformers Part 16 transformers for wind turbine applications
IS 2026 : Part 18 : 2018	Power transformers Part 18 measurement of frequency response
IS 2026 : Part 19 : 2018	Power Transformers Part 19 Rules for the Determination of Uncertainties in the Measurement of the Losses on Power Transformers and Reactors
IS 2026 : Part 21 : 2018	Power transformers Part 21 standard requirements terminology and test code for step - Voltage regulators

Role of BIS as National Standards Body of India & Salient Features of IS 12615: 2018



Energy Efficient Motors (EEM)

- In India, about 40% of the total electricity consumption is contributed by the industrial sector. Electric motors are basic need of industry and use around 28% of total National electricity.
- An Energy Efficient Motor (EEM) produces the same shaft output power, but uses less input power than a standard efficiency motor.
- EEM is manufactured using the same frame as a standard motor, but they have some differences:
  - Higher quality and thinner steel laminations in the stator.
  - More copper in the windings.
  - Optimized air gap between the rotor and the stator.
  - Reduced fan losses etc.

EEM should be considered in the following cases:

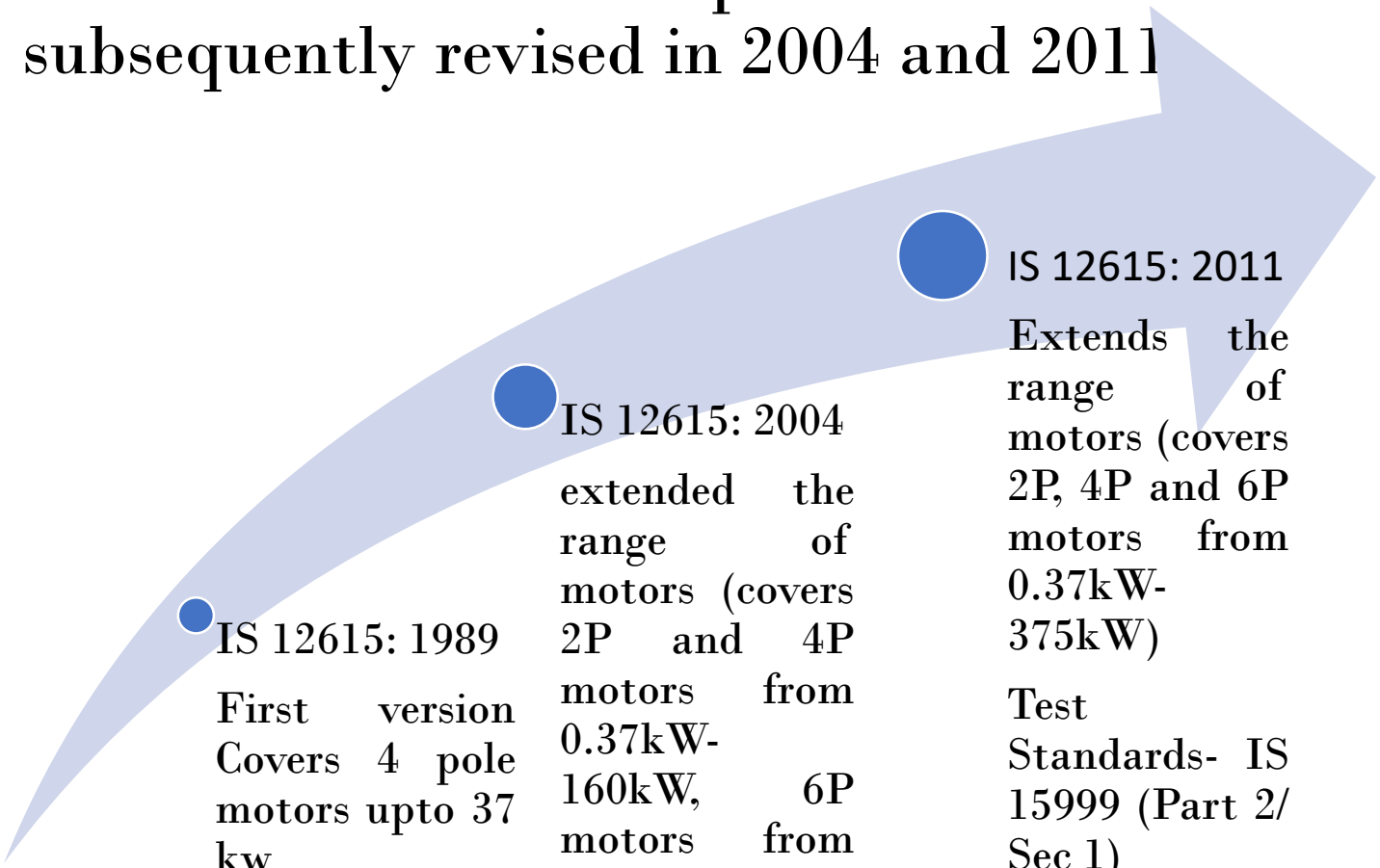
- For all new installations.
- When major modifications are made to existing facilities or processes.
- For all new purchases of equipment packages that contain electric motors.
- When purchasing spares or replacing failed motors.
- Instead of rewinding old standard motors.
- To replace grossly oversized and under loaded motors.
- As a part of an energy management or preventive maintenance program
- When utility conservation programs, rebates or incentives are offered that make energy efficient motor retrofits cost-effective.

Benefits of Energy Efficient Motors (EEM)

- Lower electricity consumption, leading to reduced electricity bills
- Almost constant efficiency between 65% to 100% load
- Better tolerance to thermal and electrical stresses
- Better performance to higher temperature
- Attractive low payback period
- Environmental benefits
- Reduction of ‘Greenhouse Gas’ emissions
- More economical benefits

Indian Standard on Line Operated Three Phase Induction Motor IS 12615

IS 12615 was first published in 1989 and subsequently revised in 2004 and 2011



IS 12615: 2018 Line Operated Three Phase a.c. Motors (IE Code) “Efficiency Classes and Performance Specification”

➢SCOPE

- This standard covers the efficiency classes (IE Codes) and performance specifications of single-speed line operated a.c. Motors that are rated according to IEC 60034-1, have a rated power from 0.12 kW to 1 000 kW and have a rated voltage Un up to 1 000 V with a rated frequency of 50 Hz.
- This standard is based on IEC 60034-30-1: 2014.

IS 12615: 2018 Significant technical changes with respect to previous version

- The scope has been modified to cover:
  - Motors with rated Power up to 1000 kW
  - 8 poles line operated a.c. motor
  - Motors with special customized dimensions
  - Motors with frame sizes higher than as defined in IS 1231
  - Motors designed for altitude up to and including 4000 m
  - Motors designed for ambient temperature between -20°C to + 60°C.
  - Motors with or without service factor
  - Geared motors
- Methods of cooling- IC411, IC511 or IC611
- Scope also clarify explicitly the types of motors which are not covered
- A new efficiency class IE4 (super premium) has been introduced
- Values of Performance Characteristics of 8 Pole Line Operated a.c. Motors

Additional factors covered in Indian standard with respect to International Standard for energy efficient motors

- Performance parameters other than efficiency are covered, such as
  - Full load current
  - Full load speed
  - Starting current
  - Starting torque.
- Frame size relation with respect to out put kW is defined up to IE4 efficiency class of motors.

Contd...

- The out put kW relation with respect to frame size is applicable even up to ambient temperature of 50°C.
- Motor to withstand higher variation in rated voltage(+/-10%) and rated frequency(+/-5%)
- Motors with service factor above 1.0 are also covered and these motors to have minimum IE2 efficiency.
- Duty types other than S1 are also covered. Manufacturer to declare equivalent S1 duty output for other duties. For this S1 duty output, minimum IE2 efficiency is must.

Contd....

- Schedule of tests covers
- Dimension measurement as type test.
- Optional test of temperature rise at rated load and at extreme conditions of voltage and frequency variation is covered. Permissible temperature rise is defined for this test.
- Locked rotor test at reduce voltage and extrapolation of locked rotor current and locked rotor torque at rated voltage.
- Minimum insulation resistance for the motor to be 30 M ohm

IS 996 : 2009 Single phase a.c. induction motors for general purpose *(Third Revision)"*

➢SCOPE

- This standard covers single phase ac induction motors of the capacitor types for voltages upto and including 250 V and having windings with Class A, Class E, Class B, Class F or Class H and output upto and including 2200 W).This standard is based on IEC 60034-30-1: 2014.


THANK YOU