

Isolated Power Specialist



Technical Information

TECHNICAL INFORMATION

ISOLATED POWER SYSTEMS — COMMON QUESTIONS & ANSWERS

It can be difficult to determine why a Line Isolation Monitor went into alarm. The alarm could be caused by a piece of equipment, frayed or pinched wiring, problem with the isolated transformer, or many other conditions. This article is to help the electrician to systematically locate the problem, so the compromised condition can be removed and restore the operating room to a safe environment.

From the Publisher: This article was comprised from a small portion of the decades of work experiences of Scott Brockman and his extensive knowledge of the NFPA codes. Additional articles will be published.

Note: Code References are from 2018 edition of the NFPA 99 Health Care Facilities Code and 2017 edition of NFPA 70 National Electric Code (NEC)

Q1. Where can I find information on IPS?

A. The main references are as follows:

1) 2017 Edition of the NFPA 70 National Electrical Code Article 517

2) 2018 Edition of the NFPA 99 Chapter 6 Electrical Systems

a. The NFPA 2012 edition went through a major overhaul. The premise of an occupancy-based document was modified to become a risk-based document. NFPA 99 was changed to a “code” instead of a “standard” to reflect how the document is used and adopted. This change was made to reflect how health care is delivered.

B. isolated-power.com. We try to keep the most relevant and up-to-date information on our blog website. You can checkout our blogs and subscribe to our blog emails, where we will send you every new blot we post (our goal is at least one a month).

Q2. Who can I contact for help in understanding the code requirements?

A. You can contact us at [no cost](#):

- Call Scott Brockman at (859) 640-2959

- Send an Email at scottb@isolatedpowerspecialist.com
- Contact Us on our websites isolatepowerspecialist.com or isolated-power.com

Q3. Why do I have to have the line isolation monitor (LIM) tested annually when I self-test the LIM monthly by pushing the LIM's test switch?

- Pushing the LIM's test switch lifts the LIM's ground wire and puts an internal fault to alarm the LIM. This is testing the alarm circuit to make sure it will respond to a fault. However, this doesn't guarantee the LIM will alarm within the threshold value of the LIM. (See NFPA 99 6.3.2.9.3.2 threshold value of 5 mA shall not alarm 3.7 mA).
- NFPA 99 3.3.95 says the line isolation monitor is a test instrument
- NFPA 99 6.3.3.1.5 Test Equipment, Electrical safety test instruments shall be tested periodically, but not less than annually, for acceptable performance.
- NFPA 99 6.3.3.2 Line Isolation Monitor Tests. The line isolation monitor circuit tested after installation
- NFPA 99 6.3.3.3.4 After any repair or renovation to an electrical distribution system
- Since the hospital cannot take the LIM out of panel for testing, we will come to the hospital to do the testing

Q4. When are isolated power systems required?

- The NFPA states at 6.3.2.3.1 "Wet procedure locations shall be provided with special protection against electric shock."
- Additionally, 6.3.2.3.2 says "This special protection shall be provided as follows: Power distribution system that inherently limits the possible ground-

fault current due to a first fault to a low value, without interrupting the power supply “

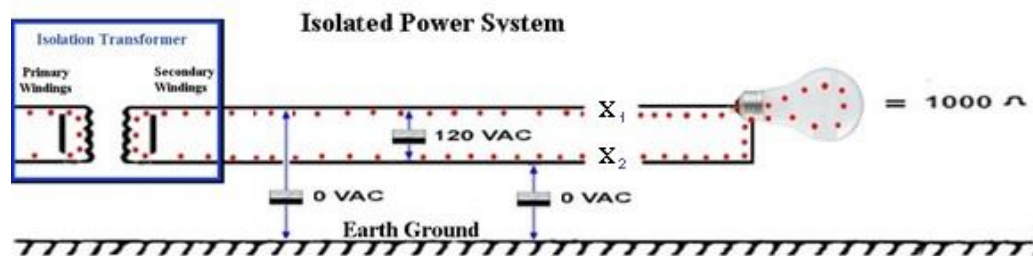
- C. Also, 6.3.2.3.4 clarifies “Operating rooms shall be considered to be a wet procedure location, unless a risk assessment conducted by the health care governing body determines otherwise.”

Q5. Is IPS required in any other areas besides Operating Rooms (Wet Procedure Location)?

- A. North Carolina requires IPS in all Operating, Delivery, ICU, CCU, Recovery and Emergency Rooms.
- B. The NEC, local codes, and the hospital’s governing body will make the determination when they need an IPS.

Q6. What is a hospital isolation transformer?

- A. The transformer is normally a step-down transformer and its primary windings are not referenced to the secondary windings, and the secondary windings are not referenced to ground. For current to flow you must go line (X1) to line (X2) on the secondary side of the transformer. Since the windings are not referenced to each other, the transformer acts like a filter.



Q7. What is the purpose of the two-pole branch circuit breaker and is it required?

A. The NEC (NFPA 70) Article 517-160(A)(1), says that each isolated power circuit shall be controlled by a switch having a disconnecting pole in each isolated circuit conductor.

- The purpose is to disconnect all power since there is no neutral wire and both wires are considered hot.
- If one conductor goes to ground it would have 0 volts on it and 120 volts on the other ungrounded conductor. Since you don't know which conductor may become grounded by insulation failure, both wires must be protected by its own breaker, thus a two-pole breaker.

Q8. What type of wire can be used?

- A. NEC 517-160(A)(6) Note 2 states that conductor insulation with a dielectric constant less than 3.5, must be used on the power wires. XHHW type wire meets that specification.
- B. Wire-pulling compounds that increase the dielectric constant (that is, all wet pulling compounds) shall not be used on the secondary conductors of the isolated power supply.
- C. Use of dry talc powder is ok.
- D. NEC 517-160(A)(5) Color code for isolated power wiring (conductors). Isolated conductor No. 1 is **orange**, conductor No. 2 **brown** with *at least one colored stripe* other than white, green, or gray along the entire length of conductor. For 3-phase, the third conductor is **yellow** with stripe as above.

Q9. Can you run grounded power and isolated power in the same room?

- A. NEC Article 517.20(A), for Wet Procedure Locations, see the Exception:

- B. Branch circuits supplying only listed, fixed, therapeutic and diagnostic equipment shall be permitted to be supplied from a normal grounded service, single or 3-phase system, provided that:
- (a) Wiring for grounded and isolated circuits does not occupy the same raceway and
 - (b) All conductive surfaces of the equipment are grounded.
- C. For Grounded Power Systems NEC 517-63(C) reads: Branch circuits supplying only fixed lighting shall be permitted to be supplied by a normal grounded service.
- NEC 517-63(C)(1) Must be located at least 2.5 m (8 ft) above the floor
- D. Also, NEC 517-63(B) reads, branch circuits supplying only listed, fixed, therapeutic and diagnostic equipment, permanently installed above the hazardous location and in other than hazardous locations, shall be permitted to be supplied from normal grounded service and located outside the hazardous (classified) location.

Q10. Are two independent sources of power required?

- A. NEC 517-41(A) says, Essential electrical systems shall have a minimum of two independent sources of power: a normal power source and an alternate source, generally supplied by a generator.
- B. NFPA 99 6.7.1.2.2, also states “Essential electrical systems shall have a minimum of the following two independent sources of power: a normal source generally supplying the entire electrical system and one or more alternate sources for use when the normal source is interrupted. “
- C. See also, NEC 517-19(A) and (B).
- D. The operating room table is considered as a bed location.

Q11.Can an IPS serve more than one operating room?

- A. NEC 517-160(A)(4) says, an IPS shall not serve more than one operating room except its induction room and for receptacles supplying power to equipment requiring 150 volts or higher, such as portable X-rays and Lasers. The receptacles and plugs are not to be interchangeable with receptacles on the local IPS.

Q12.Since there is no neutral on IPS do you need to maintain polarity?

- A. Yes. NEC 517-160(A)(5) and 200IO(B) states that isolated conductor No. 1 is **orange** and isolated conductor No. 2 is **brown**. See Q8 section D above
- B. Where isolated circuit conductors supply 125 volts, single phase, 15 and 20 ampere receptacles, the **orange** conductor(s) shall be connected to the terminal(s) on the receptacles that are identified in accordance with NEC Article 200.10(B)(1) for connection to the grounded circuit conductor. So, the **orange** wire goes where the **white** wire would go, the silver screw.

Q13.Is the ground wire required on an IPS?

- A. Yes. NEC 517-13 states, all receptacles shall be grounded by an insulated copper conductor.
- B. NFPA 99 6.3.3.1.6 Criteria for Acceptability for New Construction, states that the voltage limit shall be 20 mV and the impedance limit shall be 0.2 ohm for systems containing isolated ground receptacles and 0.1 ohm for all others.

Q14.Is it required to intentionally ground door and window frames?

- A. NFPA 99 6.3.3.1.1.2 & 6.3.3.1.1.3 states that conductive surfaces not likely to become energized, such as windows, door frames and drains, need not be intentionally grounded or periodically tested.

Q15. What are the latest code requirements for line isolation monitors (LIM)?

- A. NFPA 99 6.3.2.9.3 covers the LIM. The new LIM can be 5 mA
- B. If the IPS panel is mounted outside of the operating room, a remote annunciator with green & red lights, and a buzzer with silence switch, are required inside the operating room. A panel meter is optional except in North Carolina where meters are required.
- C. The LIM must be tested per NFPA 99 6.3.3.3.2, 6.3.3.3.3, and 6.3.3.3.4.
 - i. There it states that the LIM must be tested after installation and prior to being placed in service.
 - ii. The LIM shall also be tested at intervals of not more than 1 month by actuating the LIM test switch. For a LIM circuit with automated self-test and self-calibration capabilities, this test shall be performed at intervals of not more than 12 months. Isolated Power Specialist's Sentry 5 LIM meets this code.
 - iii. The LIM shall be tested after repairs or renovations to an electrical distribution system.

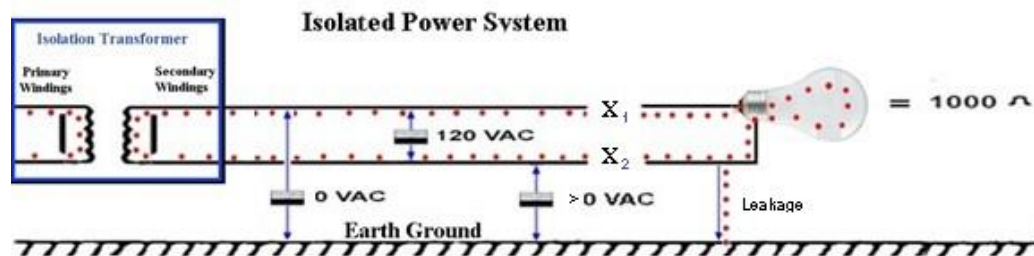
Q16. Can I use GFCI receptacles on isolated power?

- A. Since GFCI receptacles work on the principle of grounded power, they will not work on isolated power. Do not put them on isolated power.
- B. IF using on grounded power NFPA 99 6.3.2.3.9 when interruption of power is tolerable
 - Each receptacle shall be an individual GFCI device

- Each receptacle shall be individual protected by single GFCI device

Q17. How come I get voltage on both circuits to ground on isolated power?

- The isolation transformer's secondary windings are not reference to ground, so there is no neutral to ground. You will see voltage on both sides of the transformer to ground.
- If one side should short to ground, you would have 0 volts on that leg and 120 volts on the other leg.
- If both legs are isolated from ground you will have about half of the supplied voltage, if both sides were balanced in their leakage to ground.
- If one leg becomes closer to ground by a resistive or capacitive path, that side will be a lower voltage and the other leg higher. Don't worry unless one side is near 0 volts. The line isolation monitor will monitor how much leakage there is and will alarm.



Q18. How can I tell if the wiring passes the 200,000 ohms impedance test for isolated wiring in operating rooms?

- NFPA 99 6.3.2.9.2.1 states that: "The impedance (capacitive and resistive) to ground of either conductor of an isolated system shall exceed 200,000 ohms when installed. The installation at this point shall include receptacles but is not required to include lighting fixtures or components of fixtures. This value shall be determined by energizing the system and connecting a low

impedance ac milliammeter between the reference grounding point and either conductor in sequence. This test shall be permitted to be performed with the line isolation monitor connected, provided the connection between the line isolation monitor and reference grounding point is open at the time of the test."

- B. What this means is that you turn all breakers on except for those that are supplying power to X-Ray Film Viewers, Surgical Light or any other lighting fixture. If there are any hard-wired appliances connected to the system, these must be disconnected for this test.
- C. Fault Hazard Current is the leakage of all branch breakers without the line isolation monitor or any equipment on the system. With an ac amp meter, you take the leakage from each leg of the isolation transformer to ground. Take the highest reading and divide it into the secondary voltage.
- i. Example: Let's say the voltage is 120 volts on the secondary side of the transformer. Your highest leakage reading from one leg to ground with no lighting circuits on was 480 microamperes. $R = \frac{E}{I}$, so 120v divided by .000480uA would equal 250,000 ohms. It passed the 200,000 ohm test.
- D. Just make sure that there is no equipment connected to the system during this test, such as computers, stereos, X-Ray film viewers, etc.

Q19. Does the overhead fixed lighting need to be on isolated power?

- A. No, it does not as long as your ceilings are over 8' high, NEC 517.63(C). "Branch circuits supplying only fixed lighting shall be permitted to be supplied by a conventional grounded system with the following provisions":
- i Such fixtures are located at least 8' above the floor

- ii Switches for the grounded circuits are wall mounted and installed in accordance with NFPA 70 Article 517, Part D
 - iii Wiring for grounded and ungrounded circuits is installed in accordance with NFPA 70 Article 517, Part D
- B. The reason why you don't want the overhead lights on critical isolated power is because the ballast's in the fixtures contribute too much leakage to the system and may cause the line isolation monitor (LIM) to go into alarm once the breaker is turned on.
- C. Even if the LIM does not alarm, this is leakage that will limit the amount of equipment that the hospital can turn on before they have alarms.

Q20. Are Boom Boxes allowed?

- A. See NFPA 99 10.2.2.3 where it states the attachment plug shall be a two-pole, three-wire grounding type. So, if the boom box is made with ground plug it is OK

Q21. Can I use Isolated Ground Receptacles in Operating Rooms and Patient Care Areas?

- A. No. See NFPA 99 6.3.2.2.5(B) where it states an isolated ground receptacle shall not be installed within a patient-care vicinity.
- B. No. See NEC Article 517.16(A) shall not be installed within a patient care vicinity.
- C. NFPA 99 6.3.2.2.5(C) does reference to patient care spaces. Reference NFPA 99 3.3.136 definitions of spaces

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