1. **Revision Log**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Revision Log | | | | | |
| Revision Level | Revision Date | Section | Description | | Revised By |
| REL | 113016 | ---- | Initial Release | | GR |
| A | 09062017 |  | Updates to Network Section | | GR |
| B | 09/25/19 |  | Mass updates, complete re-write to standard | | NT |
| C | 7/25/20 | 4.8 | Updated Work Instruction file name | | NT |
| D | 9/11/20 | 5.7 | Added new section, 5.7-Waste Control | | NT |
| E | 12/1/23 | Header | Replaced GHSP logo with newer version | | B. Balok |
|  |  |  |  | |  |
|  |  |  |  | |  |
|  |  |  |  | |  |
| Approval: | | CN: RS, FS | | MX: JH | |
| US: JA | | Other (as req’d): DRW | |

1. **Purpose: 目的**

**1.1** To define the global standard for Equipment Installation within GHSP manufacturing facilities.

定义GHSP制造设施内设备安装的全球标准。

1. **Scope: 范围**
   1. This global standard applies to all GHSP manufacturing facilities.

本全球标准适用于所有GHSP生产设施。

1. **Definitions: 定义**
   1. Capital Equipment 固定资产设备
      1. Equipment qualifying as a capital asset is defined as an item with an acquisition cost of $5,000 or more. The acquisition cost of equipment includes installation charges and freight. Capitalized equipment can be identified as having all the following characteristics: Acquisition cost equal to or greater than $5,000.

3.1.1具备固定资产资格的设备定义为采购成本为5,000美元或以上的物品。购置设备的费用包括安装费和运费。固定资产设备定义为具有下列所有特征:购置费用等于或大于$5,000。

* 1. Earth Grounding 接地
     1. The intentional connection to earth through a grounding electrode of sufficiently low impedance to minimize damage to electrical components and prevent an electric shock that can occur from a superimposed voltage from lightning and voltage transients. In addition, earth grounding helps prevent the buildup of static charges on equipment and material. It also establishes a common voltage reference point to enable the proper performance of sensitive electronic and communications equipment.

通过一个阻抗足够低的接地电极与大地连接，以尽量减少对电气元件的损害，并防止雷电和电压瞬变造成的叠加电压造成的触电。此外，接地有助于防止设备和材料上的静电积聚。它还建立了一个共同的电压参考点，保证敏感的电子和通信设备的适当性能。

* 1. Class 1 Circuit 1类电路
     1. The portion of the wiring system between the load side of the overcurrent device or power-limited supply and the connected equipment. These circuits shall be supplied from a source that has a rated output of not more than 30volts and 1000 volt-amperes.

过流装置或限电电源负载侧与被连接设备之间的接线系统部分。这些电路的电源应具有不超过30伏和1000伏安培的额定输出。

* 1. Class 1 Remote-Control and Signaling Circuits 第1类遥控和信号电路
     1. These circuits shall not exceed 600 volts. The power output of the source shall not be required to be limited.

这些电路不应超过600伏。不应要求限制电源的输出功率。

* 1. Class 2 Circuit 2类电路
     1. The portion of the wiring system between the load side of a Class 2 power source and the connected equipment. Due to its power limitations, a Class 2 circuit considers safety from a fire initiation standpoint and provides acceptable protection from electric shock.

第2类电源负载侧与被连接设备之间的接线系统部分。由于其功率限制，第2类电路从火灾引发的角度考虑安全问题，并提供可接受的保护，防止触电。

* 1. Class 3 Circuit 3类电路
     1. The portion of thewiring system between the load side of a Class 3 power source and the connected equipment. Due to its power limitations, a Class 3 circuit considers safety from a fire initiation standpoint. Since higher levels of voltage and current than Class 2 are permitted, additional safeguards are specified to provide protection from an electric shock hazard that could be encountered.

3类电源负载侧与被连接设备之间的接线系统的一部分。由于其功率的限制，第3类电路从起火的角度考虑安全问题。由于允许的电压和电流水平高于第2级，因此规定了额外的保障措施，以防止可能遇到的触电危险。

* 1. Harmonics谐波
     1. Those voltages or currents whose frequencies are integer multiples of the fundamental frequency.

频率为基频整数倍的电压或电流。

* 1. Cable Tray System 电缆桥架系统
     1. A unit or assembly of units or sections and associated fittings made of metal or other noncombustible materials forming a rigid structural system used to support cables. Cable tray systems include ladders, troughs, channels, solid-bottom trays, and other similar structures.

由金属或其他不燃材料制成的单元或单元或部分及相关配件的组合，形成用于支撑电缆的刚性结构系统。电缆桥架系统包括梯子，槽，通道，固体底部托盘，和其他类似的结构。UPS – Uninterruptible Power Supply 不间断电源

* + 1. System used to preserve power to electrical or electronic equipment. Most UPS systems are intended to provide regulated power to prevent power supply fluctuations or aberrations that can damage or cause malfunction of sensitive electrical/electronic equipment such as computers or process controllers.

用于电气或电子设备的电源保持系统。大多数UPS系统旨在提供稳压电源，以防止电源波动或畸变，这些波动或畸变可能损坏或导致敏感的电气/电子设备(如计算机或过程控制器)故障。

* 1. Cord绳索
     1. Two or more flexible insulated conductors enclosed in a flexible covering that provides mechanical protection.

两个或更多的柔性绝缘导线包在可提供机械保护的柔性覆层中。

1. **References:参考**
   1. NFPA 70 – Nation Electrical Code 2017
   2. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance
   3. NFPA 70E – Standard for Electrical Safety in the Workplace
   4. NFPA 77 – Recommended Practice on Static Electricity
   5. NFPA 79 – Electrical Stand for Industrial Machinery
   6. ESDA ANSI/ESD S20.20-2007 Revision of ANSI/ESD S20.20-1999
   7. ESDA Technical Report TR53-01-06
   8. EM-WI-COR-X19-ESD Control Program
   9. ISO 14644-4:2001 Cleanrooms and Associated Controlled Environments Part 4: Design, Construction, and Start-Up
   10. CP-WI-MFG-X301 Global Standard Production Equipment Safety, Ergonomic, and Delivery Checklist
   11. Job Aids (Operating Standards 🡪 Job Aids 🡪8.5-Job-Aids-prod-service 🡪 Global Standards)
2. **Method:方法**
   1. **Electrical 电气**
      1. **Spaces About Electrical Equipment**电气设备的间距
         1. **Working Space.** Working space for equipment operating at 1,000 volts, nominal, or less to ground and likely to require examination, adjustment, servicing, or maintenance while energized shall comply with the dimensions of Table 5.1.

工作空间。工作于1,000伏特、标称电压或更低对地电压的设备，在通电时可能需要检查、调整、维修或维护，其工作空间应符合表5.1的尺寸。

* + - * 1. **Depth of Working Space.** The depth of the working space in the direction of live parts shall not be less than specified in Table 5.1, unless the following requirements are met. Distances shall be measured from the exposed live parts or from the enclosure or opening if the live parts are enclosed.

工作空间的深度。除非满足下列要求，否则带电部件方向上的工作空间深度不应小于表5.1所规定的深度。从暴露的带电部件开始测量距离，如果带电部件是封闭的，则从外壳或开口测量距离。

**Dead-Front Assemblies.** Working space shall not be required in the back or sides of assemblies, such as dead-front switchboards, switchgear, or motor control centers, where all connections and all renewable or adjustable parts, such as fuses or switches, are accessible from locations other than the back or sides. Where rear access is required to work on nonelectrical parts on the back of enclosed equipment, a minimum horizontal working space of 762 mm (30in) shall be provided.

空正面组件。在组件的后面或侧面，如死角开关柜、开关柜或电机控制中心，不要求有工作空间，所有连接和所有可再生或可调节部件，如保险丝或开关，都可以从后面或侧面以外的位置接触到。如果需要在封闭设备背面的非电气部件上使用后方通道，应提供762毫米(30英寸)的最小水平工作空间。

**Low voltage**. Smaller working spaces shall be permitted where all exposed live parts operate at no greater than 30volts rms., 42volts peak, or 60volts dc.

低电压。 在所有暴露的带电部件以不超过30伏均方根的电压工作时，应允许有较小的工作空间。，峰值42伏，或直流60伏。

* + - * 1. **Width of Working Space.** Thewidth of the working space in front of the electrical equipment shall be the width of the equipment or 762mm (30in), whichever is greater. *In all cases, the workspace shall permit at least a 90-degree opening of equipment doors or hinged panels.*

工作空间宽度。电气设备前的工作空间宽度应为设备宽度或762mm(30英寸)，以较大的为准。在所有情况下，工作空间应允许设备门或铰链面板至少90度打开。

* + - * 1. **Height of Working Space.** The workspace shall be clear and extend from the grade, floor or platform to a height of 2.0m (6 ½ ft.) or the height of the equipment, whichever is greater. Within the height requirement of this section, other equipment that is associated with the electrical installation and is located above or below the electrical equipment shall be permitted to extend not more than 150mm (6in) beyond the front of the electrical equipment.

o工作空间高度。工作空间应是干净的，从地面、地板或平台延伸到2.0米(6 12英尺)或设备的高度，以两者中较大的为准。在本节所规定的高度范围内，其他与电气安装有关的、位于电气设备上方或下方的设备，应允许其超出电气设备前部不超过150mm(6英寸)。

* + - * 1. **Limited Access.** Where equipment operating at 1000 volts, nominal, or less to ground and likely to require examination, adjustment, servicing, or maintenance while energized is required by installation instructions or function to be in a space with limited access, all the following shall apply:

接触权限。如果设备对地运行电压为1000伏特，标称电压或更低，并且在通电时可能需要检查、调整、维修或维护，根据安装说明或功能要求处于一个有限的接触空间，则应适用以下所有条件:

**Indoor.** Indoor installations shall comply with the following sections:

♣室内。室内装置须符合下列规定

**Dedicated Electrical Space.** The space equal to the width and depth of the equipment and extending from the floor to a height of 1.8m (6ft) above the equipment or to the structural ceiling, whichever is lower, shall be dedicated to the electrical installation. No piping, ducts, leak protection apparatus, or other equipment foreign to the electrical installation shall be in this zone.

专用电气空间。设备的宽度和深度，从地面延伸至设备上方1.8米(6英尺)的高度或延伸至结构天花板(以较低者为准)的空间，应用于电气安装。该区域内不得有管道、管道、防泄漏装置或其他电气安装以外的设备。

**Foreign Systems.**The area above the dedicated space required shall be permitted to contain foreign systems, provided protection is installed to avoid damage to the electrical equipment from condensation, leaks, or breaks in such foreign systems.

外来系统。专用空间以上的区域应允许容纳外来系统，只要安装了保护措施，以避免此类外来系统因冷凝、泄漏或破裂而损坏电气设备。

**Sprinkler protection.** Sprinkler protection shall be permitted for the dedicated space where the piping complies with this section. •自动喷水灭火保护。在管道符合本节规定的专用空间应允许安装洒水装置。

**Suspended Ceilings.** A dropped, suspended, or similar ceiling that does not add strength to the building structure shall not be considered a structural ceiling.

•悬挂天花板。不增加建筑结构强度的下层、悬挂或类似天花板，不得视为结构天花板。

**Outdoor.** Outdoor installations shall comply with the following section: 户外。户外装置须符合下列规定:

Installed in identified enclosures

•安装在指定的外壳中

Protected from accidental contact by unauthorized personnel or by vehicular traffic. •防止未经授权的人员或车辆意外接触

Protected from accidental spillage or leakage from piping systems •防止意外泄漏或管道系统泄漏

Dedicated equipment space. The space equal to the width and depth of the equipment, an extending from grade to a height of 1.8m (6ft) above the equipment, shall be dedicated to the electrical installation. No piping or other equipment foreign to the electrical installation shall be located in this zone. •专用设备空间。与设备的宽度和深度相等的空间，从设备上方的坡度延伸到1.8米(6英尺)的高度，用于电气安装。此区域内不得安装电气设备以外的管道或其他设备。

**Table 5.1 Working Spaces**

|  |  |  |  |
| --- | --- | --- | --- |
| **Nominal Voltage to Ground** | **Minimum Clear Distance** | | |
| **Condition 1** | **Condition 2** | **Condition 3** |
| 0-150 | 900 mm (3 ft) | 900 mm (3 ft.) | 900 mm (3 ft.) |
| 151-600 | 900 mm (3 ft) | 1.0 m (3 ft. 6 in) | 1.2 m (4 ft.) |
| 601-1000 | 900 mm (3ft) | 1.2 m (4 ft.) | 1.5 m (5 ft.) |

**Condition 1 –** Exposed live parts on one side of the working space and no live or grounded parts on the other side of the working space, or exposed live parts on both sides of the working space that are effectively guarded by insulating materials.

条件1 -工作空间一侧裸露带电部件，工作空间另一侧无带电或接地部件，或工作空间两侧裸露有绝缘材料有效保护的带电部件。

**Condition 2** – Exposed live parts on one side of the working space and grounded parts on the other side of the working space. Concrete, brick, or tile walls shall be considered as grounded.

条件2 -工作空间一侧裸露带电部件，另一侧接地部件。混凝土、砖墙或瓷砖墙应视为接地。

**Condition 3 –** Exposed live parts on both sides of the working space

条件3 -工作空间两侧带电部件外露

* + 1. Each service entrance is to be provided with disconnecting means and overcurrent protection.

每个服务入口均设有隔离装置和过流保护。

* + 1. **Wiring 电线**
       1. For general requirements for wiring methods and materials for wiring installations refer to Article 300 and Article 310 of Chapter 3 of NFPA 70: National Electrical Code. •关于布线方法和布线安装材料的一般要求，请参阅NFPA 70第3章第300条和第310条:国家电气规范。
       2. **Size.** The size of the supply conductor shall be such as to have an ampacity not less than 125 percent of the full load current rating of all resistance heating load plus 125 percent of the full load current rating of the highest rated motor plus the sum of the full load current ratings of all other connected motors and apparatus, based on their duty cycle, that may be in operation at the same time. •尺寸。供应导线的大小应如有载流容量不少于125%的满载额定电流的电阻加热负载加满载额定电流的125%的最高额定电动机加满载电流之和评级连接的所有其他汽车和设备,根据他们的工作周期,可能在操作在同一时间。
       3. **Conductors**. Current-carrying conductors (buses, switches, disconnects, joints, and terminations) and bracing shall be maintained to perform as follows:
          1. Conduct rated current without overheating

Withstand available fault current •

导体。应保持载流导线(母线、开关、断线、接头和端子)和支撑，以执行下列工作:

导通额定电流而不过热

能承受可用的故障电流

* + - 1. **Covers for Wiring System Components.** Covers for wiring system components shall be in place with all associated hardware, and there shall be no unprotected openings. •布线系统组件盖。布线系统组件的盖子应与所有相关硬件安装在一起，并且没有无保护的开口。
      2. **Open Wiring Protection.** Open wiring protection, such as location or barriers, shall be maintained to prevent accidental contact. •开放式布线保护。开放式布线保护，如位置或屏障，应设置成防止意外接触。
      3. **Raceway and Cable Trays.** Raceways and cable trays shall be maintained to provide physical protection and support for conductors. •线管道和电缆托盘。应维护滚道和电缆槽，为导体提供物理保护和支持。
      4. **Cables.** Exposed cables installed along the structure of the equipment, system or machinery shall be permitted. Exposed cables shall be installed to closely follow the surface and structural members of the machinery. •电缆。允许在设备、系统或机械的结构上安装外露的电缆。外露的电缆应紧跟着机械的表面和构件安装。
      5. Cables should be supported by the equipment or system structure as follow: 电缆应由以下设备或系统结构支撑:
         1. In such a manner that the cable will not be damaged by normal equipment use在正常使用设备时，电缆不会被损坏
         2. Every 305mm (12in) in a non-vertical run 每305mm(12英寸)在一个非垂直运行
         3. Every 914mm (36 in) in a vertical run每914毫米(36英寸)在垂直运行
         4. When suspended in air spanning a distance up to 457mm (18in) 悬挂在空中时，跨度可达457毫米(18英寸)
      6. Cables should not be supported by machinery guards that are likely to be removed for maintenance access. 电缆不应该由机械防护罩支撑，因为这些防护罩可能会被拆卸下来进行维护。
      7. Multiple cables shall be permitted to be supported and fastened together in a bundle, provided the method of support and fastening is enough to support the mechanical weight and strain the bundle. •允许将多根钢索支撑并捆绑在一起，前提是支撑和紧固的方法足以支撑钢索的机械重量和张力。
      8. Cables should be fastened with cable mounting clamps or with cable ties supported by any of the following methods: •电缆应用电缆安装夹或电缆系带固定，采用以下任何一种方法:
         1. Screw-on cable tie mounts螺杆式电缆系带安装
         2. Hammer-on cable tie mounting clips锤式电缆系带安装夹
         3. Around the machine or system structural members围绕机器或系统结构构件
         4. Through holes in the machine or system structural members通过机器或系统结构部件上的孔
         5. Other methods identified for the purpose为达到目的而确定的其他方法
      9. The free ends of the cable ties should be cut flush after final adjustment and fastening. Cable ties of the reusable or releasable type should not be permitted for use as a permanent fastening method. •在最后的调整和紧固后，应将电缆系带的空闲端剪平。可重复使用或可释放类型的电缆系带不允许作为永久的固定方法使用。
      10. Cables subjected to physical damage should be protected as follows: •受到物理损伤的电缆应按以下方式保护:
          1. By alternative routing
          2. With additional guarding or railings
          3. When supported by flooring or decking, with walkover or drive over cable protective devices
          4. By installation in a wire way

By installation in a floor or deck covering trapezoidal walk over raceway specifically designed for cable protection

选择替代路线

附加保护或栏杆

o由地板或甲板支撑，带有可行走或可行驶电缆保护装置

o以电线方式安装

o通过安装在地板或甲板上覆盖的梯形走道上，专门为电缆保护而设计

* + - 1. Bends in cables should be made so as not to cause undue stress. The radius is the curve (measured from the inside edge of the bend) shall not be less than five times the diameter of the cable. •电缆应弯曲，以免造成过度应力。弯曲半径(从弯曲的内缘测量)不应小于电缆直径的五倍。
      2. When a cable is used in a length longer than optimally required, the excess cable shall be coiled in loops. The coil shall be fastened to itself and to the machinery structure. •当电缆的使用长度超过最佳要求时，多余的电缆应盘绕成圈。线圈应固定在自身和机械结构上。
      3. Conductors shall be identified at each termination by number, letter, color (either solid or with one or more stripes), or in a combination thereof and shall correspond with the technical documentation. Internal wiring on individual devices purchased completely wired shall not require additional identification. •导体应在每个终止处以数字、字母、颜色(实心或带有一条或多条条纹)或两者的组合进行标识，并应与技术文件相一致。购买的单个设备的内部布线完全布线不需要额外的识别。
      4. Where numbers are used to identify conductors, they shall be Arabic font; letters shall be Roman font (either uppercase or lowercase). •用数字识别导体时，应为阿拉伯字体;字母应为罗马字体(大写或小写)。
      5. **Rigid Conduit and Fittings:** •刚性导管和配件:
         1. The minimum electrical trade size shall be metric designator 16 (trade size ½). 最小电气行业尺寸应为公制16(行业尺寸为12)。
         2. The maximum electrical trade size shall be metric designator 155 (trade size 6). 最大电气行业尺寸应为公制155(行业尺寸6)。
         3. Where conduit enters a box or enclosure, a bushing or fitting providing a smoothly rounding insulating surface shall be installed to protect the conductors from abrasion unless the design of the box or enclosure is such that it provides the same protection. Where conduit bushings are constructed entirely of insulating material, a locknut shall be provided both inside and outside the enclosure to which the conduit is attached. 在导管进入盒或外壳的地方，应安装有平滑圆角绝缘表面的套管或连接件，以保护导线不受磨损，除非盒或外壳的设计能提供同样的保护。如果导管衬套完全由绝缘材料构成，则应在导管连接的外壳内外都配置锁紧螺母。
         4. Conduit bends shall be made in such a manner that the conduit shall not be damaged, and the internal diameter of the conduit shall not be effectively reduced. The radius of the curve of any field bend to the centerline of the conduit shall not be less than shown in Table 5.2. 管弯应以不损坏管的方式制造，且不得有效减小管的内径。任何场弯到导管中心线的曲线半径不得小于表5.2所示。

**Table 5.2 Minimum Radii of Conduit Bends**导管弯的最小半径

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Conduit Size** | | **One-Shot and Full-Shoe Benders** | | **Other Bends** | |
| **Metric Designator** | **Trade Size** | **mm** | **in** | **mm** | **in** |
| 16 | ½ | 101.6 | 4 | 101.6 | 4 |
| 21 | ¾ | 114.3 | 4 ½ | 127 | 5 |
| 27 | 1 | 146.05 | 5 ¾ | 152.4 | 6 |
| 35 | 1 ¼ | 184.15 | 7 ¼ | 203.2 | 8 |
| 41 | 1 ½ | 209.55 | 8 ¼ | 254 | 10 |
| 53 | 2 | 241.3 | 9 ½ | 304.8 | 12 |
| 63 | 2 ½ | 266.7 | 10 ½ | 381 | 15 |
| 78 | 3 | 330.2 | 13 | 457.2 | 18 |
| 91 | 3 ½ | 381 | 15 | 533.4 | 21 |
| 103 | 4 | 406.4 | 16 | 609.6 | 24 |
| 129 | 5 | 609.6 | 24 | 762 | 30 |
| 155 | 6 | 762 | 30 | 914.4 | 36 |

* + - * 1. Conduits shall be securely held in place and supported at each end. 导管应牢固地固定到位，并在两端支撑。Fittings shall be compatible with the conduit and identified for the application. Fittings shall meet the following requirements: 配件应该与管道兼容，并根据应用需要进行标识。配件应满足以下要求:

Fittings and conduits shall be threaded using an electrical conduit die unless structural difficulties prevent assembly. 配件、管道使用螺纹连接除非结构性困难难以组装。

Running threads shall not be used on conduit for connection at couplings. 不得用于管道运行的线程在联轴器连接。

Metallic tubing shall not be threaded金属油管不得用螺纹

Where thread-less fittings are used, the conduit shall be securely fastened to the equipment. 使用thread-less配件,管道应安全地固定在设备。

* + - 1. **Rigid Metal Conduit.** Rigid metal conduit and fittings shall be of galvanized steel or of a corrosion resistant material identified for the conditions of service. 硬质金属导管。硬质金属导管和配件应该是镀锌钢或根据使用条件确定的耐腐蚀材料。
      2. Flexible metal conduit (FMC) and liquid-tight flexible metal conduit (LFMC) minimum electrical trade size shall be metric designator 12 (trade size 3/8). •柔性金属导管(FMC)和液密柔性金属导管(LFMC)最小电气行业尺寸应为公制12(行业尺寸3/8)。
      3. The maximum size of FMC and LFMC shall be metric designator 103 (trade size 4). FMC和LFMC的最大尺寸应为公制103(行业尺寸4)。
      4. FMC and LFMC shall be installed in such a manner that liquids will tend to run off the surface instead of draining toward the fittings. fmc和LFMC的安装方式应该使液体倾向于从表面流出，而不是流向配件。
      5. Wireways (cable trunking systems) external to enclosures shall be rigidly supported and clear of all moving or contaminating portions of the machine. •外罩的电线槽(电缆槽系统)应该有坚固的支撑，并且清除机器所有移动的或污染的部分。
      6. Covers shall be shaped to overlap the sides; gaskets shall be permitted. Covers shall be attached to wireways by hinges or chains and held closed by means of captive screws or other suitable fasteners. On horizontal wireway, the cover shall not be on the bottom. Hinged covers shall be capable of opening at least 90 degrees. 盖板的形状应重叠两侧;应允许使用垫片。盖子应通过铰链或链条连接在电线上，并通过系留螺钉或其他合适的紧固件保持关闭。在水平导线道上，阀盖不能在底部。铰链盖应该能够打开至少90度。
      7. Connection Boxesand other boxes used for wiring purposes shall be readily accessible for maintenance. Those boxes shall provide protection against the ingress of solid bodies and liquids, taking into account the external influences under which the machine is intended to operate. •用于布线的连接盒和其他盒应易于接近，便于维护。考虑到机器运行的外部影响，这些盒子应防止固体和液体进入。
      8. Those boxes shall not have opened unused knockouts or any other openings and shall be constructed to exclude materials such as dust, flyings, oil and coolant. •这些箱体不能打开未使用的隔爆件或任何其他开口，其构造应能排除灰尘、飞升物、油和冷却剂等材料。
      9. **Cable Trays.** Cable trays to be used for cable or raceway support on industrial machines shall be permitted. Cable trays shall be permitted to support the following:

电缆槽。允许用于工业机器上电缆或电缆管道支撑的电缆槽。允许电缆槽支撑以下各项：

* + - * 1. Single conductors 1/0 or larger that are otherwise permitted on industrial machines

工业机器上允许的1/0或更大的单导线

* + - * 1. Multiconductor flexible cables and cables with flexible properties that are otherwise permitted on industrial machines

多导体软电缆和工业机器上允许使用的具有柔性特性的电缆

* + - * 1. Raceways functionally associated with industrial manufacturing systems

与工业制造系统功能相关的电缆管道

* + - * 1. Special conductors and cables that are otherwise permitted on industrial machines.

工业机器上允许使用的特殊导体和电缆。

* + - 1. Cords shall not be installed in cable trays.

电线不得安装在电缆槽中。

* + 1. **Fuses and Circuit Breakers** 保险丝和断路器
       1. **Fuses.** Fusesshall be maintained free of breaks or cracks in fuse cases, ferrules and insulators. Fuse clips shall be maintained to provide adequate contact with fuses. Fuse-holders for current-limiting fuses shall not be modified to allow the insertion of fuses that are not current-limiting. Non-current limiting fuses shall not be modified to allow their insertion into current-limiting fuse-holders.

保险丝。保险丝应保持在保险丝盒、套圈和绝缘体上没有断裂或裂缝。保险丝夹应保持与保险丝充分接触。限流熔断器的熔断器座不得改装为允许插入非限流熔断器。不得修改非限流保险丝，使其能够插入限流保险丝座。

* + - 1. **Molded-Case Circuit Breakers.** Molded-case circuit breakers shall be maintained free of cracks in cases and cracked or broken operating handles.

塑壳断路器。塑壳断路器应保持外壳无裂纹，操作手柄无裂纹或断裂。

* + - 1. **Circuit Breaker Testing After Electrical Faults.** Circuitbreakers that interrupt faults approaching their interrupting ratings shall be inspected and tested in accordance with the manufacturer’s instructions.

电气故障后的断路器测试。中断接近其中断额定值的故障的断路器应按照制造商的说明进行检查和测试。

* + 1. **Extension Cords** 延长线
       1. Before an extension cord is placed into service, the plug and connector should be checked for proper polarity, and the grounding conductor should be tested for continuity and integrity. Extension cords of the proper conductor size should be used to avoid excessive voltage drop, which can result in poor operation and possible damage to the tool. (Table 5.3)

在延长线投入使用前，应检查插头和连接器的极性是否正确，并测试接地导体的连续性和完整性。应使用适当导线尺寸的延长线，以避免过大的电压降，这可能导致不良操作和可能损坏工具。（表5.3）

**Table 5.3 Recommended Extension Cord Sizes for Portable Electric Tools**

便携式电动工具的推荐延长线尺寸

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Extension Cord Length (ft)** | **Nameplate Ampere Rating** | | | | | | | | | | | |
| 0-2.0 | | 2.1-3.4 | | 3.5-5.0 | | 5.1-7.0 | | 7.1-12.0 | | 12.1-16.0 | |
| 115V | 230V | 115V | 230V | 115V | 230V | 115V | 230V | 115V | 230V | 115V | 230V |
| 25 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 16 | 18 | 14 | 16 |
| 50 | 18 | 18 | 18 | 18 | 18 | 18 | 16 | 18 | 14 | 16 | 12 | 14 |
| 75 | 18 | 18 | 18 | 18 | 16 | 18 | 14 | 16 | 12 | 14 | 10 | 12 |
| 100 | 18 | 18 | 16 | 18 | 14 | 16 | 12 | 14 | 10 | 12 | 8 | 10 |
| 200 | 16 | 18 | 14 | 16 | 12 | 14 | 10 | 12 | 8 | 10 | 6 | 8 |
| 300 | 14 | 16 | 14 | 14 | 10 | 14 | 8 | 12 | 6 | 10 | 4 | 6 |
| 400 | 12 | 16 | 10 | 14 | 8 | 12 | 6 | 10 | 4 | 8 | 4 | 6 |
| 500 | 12 | 14 | 10 | 12 | 8 | 12 | 6 | 10 | 4 | 6 | 2 | 4 |
| 600 | 10 | 14 | 8 | 12 | 6 | 10 | 4 | 8 | 2 | 6 | 2 | 4 |
| 800 | 10 | 12 | 8 | 10 | 6 | 8 | 4 | 6 | 2 | 4 | 1 | 2 |
| 1000 | 8 | 12 | 6 | 10 | 4 | 8 | 2 | 6 | 1 | 4 | 0 | 2 |

**Notes:**

1. Size is based on current equivalent to 150 percent of full load of tool and a loss in voltage of not over 5 volts.
2. 尺寸基于相当于刀具满载150%的电流和不超过5伏的电压损失。
3. If voltage is already low at the source (outlet), voltage should be increased to standard, or a larger cord than listed should be used to minimize total voltage drop.
4. 如果电源（插座）处的电压已经很低，则应将电压提高到标准值，或者使用比所列尺寸更大的电源线，以最大限度地降低总电压降。
   * + 1. **Uses.** Flexible cords and flexible cables shall be used only for the following:
       2. 用途。软线和软电缆只能用于以下用途：
          1. Pendants 悬垂型;
          2. Wiring of luminaires 灯具接线
          3. Connection of portable luminaires, portable and mobile signs or appliances

便携式灯具、便携式和移动标志或器具的连接

* + - * 1. Elevator cables 电梯电缆
        2. Wiring of cranes and hoists 起重机和提升的接线
        3. Connection of utilization equipment to facilitate frequent interchange 连接设备使用，方便频繁交换
        4. Prevention of the transmission of noise or vibration

防止噪音或振动的传播

* + - * 1. Appliances where the fastening means and mechanical connections are specifically designed to permit ready removal for maintenance and repair, and the appliance is intended or identified for flexible cord connection

紧固装置和机械连接专门设计为允许随时拆卸以进行维护和修理，并且该装置用于或确定用于软线连接。

* + - * 1. Connection of moving parts 运动部件的连接
        2. Between an existing receptacle outlet and an inlet, where the inlet provides power to an additional single receptacle outlet

在现有的插座和插座之间，插座向另一个单插座供电

* + - 1. **Attachment plugs.** Where used as permitted, each flexible cord shall be equipped with an attachment plug and shall be energized from a receptacle outlet cord connector body.

连接插头。在允许的情况下，每根软线应配备一个连接插头，并由插座电源线连接器主体供电。

* + - 1. **Uses Not Permitted.** Unless specifically permitted, flexible cables, flexible cord sets, and power supply cords shall not be used for the following:

不允许使用。除非特别允许，软电缆、软线组和电源线不得用于以下用途：

* + - * 1. As a substitute for the fixed wiring of a structure

作为结构固定布线的替代品

* + - * 1. Where run through holes in walls, structural ceilings, suspended ceilings, dropped ceilings or floors

穿过墙壁、结构天花板、吊顶、或地板的孔洞

* + - * 1. Where run through doorways, windows, or similar openings

穿过门口、窗户或类似开口的地方

* + - * 1. Where attached to building surfaces

附着在建筑表面的地方

* + - * 1. Where concealed by walls, floors, or ceilings or located above suspended or dropped ceilings

隐蔽在墙壁、地板或天花板上或位于悬挂或下降的天花板上方

* + - * 1. Where installed in raceways

安装在电缆管道中

* + - * 1. Where subject to physical damage

容易受到物理损害的地方

* + - 1. **Splices.** Flexible cord shall be used only in continuous lengths without splice or tap where initially installed in applications permitted by Article 400.10(A) of the NEC

**拼接。软线应仅在NEC第400.10（A）条允许的应用中初始安装的连续长度中使用，无接头或分接头**

* + - 1. Pull at Joints and Terminals. Flexible cords and flexible cables shall be connected to devices and to fittings so that tension is not transmitted to joints or terminals.

拉动接头和端子。柔性电缆和柔性电缆应连接到设备和配件上的，以使张力不会传递到接头或端子。

* + - 1. A flexible cord used with grounding-type utilization equipment should contain an equipment grounding conductor.

与接地型使用设备一起使用的软线应包含设备接地导体。

* + - 1. Attachment plugs and receptacles shall not be connected or altered in a manner that would interrupt continuity of the equipment grounding conductor.

不得以会中断设备接地导体连续性的方式连接或更改附件插头和插座。

* + - 1. **Frequency of Inspection.** Before each use, portable cord- and plug-connected equipment shall be visually inspected for external defects (such as loose parts or deformed and missing pins) and for evidence of possible internal damage (such as a pinched or crushed outer jacket).

检查频率。 在每次使用之前，应目视检查便携式电缆和插头连接的设备是否存在外部缺陷（例如，零件松动或销钉变形和丢失），以及是否存在内部损坏的证据（例如，夹层被挤压或压碎）。

* + - 1. **Defective Equipment.** If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service. No employee should use it until a person(s) qualified to perform the repairs and tests necessary to render the equipment safe has done so.

设备损坏。 如果存在缺陷或损坏迹象，可能会使员工受伤，则应将有缺陷或损坏的物品从服务中移除。 在有资格执行维修和测试以确保设备安全的人员之前，任何员工都不得使用它。

* + - 1. The use of an extension cord shall be limited to individual exposed lengths of 15m (50ft) or less.

延长线的使用仅限于15m（50ft）或更短的裸露长度。

* + - 1. Cord shall be permitted for use with flexible connections to pendant push button stations. Chains or wire rope external to the cord shall support the weight of pendant stations.

应允许将软线用于与悬垂按钮站的柔性连接。 绳索外部的链条或钢丝绳应能支撑悬吊站的重量。

* + - 1. Cord shall be permitted for use with connections involving small or infrequent movements. Cord shall also be permitted to complete connections to normally stationary motors, limit switches, and other externally mounted devices.

电线应允许用于涉及较小或不频繁移动的连接。 还应允许软线完成与正常静止的电动机，限位开关和其他外部安装设备的连接。

* + - 1. **Time Constraints** 时间限制
         1. **During the Period of Construction.** Temporary electric power and lighting installations shall be permitted during the period of construction, remodeling, maintenance, repair or demolition of buildings, structures, equipment, or similar activities

在建设期间。 在建筑物，构筑物，设备或类似活动的建造，改建，维护，修理或拆除期间，应允许临时安装电力和照明设备

* + - * 1. **90 Days.**  Temporary electric power and lighting installations shall be permitted for a period not to exceed 90 days for holiday decorative lighting and similar purposes.

90天。临时电力和照明装置的使用期限不得超过90天，用于节日装饰照明和类似用途。

* + - * 1. **Emergencies and Tests.** Temporary electric power and lighting installations shall be permitted during emergencies and for tests, experiments and developmental work.

紧急情况和测试。在紧急情况下以及测试、实验和开发工作期间，应允许使用临时电力和照明装置。

* + - * 1. **Removal.** Temporary wiring shall be removed immediately upon completion of construction or purpose for which the wiring was installed.

移除。 临时布线应在完成安装的施工或目的后立即拆除。

* + 1. **Installation and Operating Conditions**. The electrical equipment should be installed and operated in accordance with the conditions outlined in the manufacturer’s instructions.

安装和操作条件。电气设备的安装和操作应符合制造商说明书中概述的条件。

* + 1. **Incoming Supply.** Where practicable, the electrical equipment of a machine shall be connected to a single power supply circuit. Where it is necessary to use another supply circuit for certain parts of the equipment (e.g., electronic circuits, electromagnetic clutches), that supply circuit shall, as far as practicable, be derived from devices (e.g., transformers, converters) forming part of the equipment of the machine.

进线电源。在切实可行的情况下，机器的电气设备须连接至单一电源电路。如果需要为设备的某些部分（例如电子电路、电磁离合器）使用另一个供电电路，则该供电电路应尽可能从构成机器设备一部分的装置（如变压器、转换器）中引出。

* + - 1. The incoming supply circuit conductors shall be terminated at the supply circuit disconnecting means, where practicable. Terminals for more than one conductor shall be so identified.

在可行的情况下，输入的供电电路导体应在供电电路断开装置处连接。 多于一根导体的接线端应如此标识。

* + - 1. Where a grounded conductor is used, it should be clearly indicated in the technical documentation of the machine, such as in the installation diagram and in the circuit diagram. A separate insulated terminal shall be provided for the grounded conductor.

如果使用接地导线，则应在机器的技术文件中明确说明，例如在安装图和电路图中。应为接地导线提供单独的绝缘端子。

* + - 1. All terminals for each incoming supply circuit shall be legibly marked and correspond with markings in the technical documentation.

每个输入电源电路的所有端子应清晰标记，并与技术文件中的标记一致。

* + - 1. A grounding terminal shall be provided for each incoming supply circuit.

应为每个输入电源电路提供接地端子。

* + 1. Excepted circuits, the following circuits shall not be required to be disconnected by the main supply circuit disconnecting means:

除电路外，以下电路无需通过主电源电路断开装置断开：

* + - 1. Lighting circuits for lighting needed during maintenance or repair

维护或维修期间所需照明的照明电路

* + - 1. Attachment plugs and receptacles for the exclusive connection of repair or maintenance tools (e.g., hand drills, test equipment)

专用于维修或维护工具（如手钻、测试设备）的连接插头和插座

* + - 1. Under-voltage protection circuits that are not only used for automatic tripping in the event of supply circuit failure

在电源电路发生故障时，用于自动跳闸的欠压保护电路

* + - 1. Circuits supplying equipment that are required to remain energized for satisfactory operation [e.g. temperature-controlled measuring devices, product (work in progress) heaters, program storage devices].

为正常运行而需要保持通电的设备供电的电路[例如温控测量装置、产品（在制品）加热器、程序存储装置]。

* + 1. Where excepted circuits are not disconnected by the supply circuit disconnecting means, permanent safety signs, shall be placed adjacent to the supply circuit disconnecting operating handle, indicating that it does not de-energize all exposed live parts when it is in the open position. And a permanent safety sign shall be placed on a non-removable part inside the control enclosure in proximity to each excepted circuit.

如果电源电路断开装置未断开电路，则应在电源电路断开操作手柄附近放置永久性安全标志，表明其在打开位置时不会使所有外露带电部件断电。而永久性安全标志须放置在控制罩内靠近每个例外电路的不可拆卸部分上。

* + 1. **Accessories 附件**
       1. **Receptacles for Accessory Equipment.** Where the machine or its associated equipment (e.g. handheld power tools, test equipment), the following conditions shall apply:

附属设备插座。当机器或其相关设备（如手持电动工具、测试设备）使用时，应适用以下条件：

* + - * 1. Receptacles mounted external to the enclosure shall be ground-fault circuit-interrupter (GFCI)-protected

安装在外壳外部的插座应采用接地故障断路器（GFCI）保护

* + - * 1. Receptacles shall be supplied from a grounded 120volt ac source.

插座应由接地的120伏交流电源供电。

* + - * 1. Receptacles shall be of the parallel blade grounding type, 125volt, single-phase, 15- or 20-ampere configuration and listed for the applied voltage.

插座应为平行叶片接地型，125V，单相，15或20安培配置，并列出了所用电压。

* + - * 1. All ungrounded conductors connected to the receptacle outlet shall be protected against overcurrent and these circuits shall not be connected to the other machine circuits.

所有连接到插座插座的未接地导线应防止过电流，这些电路不得连接到其他机器电路。

* + - * 1. Where the power supply to the receptacle outlet is not disconnected by the supply disconnecting device for the machine or section of the machine, the safety sign requirements from section 4.8 shall apply.

如果插座的电源未通过机器或机器部分的电源断开装置断开，则第4.8节中的安全标志要求应适用。

* + - * 1. Receptacles shall be suitable for the environment. Receptacles mounted external to the enclosure and subject to dirt, dust, oil, or other contaminants shall be provided with a means to cover the receptacle when the plug is removed.

插座应适合环境。安装在外壳外部且易受灰尘、灰尘、油或其他污染物影响的插座，应在拆除插头时提供覆盖插座的装置。

* + - 1. **Receptacles for Maintenance Personnel.** Receptacles that are part of the industrial machine, either internal or external to the control cabinet and intended for use by maintenance personnel, shall have ground-fault circuit-interrupter (GFCI) protection for personnel.

维修人员用插座。作为工业机器一部分的插座，无论是在控制柜内部还是外部，并由维护人员使用，应为人员提供接地故障断路器（GFCI）保护。

* + 1. **Installation Diagram.** 安装示意图
       1. The installation diagram shall provide all the information necessary for the preliminary work of setting up the machine.

安装图应提供设置机器的初步工作所需的所有信息。

* + - * 1. The specified position of the electrical supply to be installed on site shall be clearly indicated.

现场安装的电源的指定位置应清楚标明。

* + - 1. The data necessary for choosing the type, characteristics, rated currents, and setting of the overcurrent protective device(s) for the supply circuit conductors to the electrical equipment of the machine shall be stated.

应说明选择机器电气设备电源电路导线的类型、特性、额定电流和过电流保护装置设置所需的数据。

* + - 1. Where necessary, the size, purpose and location of any raceways in the foundation that are to be provided by the user shall be detailed.

必要时，应详细说明用户所提供的基础上的任何电缆管道的大小、用途和位置。

* + - 1. The size, type and purpose of raceways, cable trays or cable supports between the machine and the associated equipment that are to be provided by the user shall be detailed.

应详细说明由用户提供的机器和相关设备之间的电缆管道、电缆槽或电缆支架的尺寸、类型和用途。

* + 1. **Protection of Equipment** 设备保护
       1. Overcurrent shall be provided where the current in a machine circuit can exceed either the rating of any component in the circuit or the current-carrying capacity of the conductors in the circuit, whichever is the lesser value.

如果机器电路中的电流可能超过电路中任何组件的额定值或电路中导体的载流容量（以较小值为准），则应提供过电流。

* + - 1. All overcurrent protective devices shall be selected and applied with proper consideration given to, but not limited to, the following:

所有过电流保护装置的选择和应用应适当考虑，但不限于：

* + - * 1. System maximum available fault current at the point of application

应用点的系统最大可用漏电流

* + - * 1. Interrupting rating of the overcurrent protective device

过电流保护装置的开断额定值

* + - * 1. Voltage rating of the system

系统额定电压

* + - * 1. Load and circuit characteristics

Normal operating current

Inrush characteristics

Thermal withstand capability (*I2 t*)

Magnetic withstand capability (*Ip)*

负载和电路特性

正常工作电流

涌流特性

热耐受能力（I2 t）

磁耐受能力（Ip）

* + - * 1. Current limiting ability of the overcurrent protective device

过流保护装置的限流能力

* + - * 1. Coordination of the over-current protective devices to each other

过电流保护装置之间的协调

* + - 1. Overload or loss of cooling of motors. Overload devices shall be provided to protect each motor, motor controller, and branch-circuit conductor against excessive heating due to motor overloads or failure to start.

电机过载或冷却失效。应提供过载装置，以保护每个电机、电机控制器和分支电路导线，防止因电机过载或启动失败而过热。

* + - 1. Ground Faults. 接地故障。
      2. Over-voltages due to lightning. 雷电引起的过电压。
      3. Abnormal temperatures. Resistance heating or other circuits that are capable of attaining or causing abnormal temperatures and, therefore, cause a hazardous condition shall be provided with suitable detection to initiate an appropriate control response

异常温度。电阻加热或其他能够达到或导致异常温度并因此导致危险情况的电路应配备适当的检测装置，以启动适当的控制响应

* + - 1. Loss of or reduction in the supply voltage. Where a supply interruption or a voltage reduction can cause hazardous condition or damage to the machine or to the work in progress, under-voltage protection shall be provided (e.g., to switch off the machine) at a predetermined voltage level. Where only a part of the machine or of the group of machines working together in a coordinated manner is affected by the voltage reduction or supply interruption, the under-voltage protection shall initiate appropriate control responses to ensure coordination.

电源电压损失或降低。如果电源中断或电压降低会对机器或正在进行的工作造成危险条件或损坏，应在预定电压水平下提供欠压保护（例如，关闭机器）。如果只有一部分或一组以协调方式工作的机器受到电压降低或电源中断的影响，欠压保护应启动适当的控制响应，以确保协调。

* + - 1. Over-speed of machines/machine elements.

机器/机器元件超速。

* + - 1. Incorrect phase sequence. Where a phase loss or an incorrect phase sequence of the supply voltage causes a hazardous condition or damage the machine.

相序错误。电源电压的缺相或相序不正确会导致危险情况或损坏机器。

* + 1. **Grounding**. Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintended contact with higher-voltage lines and that will stabilize the voltage to earth during normal operation.

接地。接地的电气系统应以限制雷电、线路浪涌或意外接触高电压线路的方式接地，并在正常运行期间稳定接地电压。

* + - 1. All grounding connections should be inspected for tightness and absence of corrosion.

应检查所有接地连接的紧密性和无腐蚀性。

* + - 1. Mounting hardware shall not be used for terminating conductors used for grounding or bonding.

安装硬件不得用于接地或连接的端接导体。

* + - 1. All parts of the equipment grounding circuit shall be capable of withstanding the highest thermal and mechanical stress that can be caused by fault currents flowing in that part of the circuit. All exposed conductive parts of the electrical equipment and the machine(s) shall be connected to the equipment grounding circuit.

设备接地电路的所有部分应能承受电路中流动的故障电流可能引起的最高热应力和机械应力。电气设备和机器的所有外露导电部件应连接至设备接地电路。

* + - 1. The equipment grounding conductor terminal shall be identified with the word “GROUND”, the letters “GND” or “GRD”, the letter “G”, the color GREEN, or the symbol in the following figure:

设备接地导体端子应标有“接地”、字母“GND”或“GRD”、字母“G”、绿色或下图中的符号：



* + - 1. Equipment grounding conductors and bonding jumpers of the wire type shall not be smaller than shown in Table 5.4 but shall not be required to be larger than the circuit conductors supplying the equipment.
      2. 电线类型的设备接地导线和连接跳线不得小于表5.4中所示的尺寸，但不应要求大于为设备供电的电路导线。

|  |  |
| --- | --- |
| **Table 5.4** Minimum Size of Equipment Grounding Conductors and Bonding Jumpers  设备接地导线和连接跳线的最小尺寸 | |
| Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of the Equipment (Not Exceeding Amperes)  设备前面电路中自动过电流装置的额定值或设定值（不超过安培） | Copper Conductor Size  (AWG or kcmil)  铜导线的尺寸 |
| 10 | 16 |
| 15 | 14 |
| 20 | 12 |
| 30 | 10 |
| 40 | 10 |
| 60 | 10 |
| 100 | 8 |
| 200 | 6 |
| 300 | 4 |
| 400 | 3 |
| 500 | 2 |
| 600 | 1 |
| 800 | 1/0 |
| 1000 | 2/0 |
| 1200 | 3/0 |
| 1600 | 4/0 |
| 2000 | 250 |
| 2500 | 350 |
| 3000 | 400 |
| 5000 | 700 |
| 6000 | 800 |

* + 1. **Grounding Systems, Impedance Testing of Equipment Grounding Conductor**. This test is used to determine the integrity of the grounding path from the point of test back to the source panel or supply transformer. A low impedance grounding path is necessary to facilitate operation of the overcurrent device under a ground fault conditions as well as to provide a zero-voltage reference for reliable operation of computers and other microprocessor based electronic equipment.

接地系统、设备接地导线阻抗测试。本试验用于确定从试验点到电源面板或电源变压器的接地路径的完整性。为方便过流装置在接地故障条件下的运行，以及为计算机和其他基于微处理器的电子设备的可靠运行提供零电压参考，必须有低阻抗接地路径。

* + 1. **Lighting Circuits 照明电路**
       1. One conductor of all machine lighting and maintenance lighting circuits shall be grounded. The grounding conductor shall be identified.

所有机器照明和维护照明电路的一根导线应接地。应标识接地导体。

* + - 1. Where the lighting circuit is supplied by a separate isolation transformer, one terminal of the secondary of the transformer shall be directly connected to the equipment grounding circuit.

如果照明电路由单独的隔离变压器供电，变压器二次侧的一个端子应直接连接到设备接地电路。

* + - 1. The grounding conductor, where run to a screw-shell lamp holder, shall be connected to the screw-shell.

接地导线，在通向螺套灯座的地方，应连接到螺套上。

* + 1. **Testing and Verification** 测试和验证
       1. The verification of the continuity of the equipment grounding circuit shall be conducted and documented. Applicable tests shall be performed where deemed necessary in accordance with the references in the following list:

应对设备接地电路的连续性进行验证并记录。必要时，应根据下表中的参考进行适用试验：

* + - * 1. Verification that the electrical equipment is in compliance with the technical documentation.

验证电气设备是否符合技术文件。

* + - * 1. Insulation resistance test 绝缘电阻测试
        2. Voltage test 电压测试
        3. Protection against residual voltages test

剩余电压保护试验

* + - * 1. Functional test 功能测试
    1. **Continuity of the equipment Grounding Circuit.** Use an impedance measuring device, take into account any impedance in the measuring circuit. The measured impedance shall be 0.1 ohm or less.

设备接地电路的连续性。使用阻抗测量装置，考虑测量电路中的任何阻抗。测量的阻抗应小于等于0.1欧姆。

* + 1. **Insulation Resistance Test.**  The insulation resistance measured at 500volts dc between the power circuit conductors and the equipment grounding circuit shall not be less than 1 megaohm. The test shall be permitted to be made on individual sections of the machine.

绝缘电阻试验。在500伏直流电压下测量的电源电路导体和设备接地电路之间的绝缘电阻不得小于1兆欧。允许对机器的各个部分进行试验。

* + 1. **Voltage tests.** The machine shall withstand without breakdown a test voltage gradually applied from 0 to 1500volts ac or 2121volts dc held at a maximum value for a period of at least 1 second between the conductors of all primary circuits and the equipment grounding circuit. The test voltage shall be supplied from an isolated power supply with a minimum rating of 500volt amperes. Components that are not rated to withstand the test voltage shall be disconnected during testing.

电压试验。机器应能承受在所有一次电路和设备接地电路的导体之间逐渐施加0至1500V ac或212121V dc的试验电压，并保持在最大值至少1秒。试验电压应由最小额定值为500伏安的隔离电源供电。试验期间，应断开额定值不能承受试验电压的部件。

* 1. **Network 网络**
     1. **Installation of Communications Wires, Cables, and Equipment** 通信电线、电缆和设备的安装
        1. **In Raceways, Cable Trays, Boxes, Cables, Enclosures, and Cable Routing Assemblies.**

电缆管道、电缆槽、电缆盒、电缆、外壳和电缆布线组件。

* + - * 1. Communications cables shall be permitted in the same raceway, cable tray, box, enclosure, or cable routing assembly with cables of any of the following:

通信电缆应允许与以下任何电缆敷设在同一电缆管道、电缆槽、电缆箱、外壳或电缆布线组件中：

Class 2 and Class 3 remote-control, signaling, and power limited circuits in compliance with article 645 or parts I and III of article 725 of the NEC

符合NEC第725条第3-5条和第645条第3类远程控制电路

Power-limited fire alarm systems in compliance with parts I and III of article 760 of the NEC

符合NEC第760条第一部分和第三部分的功率限制火灾报警系统

Nonconductive and conductive optical fiber cables in compliance with Parts I and V of article 770 of the NEC

符合NEC第770条第一部分和第五部分的非导电和导电光缆

Community antenna television and radio distribution systems in compliance with parts I and V of article 820 of the NEC.

符合NEC第820条第一部分和第五部分的社区天线电视和无线电分配系统。

Low-power network-powered broadband communications circuits in compliance with Parts I and V of article 830 of the NEC

符合NEC第830条第一和第五部分的低功率网络供电宽带通信电路

* + - * 1. Class 2 and Class 3 Circuits. Class 1 circuits shall not be run in the same cable with communications circuits, in which case the Class 2 and Class 3 circuits shall be classified as communications circuits and shall meet the requirements of this article.

2级和3级电路。1级电路不得与通信电路在同一电缆中运行，在这种情况下，2级和3级电路应归类为通信电路，并应满足本条的要求。

* + - * 1. Electric Light, Power, Class 1, Non-Power-Limited Fire ；Alarm, and Medium-Power Network-Powered Broadband Communications Circuits in Raceways, Compartments, and Boxes. Communications conductors shall not be placed in any raceway, compartment, outlet box, junction box, or similar fitting with conductors of electrical light, power, Class 1, non-power-limited fire alarm, or medium-power network-powered broadband communications circuits.

一级非限功率火灾用电灯、电源；电缆管道、隔间和接线盒内的警报和中等功率网络供电宽带通信电路。通信导线不得放置在任何电缆管道、隔间、出线盒、接线盒或类似配件中，与电灯、电源、1级、非功率限制火灾警报或中等功率网络供电宽带通信电路的导体一起。

* + - 1. **Other Applications**
         1. Communications wires and cables shall be separated at least 50 mm (2 in.) from conductors of any electrical light, power, Class 1, non- power-limited fire alarm, or medium-power network-powered broadband communications circuits. For Exceptions see Article 800.133(A)(2) of the NEC.
         2. **•其他应用**
         3. **通信电线和电缆应与任何电灯、电源、1级、非功率限制火灾警报或中等功率网络供电宽带通信电路的导体至少间隔50 mm（2 in.）。见第133.800条（A）的例外情况。**
    1. Where multiple stations need to be connected into an Ethernet network, a 1Gbps switch should be used.如果需要将多个站点连接到以太网中，则应使用1Gbps交换机。
    2. Wiring termination should use RJ45 Connectors. 接线终端应使用RJ45连接器
    3. Wiring method should follow T-568A or T-568B standard, straight-through when multiple devices in the network or crossover for only two devices connected directly (where no switch is needed). 布线方法应遵循T-568A或T-568B标准，当网络中有多个设备时，应直接通过，或仅为两个设备直接连接（无需交换机）进行交叉。
  1. **Environmental Control**环境控制
     1. Temperature Control shallbe provided for 温度控制应提供：
        1. Processes流程
        2. Equipment and materials材料和设备
        3. Stable conditions for personnel wearing cleanroom garments selected to suit the class of cleanliness specified穿着符合规定清洁等级的洁净室服装的人员的稳定条件
     2. Humidity Control shall be provided for湿度控制需提供
        1. Manufacturing processes制造工艺
        2. Equipment and materials材料和设备
        3. The reduction of electrostatic charges减少静电电荷
        4. Personnel comfort in conjunction with temperature control mentioned above人员舒适度和上述温度控制
     3. In cleanroom installations, humidity control is affected more by external influences (such as weather changes) than by variations in moisture generation within the space. Precautions should be taken to control static electricity effects. If the humidity in a confined space is low, static charges may be higher than in an area with higher humidity. 在洁净室装置中，湿度控制受外部影响（如天气变化）的影响比空间内产生水分的变化更大。应采取预防措施控制静电效应。如果密闭空间内的湿度较低，静电可能比湿度较高的区域高。
     4. Temperature and humidity levels for personnel comfort should be defined for these specific installations. A typical set range for relative humidity is < 65 % R.H. to > 30 % R.H. Outside this range, suitable measures should be considered to meet process and personnel requirements. 应为这些特定装置规定人员舒适的温度和湿度水平。相对湿度的典型设定范围为<65%R.H.～>30%R.H
     5. **Positive Pressure.** Cleanrooms are designed to maintain positive pressure, preventing “unclean” (contaminated) air from flowing inside and less-clean air from flowing into clean areas. The idea is to ensure that filtered air always flows from cleanest to less-clean spaces. In a multi-chambered cleanroom, for instance, the cleanest room is kept at the highest pressure. Pressure levels are set so that the cleanest air flows into spaces with less-clean air. Thus, multiple pressure levels may need to be maintained. A differential air pressure of 0.03 to 0.05 inches water gage is recommended between spaces. In order to ensure that pressure differentials remain constant when doors are opened, or other events occur, control systems must be in place. 正压。洁净室的设计目的是保持正压，防止“不干净”（受污染）的空气流入内部，不太干净的空气流入洁净区。这样做的目的是确保过滤后的空气始终从最干净的空间流向不太干净的空间。例如，在多室洁净室中，最洁净的房间保持在最高压力下。设置压力等级，以便最清洁的空气流入清洁空气较少的空间。因此，可能需要保持多个压力水平。建议空间之间的气压差为0.03至0.05英寸水表。为了确保门打开或发生其他事件时压差保持恒定，必须安装控制系统。
     6. Mechanical vibration should be minimized, or the source isolated, using methods such as high-quality fans and vibration control equipment. 应尽量减少机械振动，或采用优质风机和振动控制设备等方法隔离源。
  2. **Compressed Air**压缩空气
     1. Piping in a loop system is recommended with all piping sloped to accessible drain points. Air outlets should be taken from the top of the main line so that possible moisture will not enter the outlet. 建议所有排水点均采用倾斜管道。出风口应从主管道顶部取下，以免湿气进入出风口。
     2. **Recommended Pipe and System Sizing.** Following is a recommended system sizing procedure: 建议管道和系统尺寸。以下是推荐的系统大小调整步骤：
        1. Locate the mechanical room and layout the locations of compressors and ancillary equipment. 确定机械室的位置并布置压缩机和辅助设备的位置。
        2. Establish a general layout of the system from the storage area to the farthest outlet or use point. Measure the actual distance along the run of pipe to the most remote outlet. Next, add a fitting allowance. For ease of calculations, the addition of 30 percent to the actual measured run will give a conservative approximation of the entire system. Adding the measured length to the fitting allowance will result in the equivalent run of pipe. If a precise calculation is desired, refer to Table 5-5 for the equivalent loss of pressure, in feet, through valves and fittings. 建立从储存区到最远出口或使用点的系统总体布局。测量沿管道走向到最远出口的实际距离。接下来，添加管件余量。为了便于计算，在实际测量运行的基础上增加30%将得到整个系统的保守近似值。将测量的长度添加到管件公差中，将得到等效的管道延伸。如果需要精确计算，参考表5-5，了解通过阀门和配件的等效压力损失（单位：英尺）。
        3. Establish the actual pressure required at the farthest outlet. 确定最远出口处所需的实际压力。
        4. Calculate the allowable total system friction loss计算允许的总系统摩擦损失
           1. It is accepted practice for general use to have a minimum system pressure loss of 10 percent in the pipe. 一般情况下，管道中的最小系统压力损失应为10%。
           2. Divide the total equivalent run of pipe (in hundreds of feet) by the allowable friction loss to calculate the allowable friction loss per 100 feet of pipe. 将管道的总等效长度（以数百英尺为单位）除以允许的摩擦损失，以计算每100英尺管道的允许摩擦损失。
        5. Calculate the connected flow rate for the piping to be sized. In the absence of data from the end user, Table 5-6 provides preliminary data on air usage and pressure. For general use other than the equipment listed, a figure of 1 scfm (30 nL/min) for each outlet is used unless information from the end user indicates otherwise. 计算待确定尺寸的管道的连接流量。在没有来自最终用户的数据的情况下，表5-6提供了关于空气使用量和压力的初步数据。对于所列设备以外的一般用途，除非最终用户提供的信息另有说明，否则每个插座应使用1 scfm（30 nL/min）的数值。
        6. Calculate the expected flow rate for all points using the appropriate diversity factor for all parts of the system. For specific equipment, the duty factor must be determined from the end user. 使用系统所有部分的适当多样性系数计算所有点的预期流量。对于特定设备，负载系数必须由最终用户确定。
        7. With the above information available, the piping system can be sized using the charts for system pressure. Table 5-7 provides a sizing chart for pressure losses through piping for air at various high pressures. 根据上述信息，可使用系统压力图表确定管道系统的尺寸。表5-7提供了各种高压下空气通过管道的压力损失的尺寸表。

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 5-5 Equivalent Pressure Loss Through Valves and Fittings, ft of pipe**表5-5通过阀门和配件的等效压力损失 | | | | | | | | | | | | |
| Nominal Pipe Size, in. 公称管径，英寸。 | Actual ID, in.实际内径 | Gate Valve闸阀 | | Long Radius, All or on Run of Standard Tee | Standard Ell or on Run of Tee Reduced in Size 50 Percent | | Angle Valve | Close Return Bend | | Tee Through Side Outlet | Globe Valve | |
| ½ | 0.622 | 0.36 | | 0.62 | 1.55 | | 8.65 | 3.47 | | 3.10 | 17.3 | |
| ¾ | 0.824 | 0.48 | | 0.82 | 2.06 | | 11.4 | 4.60 | | 4.12 | 22.9 | |
| 1 | 1.049 | 0.61 | | 1.05 | 2.62 | | 14.6 | 5.82 | | 5.24 | 29.1 | |
| 1 ¼ | 1.38 | 0.81 | | 1.38 | 3.45 | | 19.1 | 7.66 | | 6.90 | 38.3 | |
| 1 ½ | 1.610 | 0.94 | | 1.61 | 4.02 | | 22.4 | 8.95 | | 8.04 | 44.7 | |
| 2 | 2.067 | 1.21 | | 2.07 | 5.17 | | 28.7 | 11.5 | | 10.3 | 57.4 | |
| 2 ½ | 2.469 | 1.44 | | 2.47 | 6.16 | | 34.3 | 13.7 | | 12.3 | 68.5 | |
| 3 | 3.068 | 1.79 | | 3.07 | 6.16 | | 42.6 | 17.1 | | 15.3 | 85.2 | |
| 4 | 4.026 | 2.35 | | 4.03 | 7.67 | | 56.0 | 22.4 | | 20.2 | 112.0 | |
| 5 | 5.047 | 2.94 | | 5.05 | 10.1 | | 70.0 | 28.0 | | 25.2 | 140.0 | |
| 6 | 6.065 | 3.54 | | 6.07 | 15.2 | | 84.1 | 33.8 | | 30.4 | 168.0 | |
| 8 | 7.981 | 4.65 | | 7.96 | 20.0 | | 111.0 | 44.6 | | 40.0 | 222.0 | |
| 10 | 10.020 | 5.85 | | 10.00 | 25.0 | | 139.0 | 55.7 | | 50.0 | 278.0 | |
| 12 | 11.940 | 6.96 | | 11.0 | 29.8 | | 166.0 | 66.3 | | 59.6 | 332.0 | |
| **Notes**: 1ft = 0.3m; 1 in = 25.4mm | | | | | | | | | | | | |
| **Table 5-6 General Air Requirements for Tools**表5-6工具的一般空气要求 | | | | | | | | | | | |
| **Tool or Equipment工具或设备** | | | **Size or Type** | | | **Air Pressure气压, psig** | | | **Air Consumed, 耗气量scfm** | | |
| Hoists起重设备 | | | 1 ton | | | 70-100 | | | 1 | | |
| Blow guns气枪 | | |  | | | 70-90 | | | 3 | | |
| Bus or truck lifts | | | 14,000-lb cap | | | 70-90 | | | 10 | | |
| Car lifts | | | 8,000-lb cap | | | 70-90 | | | 6 | | |
| Car rockers | | |  | | | 70-90 | | | 6 | | |
| Drills, rotary | | | ¼-in. cap | | | 70-90 | | | 20-90 | | |
| Engine, cleaning | | |  | | | 70-90 | | | 5 | | |
| Grease guns | | | 6 | | | 70-90 | | | 4 | | |
| Grinders | | | 2-in. wheel | | | 70-90 | | | 50 | | |
| Grinders | | | 4-in. wheel | | | 70-90 | | | 20 | | |
| Paint sprayers | | | Production gun | | | 40-70 | | | 20 | | |
| Spring oilers | | |  | | | 40-70 | | | 4 | | |
| Paint sprayers | | | Small hand | | | 70-90 | | | 2-10 | | |
| Riveters | | | Small to large | | | 70-90 | | | 10-35 | | |
| Drills, piston | | | ½-in. cap, 3-in. cap | | | 70-90 | | | 50-110 | | |
| Spark plug cleaners | | | Reach 36-45 | | | 70-90 | | | 5 | | |
| Carving tools | | |  | | | 70-90 | | | 10-15 | | |
| Rotary sanders | | |  | | | 70-90 | | | 50 | | |
| Rotary sanders | | |  | | | 70-90 | | | 30 | | |
| Tire changers | | |  | | | 70-90 | | | 1 | | |
| Tire inflators | | |  | | | 70-90 | | | 1 ½ | | |
| Tire spreaders | | |  | | | 70-90 | | | 1 | | |
| Valve grinders | | |  | | | 70-90 | | | 2 | | |
| Air hammers | | | Light to heavy | | | 70-90 | | | 30-40 | | |
| Sand hammers | | |  | | | 70-90 | | | 25-40 | | |
| Nut setters and runners | | | ¼-in. to ¾-in. cap | | | 70-90 | | | 20-30 | | |
| Impact wrenches / screwdrivers | | | Small to large | | | 70-90 | | | 4-10 | | |
| Air bushings | | | Small to large | | | 70-90 | | | 4-10 | | |
| Pneumatic doors | | |  | | | 40-90 | | | 2 | | |
| File and burr tools | | |  | | | 70-90 | | | 20 | | |
| Wood borers | | | 1-2 in. | | | 70-90 | | | 40-80 | | |
| Rim strippers | | |  | | | 100-120 | | | 6 | | |
| Body polishers | | |  | | | 70-90 | | | 2 | | |
| Carbon removers | | |  | | | 70-100 | | | 3 | | |
| Sand blasters | | | Wide variation | | | 90 | | | 6-400 | | |
| **Notes:** 1psi = 6.9kPa; 1cfm = 0.03 m3/min | | | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 5-7 High-Pressure Compressed Air Friction Loss Table**表5-7高压压缩空气摩擦损失表 | | | | | | | | | | | | |
| Cfm | Pressure Loss Through Schedule 40 Steel Pipe, feet | | | | | | | | | | | |
| ½-in. diameter | | | ¾-in. diameter | | | 1-in. diameter | | | 1 ¼-in. diameter | | |
| At 125 psi | At 175 psi | At 250 psi | At 125 psi | At 175 psi | At 250 psi | At 125 psi | At 175 psi | At 250 psi | At 125 psi | At 175 psi | At 250 psi |
| 6 | 0.102 | 0.075 | 0.054 | 0.023 |  |  |  |  |  |  |  |  |
| 8 | 0.181 | 0.133 | 0.096 | 0.041 | 0.030 |  |  |  |  |  |  |  |
| 10 | 0.283 | 0.208 | 0.149 | 0.064 | 0.047 | 0.034 | 0.017 |  |  |  |  |  |
| 15 | 0.636 | 0.469 | 0.336 | 0.144 | 0.106 | 0.076 | 0.038 | 0.028 |  |  |  |  |
| 20 | 1.131 | 0.833 | 0.597 | 0.255 | 0.188 | 0.135 | 0.067 | 0.050 | 0.036 | 0.016 |  |  |
| 25 | 1.768 | 1.302 | 0.933 | 0.399 | 0.294 | 0.211 | 0.105 | 0.078 | 0.056 | 0.025 | 0.019 |  |
| 30 | 2.546 | 1.875 | 1.344 | 0.574 | 0.423 | 0.303 | 0.152 | 0.112 | 0.080 | 0.037 | 0.027 |  |
| 35 | 3.465 | 2.552 | 1.829 | 0.782 | 0.576 | 0.413 | 0.206 | 0.152 | 0.109 | 0.050 | 0.037 | 0.026 |
| 40 | 4.526 | 3.333 | 2.388 | 1.021 | 0.752 | 0.539 | 0.270 | 0.199 | 0.142 | 0.065 | 0.048 | 0.034 |
| 45 | 5.728 | 4.218 | 3.023 | 1.292 | 0.952 | 0.682 | 0.341 | 0.251 | 0.180 | 0.083 | 0.061 | 0.044 |
| 50 | 7.071 | 5.208 | 3.732 | 1.596 | 1.175 | 0.842 | 0.421 | 0.310 | 0.222 | 0.102 | 0.075 | 0.054 |
| 60 | 10.183 | 7.499 | 5.374 | 2.298 | 1.692 | 1.213 | 0.607 | 0.447 | 0.320 | 0.147 | 0.108 | 0.078 |
| 70 | 13.860 | 10.207 | 7.315 | 3.128 | 2.303 | 1.651 | 0.826 | 0.608 | 0.436 | 0.200 | 0.147 | 0.105 |
| 80 |  | 13.331 | 9.554 | 4.085 | 3.008 | 2.156 | 1.079 | 0.794 | 0.569 | 0.261 | 0.192 | 0.138 |
| 90 |  | 16.872 | 12.092 | 5.170 | 3.807 | 2.729 | 1.365 | 1.005 | 0.721 | 0.330 | 0.243 | 0.174 |
| 100 |  | 20.830 | 14.928 | 6.383 | 4.700 | 3.369 | 1.685 | 1.241 | 0.890 | 0.408 | 0.300 | 0.215 |
| 125 |  |  | 23.325 | 9.973 | 7.344 | 5.263 | 2.633 | 1.939 | 1.380 | 0.637 | 0.469 | 0.336 |
| 150 |  |  |  | 14.361 | 10.576 | 7.579 | 3.792 | 2.793 | 2.001 | 0.918 | 0.676 | 0.494 |
| 175 |  |  |  |  | 14.395 | 10.316 | 5.162 | 3.801 | 2.724 | 1.249 | 0.920 | 0.659 |
| 200 |  |  |  |  | 18.801 | 13.474 | 6.742 | 4.965 | 3.558 | 1.632 | 1.202 | 0.861 |
| 225 |  |  |  |  |  | 17.053 | 8.533 | 6.284 | 4.503 | 2.065 | 1.521 | 1.090 |
| 250 |  |  |  |  |  | 21.054 | 10.534 | 7.757 | 5.559 | 2.550 | 1.878 | 1.346 |
| 275 |  |  |  |  |  | 25.475 | 12.746 | 9.387 | 6.727 | 3.085 | 2.272 | 1.628 |
| 300 |  |  |  |  |  | 30.317 | 15.169 | 11.171 | 8.006 | 3.671 | 2.704 | 1.938 |
| 325 |  |  |  |  |  |  |  | 13.110 | 9.396 | 4.309 | 3.173 | 2.274 |
| 350 |  |  |  |  |  |  |  | 15.505 | 10.867 | 4.997 | 3.680 | 2.637 |
| 375 |  |  |  |  |  |  |  | 17.454 | 12.509 | 5.736 | 4.224 | 3.027 |
| 400 |  |  |  |  |  |  |  | 19.859 | 14.232 | 6.527 | 4.806 | 3.445 |
| 425 |  |  |  |  |  |  |  | 22.419 | 16.067 | 7.368 | 5.426 | 3.889 |
| 450 |  |  |  |  |  |  |  |  | 18.013 | 8.260 | 6.083 | 4.360 |
| **Notes**: 1FT = 0.3M; 1in. = 25.4 mm; 1psi = 6.9kPa. | | | | | | | | | | | | |

* + 1. **Hose and fittings.** Most tools use flexible hose to connect to the piping system, and the hose used is usually larger than the air inlet port on the tool it serves. Table 5-8 indicates generally accepted practice for the selection of supply hose based on the size on the inlet port. When the length of the hose extends more than 20 feet (6m), one size larger should be used to allow for the additional friction loss. It is good practice to limit the friction loss within the hose to approximately 5psig. (Refer to Table 5-9 for pressure loss through various sizes and lengths of hose) 软管和配件。大多数工具使用柔性软管连接到管道系统，所使用的软管通常比它所服务的工具上的进气口大。表5-8显示了根据入口尺寸选择供应软管的一般公认做法。当软管长度超过20英尺（6米）时，应使用更大的尺寸，以考虑额外的摩擦损失。最好将软管内的摩擦损失限制在5psig左右。（各种尺寸和长度软管的压力损失见表5-9）

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Table 5-8 Selection of Supply Hose Size**表5-8供给软管尺寸的选择 | | | | |
|  | Air Inlet Port NPT, in. | | | |
|  |  |  |  |
| Supply Hose Size ID, in. 供给软管尺寸内径，英寸 |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 5-9 Friction Loss for Hose, psi**表5-9软管的摩擦损失，psi | | | | | | | | | | | | | | |
| **Free Air Flow, scfm** | **6 ft, 1/8 in.** | **8 ft, 5/32 in.** | **8 ft, 1/4 in.** | **8 ft, 5/16 in.** | **8 ft, 3/8 in.** | **12.5 ft, 1/2 in.** | **25 ft, 1/2 in.** | **50 ft, 1/2 in.** | **25 ft, 3/4 in.** | **50 ft, 3/4 in.** | **8 ft, 5/32 in. 25 ft, 1/2 in.** | **8 ft, 1/4 in. 50 ft, 1/2 in.** | **12.5 ft, 1/2 in. 25 ft, 3/4 in.** | **12.5 ft, 1/2 in. 50 ft, 3/4 in.** |
| 2 | 3.5 | 1.2 |  |  |  |  |  |  |  |  | 1.3 |  |  |  |
| 3 | 7.3 | 2.7 |  |  |  |  |  |  |  |  | 2.8 |  |  |  |
| 4 | 12.5 | 4.4 |  |  |  |  |  |  |  |  | 4.6 |  |  |  |
| 5 |  | 6.7 |  |  |  |  |  |  |  |  | 6.9 |  |  |  |
| 6 | 9.3 | 9.3 |  |  |  |  |  |  |  |  | 9.7 | 1.2 |  |  |
| 7 |  | 12.4 | 1.3 |  |  |  |  |  |  |  | 12.9 | 1.6 |  |  |
| 8 |  |  | 1.6 |  |  |  |  |  |  |  |  | 2.1 |  |  |
| 10 |  |  | 2.5 |  |  |  |  |  |  |  |  | 3.2 |  |  |
| 12 |  |  | 3.5 | 1.3 |  |  |  |  |  |  |  | 4.5 |  |  |
| 15 |  |  | 5.3 | 2.0 |  |  |  | 1.1 |  |  |  | 6.9 |  |  |
| 20 |  |  | 9.0 | 3.4 | 1.4 |  | 1.0 | 1.9 |  |  |  | 11.8 |  |  |
| 25 |  |  | 13.8 | 5.1 | 2.2 |  | 1.5 | 3.0 |  |  |  |  | 1.3 | 1.5 |
| 30 |  |  |  | 7.3 | 3.1 | 1.1 | 2.1 | 4.2 |  |  |  |  | 1.8 | 2.1 |
| 35 |  |  |  | 9.8 | 4.1 | 1.5 | 2.9 | 5.6 |  |  |  |  | 2.5 | 2.8 |
| 40 |  |  |  | 12.5 | 5.3 | 2.0 | 3.7 | 7.1 |  | 1.0 |  |  | 3.2 | 3.7 |
| 45 |  |  |  |  | 6.6 | 2.5 | 4.6 | 8.9 |  | 1.2 |  |  | 4.0 | 4.6 |
| 50 |  |  |  |  | 8.1 | 3.0 | 5.6 | 10.9 |  | 1.5 |  |  | 4.9 | 5.6 |
| 55 |  |  |  |  | 9.7 | 3.6 | 6.7 | 13.0 |  | 1.8 |  |  | 5.9 | 6.8 |
| 60 |  |  |  |  | 11.5 | 4.3 | 7.9 |  | 1.1 | 2.1 |  |  | 7.0 | 8.0 |
| 70 |  |  |  |  |  | 5.7 | 10.6 |  | 1.4 | 2.8 |  |  | 9.4 | 10.7 |
| 80 |  |  |  |  |  | 7.3 | 13.6 |  | 1.9 | 3.6 |  |  | 12.1 | 13.9 |
| 90 |  |  |  |  |  | 9.2 |  |  | 2.3 | 4.5 |  |  |  |  |
| 100 |  |  |  |  |  | 11.2 |  |  | 2.8 | 5.5 |  |  |  |  |
| 120 |  |  |  |  |  |  |  |  | 4.0 | 7.7 |  |  |  |  |
| 140 |  |  |  |  |  |  |  |  | 5.4 | 10.3 |  |  |  |  |
| 160 |  |  |  |  |  |  |  |  | 6.9 | 13.3 |  |  |  |  |
| 180 |  |  |  |  |  |  |  |  | 8.7 |  |  |  |  |  |
| 200 |  |  |  |  |  |  |  |  | 10.6 |  |  |  |  |  |
| 220 |  |  |  |  |  |  |  |  | 12.7 |  |  |  |  |  |
| **Note:** Based on 95-psig air pressure at hose inlet, includes normal couplings (quick-connect coupling will increase pressure losses materially). Hose is assumed to be smooth. Air is clean and dry. If an airline lubricator is upstream from the hose, pressure loos will be considerably higher. Pressure loss varies inversely as the absolute pressure (approximately). Probably accuracy is believed to be ±10 percent. Use on-half of indicated value for air at 50 psig. 注：基于软管入口的95 psig空气压力，包括普通联轴节（快速连接接头将大大增加压力损失）。假设软管是光滑的。空气干净干燥。如果空气润滑器在软管的上游，压力损失将相当高。压力损失与绝对压力（近似值）成反比。可能准确度被认为是±10%。对于50 psig的空气，使用指示值的一半。 | | | | | | | | | | | | | | |

* 1. **ESD静电释放**
     1. This section applies to activities that manufacture, process, assemble, install, package, label, service, test, inspect, transport or otherwise handle electrical or electronic parts, assemblies and equipment susceptible to damage by electrostatic discharges greater than or equal to 100 volts HBM (Human Body Model). 本节适用于制造、加工、组装、安装、包装、标签、服务、测试、检查、运输或以其他方式处理易受大于或等于100伏HBM（人体模型）静电放电损坏的电气或电子零件、组件和设备的活动。
     2. **Grounding / Equipotential Bonding Systems.** Grounding / Equipotential Bonding Systems shall be used to ensure that ESDS items, personnel and any other conductors (e.g., mobile equipment) are at the same electrical potential. An implementing process shall be selected from Table 5-10. 接地/等电位连接系统。应使用接地/等电位连接系统，以确保ESD项目、人员和任何其他导体（如移动设备）处于相同的电位。实施过程应从表5-10中选择。

|  |  |  |  |
| --- | --- | --- | --- |
| **Table 5-10 Grounding / Equipotential Bonding Requirements**表5-10接地/等电位联结要求 | | | |
| Technical Requirement技术要求 | Implementing Process实施过程 | Test Method测试发方法 | Required Limit(s)要求极限 |
| Grounding / Bonding System接地/等电位联结 | Equipment Grounding Conductor设备接地导线 | ANSI/ESD S6.1 | < 1.0 ohm impedance<1.0欧姆阻抗 |
| Auxiliary Ground辅助接地 | ANSI/ESD S6.1 | < 25 ohms to the Equipment Grounding Conductor<25欧姆至设备接地导体 |
| Equipotential Bonding等电位联结 | ANSI/ESD S6.1 | < 1.0 x 109 ohms1 |
| 1The maximum resistance between any ESD technical element and the common connection point. 任何ESD技术元件和公共连接点之间的最大电阻。 | | | |

* + - 1. For details on test methods and instrumentations that can be used to verify the performance of ESD protective equipment and materials refer to ESD Association Technical Report TR53-01-06. 有关可用于验证ESD保护设备和材料性能的试验方法和仪器的详细信息，请参考ESD协会技术报告TR53-01-06。
    1. **Discharge of Stored Energy.** Capacitors shall be provided with a means of discharging stored energy. 储存能量的释放。电容器应配备放电储存能量的装置。
    2. **Time of Discharge.** The residual voltage of a capacitor shall be reduced to 50volts, nominal, or less within 1 minute after the capacitor is disconnected from the source of supply. 放电时间。电容器的残余电压应在电容器与电源断开后1分钟内降低至标称50伏或以下。
    3. **Means of Discharge.** The discharge circuit shall be either permanently connected to the terminals of the capacitor or capacitor bank or provided by automatic means of connecting it to the terminals of the capacitor on removal of voltage from the line. Manual means of switching or connecting the discharge circuit shall not be used. 排放方式。放电电路应永久性地连接到电容器或电容器组的端子上，或者在线路电压被移除时，通过自动方式将其连接到电容器的端子上。不得使用手动方式切换或连接放电电路。
  1. **Flooring地板**
     1. Anti-fatigue ergonomic flooring shall be used at all Work Centers, where operators are present. 所有工作中心应使用抗疲劳人体工学地板，其中操作员在场。
     2. If any operator in the Work Center will be handling an electronic part, ESD safe flooring shall be used for the whole Work Center. 如果工作中心的任何操作员要处理电子部件，整个工作中心应使用防静电地板。
     3. Flooring shall be black in color, with a yellow ramped border. 地板应为黑色，带有黄色斜边。
     4. Preferred Brands首选品牌

*Selection outside the preferred brand requires approval by the Advanced Process Engineer and Global Standards Team*在首选品牌之外进行选择需要高级工艺工程师和全球标准团队的批准

* + - 1. Wearwell Wearwell公司
         1. Reference Job Aid参考工作帮助
  1. **Waste Control**废物控制
     1. Trash垃圾
        1. Trash cans/bins for general trash items shall be available for Operators. 应为操作员提供一般垃圾物品的垃圾桶/垃圾箱。
        2. Trash can/bins will be emptied per each plants standard. 垃圾桶/垃圾箱将按照每个工厂的标准清空。
     2. Recycled Materials再生材料
        1. Bins will be provided for any recyclable materials. 应为任何可回收材料提供垃圾箱。
        2. Bins will be taken to “Green Zone” (where available) and material will be placed in correct gaylord or on correct pallet. 料仓将被带到“绿色区域”（如有），材料将放置在正确的地方或正确的托盘上。
     3. For any components used on the line, that have a backer or some type of protective flim that is peeled off of the component, there must be a method to dispose of the of the backer/film. Components that potentially have this are Gaskets, Emblems, Lenses, etc. 对于在生产线上使用的任何组件，如果组件上有衬垫或某种类型的保护膜，则必须有一种处理衬垫/薄膜的方法。可能存在这种情况的部件包括垫圈、标志、透镜等。
        1. Recommended configuration推荐配置
           1. 2” – 2.5” diameter vacuum system with a hose running to a linen bag直径为2“–2.5”的真空系统，软管连接至亚麻袋
           2. System is sensor triggered by the operator’s hand系统是由操作员手触发的传感器
        2. Preferred Brands首选品牌

*Selection outside the preferred brand requires approval by the Advanced Process Engineer and Global Standards Team在首选品牌之外进行选择需要高级工艺工程师和全球标准团队的批准*

* + - * 1. Exair检验

1. **Records:** N/A记录：不适用