

# AV Positioner

## Installation in a hazardous location

### Introduction

This product application guide provides guidance on using a Type AV positioner in a location which is made hazardous by the presence of ignitable concentrations of gases, dusts or fibers.

The terminology used throughout this product application guide has been simplified for ease of understanding. However, many terms have very specific meanings to testing laboratories and inspectors. Specific details are available from the standards listed in the Applicable Standards section.

### Equipment Marking

Electrical equipment used in a hazardous location must be marked as suitable for the hazardous location by both class and group. A positioner without such a marking may not be used in a hazardous location since it may have differences in the electronics that would invalidate the protection.

### Environmental Conditions

The ignitability and explosion severity of flammable materials is dependent upon the oxygen concentration, prepressurizing and temperature. Electrical equipment evaluated for use in hazardous locations are generally tested only for the following conditions:

Ambient Temp.	O <sub>2</sub> Concentration	Ambient Pressure
-25° to 40°C (-13° to 105°F)	21% maximum	12.5 to 15.7 psi (86 to 108 kPa)

It is generally felt that temperatures between 40° and 60°C do not affect the test results for most gases as long as the T Code (temperature code) is adjusted for the higher temperature. The T Code is based upon a 40°C ambient temperature.

### Area Classification

Area classification is by class, division and group in North America. The European system of zone and group classification is further detailed in the Comparison of European versus North American Area Classification section.

Class - Hazardous locations are divided into three classes:

- Class I for gases.
- Class II for dusts.
- Class III for fibers.

Division - Each class is further divided into two divisions:

Division 1 hazardous locations are areas where the flammable atmosphere occurs during normal operation. Examples of Division 1 areas would be around paint spraying operations or where flammable liquids or vapors could escape from open tanks, indoor vents, indoor hose couplings, and inadequately ventilated pumps and valves.

Division 2 hazardous locations are areas where the flammable atmosphere only occurs because of an infrequent failure. Typical failures may be leakage from pump and valve packings, leakage from sealed containers, or failure of pressurizing or ventilating systems.

Group - The flammable materials are divided into groups to help describe the nature of the material.

Gases are divided into four groups:

- Group A for acetylene.
- Group B for hydrogen and similar gases.
- Group C for ethylene and similar gases.
- Group D for propane and similar gases.

Dusts are divided into three groups:

- Group E for metal dusts.
- Group F for carbonaceous dusts.
- Group G for chemical and agricultural dusts.

Fibers are not further divided and have no group designations.

The classification for a specific material is found in ANSI/NFPA 497M. Guidelines for area classification are found in standards such as ANSI/NFPA 497A for gases and ANSI/NFPA 497B and ANSI/ISA S12.10 for dusts.

## Temperature Codes (T Codes)

Flammable atmospheres can be ignited not only by electrical arcs but also by hot surfaces. Fortunately, most gases and dusts ignite at temperatures considerably above what would be acceptable operating temperatures for electronic equipment.

The National Electrical Code uses a system of identification numbers which will be referred to as T Codes. These codes represent the hottest component for intrinsically safe and nonincendive equipment which would ignite the flammable gas.

The T Codes most likely to be marked on a Type AV positioner are the following:

T Code	°F	°C
T3C	320	160
T4	275	135
T4A	248	120
T5	212	100
T6	185	85

The positioner must not be used with a gas which has a lower ignition temperature than the temperature corresponding to the T Code for that protection technique. The ignition temperatures for various gases can be found in ANSI/NFPA 497M.

## Division 1 Protection Techniques

Type AV positioners with TEIP11 I/P Signal Converter have been designed for use in intrinsically safe loops to allow their use in normally flammable atmospheres.

### Intrinsically Safe Loops

Intrinsic safety relies on the fact that even if the gas penetrates the enclosure, it will not be ignited by the electrical equipment because the energy available is limited. The energy required for ignition is greatly dependent upon the material, e.g. 17  $\mu$ Joules for hydrogen and 200  $\mu$ Joules for propane. Because the energy is limited, this protection can only be used for low-energy circuits such as 4 to 20 mA loops.

Intrinsic safety analysis assumes that the field wiring may short together, open circuit, or short to ground. Since the analysis assumes this will happen, it is thus permitted to use any wiring technique. On the other hand, it requires that all power sources must be energy limited. This is usually accomplished by a product called an intrinsic safety barrier. These intrinsic safety barriers limit both the open circuit voltage and the short circuit current that can enter the hazardous location. Intrinsic safety analysis further assumes that faults can occur within the control equipment so that any wire not connected to ground could become a power source. Therefore, an intrinsic safety barrier is required on each wire unless it is connected to ground.

The nature of shunt diode intrinsic safety barriers requires that they introduce series resistance into the loop. Therefore, a performance review is required to verify that the full 20 milliamps can flow with the added series resistance.

The energy limitation and tests done with shorted and grounded field wiring allows for limited maintenance to be done while the circuit is energized. The maintenance must not result in shorting of separate intrinsically safe circuits. This is a special concern when one positioner has multiple intrinsically safe circuits.

Also, maintenance of the positioner must not introduce additional capacitance or inductance into the intrinsically safe loop. Test equipment such as meters should be verified as acceptable before using on energized circuits.

Refer to the OI/TEIP11/TEIP11-PS for specific installation guidelines.

## Division 2 Protection Techniques

Although the intrinsically safe loop protection is also suitable for Division 2 hazardous locations, it requires that it be implemented as rigorously as if in a Division 1 hazardous location.

There is another protection technique that is suitable only for Division 2. This is referred to as nonincendive equipment in the United States.

The flammable atmosphere will only be present in a Division 2 hazardous location infrequently and for a short time. Therefore, if the electrical equipment is not normally an ignition source, it can be shown that the possibility of the flammable atmosphere existing simultaneously with a fault in the electrical equipment is very unlikely. The electrical equipment is evaluated to verify that there are no normal ignition sources such as arcing contacts or hot surfaces. Arcing contacts could be from motor brushes, relay contacts, switches actuated by moving parts or accessible to the operator, etc.

The advantage of the nonincendive rating is that the installation does not require intrinsic safety barriers. Typical wiring used is power limited tray cable (PLTC), a designation assigned by Underwriters Laboratories.

## Nonincendive Equipment Installations

### WARNING

Substitution of components may impair suitability for use in a hazardous location. Disconnecting/reconnecting wiring or repairing the positioner is not considered normal operation. These operations should only be done if power has been removed from all wiring or if the flammable atmosphere is known not to be present.

### AVERTISSEMENT

La substitution de composants peut rendre l'émetteur inadéquat à l'utilisation dans un environnement dangereux. Le débranchement ou le rebranchement des fils ainsi que la réparation du transmetteur n'entrent pas dans les procédures normales. Si l'atmosphère est inflammable, on ne doit effectuer les étapes ci-dessus que si l'alimentation a été interrompue.

## Nonincendive Equipment Installations

The nonincendive rating is based upon normal operation which does not include maintenance.

The circuits connected to a Type AV positioners are normally assumed to be at ignition capable levels. Therefore, this wiring must be suitable for use in Class I, Division 2, hazardous locations. The National Electric Code requires the use of rigid metal conduit or nonmetallic cable (Types MV, PLTC, SNM and PC) or metallic cable (Types MI and MC). The Canadian Electrical Code requires nonmetallic cable certified as HL or metal conduit. PLTC cable is rated 300 volts and can be obtained in wire sizes 22 AWG to 16 AWG at various temperature ratings. PLTC cable is the recommended wiring for positioners installed in the United States.

### Nonincendive Field Circuits

If it is desired to use ordinary location wiring for the circuit or if it is desired to service individual positioners while they are powered, then each power source must be voltage and current limited such that opening, shorting or grounding of the circuit will not cause an ignition capable arc. In addition, operating on live circuits should only be done if there is not a shock hazard. For dry locations, the voltage should be less than 42 VDC or 30 VAC.

The intrinsic safety and nonincendive documents listed in the Applicable Standards section provide ignition curves as guidelines for limiting voltage and current. In general, there are three criteria:

1. For a given open circuit voltage, adequate series resistance must be provided at the power source to limit the short circuit current.
2. For a given open circuit voltage, the capacitance of the positioner plus cable must not exceed a specific value.
3. For a given short circuit current, the inductance of the positioner plus cable must not exceed a specific value.

### Example of Nonincendive Levels

Table 1 shows the series resistance required to make the circuit nonincendive for the various groups based upon a 26.4 volt open circuit voltage. The inductance is based upon using a 150 ohm resistor in series with the power supply to limit the short circuit current to 176 milliamps. If the short circuit current is higher because a lower valve series resistance is used, then the allowed inductance will decrease. Table 2 tabulates the minimum output resistance for selected analog output controllers and modules. In most cases, additional series resistance is required to make the circuit nonincendive. Particular attention must be given to not exceeding the allowed inductance, since many I/P converters have inductance.

Table 1. Nonincendive Series Resistance ( $V_{oc} = 26.4V$ )

Group	Allowed Current (mA)	Series Resistance ( $\Omega$ )	Allowed Inductance @176mA (mH)	Allowed Capacitance ( $\mu F$ )
A or B	185	142	2	0.5
C	468	56	9	1.5
D	612	43	18	4.0

Table 2. Maximum Load Resistance for various ABB Units

Equipment	I/O Voltage (V)	Maximum Load ( $\Omega$ )	Minimum Output ( $\Omega$ )
IMASO01	21.6	750	12
IMCIS02	21.6	600	40
CLC03/04	21.6	700	140
CBC01	21.6	700	260
CPC01	24 nom	750	37

Any wiring type may be used for nonincendive field circuit per the exception in the NEC article 501-4 (b) and CEC article 18-066 (2). A nonincendive circuit may be installed and tested while powered. Care must be taken to insure that only one circuit is worked on at a time. Shorting of separate circuits is not part of the evaluation & could result in ignition capable arcs.

### Agency Approvals

Nomenclature	Approval/Certification
AV1 and AV23	Factory Mutual Research (cFM <sub>US</sub> ): FM Approvals - FM16US0321 FM Approvals Canada - FM16CA0160 Approved as nonincendive for: Class I, Div 2, Groups A, B, C, D / T5 Ta = 40°C Class II, Div 2, Groups E, F and G / T5 Ta = 40°C Class III, Div 2 / T5 Ta = 40°C

### Applicable Standards (AV1 and AV23)

Document	Title
FM Class 3600: 2011	Electrical Equipment for Use In Hazardous (Classified) Locations - General Requirements
FM Class 3611: 2004	Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations
FM Class 3810: 2005	Electrical Equipment for Measurement, Control and Laboratory Use
CSA C22.2 No 0: 2006	General requirements - Canadian electrical code
CSA C22.2 No 213: 2004	Nonincendive electrical equipment for use in Class I and II, Division 2 and Class III, Divisions 1 and 2 hazardous (classified) locations
CSA C22.2 No 142: 2004	Process Control Equipment

### Agency Approvals

Nomenclature	Approval/Certification
AV27__0__	Factory Mutual Research (FM): Approved as explosionproof for: X.P: Class I ; Division 1, Groups B, C, D D.I.P: Classes II, III ; Division 2, Groups E, F, G  Canadian Standards Association (CSA) Certified as explosionproof for: Classes I ; Division 1, Groups B, C, D  Refer: ABB - TEIP11 I/P Signal Converter Install per : OI/TEIP11/TEIP11-PS

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