



## Isolated or Grounded Power Systems

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In the last two decades, advancements in the technology of medical equipment and anesthetics have made many hospital owners and operators question the value of installing Isolated Power Systems (IPS) in operating rooms.

### Isolated or Grounded Power Systems

This article looks at the history of IPS, discusses the differences between IPS and Grounded Power Systems and provides guidance in system selection.

Grounding of electrical power systems can be a confusing and somewhat complex subject. Grounding is intended to primarily protect vulnerable people from energized or live parts by grounding electrical components likely to become energized. In fact, electrical systems in patient care areas are required to have a redundant ground, usually achieved by installation of a separate ground conductor and a continuous metal raceway (conduit) system. Personnel protection is accomplished by providing a low resistance return path for electrical faults so that protective devices such as circuit breakers see fault values high enough to operate and open to clear the fault. By grounding metal objects likely to be energized (junction boxes, enclosures, etc.), the potential between earth and that device is low, minimizing the risk of electrocution. In healthcare facilities, a third issue for grounding is patient safety. Penetrating the skin with electrical conductors, as in the case with some surgical procedures, can make a patient susceptible to electrical shock. If procedures include the wetting down of a patient, susceptibility becomes even more critical as moist skin reduces resistance to the flow of electricity. Conditions that make this an important issue include:

1. Patients who are sedated are dependent on hospital staff to protect them from electrical shock.
2. Patients can be connected to a variety of electrical apparatuses, including catheters.

For these reasons, properly designed grounding systems are imperative in hospitals. *How does this relate to IPS?* We shall see. First we must understand why IPS was developed.

### History of Isolated Power Systems

Prior to 1980, some anesthetics used in hospitals were highly flammable. Risk of explosions in operating rooms were high, as any discharge or electrical spark could ignite the anesthetic agents. One area of concern was static electricity stored up in a person's clothing or body. By touching a metal element (table, tray, etc.) the ensuing spark could cause an explosion. Conductive flooring was used to minimize this risk by reducing or "bleeding off" the stored static energy. However, these floors increase the chance of shock from a grounded electrical system. Therefore, isolated power systems were developed to reduce this risk. By "isolating" the electrical system from ground, IPS reduced the risk of arcing and the potential for electrical shock. When a person is shocked, electricity flows through the body and to the ground. Since IPSs are underground, no current will flow if a person comes in contact with an electrically charged surface.

In reality, a small level of current “leakage” (in the magnitude of milliamperes) can exist between an IPS and ground. Although small in magnitude, these low level current flows can cause micro-shock which can be dangerous to patients connected to electrical equipment such as heart catheters. To reduce this risk, IPS are equipped with Line Isolation Monitors (LIM) and alarms. These devices measure low-level currents and alarm medical staff if leakage current approaches or exceeds 5 milliamperes.

### Present day applications, Grounded versus Isolated Power Systems

In the past two decades, flammable anesthetics and conductive flooring have all but disappeared in the operating room. However, IPS have remained a staple in operating room electrical systems design. In fact, applicable codes require IPS if either of the following are present:

- Flammable anesthetics
- The procedure room is considered a wet location

As stated earlier, advancements in electrical technology have made equipment much safer and have greatly reduced the threat of inadvertent electrical shock. This coupled with the use of non-flammable anesthetics has allowed the application of traditional grounded electrical systems in operating rooms, unless the room is considered a wet location. NFPA 99 defines a wet location as:

*A Patient Care area that is subject to wet conditions while patients are present. This includes standing fluids on floors or drenching of the work area, either of which condition is intimate to the patient or staff. Routine housekeeping procedures and incidental spillage of liquids do not define a wet location.*

As an example, procedure rooms for Cytology are typically classified as wet locations. Most authorities having jurisdiction require hospital staff to determine which procedure rooms are to be classified as wet locations and, in these cases, IPS would be required. For those rooms not considered wet locations, a choice between a grounded electrical system and an IPS must be made.

From an economical standpoint, there is little difference between the installation of a grounded electrical system and an IPS. However, there are some design and operational issues that should be considered when selecting the right system. Some of these are listed below:

- IPS provides a higher level of patient safety. The LIM provides a *first warning* of any low level fault conditions in the electrical system or any medical equipment plugged into the IPS. This allows for detection, isolation and correction of a fault condition before it becomes a safety issue.
- IPS requires less space in electrical rooms because the transformers are an integral part of the IPS, reducing the need for step-down transformers in the electrical room.
- IPS can be somewhat more reliable, as each system is independent and does not rely on a common transformer, as is typically designed in a grounded system.
- The maintenance costs of IPS are higher than grounded systems. LIMs are sensitive devices that require calibration and maintenance on a regular basis. Additionally, these devices have a potential for nuisance alarms that can be disturbing for hospital staff.

There are benefits and drawbacks to both IPS and Grounded Power Systems. Hospital design teams should weigh each advantage or disadvantage for the specific project application to determine which system best suits the needs of the facility. Because the final system choice can have a large impact on other facets of the overall project design, this subject should be considered early in the design process.

