FESHM 9111: APPROVAL OF UNLISTED ELECTRICAL EQUIPMENT

Revision History

Author	Description of Change	Revision Date
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1.0 INTRODUCTION AND SCOPE

All electrical equipment in use at the Fermilab site or in its leased spaces that contains or produces hazardous electrical energy, as defined in section 6.1 of FESHM Chapter 9100, shall be listed and labeled by a nationally recognized testing laboratory (NRTL), field inspected by a NRTL, or approved by the Fermilab Electrical Authority Having Jurisdiction (AHJ) or designee prior to use. Listed equipment that has been modified or is used outside its use defined by the listing or manufacturer's instructions shall also be approved by an AHJ prior to use. Fermilab Site management shall:

- Ensure NRTL-listed electrical equipment is purchased and utilized if it exists, and
- Ensure that all equipment containing an electrical hazard that is not NRTL listed has been approved by the electrical AHJ.

Evaluation and approval by the Electrical AHJ or designee is required for all unlisted electrical equipment to be used at the Fermilab site or in its leased spaces. This applies to all equipment owned by Fermilab, its subcontractors, users, visitors, and other persons and entities. These requirements apply as follows:

- New unlisted electrical equipment shall be approved by the electrical AHJ before use.
- Unlisted equipment previously used at Fermilab without examination shall be approved by the electrical AHJ prior to being placed into service for a new application or restarting a decommissioned system.
- Equipment that has been modified or is to be used outside of its listing or manufacturer's instructions shall be approved by the electrical AHJ.

This chapter provides standard criteria for evaluation, labeling, and documentation of unlisted electrical equipment. The Occupational Safety & Health Administration (OSHA) requires explicit approval of all electrical equipment in the workplace to ensure it is free from recognized hazards that are likely to cause death or serious physical harm to employees.

NRTL-listed equipment shall be purchased and utilized if it exists. For new or replacement equipment, a NRTL-listed product shall be purchased instead of an unlisted product if both exist. If only one NRTL-listed product is available, this is justification for sole-sourcing the listed product. All NRTL-listed equipment shall be used for its intended purpose in accordance with the manufacturer's instructions. Otherwise, the equipment has to be treated as unlisted and is required to be approved by the AHJ.

Equipment that is not NRTL-listed and is unable to receive approval through a NRTL or AHJ field inspection shall not be placed into use at Fermilab until corrective measures are implemented to gain approval. In exceptional cases that meet the criteria in FESHM Chapter 1010, a variance or exception may be pursued to permit operation without fulfilling the requirements of this Chapter.

2.0 DEFINITIONS

Approved Equipment – Equipment acceptable to the AHJ consisting of: (1) NRTL-listed equipment being used in accordance with its listing or labeling for the manufacturer's intended purpose; (2) equipment that is field inspected and approved by a NRTL inspector as safe for its intended purpose or, (3) equipment that is inspected and approved by an AHJ electrical inspector as safe for its intended purpose.

Electrical Equipment – Equipment that uses electrical energy for electronic, electro mechanical, or chemical operations; heating; lighting; or similar purposes. Electrical equipment includes equipment used in laboratory research and development (R&D), other specialized equipment, as well as utility, facility, and shop equipment.

Electrical Inspector – A qualified Electrical Inspector is one who has been determined by the Fermilab AHJ, or designee, to have the skill, knowledge, and abilities to safely perform the work to which he/she is assigned. In addition, he/she shall have knowledge of the applicable electrical safety requirements, as well as demonstrated field experience in the design, installation, and/or operation of facility or R&D electrical systems. He/she also performs field evaluations, approves, labels and documents electrical equipment installations and work.

Facility Electrical Equipment – Electrical equipment that is considered an integral part of a facility or building and is generally not under direct control by R&D or office personnel. Examples include building pumps; compressors; heating, ventilation, air conditioning equipment; fixed general lighting fixtures that are permanently attached to the building structure; and facility power distribution equipment, such as panelboards, disconnect switches, and transformers.

Field Evaluation – The process used for one-of-a-kind, limited production, used, or modified products that are not listed or labeled under a full listing and certification program. The process is completed at the point of manufacturing, interim points of distribution, in the evaluating company's facilities, or at the final installation site or a combination of the above. Note that independent testing agencies, including NRTLs, can perform a field evaluation, generally in accordance with NFPA790/791. A contractual relationship directly between the manufacturer/distributor and the testing entity is preferred because it provides a simpler and more robust mechanism for resolution of non-compliant issues prior to Fermilab receiving the equipment. The AHJ approves the testing entity and the field report prior to the equipment being placed into service.

In-House-Built Equipment – Electrical equipment designed and/or fabricated by employees of a facility, including employees of subcontractors, other research organizations, including universities, other laboratories, and other research institutions.

Low-Hazard Equipment – Equipment that contains only negligible or low electrical hazards. This equipment will not have capability, under both normal operation and fault conditions, to deliver alternating or direct current, or contain stored energy, in excess of the hazardous energy thresholds listed in FESHM Chapter 9100 section 6.1, or emit radio frequency

energy above the thresholds given in FESHM Chapter 4320..

Modified Equipment – NRTL-listed equipment that has been modified or is being used for a purpose other than intended by the manufacturer/builder, and or NRTL or AHJ approved electrical equipment that is being used in a different location or for a different purpose than what it was to be used for when the inspection was conducted. Modified equipment includes equipment that is not used in accordance with the standard under which it listed, or the manufacturer's/builder's installation, use, or maintenance instructions.

Nationally Recognized Testing Laboratory (NRTL) – An organization (e.g., Underwriters Laboratory, or UL) That is recognized by OSHA in accordance with Appendix A of 29 CFR 1910.7. A list of the current roster of NRTLs can be found at the OSHA website.

Listed Equipment – Equipment included in a list published by an NRTL and used in accordance with any instructions included in the product standard under which it is listed and follows all manufacturer instructions or other documentation. Listed equipment includes industrial control panels built by firms participating in a NRTL Industrial Control Panel Shop Program that bear the NRTL's seal.

Non-listed Equipment – Equipment, that is not included in a list published by an NRTL. For the purposes of this Chapter, the term non-listed equipment also includes equipment that is listed, but is used for purposes that are not described in the product standard under which it is listed or does not follow any manufacturer instructions or other documentation.

System – A combination of components integrated into a unit to perform a specific task that is unlikely to change.

Unlisted Equipment – Equipment that has not been listed by an NRTL.

3.0 RESPONSIBILITIES

3.1 Division, Section, or Project (D/S/P) Heads

The D/S/P heads are responsible for ensuring that any and all instances in which electrical equipment, other than low-hazard equipment, are not NRTL listed or are NRTL listed but not used in conformance with its listing standard and manufacturer's instructions, receive AHJ approval through a NRTL or AHJ field inspection.

3.2 Electrical AHJ

The Electrical AHJ is responsible for evaluation of electrical equipment in conformance with 29 CFR 1910. The Electrical AHJ develops the electrical inspection program for non-listed equipment, inspects non-listed electrical equipment, and designates other laboratory individuals who may also inspect non-listed electrical equipment.

3.3 Department managers, experiment spokespersons, electrical coordinators, task managers, and construction coordinators

Department managers, experiment spokespersons, electrical coordinators, task managers, and construction coordinators are responsible for communicating requirements for listed equipment and for complying with the equipment inspection process to persons specifying, designing, constructing, and installing electrical equipment.

3.4 Persons specifying, designing, constructing, and installing electrical equipment

Persons specifying, designing, constructing, and installing electrical equipment are responsible for defining the performance required from the equipment to be used for their specific applications, and specifying and selecting NRTL-listed equipment that will meet the performance requirements. Only when a reasonably thorough search of manufacturers' or distributors' products determines that no available NRTL-listed equipment will meet their performance requirements will the acquisition of non-NRTL equipment be permitted. In such a case the requester shall furnish the Electrical AHJ with the search results and engineering and specification documents for their recommended equipment for preliminary approval prior to acquisition. The requester shall make the equipment available to Electrical AHJ or designee upon its arrival for a physical inspection prior to its use. Guidance for the design and construction of custom-built electrical equipment can be found in Fermilab's *Electrical Design Standards for Electronics to be used in Experimental Apparatus at Fermilab* (https://esh-docdb.fnal.gov/cgi-bin/ShowDocument?docid=2781), and Chapter 13 of the 2013 edition of the DOE Electrical Safety Handbook, DOE-HDBK-1092-2013.

4.0 PROGRAM DESCRIPTION

The unlisted electrical equipment program has two goals. The first is to assure that all electrical equipment purchased, made, or otherwise provided to Fermilab and used at Fermilab or its leased sites has been approved by the electrical AHJ. The second goal is to provide centralized records and equipment markings that expedite the process of obtaining inspection records and the supporting documentation for each piece of unlisted equipment.

Throughout its history, Fermilab's mission has required the use of specialized, and often unique, equipment that was and is not commercially available. The vast majority of this equipment was produced and used in accordance with the standards that existed at the time of its manufacture. It often exceeded those minimum requirements in the interest of operational reliability. Following the principle established by NFPA 70, *National Electrical Code,* for the electrical distribution system, existing non-listed equipment that has remained in its present service, other than for repair and scheduled shutdowns, will not be required to be inspected. The electrical AHJ does have authority to require equipment be retrofitted to mitigate risks to employees or facilities regardless of the equipment's service history.

The unlisted electrical equipment program is administered by the Electrical AHJ. The AHJ will identify the resources to be used to comply with the program. The AHJ will also designate personnel

who are authorized to perform unlisted electrical equipment inspections. Such designees are responsible for understanding the limitations of their expertise and to seek additional help when inspecting portions of equipment with portions or components beyond their expertise.

4.1 Electrical equipment inspections

A successful electrical inspection is required before non-listed electrical equipment is energized or operated. The inspection is requested by the person or manager responsible for the equipment from the AHJ or an AHJ designee. The equipment will be assigned a simple serial identification number. Multiple pieces of identical equipment may be assigned the same inspection number.

It is recommended that the inspection process begin in the early design stages of custom fabricated equipment, or at least before the equipment is specified and purchased. This allows changes needed to meet the requirements in lab standards to be incorporated with the least impact to schedules and budgets,and will expedite the final review prior to operation. This is strongly encouraged for equipment that is particularly complex or employs novel or unusual methods or components.

4.1.1. Employee and Subcontractor owned equipment

Equipment owned by employees of Fermi Forward Discovery Group, LLC (FermiForward) and its subcontractors is required to comply with the same regulations and standards as equipment owned by Fermilab. Employees and subcontractors shall promptly repair or remove any equipment that does not comply with these regulations from Fermilab and its leased spaces.

4.1.2. User, visitor, and institution owned equipment

Fermilab hosts many tests and experiments that consist of equipment and materials that are and will remain the property of persons or institutions other than Fermilab and its employees and subcontractors. Equipment that is not inseparably part of a test or experiment, such standard personal computing equipment, task lighting and appliances for personal care, food preparation, communication, and entertainment must comply with the same regulations and standards as equipment owned by Fermilab. Equipment that is inseparably part of a test or experiment preferably complies with the same regulations and standards as equipment owned by Fermilab. Such equipment that does not comply with these regulations and standards will be inspected by a Fermilab Electrical Inspector. If this equipment does not offer a level of safety equivalent to that offered by compliant equipment, the Electrical Inspector may require the owner of the equipment to take additional measures to achieve an equivalent level of safety. If, in the sole judgement of the electrical AHJ, an equivalent level of safety cannot be achieved even with additional measures, the owner will promptly remove that equipment from Fermilab and its leased spaces.

4.1.3. Standards to which equipment is to be inspected

The equipment shall be inspected according to the standard most applicable to the type and purpose of the equipment. In unusual cases, more than one standard may apply. The electrical AHJ should be consulted if it is not clear which standard should be applied. The following is a list of the most common standards which non-listed equipment at Fermilab must follow. It is not an exhaustive list of all the standards that might apply.

UL 508A Standard for Industrial Control Panels
UL 60950 Information Technology Equipment - Safety
UL 61010 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

4.1.4. Inspection criteria for Non-Listed and Modified NRTL-Listed Electrical Equipment

The inspection shall review the following list of features, requirements, and identifying information and shall record the results of the inspection in an appropriate document as described in section 4.2. Information already present in equipment documentation submitted with the request for inspection does not have to be repeated in the inspection document.

- Equipment owner name (optional), Badge # (optional), group/organization
- Equipment name
- Equipment manufacturer
- Equipment model number
- Equipment serial number and property number, if applicable
- Equipment location (optional)
- Equipment status: new, modified, not previously approved, in-use, etc.
- Equipment type (optional):
  - Stand-alone custom built
  - System
  - Powered rack
  - Appliances and electrical tools
  - Powered workbench
  - Extension cords and relocatable power taps
  - Other
- Function
- Usage:
  - Operating Environment
- Conditions of Usage/comments
- Electrical inspection identification number
- Date examined and approved/rejected
- Name of electrical inspector who examined and approved/rejected the equipment

The inspection shall evaluate the following items unless inapplicable. For modified NRTL equipment, these items only need review if affected by the modifications made:

- External Inspection:
  - Enclosure
    - Operator is not exposed to any hazard
    - Is not damaged
    - Is of appropriate material
    - Protects contents from operating environment
    - Cords, other than incoming power, run outside of enclosure are properly supported
  - Power Source
    - Cords and Plugs
      - Proper voltage and ampacity rating for plug and cord
      - Grounding conductor included, if required
      - Are not frayed or damaged
      - Proper wiring of plug and properly torqued
      - Proper strain relief on cord
    - Direct wired into facility power
      - Proper voltage and ampacity rating for wiring method
      - Installation according to the National Electric Code (NEC)
      - Proper loading and overcurrent protection in branch circuit
      - Source of feed identified at equipment
  - Grounding
    - Ground from cord or other is properly terminated
    - All noncurrent-carrying exposed metal is properly bonded
    - All noncurrent-carrying internal subsystems are properly bonded
    - Equipment ground is run with circuit conductors
    - Auxiliary ground permitted installed appropriately, if required
    - Check termination
  - Foreign Power Supplies and Equipment
    - Connected to facility power, with appropriate NRTL listed adapters
    - Correct voltage, frequency, and phasing
    - Correct wire ampacity for U.S. use
  - Overcurrent Protection
    - Adequate overcurrent protection in equipment, or branch circuit
  - Marking Requirements
    - Hazards, including stored energy
    - Power requirements (voltage, current or power, frequency)
    - Manufacturer/make/model/drawing number/serial number
    - Restrictions and limitations of use
  - Miscellaneous Requirements

        - Documentation adequate
        - Procedures to use
        - Training and qualifications to use
    - Secondary Hazards
        - RF hazards
        - DC electric or magnetic fields
        - Infrared (IR), visible, or UV
        - X-rays
        - Fire, electrical explosion
        - Engage industrial health or fire protection subject matter experts to ascertain if workers are adequately protected from these hazards.
- Internal inspection:
    - Internal Wiring
        - Polarity correct
        - Phasing correct
        - Landing of ground correct
        - Separation of line voltage and high-voltage from low-voltage
        - Wiring terminals and leads
        - Wire size adequate and correctly identified
            - Printed circuit board “traces” compliant with IPC-2152
        - Proper dielectric
        - Clearance/creepage distances for high-voltage
        - Listed conductors, if applicable
    - Other Internal Issues
        - Neat workmanship
        - Listed components used, if applicable
        - Proper management of conductors
        - Free of sharp edges
        - Adequate cooling
        - Automatic discharge of high-voltage capacitor(s)
- Tests performed as deemed appropriate by electrical inspector
    - Ground continuity (less than an ohm)
    - Polarization of cord and plug
    - Auto discharge of high-voltage capacitor
    - Functional tests (e.g. ground fault circuit interrupter (GFCI), emergency shut-off etc.)
- Failure Analysis
    - Effect of ground fault
    - Effect of short circuit
    - Effect of interlock failure
    - Effect of overload

  - Effect of incorrect setting
- Maintenance
  - Any safety issues with access and maintenance
- Hipot (high voltage) Testing
  - The local AHJ may also choose to perform an ac/dc Hipot test to include Dielectric Withstand, Ground Bond/Continuity, Earth Leakage, and Insulation Resistance test per IEC/UL 61010-1 & CSA 22.2 for Laboratory Control Test & Measurement Equipment. There are commercially available test systems that are designed to autonomously perform a prescribed test sequence on cord-and-plug laboratory and analytical equipment. This test can be performed in lieu of, or in addition to, the requirements in Section 10.6.1 at the AHJ's discretion.

4.1.5. Unlisted facility equipment

The need for unlisted facility equipment is expected to be extremely rare. In the event that no existing listed facility equipment will meet application requirements, the following items should be inspected on the selected non-listed equipment:

- Suitability for installation and use in conformity with 29 CFR 1910 Subpart S, and/or, the NEC;
- Mechanical strength and durability, including for parts designed to enclose and protect other equipment, and the adequacy of the protection is thereby provided;
- Wire bending and connection space;
- Electrical connections and insulation;
- Heating effects under normal condition of use and also under abnormal conditions likely to arise in service;
- Arcing effects;
- Classification by type, size, voltage, current capacity, and specific use; and
- Other factors that contribute to the practical safeguarding of persons using or likely to come in contact with the equipment.

4.1.6. Electrical equipment systems

Combining two or more pieces of electrical equipment into a system can result in hazards if not carefully executed. Inspections of such systems are often done in the context of other lab programs, such as ORC inspections. These inspections should document the following:

Reference information:

- The items required to be evaluated for the system field evaluation;
- Conditions of use;
- System description;

- Subsystems;
- System name;
- Manufacturer;
- Date built;
- Date last modified;
- Number of pieces of equipment (e.g., 3 power supplies, 2 modulator racks);
- System status;
- System owner name (optional), Badge etc.#(optional), group/organization;
- Equipment location (optional);
- Specific tests performed for approval;
- Immediate improvements, required modifications (with a due date) and compensatory measures taken in the meantime;
- Name of division and group electrical inspector(s) who examined and approved/rejected the system; and
- Electrical inspector tracking number if equipment is approved.

Site organizations may approve unlisted electrical equipment as systems, with Site AHJ approval. Systems shall be examined at a minimum as follows:

- Hazard Assessment to include:
  - Electrical hazard classification);
  - Stored electrical energy in capacitors (voltage and energy);
  - Batteries, including uninterruptible power supplies (UPS);
  - Electromagnetic fields produced (dc to 300 GHz, pulsed);
  - Infrared, optical, and UV;
  - X-rays;
  - Heat and sparks;
  - Acoustic energy; and
  - Other (e.g., chemical high pressure, cryogen, etc. This may require other subject matter expert (SME) review.
- Evaluation for operation to include:
  - Enclosure, isolation. There are no exposed hazardous energized conductors, no unused openings;
  - Grounding. All conductive enclosures exposed to personnel that may become energized shall be properly grounded;
  - Overcurrent protection. Overload protection, ground fault, and short circuit protection are in place;
  - Failure analysis. There are adequate electrical and fire protection systems for failure modes. (e.g. wiring, component failures etc.);
  - Operation safety analysis and controls are documented; and
  - System is labeled appropriately.
- Evaluation for working on system to include:
  - Method(s) of energy isolation (e.g., plug control, LOTO, Kirk key);
  - Automatic methods of stored energy removal;

- Proper design for the manual removal and/or verification of capacitively stored energy; and
- Documentation for entry and work on system.

4.1.7. Multiple identical units

For the case where multiple units of a full-custom or semi-custom design are incorporated into an installation or system, and those units contain hazardous electrical energy, whether built by a commercial manufacturer or built in-house, a determination is needed as to the consistency of the manufacturing materials and methods as they pertain to safety as part of the inspection process. Generally, the inspector should evaluate the quality of workmanship of the first unit to be inspected in making the determination as to how many units need to be inspected. The inspection of a minimum of 2 units is recommended, with additional inspections added depending on the findings. The following guidelines should be employed:

a. Units having sub-standard workmanship compared to industry standards are an indication that multiple inspections are needed.
b. Identical models with different manufacturing dates should be checked to ensure that the same quality of manufacturing regarding materials and methods have been employed.
c. Similar models with different model numbers (e.g. Model 100A → Model 100B) should be checked to ensure that nothing has changed regarding the electrical safety aspects.
d. Units without model numbers or dates of manufacturing should be considered as different models.
e. Units without professional documentation should be considered as different models.
f. Units without serial numbers should be considered as different models. If safety issues are found, it is recommended that serial numbers be applied as part of the remediation process.
g. Any single unit having safety issues should necessitate additional units being inspected. Multiple units having the same safety issue may be used as a basis to fail all units without inspecting each and every unit.

The inspector may elect to cover the inspection of multiple units in a single field inspection. If no safety issues are found in any of the units, the same inspection identification number may be used for multiple identical make and model units/systems. The serial number, lab property number, or other unique identifier of each identical model unit/system identified as approved is documented on the same approval form used to document the approval of the representative sample,

4.2 Inspection documentation and archive

The documents used by and produced by the inspection process will be archived in a location accessible to the electrical AHJ and designees, and preferably to others involved in electrical design, operation, and maintenance work. This is presently provided on the Electrical Safety Subcommittee Sharepoint site. The purpose of this archive is two-fold. The first is to comply with the requirement to maintain testing records of custom-built equipment found in the definition of Acceptable in 29 CFR 1910.399. The second purpose is to provide a central, readily accessible resource for finding

records and information regarding non-NRTL equipment. This second objective recommends a policy to be minimally restrictive in the types and kinds of documents permitted to be stored in this archive.

The archive shall consist of records, which are assigned a serial record number. Each record number is specific to a particular manufacturer and model of equipment. Where variants of a model of equipment exist that have different components or construction, separate records shall be created for each variant. Optional or auxiliary equipment, such as plug-in modules, should be assigned separate record files. The title of each record should include both the record number and a brief identification of the equipment covered.

4.2.1. Equipment documentation

Documents that provided data used to perform the inspections shall be stored in the archive for future reference. It is also recommended that other documents related to the equipment, such as installation, operation, and maintenance manuals also be put in the archive.

4.2.2. Electrical inspection reports

The Technical Appendix B of the chapter contain inspection forms that may be used to document the inspections performed. While not required, these forms do provide a ready means to ensure that the items identified in section 4.1 of this chapter are addressed during the inspection. The titles of inspection reports saved in a record file shall contain the file record number and the serial number of the equipment inspected. Where multiple pieces of identical equipment are inspected at the same time, the date of the inspection can be substituted for the serial number in the inspection report.

4.2.3. Other acceptable inspection documents

Prior to the development of this chapter, several of Fermilab's administrative units had already developed robust and mature design evaluation and equipment inspection procedures and documentation systems. Archives of the documents used and produced by these processes are often specific to and only accessible by the organizational unit that produced them. While entry of inspection and resource documents into the archive managed under this chapter is mandatory, recording and archiving of these same documents in other locations is permitted. Those archiving the documents in alternate locations are advised to incorporate robust version control into such documents.

4.3 Inspected equipment labeling

Key to efficient use of this program are clear indications of the inspection status of each piece of unlisted equipment. Three types of labels are to be used, each one will identify the type of label in

permanent black ink and provide a space to write in the record number and the Fermi ID number of the inspector.

a. A green "approved" label will be applied to equipment that has successfully completed inspection.
b. A yellow "conditional" label will be applied to equipment on which the inspector has placed restrictions on the use of the equipment, time duration, or equipment which does not meet inspection requirements but has been given permission to operate through the variance or exception process in FESHM 1010.
c. A red "rejected" label will be applied to equipment that has not passed inspection and is not permitted to operate.

A white label, simply marked "NRTL Listed" and with a place for the inspector's Fermi ID number, may be applied to a readily accessible surface of a piece of NRTL listed equipment, if the installation of the equipment renders it difficult to view the manufacturer's NRTL seal.

While procurement may dictate exact label sizes, the expected size will be roughly 1 inch tall by 2 inches wide. Labels are to be applied in a place that will be as close to readily viewable as reasonable without obstructing equipment markings, controls, or displays.

4.4 Equipment that is salvaged, excessed, abandoned in place, or removed

The AHJ approval is invalidated for unlisted equipment that is no longer is service, other than for periods of maintenance, repair, or operational shutdowns. The inspection label may be kept on the equipment for tracking purposes, but the word "approved" shall be struck through with permanent black ink. Equipment with conditional approval shall also have its conditional approval invalidated for the same conditions as approved equipment, and additionally when any of the conditions of approval are no longer true. The word "conditional" on its label shall be similarly struck through.

All AHJ inspection labels shall be removed from any equipment for which ownership is transferred to any entity other than other sites and laboratories that are administered by the DOE or its contractors. The DOE and its contractors that receive Fermilab equipment either on loan or through transfer of ownership have the option of accepting Fermilab's AHJ approval through use of the inspection reciprocity program described in FESHM Chapter 9110.

4.5 Equipment that retrieved from salvage, excess, or abandonment

Unlisted equipment retrieved from salvage, excess, or abandonment shall be inspected prior to re-energization following the same process as for newly built or acquired equipment. If there are previous inspection reports, those may be used as a resource for the inspector. If the equipment was previously assigned a record number, the same record number should be retained, the new inspection reports added, and the previous reports placed in a "superseded" subdirectory. In addition to standards requirements, the inspection should also check for deterioration that could occur due to age, periods of disuse (e.g., electrolytic capacitors), environmental conditions, and infestation.

4.6 Equipment received from other DOE sites and laboratories

Depending on the laboratory from which unlisted equipment is received and the inspection records that the providing laboratory supplies, the equipment may be eligible for a reduced receiving inspection scope under the reciprocity program described in FESHM Chapter 9110 at the discretion of the electrical AHJ. If the other site or laboratory retains ownership of the equipment, a Fermilab record does not need to be generated. If ownership is transferred to Fermilab a record shall be generated for it.

4.7 Subcontractor-owned unlisted electrical equipment

Subcontractors are required to follow the same requirements as Fermilab through the flow-down of 10 CFR 851. Only in the most unusual circumstances should a subcontractor have a legitimate need to use unlisted equipment. 29 CFR 1910 clearly requires that listed equipment is to be used if it exists. Subcontractors are required to request approval of unlisted equipment in advance of needing to use it, and the task manager / construction coordinator should recommend alternate methods before requesting an inspection, due to the additional burden placed on lab resources. If a subcontractor has a legitimate need to use unlisted equipment, the record of the inspection is to be retained by the construction coordinator or task manager. The assignment of a record identification number to subcontractor-owned equipment is not recommended.

4.8 Rental equipment

Equipment that is rented by Fermilab or by its subcontractors is subject to the same requirements as equipment they might own. The requirement to supply NRTL-listed equipment should be identified in any rental contract. Non-listed equipment for which a listed equivalent does not exist shall be inspected. The assignment of a record identification number to rented equipment is not recommended. The person responsible for the rental equipment is responsible for maintaining documentation of the equipment and of the inspection for the duration of the rental period.

Rental equipment, whether NRTL listed or not, is arguably at greater risk of deficient conditions due to misuse, abuse, or inadequate repairs. Task managers / construction coordinators should inspect all subcontractor's equipment, rented or not, for physical condition and notify the Fermilab ES&H construction representatives of any potentially deficient equipment conditions or absent NRTL seals.

4.9 International In-Kind Contributions

The magnitude of the burdens of executing leading edge high-energy physics research has dictated that such burdens be shared among international research partners. These agreements often make Fermilab the recipient of electrical equipment provided by international partners, and the specifics

of these agreements governing the requirements for contributed equipment do not always align with certain provisions of the DOE- FermiForward contract.

The specifics of each set of agreements are summarized in Technical Appendix A because the scopes and structures of the international agreements that support this research vary significantly and are subject to change. This allows summaries to be added or revised to accurately document the effects of these agreements on electrical equipment inspections without requiring a lab-wide review of this Chapter each time an addition or change made.

It is highly preferable that contributed equipment be listed by a NRTL or have a NRTL field inspection. Language requiring NRTL listings or field inspections for contributed equipment should be included in the agreements providing for in-kind contributions where possible.

When the terms of an agreement permit contributed equipment to be furnished without a NRTL listing or field inspection, engaging the Electrical Inspector or a knowledgeable SME during design, prototyping, and manufacturing stages will help ensure that the contributed equipment will provide an equivalent level of safety to what NRTL listed or field inspected equipment would provide with the least impact to schedule and budget. Doing so will also expedite the inspection process when the equipment arrives at Fermilab.

All electrical equipment that is not NRTL listed or field inspected must receive approval from a Fermilab Electrical Inspector prior to connection to the Fermilab electrical system. If the contributed equipment does not offer a level of safety equivalent to that offered by NRTL listed or field inspected equipment, the Electrical Inspector may require that additional measures are taken to achieve an equivalent level of safety prior to connection to the Fermilab electrical system. These additional measures may take the form of modifications to the equipment or additional protective equipment between the contributed equipment and the systems and controls to which the contributed equipment connects. It is the responsibility of the Fermilab Project, Associated Directorate, or Division that is the beneficiary of the contributed equipment or will operate the contributed equipment to work with the contributing entity in the design and development stages to include those measures, or to fund and implement those additional measures and accept what impact, if any, those measures may have on product certifications, guarantees or warranties.

If, in the sole judgement of the Fermilab Electrical Safety Officer, an equivalent level of safety cannot be achieved even with additional measures, or if the Fermilab Project, Associated Directorate, or Division that is the beneficiary of the contributed equipment or will operate the contributed equipment finds it impractical to implement the additional measures, the contributed equipment will be rejected and its use at Fermilab prohibited. The Fermilab Project, Associated Directorate, or Division that is the beneficiary of the contributed equipment or would have operated the contributed equipment is responsible for the disposition of rejected contributed equipment.

5.0 REFERENCES

Fermilab's *Electrical Design Standards for Electronics to be used in Experimental Apparatus at Fermilab* (https://esh-docdb.fnal.gov/cgi-bin/ShowDocument?docid=2781)

DOE HDBK-1092-2013, *Electrical Safety Handbook*

6.0 TECHNICAL APPENDIX A

The following sections summarize the effects on electrical equipment inspections of certain international agreements that make Fermilab the recipient of electrical equipment provided by international partners. These sections are best efforts at distilling the effects of these agreements on electrical equipment inspections; in certain circumstances it may be necessary to reference the agreements themselves to resolve specific questions.

6.1 CERN Neutrino Protocol

A series of three agreements were executed by the Department of State, between the United States of America and the European Organization for Nuclear Research (CERN). These are indexed by the Department of State as 15-507, *Scientific and Technical Cooperation*, 15-1218, *Scientific and Technical Cooperation, Neutrino Program, Protocol 1*, and 17-502, *Scientific and Technical Cooperation, Neutrino Program, Addendum 1 to Protocol 1*. Together these agreements establish the conditions under which the USA and CERN mutually contribute to each other's neutrino research programs. For the purpose of this Chapter these three agreements will be collectively referred to as the Neutrino Protocol, and only the impacts to Fermilab's electrical equipment inspection process will be addressed here.

Because this Chapter applies only to equipment in use at the Fermilab site or in its leased spaces, it will not address any of Fermilab's contributions to CERN's neutrino programs. The Neutrino Protocol specifies that the only contributions it covers come only from CERN, and that these contributions are made only to the Short Baseline Neutrino (SBN) and Long Baseline Neutrino (LBN) experiments. The Neutrino Protocol clarifies that CERN contributions may also be made through its member institutions and by contractors retained by CERN.

The inspection of electrical equipment for assembly and installation work contributed or used by CERN to Fermilab is done through a joint CERN – Fermilab Acceptance Procedure, CERN EDMS identifier 2583016 and LBNF DocDB DUNE-doc-25593. Another procedure for the inspection of equipment contributed by CERN for LBNF/DUNE operations is under development.

Under the procedure for the inspection of electrical equipment for assembly and installation work, CERN will perform a physical inspection of the equipment to be contributed or used at Fermilab or its leased spaces. CERN will transmit a copy of the inspection report for equipment that passed the inspection, along with its certifications and manufacturer documentation not less than three months prior to when the equipment is to be used. As stated in the procedure, "The Fermilab AHJ or designee will perform additional and final electrical inspections at SURF during the Work Package analysis process and the Safety Inspection on Site before authorizing the activity."

6.2 PIP-II Agreements

PIP-II has several international partners engaged to contribute electrical equipment to the project. Because the terms of these agreement vary, the effects of each country's agreements are summarized

separately. Some of the identified agreements reference other documents that have not yet been furnished, the impact of these other documents is not known.

6.2.1. India

The Superfluid Helium Cryogenic Plants (SHCP), one for Fermilab and one for Indian institutions have jointly developed technical specifications that each institutions policies and applicable standards, which should include NRTL requirements.

For other equipment, the "requirements and specifications of equipment" and "standards for safety" are to be included through the use of non-binding written instruments such as project planning documents and technical specifications, and that fabrication is only permitted to start once design and specifications have been finalized, which should provide opportunity to ensure compliance with standards.

Specific agreements:

Financial responsibilities for the Superfluid Helium Cryogenic Plant (SHCP) the be procured by DAE for installation and commissioning at FNAL site [8 Sept. 2016]

No impact

Superfluid Helium Cryogenic Plant PROJECT PLAN [29 Apr. 2016]

Article 4, Scope of Work: "The [DAE-DOE Discovery Science collaboration will jointly work to develop detailed technical specifications."

Article 6, Procurement: "Specific procurement requirements may vary between BARC-VC and Fermilab. The Acquisition Board holds the responsibility for assuring that all requirements are met in a manner that provides for cost efficient procurement."

Article 9, Technical Environment: "Requirements that describe the functional performance criteria for the Cryoplant will be listed in the Cryoplant Technical Specification (TS). The TS will allow vendors to use their standard components and processes as long as they meet the technical and functional requirements. In addition, the TS will list the various codes (such as ASME, BPV, NEC, NEPA, etc) and standards as well as Laboratory policies (such and the Fermilab ES&H Manual, BARC-VC Safety Manuals) that must be followed."

Joint Project Document for the Research and Development Phase of the Indian Institutions and Fermilab Collaboration Under the framework of Project Annex-I to the Implementing Agreement between DAE, India, and DOE, USA [28 Aug. 2015]

Article 3, Goals, defines a scope of supply that consists of the development and testing of several RF cavities, two cryomodules, and "associated components such as RF couplers, tuners, magnets, solid state power amplifiers, and cavity test facilities."

Article 4, Accelerator Design and Development: "Fabrication of components will be started only after design drawings and technical specifications have been finalized."

Agreement on Science and Technology Cooperation between the Government of the United States of America and the Government of the Republic of India [23 Sept. 2019]

Article II, "Cooperative activities under this Agreement shall be conducted in accordance with the applicable laws, regulations, and procedures in both countries…."

Project Annexes under the Collaboration on High Intensity Superconducting Proton Accelerator (HISPA) and Long Baseline Neutrino Experiment (LBNE) [6 Nov. 2014 / 21 Jan. 2015]

Section 4.C.3 establishes that equipment sent to DOE by DAE becomes property of the US Gov't "once it has been installed as a functional component of a DOE facility."

Amendment to Project Annex I to the Implementing Agreement between the Department of Energy of the USA and the Department of Atomic Energy of the Republic of India for Cooperation in the area of Accelerator and Particle Detector Research and Development for Discovery Science for High Intensity Proton Accelerators [8 Feb. 2022 / 2 May 2022]

Section 3 adds paragraph 4.5.F to Project Annex I that permits non-binding written instruments to exchange and memorialize, among several other items, "requirements and specifications of equipment" and "standards for safety."

Amendment to Project Annex II to the Implementing Agreement between the Department of Energy of the USA and the Department of Atomic Energy of the Republic of India for Cooperation in the area of Accelerator and Particle Detector Research and Development for Discovery Science for Neutrino Physics Collaboration [8 Feb. 2022 / 2 May 2022]

Section 3 adds paragraph 4.F.6 to Project Annex II that permits non-binding written instruments to exchange and memorialize, among several other items, "requirements and specifications of equipment" and "standards for safety."

6.2.2. Italy

The language is clear that the contributed equipment has to meet requirements and specifications developed by Fermilab, in which the lab should be able to the NRTL requirements as appropriate. The "requirements and specifications of equipment" and "standards for safety" are to be included through the use of non-binding written instruments such as project planning documents and technical specifications

Specific agreements:

Project Annex to the Implementing Agreement between the Department of Energy of the USA and the Ministry of Education, Universities and Research of the Italian Republic for Cooperation in High Energy, Astroparticle, and Nuclear Physics Research concerning Accelerator Science and Technology [4 Dec. 2018]

Section 4.C.3 establishes that all equipment sent to DOE by MUIR becomes property of the US Gov't when DOE provides written confirmation the equipment meets acceptance criteria.

Section 4.F.2 includes "The design and fabrication of components for the project shall meet performance requirements and specifications developed by Fermilab."

Section 4.F.6 permits non-binding written instruments to exchange and memorialize, among several other items, "requirements and specifications of equipment" and "standards for safety."

6.2.3. Poland

FermiForward is responsible for identifying the applicable codes and standards. "Best efforts" are requested to ensure that the contributed equipment conforms to Fermilab's safety standards. Defining what "best efforts" are could become like nailing a congealed gelatin dessert to a wall. The "requirements and specifications of equipment" and "standards for safety" are to be included through the use of non-binding written instruments such as project planning documents and technical specifications.

Specific agreements:

CRADA No. 2019-0036, between FRA [now FermiForward] *and Wroclaw University of Science and Technology* [2 Jan. 2020]

Article IV: Equipment / Personal Property states in the fourth paragraph that "The participant shall use its best efforts to ensure that all equipment it supplies to the Project shall conform to the safety standards in force at the Laboratory's Facility at the time of delivery to the Laboratory."

Section 4 paragraph 3 permits Project Planning Documents to include non-binding written instruments to exchange and memorialize, among several other items, "requirements and specifications of equipment."

Annex A, Section 6.3.a makes a List of Codes and Standards a FermiForward (formerly FRA) deliverable.

Annex A, Section 7, Article IV, second paragraph that after installation and commissioning the ownership of contributed equipment is transferred to the Laboratory.

Annex B, Section 7, Article IV, second paragraph that after installation and commissioning the ownership of contributed equipment is transferred to the Laboratory.

CRADA No. 2020-0026, between FRA [now FermiForward] *and Warsaw University of Technology and Lodz University of Technology* [30 Nov. 2020]

Article IV: Equipment / Personal Property states in the fourth paragraph that "The participant shall use its best efforts to ensure that all equipment it supplies to the Project shall conform to the safety standards in force at the Laboratory's Facility at the time of delivery to the Laboratory."

Section 4 paragraph 3 permits Project Planning Documents to include non-binding written instruments to exchange and memorialize, among several other items, "requirements and specifications of equipment" and "standards for safety."

Annex A, Section 7, Article IV, second paragraph that after installation and commissioning the ownership of contributed equipment is transferred to the Laboratory.

6.2.4. United Kingdom

The language is clear that the contributed equipment is expected to meet all applicable safety standards, which would include NRTL requirements where appropriate. The "requirements and specifications of equipment" and "standards for safety" are to be included through the use of non-binding written instruments such as project planning documents and technical specifications.

Specific agreements:

Project Annex to the Implementing Agreement between the Department of Energy of the USA and the Ministry of Education, Universities and the Department for Business, Energy, and Industrial Strategy of the United Kingdom for Research and Development in Energy and Physical Science Fields Concerning Cooperation in the Area of Neutrino and Accelerator Science and Technology for High Energy Physics [22 Jan. 2022]

Section 5.C.4 establishes that all equipment sent to DOE by BEIS or STFC becomes property of the US Gov't when DOE provides written confirmation the equipment meets acceptance criteria.

Section 5.F.4 establishes that "Contributions are expected to … satisfy all applicable environmental, safety, health, and radiological control standards."

Section 5.F.6 establishes that non-binding written instruments to exchange and memorialize, among several other items, "requirements and specifications of equipment" and "standards for safety."

7.0 TECHNICAL APPENDIX B

The following inspection forms are based on those included in Appendix C of the 2013 edition of the DOE *Electrical Safety Handbook*. Guidance for using these forms can be found is section 7 of Appendix C of the DOE *Electrical Safety Handbook*.

7.1 Custom-built and Modified NRTL-Listed Electrical Equipment (page 1 of 2)

SECTION 1 – Information		
Group:	Responsible Person: (optional)	employee#: (optional)
Equipment Name: Multiple Single		
Manufacturer:		
Model Number:		
Serial number of piece of equipment actually evaluated (see attached form for multiple units):		
Property number of piece of equipment actually evaluated (see attached form for multiple units):		
Location Site: Bld: Room:		
Identify Equipment Status: New Modified Not Previously Approved In Use		
Equipment Type: Stand-alone custom built or other System Powered rack Appliance/electrical tools Powered workbench Extension cord/relocatable power taps ☐ Other		
Function and Use (duty cycle):		
Operating Environment: Indoor/dry Outdoor/wet/damp Flammable vapor/dust/flyings		

SECTION 2 – External Inspection	
Enclosure:	**Foreign Power Supplies and Equipment:**
Operator not exposed to any hazard:	Connected to facility power with appropriate adapters: NA:
Not damaged:	Correct voltage, frequency, and phasing: NA:
Appropriate Material:	Correct wire ampacity for U.S. use: NA:
Protects contents from operating environment:	**Overcurrent Protection:**
Will contain any arcs, sparks, electrical explosions:	Overcurrent protection: Equipment Branch Circuit: NA:
Power Source – Cord and plugs:	**Marking Requirements:**
Proper voltage and ampacity rating for plug and cord: NA:	Hazards, including stored energy: Yes NA:
Grounding conductor included if required: NA:	Power requirements (voltage, current, frequency)
Not frayed or damaged: NA:	Restriction and limitations of use: Yes NA:
Proper wiring of plug: NA:	Make/Model/Drawing number:
Strain relief on cord: NA:	**Other Requirements:**
Power Source – Direct wired into facility	Documentation adequate:
Proper voltage and ampacity rating for wiring method: NA:	Procedures to use (IWD): Yes No
Installation according to NEC: NA:	Training and qualification to use: Yes No
Proper loading and overcurrent protection in branch circuit: NA:	**Secondary Hazards:**
Grounding:	RF hazards: Yes No
Ground from cord or other is properly terminated: NA:	dc electric or magnetic fields: Yes No
All non-current carrying exposed metal is properly bonded: NA:	IR, visible, or UV: Yes No
All non-current carrying internal subsystems are properly bonded: NA:	X-rays: Yes No
Equipment ground is run with circuit conductors: NA:	Fire, electrical explosion: Yes No
Auxiliary ground permitted: Check Termination: NA:	

(7.1 continued) Custom-built and Modified NRTL-Listed Electrical Equipment (page 2 of 2)

PART 2 – Internal Inspection	
Internal Wiring	**Tests Performed**
Polarity correct: NA:	Ground continuity (less than 1 ohm):
Phasing correct: NA:	Polarization of cord and plug:
Landing of ground correct: NA:	Auto discharge of high voltage capacitor: NA:
Separated – line voltage and high voltage from low voltage: NA:	Functional test (e.g., GFCI, emergency shut-off): NA:
Wiring terminals and leads ok:	Others:
Wire sizes adequate:	
Proper dielectric:	**Failure Analysis:**
Clearance/creepage distances for high voltage ok: NA:	Effect of ground fault:
Listed conductors, if applicable:	Effect of short circuit:
Other Internal Issues:	Effect of interlock failure: NA:
Neat workmanship:	Effect of overload:
Listed components used, if applicable: NA:	Effect of incorrect setting: NA:
Proper management of conductors:	Others:
Free of sharp edges:	**Maintenance:**
Proper cooling:	Any safety issues with access and maintenance: Yes No Explain
Automatic discharge of high voltage capacitor: NA:	
Electrical inspector Tracking Number of Piece of Equipment Actually Evaluated (See next page for additional Tracking numbers of identical equipment if individual numbers were assigned:	

NOTE: APPROVED EQUIPMENT SHALL BE INSTALLED AND USED IN ACCORDANCE WITH THE INSTRUCTIONS PROVIDED BY THE DESIGNER/BUILDER AND AHJ.
Condition of Usage/comments: (Include all designer/builder instructions, drawings, or information that is relevant to the safe installation and use of this equipment. Attach additional sheets as necessary.):

This equipment is **APPROVED** for installation and use at FERMILAB. IF THIS EQUIPMENT IS MODIFIED, DAMAGED, OR UTILIZED FOR OTHER THAN THE INTENDED USE STATED ABOVE, THIS APPROVAL IS VOID, PENDING RE-EXAMINATION.

DATE:	AHJ approved -Electrical inspector Printed Name:	AHJ approved -Electrical inspector Signature

This equipment is **REJECTED** for use at FERMILAB (see comments above).

DATE:	AHJ approved -Electrical inspector Printed Name:	AHJ approved -Electrical inspector Signature

7.2 Facility Unlisted Electrical Equipment Approval Form

SECTION 1 – Information		
Group:	Responsible Person: (optional)	Employee #: (optional)
Equipment Name: Multiple Single		
Manufacturer:		
Model Number:		
Serial number of piece of equipment actually evaluated (see attached form for multiple units):		
Property number of piece of equipment actually evaluated (see attached form for multiple units):		
Location Site: Bld: Room:		
Identify Equipment Status: New Modified Not Previously Approved in Use		
Equipment Type: Stand-alone custom built or other System Powered rack Appliance/electrical tools Powered workbench Extension cord/relocatable power taps Other		
Function:		

SECTION 2 – Inspection	**APPROVE**	**REJECT**
1. Suitability for installation and use in conformity with 29 CFR 1910 Subpart S and/or NEC.		
2. Mechanical strength and durability, including for parts designed to enclose and protect other equipment, the adequacy of the protection thus provided.		
3. Wire bending and connection space.		
4. Electrical insulation.		
5. Heating effects under normal conditions of use and also under abnormal conditions likely to arise in service.		
6. Arcing effects.		
7. Classification by type, size, voltage, current capacity, and specific use.		
8. Other factors that contribute to the practical safeguarding of persons using or likely to come in contact with the equipment.		
Electrical Inspector Tracking Number of Piece of Equipment Actually Evaluated (See next page for additional Electrical Inspector Tracking Numbers of identical equipment if individual numbers were assigned):		

NOTE: APPROVED EQUIPMENT WILL BE INSTALLED AND USED IN ACCORDANCE WITH THE INSTRUCTIONS PROVIDED BY THE DESIGNER/BUILDER AND AHJ.
Condition of Usage/comments: (Include all designer/builder instructions, drawings, or information that is relevant to the safe installation and use of this equipment. Attach additional sheets as necessary.):

This equipment is **APPROVED** for installation and use at FERMILAB. IF THIS EQUIPMENT IS MODIFIED, DAMAGED, OR UTILIZED FOR OTHER THAN THE INTENDED USE STATED ABOVE, THIS APPROVAL IS VOID, PENDING REEXAMINATION.

DATE:	AHJ approved -Equip. Inspector Printed Name:	AHJ approved -Electrical Inspector Signature

This equipment is **REJECTED** for use at FERMILAB (see comments above).

DATE:	AHJ approved -Equip. Inspector Printed Name:	AHJ approved -Electrical Inspector Signature

7.3 Unlisted Commercial Electrical Equipment Approval Form

SECTION 1 – Information		
Group:	Responsible Person: (optional)	Employee #: (optional)
Equipment Name: Multiple Single		
Manufacturer:		
Model Number:		
Serial number of piece of equipment actually evaluated (see attached form for multiple units):		
Property number of piece of equipment actually evaluated (see attached form for multiple units):		
Location Site: Bld: Room:		
Identify Equipment Status: New Modified Not Previously Approved in Use		
Function:		

SECTION 2 – Inspection	**APPROVE**	**REJECT**
1. The case is grounded through the power cord to the grounding pin on the plug.		
2. The plug is polarized, if necessary.		
3. The equipment input voltage and frequency match those of the building's electrical system.		
4. The equipment construction is suitable for the intended operating environment.		
5. The equipment is in its original, unmodified and undamaged condition.		
6. The equipment has externally accessible supplementary over-current protection (e.g., fuses) that are properly sized. (Equipment not having this, needs evaluation to determine if the equipment is safe for use)		
Electrical Inspector Tracking Number of Piece of Equipment Actually Evaluated (See next page for additional Electrical Inspector Tracking Numbers of identical equipment if individual numbers were assigned):		

NOTE: APPROVED EQUIPMENT WILL BE INSTALLED AND USED IN ACCORDANCE WITH THE INSTRUCTIONS PROVIDED BY THE DESIGNER/BUILDER AND AHJ.

Conditions of Usage: ☐ Indoor Only ☐ Damp/Wet Locations ☐ Hazardous Classified Locations (Flammable/Explosive)
Comments: (Include all designer/builder instructions, drawings, or information that is relevant to the safe installation and use of this equipment. Attach additional sheets as necessary.):

This equipment is **APPROVED** for installation and use at FERMILAB. IF THIS EQUIPMENT IS MODIFIED, DAMAGED, OR UTILIZED FOR OTHER THAN THE INTENDED USE STATED ABOVE, THIS APPROVAL IS VOID PENDING REEXAMINATION.

DATE:	AHJ approved -Equip. Inspector Printed Name:	AHJ approved -Electrical Inspector Signature

This equipment is **REJECTED** for use at FERMILAB (see comments above).

DATE:	AHJ approved -Equip. Inspector Printed Name:	AHJ approved -Electrical Inspector Signature

7.4 Electrical System Approval Form (page 1 of 3)

SECTION 1 – Information Approval is for intended use within the approving organization only		
Group:	Responsible Person: (optional)	Employee #: (optional)
System Name:		
System Description:		
Manufacturer, if any:	# of pieces of equipment in system:	
Model Number, if any:		
Serial Number of System Actually Evaluated (see attached for additional serial numbers of identical equipment):		
Date Built:	Date Last Modified:	
Location Site: Bld: Room:		
Identify Equipment Status: New Modified Not Previously Approved in Use		
Function and List of Subsystems:		

SECTION 2 – Hazard Assessment
Determine all electrical and non-electrical hazards that could injure an employee, including operation and maintenance workers.

1	**Electrical hazard classifications**	
2	Stored electrical energy in capacitors (E and V)	
3	Batteries, including UPSs	
4	Electromagnetic fields produced (dc to 300 GHz, pulsed)	
5	IR, optical, or UV produced	
6	X-rays (give voltage value in vacuum)	
7	Heat and sparks	
8	Acoustic energy	
9	Other (chemical, high pressure, cryogen, etc.)	

(7.4 continued) Electrical System Approval Form (page 2 of 3)

SECTION 3 – Evaluation for Operation: Determine that engineering controls adequately protect the operators and users during system operation.		**APPROVE**	**REJECT**
1	Enclosure, isolation. No exposed hazardous energized conductors, no unused openings.		
2	Grounding. All conductive enclosures exposed to personnel properly grounded.		
3	Overcurrent protection. Provision for overload, ground fault, and short circuit		
4	Failure analysis. Adequate electrical and fire protection systems for failure modes.		
5	Operation safety analysis and controls documented where? E.g., IWD		
6	System is labeled as approved, how?		
7	Other, explain.		
SECTION 4 – Evaluation for Working on System: Determine that engineering controls are implemented, in conjunction with work control to safely enter into and work on the system.		**APPROVE**	**REJECT**
1	Method(s) of energy isolation (e.g., plug control, LOTO, Kirk key)		
2	Automatic methods of stored energy removal, if necessary		
3	Proper design for the manual removal and/or verification of capacitively stored energy		
4	Documentation for entry and work on system where? E.g., IWD		
Electrical Inspector Tracking Number:			

NOTE: System will be installed and used in accordance with the instructions provided by the designer/builder and AHJ approval.

Comments/conditions of use: (Include all designer/builder instructions, restrictions on use, drawings or information that is relevant to the safe installation and use of this equipment. Attach additional sheets as necessary)

☐ This system and its associated electrical equipment are **APPROVED** for installation and use at FERMILAB. IF THIS SYSTEM IS MODIFIED, DAMAGED, OR REPAIRED IN A MANNER THAT AFFECTS SAFETY, THIS APPROVAL IS VOID, PENDING RE-EXAMINATION BY AN ELECTRICAL INSPECTOR.

☐ This system is **REJECTED** for use at FERMILAB. (See comments above.)

Note: The following signatures indicate that these electrical inspector(s) have reviewed some or all parts of this system for safety. In some cases, an electrical inspector inspects only sections of the system for which their group is responsible. The head electrical inspector (if any) ensures that all components have been reviewed by one or more group electrical inspectors.

(7.4 continued) Electrical System Approval Form (page 2 of 3)

SECTION 5 – Approval Signatures			
Division/Group	Date:	Lead Equipment Inspector Printed Name	Lead Electrical Inspector Signature:
Division/Group	Date:	Equip. Insp Printed Name	Equip. Inspector Signature:
Division/Group	Date:	Equip. Insp Printed Name	Equip. Inspector Signature:
Division/Group	Date:	Equip. Insp Printed Name	Equip. Inspector Signature:
Division/Group	Date:	Equip. Insp Printed Name	Equip. Inspector Signature:

	SECTION 6 – Specific Tests Performed for Approval List tests performed relevant to safety.	**Date**	**Who**
1			
2			
3			
4			
5			
6			
7			

	SECTION 7 – Immediate Improvements List required modifications (with a due date) and compensatory measures taken to ensure safety if system is operated before modifications.	**Date**	**Who**
1			
2			
3			
4			
5			
6			
7			

7.5 Form for additional identical units under a single unlisted equipment inspection

Inspection Identification Number:

Additional: Serial Numbers; Property Numbers (if applicable)

S#: **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**
S#: **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**
S#: **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**
S#: **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**
S#: **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**
S#: **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**
S#: **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**
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S#: **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**
S#: **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**
S#: **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**	**S#:** **P#:**