

Fire/Life Safety ORC Review Guidelines for Experimental Installations

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Overview:

When reviewing the Fire/Life Safety and material-related issues for experiment installations, particularly but not exclusively in the MTest area, several areas of concern seem to arise repeatedly. This document describes these common problems. *It is intended to support but not to replace, revise or obfuscate the fundamental rules for the Fire and Life safety applicable at Fermilab or found in the FESHM 6000 chapters or requirements of National Fire Protection Association (NFPA), National Electric Code (NEC), International Building Code (ICC) and DOE Order 1066, which Fermilab follows.* Of course, sometimes the materials used in the installation or piece of equipment require special considerations due to operational requirements and that is why these are “guidelines”, not a list of inflexible rules. Keep in mind though; there are some fundamental rules with regards to *Fire and Life Safety*, General Safety and the fire properties of the materials used in construction of your experiment that must be adhered to. Also, we review the installation starting with an experiment’s fire safety affecting the facility, operations within the facility and other experiments.

We will be looking at:

- The fire properties of materials (plastics, wire, foam board or foam) chemicals that are toxic, combustible or flammable and flammable gasses).
- Your experiment in relation to other experiments in the area.
- How a fire and corrosive smoke in your experiment would affect adjacent experiments and or flammable gas use in the area.
- Position of equipment, how you route and the means you use to secure your cables affects being able to exit the area safely.
- Fire Department access and ability to suppress a fire or reach an injured person.
- If specifications and fire rating for the materials and cables and gasses used can not be produced then special mediation requirements and additional reviews and requirements and testing of the materials and maybe necessary.

The (Operational Readiness Clearance) review is a complete review of all aspects of an experimenter’s/user’s installation of which the fire/life safety are just a part. Advisory reviews can be requested for any setup, no matter how complex, if there are any questions about safe operation and what should be done to ensure its safe operation, both for the knowledgeable persons and for persons who are not directly responsible for a setup’s design or operation. Remember: if in doubt, **please ask!!**

Reference material used for the Fire/Life Safety Review criteria:

The primary sources for these fundamental rules for the electrical safety of electrical installations at Fermilab are listed below:

- FESHM 6020.3: Storage and Use of Flammable Gases <http://esh.fnal.gov/xms/ESHQ-Manuals/FESHM>
- Electrical Design Standards for Electronics to be used in Experiment Apparatus at Fermilab <http://esh-docdb.fnal.gov/cgi-bin/ShowDocument?docid=2781>

- Fermilab ES&H Manual Chapter 9000 series, Fermilab Electrical Safety Program
<http://esh.fnal.gov/xms/ESHQ-Manuals/FESHM>

Commonly arising areas of concern during the Fire/Life Safety Review of the ORC review of experiments

1. **Flammable gas:** Use of a Flammable gas or non-flammable gas mixed with one component gas beginning flammable. The experiment must submit to the chair of the Fire Safety Committee all paper work required by FESHM Chapter 6020.3. This should be done as early as possible before starting installation of your experiment. The facility is responsible operability of the shed.
2. **Foam boards:** The pink construction-type or black display-type used to make boxes to hold experiments and copper lined. The pink construction foam boards are not fire-rated and by code require to be covered by 5/8-inch gypsum board which is not practical in experiment use.

Remediation measures that might be used is to cover with Herculite or foil and approved for the specific use based on exposure to ignition sources.

Black display board: normally this is not a fire rated board. There are a few fire-rated types that are available in white in 4 x 8 ft. sheets. Using this board will require the edges to be covered in metal tape or silicon applied to the edge.

Sheets of extra foam boards should be removed from the experimental area and covered with fire-retardant Herculite.

If you can find a fire-rated foam low density tested to some fire-resistance, **it might have a UL rating of (HF-1, HF-2, HBF) and thin films (VTM-0, VTM-1, VTM-2); or if used as a building material, CLASS A, B or C.** With foams there are normally restrictions on how it is installed and may require an exterior covering. As always, ask the Fermilab liaison if you are not sure or contact the ESH&Q FPE AHJ.

3. Use of untreated fire resistive wood

If possible it is preferred that fire treated wood be used. Wood can be painted with fire retardant paint or clear coat available in the Fermi stockroom. If painted off site, a label must be applied to the wood with the type of coating and a photo of the paint or coating container.

4. Storage of wood or plastic pallets or packing material

Should be removed from the experiment area as soon as possible. Material kept on site should be stored elsewhere safe manner.

Or may require a Herculite cover to limit exposure.

5. **Plastics:** More and more plastics are available with some sort of fire resistive properties. Plastics which are non-halogenated are preferred with an Underwriters Laboratories, Inc. with a classification of 94V-1, 94V-0 or Class A (if used as a building material).

UL 94 is a plastic flammability standard released by Underwriters Laboratories of the USA. The standard classifies plastics according to how they burn in various orientations and thicknesses. From lowest (least flame-retardant) to highest (most flame-retardant), the classifications are:

- HB: slow burning on a horizontal specimen; burning rate < 76 mm/min for thickness < 3 mm.
- V2: burning stops within 30 seconds on a vertical specimen; drips of flaming particles are allowed.
- V1: burning stops within 30 seconds on a vertical specimen; drips of particles allowed as long as they are not inflamed.
- V0: burning stops within 10 seconds on a vertical specimen; drips of particles allowed as long as they are not inflamed.
- 5VB: burning stops within 60 seconds on a vertical specimen; no drips allowed; plaque specimens may develop a hole.
- 5VA: burning stops within 60 seconds on a vertical specimen; no drips allowed; plaque specimens may not develop a hole

Tests are generally conducted on a 5" x 1/2" (12.7 cm x 1.27 cm) specimen of the minimum approved thickness. For 5VA and 5VB ratings, tests are performed on both bar and plaque specimens, and the flame ignition source is approximately five times as severe as that used for testing the other materials.

6. Cable Jackets

Preferred cables are fire resistive and non-halogen or Plenum – non-halogen

Plenum (CMP) Rated Cable

Complies with NFPA-262 and UL-910. Only cable allowed in spaces defined as air plenums such as raised flooring systems and air handling ducts. Plenum cables must self-extinguish and not reignite. They also produce less smoke than traditional PVC cables. The smoke and fumes are toxic.

Riser (CMR) Rated Cable

Complies with UL-1666. Defined for usage in vertical tray applications such as cable runs between floors through cable risers or in elevator shafts. These spaces cannot be used for environmental air. These cables must self-extinguish and must also prevent the flame from traveling up the cable in a vertical burn test.

Other Cable Ratings:

Low Smoke Zero Halogen (LSZH) Rated Cable

Used by CERN and other EU collaborations for all applications and is not limited to experiments, computer networking rooms open wiring and in cable trays. The LSZH rating provides low toxic or acidic smoke and fumes can injure people and/or equipment and high radiations resistant. Examples of Halogens include Fluorine, Chlorine, Bromine, and Iodine. When halogenated materials burn, they produce acidic smoke that can harm people and computer equipment. Low Smoke means the cable does not produce the heavy black soot and smoke common with PVC cables. Most of these cables will self-extinguish at a greater time and burn distance, therefore they cannot pass UL-910 or UL-1666 for a plenum or riser rating. They are generally more brittle and have less mechanical strength and are normally not tested to meet the NEC mechanical requirements. These cables require approval by the Electrical and Fire Subcommittees.

General Purpose (CM, CMG, CMx) Cable

Complies with UL-1581 testing. Will burn and partially self-extinguish. Not for use between build floors or in air plenum spaces. Often these cables are used for workstation cables and patch cords.

Current Protection for both AC and DC Powered Installations (Fire/Smoke Hazard) see “Electrical Safety ORC Review Guidelines for PPD Experimental Installations” for detailed guidelines.

All powered electrical equipment (non-commercial / non-UL listed) and conductors carrying that power to the equipment need to have current protection. This protection can be in the form of a current protection device (such as a fuse or circuit breaker). In the case of DC power coming from a power supply without fuse protection, the power supply must be current-limited so that no part of the installation can get current in excess of its rated capacity. The limiting ability of the power supply should not be easily changed by inadvertent contact with the power supply's controls. Otherwise, a fuse will be required at or near the source of the power. Always provide current protection if the current available, not just the normal operational current, exceeds the current capacity of the equipment or its conductors that supply that current. Devices designed for current protection should provide current protection. Do not use or depend on low-current rated components (such as an undersized resistor) to provide disconnection or "open up" in the event of an over-current condition

7. Rack Protection

As a norm, Fermilab does not require rack protection with interlocks for installations unless they are going underground, are part of high profile experiments; in ODH or interlocked areas with limited access by the Fire Department, or the ESH&Q FPE AHJ requires for the safety of the experiment or the facility. Fermi has a limited availability of rack-mounted units that provide smoke interlocks for AC power for user use. As far as MTest is concerned, rack protection is "normally" not required. As always, ask the Fermilab liaison if you are not sure or contact the ESH&Q FPE AHJ.

Summary

Materials cannot be substituted for the sake of convenience. The proper materials and gases must be used in the appropriate location as required by code and practice. What was approved in one experiment may not be the same in another. Always check with the Fermilab liaison if you are not sure or contact the ESH&Q FPE AHJ.