

# Field Fabricated Experimental Equipment

## Guideline

Revision Date: 03/8/2016

**Applies To:** All University of Michigan personnel conducting scientific research with field fabricated equipment.

## Summary

Experimental equipment designed and/or assembled by researchers or “field fabricated” has the potential to cause loss of life and major facility damage. Such equipment has produced several unfortunate incidents on the U-M campus, and the cause is typically unsafe electrical and mechanical system design or assembly. Electrical and mechanical system installation and use is strictly regulated through building codes, electrical code and safety standards.

This guideline provides mechanisms for the reduction or elimination of hazards commonly associated with non-commercial, field fabricated research equipment. Primary responsibility falls upon the Laboratory Director (LD) and the individual academic unit which must implement policies and educate their constituents on equipment safety requirements.

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## Scope

This Guideline applies to all University of Michigan personnel conducting scientific research with field fabricated equipment.

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## Reference Documents

These documents provide guidance, rules, and regulations that govern the creation and/or use of electrically energized equipment and building utilities.

- State of Michigan Mechanical Code and Plumbing Code.
- NFPA 45 -Fire Protection for Laboratories Using Chemicals
- State of Michigan Electrical Code incorporating “NFPA 70 - National Electrical Code:, edition with U-M modifications
- NFPA 72 -National Fire Alarm Code, U-M modifications
- UM Design Guidelines Special Instructions to Designers
- [June 2012 SID-F: Codes and Regulatory Agencies](#)
- Various MIOSHA Safety Standards related to the specific equipment or application
- [MIOSHA General Industry Safety Standards](#)
- MIOSHA Part 85 Control of Hazardous Energy Sources.

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## Responsibility

### *Laboratory Director*

- Implement and document appropriate safety policies and procedures in accordance with the U-M Chemical Hygiene Plan.
- Ensure that adequate facilities, ventilation, and equipment are provided for the safe use of Field Fabricated Equipment.
- Ensure employees are instructed on and follow proper procedures and utilize protective equipment provided during their work as detailed in written SOPs.

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## Procedures

The following procedures have been prepared to provide a consistent approach to the safe use of field fabricated equipment at the University of Michigan. Of particular concern is any equipment that involves an open flame, pressure vessel, high voltage, open electrical conductors, pinch or crush points, chemical exposure, or modification/connection to any utility or building system.

### *Advanced Planning*

1. Contact EHS (734) 647-1143 during the planning stages of new or modified field fabricated equipment. EHS will assist in the identification of potential risk factors or hazards and facilitate control measures. Some of the most common hazards identified with field fabricated equipment include the following: non-listed electrical, flame-producing equipment, pressure vessels, high voltage, open electrical conductors, pinch or crush points and chemical exposure.
2. Contact one of the three companies listed in the technical support section below. You can request testing and engineering services for modified equipment to evaluate its health and safety aspects.
3. Contact Utilities & Plant Engineering (UPE, 764-2492) if the project may impact building systems including: heating, ventilation, air conditioning, electrical, plumbing, or structural. UPE must approve all such system changes or modifications.

4. Contact Plant Electrical inspectors to review electrical equipment or devices that are not UL or FM listed.
5. Comply with all required modifications and recommendations.

### ***Review of Equipment Already in Use***

1. Contact EHS (734) 647-1143 to evaluate field fabricated equipment for potential hazards and facilitate implementation of controls.
2. Contact UPE (734) 764-2492 to evaluate any connections or potential impacts to building systems.
3. Comply with all EHS and UPE recommendations before continuing operations with this equipment.

### ***Requirements for Operation of Equipment***

- Write standard operating procedures that detail safe operation.
- Document training provided to employees working with the equipment.

## **Technical Support**

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A list of three research and development companies are listed below with a short description of their capabilities and contact information. These organizations can evaluate and control hazards associated with field fabricated equipment.

### ***National Sanitation Foundation***

Many manufacturers, regulators and consumers look to the National Sanitation Foundation (NSF) for the development of public health standards and certification programs that help protect the world's food, water, consumer products and environment. Their mission is to protect and improve global human health. As an independent, accredited organization, they develop standards, and test and certify products and systems. They can provide auditing, education and risk management solutions for public health and the environment.

The Engineering Lab Testing Services group evaluates products and materials for material properties, performance and safety of the finished product. Specific testing services include:

#### **Evaluation Services**

- Testing to highly-credible standards
- Test method development
- Protocol development
- Witness testing at client facility
- Failure analysis
- Quality control procedures

#### **Material and Product Testing**

- Low and high temperature performance
- Compostability
- Performance and failure analysis
- Structural integrity (packaging, etc.)
- Tensile/compressive/flexural properties
- Abrasion, corrosion and wear
- UV and chlorine resistance
- Izod and charpy impact
- Fourier transform infrared spectroscopy (FTIR)
- Chemical extraction
- Surface and interfacial tension
- Surface roughness
- Corrosion resistance
- Electrical and electrical safety
- Hydraulic pressure, i.e. cyclic, burst, long-term sustained
- Failure analysis
- Material comparisons by type/supplier
- Fatigue
- Creep
- Coatings abrasion and wear resistance
- Viscosity
- High heat distortion
- Low temperature brittleness
- Cleanability
- Composition
- Extensive polymer capabilities
- Recycled PET (rPET)

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## Flammability Tests

- Testing to ASTM E84 and ULc S102.2 for material burning characteristics

## Electrical Tests

- Testing to UL and CSA standards for food equipment, swimming pools and spas
- Conduit testing

## Hydraulic Pressure Tests

- Sustained long-term high pressure control (pipes and fittings)
- Flows up to 1500 gpm
- Plumbing up to 36" in diameter
- Pressure testing up to 3,000 psi
- Temperatures from 20°C–120°C
- Cyclic pressure
- Thermal cycling
- Burst testing

## Engineering Lab: Equipment

The NSF Engineering Lab hosts a variety of customized test chambers, mechanical and electrical equipment for analyzing data, with both computerized and video recording capacity:

- Torsion test fixture
- Calcium monitor
- Dielectric analyzers
- Sound meters and calibrators
- Vibration monitors
- Air velocity meters
- Photometers
- Tensile test machine
- Brittleness tester
- Pent tester
- Transformers
- Izod impact tester
- DSC differential scanning calorimeter
- FT-IR spectrometer
- Abrasion tester
- Deflection temperature tester
- Melt flow index test machine
- Flow-through thermocyclic test machine
- IPT electronic bore gage
- Laser extensometer
- Multi-product calibrator
- Compression molder
- Video microscope
- Oscilloscope fluke electrical
- Optical comparator
- Microscope PC

## Test Rigs and Chambers

- Thermocyclic test rig
- Singleton salt fog test cabinet
- Lathe
- Dishwasher test rig
- Fusion weld system for PE pipe testing
- Walk-in temperature test chamber
- Vacuum oven
- Chemical resistant oven
- IPT test chambers (pressure testing of pipe)
- Faucet test machine
- Backflow preventer test rig
- Water hammer arrester test machine
- TUP impact tester
- Impulse test rig
- Inline UV transmittance monitor
- High flow flow-meters and pumps
- Water chemistry analytical instruments

## Contact Information

NSF International	info@nsf.org
P.O Box 130140	734 769 8010
789 N. Dixboro Road	734 769 0109
Ann Arbor, MI 48105, USA	800 673 6275

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## ***Spears Fire & Safety Services***

The Spears Fire & Safety Services is Michigan's largest fire protection and life safety specialist. They're a full-service company that designs, installs, repairs, services and inspects a wide variety of fire suppression and life safety systems. They also offer on-the-spot fire extinguisher and fire system recharging.

### **Services**

- Automatic fire suppression systems
- UL 300 listed kitchen hood fire systems
- Smoke and carbon monoxide detectors
- Pressure vessel testing

### **Contact Information**

Spears Fire & Safety Services Inc.  
287 Jackson Plaza  
Ann Arbor, MI 48103

Phone: 734-663-4133  
Fax: 734-663-9540  
<http://www.spearsfiresafety.com/>

## ***Southwest Research Institute***

Southwest Research Institute (SwRI), headquartered in San Antonio, Texas, is one of the oldest and largest independent, nonprofit, applied research and development (R&D) organizations in the United States. Southwest Research Institute's [technical divisions](#) offer a wide range of technical expertise and services in such areas as chemistry, space science, nondestructive evaluation, automation, engine design, mechanical engineering, electronics and more.

The Institute has 10 [technical divisions](#) cooperating in multidisciplinary approaches to problem-solving. A partial listing of research areas includes:

- advanced electronics
- aircraft structural integrity
- antennas
- radio wave propagation and electromagnetic modeling
- automation, robotics, and intelligent systems
- automotive engineering
- avionics and support systems
- ballistics and explosion hazards
- bioengineering, biomechanics and biomaterials
- chemistry and chemical engineering
- communications systems and signal processing
- corrosion and electrochemistry
- cyber security and information assurance
- defense and intelligence solutions
- Earth and planetary sciences
- engineering mechanics
- environmental and health sciences
- fire technology
- fluid systems and fluid machinery
- fracture mechanics
- fuels and lubricants
- geochemistry and radiochemistry
- geological and mining engineering
- geophysical and geological investigations
- hydrology and geohydrology
- information and electronic warfare
- intelligent transportation systems and vehicles
- internal combustion engine emissions research
- manufacturing technology
- marine technology
- materials sciences
- medical information systems
- modeling and simulation
- nondestructive evaluation
- oil and gas exploration and development
- optics and sensor technology
- penetration and armor mechanics
- pipeline technology
- probabilistic mechanics and uncertainty quantification
- risk and hazard assessment
- signal exploitation and geolocation
- software engineering
- space science
- space instrumentation and spacecraft systems
- structural engineering
- surface modification and coatings
- surveillance technology, training systems and simulators
- unmanned aerial vehicles and systems
- vehicle, engine and powertrain design, research and development

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## Contact Information

Ann Arbor Technical Center  
(734) 786-3801  
Southwest Research Institute

2001 Commonwealth Blvd., Suite 202  
Ann Arbor, MI 48105  
annarbor.swri.org

## ***EHS***

EHS (647-1143) provides technical support and is able to call upon Plant engineers, architects, and code inspectors to assist in the evaluation and control of hazards associated with field fabricated equipment. EHS may also call upon the University's loss prevention insurance company, FM Global, to provide expert analysis.