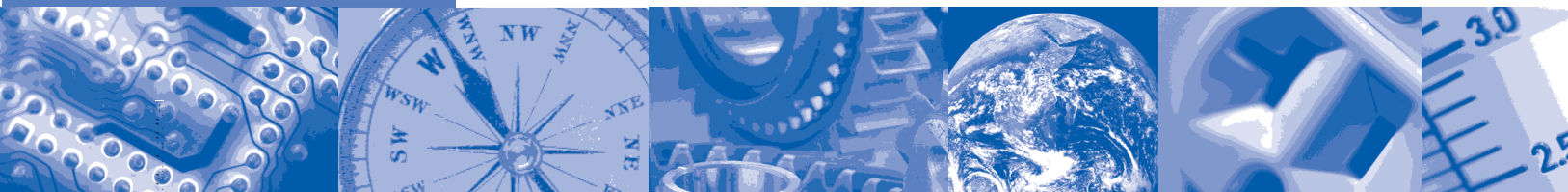


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Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety

Approved 16 April 2003



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Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1:
Intrinsic Safety

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This preface, as well as all footnotes and annexes, is included for information purposes and is not part of ANSI/ISA-RP12.06.01-2003.

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Table of Contents

Preface	3
1 Purpose	9
2 Scope	9
3 Definitions	9
4 Article 504 and 505 of the NEC (ANSI/NFPA 70-2002) with explanation	14
5 Guidelines for combinations of apparatus under the entity concept	44
6 Maintenance and inspection	46
Annex A — Explanatory notes	49
Annex B — Wiring in hazardous (classified) locations	53
Annex C — Marking for the zone classification system	55
Annex D — References	57

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1 Purpose

1.1 This recommended practice is intended to promote the uniform installation of intrinsically safe systems for hazardous (classified) locations. Information is provided to clarify and explain the requirements of Articles 504 and 505 of the *National Electrical Code*® (*NEC*®) ANSI/NFPA 70. (For further information, see Annex A.)

NOTE — Throughout clause 3 and 4, text that has been excerpted from the *National Electrical Code*® (*NEC*®) is distinguished from the main body of text as follows:

- **NEC® Article 500, 504 and 505 text is shaded and indented at the left and right margins.**
- **Other excerpted NEC® text (such as articles on sealing) is shaded but not indented.**

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1.2 This recommended practice applies to the installation of intrinsically safe systems for use in hazardous (classified) locations.

2 Scope

2.1 This recommended practice provides guidance to those who design, install, and maintain intrinsically safe systems for hazardous (classified) locations.

2.2 This recommended practice should be used in conjunction with nationally recognized codes that cover wiring practices — such as the *National Electrical Code*® (*NEC*®), ANSI/NFPA 70, and the *Canadian Electrical Code* (*CEC*) Part I, CSA C22.1.

2.3 This recommended practice is not intended to:

- a) include guidance for designing, testing, or repairing intrinsically safe or associated apparatus; or
- b) apply to the use of portable equipment, except as shown on the control drawing.

3 Definitions

For purposes of this recommended practice, the following definitions apply:

3.1 approved:
acceptable to the authority having jurisdiction (for additional information, see *NEC*® Article 100).

3.2 associated apparatus:

Associated Apparatus: Apparatus in which the circuits are not necessarily intrinsically safe themselves, but that affect the energy in the intrinsically safe circuits and are relied on to maintain intrinsic safety. Associated apparatus may be either of the following:

1. Electrical apparatus that has an alternative-type protection for use in the appropriate hazardous (classified) location, or

2. Electrical apparatus not so protected that shall not be used within a hazardous (classified) location.

FPN No. 1: Associated apparatus has identified intrinsically safe connections for intrinsically safe apparatus and also may have connections for nonintrinsically safe apparatus.

FPN No. 2: An example of associated apparatus is an intrinsic safety barrier, which is a network designed to limit the energy (voltage and current) available to the protected circuit in the hazardous (classified) location, under specified fault conditions.

3.3 authority having jurisdiction (AHJ):
the organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure.

3.4 channel:
an ungrounded conductor in a grounded intrinsically safe circuit, or a conductor and its reference in a galvanically isolated intrinsically safe circuit.

3.5 control drawing:

Control Drawing: A drawing or other document provided by the manufacturer of the intrinsically safe or associated apparatus, or of the nonincendive field wiring apparatus or associated nonincendive field wiring apparatus, that details the allowed interconnections between the intrinsically safe and associated apparatus or between the nonincendive field wiring apparatus or associated nonincendive field wiring apparatus.

3.6 corrective maintenance:
any maintenance activity that is not normal in the operation of equipment and requires access to the equipment's interior. Such activities are expected to be performed by qualified personnel who are aware of the hazards involved. Such activities typically include locating causes of faulty performance, replacement of defective components (see 6.2.1), adjustment of internal controls, and the like. Corrective maintenance is referred to simply as maintenance in clause 6.

3.7 different intrinsically safe circuits:

Different Intrinsically Safe Circuits: Intrinsically safe circuits in which the possible interconnections have not been evaluated and identified as intrinsically safe.

3.8 entity evaluation:
a method used to determine acceptable combinations of intrinsically safe apparatus and connected associated apparatus that have not been investigated in such combination.

3.8.1 Entity parameters for intrinsically safe apparatus:

C_i :	Total equivalent internal capacitance of the apparatus that is considered as appearing across the connection facilities of the apparatus.
I_i or I_{max} :	Maximum current (peak a.c. or d.c.) that can be applied to the connection facilities of the intrinsically safe apparatus circuits without invalidating intrinsic safety. The maximum input current may be different for different terminals.
L_i :	Total equivalent internal inductance of the apparatus that is considered as appearing across the connection facilities of the apparatus.
L_i/R_i :	The maximum value of ratio of inductance to resistance that is considered as appearing across the terminals of the intrinsically safe apparatus.
P_i :	Maximum power in an external intrinsically safe circuit that can be applied to the connection facilities of the apparatus. The maximum input power may be different for different terminals.
U_i or V_{max} :	Maximum voltage (peak a.c. or d.c.) that can be applied to the connection facilities of the apparatus without invalidating the type of protection. The maximum input voltage may be different for different terminals.

3.8.2 Entity parameters for associated apparatus:

C_o or C_a :	Maximum capacitance in an intrinsically safe circuit that can be connected to the connection facilities of the apparatus.
I_o or I_{sc} :	Maximum current (peak a.c. or d.c.) in an intrinsically safe circuit that can be taken from the connection facilities of the apparatus.
L_o or L_a :	Maximum inductance in an intrinsically safe circuit that can be connected to the connection facilities of the apparatus.
L_o/R_o or L_a/R_a :	The maximum value of ratio of inductance to resistance that may be connected to the intrinsically safe circuit of the associated apparatus.
P_o :	Maximum electrical power in an intrinsically safe circuit that can be taken from the apparatus.
U_o or V_{oc} :	Maximum output voltage (peak a.c. or d.c.) in an intrinsically safe circuit that can appear under open-circuit conditions at the connection facilities of the apparatus.

3.8.3 Additional entity parameters for associated apparatus with multiple channels may include the following:

I_t :	The maximum DC or peak AC current that can be drawn from any combination of terminals of a multiple-channel associated apparatus configuration.
V_t :	The maximum DC or peak AC open circuit voltage that can appear across any combination of terminals of a multiple-channel associated apparatus configuration.

3.9 galvanic isolation:

the transfer of electrical power or signal from one circuit to another by means that do not include a direct electrical connection (e.g., through an isolating transformer or optical coupler).

3.10 hazardous (classified) location:

a location in which fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings.

3.11 identified:

Identified (as applied to equipment). Recognizable as suitable for the specific purpose, function, use, environment, application, and so forth, where described in a particular *Code* requirement.

FPN: Some examples of ways to determine suitability of equipment for a specific purpose, environment, or application include investigations by a qualified testing laboratory (listing and labeling), an inspection agency, or other organizations concerned with product evaluation.

3.12 intrinsic safety:

a type of protection in which a portion of the electrical system contains only intrinsically safe equipment (apparatus, circuits, and wiring) that is incapable of causing ignition in the surrounding atmosphere. No single device or wiring is intrinsically safe by itself (except for battery-operated, self-contained apparatus such as portable pagers, transceivers, gas detectors, etc., which are specifically designed as intrinsically safe, self-contained devices), but is intrinsically safe only when employed in a properly designed intrinsically safe system. Also see "associated apparatus."

3.13 intrinsic safety barrier:

a network designed to limit the energy (voltage and current) available to the protected circuit in the hazardous (classified) location, under specified fault conditions (see ISA 12.01.01).

3.14 intrinsic safety ground system:

a grounding system that has a dedicated conductor isolated from the power system, except at one point, so that ground currents will not normally flow, and that is reliably connected to a grounding electrode in accordance with Article 250 of the *NEC*®.

3.15 intrinsically safe apparatus:

Intrinsically Safe Apparatus: Apparatus in which all the circuits are intrinsically safe.

3.16 intrinsically safe circuit:

Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions.

FPN: Test conditions are described in ANSI/UL 913-1997 *Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations*.

3.17 intrinsically safe systems:

Intrinsically Safe System: An assembly of interconnected intrinsically safe apparatus, associated apparatus, and interconnecting cables in that those parts of the system that may be used in hazardous (classified) locations are intrinsically safe circuits.

FPN: An intrinsically safe system may include more than one intrinsically safe circuit.

3.18 labeled:

equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner (for additional information, see *NEC*® Article 100).

3.19 listed:

equipment, materials or services included in a list published by an organization acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that the equipment, material or services either meets appropriate designated standards or has been tested and found suitable for a specified purpose. (See *NEC*® Article 100.)

3.20 qualified person:

one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training on the hazards involved.

3.21 simple apparatus:

Simple Apparatus. An electrical component or combination of components of simple construction with well-defined electrical parameters which does not generate more than 1.5 volt, 100 milliamps and 25 milliwatts, or a passive component which does not dissipate more than 1.3 watts and which is compatible with the intrinsic safety of the circuit in which it is used.

FPN: The following apparatus are examples of simple apparatus:

a) Passive components, for example switches, junction boxes, resistance temperature devices and simple semiconductor devices such as LEDs;

b) Sources of generated energy, for example thermocouples and photocells, which do not generate more than 1.5 V, 100 mA and 25 mW.

3.22 unclassified locations

Unclassified Location:

Locations determined to be neither Class I, Division 1; Class I, Division 2; Class I, Zone 0; Class I, Zone 1; Class I, Zone 2; Class II, Division 1; Class II, Division 2; Class III, Division 1; Class III, Division 2; or any combination thereof.

3.23 wiring drawing:

a drawing or other document created by the user based upon the relevant control drawings. The wiring drawing is used by the installer to determine the type, color, and size of the wire used to connect each terminal of the equipment used in the intrinsically safe circuit.

4 Article 504 and 505 of the NEC (ANSI/NFPA 70-2002) with explanation

504.1 Scope. This article covers the installation of intrinsically safe (I.S.) apparatus, wiring, and systems for Class I, II, and III locations.

504.2 Definitions.

Associated Apparatus: Apparatus in which the circuits are not necessarily intrinsically safe themselves, but that affect the energy in the intrinsically safe circuits and are relied on to maintain intrinsic safety. Associated apparatus may be either of the following:

Intrinsic safety barriers are a common form of associated apparatus. These barriers are connected between the intrinsically safe apparatus and the control equipment. Their primary purpose is to limit the energy to the hazardous location under fault conditions. They may also provide isolation, signal conditioning, or both. There are also many types of associated apparatus that normally are not referred to as intrinsic safety barriers, but have energy-limiting circuits suitable for connection directly to intrinsically safe apparatus. An example of this type of associated apparatus is a controller that is not itself intrinsically safe, but has connections for intrinsically safe sensors.

504.3 Application of Other Articles. Except as modified by this article, all applicable articles of this Code shall apply.

Although intrinsically safe circuits are inherently low-energy circuits, they may still be shock hazards because of the operating voltage.

Clause 500.7 (E) provides an exception for intrinsically safe apparatus and wiring from the requirements of Articles 501 through 503 and 510 through 516. All other articles of the Code apply to intrinsically safe wiring, except as exempted by specific articles.

If the rated voltage of the circuit exceeds 60 volts DC or 30 volts AC, the wiring requirements for Class 3 circuits apply. (See NEC[®] Article 725.)

Other articles may apply, depending on the functional application — e.g., Article 725 for cables installed in ducts, plenums, risers, and other air-handling spaces, Article 760 for fire protective signaling systems, and Article 800 for communications circuits.

504.4 Equipment Approval. All intrinsically safe apparatus and associated apparatus shall be listed.

Exception: Simple apparatus, as described on the control drawing, shall not be required to be listed.

Electrical equipment that is listed or labeled by a nationally recognized testing laboratory (NRTL) normally will be accepted by the AHJ. The AHJ may also accept specialized equipment not listed or labeled by a NRTL, with appropriate technical justification. A written report of the investigation and conclusion should be kept on file, and the markings on the equipment should identify the report. For additional information see NEC 90.7.

504.10 Equipment Installation.

(A) Control Drawing. Intrinsically safe apparatus, associated apparatus, and other equipment shall be installed in accordance with the control drawing(s).

Exception: A simple apparatus that does not interconnect intrinsically safe circuits.

FPN: The control drawing identification is marked on the apparatus.

There are three basic types of control drawings:

- a) Intrinsically safe apparatus and associated apparatus are both specified by manufacturer and model number. (See figure 4.1 for an example.)
- b) Intrinsically safe apparatus is specified by manufacturer and model number for connection to associated apparatus specified by entity parameters. (See figures 4.2a and 4.2b for an example.)
- c) Associated apparatus is specified by manufacturer and model number for connection to intrinsically safe apparatus that is specified by entity parameters or to simple apparatus. (See figures 4.3a and 4.3b for an example.)

Control drawings that are combinations of the above types are also possible. For example, control drawings for intrinsically safe apparatus often specify permissible connections to specific associated apparatus and also specify entity parameters to allow additional flexibility in selecting associated apparatus. (See figure 4.3c for an example.)

To ensure that a given interconnection forms an intrinsically safe system, it is necessary to obtain control drawings that specify each intrinsically safe apparatus and associated apparatus to be interconnected. If a control drawing of the type shown in figure 4.1 that correctly describes the interconnection is available, only that control drawing is necessary.

If the intrinsic safety of the system is to be based on the comparison of entity parameters, it is necessary to obtain a control drawing for each intrinsically safe apparatus and associated apparatus. Care should be taken to ensure that the entity parameters used in the comparison apply to the specific set(s) of terminals to be interconnected.

If the system includes only simple apparatus connected to an associated apparatus, only the associated apparatus control drawing is necessary. Multiple channels of associated apparatus should not be connected to a single simple apparatus unless specifically permitted by the control drawing.

Frequently, the user creates a wiring drawing based on the control drawings provided by the manufacturers of the intrinsically safe apparatus and associated apparatus or other specification sheets that provide information such as terminal identification.

NOTE — Figures 4.1, 4.2a, 4.2b, 4.3a, 4.3b and 4.3.c were provided by the SP12.02 subcommittee.

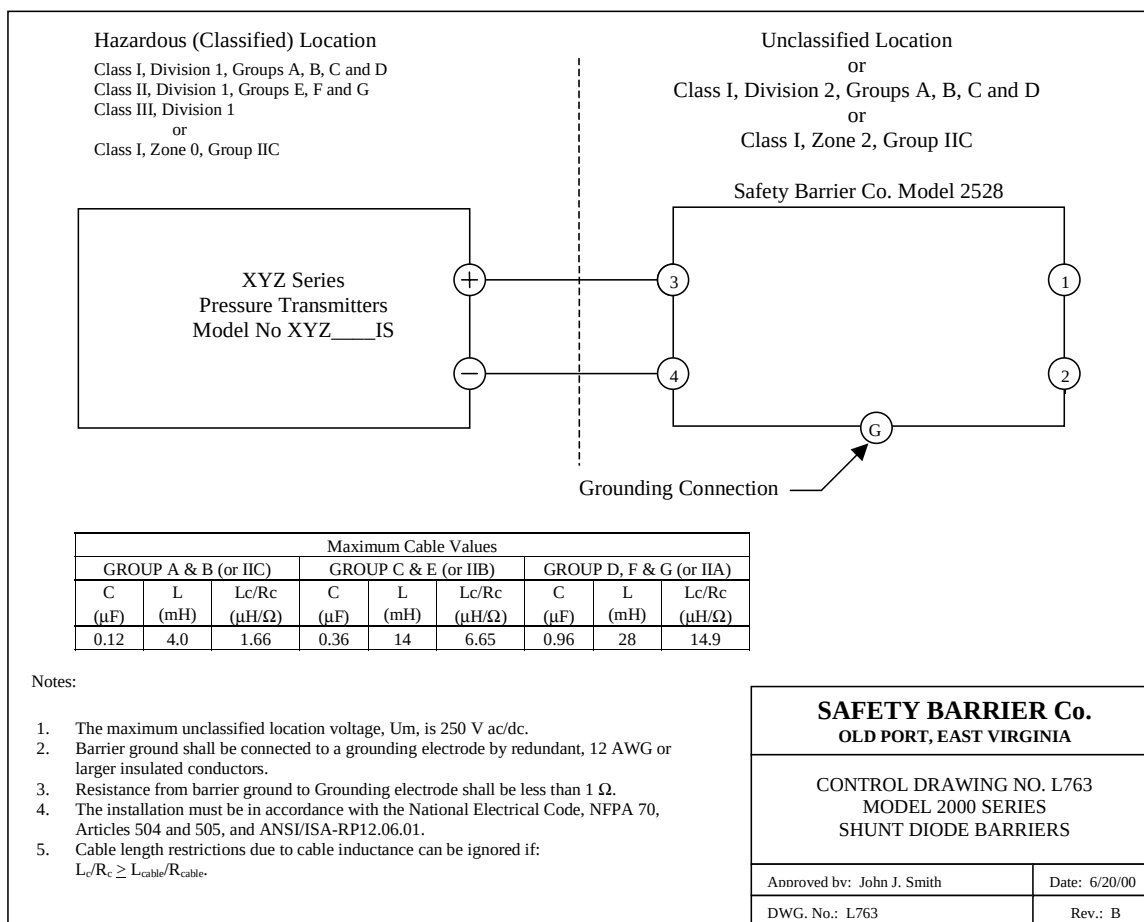


Figure 4.1 — Example of a control drawing for an intrinsically safe system



Figure 4.2a — Example of a control drawing for an intrinsically safe apparatus with entity parameters for Division 1 and Zone 0