

16 ELECTRICAL - V16000**16.1 GENERAL****16.1.1 Description**

This section identifies minimum requirements that shall be met for all electrical applications in the design and construction of elements for Arlington County Building Design Standards.

16.1.2 Related Arlington County Standards, Specification and Policies

including, but not limited to, those listed in Table 16.1.2

Table 16.1.2 Applicable Standards and Specifications
Arlington County Zoning Ordinance (ACZO)
Arlington County Code (Code of the County of Arlington County, Virginia) (ACC)
Arlington County Building Energy Performance Targets for County-owned and – managed buildings
Arlington County Government Street Light Policy and Planning Guide
Arlington County Government Department of Technology Services Network Infrastructure Standards (6/19/2015)
DAS TECHNICAL SPECIFICATIONS (see Appendix C, page C-92)

16.1.3 Quality Assurance

16.1.3.1 Reserved

16.1.4 Applicable Standards and Specifications

including, but not limited to, those listed in Table 16.1.4

Table 16.1.4
EPA Energy Star®
ICC International Building Code/2012
ICC International Energy Conservation Code/2012
The Illuminating Engineering Society of North America (IES)
National Electric Code (NEC)
National Fire Protection Association (NFPA)
NFPA 70E-2012
Occupational Safety and Health Administration (OSHA)
OSHA 1910.333,335
US Green Building Council's Leadership in Energy and Environmental Design (LEED) green building rating system

16.1.5 Submittals

16.1.5.1 The Registered Design Professional shall identify, in the specification sections, manufacturer's products, descriptions, energy efficiency, performance criteria,

16.2.1 REGISTERED DESIGN PROFESSIONAL COORDINATION

materials, components, fabrication, source quality control, finish, and accessory materials pertaining to all Electrical work.

- 16.1.5.2 On a case by case basis the County will determine if the project specifications shall require the Contractor to provide drawings for all electrical work and load calculations which shall be signed and sealed by a PE licensed in the Commonwealth of Virginia.

16.2 DESIGN

16.2.1 Registered Design Professional Coordination

- 16.2.1.1 New services where possible a three-phase four wire 277/480 volt main service is preferred. A circuit breaker coordination study shall be provided with the final sizing of the service. All Building wiring shall comply with the requirements of the current version of the National Electrical Code (NEC). Breakers shall not be the kind that trip on a power loss unless this is specifically required by code.
- 16.2.1.2 Trapeze mounted transformers *are* Not Acceptable.
- 16.2.1.3 Main Switchboard/Switchgear or the Main Distribution Panel (MDP) and sub panels shall be provided with at least 25% spare capacity and spaces for future use.
- 16.2.1.4 Specifications shall require installation of electric demand meters/monitors as part of the Building Automation System.
- 16.2.1.5 Electrical Distribution
The Registered Design Professional shall compose the Specification in accordance with the requirements of Table 16.2.1.5.

Table 16.2.1.5 Electrical Distribution - Owner's Project Requirements	
Building Element	Requirement
Cable - Metal-Clad (armored)	The use of metal-clad (armored) cable is only acceptable at equipment and/or fixture terminations.
Cable - Metal-clad and plenum-rated	The use of metal-clad and plenum-rated cable is only acceptable in minor renovations in concealed locations and with approval of Arlington County Project Officer.
Conductor – Electrical	The use of aluminum cable/wire as an electrical conductor is Not Acceptable. Provide only copper cable/wire.
Conduit - Electrical	All electrical conduit including low voltage shall run in rigid conduit or electric metallic tubing (EMT).

- 16.2.1.6 Dedicated data and Communication Room shall be provided separate from the electrical rooms or supply closets. No electrical transformers or distribution panels shall be permitted in data or Communication Room. All data and Communication Rooms shall be provided with receptacles that are powered by the emergency Generator circuit if available.
- 16.2.1.7 The Registered Design Professional shall confirm design conditions at schematic design phase in the project and submit all electrical load calculations for review by the

16.2.2 SUBMISSION REQUIREMENTS FOR ELECTRICAL DRAWINGS

Arlington County Project Officer. The County and Architect/Engineer shall meet to determine what options shall be evaluated and to review costs/benefits of various design alternatives. The Registered Design Professional shall provide the County an annual energy budget based upon computer simulations.

16.2.1.8 Motor’s efficiency shall be Premium Efficiency.

16.2.2 Submission Requirements for Electrical Drawings

16.2.2.1 Specifications shall require the designer to prepare 1/4 inch = 1 foot scale equipment layout drawings of all electrical and data/communications closets/rooms.

16.2.2.2 Specifications shall require the installing Electrical Contractor to provide 1/4 inch = 1 foot scale layouts of all electrical and Communication Rooms with actual equipment sizes.

16.2.2.3 The layout drawings shall show all equipment, using the basis of design for equipment sizing, showing Switchboard/Switchgear, Main Distribution Panel (MDP), panel boards and transformers, cable tray and conduit routing, fire protection, lighting and all other appurtenances in the room.

16.2.2.4 The design shall provide for code-mandated and manufacturers recommend clearances around all equipment, but in no case shall be less than 36 inches. Only for renovations and no minimum clearance requirement, clearances less than 36 inches will be considered due to architectural and design priorities and/or existing site conditions on a case by case basis by the Arlington County Project Officer. Drawings shall indicate layout and clearances for the largest and heaviest equipment included in the design and specifications. At a minimum, the Registered Design Professional team shall design around three manufacturers.

16.2.2.5 The design shall indicate, at each submission, required accessibility clearances and all structural supports for all electrical equipment, control panels and other items such as walk ways, cat walks and access doors etc requiring access. Panels shall be mounted so that access to breakers does not require a ladder.

16.2.2.6 Indicate on each panel schedule as “Fed from -----“. This designation shall be required to be shown on typed panel schedules posted on the panels in the field by the installing electrical Contractor.

16.2.2.7 Arc Flashing Prevention: Provide Arc Flashing analysis and proper labeling of the electrical equipment and clearances marked on the floor complying with OSHA 1910.333,335 and NFPA 70E-2012.

16.2.3 Generator & Transfer Switches

16.2.3.1 The Registered Design Professional shall include a Generator in the design of new a building or a significant renovation of an existing Building and in addition to Building code requirement when the facility contains the Building Elements or systems listed in Table 16.2.3.1

Table 16.2.3.1 Requirements for a Generator
Buildings that provide space for the Office of Emergency Management (OEM) with an emergency support function or shelter in place.

**Table 16.2.3.1
Requirements for a Generator**

Buildings with a Safe Haven operation
Fire Stations
If the Building is for County Network a Hub Site.
Network Operations Center (NOC)
Refrigerators and freezers used by DHS, OEM, ACFD and ACPD that store blood, emergency food supplies, medical supplies and equipment related to emergency supply for water.

- 16.2.3.2 When a Generator is required for a new Building or a significant renovation of an existing Building and in addition to Building code requirements, the Building Elements & Systems listed in Table 16.2.3.2 shall be connected to the Generator and to meet load demands.

**Table 16.2.3.2
Building Elements & Systems Connected to Generator**

BAS/EMCS Systems
Closed-circuit television (CCTV)
Communication Room HVAC equipment (Refer to pg. D-112 , BDVI, Appendix D - COMMUNICATION ROOM STANDARDS)
Distributed Antenna System (DAS) (Refer to pg. C-92, BDVI, Appendix C - DAS TECHNICAL SPECIFICATIONS)
Door access system
<u>Elevators</u>
Emergency lighting in Transformer Vaults, Switchgear Rooms, Elevator Machine Rooms and Mechanical Rooms.
Emergency Services: Building Elements, Systems including HVAC and all other electrical loads defined by the County for Buildings that provide space for Office of Emergency Management (OEM) with an operational function for Emergency Services
Emergency Shelters and “Shelter in place” Buildings
Fire sprinkler system (for pumps and other equipment), if required by code
Fire Stations: All Building loads with County approved load diversity factor
Freeze Protection: All heating system pumps, and related control systems to maintain freeze protection.
Life Safety and Fire Alarm Systems including emergency lighting, exit lighting and fire alarm system power supplies

16.2.3 GENERATOR & TRANSFER SWITCHES

Table 16.2.3.2 Building Elements & Systems Connected to Generator	
	Network Routers if the network is used to monitor fire alarm systems
	Security System
	Security systems and power supplies for building (Refer to pg. 13-48, BDVI Chapter 13 SPECIAL EQUIPMENT - V13000)
	Sewer ejector pumps
	Smoke exhaust fans
	Sump pumps
	Telephone switches (where applicable)
	Wheelchair lifts

- 16.2.3.3 The emergency Generator system where applicable, shall be designed such that load shedding is not required. (The *Registered Design Professional* shall be responsible for designing the emergency and standby power Engine/Generator of sufficient capacity and rating for the anticipated maximum simultaneous load in accordance with NEC 700.5(A) and NEC 701.6.) Connected loads shall meet the code requirements and other operational requirements. Provide twenty-five percent (25%) spare capacity above the Generator safety factor to carry future loads unless directed otherwise by the County.
- 16.2.3.4 The emergency Generator system where applicable, shall be designed such that load shedding is not required. Connected loads shall meet the code requirements and other operational requirements. Provide twenty percent (25%) spare capacity above the Generator safety factor to carry future loads unless directed otherwise by the County.
- 16.2.3.5 Generators less than 150kW in size, other than those that serve Fire Stations, shall be fueled by natural gas where available. All other Generators shall be fueled by ultra low sulfur fuel oil (Diesel). Generator runtime shall be determined on a project by project basis. Fuel ports and fill pipes shall be industry standard and shall extend to location adjacent to driveway or other agreed to location with approval of Arlington County Project Officer. It is preferred that Generators be installed at ground level. In the case where this is not practicable, only natural gas Generators shall be installed on roof tops.
- 16.2.3.6 All Generator equipment located on the exterior of the Building shall be set back and screened in accordance with the Arlington County Zoning Ordinance and the Arlington County Code where applicable.
- 16.2.3.7 The Generator shall include the following items:
- 16.2.3.7.1 The Jacket Water Heater shall be provided with a set of water shutoff valves to facilitate jacket water hose and heater replacement without the necessity of draining the engine coolant system.
 - 16.2.3.7.2 The full instrumentation shall include as minimum: RPM, Engine Water Temp, Engine Oil Press., Engine Oil Temp., Fuel Level, Run Hrs. on the Generator display. Provide a “Red Mushroom Emergency Stop Button” on

16.2.3 GENERATOR & TRANSFER SWITCHES

the engine control panel. Depression of this emergency stop button shall trip the main circuit breaker.

- 16.2.3.7.3 The Generator shall have BACnet and capable of communicating with the building BAS/EMCS.
- 16.2.3.7.4 The main circuit breaker shall be provided with auxiliary contacts to indicate light and alarm “not in the auto position” on the engine control panel and the Remote Generator Annunciator Panel (RGAP) and the BMS/EMCS. The panel shall show all failures in the *Generator*. Locate the RGAP as directed by the County in an occupied location.
- 16.2.3.7.5 The Generator shall be required to meet Arlington County Noise Ordinance Requirements at the property line. The Registered Design Professional shall provide documentation to the County indicating compliance with County Ordinance.
- 16.2.3.7.6 A 60 amp single phase load center with a main circuit breaker integral to the Generator shall be specified and shown nearest to the engine control panel inside the protective housing and shall be factory hard wired for the jacket water heater, battery charger and the 20- amp duplex receptacle which shall be located on the side of the engine control panel inside the Generator housing. Provide two additional spare 15 AMP breakers one for the purpose of wiring the day tanks controls and the other for future use. Provide the remaining as spaces in the panel.
- 16.2.3.7.7 Locate the Generator exhaust as far away as is possible from the Building air intakes, but not less than twenty (20) feet. The Generator muffler shall be located inside the outdoor Generator set enclosures.
- 16.2.3.7.8 Specifications shall require the Contractor to conduct an on-site Field load bank performance test with unity power factor in accordance with NFPA-110 requirements for all new emergency Generators witnessed by the project engineer or his designee. A minimum of two day notice shall be provided to the Arlington County Project Officer to schedule the test.
- 16.2.3.7.9 Provide a 24 (twenty four) light LED RGAP. A separate 1” conduit with 28 #14 wires shall be provided from the engine control panel to the RGAP. The RGAP shall comply with the requirements of NFPA 110 with extra lights as optional on all projects as specified Table 16.2.3.7.9. Additional lights may be added as required by specific needs of the project.

Table 16.2.3.7.9
Extra Lights for LED RGAP

Light Description
Battery Charger A/C Failure Alarm
Breaker Tripped Over Current Alarm
Circuit Breaker Closed
Circuit Breaker Open
Day Tank Trouble Alarm

Table 16.2.3.7.9 Extra Lights for LED RGAP
Light Description
Engine Running
Fuel Day Tank – High
Fuel Day Tank – Low
Generator Fault (Trouble)
Generator Running
Ground Fault Alarm
High Oil Press Alarm -High
Main Breaker Switch On in Auto Position
Main Circuit Breaker “OFF” position
Oil Press Alarm - Low
Oil Press Warning - Low
Over Crank Alarm
Panel Should Also have alarm sound silence button and lamp test button
Power - Normal
Spare
Spare
Voltage Alarm - High
Voltage Alarm - Low
Water Temp Alarm – High
Water Temp Warning - low
Water Temp Warning – High

- 16.2.3.7.10 Provide a separate 1” conduit with 6 #12 wires for control wires from the ATS to the Generator Engine Control Panel for the purpose of providing start-Stop controls and any other future controls.
- 16.2.3.7.11 Multiple Automatic Transfer Switches are required at all locations where load exceeds 100 amps. All control wires shall be brought to a common junction box located nearest the Life Safety Automatic Transfer Switch and terminated on a strip inside this junction box. One set of control wires shall be connected to the Generator start-stop controls from this junction box.
- 16.2.3.7.12 All transfer switches over 200 amps shall be close transition switches.
- 16.2.3.7.13 All transfer switches shall have manual start-up for testing the Generator and manual transfer of the load. Shall also include hardware and software necessary to record event history, shall have BACnet communication capable or MODbus only if BACnet is not available from manufacturer.

- 16.2.3.7.14 The Generator and the Automatic Transfer Switch shall have a 5 year manufacturer's full parts and labor warranty. The installation Contractor shall provide a one year labor warranty with a response time of two hours, 24/7.
- 16.2.3.7.15 O&M training for Emergency & Standby Generators and Automatic Transfer Switches shall be conducted by a certified training instructor provided by the manufacturer and shall be performed onsite after startup when all the tests are completed and accepted. Training for the County's owners/ occupiers for these systems shall be at least four hours and shall be conducted by O&M Generator Maintenance Staff.
- 16.2.3.7.16 Proprietary Emergency & Standby Generator and Automatic Transfer Switch diagnostic tool shall be provided by the installer.
- 16.2.3.7.17 ATS Maintenance Bypass: Normal bypass test and service at the automatic transfer switch shall be performed without disrupting power to the load. The equipment should be capable of providing the test bypass and complete isolation of the automatic transfer switch without opening the doors of the cabinet. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.

16.2.4 Roll Up Generators

Roll Up Generators: where the Building conditions and the Facilities Management Bureau require roll up Generator provisions, the following shall be met:

- 16.2.4.1 Roll-up Generator provisions shall be provided for Generator installations or replacements at new and existing Buildings.
- 16.2.4.2 A lockable 3 – position manual transfer switch (MTS) shall be located upstream of the ATS to allow selection between the permanent or rollup Generator.
- 16.2.4.3 A cam-lock quick-connect and all other connections enclosure suitable for outdoor use shall be provided at location adjacent to the anticipated location of the roll up Generator.
- 16.2.4.4 Property sized electrical outlets shall be provided next to the quick-connect enclosure to provide power for roll up Generator battery charger and jacket heater(s). Generator start control circuit shall be integrated with the MTS.
- 16.2.4.5 The MTS shall have provisions for position monitoring.

16.2.5 Lighting

- 16.2.5.1 Lighting shall be designed to meet current NEC ASHRAE/IES luminance levels for the appropriate space type (e.g. as foot candle levels), while also meeting current ICC International Energy Conservation Code/2012 power density limitations.
- 16.2.5.2 The mechanical and the electrical room lighting shall be on the standby emergency Generator.
- 16.2.5.3 Day lighting or indoor electrical illumination should comply with current IES recommended light levels.

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- 16.2.5.4 Occupancy sensors to automatically shut off lights for offices, conference rooms, storage rooms, gymnasiums, and other appropriate spaces shall be provided.
 - 16.2.5.5 Emergency Exit lights shall be Light Emitting Diode (LED) type.
 - 16.2.5.6 Light fixtures used as HVAC diffusers are Not Acceptable.
 - 16.2.5.7 Task lighting may be provided to supplement ambient lighting where appropriate.
 - 16.2.5.8 Decorative, accent and neon lighting unless specifically required for the space application as determined by the County on a case by case basis are Not Acceptable.
 - 16.2.5.9 Dimming systems unless specifically required for the space application as determined by the County on a case-by-case basis are Not Acceptable. If a dimming system is designed it shall be part of the Building BAS/EMCS and not a separate stand alone system.
 - 16.2.5.10 Track lights, mono, twin rail, low voltage decorative lights are not recommended and their use shall be determined by the County on a case-by-case basis.
 - 16.2.5.11 Incandescent fixtures are Not Acceptable.
 - 16.2.5.12 All fluorescent tube fixtures shall be provided with lamps and electronic ballasts. Recommended light fixtures are: 2 x 4 lay-in with parabolic louvers, three tubes (277 volts).
 - 16.2.5.13 Lighting in atrium areas or in high ceiling areas shall utilize light-emitting diode (LED) when possible. When LED fix fixtures are not suitable, use induction lighting, or fluorescent fixtures with remote ballasts located in a properly ventilated area.
 - 16.2.5.14 Remote ballasts shall be grouped in a space with sufficient size and ventilation to support the equipment and shall be readily accessible for maintenance purposes.
 - 16.2.5.15 Buildings with remote ballasts shall have a floor plan affixed to the remote ballast location showing the corresponding ballast and lamp locations and a copy shall be installed in a permanent placard in the electrical main service equipment room.
 - 16.2.5.16 Programmable ballast shall be used were appropriate.
 - 16.2.5.17 Lighting in high bay areas such as garages, gymnasiums or warehouses shall use pendant type LED lighting, induction lighting, or high output fluorescent fixtures and shall be readily accessible for maintenance purposes. Safety chains shall be provided on each fixture and cord and plug connections are preferred. Where Emergency *Generators* supply the power provide striker lights in the fixtures for instantaneous illumination in accordance with Life Safety Code requirements for emergency egress.
 - 16.2.5.18 In libraries where stack lighting is to be used, it is preferred that lights are located to facilitate access for maintenance with a 10 foot ladder.
 - 16.2.5.19 It is preferred that lighting fixtures will be accessible for maintenance with a ten-foot stepladder. Appropriate mechanical lifts with suitable in Building storage shall be provided as part of the project scope for fixtures installed in high ceiling areas or atriums and that cannot be accessed with a 10 foot ladder.
 - 16.2.5.20 Where appropriate all exterior lighting shall be controlled by photocell controls. The lighting controls, clocks and photo controls shall be located in the main electrical room. All circuits for exterior lighting shall be routed in conduit.

16.2.6 GROUNDING, BONDING AND LIGHTNING PROTECTION

- 16.2.5.21 Exterior lighting fixtures shall be dark sky type, high efficiency and have glass lenses efficiency. Exterior Lighting shall be controlled by the Building BAS/EMCS of one is installed or a time clock, astronomical type with auto adjusting to daylight saving and standard time in series with a photocell.
- 16.2.5.22 Where appropriate, the fuel site lighting and the power should be on the emergency Generator.
- 16.2.5.23 Light fixtures and sprinkler heads located in athletic facilities, gymnasiums, multipurpose rooms used as gymnasiums, and other similar types of facilities or rooms affected by ball fight or other similar activity shall provide shockproof and impact resistant features such as locking landholders, inverted tempered glass diffusers set in flush steel frames, protective cages or provide barriers to withstand impact and not be affected by ball fight or other similar activity.
- 16.2.5.24 The light fixtures in gymnasiums shall be recessed between the open steel trusses for added protection from balls and other objects.

16.2.6 Grounding, Bonding and Lightning Protection

- 16.2.6.1 Provide grounding bar for all data and Communication Rooms.
- 16.2.6.2 Contractor must submit detailed as-built drawings for the building grounding system with certification. As-built drawings must show rod sizes, locations, and configuration and connection details. The Contractor shall obtain a UL certification for the grounding system and submit a copy of the certificate to the Registered Design Professional for review and approval before final submission to the Arlington County Project Officer.
- 16.2.6.3 Contractor must submit detailed as-built drawings for the lightning protection system with UL certification. As-built drawings must show down-rod locations, conductor routing and conductor connections sites. It is the installing Contractor's responsibility to provide a bond for the lightning protection system with the main grounding grid or main grounding bar. The Contractor shall obtain a certification for the lightning protection system and submit a copy of the certificate to the Registered Design Professional for review and approval before final submission to the Arlington County Project Officer.

16.2.7 Communication Room

- 16.2.7.1 Communication Rooms for telephone, data, cable television, etc., must be separate from electrical rooms. Transformers or electrical distribution panels located in Communication Rooms is Not Acceptable.
- 16.2.7.2 Refer to the Building Design – Vertical Infrastructure - COMMUNICATION ROOM STANDARDS (Appendix D) pg. D-112, Building Design - Vertical Infrastructure Chapter 16 ELECTRICAL - V16000, Section 16.2.7 Communication Room for information on Communication Room design criteria.

16.2.8 Exterior Conduits

Shall be installed in a way that does not affect the exterior aesthetics of the Building and shall not be installed in the front of the Building. Previous authorization from the FMB is needed when installation of exterior conduits is necessary at an existing facility. Conduits shall be metallic, water tight and painted to match Building façade per manufacturer recommendations.

16.2.9 Housekeeping Pads

A concrete House Keeping Pad shall be provided for each piece of floor mounted electrical equipment.

- 16.2.9.1 Concrete housekeeping pads for ground mounted equipment shall be oversized by a minimum of 36 inches on all sides of the equipment and a minimum of 4" inches high.

16.3 PRODUCTS**16.3.1 Emergency Standby Generator**

Brand Name(s) for Building Element in accordance with Table 16.3.1 The Specification shall identify a minimum of three (3) Brand Names (manufactures) that comply with the Owner's Project Requirements used for the Invitation to Bid, unless the Brand Name Category listed as No Substitutions.

Table 16.3.1 <i>Brand Name Product(s) for the Basis of Design</i>			
Building Element	Brand Name(s)	Brand Name Model	Brand Name - Category
Automatic Transfer Switch	Asco, Caterpillar, Cutler Hammer/Onan/Cummins & Russell Electric		No Substitutions
Emergency Standby Generator	Caterpillar, Kohler, MTU & Onan/Cummins		No Substitutions
Engine	Detroit	V-12 engine	Not Acceptable

16.3.2 Electrical Main Service

Brand Name(s) for Building Element in accordance with Table 16.3.2 The Specification shall identify a minimum of three (3) Brand Names (manufactures) that comply with the Owner's Project Requirements used for the Invitation to Bid, unless the Brand Name Category listed as No Substitutions.

Table 16.3.2 <i>Brand Name Product(s) for the Electrical Main Service</i>			
Building Element	Brand Name(s)	Brand Name Model	Brand Name - Category
Main distribution panels, sub panels and disconnects	Cutler Hammer, Siemens, and Square D		No Substitutions Cutler Hammer type PB panels are preferred with bolt in breakers. The type PB panels give flexibility by accepting both bolt-in and push-in breakers. Provide one stock circuit breaker for each type installed.

Main Distribution Panels	FPE and Challenger		Not Acceptable
Motor Control Centers	General Electric, Siemens and Square D		No Substitutions