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Technical Information

Rxn-41 Raman spectroscopic probe

Endress+Hauser
People for Process Automation

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Function and system design

Fields of application

The Rxn-41 Raman spectroscopic probe is intended for liquid immersion sample analysis in a process plant setting.

Recommended applications include:

- **Chemical:** reaction monitoring, blending, feed, and final product monitoring
- **Polymer:** polymerization reaction monitoring, polymer blending
- **Pharmaceutical:** active pharmaceutical ingredient (API) reaction monitoring, crystallization, polymorph, drug substance production unit operation
- **Oil and gas:** any hydrocarbon analysis

Use of the device for any purpose other than that described, poses a threat to the safety of people and of the entire measuring system and invalidates any warranty.

Laser safety indicator

The Rxn-41 probe, as installed, forms part of the interlock circuit. If the fiber cable is severed, the laser will turn off within milliseconds of the breakage.

NOTICE

Handle probes and cables with care.

Fiber cables should NOT be kinked and should be routed to maintain the minimum bend radius of 152.4 mm (6 in.).

▶ Permanent damage may result if cables are not routed appropriately.

The interlock circuit is a low-current electrical loop. If the Rxn-41 probe is used in a hazardous classified area, the interlock circuit must pass through an intrinsically safe (IS) barrier.

Rxn-41 probe

The parts of the Rxn-41 probe are shown below.

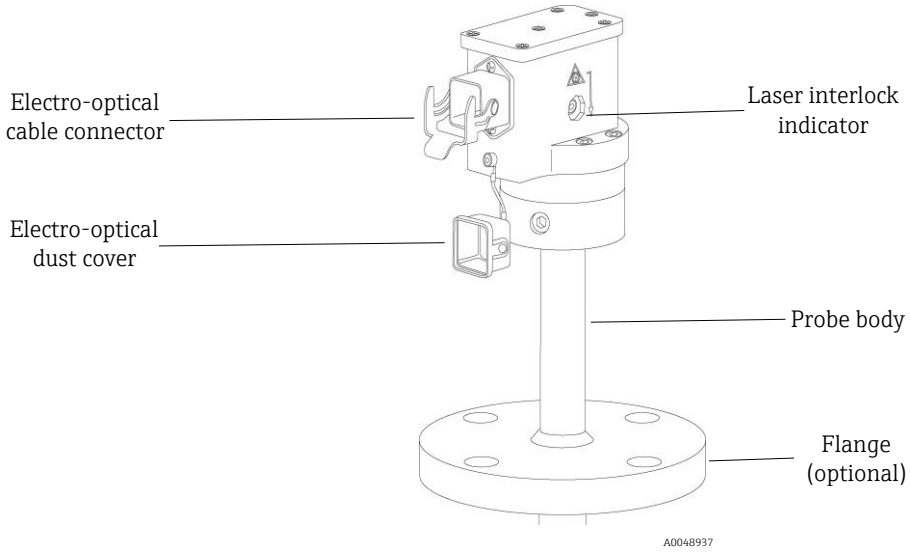

Figure 1. Rxn-41 probe

Process and probe compatibility

Prior to installation, the user must verify that the probe pressure and temperature ratings, as well as the materials from which the probe is made, are compatible with the process into which it is being inserted.

The probes should be installed using sealing techniques (e.g., flanges, compression fittings) appropriate and typical for the vessel or piping.

⚠ WARNING

If the probe will be installed in a high temperature or pressure process, additional safety precautions must be taken to avoid equipment damage or safety hazards.

A blow-out protection device is highly recommended in accordance with local safety standards.

- ▶ It is the responsibility of the user to determine if any blow-out protection devices are required and ensure they are attached to the probes during installation.

⚠ WARNING

If the probe being installed is constructed of titanium, the user should be aware that impacts or excessive process friction could cause a spark or otherwise cause ignition.

- ▶ The user must ensure that precautions are taken when installing and using a titanium probe to avoid such an occurrence.

Installation

Prior to installation in the process, verify that the amount of laser power out of each probe is no more than the amount specified in the Hazardous Area Equipment Assessment (4002266) or equivalent.

Standard eye and skin safety precautions for Class 3B laser products (as per EN-60825/IEC 60825-14) should be observed during installation as described below.

⚠ WARNING	**Probes are designed with specific sealing boundaries.** ▶ The probe pressure specifications are only valid if sealing is accomplished on the intended sealing feature (shaft, flange, etc.). **Standard precautions for laser products should be observed.** ▶ Probes should always be capped and/or pointed away from people toward a diffuse target if not installed in a sample chamber.
⚠ CAUTION	**If stray light is allowed to enter an unused probe, it will interfere with data collected from a used probe and may cause calibration failure or measurement errors.** ▶ Unused probes should ALWAYS be capped to prevent stray light from entering the probe.
NOTICE	**Take care to install the probe such that it measures the flowing sample or sample region of interest.**

The Rxn-41 probe is designed for installation directly into process streams and reactor vessels according to the installation guidelines below:

- When installing a probe equipped with the non-removable right-angle fiber connector (EO style) assembly, it is recommended that the fiber cable assembly be disconnected from the probe during installation.
- Ensure that the laser interlock is connected to the safety indicator light and to any other safety systems, such as liquid level sensors or purges appropriate to the installation.
- The Rxn-41 probes have no active electrical devices requiring earthing. The user should determine if the probe requires earthing for other reasons associated with its installation.

Specifications

Temperature and pressure

The temperature and pressure specifications for the Rxn-41 probe vary depending on the probe size and materials of construction. A cryogenic compatible version is available for the 1 inch Rxn-41 probe upon request. Additionally:

- Max pressure is calculated per ASME BPVC VIII.1 UG-28(c) for material and probe geometry at the maximum rated temperature.
- Max service pressure ratings do not include the ratings of any fittings or flanges used to mount the probe into the process system. These items need to be independently evaluated and may lower the maximum service pressure of the probe.
- Minimum pressure rating: All probes have a minimum pressure rating of 0 Bara (full vacuum). However, unless specified, they are not rated for low outgassing at high vacuum service.
- The probe withstands 0 100 °C (32 to 212 °F) water shock.
- The temperature ramp is ≤ 30 °C/min (≤ 54 °F/min).

Component	Materials of construction	Min temp	Max temp	Max service pressure
1-inch Rxn-41 probe	316L stainless steel	−30 °C (−22 °F)	120 °C (248 °F)	77.0 barg (1120 psig)
	C276 alloy	−30 °C (−22 °F)	150 °C (302 °F)	98.5 barg (1420 psig)
	Grade 2 titanium	−30 °C (−22 °F)	150 °C (302 °F)	76.0 barg (1100 psig)
2-inch (nominal) Rxn-41 probe	316L stainless steel	−30 °C (−22 °F)	120 °C (248 °F)	42.7 barg (620 psig)
	C276 alloy	−30 °C (−22 °F)	150 °C (302 °F)	66.1 barg (960 psig)
1-inch Cryogenic Rxn-41 probe	C276 alloy	−196 °C (−320.8 °F)	70 °C (158 °F)	111.0 barg (1610 psig)
	Hybrid metal combination (C276 tip/316L)	−196 °C (−320.8 °F)	70 °C (158 °F)	87.5 barg (1270 psig)
Cable and connector	Cable: PVC jacketed, proprietary construction Connections: proprietary electro-optic	−40 °C (−40 °F)	70 °C (158 °F)	not applicable

Table 1. Temperature and pressure specifications

General specifications

General specifications for the Rxn-41 probe are listed below.

Item		Description
Laser wavelength		532 nm, 785 nm, or 993 nm
Spectral coverage		probe spectral coverage is limited by the coverage of the analyzer being used
Maximum laser power into probe		< 499 mW
Materials of construction Wetted, in contact with sample	probe body	• C276 alloy or 316L stainless steel • Grade 2 titanium available upon request • Hybrid metal combination (316L stainless steel, C276 alloy) available upon request
	window	high-purity sapphire
Probe immersible length	C276 alloy	• 1-inch Rxn-41: Up to 3040 mm (120 in.) • 2-inch Rxn-41: Up to 4550 mm (179.1 in.)
	316L stainless steel	• 1-inch Rxn-41: Up to 3040 mm (120 in.) • 2-inch Rxn-41: Up to 4550 mm (179.1 in.)
	Grade 2 titanium	1-inch Rxn-41: Up to 350 mm (13.78 in.)
Probe immersible diameter	C276 alloy	• 25.4 mm (1 in.) • 60.325 mm (2-inch nominal; actual OD 2.38 in.)
	316L stainless steel	• 25.4 mm (1 in.) • 60.325 mm (2-inch nominal; actual OD 2.38 in.)
	Grade 2 titanium	25.4 mm (1 in.)
pH range		0 to 14
Relative humidity		up to 95 %, non-condensing
Flanges	type	ASME B16.5 or DIN EN1092 Type B flanges available upon request
	diameter	up to 305 mm (12 in.)
Fiber cable (sold separately)	design	PVC jacketed, proprietary construction
	connections	proprietary electro-optic
	minimum bend radius	152.4 mm (6 in.)
	length	EO cable available from 5 m to 200 m in 5 m increments (16.4 ft. to 656.2 ft. in 16.4 ft. increments) limited by application
	pull strength	204 kg (450 lbs.)
	flame resistance	Certified: CSA-C/US AWM I/II, A/B, 80C, 30V, FT1, FT2, VW-1, FT4 Rated: AWM I/II A/B 80C 30V FT4

Table 2. General specifications

Dimensions: 1-inch probe The dimensions for the 1-inch diameter Rxn-41 probe and its tip are shown below.

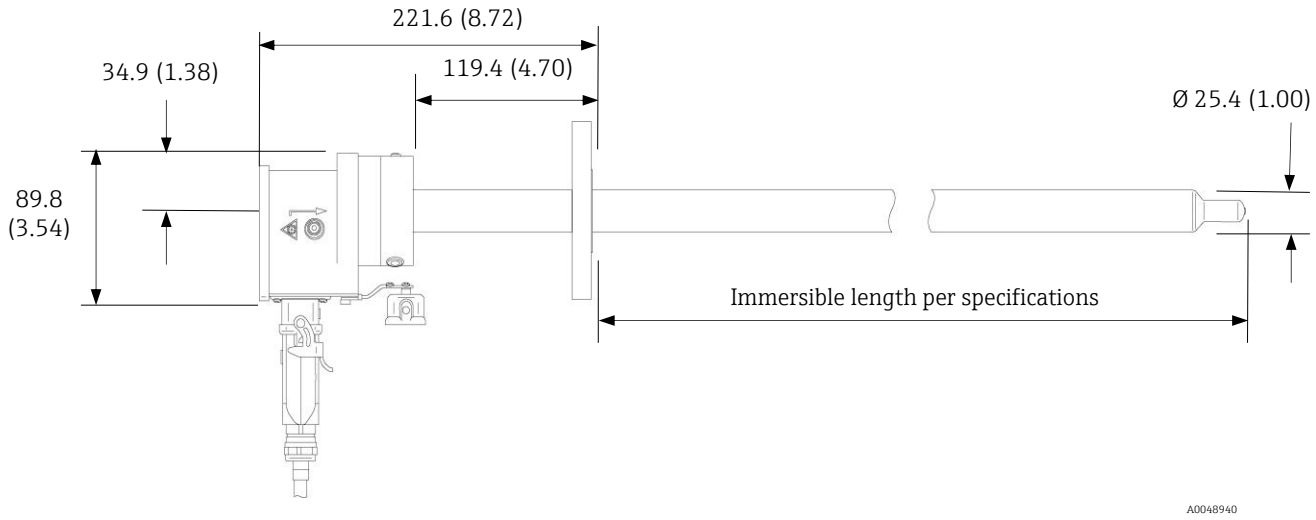

Figure 2. Dimensions of 1-inch Rxn-41 probe

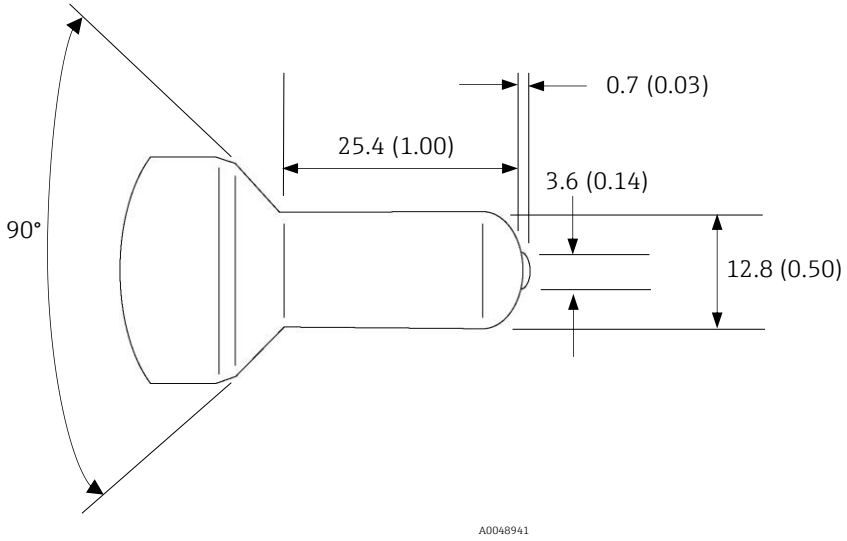

Figure 3. Tip of 1-inch Rxn-41 probe

Dimensions: 2-inch probe

The dimensions for the 2-inch (nominal) diameter Rxn-41 probe and its tip are shown below.

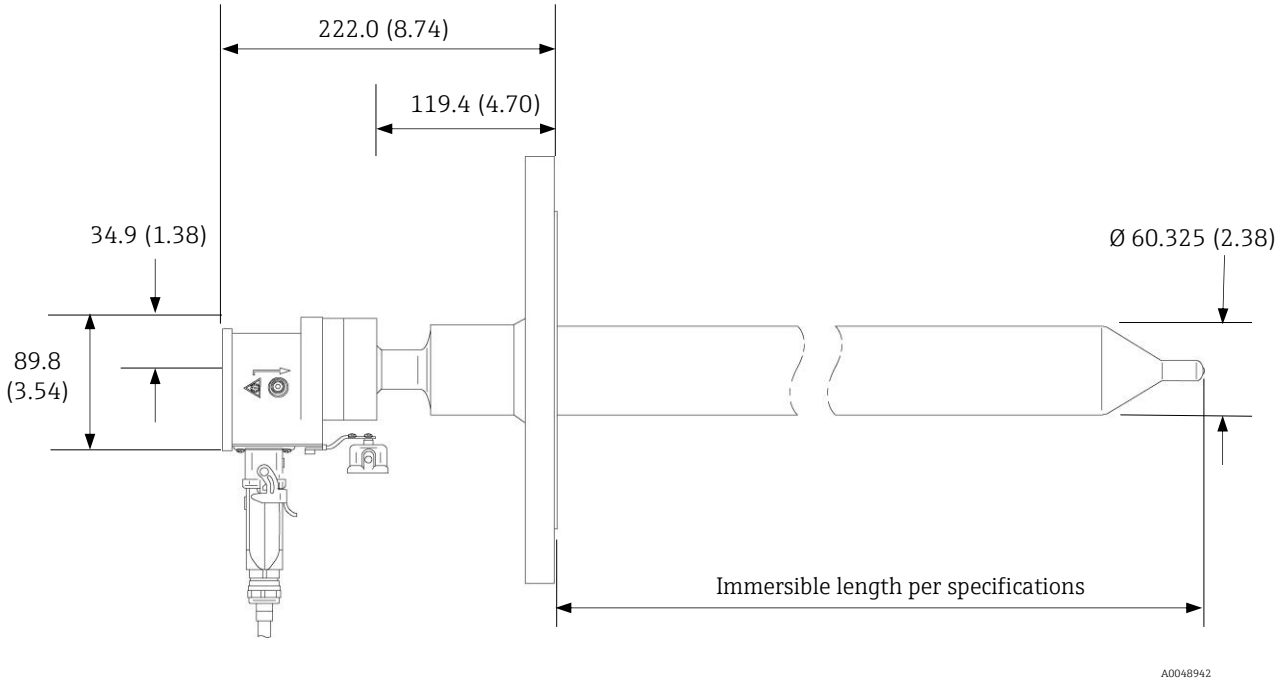

Figure 4. Dimensions of 2-inch Rxn-41 probe

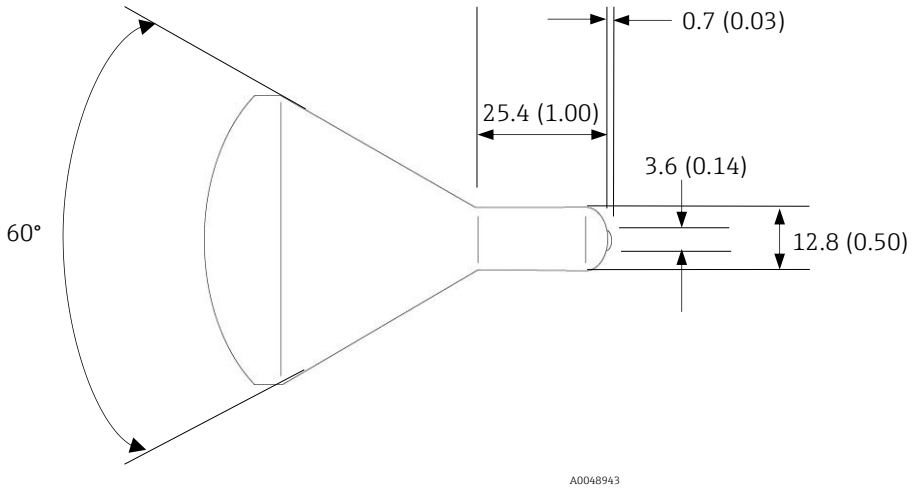

Figure 5. Tip of 2-inch Rxn-41 probe

MPE: ocular exposure

Refer to the tables below from the ANSI Z136.1 standard to calculate the maximum permissible exposure (MPE) for point source ocular exposure to a laser beam.

A correction factor (C_A) may also be required and can be determined below.

Wavelength λ (nm)	Correction Factor C_A
400 to 700	1
700 to 1050	$10^{0.002(\lambda-700)}$
1050 to 1400	5

Table 3. Wavelength dependent correction factor C_A

MPE for point source ocular exposure to a laser beam			
Wavelength λ (nm)	Exposure Duration t (s)	MPE Calculation	
		$(J \cdot cm^{-2})$	$(W \cdot cm^{-2})$
532	10^{-13} to 10^{-11}	1.0×10^{-7}	-
	10^{-11} to 5×10^{-6}	2.0×10^{-7}	-
	5×10^{-6} to 10	$1.8\ t^{0.75} \times 10^{-3}$	-
	10 to 30,000	-	1×10^{-3}

Table 4. MPE for ocular exposure with 532 nm laser emission

MPE for point source ocular exposure to a laser beam				
Wavelength λ (nm)	Exposure Duration t (s)	MPE Calculation		MPE where C_A = 1.4791
		$(J \cdot cm^{-2})$	$(W \cdot cm^{-2})$	
785 and 993	10^{-13} to 10^{-11}	$1.5\ C_A \times 10^{-8}$	-	2.2×10^{-8} $(J \cdot cm^{-2})$
	10^{-11} to 10^{-9}	$2.7\ C_A\ t^{0.75}$	-	Insert time (*t*) and calculate
	10^{-9} to 18×10^{-6}	$5.0\ C_A \times 10^{-7}$	-	7.40×10^{-7} $(J \cdot cm^{-2})$
	18×10^{-6} to 10	$1.8\ C_A\ t^{0.75} \times 10^{-3}$	-	Insert time (*t*) and calculate
	10 to 3×10^4	-	$C_A \times 10^{-3}$	1.4971×10^{-3} $(W \cdot cm^{-2})$

Table 5. MPE for ocular exposure with 785 nm or 993 nm laser emission

MPE: skin exposure

Refer to the table below from the ANSI Z136.1 standard to calculate the MPE for skin exposure to a laser beam.

MPE for skin exposure to a laser beam				
Wavelength λ (nm)	Exposure Duration t (s)	MPE Calculation		MPE where C_A = 1.4791
		$(J \cdot cm^{-2})$	$(W \cdot cm^{-2})$	
532, 785 and 993	10^{-9} to 10^{-7}	$2\ C_A \times 10^{-2}$	-	2.9582×10^{-2} $(J \cdot cm^{-2})$
	10^{-7} to 10	$1.1\ C_A\ t^{0.25}$	-	Insert time (*t*) and calculate
	10 to 3×10^4	-	$0.2\ C_A$	2.9582×10^{-1} $(W \cdot cm^{-2})$

Table 6. MPE for skin exposure with 532 nm, 785 nm, or 993 nm laser emission

Certificates and approvals

Hazardous area approvals

The hazardous area approvals are listed below.

Type	Description
Hazardous area approvals	**ATEX** The Rxn-41 probe has been third-party approved for use in hazardous areas in accordance with Article 17 of Directive 2014/34/EU of the European Parliament and of the Council dated 26 February 2014. The Rxn-41 probe has been certified to the ATEX Directive for use in Europe, as well as in other countries accepting ATEX-certified equipment. **IECEx** The Rxn-41 probe can also be marked for International Electrotechnical Commission (IEC) Certification Systems for Explosive Atmospheres when installed in accordance with the Hazardous Area Installation Drawing. **North American** The Rxn-41 probe has also been approved for use in hazardous areas in the United States (US) and Canada by the Canadian Standards Association when installed in accordance with the Hazardous Area Installation Drawing. The products are eligible to bear the CSA Mark with adjacent indicators 'C' and 'US' for Canada and US or with adjacent indicator 'US' for US only or without either indicator for Canada only.

Table 7. Hazardous area approvals

Certifications and markings

Endress+Hauser offers certifications for the Rxn-41 probe to the standards below. Select the desired certification(s) and the probe or probe tag is marked accordingly.

Type	Description
ATEX marking and installations	ATEX marking is available as an option at the time of purchase. Available markings: II 2/1 G Ex ia op is IIA or IIB or IIB+H2 or IIC T3 or T4 or T6 Ga Prior to the order, the marking for the particular probe/application must be determined. The customer must do one of the following: ▪ Work with purchasing to identify the required marking OR ▪ Provide Endress+Hauser with a completed copy of the Hazardous Area Equipment Assessment (4002266). Endress+Hauser will mark the Rxn-41 probes according to the customer's provided information. Endress+Hauser is not responsible for the customer's inaccuracies. **⚠ WARNING** **In an ATEX-governed environment, only ATEX-marked probes may be used.**
North American hazardous area marking and installations	CSA marking is available as an option at the time of purchase. Available markings: Ex ia op is IIA or IIB or IIB + H2 or IIC T3 or T4 or T6 Ga Class I, Zone 0 AEx ia op is IIA or IIB or IIB + H2 or IIC T3 or T4 or T6 Ga Class I, Division 1, Groups A, B, C, D T3/T4/T6 Prior to the order, the marking for the particular probe/application must be determined. The customer must do one of the following: ▪ Work with purchasing to identify the required marking OR ▪ Provide Endress+Hauser with a completed copy of the Hazardous Area Equipment Assessment (4002266). Endress+Hauser will mark the Rxn-41 probes according to the customer's provided information. Endress+Hauser is not responsible for the customer's inaccuracies. For North American applications into classified environments, the probe set will have the CSA mark and can be considered intrinsically safe when installed according to the Hazardous Area Installation Drawing (4002396). **⚠ WARNING** **In a CSA-governed environment, only CSA-marked probes may be used.**
IECEx hazardous area marking and installations	IECEx marking is available as an option at the time of purchase. Available markings: Ex ia op is IIA or IIB or IIB + H2 or IIC T3 or T4 or T6 Ga IECEx ITS 14.0015X Prior to the order, the marking for the particular probe/application must be determined. The customer must do one of the following: ▪ Work with purchasing to identify the required marking OR ▪ Provide Endress+Hauser with a completed copy of the Hazardous Area Equipment Assessment (4002266). Endress+Hauser will mark the Rxn-41 probes according to the customer's provided information. Endress+Hauser is not responsible for the customer's inaccuracies. For IECEx applications into classified environments, the probe set will have the IECEx mark and can be considered intrinsically safe when installed according to the Hazardous Area Installation Drawing (4002396). **⚠ WARNING** **In an IECEx-governed environment, only IECEx-marked probes may be used.**

Table 8. Certifications and markings

Hazardous area drawing The Hazardous Area Installation Drawing is shown below.

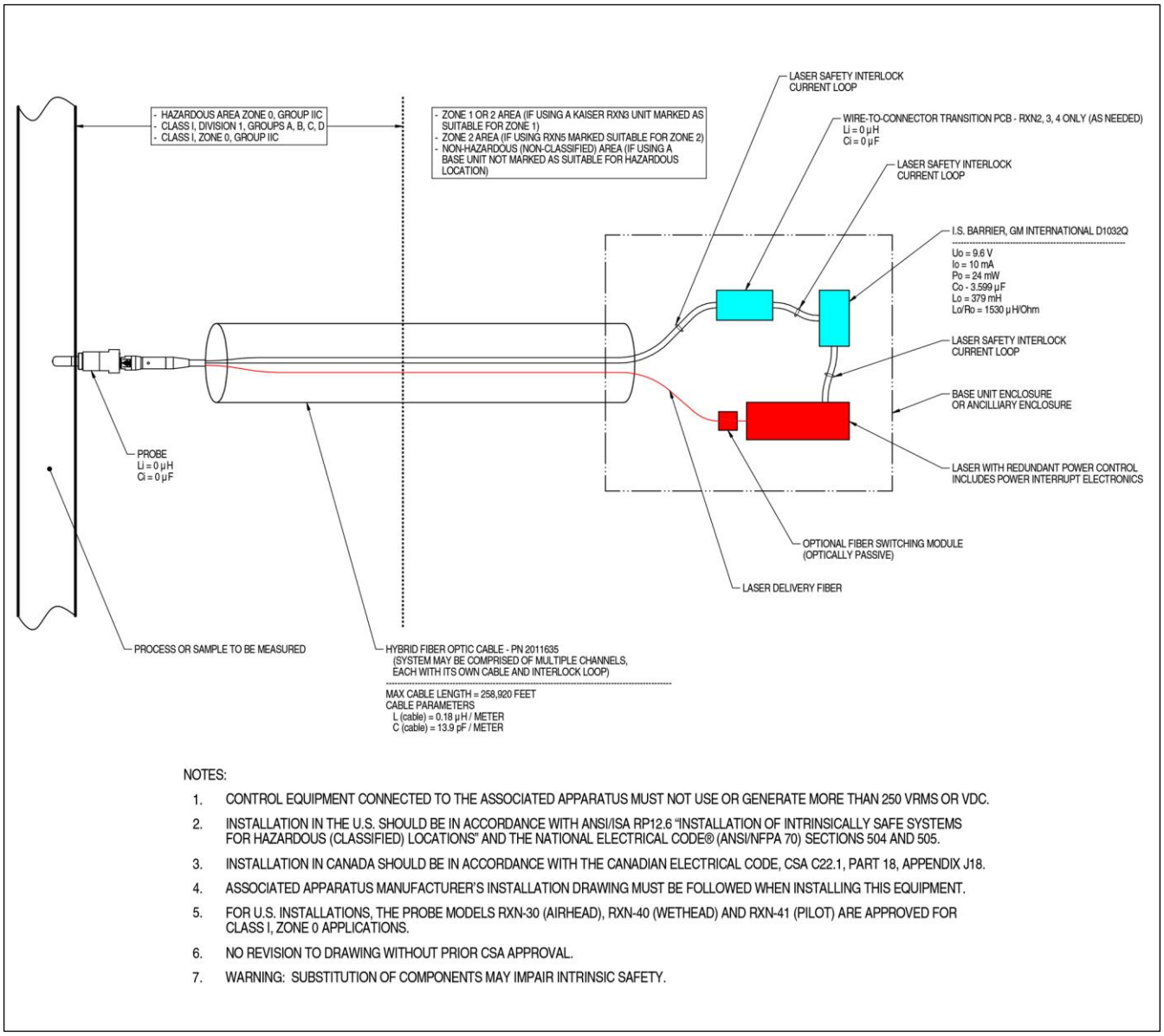

Figure 6. Hazardous Area Installation Drawing (4002396 version X5)

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