QuadTech

Application Note

Custom Design Your Own Shock Therapy

Electrical Safety, what's it worth to you? Are government or international safety standards mandated by your business contracts driving you crazy? Where does one start incorporating electrical safety into a production environment? Since the safety of personnel and property is the highest priority, how then do we ensure this safety of personnel and equipment? What kind of electrical hazards really do exist in your work environment? The standards of today are the best effort yet in trying to make surprise electrical shock a thing of the past but understanding and implementing them in the work place is all together different. Take a brief moment to think of how these questions pertain to your business and let's see if we can custom design you a little shock therapy.

There are numerous national and international standards that specify requirements for electrical safety including IEC 950 (Safety of Information Technology Equipment including Electrical Business Equipment), CSA C22.2 No. 601-1 (Medical Electrical Equipment General Requirements for Safety) and UL 1950 (Safety of Information Technology Equipment). These and other standards are developed by committees composed of representatives from industry, academia, test laboratories, government and consumer groups in an effort to make electrical equipment safer for the operator and the consumer. Product Safety Testing is necessary not only in making a product safe for the consumer but also in making the product safe in the work place. The requirements for Electrical Safety Testing of medical equipment may vary considerably from those for consumer electronics due to the end-use of the product but the requirement for no electrical shock doesn't change. So no matter what standard you are required to test to, personnel, property and product safety is the main issue. This article will specifically focus on Electrical Safety Testing in a production environment and the factors of test setup, test equipment, device under test and employee training in increasing safety.

In the United States, OSHA, the Occupational Safety & Health Administration, of the Department of Labor is a governing agency that publishes regulations on public health and safety. For this discussion, let's take a look at Standard-29CFR, #1910, Subpart S –Electrical, Sections 1910.301 – 1910-308. These sections define design safety standards for electrical systems in terms of the control of potential hazardous electrical energy. Anticipation of unexpected hazardous energy when applying power to an electrical device or upon the release of stored energy in an instrument or a device under test (DUT) is the purpose of this OSHA standard. The intention of this standard is to have safety measures in place upon the accidental release of hazardous electrical energy. This anticipation of potential hazards and resultant safeguarding methods can be summed up in 8 basic provisions for control of hazardous energy.

OSHA & Hazardous Energy Control

How do you control hazardous energy in your test lab? That energy which is encountered when turning ON (applying power to) an electrical instrument OR the release of stored energy in the instrument or the device under test. Take a look at this list of 8 questions on Energy Control from the OSHA standard 29 CFR 1910:

1. Does your instrument have the potential for stored or residual energy or for re-accumulation of stored energy after shutdown?
2. Does your instrument have a single energy source that can be readily identified and isolated?
3. Does the isolation and locking-out of that source COMPLETELY de-energize and deactivate the instrument?
4. Is the instrument isolated from that energy source during maintenance & servicing?
5. Does the instrument have a single lockout device that achieves locker-out conditions?
6. Is this lockout device under the exclusive control of the authorized employee performing the servicing or maintenance of the instrument?
7. Does the servicing or maintenance create hazards for other employees?
8. Has the company experienced any accidents involving the unexpected activation of the instrument?

What's Your LOTO IQ?

Energy-Isolating Device: a mechanical device that physically prevents the transmission or release of energy

Lockout: the placement of a lockout device on an energy-isolating device such that the device cannot be operated with the lock in place.

Lockout Device: holds the energy-isolating device in the safe position and prevents the energizing of the machine/equipment.

Tagout: the placement of a tagout device on an energy-isolating device.

Tagout Device: a prominent warning device, securely fastened to an energy-isolating device that indicates that the energy-isolating device cannot be located until the tag is removed.

So How Do You Harness that Energy?

OSHA 1910.147 prescribes that the lock and tag devices must be designed of protective materials and hardware and durable enough to withstand the environment in which they are used. These devices must also be standardized within a facility to promote easy recognition of possible hazardous energy. The lock and tag devices must be inspected periodically to identify any deviations or inadequacies. Training of employees is required to fully explain the purpose and function of the facility's energy control program and the employee's responsibility in that program.

The 1910.147 document not only defines safety regulations but prescribes that each operation have Energy Control Procedures in place. It is simply not enough to identify the sources of hazardous energy in your facility, you need to physically distinguish them and have procedures in place on how to control them. If and when an accident happens the quickest response time in controlling the source of hazardous energy will greatly increase your employee's safety.

Contents of an Energy Control Procedure

- Intended use of procedure
- Specific steps for shutting down, isolating, blocking and securing equipment
- Specific steps for placement, removal, transfer and responsibility for lockout/tagout devices
- Specific tests for testing the effectiveness of lockout/tagout devices
- Specific requirements of lockout/tagout devices:
    - Protective material and hardware:
        - Durable (to withstand the environment in which they are used)
        - Standardized throughout facility
        - Substantial (to prevent removal without the use of excessive force)
        - Identifiable (to specify hazard and responsible employee)
- Periodic Inspection (to ensure the procedure is being followed and it remains valid)
- Employee Training
- Energy Isolation (LOTO to be performed only by authorized employees)
- Employee Notification (of LOTO application or removal)

Employee Training: How much is enough?

With regard to OSHA regulation 1910.147, 'The control of hazardous energy', employers are required to train affected employees in the company's Energy Control Program. The employees need to understand the function of the energy control program and acquire the proficiency of applying, using and removing energy controls in their respective work environment. The specific requirements of 1910.147 Employee Training are listed below.

Energy Control Program Employee Training:

- Affected Employee Training:
  - Identity of Hazardous Energy Source(s)
  - Type and Magnitude of Energy Available
  - Method and Means for isolating and controlling that Energy
  - Purpose and use of Energy Control Procedure
- Other Employee Training:
  - Purpose and use of Energy Control Procedure
  - Prohibition of restarting equipment that has been locked or tagged out.
- All Employees:
  - Limitation of Tags (if used):
    - Tags are warning devices and do not provide physical restraint.
    - Tag meaning must be clearly understood (not bypassed)
    - Tags are not to be removed except by the authorized employee.
    - Tags must be legible and understandable by all employees.
    - Tag must be securely attached.
    - Tags and attachment must withstand the environment in which they are used.
- Employee Retraining:
  - Change in job assignment, equipment, process or in the Energy Control Procedure

So what kind of training does the operator of the Electrical Safety Tester need? Ideally one would like a skilled electronics technician to operate electrical safety tests but that is not always possible. The employee needs to be explained the test setup including the reasons for ESD precautions like anti-static tables and wrist straps. Clearly define the voltage and current potential of the test equipment along with the methods to safeguard the operator in case of accidental release of this energy. Explain the connection of the device under test (DUT) to the test leads or fixture. Design the setup so the operator does not touch the DUT during test or discharge. Attach or post "Danger – High Voltage" warning signs to test setup. Possible lapses in safety practices could potentially be prevented by continually training (perhaps cross-training) the operator and avoiding job complacency. Continually monitor the equipment for signs of wear and the setup for deviation from the norm so repairs can be made before safety of personnel or property is compromised. Safe guard your employees with **continuous** EST training to include:

- Written Test Procedure(s) prominently displayed at Test Setup
- Written and Verbal Explanation of Safety Hazards of Test Setup (DUT, equipment)
- Written and Verbal Explanation of Safety Hazards of Self (Clothing, Jewelry, Hair)
- Warning Signs prominently displayed that caution High Voltage is present

Is Your Test Lab Safe?

What does your test lab contain? Before we get into your test equipment, lets examine how your testing area is designed. Is the location of your test area in the middle of a high trafficked corridor? Is the point of test clearly delineated from other manufacturing functions such as inspection and assembly? What protective barriers or shields are in place to safeguard non-test employees from accidental contact with live (energized) test equipment?

Suggestions for Test Area Safety:

- Barriers or walls around Test area.
- Separate Test area from Assembly and Inspection.
- Single Emergency Switch to instantaneously cutoff all power to test area (one inside the test area and one outside of the test area).
- Non-Conductive Test Bench (use of ESD mats, wrist straps and ESD floor coatings).
- Posted WARNING signs.
- Indicator LIGHTS that denote HIGH VOLTAGE is IN USE.
- Insulated cover (hood) over DUT (with fail-safe interlocks so that voltage is NOT output to DUT unless the cover is DOWN).
- Use 2-Handed Switches (palm switches) to initiate test (if insulated cover cannot be used)
- Use two separate Safety Probes (one to apply voltage, the other to terminate it).
- Use a Shorting Device to discharge any stored energy in DUT.
- Use a Lockout Device on Test Equipment to prevent unauthorized operation.

Now take a look at your test equipment. Do you have equipment capable of producing high voltage? High Voltage can be defined as Voltage ≥ 60 volts by some standards. All electrical safety test instrumentation designed to stress a product's insulation produces at least that and usually much greater potential. Test Voltages of up to 5000VAC/6000VDC are the standard in today's Electrical Safety Testers. The norm for some dielectric withstand (hipot) tests is a test voltage equal to 1250VAC. Does your Electrical Safety Test equipment stack up to the requirements and recommendations from OSHA?

Suggestions for Test Equipment Safety:

- Ground Fault Interrupt (GFI) circuitry and/or Automatic Shut-off.
- Programmable Trip Limit(s)
- Programmable Discharge (Fall) Time
- Remote Operation Capability
- Programmable Store & Recall of Test Setups
- Front Panel Lockout (Software/Password)
- Front Panel Lockout (Physical Switch)
- Connection for Dual Switches (palm switches, HV probes, etc)
- Scanner Interface for Multiple Point testing of DUT (without operator touching DUT)

What's in a DUT?

Potential Energy – that's what's in a DUT. What device is being tested? If capacitive devices are being tested there exists the possibility that the charge stored in the DUT during test could accumulate to lethal levels and cause electrical shock if touched by the operator. The DUT must be allowed sufficient discharge time to release the stored energy. Can you program Ramp, Test and Discharge Time with your Electrical Safety Tester? A programmed Ramp time will allow the DUT time to reach the test voltage, sufficient Test time will stabilize the DUT at the test voltage and the Discharge time will provide the DUT time to release any stored energy. Can you then store this test setup and recall it as needed? Is it password protected so test specifications cannot be changed by just anyone?

The voltage across an inductor is proportional to its inductance and the **rate of change** of the current through it. $E = L(di/dt)$. If the current could be instantaneously switched OFF, then the voltage would in theory become infinite. This does not occur because the high voltage develops an arc across the switch as contact is broken, keeping di/dt from becoming infinite. This does not however prevent the voltage from increasing to potentially **lethal** levels. If a person breaks the contact without the proper protection, the inductor induces a high voltage forcing the current through the person (arm to arm across the heart) as illustrated in Figure 1.

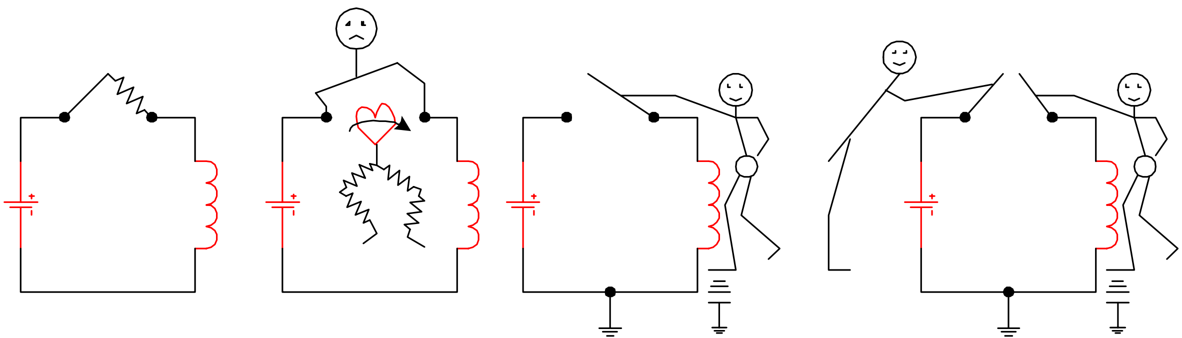

Figure 1: Breaking the Contact across an Inductor

Suggestions for DUT Safety:

- Dedicated Test Fixture enclosed in Insulated Hood
- Fail-safe Interlock where test cannot be initiated until hood is down.
- Scanner Matrix for multi-point testing without repositioning DUT
- Programmable Discharge (Fall) Times to allow discharge of stored charge
- Dual (Palm) Switches requiring the use of both hands to initiate a test
- Dual Retractable (HV) probes requiring the use of both hands to initiate a test
- Insulated Test Leads
- Chassis Ground connection

In Need of a Little Shock Therapy?

As a business in which electrical test is an integral part, safety of personnel and property is paramount to success. Training of employees on proper use of test equipment is as necessary as making sure their work environment is designed for maximum safety and function. There are many options when designing a test lab, purchasing test equipment and providing employee training. Incorporating the minimum performance requirements for the control of unexpected hazardous energy as specified in the OSHA 1910.147 regulation, provide the manufacturer with some 'shock therapy'. However, not all accidents can be anticipated or prevented. This article has hopefully outlined guidelines your facility can implement to increase its safety in terms of test area design, test equipment, DUT characteristics and employee training. Consider the checklists of suggestions for increased safety in the four categories (test area, test equipment, DUT and employee training) and decipher what works for your facility. Not all recommendations are cost prohibitive, some just require a little extra time for training. Read on for an example of how QuadTech answered a customer's request for safer test equipment.

We Can Do That!

QuadTech has customized several of its products per customer specification, some for increased employee safety. A manufacturer of wafer connectors for telecommunications equipment called QuadTech with a request for an AC hipot tester that had a limited output voltage. This particular manufacturer was looking to address employee safety on the assembly floor by purchasing test equipment in which the maximum output voltage was equal to 1000V AC and maximum output current equal to 1mA AC. The manufacturer's concern was grounded in the fact that some employees had pacemakers. Were they putting the employees with implanted medical devices at a risk by having them operate high voltage equipment? Also the high turnover rate of personnel on the assembly floor was another consideration. The goal was to limit any 'dangerous' voltage levels to avoid possible electrical shock and also to keep stray EMF and RF signals to a minimum. Did QuadTech have an instrument that could do this and could the front panel programming be locked out to further enhance operator safety?

QuadTech took the Sentry 10 AC Hipot Tester (capable of producing AC Output Voltage up to 5000VAC) and reconfigured the instrument's software so that its maximum output voltage was 1000VAC and maximum output current was 1mA AC. Front panel lockout is another feature of this hipot tester. Effectively, the customer's requirement of reducing the High Output Voltage and locking out the front panel was accomplished with one instrument. The manufacturer now provides a safer work environment for his employees and increased throughput in his production line. A simple low cost solution.

For complete product specifications on the Sentry Series Hipot Testers or any of QuadTech's products, visit us at http://www.quadtech.com/products. Call us at 1-800-253-1230 or email your questions to info@quadtech.com.

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