

ANSI/ISA-S82.03-1988

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(Partial Revision and Redesignation of ANSI C 39.5-1974)

American National Standard

Safety Standard for Electrical and Electronic Test, Measuring, Controlling, and Related Equipment

ELECTRICAL AND ELECTRONIC PROCESS MEASUREMENT
AND CONTROL EQUIPMENT



ANSI/ISA-S82.03 — Safety Standard for Electrical and Electronic Test, Measuring, Controlling,
and Related Equipment

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Preface

This preface is included for information purposes and is not part of ANSI/ISA-S82.03.

This standard has been prepared as part of the service of ISA toward a goal of uniformity in the field of instrumentation. To be of real value, this document should not be static, but should be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms, and asks that they be addressed to the Secretary, Standards and Practices Board, ISA, 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, NC 27709, telephone (919) 549-8411, e-mail: standards@isa.org.

The ISA Standards and Practices Department is aware of the growing need for attention to the metric system of units in general, and the International System of Units (SI) in particular, in the preparation of instrumentation standards. The Department is further aware of the benefits to U.S.A. users of ISA standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Toward this end, this Department will endeavor to introduce SI-acceptable metric units in all new and revised standards to the greatest extent possible. *The Metric Practice Guide*, which has been published by the Institute of Electrical and Electronics Engineers as ANSI/IEEE Std. 268-1982, and future revisions will be the reference guide for definitions, symbols, abbreviations, and conversion factors.

It is the policy of ISA to encourage and welcome the participation of all concerned individuals and interests in the development of ISA standards. Participation in the ISA standards-making process by an individual in no way constitutes endorsement by the employer of that individual, of ISA, or of any of the standards that ISA develops.

The information contained in the preface, footnotes, and appendices is included for information only and is not a part of the standard.

The development of this standard dates back to 1958. The need for the standard arose from requests that recording instruments meet the requirement of the American National Standard, the National Electrical Code. At that time there was also the beginning of the need for examination of measuring instruments by testing laboratories. The initial version of this standard was approved in 1964 after several years of careful development, review, and trial use.

Work began on safety requirements for electrical measuring instruments at the international level at about the same time. While consideration of specific safety requirements for measuring apparatus was begun in 1965, resulting first editions of IEC Publications 348 and 414 became available in 1971 and 1973, respectively.

American National Standard C39.5-1964 was reaffirmed in 1969 and revised in 1974. In 1982, responsibility for C39.5-1964 was transferred to the ISA and the document was renumbered ISA-S82.01.

This 1988 edition reflects four major considerations:

- The scope has been expanded to include more equipment types. The scope and organization now readily allow future inclusion of more types of related equipment.
- A major goal was harmonization — to the extent possible — with worldwide standards, especially North American and IEC Standards. Not only were the IEC clause and multi-

part formats adopted, but also many of the IEC requirements; many requirements were further defined and developed from the work of IEC Subcommittee 66E.

- Digital and microelectronic innovations have narrowed the one-time separation between digital and analog technologies and prompted commonality of safety requirements.
- Significant technical contributions were made by industry organizations and independent certifying laboratories.

The following are significant features incorporated in this ongoing edition:

- Constructional requirements.
- Measurement of conformance to requirements is through the use of specific compliance statements. This allows the user of the standard to determine product compliance and to better understand the nature and intent of the requirements.
- Expansion of requirements for protection against fire and personal injury.

The following people served as members of ISA Subcommittee SP82.03, which prepared this standard:

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- SPECIFIC CLAUSE TREATMENTS -

The **SCOPE** includes environmental conditions envisioned for the equipment. **DEFINITIONS** have extensive additions to reduce misinterpretations. **MARKINGS** are expanded and clarified by inclusion of internationally recognized symbols. X-radiation considerations are added while several other **EMANATIONS** are identified as "under consideration" due to lack of recognized limits and standardized measurements. The clause for **PROTECTION FROM ELECTRIC SHOCK** deletes requirements for resistance tests, clarifies leakage current measurement procedures, details dielectric tests and includes requirements for measuring terminals and routine tests. **TESTING UNDER FAULT CONDITIONS** is new. **PROTECTION FROM FIRE** is an approach to measuring the likelihood of spread of fire. **EXTRA LOW VOLTAGE AND POWER LIMITED CIRCUITS** defines the circuits which could cause electric shock or the likelihood of fire and for which protection requirements of the standard apply.

Understanding the Appendix material of ISA-S82.01 under Clause 9 is also necessary for this edition.

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IN THIS STANDARD

Requirements proper are printed in normal helvetica type.

Explanatory matter regarding the requirements is printed in smaller helvetica type.

Test specifications are printed in *italic type*.

Explanatory matter regarding the test specifications is printed in *smaller italic type*.

Further explanatory matter regarding the requirements or specific subject marked by an asterisk can be found in the Appendix.

CAUTION

MANY TESTS REQUIRED BY THIS STANDARD ARE INHERENTLY HAZARDOUS. ADEQUATE SAFEGUARDS FOR PERSONNEL AND PROPERTY SHOULD BE EMPLOYED IN CONDUCTING SUCH TESTS.

1 General

1.1 Scope

This standard applies to electrical, electronic (analog/digital) and electromechanical process measurement and control equipment which:

- 1) measures and controls directly or indirectly an industrial process through a final control element (or elements)
- 2) is intended to be connected to supply circuits which do not exceed 250 volts rms, single phase, or dc
- 3) is rated for use in either indoor, outdoor or sheltered locations

This equipment includes but is not necessarily restricted to:

- indicating, integrating or recording equipment with or without a control function
- transmitters
- transducers
- analyzers
- supervisory or telemetry equipment
- accessories used with any of the above equipment

1.2 Environment

1.2.1 Indoor locations. Equipment according to this standard is intended for use where air temperature is controlled within specified limits.

Exception: where specified otherwise.

The basic climatic conditions for heated and/or cooled locations at an atmospheric pressure of 86 to 106 kPa (12.5 to 15.4 psi) are according to [Table 1-1](#).

Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected. In air-conditioned locations no pollution or only dry, nonconductive pollution occurs and has no influence.

Table 1-1 — Heated and/or cooled indoor locations^a

Location Class	Temperature (°C)	Relative Humidity	Maximum Moisture Content kg/kg Dry Air
B1	+15 to +30	10 to 75%	0.020
B2	+5 to +40	10 to 75%	0.020
B3	+5 to +40	5 to 95%	0.028
BX	Equipment designed and rated for higher limits, however, intended only for use in indoor locations		

^a The environment inside an equipment enclosure is considered to be the same as that external to the equipment enclosure when the enclosure does not provide adequate protection against the environmental stresses.

1.2.2 Sheltered locations. Equipment according to this standard intended for use in sheltered locations shall comply with the applicable requirements according to Clause 19 of ISA-S82.03.

Exception: where specified otherwise.

The basic climatic conditions for sheltered locations at an atmospheric pressure of 86 to 106 kPa (12.5 to 15.4 psi) are according to [Table 1-2](#).

Normally, conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation which is expected.

Table 1-2 — Sheltered locations^a

Location Class	Temperature (°C)	Relative Humidity	Maximum Moisture Content kg/kg Dry Air
C1	−25 to +55	5 to 100% ^b	0.028
C2	−40 to +70	5 to 100% ^b	0.028

^a The environment inside an equipment enclosure is considered to be the same as that external to the equipment enclosure when the enclosure does not provide adequate protection against the environmental stresses.

^b Including condensation.

1.2.3 Outdoor locations. Equipment according to this standard intended for use in outdoor locations shall comply with the applicable requirements according to Clause 19 of ISA-S82.03.

Exception: where specified otherwise.

The basic climatic conditions for outdoor locations at an atmospheric pressure of 86 to 106 kPa (12.4 to 15.4 psi) are according to [Table 1-3](#).

Normally, the pollution generates high and persistent conductivity caused, for instance, by conductive dust or by rain or snow.

Table 1-3 — Outdoor locations^a

Location Class	Temperature (°C)	Relative Humidity	Maximum Moisture Content kg/kg Dry Air
D1	–25 to +70	5 to 100% ^b	0.050
D2	–40 to +85	5 to 100% ^b	0.050

^a The environment inside an equipment enclosure is considered to be the same as that external to the equipment enclosure when the enclosure does not provide adequate protection against the environmental stresses.

^b Including condensation and direct wetness.

2 Definitions

2.1 Control equipment: Equipment which controls one or more output quantities to specific values, each value being determined by manual setting, local or remote programming, or by one or more input variables.

2.2 Electronic measuring equipment: Equipment which, by means of incorporating electronic devices, serves to measure or to observe quantities or to supply electrical quantities for measuring purposes.

Electronic devices are parts or assemblies of parts which use electron or hole conduction in semiconductors, gases, or a vacuum.

2.3 Indicating measuring equipment: Equipment which indicates the value of the measured quantity.

Process measurement and control equipment may combine one or more of the functions of Sub-clauses 2.1, 2.2, or 2.3 above.

2.4 Outdoor location: Locations where neither air temperature nor humidity are controlled and the equipment is exposed to outdoor atmospheric conditions such as direct sunshine, wind, rain, hail, sleet, snow and icing.

Sensors, transmitters, final control elements and actuators and some indicators separate from controllers are often located in outdoor locations.

2.5 Sheltered locations: Locations where neither air temperature nor humidity is controlled and equipment is protected against direct exposure to such climatic elements as direct sunlight, fall of rain and other precipitation, and full wind pressure.

Indoor locations which are neither heated nor cooled are sheltered locations.

Transmitters, final control elements, and some indicators separate from controllers are often located in sheltered locations when frequent operator attention is not important.

3 General information

3.1 Object. ISA-S82.03 supplements or amends the requirements of ISA-S82.01.

3.2 Compliance

Where protections are adequately covered by ISA-S82.01 and identified by cross reference, the equipment shall comply with the requirements of the referenced Clauses of ISA-S82.01.

Compliance with the requirements of ISA-S82.03 is determined by performing inspections and tests according to the Clauses applicable to the particular equipment.

4 General test requirements

4.1 General

The requirements of Clause 4 of ISA-S82.01 shall apply and the requirements according to Sub-clause 4.2 below.

4.2 Reference test conditions

Reference test conditions shall be the same as those in Sub-clause 4.2 of ISA-S82.01 for equipment ratings not exceeding those according to Sub-clause 1.2.1 of ISA-S82.03.

Equipment

- 1) *with ambient temperature ratings exceeding, or*
- 2) *rated for sheltered or outdoor use, where environmental conditions exceed those specified in Sub-clause 1.2.1 of ISA-S82.03, shall be tested at the extended environment ratings if hazards may result at the more severe environmental conditions.*

Exception: Unless otherwise specified.

Testing at higher ambient temperatures will ensure, among other factors, that absolute temperatures will not exceed the safe limits for insulating materials used.

See Clause 19 of ISA-S82.03 for extended environmental enclosure requirements and tests.

5 Marking

5.1 General. The requirements of Clause 5 of ISA-S82.01 shall apply and the requirements according to Subclauses 5.2 and 5.3 below.

5.2 Terminals. Terminals for external connection to switch and relay contact inputs and outputs shall be marked with the voltage and current rating of the contacts adjacent to the terminals or on the equipment name or data-plate.

Compliance is checked by inspections.

5.3 Enclosures for extended environments. In addition to such markings as may be required for electrical equipment within an enclosure rated for use in sheltered or outdoor locations, there shall be a marking to identify the conditions for which the enclosure is rated.

The enclosure type designation marking (see Clause 19) shall be a permanent marking (engraved, etched, die stamped, or equivalent) on the enclosure, or on a suitable nameplate on the enclosure.

Exception: Where this requirement conflicts with other equipment safety standards, the enclosed rating information may be provided in the equipment instructions.

Compliance is checked by inspection.

6 Equipment emanations

6.1 General. The requirements of Clause 6 of ISA-S82.01 shall apply.

7 Heating

7.1 General. The requirements of Clause 7 of ISA-S82.01 shall apply and the requirements according to Sub-clause 7.2 below.

Exception: Surface temperature rise of an enclosure not operator accessible may exceed the maximum temperature rise specified according to Table 7-1 of ISA-S82.01.

7.2 Maximum temperature rise. See Table 7-1 (ISA-S82.01)

NOTE: The temperature rises specified in Table 7-1 are based on environmental conditions according to Sub-clause 1.1.6 of ISA-S82.01 and which may be as high as 40°C occasionally and for brief periods. If equipment is intended specifically for use in a prevailing ambient temperature constantly more than 25°C, the test of the equipment shall be made with that higher ambient temperature, and the allowable temperature rises specified in Table 7-1 shall be reduced by the amount by which the higher ambient exceeds 25°C.

7.2.1 Operator accessible parts. Operator accessible parts exceeding the allowable temperature rise according to Table 7-1 of ISA-S82.01 shall be marked with a warning marking according to Sub-clause 5.4 of ISA-S82.01.

Compliance is checked by inspection.

8 Protection from implosion and explosion

8.1 General. The requirements of Clause 8 of ISA-S82.01 shall apply.

9 Protection from electrical shock

9.1 General. The requirements of Clause 9 of ISA-S82.01 shall apply and the requirements according to Sub-clauses 9.2 through 9.5 below.

9.2 Live part

9.2.1 Accessible parts shall not be live.

A live part is a part where under reference test conditions the potential difference between the part and any other accessible part including ground either:

- 1) *exceeds those values specified in Sub-clause 9.2 of ISA-S82.01, or*
- 2) *under damp conditions (as in certain outdoor environments, tropical regions, etc.) exceeds*
 - a) *15 volts rms (12.2 volts peak), or*
 - b) *30 volts dc, or*
 - c) *12.4 volts dc interrupted at a rate of 10-200 hertz and from which the leakage current according to Sub-clause 9.11 of ISA-S82.01 is exceeded.*

9.3 Construction requirements - extended environments. Equipment intended to be used outdoors, or in sheltered locations under extended environmental conditions, according to Sub-clauses 1.2.2 and 1.2.3 shall have an enclosure rating according to Clause 19 of ISA-S82.03.

Equipment intended to be used indoors, where falling dirt, liquids, splashing water, or dust is expected, may require additional protections according to Clause 19 of ISA-S82.03.

Compliance is checked by inspection and by the tests specified in Clause 19 of this standard.

9.4 Spacing - extended environments

9.4.1 Supply circuits. The spacings between an uninsulated part conductively connected to the supply circuit and

- 1) an uninsulated part conductively connected to another pole of the supply circuit
- 2) another uninsulated part of any other circuit
- 3) a grounded part
- 4) accessible conductive parts
- 5) the point of closest approach of either accessibility probe, when applied according to Sub-clause 9.1.1 of ISA-S82.01, to any opening of the enclosure (see Figure 9-3 of ISA-S82.01)

shall be at least those

- 1) according to Table 9-1 of ISA-S82.01, and
- 2) additionally protected by at least an equipment enclosure type according to Clause 19 of this standard for use in sheltered locations, or
- 3) additionally protected
 - a) by a protective coating in compliance with Sub-clause 13.2 of this standard, and
 - b) by at least a Type 4 equipment enclosure type according to Clause 19 of this standard for use in sheltered or outdoor locations; or

Exception: Supply circuits that are power-limited according to Subclause 14.2 of ISA-S82.01 and not live according to Sub-clause 9.2.1 above need not comply with the spacing requirements.

Spacing requirements are not applied to the internal spacings of electronic devices.

Compliance is checked by first applying and removing a 2-newton (0.5-pound) force against any wire or uninsulated part followed by measuring the creepage distance or clearance.

9.4.2 Other circuits. The spacings in other circuits shall be additionally protected by a protective coating in compliance with Sub-clause 13.2 of this standard.

Exception: Where spacings are:

- 1) at least those according to Table 9-1 of ISA-S82.01, or
- 2) additionally protected by an equipment enclosure according to Clause 19 of this standard suitable for the intended environment.

The spacings in other circuits are evaluated according to Sub-clause 9.12 (dielectric voltage-withstand tests) of ISA-S82.01.

Exception: Circuits that are power-limited according to Sub-clause 14.2 of ISA-S82.01 and not live according to Sub-clause 9.2 of this standard.

9.4.3 Field wiring terminal parts. The requirements of Sub-clause 9.8.3 of ISA-S82.01 shall apply.

Exception: Circuits that are power-limited according to Sub-clause 14.2 of ISA-S82.01 and not live according to Sub-clause 9.2. of this standard.

9.5 Dielectric voltage-withstand tests

9.5.1 Supply circuits

- 1) Type test.

The requirements of Sub-clause 9.12.2 (1) of ISA-S82.01 shall apply.

Exception: Circuits that are power-limited according to Sub-clause 14.2 of ISA-S82.01, and not live according to Sub-clause 9.21 of this standard.

- 2) Routine test.

The requirements of Sub-clause 9.12.2(2) of ISA-S82.01 shall apply except for the test potentials.

The test potential, for supply circuits rated greater than extra-low voltage according to Sub-clause 14.1 of ISA-S82.01, shall be 1200 V rms at supply circuit frequency, or 1700 V dc, applied for one second. Alternately, the test potential shall be 1000 V rms at supply circuit frequency, or 1420 V dc, applied for one minute.

The test potential for extra-low voltage supply circuits according to Sub-clause 14.1 of ISA-S82.01 shall be 600 V rms at supply circuit frequency, or 860 V dc, applied for one second. Alternately, the test potential shall be 500 V rms at supply circuit frequency, or 707 V dc applied for one minute.

Exception: Circuits that are power-limited according to Sub-clause 14.2 of ISA-S82.01 and not live according to Sub-clause 9.2 of this standard.

10 Testing under fault conditions

10.1 Application of fault conditions. Fault conditions shall be applied to the equipment in the manner described in Clause 10 of ISA-S82.01.

11 Mechanical requirements

11.1 General. Equipment enclosures, or parts of the enclosure, required to be in place to comply with the requirements in this standard shall have mechanical strength and stability necessary to resist the abuse to which they may be subjected in their intended uses. The requirements of Clause 11 of ISA-S82.01 shall apply.

Additional factors to be considered when evaluating process measurement and control equipment enclosures with regard to their intended uses include but are not limited to:

- 1) resistance to corrosion,
- 2) resistance to harmful solvents and gases.

12 Protection from fire

12.1 General. The requirements of Clause 12 of ISA-S82.01 shall apply.

13 Component requirements and applications

13.1 General. The requirements of Clause 13 of ISA-S82.01 shall apply and the requirements according to Sub-clause 13.2 below.

13.2 Protective coatings. Where protective coatings are used according to Sub-clause 9.4 of this standard the suitability of the coating shall be determined by subjecting the equipment or the coated part of the equipment being evaluated to the tests specified in Sub-clauses 13.2.1 through 13.2.4. The equipment shall not be operated during aging and humidity conditioning.

13.2.1 Aging

The equipment (or the coated part of the equipment) being evaluated shall be aged by maintaining it at $90^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ($194^{\circ}\text{F} \pm 2^{\circ}\text{F}$) for 96 hours. The test sample shall be removed from the aging chamber and subjected to a dielectric voltage-withstand test according to Sub-clause 13.2.3 of this standard.

13.2.2 Humidity conditioning

Following aging according to Sub-clause 13.2.1 of this standard, the equipment or the coated part of the equipment being evaluated shall be conditioned by maintaining it at $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ($73^{\circ}\text{F} \pm 2^{\circ}\text{F}$) and 96 ± 2 percent relative humidity for 96 hours. The test sample shall be removed from the conditioning chamber and subjected to a dielectric voltage-withstand test according to Sub-clause 13.2.3 of this standard.

13.2.3 Dielectric voltage-withstand test

A test voltage according to Table 9-5 of ISA-S82.01 shall be applied for one minute without breakdown between adjacent circuits where coated spacings exists.

13.2.4 Adhesion

Following the tests of Sub-clause 13.2.1 and 13.2.2. above, the equipment or the coated part of the equipment being evaluated shall be investigated for adhesion of the coating, where coated spacings exist, by scraping or cutting. The coating shall not flake.

14 Extra-low voltage and power-limited circuits

14.1 General. The requirements of Clause 14 of ISA-S82.01 shall apply.

15 Terminal devices

15.1 General. The requirements of Clause 15 of ISA-S82.01 shall apply and the requirements according to Sub-clause 15.2 below.

15.2 Terminal screws. Wire-binding screws for field wiring terminals shall be selected according to [Table 15-1](#).

Table 15-1 — Wire-binding screws

Wire Size (AWG)	10	12	14
Minimum Binding Screw Size	10	8	6

Compliance is checked by inspection.

16 External cords

16.1 General. The requirements of Clause 16 of ISA-S82.01 shall apply.

17 Equipment instructions

17.1 General. The requirements of Clause 17 of ISA-S82.01 shall apply and the requirements according to Sub-clauses 17.2 and 17.3 below.

Additional applicable safeguard information considered appropriate by the manufacturer may be included.

Instructions according to this Clause may be supplemented, but not replaced, by illustrations.

Compliance is checked by inspection.

17.2 Form of equipment instruction. Equipment instructions shall be in the form of either:

- 1) a pamphlet, a folder, or data sheet(s) containing operator instructions and operational maintenance information; or
- 2) a combined operators' and servicing manual; or
- 3) an operators' manual and a separate servicing manual.

17.3 Equipment information and instructions. Operating and operational maintenance instructions shall be separated from servicing instructions within the equipment instructions.

17.3.1 Operating instructions. With regard to equipment protections, the operating instructions shall:

- 1) describe the equipment installation, including specifically:
 - a) assembly, if required, and mounting,
 - b) protective grounding means, if employed,
 - c) intended supply circuit and connection of the equipment to the supply circuit,
 - d) ventilation consideration,
 - e) the environmental conditions under which the equipment can be operated, and

- f) additional protective means, if any, for equipment operated in sheltered or outdoor locations;
- 2) explain equipment markings, including specifically
 - a) symbols
 - b) controls
 - c) terminal ratings;
- 3) identify and describe interconnection with
 - a) auxiliary and accessory equipment
 - b) other equipment;
- 4) where operating instructions and servicing instructions are combined into a single manual and where servicing requires access to parts which could render electrical shock or replacement of a like component(s) is depended upon to provide extra-low voltage and power-limited circuits according to Clause 14 of ISA-S82.01, servicing instructions shall be preceded by a warning.

The warning shall be prefaced by the signal word "WARNING", and

- a) state that servicing requires access to parts which could render an electrical shock, and refer servicing only to qualified personnel;
 - b) state that extra-low voltage and power-limited circuits are dependent upon replacement of live components;
- 5) include operational maintenance information.

17.3.2 Servicing instructions. With regard to equipment protections, the servicing instructions shall include specifically:

- 1) equipment calibration other than factory calibration;
- 2) equipment maintenance;
- 3) equipment repair, including any limitations thereto.

18 Pressure-actuated equipment

18.1 General. The requirements of this Clause are intended to:

- 1) provide a means by which the pressure protections of fluid-pressure-actuated equipment can be verified (type tested);
- 2) apply to fluid-pressure-actuated equipment employing flexible-metal bellows, diaphragms, Bourdon tubes, or the like that are rated for pressures between 2000 kPa and 175,000 kPa (300 and 25,000 psig); and
- 3) apply to use of fluid-pressure-actuated equipment with ordinary benign fluids.

Equipment rated above 175,000 kPa (25,000 psig) or actuated by hazardous fluids is special-purpose equipment outside the scope of this standard.

Compliance is checked by inspection and by performing the tests according to Sub-Clause 18.2 below.

The maximum rated operating pressure used in conjunction with pressure test multipliers is that which is marked on the equipment. In the case of different pressure equipment, this marked rating would be the maximum static (working) pressure.

The maximum rated overrange pressure (maximum pressure which may be applied without permanent change in performance) is used in conjunction with pressure test multipliers only when marked on the equipment.

18.2 Hydrostatic test

The part of the equipment that is normally subjected to the actuating fluid pressure shall be:

- 1) filled with a suitable liquid, such as water, to exclude air, and*
- 2) connected to a hydraulic pump, and the pressure shall be raised gradually to the hydrostatic pressure indicated in the Sub-clauses below.*

Those portions of the equipment which normally receive indirect pressure loading, as in hydraulically coupled systems, shall be simultaneously subjected to the hydrostatic test pressure either through the original hydraulic filling fluid or, in its absence, by filling with the test liquid.

18.2.1 Initial hydrostatic test

The following test sequence shall be followed:

- 1) The equipment shall withstand a hydrostatic pressure for one minute applied in accordance with Column II of [Table 18-1](#).*

No visible leakage shall occur.

- 2) The equipment shall withstand a hydrostatic pressure for one minute applied in accordance with Column III of [Table 18-1](#).*

No rupture or failure which results in flying fragments outside of the equipment shall occur.

Leakage may occur because of splits in Bourdon tubes, diaphragms, or bellows or because of joint or gasket failure. These are not considered test failures if the hydrostatic pressure can be maintained for one minute.

18.2.2 Hydrostatic test-modifications to minimize leakage. If excessive leakage occurs in tests according to Sub-clause 18.2.1(2) above such that the hydrostatic pressure cannot be maintained for one minute, certain equipment modifications shall be permitted:

- 1) External fittings may be modified to eliminate leakage.*
- 2) A leaking gasket or flexible seal member (not part of the measuring element) which serves as a structural partition (barrier) between that part of the equipment normally subjected to the actuating fluid pressure and the external components (enclosure) may be replaced by a stronger non-functional member.*

The modified equipment shall then comply with the requirements of Sub-clause 18.2.1(2) above.

If modifications are made in the structural partition, the modified equipment shall also comply with the requirements of Sub-clause 18.2.4 below.

18.2.3 Hydrostatic tests — under conditions of excessive leakage. Where excessive leakage cannot be successfully reduced according to the modifications of Sub-clause 18.2.2 above so that the leakage, in fact, serves as a pressure relief mechanism, the equipment complies with this Clause when tested according to the following requirements:

- 1) *Where no enclosure is provided, the equipment shall withstand, for one minute, a hydrostatic pressure applied in accordance with Column IV of [Table 18-1](#).*
No rupture or failure which results in flying fragments outside of the equipment shall occur.
- 2) *Where an enclosure is provided, the equipment shall withstand, for one minute, a hydrostatic pressure applied in accordance with Column IV of [Table 18-1](#).*

No rupture or failure which results in flying fragments outside of the equipment shall occur.

The equipment shall also comply with the requirements of Sub-clause 18.2.4 below.

An enclosure is an compressed case, cover or housing, which may enclose all or part of the pressure-actuated equipment. The enclosure is not subjected to the actuating fluid pressure under normal operation.

18.2.4 Supplementary tests —under conditions of excess leakage. One of the following requirements shall be met for equipment tested according to Sub-clauses 18.2.2 or 18.2.3(2) above:

- 1) *The enclosure shall leak at a rate sufficient to prevent a pressure buildup without rupture or failure which results in flying fragments outside of the equipment; or*
"Sufficient" means a leakage rate at least equal to the leakage rate of the primary structure.
- 2) *The enclosure shall withstand, without rupture or failure which results in flying fragments outside of the equipment, a pressure equal to the maximum operating pressure of the equipment; or*
- 3) *The unaltered structural partition shall withstand a hydrostatic pressure in accordance with Column IV of [Table 18-1](#).*

No visible leakage shall occur.

Table 18-1 — Test pressure

Col. I	Col. II	Col. III	Col. IV
Marked Maximum Operating Pressure Rating	Test Pressure for Sub-clause 18.2.1 (1)	Test Pressure for Sub-clauses 18.2.1 (2) & 18.2.2	Test Pressure for Sub-clauses 18.2.1 (1) & (2) & 18.2.4 (3)
	(a)	(a)	(a)
2100-14,000 kPa (300-2,000 psig)	2.0 Times Rated Pressure	3.0 Times Rated Pressure	2.5 Times Rated Pressure
Over 14,000-70,000 kPa (over 2,000-10,000 psig)	1.75 Times Rated Pressure plus 3,500 kPa (500 psig)	2.5 Times Rated Pressure plus 7,000 kPa (1,000 psig)	2.0 Times Rated Pressure plus 7,000 kPa (1,000 psig)
Over 70,000-175,000 kPa (over 10,000-25,000 psig)	1.3 Times Rated Pressure plus 35,000 kPa (5,000 psig)	2.0 Times Rated Pressure plus 42,000 kPa (6,000 psig)	1.5 Times Rated Pressure plus 42,000 kPa (6,000 psig)

(a) Marked Maximum Operating Pressure or Maximum Overrange Rating

19 Equipment enclosures for use in extended environmental conditions

19.1 General. This Clause specifies additional protections for equipment in an enclosure intended to be used outdoors or in sheltered locations under the environmental conditions according to Sub-clauses 1.2.2 and 1.2.3 of ISA-S82.03.

Enclosures intended to be used under the environmental conditions according to Sub-clauses 1.2.2 and 1.2.3 of ISA-S82.03 shall be a NEMA enclosure type according to [Table 19-1](#) and shall comply with the applicable requirements of ANSI/NEMA-250, "Enclosures for Electrical Equipment" for the specific enclosure type selected.

Enclosures intended to be used under extended environmental conditions are designated by a type number which is intended to indicate the environmental conditions for which they are suitable. The higher the type number, the higher the degree of protection provided by the enclosure.

Other ANSI/NEMA-250 type enclosures may be suitable for application in sheltered and outdoor locations provided the requirements of Clause 19 of ISA-S82.03 have been satisfied.

Equipment which, due to transport, may occasionally be subjected to condensation is not considered to require protections for extended environmental conditions.

Equipment intended to be used indoors where falling dirt, liquids, splashing water, or dust is expected, may require additional protections according to [Table 19-1](#).

Compliance is checked by performing the tests according to ANSI/NEMA-250 for the specified enclosure type.

Equipment is tested in a non-energized state unless otherwise specified.

Table 19-1 — Enclosure types suitable for use in sheltered and outdoor locations

Environment	NEMA Enclosure Type					
	3	3R	3S	4	4X	5
Sheltered Locations (see sub-clause 1.2.2 of ISA-S82.03)				X	X	X
Outdoor (see sub-clause 1.2.3 of ISA-S82.03)	X	X	X	X	X	

*See ANSI/NEMA-250-1986.

Appendix Comparison between NEMA enclosure type numbers and IEC enclosure classification designations

IEC Publication 529 *Classification of Degrees of Protection by Enclosures* provides a system for specifying the enclosures of electrical equipment on the basis of the degree of protection provided by the enclosure. IEC 529 does not specify degrees of protection against mechanical damage of equipment, risk of explosions, or conditions such as moisture (produced, for example, by condensation), corrosive vapors, fungus, or vermin. NEMA Standards Publication 250 does test for environmental conditions such as corrosion, rust, icing, oil, and coolants. For this reason, and because the tests and evaluations for other characteristics are not identical, the IEC Enclosure Classification Designations cannot be exactly equated with NEMA Enclosure Type Numbers.

The IEC designation consists of the letters IP followed by two numerals. The first characteristic numeral indicates the degree of protection provided by the enclosure with respect to persons and solid foreign objects entering the enclosure. The second characteristic numeral indicates the degree of protection provided by the enclosure with respect to the harmful ingress of water.

[Table A-1](#) provides an equivalent conversion from NEMA Enclosure Type Numbers to IEC Enclosure Classification Designations. The NEMA Types meet or exceed the test requirements for the associated IEC Classifications; for this reason Table A-1 cannot be used to convert from IEC Classifications to NEMA Types.

Table A-1 — Conversion of NEMA type numbers to IEC classification designations

(Cannot be used to convert IEC Classification Designations to NEMA Type Numbers)

NEMA Enclosure Type Number	IEC Enclosure Classification Designation
1	IP10
2	IP11
3	IP54
3R	IP14
3S	IP54
4 and 4X	IP56
5	IP52
6 and 6P	IP67
12 and 12K	IP52
13	IP54

NOTE: This comparison is based on tests specified in IEC Publication 529.

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