

# Misconceptions on Absence of Voltage Testing

## Analyzing Risks & Safety Solutions



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**A**bsence of voltage testing is the most vital step in the process of verifying and establishing a deenergized state of any electrical system. According to the Article 120.5, NFPA 70E, it is a process-oriented approach that takes various steps to establish a deenergized state and is not accomplished with any single device. Verifying a deenergized state is further a risky task which requires strict adherence to policies and procedures to establish a safe environment to work.

**Because it is a high risk task, verifying a deenergized state requires strict adherence to policies and procedures.**

Additionally, it is also a regulatory requirement per OSHA's 29 CFR 1910.333 (b)(2)(iv)(B) and NFPA 70E, Article 120.5. Historical data suggests

high incident rates of both shock and electrocution because of performing the task of "absence of voltage testing" inside the electrical cabinets. The data further points out that the incidents are primarily caused due to workers' inadvertent contact with electrical circuit parts inside the panel, wrong application of test instruments, human error, production pressures, and complacency. Many safety centric organizations and product innovators have devised a variety of methods to minimize the risk of exposure to workers from the hazards of presence and absence of voltage testing over the past several decades. In its recent edition, NFPA 70E, 2018 allowed an alternative method through a new exception for the same task under the Article 120.5 (7). This document delineates the differences between presence and absence of voltage testing from the application standpoint of lockout/tagout and compares the pros and cons of these devices, and their limitations of use. Products

discussed include, voltage indicators, test portals, permanently mounted accessories, portable test instruments, and absence of voltage testers. Given the process centric approach, additional clarification is placed on worker qualification, installation conditions, training requirements, procedures, and failure modes of these risk control methods and their effect on both the task and the worker.

**Permanently Mounted Accessory:** An accessory that is used in conjunction with a portable test instrument for absence of voltage testing. Meets Article 120.5 (7), NFPA 70E, 2018, Listed to UL 61010 (UL CCN. PICQ, measurement, testing and signal-generation equipment). Chapter 6.1.1 defines the retirements for accessible parts to be non-hazardous.

**Permanently Mounted Tester:** A standalone device that is used for absence of voltage testing (a tester) Meets Article 120.5 (7), Exception. 1, NFPA 70E, 2018, Listed to UL 1436.

## What are Test Portals?

*(Conductive vs. Non-Conductive)*

Test portals are permanently mounted accessories and are classified into two categories based on the application of use.

1. Portals that are non-conductive and use non-contact voltage detector pen (NCVD pen) for voltage detection
2. Portals with conductive test points that use portable test instrument and test probes for absence voltage testing & trouble shooting

Permanently Mounted Accessories are UL 61010 listed devices that are meant for voltage testing using an adequately rated portable test instrument. The

UL classification further terms this product as “Panel Mounted Test Point Meter”. These devices can be used for both troubleshooting the equipment and to verify the absence of voltage to the source they are connected to.

The major difference is the application of use. If the portals are used with an NCVD pen for voltage detection, they are meant for unqualified workers (AKA task qualified workers who are not qualified electrical workers). The main purpose of both the voltage indicators and portals with NCVD pens are to assist task qualified workers performing mechanical LOTO to quickly verify the deenergized state in addition to bump test once the energy isolating device or disconnect is thrown to the “off” position. While the indicators and the portals that use NCVD pens are meant for voltage presence indication only, the test points are used for absence of voltage testing.

## Mechanical Lockout/Tagout

### ✓ Voltage Presence



## Electrical Lockout/Tagout

### ✓ Voltage Absence

### ✓ Voltage Presence and Absence



*Devices that are listed to UL CCN. PICQ are investigated with respect to fire, shock or injury to persons.*

## Why use Safe-Test Points™ to Verify the Absence of Voltage?

Test portals with test points greatly reduce the risk of exposure to qualified electrical workers as they use high impedance protected circuitry that is built-in these devices.

**Maximum fault current is limited to less than 3.5mA at the door with a Safe-Test Point installed.**

Hence there is no shock or arc flash hazard for the worker performing the task. Compared to the conventional method of absence of voltage testing inside an electrical cabinet assuming the system is still energized, these devices provide a much safer alternative to verify the absence of voltage as outlined in the both Article 120.5 (7), of NFPA 70E, 2018 and OSHA 29 CFR 1910.333(b)(2)(iv)(B).

Per NFPA 70E, there are six risk control methods that are required to be implemented per Article 110.1(H)(3). Risk Control Hierarchy (RCH) classifies risk controls in six categories such as elimination, substitution, engineering controls, awareness, administrative controls, and PPE and the controls must be applied in the order of priority with elimination as highly effective to PPE as least effective. The purpose of the RCH is to identify and apply a single or combination of risk control methods that are suitable for the specific application and the task performed. Permanently mounted electrical safety devices fall under the engineering controls category within the RCH. NFPA 70E realizes that there is no one-size-fits-all solution as it relates to applying risk controls across a wide variety of tasks performed.

Further, when it comes to electrical safety there is no such thing as absolute zero risk and the same is outlined in the NFPA 70E handbook as failure modes associated with every type of risk control method with examples.

**When it comes to electrical safety, there is no such thing as absolute zero risk.**

Using any permanently mounted device for absence of voltage testing at the door still begs the question of failure modes in terms of device functionality, wiring, workmanship, worker qualification, training, and physical damage to the device itself. These failure modes are common with any product such as an Absence of Voltage Tester or a Test-Point using an adequately rated portable test instrument with test probes.

**Permanently Mounted Accessory:** A device with NO cords and plugs. Meaning the leads of the device are permanently connected to the circuit part or source of voltage using UL 508A connection requirements.



## UL 61010 Listed Permanently Mounted Devices

Permanently mounted devices that are listed and labeled to UL 61010 are NOT allowed to have plug ends. These devices are not meant to be connected using a corded supply and they are only intended for permanent connection.

**Key point:** Poor workmanship, installation failures, and device malfunctions are all potential failure modes that can lead to a zero-voltage indication/no indication when the conductor is still energized.

## Importance of Worker Qualification & Training

As we know, there are several failure modes that exist with every product from design through installation and operation, it is equally important to know the effect of those failure modes on both the worker and the task performed.

## Typical Absence of Voltage Tester (AVT)



### Potential failure modes :

1. Missing battery or wrong battery in the indicator module (AA Type, 3.6 Volt Lithium Battery).
2. Accidental disconnection of leads and contacting low impedance ground path – **leads to false indication of absence indication “GREEN” when the circuit is still energized.**

3. Loose/disconnection of AVT system cable connecting from the isolation module to the door module.
4. Miswiring of leads by connecting one set to the line side and second set to the load side on the connections.
5. Wrong application of device in CAT IV, 600V environments when the device is only rated for CAT IV, 300V.
6. Misinterpretation of the fault codes by the operator.

**Limitations:** Before installation, please ensure the phase to ground voltage is less than 1.3 volts of circuit to be monitored when the power is removed. If the voltage of the monitored circuit is above 3 Volts, absence of voltage cannot be verified at the door.

## Safe-Test Point™

### Potential failure modes:

1. Accidental disconnection of the leads from the source inside the panel.
2. Insulation damage to the conductors coming to the door.

**Limitations:** Voltage measured value is affected by -2% (10 Meg Ohm meter) due to impedance protection in the device.



### **What if one cannot verify absence of voltage from outside the door?**

**Answer:** Verify deenergized state inside the panel with the use of an adequately rated portable test instrument.

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Per NFPA 70E, Article 110.4 (A), only qualified persons shall perform the absence of voltage testing. The qualified person is the one who knows what steps must be taken if the absence of voltage cannot be verified from outside an electrical cabinet.

**In simplistic terms, “Push of a Button” to verify the deenergized state does not necessarily constitute a qualified electrical work.**

Given the failure modes with every product, it is more important to address what steps must be adhered to verify the deenergized state inside the panel (example: donning the right amount of PPE and following safety policies and procedures to establish a deenergized state). With the use of Safe-Test Point™ and a portable test instrument, the fundamental assumption is the qualified person is the one who is performing the task of absence of voltage testing that ensures he/she will take the adequate safety measures before opening the panel.

**Verifying absence of voltage using a portable test instrument fundamentally assumes a qualified electrical worker is performing the task.**

**Qualified Person:** One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify the hazards and reduce the associated risk.

**Article 250.4 Test Instruments:** Test instruments and associated test leads used to verify the absence or presence of voltage shall be maintained to assure functional integrity. The maintenance program shall

include functional verification as described in 110.4(A) (5).

Article 110.4 Test Instruments and Equipment

- A) Clearly defines only qualified persons shall perform the tasks such as testing, troubleshooting, and voltage measurements on electrical equipment operating at voltages greater than or equivalent to 50 Volts
- B) Defines the rating of the instruments, equipment, and their accessories shall be:
- 1) Rated for circuits and equipment where they are utilized
  - 2) Approved for the purpose
  - 3) Used in accordance with the instructions provided by manufacturer

The informational note further clarifies the use of UL 61010-1 listed products for the equipment used in systems 1000 Volts and below.

## **Non-Hazardous Voltage to the Door**

As the Safe-Test Point™ and voltage indicators have built-in impedance protected circuits, these devices limit the current at the device, and they are validated to ensure the hazardous voltage and current are not brought to the outside of the door. (UL CCN PICQ) UL 61010 limits values for accessible parts both in normal and single fault conditions and determines the accessible parts are not hazardous live before listing the devices to UL 61010 standard. Additionally, protecting the wires from pinch against door hinges is usually addressed with the use of fray resistant sleeves when the wires are brought to the doors via hinges and sharp objects. Most end users and panel OEMs mount voltage indicators and Safe-Test Points™

on the flange as close as possible to the isolators or on a subpanel to avoid insulation damage to the wires.



## Overcurrent Protection & Installation Code Requirements

In this specific case, the overcurrent protection is meant to protect the wires that are connected to the device, and not the device itself. Use of overcurrent protection is NOT required for an AVT, and not recommended with both voltage indicators and Safe-Test Points™. Therefore, the fusing concerns are common to all permanently mounted electrical safety devices. Fuses create an additional point of failure and result in a false negative condition when voltage is present. Additionally, the impedance protected circuit design in the device limits the voltage and current to safe levels during normal and single-fault conditions and do not create a hazardous condition at the door. No short circuit current protection (SCCR) is required for these devices.

These devices are further listed to the transient overvoltage category up to 8kV allowing the devices safe use in feeders and branch circuits inside distribution (CAT III), Three phase utility connections, and outside (CAT IV). Under certain circumstances, per NEC Article 240.21(B)(1)(b) the feeder tap rule exception, allows these devices to be installed without over current protection. However, your local codes and AHJs may still require you to provide the overcurrent protection in which case the device will function normally even with the fusing.

## NFPA 70E and the Technical Committee Statement

The NFPA 70E is considered the golden standard for electrical safety in the workplace and provides a solid foundation for facilities around the globe in developing their electrical safety programs. The 70E technical committee welcomes public inputs during every revision cycle and goes through a very regimented process in reviewing those inputs. Since the standard touches a wide variety of facilities and industries, public inputs from users who found new ways to reduce risks can submit their practices to the NFPA 70E committee, which in turn decides if the 70E standard should be updated or if the user's submittal is already covered, in principle, in the NFPA 70E. Every facility and industry are unique, and the NFPA 70E arms personnel to reduce their risk as they perform their daily tasks, without regulating activities for every type of work situation.

**NFPA 70E provides a broader language that allows users to customize their safety programs to meet their precise needs.**

Therefore, many manufacturers have devised methods and new types of devices to reduce workers' risks that are not even mentioned in NFPA 70E. A dual interlocked disconnect switch is one good example of a new electrical safety practice that is not mentioned in NFPA 70E. High impedance test points are another good example where the portable test instruments are used in a much safer way for absence of voltage testing.

As you know by now, for absence of voltage testing NFPA 70E has two options to use as outlined below.

- a. Article 120.5 (7) using a Portable Test Instrument (Live-dead-live test) (OR)
- b. Article 120.5 (7) Exception 1, Permanently Mounted Absence of Voltage Tester

## The Unexplained and Acceptable option for Article 120.5 (7) in NFPA 70E, 2018

Use of Permanently Mounted Accessories that are listed and labeled to UL 61010 (High impedance test points) for absence of voltage testing with portable

test instruments are undefined in 70E, but still are acceptable for use.

There has been a lot of confusion and misinformation floating around since the publication of NFPA 70E, 2018 edition with the use of our high impedance protected Safe-Test Points™ for absence of voltage testing. We reached out to NFPA 70E, technical committee during the 2021 revision cycle seeking clarification through public inputs. And as part of the clarification, the technical committee provided a response statement as shown below. Moreover, the context of the public comments and response is around “Absence of voltage testing” and there is no such requirement for presence voltage testing under Article 120.5 as published by others.



### 3. List names of guests addressing the TC, the subject of their address, and the length of time they spoke:

Bhanu Srilla, Director of Technical Marketing, Grace Engineered Products addressed the Technical Committee related to Public Comments 51, 106, 107, 109 and 121 on proposed new Exception No. 3 to 120.5(7) on absence of voltage testing outside of enclosures. Mr. Srilla spoke for less than 10min with Q&A for 5min.

PC-106-NFPA 70E-2019 submitted by [ Bhanu Srilla ] on Tue May 07 02:05:42 EDT 2019

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Public Comment No. 106-NFPA 70E-2019

Section No. 120.5

**Committee Action:** Rejected

**Response Message:** The present text does not prohibit the use of permanently mounted accessories that are listed and labeled in accordance with UL 61010 for voltage testing in conjunction with portable test instruments. Permanently mounted absence of voltage testers must be listed and labeled in accordance with UL 1436.

REVIEWED

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Marketing literature published by other product manufacturers are misleading users with partial information by emphasizing the term committee action as “Rejected” and masking the “Response Message”. Refer to the image below, “Rejected” in the context of the response is stating that these devices do not require any additional clarification for use per Article 120.5 (7), NFPA 70E standards. Further, the response message clearly states the context of absence of voltage testing:

***“The present text does not prohibit the use of permanently mounted accessories that are listed and labeled in accordance with UL 61010 in conjunction with portable test instrument.”***

## **The Unexplained and Acceptable option for Article 120.5 (7) in NFPA 70E, 2018 (Three-Point Test)**

Use of Permanently Mounted Accessories that are listed and labeled to UL 61010 (High impedance test points) for absence of voltage testing with portable test instruments are undefined in 70E, but still are acceptable for use. During the review of public inputs on the topic of permanently mounted accessories for absence of voltage testing, the NFPA 70E technical committee established that the door mounted accessories and test leads must be listed and labeled to UL 61010 safety standards to be brought to the door. Further, adding an additional statement about UL 1436 is purposeful to ensure the readers do not confuse UL 1436 permanently mounted absence of voltage testers with UL 61010 permanently mounted accessories. Also, there is no product category in UL standards or mention of “Permanently Mounted test instruments” in NFPA 70E standards as published by others.

## **Conclusion**

It is imperative to note that safety is a condition of being protected from the risk of injury or hazard and is not something that can be attained by just installing a device at the door. Further, workers’ confidence plays a significant role when it comes to safety, as safety is very personal. The simplest way to look at it, a facility owner/operator can enforce their workers to don a higher amount of PPE for a task at hand and make them comply. However, for the same task, one cannot enforce compliance of lower amount of PPE when the worker realizes it provides less protection or feels unsafe to do so. Installing a permanently mounted device for absence of voltage testing outside the door is similar in that way. A facility can install a permanently mounted test device on the door for absence of voltage testing and ask their worker to perform the task (through a push to test) as it greatly reduces the risk of both shock and arc flash hazards. At the same time, one cannot stop their electricians to reverify the circuit part inside the cabinet with a portable test instrument even after the system is deenergized. It is that extra measure of reverification that adds confidence to the safety of the worker.

Maybe over a period, the same worker will choose not to reverify the circuit part inside the cabinet after developing confidence, but it takes time to develop that trust as with any device. Portable test instruments and accessories have built that trust and demonstrated confidence with absence of voltage testing for over four decades through several iterations of use. In conclusion, determining a right product fit for absence of voltage testing is a key step in your electrical safety program.

A facility must perform a thorough risk analysis to figure out that right product/application fit. The detailed analysis must consider worker qualifications,



installation conditions, training, and failure modes of the products and further evaluate the effects of those failure modes on your application.

**The qualified worker community has built trust and confidence with portable test instruments and accessories for decades with absence of voltage testing, and that trust cannot be simply replaced overnight.**

## About the Author



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Bhanu Srilla is the Director of Technical Marketing at Grace Technologies. He is responsible for developing strategy for new products, overseeing new product development efforts and product applications at Grace. Bhanu has over two decades of experience in power generation and distribution industry, and has led diverse programs in electrical power distribution and control system projects in various IEC and ANSI applications for low and medium voltage systems. Bhanu is an IEEE member, and a member of Standards Technical Panel (STP) for UL 1436, UL 61010, UL 508, and 508A Standards. Bhanu is a certified electrical safety compliance professional (CESCP) by NFPA, certified maintenance and reliability professional (CMRP) by SMRP, certified reliability leader (CRL) by reliability web, and holds advanced degrees in Electrical Engineering, Manufacturing Systems, and Technology Management.