

**MWI 8715.1**

**REVISION J**

**EFFECTIVE DATE: August 10, 2012**

**EXPIRATION DATE: June 5, 2022**

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# **MARSHALL WORK INSTRUCTION**

**QD01**

# **ELECTRICAL SAFETY PROGRAM**

**COMPLIANCE IS MANDATORY**

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### DOCUMENT HISTORY LOG

Status (Baseline/ Revision/ Change/ Revalidation/ Canceled)	Document Revision/ Change	Effective Date	Description
Baseline		12/20/99	
Revision	A	5/9/01	Renumbered document in accordance with MPG 1410.2; rewrote P.1; changed P.2 to read "...applies to all MSFC employees and contractor personnel at MSFC that are exposed to unguarded energized electrical components and equipment during maintenance, service or troubleshooting activities..."; added MWI 3410.1, MWI 8715.15, MIL-HDBK-454, NFPA 70, ANSI ISA-S82.01-1988, 29 CFR 1910.147, and 29 CFR 1910.303 to section 3; "deleted "c" in section 3, applicable documents, and added 3.8 through 3.10; added 4.1, 4.2, and 4.3; added definition for authorized employee, buddy system, CPR, CERTRAK, Energized, Exposed, and Guarded; updated definition for qualified person; updated paragraph 6.1.2 to read "Verify if personal protection equipment is required for the job. If required ensure PPE meets..."; changed paragraph 6.1.3 to read "If not, a lockout/tagout procedure and authorized employee shall be required. (Reference..."; added 6.1.4.1-6.1.8; added 6.1.10, 6.1.11, 6.2.1-6.2.2.2, 6.2.5 and 6.2.5.1, 6.2.7-6.3.1.3; added "tag it out (reference MWI 8715.3) and" to paragraph 6.3.2; changed paragraph 6.3.8 to read "Extension cord length in the office area shall not exceed 15 feet. Extension cord length..."; added paragraph 6.3.15; added 6.4.2.1, 6.4.4.1, and 6.4.5.1; added paragraph 6.4.2.3; deleted paragraph 6.d.(6); changed paragraph 6.4.6 to read "...etc.). Reference MWI 8715.11, "Fire Safety Program," section 6.6, "Portable Appliances," for exact requirements"; deleted "NOTE 1" and "NOTE 2" after paragraph 6.4.6; changed 6.6.4 to read "Safe working access and clearance...shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of the equipment. Clearance distances shall comply with 29 CFR 1910.303 (g) Table S-1"; added 6.4.15 and 6.4.16; added 6.5.2.2-6.5.2.4; added paragraph 6.7.3; added 6.8.3; changed paragraph 9.1 to read "All employees that may be exposed to energized electrical components shall be trained in and familiar with the safety-related work practices required by 29 CFR 1910.331 through 335 that pertain to their respective job assignments. This training may be performed during a Safety Meeting and maintained by the Supervisor"; added 9.2 and 9.3 to section 9; changed paragraph 10.1 to read "Supervisors shall ensure employees who are exposed to energized electrical equipment and face a risk of electric shock that is not reduced to a safe level or are exposed...task. At a minimum will ensure the employee is trained and familiar with:" added 10.1.1 through 10.1.3; revised paragraph 10.2 to read "...components are required to be trained..."; added 10.3-10.3.11; and added paragraph 10.7.
Revision	B	10/15/2004	Major rewrite, added requirement for shock assessment, written in accordance with HQ action.
Revision	C	8/4/2005	Major rewrite affecting most sections and appendices. The rewrite is mostly grammar and intended to make the document flow better; easier to read, and better explain the processes when an energized equipment work permit is required. Added definitions 5.20, 5.37, & 5.43. Rearranged sections 6.2, 6.3, 6.4, and 6.5. Added section 6.5.3 (Memorandum of Agreement), records 9.6, 9.7, 9.8. Revised Appendices B, E, and F, deleted reference to voltages greater than 15KV. Added Appendix H (MOA) Appendix B is being revised to reflect these changes.

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Revision	D	11/01/2006	Major rewrite affecting most sections as a result of a HQ audit, shortened MWI to be clearer and more precise for the user. Identified facility related and flight hardware related equipment/system requirements per this MWI. Renumbered Appendices, deleted original Appendix A, C, D, F. Added new Appendix F and G.
Revision	E	11/8/2007	Reworded Purpose and Applicability. Added definition for complex and simple equipment/systems. Clarified requirements throughout document causing renumbering in most sections. Deleted requirements that were stated twice. Reworded sections 6.1 through 6.5 to clarify requirements. Clarified request process for MSFC Form 4462, Energized Electrical Work Permit. Added arc flash labeling requirement. Changed retention schedule for MSFC Form 4462, Electrical Energized Work Permit. Reworded section 10 to clarify needed training. Reflects minor editorial changes.
Revision	F	4/16/2008	Revised 2. Applicability statement to address the applicability of this directive to the Michoud Assembly Facility (MAF). Added MSFC's MAF responsibilities throughout MWI. Changed ISD to ISB. Changed appendices to chapters, and added Chapter 8 for portable electric equipment. [On 5/23/08, an administrative correction updated name for MWI 8715.15.]
Revision	G	12/08/2008	Added Table of Contents. Minor grammar changes for Table of Contents Added 6.20 and Changed MAF NASA Safety Office to MSFC S&MA representative or designee. Added MSFC Center Operations representative or designee. Deleted MSFC's MAF NASA Safety Office throughout document, since these requirements are addressed in 6.20.
Revision	H	10/23/2009	Changes made due to revision of NFPA 70E. Deleted tables CH3.2, CH3.3 and Ch3.4, and referenced to NFPA 70E tables. Added CH9. Made more references to appropriate NFPA 70E articles for certain activities. Made minor grammar changes throughout and rearranged a couple of sections for better process flow. Added retraining requirements. Rearranged sections for better flow. Revised Energized Permit. Moved References to Appendix A.
Revision	I	3/24/2011	Changes made due to IFO Audit finding Elect 003, 004. Deleted document titles in body of MWI. Rearranged and renumbered most sections. Added a new 6.9. Add a couple of definitions. Deleted original Chapters 1, 2 and 3.
Revision	J	8/10/2012	Total rewrite. Revised per 2011 management review. Rearranged some sections so that the flow is easier to follow and the requirement is clearer. Moved Training to Appendix E. Deleted reference to design and installation of electric equipment; this is covered by NFPA 70 and 29 CFR Part 1910. 301 through 335. Deleted reference to uninsulated overhead lines as this is covered by NFPA 70E, Article 130.5. Deleted reference to the testing of GFCI as this is covered by NFPA 70, Article 590.6(A) and (B). Deleted section on MAF. Reformatted per MPR 1410.2 revised MWI template.
Change	1	5/9/2013	<i>This update is to facilitate the cancellation of OI QD-MAF-001.</i> On 5/9/13, at the request of the OPRD the following administrative changes were made: Added references of an equivalent NFPA 70E energized electrical work permit. The update makes the MWI more generic so that it is applicable to both MSFC and MAF. Where applicable replaced "MSFC and MAF" with "Center" so the instructions is more generic and can be easily applicable to both locations. Where applicable replaced Center specific organization names (ISB, EEOH, FMO and PSO) with the generic terms "Center Safety Office and Center Facilities Management Office" so the instruction can be easily applicable to both locations. Used MSFC or MAF if the instruction is applicable to only one location. Added definitions in Appendix A for "Center Safety Office and Center Facilities Management Office" and identified which org at each location (MSFC or MAF) performs the instruction.

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Change	2	3/28/2016	On 3/28/2016, at the request of the OPRD, administrative changes were made to change Inside Marshall to Explornet Homepage and SHE Webpage to SHE Community, reformat italicized NOTES, change NPR 1441.1 to NRRS 1441.1, delete some acronyms, and clarify training and definition for Qualified Employee.
Revalidation	J	6/5/2017	Directive expires 8/10/2017, but only administrative changes are needed. Updated Appendix D Records, updated references to MSFC's Explornet page, and updated Table of Contents to include chapter sections titles per NPR 1400.1. Deleted reference to NSTC 309.

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## **1. PURPOSE**

To establish instructions and define the processes for activities associated with the Center's Electrical Safety Program as required by NPR 8715.3.

## **2. APPLICABILITY**

2.1 This MWI applies to Center personnel, programs, projects, and activities, including contractors and resident agencies to the extent specified in their respective contracts or agreements. ("Contractors," for purposes of this paragraph, include contractors, grantees, Cooperative Agreement recipients, Space Act Agreement partners, or other agreement parties.)

2.2 This MWI applies to the Michoud Assembly Facility (MAF).

2.3 This MWI applies as follows: all mandatory actions (i.e., requirements) are denoted by statements containing the term "shall." The terms: "may" or "can" denote discretionary privilege or permission; "should" denotes a good practice and is recommended, but not required; "will" denotes expected outcome; and "are/is" denotes descriptive material.

2.4 This MWI applies the following: all document citations are assumed to be the latest version unless otherwise noted.

2.5 This MWI applies to equipment/systems that cannot be deenergized and placed in an electrically-safe working condition during testing, troubleshooting, maintenance, service, repair and construction.

2.6 This MWI applies to work performed on organization owned and Research and Development (R&D) type equipment/systems that operate in any voltage range and cannot be deenergized and placed in an electrically-safe working condition during testing, troubleshooting, maintenance, service, repair and construction.

2.7 This MWI does not apply to work performed on building/facility utility-related equipment/systems operating at 600 Volts (V) and above that is maintained and serviced by the Redstone Arsenal utility organization at MSFC.

## **3. AUTHORITY**

NPR 8715.3, NASA General Safety Program Requirements

## **4. APPLICABLE DOCUMENTS AND FORMS**

4.1 Occupational Safety and Health Standards, 29 CFR pt 1910

4.2 Safety and Health Regulations for Construction, 29 CFR pt 1926

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- 4.3 NPD 8700.1, NASA Policy for Safety and Mission Success
- 4.4 NPR 8715.1, NASA Occupational Safety and Health Programs
- 4.5 NPR 8831.2, Facilities Maintenance and Operations Management
- 4.6 NRRS 1441.1, NASA Records Retention Schedules
- 4.7 MPR 1810.2, Automated External Defibrillator (AED) Program
- 4.8 MPR 3410.1, Training
- 4.9 MPR 8715.1, Marshall Safety, Health and Environmental (SHE) Program
- 4.10 MWI 8715.2, Control of Hazardous Energy (Lockout/Tagout) Program
- 4.11 MWI 8715.11, Fire Safety Program
- 4.12 MWI 8715.15, Ground Operations Safety Assessment Program
- 4.13 NFPA 70, National Electric Code
- 4.14 NFPA 70E, Standard for Electrical Safety in the Workplace
- 4.15 MSFC Form 4462, Energized Electrical Work Permit

## **5. INSTRUCTIONS**

### **5.1 General**

5.1.1 No work shall be permitted to be performed on energized equipment/systems except for the following:

5.1.1.1 Facility-related equipment/systems, the management (branch chief or above) identified as the owner of the equipment/system being worked while energized provides the following:

- a. Acknowledgement that the equipment/system cannot be de-energized or the work postponed to a later date.
- b. Acknowledgement that the equipment meets justification for energized electrical work in accordance with section 5.2 of this MWI.

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c. Acknowledgement that they are accepting the risk of potential employee injury because the equipment/system is not de-energized and the employee(s) will be exposed to energized electrical conductors or circuit parts while performing the work in accordance with NPD 8700.1.

d. Concurrence that the work can be performed safely.

5.1.1.2 Facility-related equipment/systems, the management (supervisor or above) identified to have responsibility for performing the work provides the following:

a. Acknowledgement that the appropriate level of assessment has been performed for the work to identify the potential hazardous conditions and control methods in accordance with NFPA 70E Chapter 1 and MWI 8715.15.

b. Acknowledgement that they are accepting the risk of potential employee injury because the equipment/system is not de-energized and the employee(s) will be exposed to energized electrical conductors or circuit parts while performing the work in accordance with NPD 8700.1.

c. Acknowledgement that the employees performing the work are qualified for the type work being performed.

d. Concurrence that the work can be performed safely.

5.1.1.3 Organization owned, R&D-related, and hardware production-related energized equipment/systems, the management (branch chief or above) identified as the owner of the equipment/system being worked energized provides the following:

a. Acknowledgement that the work cannot be performed with the equipment/system de-energized.

b. Acknowledgement that the appropriate level of assessment has been performed for the work to identify the potential hazardous conditions and control methods in accordance with NFPA 70E Chapter 1 and MWI 8715.15.

c. Acknowledgement that they are accepting the risk of potential employee injury because the equipment/system is not de-energized and the employee(s) will be exposed to energized electrical conductors or circuit parts while performing the work in accordance with NPD 8700.1.

d. Acknowledgement that the employees performing the work are qualified for the type work being performed.

e. Concurrence that the work can be performed safely.

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## 5.2 Justification for Energized Electrical Work on Equipment/Systems

5.2.1 Energized equipment/systems shall be placed in an electrically-safe work condition prior to an employee performing work on or within the Limited Approach Boundary to energized electrical conductors or circuit parts, unless the Center organization identified as the equipment/system owner can demonstrate the following:

5.2.1.1 Additional or increased hazardous conditions can be created by deenergizing the equipment/system to perform the work.

5.2.1.2 The equipment/system design or operational limitations deems it infeasible to deenergize the equipment/system to perform the work.

*NOTE: Civil Service organizations are normally identified as the equipment/system owners. Contractor organizations are not considered as the owner organization of government-owned equipment.*

## 5.3 MSFC Form 4462 is Required

5.3.1 Approval to work on or within the Limited Approach Boundary to energized equipment/systems shall be authorized by use of an MSFC Form 4462.

*NOTE: The use of an equivalent NFPA 70E energized electrical work permit may be permitted, so long as the permit contains all of the information and signatures listed in section 5.4 of this MWI.*

5.3.2 An MSFC Form 4462 shall be required for installing new circuits or parts in energized equipment/systems for the following:

5.3.2.1 Deenergization of the equipment/systems can introduce or create additional or increased hazardous conditions to personnel, or the equipment/systems designed operational limitations.

5.3.2.2 Deenergization of the equipment/systems is not feasible due to the design or operational limitations of the equipment/system.

5.3.2.3 Deenergization of the equipment/systems is not feasible because the equipment/systems form an integral part of a hazardous material detection or ventilation system, fire protection/detection system, life support system, or emergency warning system, and similar systems.

*NOTE: Deenergizing fire protection/detection systems electronically are not included.*

5.3.2.4 Deenergization of the equipment/systems is not feasible because the equipment/system is identified as mission critical and forms an integral part of a system supporting the Space Station,

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or other NASA systems that require continual operation and cannot be deenergized at the time needed.

*NOTE: An MSFC Form 4462 can be required when performing maintenance activities on energized equipment/systems. This will be determined on a case-by-case basis by considering the hazardous conditions to which the employees will be exposed. Contact the Center's Safety Office or Center's Facilities Management Office (FMO) for more information. (See Appendix A of this MWI for more information.)*

#### 5.4 Requesting an MSFC Form 4462

*NOTE 1: The MSFC Form 4462 is maintained on "NASA's Explornet page," select "Center," select "Marshall Integrated Document Library (MIDL)," select "Forms Management - MSFC Forms." (See NFPA 70E Chapter 1 for more information.)*

*NOTE 2: MSFC's "Inside Marshall" is located on NASA's Explornet page.*

5.4.1 The Center (civil service) organization identified as the equipment/system owner shall be contacted for concurrence prior to starting any work on energized equipment/system.

*NOTE: The Center's FMO is identified as the owner of facility-related equipment/systems in most cases, but there are situations where the responsibility for this equipment/systems has been assigned to a user organization (e.g., Engineering or Test). The Center's FMO can assist in determining who has primary responsibility for the equipment/system.*

5.4.2 The scope of work shall be evaluated to determine if the equipment/system can be deenergized or work postponed to the next scheduled equipment/system outage.

5.4.3 The MSFC Form 4462 shall be initiated by the organization identified to perform the work and routed for concurrence from all organizations listed on the form.

5.4.4 A clear justification shall be provided as to why the work cannot be postponed to the next scheduled outage of equipment/systems.

5.4.5 A signature of the branch chief or above of the organization identified as the owner of the equipment/system shall note the acceptance of risk of possible employee injury in accordance with NPD 8700.1.

5.4.6 Evidence of the appropriate level safety assessment [electrical hazard analysis (HA), job hazard analysis (JHA), job safety analysis (JSA), workplace safety assessment, Safe Plan of Action (SPA) or an equivalent level safety assessment] is being performed prior to the start of work.

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5.4.7 All supporting information, including the documented safety assessment, shall be included with the permit prior to obtaining the approval/concurrence signatures in Part II.

5.4.8 No work shall be performed until all required signatures in Parts I and II have been obtained.

5.4.9 The signed permit and assessment or operating procedure shall be maintained with the Facility Work Request (FWR), Trouble Call (TC), Construction of Facilities (CoF), or other Work Authorization Document (WAD) package.

*NOTE: It is recommended that photographs of the equipment/system work area be taken. The photographs aid in ensuring that all parties involved in the review of the permit get a full understanding of where employees can expect to be close to energized electrical conductors and circuit parts. When photographs are taken, they can be attached to the permit.*

#### 5.5 Contractor-Issued MSFC Form 4462

*NOTE: Contractors can be permitted to issue the MSFC Form 4462 for the work performed by their company by submitting a Memorandum of Agreement (MOA) to the Center's Safety Office for approval. (See Appendix E of this MWI for more information.)*

5.5.1 When approved to issue the MSFC Form 4462 the contractor shall forward a copy of any issued MSFC Form 4462 to the Center's Safety Office within 5 working days of issuance.

#### 5.6 MSFC Form 4462 is not Required

5.6.1 An MSFC Form 4462 shall not be required for the following:

5.6.1.1 Work is being performed within the Limited Approach Boundary of energized electrical conductors or circuit parts and all of the following are met:

- a. Work is being performed by a qualified employee.
- b. Work is limited to tasks such as testing, troubleshooting, voltage measuring, and similar tasks.
- c. Employees are provided with and wear the protective clothing and Personal Protective Equipment (PPE) appropriate for the electrical hazards to which they are exposed.
- d. Employees adhere to the necessary electrical safe-work practices. (See NFPA 70E Chapter 1 and Appendix F of this MWI for more information.)

5.6.1.2 The purpose of crossing the Limited Approach Boundary is only for visual inspection and the Restricted Approach Boundary is not crossed.

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## 5.7 Safety Assessment for Energized Electrical Work

5.7.1 A safety assessment shall be conducted by the organization performing the work when an employee is required to work on or within the limited approach boundary to energized electrical conductors or circuit parts operating at 50 V or more and face the risk of an electrical shock that has not been reduced to an electrically-safe work level in accordance with NFPA 70E Chapter 1 and MWI 8715.15.

*NOTE 1: Work considered as routine, repetitive or similar in nature can be permitted to be grouped together into a single safety assessment such as an electrical HA, JHA, JSA, or SPA.*

*NOTE 2: The JSA and SPA are similar forms of a JHA, and can serve the same purpose of a JHA if they are specific in identifying the hazardous conditions and the control methods.*

*NOTE 3: Contact the Center's Safety Office for assistance if needed.*

5.7.2 The safety assessment shall identify the following:

5.7.2.1 Specific electrical hazards expected to be encountered while performing the work.

5.7.2.2 The voltage level to which the employees can be exposed.

5.7.2.3 Arc flash information (short circuit current, clearing time and incident (thermal) energy).

5.7.2.4 The protective boundary limits (limited, restricted, prohibited, or arc flash), as appropriate.

5.7.2.5 The type and level of PPE necessary in order to minimize the possibility of electric shock or arc flash protection when working within the arc flash protection boundary.

5.7.2.6 Level of risk and/or hazard/risk category identified for the work being performed.

5.7.2.7 Other hazards/risks that are associated with the work, as appropriate.

5.7.2.8 Additional electrically-safe work practices, as appropriate.

*NOTE 1: The types of HA conducted for electrical work normally includes a shock HA or an arc flash HA. (See NFPA 70E Chapter 1, Annex D and Annex F, Institute of Electrical and Electronics Engineers Standard 1584, and National Electrical Safety Codes and MWI 8715.15 for more information.)*

*NOTE 2: An arc flash HA is not required when (1) the circuit is rated at 240 V or less; (2) the circuit is supplied by one transformer; and (3) the transformer supplying the circuit is*

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*rated less than 125 Kilovolt-Ampere (kVA). (See NFPA 70E Chapter 1 for more information.)*

5.7.3 The safety assessment (HA, JHA, JSA or SPA) shall be attached to the MSFC Form 4462 when obtaining approval signatures. (See NFPA 70E Chapter 1 for more information.)

#### 5.8 Identifying the Level of Risk and/or Hazard Category

5.8.1 The level of risk and/or hazard category associated with the work shall be based on the following:

5.8.1.1 Type of equipment/system.

5.8.1.2 The nominal operating voltage level of the equipment/system.

5.8.1.3 The specific type of work expected to be performed. (See NFPA 70E Chapter 1.)

*NOTE: NFPA 70E identifies the hazard categories as 0, 1, 2, 3, and 4. The Center identifies the risk levels in MWI 8715.15 as high, moderate, low and minimal.*

5.8.2 The Center's hazard/risk categories for electrical-related work shall be identified as the following:

5.8.2.1 Hazard categories 4 and 3 are considered as a high risk.

5.8.2.2 Hazard category 2 is considered as a moderate risk.

5.8.2.3 Hazard category 1 is considered as a low risk.

5.8.2.4 Hazard category 0 is considered as a minimal risk.

#### 5.9 Selecting and Using Protective Clothing, PPE and Insulating Equipment

5.9.1 Protective clothing and PPE shall be provided to and used by the employees when they are expected to work in areas where electrical hazards are present or when identified as a method to control a hazardous condition in a safety assessment (HA, JHA, JSA, SPA, or workplace safety assessment) in accordance with NFPA 70E Chapter 1 and 29 CFR pt 1910.132.

*NOTE: The use of PPE alone cannot completely prevent a mishap or guarantee an employee will not be injured, because the use of PPE can only limit extent of the injury that can be received as a result of an incident.*

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5.9.2 Protective clothing and PPE shall:

5.9.2.1 Be appropriate for the level of electrical hazards the employee is expected to encounter while performing electrical-related work.

5.9.2.2 Be selected based on its ability to provide the necessary level of protection against the identified electrical hazard in accordance with 29 CFR pt 1910.132 and NFPA 70E Chapter 1.

5.9.2.3 Be nonconductive.

5.9.2.4 Be designed and constructed for the specific part of the body that is to be protected.

5.9.2.5 Be designed and constructed to provide the necessary level of protection for the type work being performed.

5.9.2.6 Provide protection against electric shock and incurable arc flash burns due to contact with energized-electrical conductors or circuit parts or from flying objects resulting from electrical explosion.

5.9.2.7 Not create a greater hazard for the employee that it is intended to prevent.

5.9.2.8 Be selected based on the hazard category identified for the work being conducted. (See NFPA 70E Chapter 1 for more information.)

5.9.3 Protective clothing and PPE, at a minimum, shall be used and worn for the following:

5.9.3.1 Flame Resistant clothing when exposed to a potential electric arc flash above the threshold incident-energy level for a second-degree burn [ $5 \text{ Joule/centimeter (J/cm)}^2$  ( $1.2 \text{ calories/centimeter (cal/cm)}^2$ )]. (See NFPA 70E Chapter 1 for more information.)

*NOTE: When flame resistant clothing is worn to protect an employee, it will be worn so that it covers the necessary parts of the body as well as all flammable apparel while still allowing the necessary movement and visibility to perform the work in a safe manner.*

5.9.3.2 Nonconductive head protection when there is a potential danger of head injury from electric shock or burns due to contact with energized electrical conductors or circuit parts or from flying objects resulting from electrical explosion.

5.9.3.3 Nonconductive protective equipment for the face, neck, and chin when there is a potential danger of injury from exposure to electric arcs or flashes or from flying objects resulting from electrical explosion.

5.9.3.4 Protective equipment for the eyes when there is potential danger of injury from electric arcs, flashes, or from flying objects resulting from electrical explosion.

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5.9.3.5 Rubber insulating gloves with leather protectors, as needed, when there is a potential danger of hand and arm injury from electric shock or arc flash burn due to contact with energized electrical conductors or circuit parts. (See NFPA 70E Table 130.7(C)(9) and (C)(10) for more information.)

*NOTE: Ensure rubber gloves are rated for the voltage to which they will be exposed.*

5.9.4 PPE and electrical insulating equipment shall:

5.9.4.1 Be maintained in a safe, reliable condition. (See NFPA 70E, Article 130.7(C) for more information.)

5.9.4.2 Be inspected for damage prior to each day's use and immediately following any incident that can reasonably be suspected of having caused damage.

5.9.4.3 Be subjected to periodic tests in accordance with 29 CFR pt 1910.137 and 335.

#### 5.10 Electrical Work Performed On Organization Owned, R&D-Related, and Hardware Production-Related Equipment/Systems

5.10.1 Electrical safety-related work practices and controls that are appropriate for the type work being performed on organization owned and R&D type equipment/systems shall be developed, implemented and followed by all employees performing the electrical work in accordance with appropriate articles of NFPA 70E.

5.10.2 All energized terminals on equipment/systems that can be inadvertently contacted by employees during testing and troubleshooting activities shall be covered or guarded, when possible.

5.10.3 The appropriate level safety assessment (HA, JHA, JSA, SPA or workplace safety assessment) shall be conducted to identify potential hazardous conditions and control methods in accordance with MWI 8715.15 when special test equipment is required to support test or R&D-related activities.

*NOTE: Contact the Center's Safety Office if assistance is needed in performing the safety assessment. Safety assessments are normally performed jointly between the Center Safety Office and the Center organization directly responsible for the equipment/system or operation.*

#### 5.11 Organization Electrical Safe-Work Practices

5.11.1 Organization electrical safe-work practices shall:

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5.11.1.1 Be developed and implemented by the organizations which expect employees to work on or within the limited approach boundary to energized electrical conductors and circuit parts and can face a risk of receiving an electrical shock that has not been reduced to a safe-work level.

*NOTE: These jobs/tasks normally include, but are not limited to, diagnostic or visual inspections where an employee is not required to place any part of their body directly on or be exposed to energized electrical conductors or circuit parts.*

5.11.1.2 Be consistent with the nature and extent of the electrical hazards associated with the type work being performed.

5.11.1.3 Be used by employees to safeguard themselves from injury when they are exposed to electrical hazards from electrical conductors or circuit parts that are or can become energized. (See NFPA 70E Chapter 1 for more information.)

5.11.1.4 Be compatible to the electrical safe-work practices described in Appendix F of this MWI.

*NOTE 1: An example JHA for electrical work is located on MSFC's "Inside Marshall," select "Organizational Websites," locate "Safety and Mission Assurance Directorate," select "Safety, Health and Environmental," select "Safety Information," select "Safety Assessments."*

*NOTE 2: Safety checklists for electrical work can also be used and are located on MSFC's "Inside Marshall," select "Organizational Websites," locate "Safety and Mission Assurance Directorate," select "Safety, Health and Environmental," select "Safety Information," select "Safety Assessments," select "Safety Checklists."*

*NOTE 3: MSFC's "Inside Marshall" is located on NASA's Explornet page. Contact the Center's Safety Office if assistance is needed.*

## 5.12 Buddy System

5.12.1 The buddy system shall be required when:

5.12.1.1 An employee performs an electrical-related job or operation that is identified as high or moderate risk in an operating procedure or hazard assessment in accordance with NPR 8715.3 Chapter 3 and MPR 8715.1.

5.12.1.2 The supervisor determines the buddy system is an appropriate safety-related work practice and control method to ensure the electrical-related job or operation is performed in a safe manner.

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## **6. CANCELLATION**

MWI 8715.1J, Electrical Safety Program, dated August 10, 2012.

*Original signed by*

Todd A. May  
Director

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## **CHAPTER 1 TRAINING**

### **CH1.1 Working Within the Limited Approach Boundary**

CH1.1.1 Employees who perform work within the Limited Approach Boundary of exposed energized-electrical conductors and circuit parts that operate at 50 V or more and can face the risk of being exposed to electrical hazards that have not been reduced to an electrically-safe working level shall be designated as “qualified” by their supervisor to perform this type of work.

CH1.1.2 Employees designated as “qualified” shall be trained, knowledgeable and have the ability to demonstrate the electrical safety-related work practices directly associated to their job assignments in accordance NFPA 70E Chapter 1, 29 CFR pt 1910.331 through 335, and NPR 8715.3 Chapter 7.

CH1.1.3 Any training provided shall include the employee’s name and dates of training.

CH1.1.4 The type and level of training needed for employees to be identified as “qualified” shall be determined by the supervisor based on the employee’s job assignments. (See NFPA 70E Article 110 and 29 CFR pt 1910.331 through 335 for more information.)

*NOTE 1: This training includes if On the Job Training (OJT) as needed.*

*NOTE 2: An employee can be considered qualified based on the training they receive to safely work on certain equipment/systems or to perform certain jobs, but can still be considered unqualified to work on equipment/systems or perform jobs for which they not have received adequate training. Example: An employee, based on their training, can be qualified to safely work on equipment/systems operating at 120 V, but since their training did not include working on 480 V equipment/systems, they are not considered qualified to work on equipment/systems operating at 480 V.*

### **CH1.2 Qualified Employee**

CH1.2.1 To be considered as “qualified” employees, the following shall be accomplished:

CH1.2.2 Successful completion of electrical safety training courses identified by their supervisor that enables the employee to demonstrate they are trained, knowledgeable and able to implement the electrical safety-related work practices directly associated with their job assignments. (See NFPA 70E Article 110 and 29 CFR pt 1910.331 through 335 for more information.)

*NOTE: Electrical safety-related training may include, but not limited to, successful completion of an electrician apprenticeship program, diploma/degree/certificate for electrician from a state accredited school, or electrician certification recognized by the state/county/city. Contact the Center’s Safety Office or Center’s Authority Having*

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*Jurisdiction (AHJ) for assistance in identifying the appropriate type of electrical safety-related training if needed.*

CH1.2.3 Successfully complete SHE 210, or an equivalent accident prevention training that includes methods to release a victim from contact with exposed energized parts; methods and techniques of first aid; and familiarization with emergency procedures such as Cardiopulmonary Resuscitation (CPR) techniques for employees that are to perform work within the restricted approach boundary on or while being exposed to energized-electrical parts operating at 50 V or more. Contact the Center’s Occupational Health Office if assistance is needed.

CH1.2.4 Receive additional training in accordance with NFPA 70E Chapter 1, as needed.

### CH1.3 Certification

CH1.3.1 Employees designated to work within areas where they face the risk of receiving an electrical shock that has not be reduced to a safe level shall receive certification in CPR and Automated External Defibrillator (AED) training if the duties warrant such training. (See MPR 1810.2 for more information.)

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## CHAPTER 2

### TEMPORARY WIRING (Extension/Flexible Cords and Multiple-Outlet Power Strips)

*NOTE: Due to the age of some of the Center buildings, the Center's AHJ for National Fire Protection Association (NFPA) has permitted the use of extension cords and relocatable multiple-outlet power strips to provide power to and protect electronic office-related equipment such as computers, copiers, printers, fax machines, analytical instruments, portable appliances, and other critical electronic components from transient voltage surges when the office does not provide an adequate number of receptacles. Installing additional receptacles is the preferred method, but there are times when installing additional receptacles cannot be accomplished due to funding limitations.*

#### CH2.1 Extension/Flexible Cord and Multiple-Outlet Power Strips

CH2.1.1 Extension/flexible cord and multiple-outlet power strips shall:

CH2.1.1.1 Be used in accordance with manufacturer's rating, labeling, listings, and any instructions included in the manufacture's labeling and listing. (See NFPA 70 Articles 100, 110.14, 210.50, 240.5, 310, 400, 400.5, 400.8, 400.14, 400.36, 590.4, 590.6, 29 CFR pt 1910.303(b)(1) and 305(a)(2),(g) and (j), and 29 CFR pt 1926.404(b), Occupational Safety and Health Administration (OSHA) Standard Interpretation Letter 05/05/2006 – Use of flexible cords and cables for wiring in permanent or temporary installations, OSHA Standard Interpretation 11/18/2002 – Compliance requirements for relocatable power taps or power strips, OSHA Standard Interpretation 06/17/1992 – Acceptable job-made extension cords, and OSHA Standard Interpretation 04/18/1991 – Extension cords connected to permanent wiring of a construction site building.

CH2.1.1.2 Bear the label of an Nationally-Recognized Testing Laboratory (NRTL) [e.g., Underwriters Laboratory (UL) or Factory Mutual (FM)] label.

CH2.1.1.3 Be plugged directly into approved permanently-installed/mounted electrical branch circuit receptacles that are protected by an overcurrent device in accordance with their current rating. (See NFPA 70, Articles 240.5 and 210.50, and OSHA Standard Interpretation 11/18/2002 – Compliance requirements for relocatable power taps or power strips.)

CH2.1.1.4 Be inspected by the user before use for defects such as exposed wiring, loose connections, cracked insulation, missing ground plug, and loose strain reliefs. Discard or repair extension cords found defective. (See NFPA 70 Article 400 for more information.)

CH2.1.1.5 Be kept clear of walkways where they can become a tripping hazard or damaged. Protect cords by placing along a perimeter wall or under protective covers (e.g., floorTrak or floor cable cover).

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CH2.1.1.6 Be permitted for use to support a portable appliance when approved by a Building Manager/Assistant Building Manager. This includes the use of multiple-outlet power strips. (See MWI 8715.11 for more information.)

CH2.1.1.7 Be permitted for the duration of the time needed to support hardware or software development, testing and experiments, maintenance and repair, construction and demolition, and emergencies. (See 29 CFR pt 1910.305(a)(2) for more information.)

*NOTE: The Center's AHJ for NFPA has permitted the use of extension cords and multiple outlet power strips for the duration of the activities.*

CH2.1.1.8 Have an attachment plug that includes a grounding connector.

*NOTE: A ground conductor is not required when the appliance being powered consists of a two-conductor power cord. This is normally only allowed in the office environment.*

CH2.1.1.9 Be discarded or repaired when discovered as being defective. (See NFPA 70, Articles 110.14(B) and 400.36 for more information.)

CH2.1.1.10 Not be attached to building surfaces.

*NOTE: The Center's AHJ has permitted extension cords used in association with communication wiring and equipment to be attached/restrained on fire-treated communication backboards using approved nonmetallic fasteners in communication equipment rooms.*

CH2.1.1.11 Not be allowed for use as a replacement for permanent wiring of a facility or equipment. (See NFPA 70, Articles 400.8, and 590, 29 CFR Part 1910.305(g), 29 CFR pt 1910.399 and OSHA Standard Interpretation Letter 05/05/2006 – Use of flexible cords and cables for wiring in permanent or temporary installations.)

CH2.1.1.12 Not be connected in series (“piggybacked” or “daisy chaining” one power strip or extension cord connected to another power strip or extension cord) in the office environment.

*NOTE: This includes connecting to Uninterruptible Power Supplies (UPS), electrical distribution boxes, and panelboards.*

CH2.1.1.13 Not exceed 15 feet in length when used in the office environment.

CH2.1.1.14 Not be routed under carpet, rugs, through holes in walls, ceilings, floors, doorways, windows, or similar openings.

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## CH2.2 Multiple-Outlet Power Strips

CH2.2.1 Multiple-outlet power strips (surge/spike protectors, relocatable power taps and portable outlets) shall:

CH2.2.1.1 Comply with the requirements listed in section CH2.1 of this MWI.

CH2.2.1.2 Be equipped with a 15 amp circuit breaker, reset switch, and a grounded flexible power cord if a multiple outlet power strip.

*NOTE: The requirement for a 15 amp circuit breaker only applies to multiple outlet power strips purchased after October 23, 2009.*

## CH2.3 Field-Assembled Extension/Flexible Cord Sets

CH2.3.1 The Center's AHJ has permitted the use of field-assembled extension/flexible cord sets to be constructed in support of hardware or software development, testing and experiments, maintenance and repair, construction and demolition, and emergencies where factory-assembled extension/flexible cords are unavailable or unfeasible for use. These extension/flexible cords shall be constructed using NRTL (e.g., UL or FM) approved parts and in accordance with NFPA 70, Articles 100, 310, 400, 400.5(A), 400.14, 29 CFR pt 1910.303(b)(1)(i), 29 CFR pt 1910.305(j) and OSHA Standard Interpretation 06/17/1992 – Acceptable job-made extension cords.

## CH2.4 Extension/Flexible Cord Sets and Receptacles Used on Construction Sites

CH2.4.1 Extension/flexible cord sets used on construction sites shall be used in accordance with NFPA 70, Article 509.4(D), 29 CFR pt 1926.404 and 405, 29 CFR pt 1926.404 (b)(1) and OSHA Standard Interpretation 04/18/1991 – Extension cords connected to permanent wiring of a construction site building.

*NOTE: The preferred method of employee protection is for the extension cord to be protected by a ground-fault circuit interrupter (GFCI) either on the extension cord itself or by a GFCI breaker located in the electrical panel. Building wiring at a construction site is not considered as permanent until the entire building's wiring system has been accepted by the Center's FMO.*

CH2.4.2 Multiple-outlet power strips shall not be permitted for use on construction sites. (See OSHA Standard Interpretation 11/18/2002 – Compliance requirements for relocatable power taps or power strips for more information.)

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## CH2.5 Test and Approval for Use of Field-Assembled Extension/Flexible Cord Sets

CH2.5.1 Field-assembled extension/flexible cord sets shall be assembled and tested for correct phasing (hot-to-hot, neutral-to-neutral, and ground-to-ground) prior to first use by a qualified employee knowledgeable in wiring methods as required by NFPA 70 for electrical equipment.

*NOTE: In an effort to ensure field-assembled extension/flexible cord set are constructed correctly and include NRTL (e.g., UL or FM) approved parts, the Center's AHJ for NFPA can request the following information to be provided from the organization that constructed the field-assembled extension/flexible cord set (1) a sketch of the extension/flexible cord design, (2) a list of the parts used to build the extension/flexible cord, and (3) the method used to verify the extension/flexible cord is assembled and operates correctly. (See NFPA 70, Article 100, "Approved" and 29 CFR pt 1910.399, "Acceptable," for more information.)*

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### CHAPTER 3

## LABELING/MARKING WIRING AND ELECTRICAL EQUIPMENT, AND CONTROLLING UNAUTHORIZED ENTRY INTO ELECTRICAL EQUIPMENT

### CH3.1 Labeling Electrical Equipment

CH3.1.1 Electrical equipment/systems (e.g., switchboards, panelboards, motor control centers, or industrial control panels) shall:

CH3.1.1.1 Be labeled to warn qualified employees of the potential electric arc flash hazards with the available incident energy that will be generated during an electrical arc event or the required level of protective clothing and PPE if they are likely to require examination, adjustment, servicing, or maintenance while energized. (See NFPA 70 Article 110.16 and NFPA 70E Article 130.3 (C) for more information.)

*NOTE: The labels will normally contain the available incident energy that can be generated during an electrical arc event and/or the required level of protective clothing and PPE.*

CH3.1.1.2 Be labeled “DANGER – HIGH VOLTAGE – KEEP OUT” if they operate a 250 V or greater Alternating Current (AC) or Direct Current (DC) and there is potential that employees can come into contact with energized conductors or circuit parts when the doors are opened or the panel covers are removed where and employees can be exposed to energized conductors and parts. (See 29 CFR pt 1910.306(g)(1) for more information.)

CH3.1.1.3 Labeling shall be located so it is clearly visible to the qualified employee before they begin any work on the equipment/systems.

CH3.1.1.4 Labeling shall be of sufficient durability to withstand the environment involved if used to warn qualified employees of the potential electric arc flash hazards.

CH3.1.1.5 Labeling shall be replaced when no longer legible.

### CH3.2 Labeling Inactive Cables/Wiring and Equipment/Systems

CH3.2.1 Cables/wiring that is inactive shall:

CH3.2.1.1 Be removed (if possible), or marked/labeled/tagged to clearly indicate it is abandoned in place or no longer in use. (See NFPA 70, Articles 390.7, 640.6 (C), 645.5, 725.25, 760.3(A), 760.25, 770.25, 770.154(A), 800.25, 800.154(A), 820.25, 820.154(A) and 830.25 for more information.)

*NOTE: Only the portion of the cable/wiring that is accessible is to be removed.*

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CH3.2.1.2 Be marked/labeled/tagged to clearly indicate they have been identified for use in the future.

CH3.2.2 Equipment/systems that are inactive shall be removed or marked/labeled/tagged to clearly indicate it is inactive or no longer in use.

CH3.2.3 The labels/tags used for the identification of cables/wiring and equipment/systems shall be of sufficient durability to withstand the environment involved and replaced when no longer legible.

### CH3.3 Unauthorized Entry Into Electrical Equipment/Systems

CH3.3.1 Unauthorized entry into electrical equipment/systems (e.g., switchboards, panelboards, motor control centers, or industrial control panels) shall be controlled in any manner determined as appropriate by the organization identified as the owner of the electrical equipment. (See OSHA Interpretation Letter – 2005-10/24/2005 – The definition of “readily accessible” does not necessary preclude the locking of the electrical panels, provided those needing ready access are provided a key or lock combination for more information.)

*NOTE: The Center’s FMO is the owner of all building infrastructure electrical equipment and systems.*

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## **APPENDIX A DEFINITIONS**

Arc Blast A pressure wave resulting from arcing.

Arc Flash An electrical short circuit through air when insulation or isolation between electrified conductors is breached, or can no longer withstand the applied voltage. Temperatures can reach up to 35,000 degrees Fahrenheit.

Arc Flash Hazard A dangerous condition associated with the possible release of energy caused by an electric arc. An arc flash can exist when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided the employee is interacting with the equipment in such a manner that could cause an electric arc. Under normal operating conditions, enclosed energized equipment that has been properly installed and maintained is not likely to pose an arc flash hazard. (See NFPA 70E Article 100 for more information.)

Arc Flash Hazard Analysis (HA) A study investigating a worker's potential exposure to arc flash energy, conducted for the purpose of injury prevention and the determination of an electrically-safe work practices, arc flash protection boundary and the appropriate levels of personal protective equipment. (See NFPA 70E Article 130.3 for more information.)

Authority Having Jurisdiction (AHJ) An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, and installation, or a procedure. (See NFPA 70 Article 100 for more information.)

Boundary, Arc Flash Protection When an arc flash hazard exists, an approach limit at a distance from a prospective arc source within which an employee could receive a second degree burn if an electrical arc flash were to occur. (See NFPA 70E, Article 100 for more information.)

Boundary, Limited Approach An approach limit at a distance from an exposed energized-electrical conductor or circuit part within which a shock hazard exists. (See NFPA 70E, Article 100 and Table 130.2 (C) for more information.)

Boundary, Prohibited Approach An approach limit at a distance from an exposed energized-electrical conductor or circuit part within which work is considered the same as making direct contact with the electrical conductor or circuit part. (See NFPA 70E, Article 100 and Table 130.2 (C) for more information.)

Boundary, Restricted Approach An approach limit at a distance from an exposed energized-electrical conductor or circuit part within which there is an increased risk of shock, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part. (See NFPA 70E, Article 100 and Table 130.2 (C) for more information.)

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Buddy System While one person works on the equipment, another person that is trained and able to recognize electrical hazards serves as an attendant. The attendant watches the movements of the person performing the work and warns or alerts them if they get dangerously close to exposed electrical hazards or live conductors, or performs an unsafe act. The attendant also assists the employee in the event of an accident.

Cardiopulmonary Resuscitation (CPR) A procedure designed to restore normal breathing after cardiac arrest that includes the clearance of air passages to the lungs and heart massage by the exertion of pressure on the chest.

Center NASA owned property that has been designated as a NASA Center. In this MWI the Center is MSFC or MAF.

Center's Facilities Management Office (FMO) The Center Office/Department/Branch that provides insight, oversight and coordination of facility operation and maintenance-related issues with internal and external organizations to ensure compliance is maintained with all applicable facility-related Executive Orders, federal, state, local, NASA and Center regulations in accordance with NPR 8831.2. At MSFC these functions are performed by the Office of Center Operations/FMO/AS20. At MAF these functions are performed by the MAF Operations Office/AS60 and the Synergy Achieving Consolidated Operations and Maintenance (SACOM) Environmental Services FMO Department who ensure all facility-related day-to-day functions identified in this MWI for FMO are performed.

Center's Safety Office The Center Office/Department/Branch that provides insight, oversight and Coordination of safety-related issues with internal and external organizations to ensure compliance is maintained with all applicable safety-related Executive Orders, federal, state, local, NASA and Center regulations in accordance with in NPR 8715.1 and NPR 8715.3. At MSFC these functions are performed by the Safety and Mission Assurance (SMA) Directorate/Industrial Safety Branch (ISB)/QD12. At MAF these functions are performed by the MAF SMA Manager/QD12 and the SACOM Safety and Health Services who ensure all safety-related day-to-day functions identified in this MWI for SMA and ISB are performed.

Deenergized (as related to current-carrying parts) Free from any electrical connection to a source of potential difference and from electric charge; not having a potential difference from that of the Earth.

Electrical Hazard A dangerous condition where contact with energized parts or equipment/systems failure can result in electric shock, arc flash burn, thermal burn, or arc blast. (See NFPA 70E, Article 100 for more information.)

Electrical Hazard Analysis (HA) An analysis conducted to identify safety-related work practices when employees are to perform work while being exposed to electrical hazards and normally

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involves conducting a shock HA and arc flash HA. (See NFPA 70E, Article 110.8 and MWI 8715.15 for more information.)

Electrically-Safe-Work Practices Techniques used by the worker when working on electrical equipment to ensure safety of the worker and the equipment/systems. These safe-work practices can include the use of such items as PPE, barriers, insulated tools, and OJT. (See Appendix F of this MWI for more information.)

Electrical Shock Occurs when current passes through the human body.

Electrically-Safe Work Condition A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to ensure the absence of voltage, and grounded if determined necessary. (See NFPA 70E, Article 120, 29 CFR pt 1910.147 and MWI 8715.2 for more information.)

Energized Connected to an energy source, or containing residual or stored energy.

Energized Parts Electric conductors, buses, terminals, or components that are uninsulated or exposed, and where a possibility of a shock hazard exists.

Equipment/Systems A general term used to describe a single or a group of fixtures, components, and devices assembled in connection with an electrical system.

Exposed (as applied to energized electrical conductors or circuit parts) Capable of being inadvertently touched or approached at less than a safe distance; it is applied to electrical conductors or circuit parts that are not suitably guarded, isolated, or insulated.

Flash Hazard A dangerous condition associated with the release of energy caused by an electric arc. (See NFPA 70E, Article 100 for more information.)

Grounded Connected to Earth or to some conducting body that serves in place of the Earth.

Ground-Fault Circuit-Interrupter (GFCI) A device intended for the protection of personnel that functions to deenergize a circuit, or portion thereof, within an established period of time when a current to ground exceeds the established values.

Hazard Analysis (HA) A term used to describe a method or technique used to identify hazards, the hazard cause, the hazard effect (undesired event), and their associated risks for a given equipment or system and for providing the corrective actions to mitigate these hazards and their risks. This level safety assessment is normally conducted for equipment/system identified to have an overall level of risk of high or moderate. (See MWI 8715.15 for more information.)

Hazard/Risk Category A level of hazard this is determined by the following: (1) the voltage level of the equipment; (2) the type of work performed by an employee within a predetermined

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boundary (limited, restricted, or prohibited) to exposed energized-electrical parts operating at 50 V or more where they face risk of being exposed to a shock hazard that has not been reduced to a safe-work level; and (3) identifies the Personal Protective Equipment (PPE) to be worn by the employee that provides protection against electric shock and incurable arc flash burns while performing the work. (See NFPA 70E, Article 130.7 for more information.)

High Voltage Voltages greater than 600 V.

Job Hazard Analysis (JHA) An assessment that focuses on identifying hazards associated with jobs or tasks and taking the necessary actions to eliminate the hazards before they can occur. This level safety assessment is normally conducted for facilities/operations identified to have an overall level of risk of low or minimal. A JHA is sometimes referred to as a JSA or SPA and are similar forms of a JHA, and can serve the same purpose of a JHA if they are specific in identifying the hazardous conditions and the control methods. (See MWI 8715.15 for more information.)

Incurable Arc Flash Burn Burns to the skin that extend into deeper tissues and are normally considered as second and third degree burns.

Mission Critical Equipment/Systems Equipment/systems that form an integral part of a system supporting the International Space Station, or other NASA-required system.

Nationally-Recognized Testing Laboratory (NRTL) An OSHA program in OSHA’s Directorate of Science, Technology, and Medicine. It recognizes private sector organizations as NRTLs, and this recognition signifies that an organization has met the necessary qualifications specified in the regulations for the program. The NRTL determines that specific equipment and materials (“products”) meet consensus-based standards of safety to provide the assurance (required by OSHA) that these products are safe for use in the United States workplace.

Organization Electrical Safe-Work Practices General instructions developed by the organization that contain electrical safe-work practices for the employees to follow while working on electrical equipment. These instructions generally contain less detail than an operating procedure. (See Appendix F of this MWI for more information.)

Owner The organization identified to have primary responsibility for the equipment/system.

Permanent Wiring. Wiring not identified as temporary by NFPA 70 Articles 400 and 590.

Qualified Employee An employee who has received training, possesses the skills and knowledge related to the construction, installation and operation of the electrical equipment/systems, and able to demonstrate electrical safety-related work practices in the recognition and avoidance of electrical hazards directly associated to their job assignments. (See NFPA 70E Article 110.6 and Chapter 1 of this MWI for more information.)

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Research and Development (R&D) An activity in an installation specifically designated for research or development conducted with custom or special electrical equipment. (See NFPA 70E, Article 350.2.)

Shock Hazard Analysis A method or technique used to determine the voltage to which personnel will be exposed, boundary requirements, and the personal protective equipment necessary in order to minimize the possibility of electrical shock to personnel. (See NFPA 70E, Article 130.2 for more information.)

Shock Hazard A dangerous condition associated with the possible release of energy caused by contact or approach to energized parts. (See NFPA 70E, Article 100 for more information.)

Special Test Equipment Equipment designed and built for specific and unique requirements such as providing an interface between the facility-related equipment/systems and the equipment/system used for testing and the test article.

Temporary Wiring. Wiring identified as temporary by NFPA 70 Articles 400 and 590.

Unqualified Employee An employee that has not received training nor has the knowledge and skills related to the construction and operation of the electrical equipment/systems, installations, and the hazards involved when working on electrical equipment. (See NFPA 70E Article 110.6 and Chapter 1 of this MWI for more information.)

Voltage (of a Circuit) The greatest root-mean-square (rms) (effective) difference of potential between any two conductors of the circuit concerned. (See NFPA 70E, Article 100 for more information.)

Voltage (Nominal) A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (e.g., 120/240 V, 277/480 V, or 600 V). The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment. (See NFPA 70E, Article 100 for more information.)

Work Authorization Document (WAD) A control document that authorizes and outlines the scope, purposes, authorization, rules, requirements, techniques, and specific steps to accomplish a work task. Examples include, but are not limited to, process plans, test preparation sheet, discrepancy and correction report, troubleshooting and inspection report, SPA, and engineering change request.

Working On (energized electrical conductors or circuit parts) Coming in contact with energized electrical conductors or circuit parts with hands, feet, or other body parts, tools, probes, or test equipment regardless of the PPE an employee is wearing. (See NFPA 70E, Article 100 for more information.)

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Working On – Diagnostic (testing) Taking readings or measurements of electrical equipment with approved test equipment that does not require making any physical change to the equipment. (See NFPA 70E, Article 100.)

Working On – Repair Any physical alteration of electrical equipment such as making or tightening connections, adding, removing or replacing components. (See NFPA 70E, Article 100 for more information.)

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## **APPENDIX B ACRONYMS**

AC - Alternating Current

AED - Automated External Defibrillator

AHJ - Authority Having Jurisdiction

Amp - Amperage

Cal/cm - Calories/centimeter

CFR - Code of Federal Regulations

CoF - Construction of Facilities

CPR - Cardiopulmonary Resuscitation

DC - Direct Current

FM - Factory Mutual

FMO - Facilities Management Office

FWR - Facility Work Request

GFCI - Ground-Fault Circuit-Interrupter

HA - Hazard Analysis

Hz - Hertz

ISB - Industrial Safety Branch

J/cm - Joule/centimeter

JHA - Job Hazard Analysis

JSA - Job Safety Analysis

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kHZ - Kilohertz

Kohms - Kilohms

kV - Kilovolt

kVA - Kilovolt-Ampere

mA - Milliampere

MAF - Michoud Assembly Facility

MIDL - Marshall Integrated Document Library

MOA - Memorandum of Agreement

MSFC - Marshall Space Flight Center

MWI - Marshall Work Instruction

NFPA - National Fire Protection Association

NPD - NASA Policy Directive

NPR - NASA Procedural Requirement

NRRS – NASA Records Retention Schedules

NRTL - Nationally-Recognized Testing Laboratory

OJT - On-the-job training

OSHA - Occupational Safety and Health Administration

pt - Part

PPE - Personal Protective Equipment

R&D - Research and Development

rms - Root-Mean-Square

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SACOM - Synergy Achieving Consolidated Operations and Maintenance (applicable to MAF)

SHE - Safety, Health and Environmental

SMA - Safety and Mission Assurance

SPA - Safe Plan of Action

TC - Trouble Call

UL - Underwriters Laboratory

UPS - Uninterruptible Power Supplies

V - Volts

W - Watts

WAD - Work Authorization Document

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**APPENDIX C  
VERIFICATION MATRIX**

Section	Brief Description	Verification			Comments
		Inspect	Document	Test	
5.1	General		x		
5.2	Justification for energized electrical work on equipment/systems		x		
5.3	Requesting an MSFC Form 4462		x		
5.4	Requesting an MSFC Form 4462		x		
5.5	Contractor-Issued MSFC Form 4462		x		
5.6	MSFC Form 4462, not required	x			
5.7	Safety Assessment for Energized Electrical Work		x		
5.8	Identifying the Level of Risk and/or Hazard Category		x		
5.9	Selecting and Using Protective Clothing, PPE and Insulating Equipment	x			
5.10	Electrical Work Performed on Organization-Owned, R&D-Related and Hardware Production-Related Equipment/Systems		x		
5.11	Organization Electrically-Safe-Work Practices		x		
5.12	Buddy System	x			

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**APPENDIX D  
RECORDS**

<b>RECORD</b>	<b>REPOSITORY</b>	<b>RETENTION</b>
Electrical Safety Training Records	Maintained per MPR 3410.1	Per MPR 3410.1
MSFC Form 4462 or equivalent NFPA 70E Form	Original maintained by the organization performing the work and attached to FWR, TC, CoF, or other WAD package  At MSFC, Copy maintained by ISB  At MAF, Copy maintained by MSFC Safety and Health Services	NRRS 1/123: destroy on expiration of permit or when superseded.
HA, JHA, JSA, SPA or Workplace Safety Assessment	Original maintained by organization performing the assessment	Per MWI 8715.15
General Organization Electrical Safe-Work Practices	Original maintained by organization performing the work	NRRS 1/72/B/2: destroy when superseded or obsolete.
Operating Procedures	Original maintained by organization performing the operation	Per MWI 8715.15
MOA (authorization permit)	At MSFC, Copy maintained by ISB  At MAF, Copy maintained by MSFC Safety and Health Services  Original maintained by the contractor	NRRS 1/123: destroy on expiration of permit or when superseded.
Records of OJT	Original maintained by supervisor responsible for the position requiring OJT	Per MPR 3410.1

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**APPENDIX E  
MEMORANDUM OF AGREEMENT  
TO ISSUE ENERGIZED ELECTRICAL WORK PERMITS**

**MARSHALL SPACE FLIGHT CENTER**

**SAFETY AND MISSION ASSURANCE (SMA) DIRECTORATE**

**AND**

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SUBJECT: Memorandum of Agreement (MOA) between Marshall Space Flight Center (MSFC) or Michoud Assembly Facility (MAF) and approved Contractor to allow the Contractor to issue the MSFC Form 4462 or an equivalent NFPA 70E electrical energized work permit for work they perform. This permit shall be required for all operations that require an employee to place any part of their body within the limited approach boundary defined in National Fire Protection Association (NFPA) 70E, Article 130.2, Table (C), and perform work on or while being exposed to energized-electrical conductors or circuit parts operating between 50 V and 600 V.

*NOTE: This MOA can also be used to provide approval from the Center's Safety Office for the contractor to perform repetitive tasks that are performed on a routine basis that would otherwise require this permit.*

The approval is based on the following four methods:

- a. The tasks shall not have a risk rating of greater than low risk. (See MWI 8715.1, section 6.3.)
- b. The tasks shall be identified individually.
- c. The tasks shall be accompanied by a hazard assessment conducted in accordance with MWI 8715.15.
- d. The tasks shall have safe-work procedures that are written in sufficient detail to provide enough direction so that the employees can follow the procedure to determine how to safely perform the work.

**PURPOSE:** The intent of this MOA is to establish the responsibilities and relationship between the Center's Safety Office and the contractor providing this service.

**RESPONSIBILITIES:** The Center Director has overall responsibility for ensuring all Center employees, contractors, and visitors are provided with a safe and healthful working environment. The following requirements have been established in the Center's Electrical Safety Program and shall be part of the contractor's Electrical Safety Program. Failure to follow any of these

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requirements can result in terminating the contractor's permission to issue the MSFC Form 4462 or an equivalent NFPA 70E electrical energized work permit for their operations.

This MOA shall be reviewed when changes to this process are identified or annually from date of signature. Failure by the contractor to comply with any requirement in MWI 8715.1 or this MOA shall result in termination of this MOA and any additional action deemed appropriate by the Contracting Officer or Contracting Officer Representative in accordance with the contract requirement and/or the Center's Disciplinary Program.

Specifically, the contractor shall:

1. Ensure all activities that require an employee to place any part of their body in equipment/systems and be within the limited approach boundary defined in NFPA 70E, Article 130, and perform work on or while exposed to energized-electrical conductors or circuit parts are identified.
2. Ensure a hazard assessment is performed for all work identified meeting the above description. The hazard assessment can be performed using any one of the two following methods.
  - a. Hazard Assessment per MWI 8715.15.
  - b. Shock Boundary per NFPA 70E, Article 130.2 and Arc Flash Analysis per NFPA 70E, Article 130.3
3. Ensure Operating Procedures are developed for the work and include safe-work practices and PPE requirements that provide protection against electric shock and incurable arc flash burns.
4. Ensure the employee performing the work is qualified for the level of voltage for which they are to be exposed and has received training in the classroom, on-the-job, or a combination of both that focused on electrical safety-related work practices and the recognition of electrical hazards.
5. Ensure the employee performing the work has the skills and expertise necessary to distinguish exposed energized parts from deenergized parts of electrical equipment and capable of determining the nominal voltage of the energized parts.
6. Ensure the employee has the knowledge and skills necessary to avoid electrical hazards, the use of special precautionary techniques, personnel protective equipment, including arc flash, insulating and shielding materials, and insulated tools and test equipment.
7. Ensure the employee is knowledgeable of the approach distances specified in NFPA 70E, Article 130, Table 103.2 (C) and the corresponding voltages to which a qualified employee can be exposed without wearing additional protection.

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8. Ensure the employee is knowledgeable in accident prevention techniques, methods of first aid emergency procedures, such as approved methods of CPR if their duties warrant such training, and the methods to release a victim from contact with exposed energized conductors or circuit parts.
9. Ensure employees designated to work within areas where they face the risk of receiving an electrical shock that has not be reduced to a safe level shall be receive certification in CPR and AED training if the duties warrant such training. (See MPR 1810.2 for more information.)
10. Ensure NO unqualified employees are allowed to perform work on or be exposed to energized-electrical conductors or circuit parts operating at 50 V or more.
11. Provide a copy of the contractor's Electrical Safety Program, including organization safe-work practices, Hazard Assessments, and Operating Procedures for review.
12. Provide a copy of all issued MSFC Form 4462 or an equivalent NFPA 70E electrical energized work permit to the Center's Safety Office within 5 working days of issuance.
13. The contractor shall NOT issue permits for more than one job at a time or for an extended period of time, such as a permit issued for 3 months.
14. The contractor shall inform the Center's Safety Office of any organization, other than the company listed below, that has been granted permission to issue permits under this MOA.

Company Name: \_\_\_\_\_

Contract Number: \_\_\_\_\_

Company Manager or Business Office  
(print): \_\_\_\_\_

(Signature): \_\_\_\_\_

Phone: \_\_\_\_\_ Date: \_\_\_\_\_

Center Contracting Officer Representative for the above contract

(Print): \_\_\_\_\_

(Signature): \_\_\_\_\_ Date: \_\_\_\_\_

Directorate/Office Director/Manager (or designee)

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*NOTE: This signature is only required if requesting not to issue energized-electrical work permits for tasks performed on a routine basis.*

Organization: \_\_\_\_\_

(Print): \_\_\_\_\_

(Signature): \_\_\_\_\_ Date: \_\_\_\_\_

Contracting Officer for the above contract

(Print): \_\_\_\_\_

(Signature): \_\_\_\_\_ Date: \_\_\_\_\_

Center Safety Office Manager (or designee)

(Print): \_\_\_\_\_

(Signature): \_\_\_\_\_ Date: \_\_\_\_\_

Center Safety and Mission Assurance (SMA) Directorate Director (or designee)

(Print): \_\_\_\_\_

(Signature): \_\_\_\_\_ Date: \_\_\_\_\_

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## **APPENDIX F GENERAL ELECTRICAL SAFE-WORK PRACTICES**

F.1 Deenergize equipment/systems whenever possible, performing work on or while being exposed to energized conductors or circuit parts is to be the last alternative. (See 29 CFR pt 1910.332-335 and NFPA 70E for more information.)

F.2 Employees can face the risk of receiving an electrical shock that have not been reduced to a safe level while performing any of the following:

F.2.1 Taking voltage, current measurements, or any other data measurement.

F.2.2 Moving meter probes from one location to another within the equipment/systems.

F.2.3 Opening electric equipment doors and panels for inspection.

F.2.4 Removing equipment panels and dead fronts.

F.2.5 Opening and closing equipment/systems disconnects and breakers.

F.3 The following safe-work practices are recommended to be followed when employees perform work/tasks where they can face the risk of receiving an electrical shock that have not been reduced to a safe-work level.

F.3.1 Always assume any exposed conductors or circuit parts are energized unless it is proven otherwise by test meters, or by attempting to operate the equipment/systems. Never assume anything without checking it out for yourself!

F.3.2 Be knowledgeable of the construction and operation of the equipment/systems and any potential hazards associated with the work to be performed.

F.3.3 Be qualified and trained to safely perform the required work. This can be by experience gained from performing similar type work and training obtained OJT.

F.3.4 When possible, supervisors are to hold work status meetings to discuss current work activities where employees can be exposed to energized conductors and circuit parts.

F.3.5 When possible, supervisors are to regularly observe their employees while they perform work on or while being exposed to energized conductors and circuit parts to ensure they are performing work in a safe manner.

F.3.6 If the work on the equipment/systems is determined complex or hazardous in nature, refer to MWI 8715.15 to determine the need for a written procedure.

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F.3.7 Perform tests and set-up with the equipment/systems deenergized and/or unplugged when possible.

F.3.8 Always connect/disconnect metering and monitoring connections in cramped or difficult to access locations with the equipment/systems deenergized.

F.3.9 Use only insulated or nonconductive tools when performing work within the limited approach boundary on or while being exposed to energized conductors or circuit parts.

F.3.10 Always use test probes with safety guards or barriers on the tip of the test probes. This can help you avoid accidentally touching a grounded surface and causing a short.

F.3.11 Use barriers or nonconductive material/covers to shield you from accidentally touching exposed energized conductors and circuit parts, when possible. This can be as simple as placing electrical tape over the exposed parts.

F.3.12 If a circuit board or circuit component needs to be removed from its mounted location inside equipment/systems, place insulating material between the board/component and anything it can come into contact with that can cause a short.

F.3.13 Avoid contacting the metal surfaces of the equipment/systems with both hands and never rest on the equipment/systems while taking any measurements. This can prevent you from creating a ground path for electric current to flow through your body from hand to hand.

F.3.14 If both hands are needed, wear a rubber/leather glove on one hand to help keep from providing a direct path to ground.

F.3.15 Wear the PPE that is designed/rated for the work being performed and provides protection against electric shock and incurable arc flash burns. (See NFPA 70E for more information.)

F.3.16 Wear rubber sole shoes/boots and, when possible, use insulated/rubber floor mats.

F.3.17 Wear rubber or leather gloves when possible.

NOTE: Do not wear gloves if they pose a greater hazard than they prevent.

F.3.18 Wear long-sleeved cotton shirts or equivalent slip-on nonconductive sleeves to help prevent the arm from coming into direct contact with exposed conductors or circuit parts.

F.3.19 Wear head protection, such as a nonconductive hard hat, when there is a chance of touching energized parts with your head.

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F.3.20 Wear eye protection, such as safety glasses or goggles and arc rated face shield, when there is a possibility of an arc flash by touching an energized part to ground.

F.3.21 Remove metallic personal items, such as jewelry, watches, necklaces, etc., so they cannot come into contact with exposed energized conductors or circuit parts.

F.3.22 Do not reach blindly or place your hands and arms in any energized equipment/systems where you cannot see.

F.3.23 Do not bypass any interlocks or safety devices that protect against electrical shock except when absolutely necessary.

F.3.24 Ensure there is adequate lighting in the work area to safely perform the work. If possible, move the equipment to another area with better lighting or provide a means of temporary lighting.

F.3.25 Ensure there is adequate clear work area around the equipment. When working in an electrical panel, ensure the panel door can open at least 90 degrees to allow safe access or remove the door entirely.

F.3.26 Do not perform work on or be exposed to energized conductors or circuit parts in wet or damp areas, or in areas that contain flammable or corrosive atmospheres.

F.3.27 When there are exposed-energized circuit parts and you are not working in the equipment/systems, place signs and/or barriers. This can alert others and keep them from accidentally coming into contact with any exposed energized conductors and circuit parts.

F.3.28 Use the buddy system when working on energized equipment/systems deemed hazardous or when you feel it is necessary.

*NOTE: Never touch anyone being shocked or you can also become shocked. To free someone from an electrical shock, disconnect the power or use some type of non-conductive device or method and attempt to hit them with a driving force strong enough to knock them loose from the current (600 V and below).*

F.3.29 Lifting circuit wires or removing mounted and electrically-connected components will not be performed while the equipment/systems are energized.

F.3.30 Ensuring no electrostatic discharge occurs while working on flight hardware can lead to some of the standard safe-work practices being impractical to implement. In these cases, supervisors and employees will ensure extra precautions are implemented.

F.3.31 Do not disturb or tamper with any lock or tag that is placed on an energy isolation mechanism.

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F.4 The table below provides the approximate current rating that can provide an electric shock someone can receive by making contact with an energized circuit for 1 second. The listed current and voltage levels and effects can vary depending on the individual, if the body is damp/dry, or male/female.

**Table 1 Effects of Electric Current on the Human Body  
(All values are approximations)**

Bodily Effect	DC	60 Hz AC	10 KHz AC	Voltage for body resistance 10, 000 Ohms	Voltage for body resistance 1,000 Ohms	Maximum Power - Watts(W)
Slight sensation or faint tingle felt at hand(s).	0.6 - 1.0 Milliampere (mA)	0.3 - 0.4 mA	5 - 7 mA	10 V	1 V	0.01 W
Threshold of perception, slight shock felt, not painful but disturbing. Average individual can let go. Maximum current which is considered harmless.	3.5 - 5.2 mA	0.7 - 1.1 mA	8 -12 mA	50 V	5 V	0.25 W
Painful, but voluntary muscle control maintained. This is called the freezing current or "let go" range.	41 - 62 mA	6 - 9 mA	37 55 mA	100 - 200 V	10 - 20 V	1 - 4 W
Extreme pain, respiratory arrest. Sustained, severe muscular contractions *. Individual "cannot let go" of wires. Death possible.	51 - 76 mA	10.5 - 16 mA	50 - 75 mA	500 V	50 V	25 W
Severe pain. Ventricular interference. Difficulty in breathing.	60 - 90 mA	15 - 23 mA	63 - 94 mA	1000 - 3000 V	100 - 300 V	100 - 900 W
Possible heart fibrillation after 3 seconds.	500 mA	100 mA		60,000 V	6, 000 V	400,000 W

*NOTE: Resistance is measured in ohms.*

F.4.1 The frequency of the AC has a lot to do with the effect on the human body. AC 60 cycle current is more dangerous than higher frequency currents.

F.4.2 AC is more dangerous than DC and likely to cause a victim's heart to fibrillate and cause severe muscular contractions.

F.4.3 The effects of an electrical shock can vary from a slight tingle to immediate cardiac arrest.

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F.4.4 The severity of shock from a given source depends on the currents path through the body.

F.4.5 Results of power frequency current. (See NFPA 70E, Article 340.5 for more information.)

F.4.5.1 At 5 mA, shock is perceptible.

F.4.5.2 At 10 mA, a person may not be able to voluntarily let go of the hazard.

F.4.5.3 At about 40 mA, the shock, if lasting for 1 second or longer, may be fatal due to ventricular fibrillations.

F.4.5.4 Further increasing current leads to burns and cardiac arrest.

F.4.6 Result of DC.

F.4.6.1 A DC current of 2 mA is perceptible.

F.4.6.2 A DC current of 10 mA is considered the threshold of the let-go current.

F.4.7 Results of Voltage.

F.4.7.1 A voltage of 30 V rms, or 60 V DC, is considered safe except when the skin is broken. The internal body resistance can be as low as 500 ohms, so fatalities can occur.

F.4.8 Results of short contact.

F.4.8.1 For contact less than 0.1 second and with currents just greater than 0.5 mA, ventricular fibrillation may occur only if the shock is in a vulnerable part of the cardiac cycle.

F.4.8.2 For contact of less than 0.1 second and with currents of several amperes, ventricular fibrillation may occur if the shock is in a vulnerable part of the cardiac cycle.

F.4.8.3 For contact of greater than 0.8 second and with currents just greater than 0.5 A, cardiac arrest (reversible) may occur.

F.4.8.4 For contact greater than 0.8 second and with currents of several amperes, burns and death are probable.

F.4.9 Results of AC at frequencies above 100 Hertz (Hz).

F.4.9.1 When the threshold of perception increases from 10 Kilohertz (kHz) to 100 kHz, the threshold of let-go current increases from 10 mA to 100 mA.

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F.4.10 Effects of waveshape.

F.4.10.1 Contact with voltages from phase controls usually causes effects between those of AC and DC sources.

F.4.11 Effects of capacitive discharge.

F.4.11.1 A circuit of capacitance of 1 microfarad having a 10 Kilovolt (kV) capacitor charge may cause ventricular fibrillation.

F.4.11.2 A circuit of capacitance of 20 microfarad having a 10 kV capacitor charge may be dangerous and probably cause ventricular fibrillation.

F.5 Dry skin does not conduct electricity very well and, therefore, has a high resistance, about 10 – 100 kilohms (Kohms). Moist skin is a very good electrical conductor, and therefore, has a small resistance, closer to 1 Kohm. Once the skin is broken through (for example, by the burning away of skin), the body presents no more than 500 ohms resistance to current. Table 1 provides approximations of current ratings that can provide an electric shock.

**Table 2 Typical human body resistance to electrical current.**

<b>Body Area</b>	<b>Resistance in ohms</b>
Dry skin	100,000–600,000
Wet skin	1,000
Internal body (hand to foot)	400–600
Ear to ear	≈100

F.6 Electric shock is the leading cause of injuries and death due to electricity.

F.6.1 Electrical injuries consist of four main types:

F.6.1.1 Electrocutation (fatal).

F.6.1.2 Electric shock.

F.6.1.3 Burns.

F.6.1.4 Falls (caused as a result of contact with electrical energy).

F.6.2 Electrocutation (fatal) occurs when the human body is in direct contact with the electrical energy and becomes part of an active electrical circuit that has a lethal amount of current capable of overstimulating the nervous system or causing damage to internal organs.

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F.6.2.1 The extent of injury received from electrical energy depends on the following:

F.6.2.1.1 The current's magnitude (measured in amperage (amp)).

F.6.2.1.2 The pathway of the current through the body.

F.6.2.1.3 The duration of the current flow through the body.

F.6.3 All voltages are considered dangerous, but it is the electrical current that does the damage. Current equals voltage divided by resistance (Current =Voltage/Resistance). The resistance of the human body varies so widely it is impossible to state that one voltage is "dangerous" and another is "safe."

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## **APPENDIX G REFERENCE DOCUMENTS**

G.1 Institute of Electrical and Electronics Engineers Standard 1584, Guide for Performing Arc Flash Hazard Calculations (5.7.2.8)

G.2 National Electrical Safety Codes (5.7.2.8)

G.3 OSHA Standard Interpretation 11/18/2002 – Compliance requirements for relocatable power taps or power strips (CH2.1.1, CH2.1.3 and CH2.4.2)

G.4 OSHA Standard Interpretation 06/17/1992 – Acceptable job-made extension cords (CH2.1.1 and CH2.3.1)

G.5 OSHA Standard Interpretation 04/18/1991 – Extension cords connected to permanent wiring of a construction site building (CH2.1.1 and CH2.4.1)

G.6 OSHA Standard Interpretation Letter 05/05/2006 – Use of flexible cords and cables for wiring in permanent or temporary installations (CH2.1.1 and CH2.1.11)

G.7 OSHA Standard Interpretation Letter – 2005-10/24/2005 – The definition of “readily accessible” does not necessarily preclude the locking of the electrical panels, provided those needing ready access are provided a key or lock combination (CH3.3.1)