SECTION 27 62 01 – DATA CENTER

PART 1 - GENERAL.

1.1 REFERENCES

A. General provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections.

B. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.

C. Applicable Codes, Standards, and Specifications.
1. The following table of codes, standards, specifications, recommendations, and methods and procedures are applicable to the provisioning of a data center (DC) for the University of Colorado (CU) Denver | Anschutz Medical Campus (AMC), Office of Information Technology (OIT). The latest editions are incorporated by reference.

Number	Title
NFPA 70	National Electric Code (NEC)
IEEE C2	National Electric Safety Code (NESC)
TIA 942	Telecommunications Infrastructure Standard for Data Centers
BICSI	Telecommunications Distribution Methods Manual; Customer-Owned Outside Plant Design Manual; ANSI/BICSI 002, Data Center Design and Implementation Best Practices
OSHA	Standard 29 CFR 1910.268

2. OIT shall be regularly consulted with during Anschutz Data Center (ADC) project design, construction, and commissioning through the assigned CU AMC Facilities Projects, project manager (PM).
3. A BICSI certified Registered Communications Distribution Designer (RCDD) and a Data Center Design Consultant (DCDC) are required for this data center project.
4. OIT will assign a PM for the information technology (IT) portion of the ADC project. Contact Rob Lee (Rob.Lee@UCDenver.edu, 303.724.0443) TNI program director or Tasha Carlson (Tasha.Carlson@UCDenver.edu, 303.724.0402) Construction Services manager for OIT PM support.
5. OIT will also assign members of its Data Center directorate to participate in the project as Data Center SMEs. The OIT Data Center program director is Frank Whispell (Frank.Whispell@UCDenver.edu, 303.724.0300). The OIT Data Center manager is Steve Stelzer (Steve.Stelzer@UCDenver.edu, 303.724.0498).
6. OIT operates three existing CU data centers with these characteristics:
   a. North Classroom Data Center: 34 racks, ~1700 ft^2.
   b. Communications Center: 26 racks, ~1720 ft^2.
   c. Communications Center Annex: 18 racks, ~1000 ft^2.
   d. 78 total racks in ~4420 ft^2.
7. OIT SPLICE goals for the ADC:
   a. Service: the ADC shall materially enhance the voice, networking, computing, storage, and security services provided by OIT.
   b. Professional: the ADC shall be designed and constructed to reflect professional OIT DC administration and operations.
   c. Leadership: the ADC shall reflect CU Denver | AMC leadership in the data center field.
   d. Innovation: the ADC shall be designed around DC innovations and materially enhance innovation in telephony, networking, security, computing, and storage.
   e. Community: provide a community space for the telephony, networking, security, computing, and storage teams to create OIT services in a collegial environment.

f. Excellence: the ADC shall be designed to support OIT excellence in providing IT services.

1.2 ABBREVIATIONS AND ACRONYMS AND DEFINITIONS

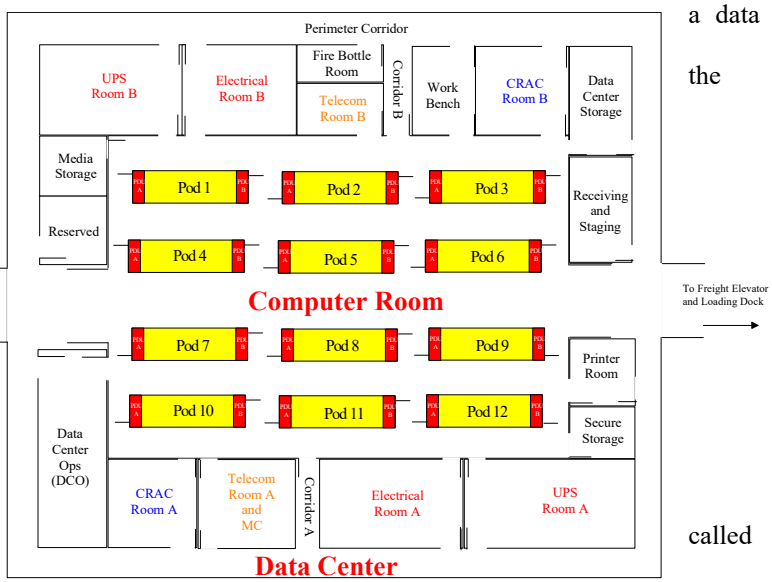
A. Abbreviations and Acronyms.

1. ADC: Anschutz Data Center
2. AHEC: Auraria Higher Education Center
3. AHJ: Authority Having Jurisdiction
4. AMC: Anschutz Medical Campus
5. ANSI: American National Standards Institute
6. AOC: ADC Operations Center
7. AP: Access Point
8. APC: American Power Conversion Corporation
9. ASF: Assignable Square Footage
10. ATP: Acceptance Test Plan
11. BAS: Building Automation Systems
12. BICSI: Building Industry Consulting Service International
13. BOM: Bill-of-Materials
14. BTU: British Thermal Unit
15. CAD 3D: Computer-Aided Design three dimensional
16. CCPM: Colorado Center for Personalized Medicine
17. CCTV: Closed Circuit Television
18. CDAS: Campus Distributed Antenna System
19. CI: Computing Infrastructure
20. CRAC: Computer Room Air Conditioner
21. CRM: Customer Relationship Management
22. CU: University of Colorado
23. CUP: Central Utility Plant
24. DAS: Distributed Antenna System
25. DC: Data Center
26. DCDC: Data Center Design Consultant
27. DCiE: Data Center Infrastructure Efficiency
28. DCIM: Data Center Infrastructure Management
29. DX: Direct Expansion
30. EIA: Electronic Industries Alliance
31. EMI: Electromagnetic Interference
32. EPO: Emergency Power Off
33. ERP: Enterprise Resource Planning
34. ESD: Electrostatic Discharge
35. FCC: Federal Communications Commission
36. FCU: Fan Coil Unit
37. FM-200: Factory Mutual 200 fire suppressant agent
38. ft^2: square foot
39. HPC: High Performance Computing
40. HVAC: Heating, Ventilation, Air Conditioning
41. IEEE: Institute of Electrical and Electronics Engineers
42. IPS: Intrusion Protection System
43. IT: Information Technology
44. kW/hr: kilowatt per hour
45. lbs/ft^2: pounds per square foot
46. N: Need
47. NEC: National Electric Code
48. NESC: National Electric Safety Code
49. NFPA: National Fire Protection Association
50. NIC: Not In Contract
51. NRC: Noise Reduction Coefficient

52. OIT: Office of Information Technology
53. OSHA: Occupational Safety and Health Administration
54. PDU: Power Distribution Unit
55. PIN: Personal Identification Number
56. PM: Project Manager
57. POC: Point of Contact
58. PSAP: Public Safety Answering Point
59. PUE: Power Usage Effectiveness
60. RAM: Reliability, Availability, Maintainability
61. RCDD: Registered Communications Distribution Designer
62. REES: Redundancy, Effectiveness, Efficiency, and Scalability
63. SAN: Storage Area Network
64. SME: Subject Matter Expert
65. SPLICE: Service, Professionalism, Leadership, Innovation, Community, Excellence
66. TEAM: Telecommunications, Electrical, Architecture, Mechanical
67. TGB: Telecommunications Grounding Busbar
68. TIA: Telecommunications Industry Association
69. TMGB: Telecommunications Main Grounding Busbar
70. TNI: Telecommunications and Networking Infrastructure
71. UPS: Uninterruptible Power Supply
72. UTP: Unshielded Twisted Pair
73. VESDA: Very Early Smoke Detection Apparatus
74. VoIP: Voice over Internet Protocol
75. VTC: Video Teleconference
76. W/ft^2: wattage per square foot

B. Definitions.

1. *Computer Room*: area in a data center containing the equipment racks, but not the support utilities and other support services. Computer rooms are unstaffed areas. See illustration.



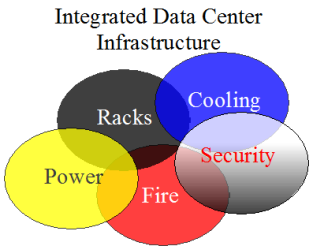
2. *Data Center*: area containing the computer room and support utilities and other needed services. Smaller data centers may have the computer room and support utilities embedded in one room called the data center. Staff offices may be housed in the data center.
3. *OIT*: the university unit that creates, manages, and operates centralized IT at CU Denver | AMC.
4. *Pod*: a collection of racks, PDUs, and CRACs that form a self-contained unit. Typically the inside of the pod is the hot aisle, while the exterior of the pod creates the cold aisles.

1.3 SUMMARY

A. Systems Performance Requirements.

1. Design, build, and commission a TIA-942, Tier 3 mission critical data center. The data center shall provide computer room space and supporting integrated infrastructure such as racks and

pods, cooling, power, fire, and security for converged low voltage systems such as telephony, routing, switching, data storage, computing, servers, High Performance Computing (HPC), security, visualization, Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), closed circuit TV (CCTV), community antenna TV, Building Automation Systems (BAS), Distributed Antenna System (DAS), overhead-paging systems, and other low voltage systems. Coordinate ADC design criteria and construction with the OIT PM and DC SME.



2. The data center must be reliable, available, and maintainable. It must be secure, efficient, effective, and scalable.
3. The data center shall provide a safe working environment for OIT personnel.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 National Electrical Code.

B. Manufacturers: Firms regularly engaged in manufacture of data center components and infrastructure, whose products have been in satisfactory use in similar service for not less than five years.

C. Installer's Qualifications: Firms with at least five years of successful installation experience on similar data center projects.

D. NEC Compliance: Comply with NEC as applicable to the design, construction, and installation of data center systems and infrastructure.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

1.6 SEQUENCING AND SCHEDULING

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

1.7 PROJECT SITE CONDITIONS

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

1.8 WARRANTY

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

1.9 SPECIFICATION RESPONSE

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

1.10 DEFINITIONS

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufactures for UPS, CRACs and PDUs: subject to requirements and OIT approval, provide products by the following:
   1. Schneider (APC).
   2. Emerson (Liebert).

B. OIT has extensive experience with Schneider and Emerson products and they are our preferred vendors. The APC product line has a much wider distribution on the CU Denver | AMC campuses.

PART 3 - SUBMITTALS

3.1 SUBMIT THE FOLLOWING

A. General: Submit the following in accordance with Conditions of contract and Division 1 Specification Section.

B. Installation Instructions: Manufacturer's written installation instructions for all ADC products.

C. Submit a combination ADC layout plan for coordination, providing section views of areas as required, in according with the requirements of Section 26 05 00.
   1. Provide as-built, scale floor plans showing all equipment.
   2. Label all equipment shown on the drawings.

D. Submit to OIT the following ADC materials:
   1. Provide a Bill-of-Materials (BOM) containing all components.
   2. Product Data and cut sheets for the following products:
      a. CRAC.
      b. UPS.
      c. PDU.
      d. Racks and enclosures.
      e. Humidification systems.
      f. Fire detection and suppression systems.

E. Deliver hardware and software manuals for all components.

F. Submit shop drawings in hard copy and electronic format as specified by OIT.
   1. Submit pictures of installation workmanship.
   2. Submit pictures and sketches of electrical and chilled water pathways.

G. Acceptance Test Plan (ATP) in hard copy and electronic format as specified by OIT.
   1. Submit an ATP showing the viable operation of all components.
   2. Testing of the ADC physical infrastructure as a whole system, including the following:
      a. IT and physical infrastructure or IT loads simulation.
      b. Cooling system testing.
      c. Induced utility power interruption.
      d. Fire suppression system testing.
      e. System monitoring and alarming testing.
      f. EPO tests.
      g. System set points are verified.
   3. Submit test results in hard copy and electronic format as specified by OIT.
   4. Provide demonstration and training on operational components.

H. Submit appropriate warranty documents in hard copy.
   1. Submit warranty for all manufactured components used in the ADC
   2. Submit contractor's system warranty.
   3. Submit manufacturer's extended warranty.

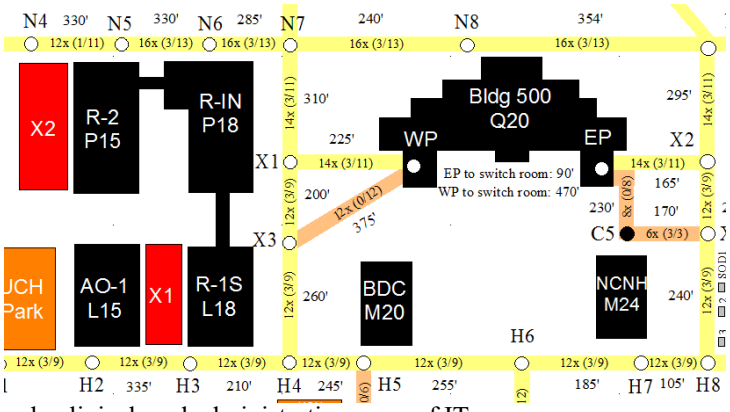
I. Provide technical POCs for each ADC system or major subsystem to include name, company, street address, position, telephone number, and email address.

PART 4 - DATA CENTER DESIGN CRITERIA

4.1 DATA CENTER SITE

A. The Anschutz Data Center (ADC) will be placed on the CU Anschutz Medical Campus (AMC) located in Aurora, CO.

1. The working name of the building housing the ADC is the CCPM (Colorado Center for Personalized Medicine) Building.
2. The building housing the ADC shall be a shared multistory structure, not dedicated as a data center facility.
3. The CCPM Building may approach 500,000 ft^2 on 12 floors.
4. Two locations, sites X1 and X2 as shown in red in the sketch, are under consideration at AMC for the CCPM Building and the ADC placement. The university will select the construction site prior to design.



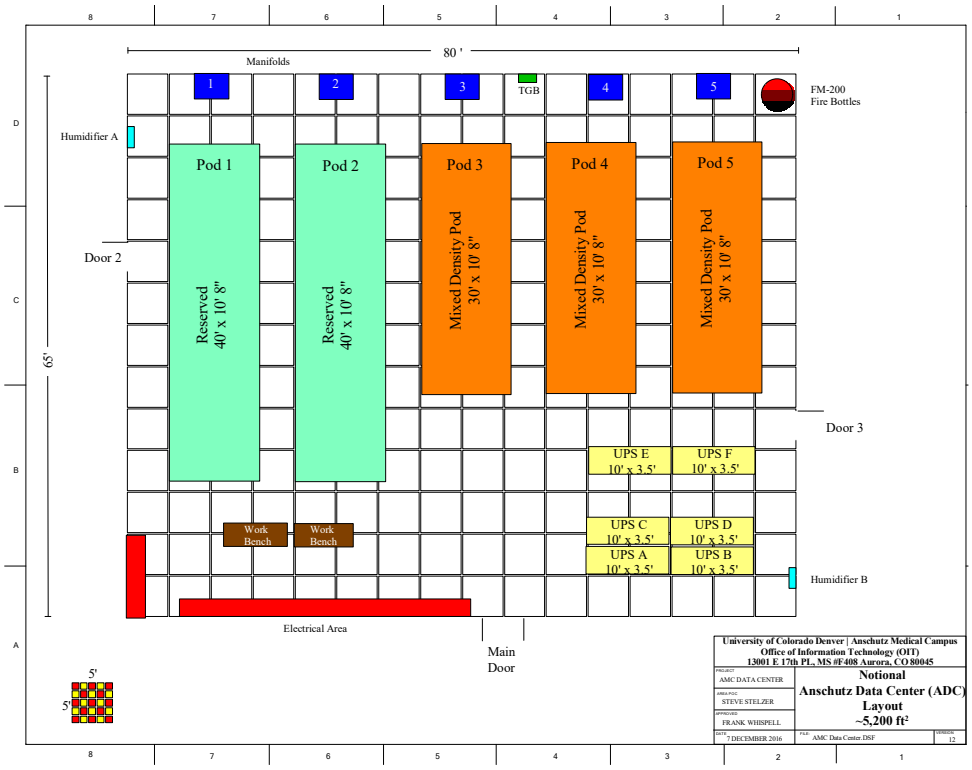
5. The CCPM Building will probably house academic, research, clinical, and administrative users of IT.

B. The ADC should not be placed in the CCPM building's basement or on the first floor. The building's top floor is also inappropriate due to potential water infiltration from roof leaks.

1. Avoid placing the ADC near or adjacent to:
   a. Building core areas (security concerns).
   b. Cafeterias (water infiltration issues).
   c. Breakrooms (water infiltration issues)
   d. Elevator control rooms (potential EMI).
   e. Loading docks (vibration effects).
   f. Trash compactors (vibration effects).
   g. Mechanical rooms (potential EMI).
   h. Electrical rooms (potential EMI).
   i. Restrooms (water infiltration issues).
   j. Wet labs (water infiltration issues).
2. Systems that support the data center may be placed in the ADC footprint, with OIT approval. All other systems shall be routed around the ADC.
3. All overhead and beneath floor infrastructure collisions should be presented in CAD 3D to the OIT PM for their review and routing approval.

C. ADC Size.

1. The ADC should be 5,200 assignable square feet (ASF), roughly 80 feet by 65 feet.
   a. The computer room shall be combined with the support utilities and services into one large data center footprint.
   b. The equipment in the computer room will probably be built in phases, where the capacity needed for the foreseeable future is created by adding just-in-time pods.
   c. The computer room should be designed to facilitate expansion via plug-in pods.
   d. A notional ADC floor layout is shown below.



2. Initial rack count planning.
   a. The university may elect to consolidate all existing decentralized AMC server rooms into the ADC because of the enhanced security, effectiveness, and efficiency of the ADC. If implemented, this consolidation may require up to 32 racks.
   b. OIT may elect to share racks with other state and higher education entities to foster better disaster recovery. This effort may require 6 racks.
   c. OIT's initial 2-year build-out requirement may consume 16 racks.
   d. The initial design should allocate three pods of a minimum of 18 racks each to cover the above rack count estimates. The estimated maximum electrical and thermal loads for 54 initial racks are shown below.

Rack Use	Estimated kW/rack	Initial Racks Needed	Total kW	Total BTU	Tons of Cooling
Telecom	5	6	30	102,363	9
Server	12	42	504	1,719,698	144
HPC	25	6	150	511,815	43
		54	**684**	**2,333,876**	**196**

3. The final rack build-out in the ADC may entail over 100 racks in 5 pods. See maximum kW and BTU estimates below for the total ADC build-out.

Rack Use	Estimated kW/rack	Total Racks Needed	Total kW	Total BTU	Tons of Cooling
Telecom	5	14	70	238,847	20
Server	12	74	888	3,029,945	253
HPC	25	12	300	1,023,630	86
		100	**1,258**	**4,292,422**	**359**

4. Incorporate these auxiliary spaces (ranges from 1,044 to 1,104 ASF) into the ADC design. These auxiliary spaces are not in the ADC 5,200 ASF footprint:

a. Office areas.
   1) Two data center offices are required that are sized 10 feet x 12 feet (240 ft^2).
   2) Four open office landing zones are desired (80 ft^2 x 4 = 320 ft^2).
b. Secured (via university access card reader with PIN pad) ADC Operations Center, sized about 10 feet x 12 feet (120 ft^2). If an audio-visual control room is collocated in the ADC Operations Center (AOC), the room should be increased in size to 12 feet x 15 feet (180 ft^2).
c. One conference room with integrated VTC support (~120 ft^2).
d. Secured (via university access card reader with PIN pad) supply and storage room (10 feet x 10 feet = 100 ft^2).
e. Secured (via university access card reader with PIN pad) shipping, receiving, and equipment staging area (12 feet x 12 feet = 144 ft^2).
f. This auxiliary space may be used for future ADC expansion.

4.2 DATA CENTER TIER

A. Provide a TIA 942, Telecommunications Infrastructure Standard for Data Centers, Tier 3, Concurrently Maintainable Data Center or as specified by OIT.
   1. Tier 3: a data center that has redundant components and multiple independent distribution paths serving the computer equipment in the computer room. Typically, only one distribution path serves the computer equipment at any time. The data center is concurrently maintainable which means that each component including the distribution path, can be removed, replaced, or serviced without disrupting the capabilities to the customer. The Tier 3 Concurrently Maintainable data center has protection against most physical events or outages.
   2. The Concurrently Maintainable data center should have an availability that approaches 99.982% which translate into 1.6 hours of *unplanned* outages per year. This tier provides 2N availability.
   3. TIA-942 Availability Percentages by tier are shown:

Availability Percentage	Uptime (min/year)	Uptime (hours/year)	Downtime (min/year)	Downtime (min/month)	Downtime (hours/month)	Downtime (hours/year)	Notes
99.671	523,871	8,731	1,729	144	2.4	28.8	Tier 1, Basic Data Center, N
99.749	524,281	8,738	1,319	110	1.8	22.0	Tier 2, Redundant Components, N+1
99.982	525,505	8,758	95	7.9	0.13	1.6	Tier 3, Concurrently Maintainable, 2N
99.995	525,574	8,760	26	2.2	0.04	0.44	Tier 4, Fault tolerant, 2(N+1)

B. TEAM = $T^3E^3A^2M^3$.
   1. TEAM is an acronym standing for Telecommunications, Electrical, Architectural, and Mechanical, the four quintessential operational elements of a DC.
   2. $T^3E^3A^2M^3$ signifies that not all levels of the TEAM components can be commissioned at the Tier 3 level. The campus has architectural site constrains such as a proximity to running water, an Interstate nearby, a police station on campus, several hospitals collocated on campus, overhead airways, extensive on-campus research facilities, and other significant, potential site hazards.
   3. The ADC's Telecommunications, Electrical, and Mechanical systems should be designed and built to the Tier 3 standard.
   4. Architectural systems should be built to Tier 3 if possible, but Tier 2 may be the highest tier that can be achieved, given the inherent campus constraints.

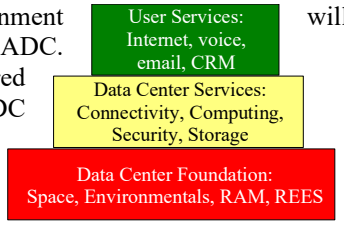
C. Criteria used for building a Tier 3 data center at AMC.
   1. The university has a high dependence on IT.
   2. There is a high cost associated with IT downtime.
   3. The university is a large, multimillion dollar business.
   4. The university possesses a Public Safety Answering Point (PSAP) or emergency 911 call center.
   5. We have a highly recognized brand.

6. The university has a state-wide, country-wide, and world-wide Internet presence.
7. The university engages in four different higher education activities with widely varying IT requirements:
   a. Research.
   b. Administration.
   c. Clinical and healthcare.
   d. Education.
8. The university has 24x7x365 expectations for IT services.
9. The university supports three campuses (CU Denver at AHEC, AMC in Aurora, and CU South in Parker) and about 30 offsite business locations, many of the offsite locales are clinical in nature.
10. The university readily complies with a variety of governmental regulations that require we secure and safeguard our data resources.
11. The faculty, staff, and students have high expectations for the university's disaster recovery abilities.
12. OIT implemented a network-based VoIP telephone system; that phone system is critical to university business.
13. OIT has a relentless focus on uptime and enhanced customer service that can only be achieved with a Tier 3 data center.

D. It should be noted that availability level cannot be ensured by design specification alone. Most DC service interruptions result from human error, not mechanical failure. Therefore, thoughtful attention to skill development, hands-on training, knowledge-based certification, and a positive, nurturing work environment will help contribute to a high availability, zero-defect computing environment that OIT desires.

4.3 GENERAL DATA CENTER GUIDELINES

A. All successful operational aspects of the university computing environment will result from the reliability, availability, and maintainability (RAM) of the ADC. Redundancy, effectiveness, efficiency, and scalability (REES) are required for the long-term viability and success of the ADC. The RCDD/DCDC designer needs to incorporate these guidelines into their ADC design.



Data Center Services Pyramid

B. ADC Guidelines.
1. Floor loading: minimum 250 lbs/ft^2.
   a. This number includes battery weight loads.
   b. If the ADC exceeds 5,200 ft^2, consider 300 lbs/ft^2 minimum floor loading.
2. Raised Floor: none desired.
3. The ADC floor shall not be carpeted.
4. A minimum floor-to-floor clearance of 13 feet is desired.
5. Windows: placed so OIT can use the windows for ADC emergency cooling in the winter.
6. Place electrical pathways in the cold aisle pathway in the ceiling.
7. Place telecommunications pathways in the hot aisle pathway located in the ceiling.
8. Route chilled water pipelines from below the floor, if feasible.
9. Chilled water leak detection required.
10. The ADC shall not be located below lavatories, wet labs, washrooms, break rooms, or other areas where inadvertent water leakage may occur.
    a. The ADC shall have a drainage point for water removal.
       1) The ADC drainage piping shall have a shutoff ball or check valve to prevent backflow from entering the ADC through drain lines.
       2) A 12" diameter or larger drainage point is desired.
11. Avoid placing the ADC in areas of high EMI.
12. Ensure there is a freight elevator in the CCPM Building sized to meet the needs of the ADC.
13. The computer room shall not be a primary pathway to support areas.

C. Pods and racks.

1. Pods may support the following types of equipment:
    a. Telecommunications.
    b. Servers.
    c. HPC.
    d. Mixed telecommunications, server, and HPC equipment.
2. Racks shall comply with EIA-310-D standard to house EIA-310 compliant equipment.
    a. Each rack shall support a static weight load of up to 3,000 lbs.
    b. Rack depth shall be a minimum of 46 inches or as specified by OIT.
    c. Racks should be hinged for right or left operation.
    d. Racks shall possess numbered U positions.
    e. Racks shall have adjustable leveling feet.
    f. Racks shall have lockable doors and lockable side panels.
        1) With individually unique locksets with four master keys.
    g. Racks should be equipped with a university card access control system.
    h. Ground (earth) all rack enclosures.
3. Do not place more than 20 racks in row in any pod.
    a. Do not place more than 10 racks in a row if one end of the hot aisle is closed off and there is no secondary personnel exit in the pod.
4. Pods require redundant electrical feeds.
    a. Place redundant PDUs to support the pod.
    b. Attach the redundant PDUs to redundant UPSs.
    c. Each rack in a pod requires redundant metered power strips that connect to the redundant PDUs.
5. Label all pods and racks as specified by OIT.

D. The ADC doors shall be a minimum of 36” wide by 80” high. Due to the nature of the equipment located in the ADC, the ADC requires at least one oversized door (72” by 90” or larger) to allow oversized equipment to be moved in or out. All doors shall be self-closing. ADC doors shall open outward or be removable from the inside. ADC doors shall have a minimum of a 1-hour fire-rating or as stipulated by the AHJ.

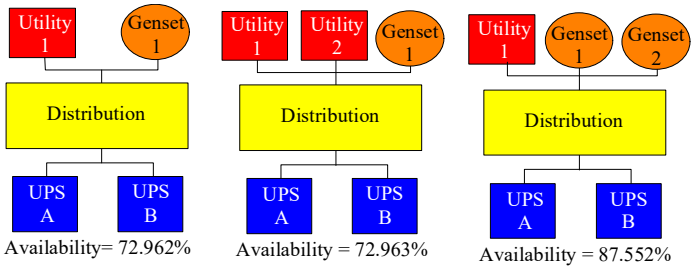
E. The ADC requires lighting with a uniform intensity exceeding 50 foot-candles (500 lux) when measured 3 feet above the finished floor. Indirect lighting is not desired. Use white colored finish to enhance ADC lighting.
1. Connect ADC lighting fixtures to separate electrical circuits from those that accommodate the IT equipment in the room.
2. ADC lighting shall use high efficiency ballasts and lamps.
3. Lighting fixtures shall be aligned parallel to equipment rows and centered over the aisles.
4. Provide emergency lighting in the ADC.

F. Working clearances of 4 feet shall be provided for all installed ADC equipment. Consider working clearances of 5 feet or more in main ADC corridors and fire egress areas.
1. Clearance between IT and physical infrastructure equipment rows shall conform to the following minimum clearances:
    a. Cold aisles (rack fronts facing each other): 4 feet wide.
    b. Hot aisles (rack backs facing each other): 3 feet wide.

4.4 ELECTRICAL POWER

A. Provide redundant electrical power feeds to the data center building.
1. A single commercial feed sized to support the building and ADC is required.
    a. The electrical utility service entrance shall be sized to at least 125% of the projected final load.
2. Two backup generators sized to support the ADC’s full load are required. This is a 2N requirement.

a. Power utilities in the US average 1.86 outages annually with an average repair time of 4 hours. Assuming a mission time of 5 years, an average generator availability of 80%, power distribution uptime of 95%, and an UPS uptime of 80%, the following result (see sketch):



b. The generator should be sized to at least 125% of the projected final load.
c. The backup generators should have sufficient fuel to run for 3 continuous days.
d. Place the generators, mechanical infrastructure, electrical gear, and fuel tanks in a secure enclosure.
e. The generators should supplement utility power within 30 seconds of utility power loss.

3. The redundant underground power feeds to the building should be placed a minimum of 66 feet apart.
4. Dedicated electrical panels should be placed in the ADC, sized to support the ADC.
5. Electrical infrastructure for the ADC should be isolated from the building's electrical infrastructure.
6. Transformers, if placed in the ADC, shall be placed a minimum of 4 feet from the pods or cabling.

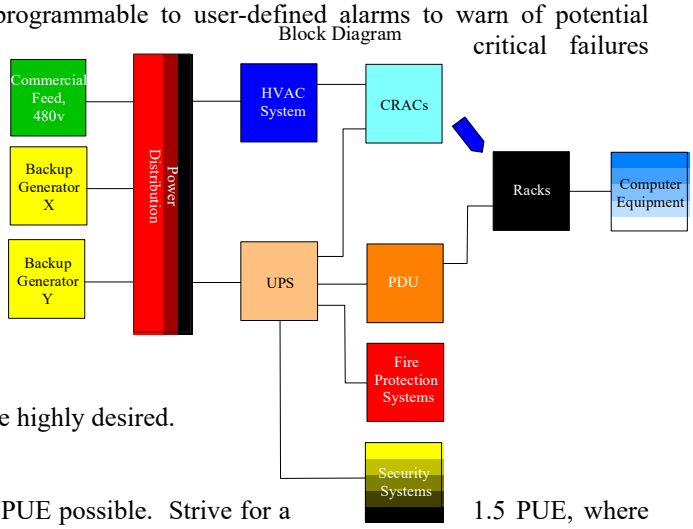
B. Redundant UPS and PDUs are required.
1. The redundant UPS should be sized to offer 30 minutes of run time.
   a. The commercial electrical feed, dual backup generators, and 30 minutes of battery runtime provides the ADC with three lines of defense for maintaining electrical power.
2. The redundant UPS shall not exceed 80% of its capacity when carrying a full electrical load.
3. UPS and PDUs shall be modular and scalable to allow for ADC equipment growth and consolidation.

C. UPS requirements:
1. Redundant UPS are provided at 2N.
2. The UPS shall be modular.
3. Possess hot swappable power modules.
   a. Provide N+1 power modules as a minimum.
4. Have hot swappable batteries.
   a. Provide N+1 batteries as a minimum.
5. Be manageable with self-diagnostic capabilities.
6. UPS should be scalable.
   a. Be scalable to 500 kVA.
7. Provides maintenance bypass.
   a. Possess an external make-before-break maintenance bypass system to electronically isolate the UPS during maintenance and service.
8. Possesses emergency shutdown capability.

D. Power strip requirements:
1. Equip each rack in a pod with a minimum of two power strips, one strip connected to each of the redundant PDUs.
2. The power strip should be rated at 208 V and 60 amps.
   a. Four metered power strips are required in each HPC rack.
3. Provide metered power strips to allow real-time monitoring of connected power loads.

a. The power strips should be programmable to user-defined alarms to warn of potential circuit overloads before critical failures occur.

E. A notional ADC electrical block diagram is portrayed to the right.



F. Label all ADC electrical components as specified by OIT or CU Facilities:
1. UPS.
2. PDU.
3. Metered power strips.

G. Electrical power filtering and conditioning are highly desired.

H. Power Usage Effectiveness (PUE).
1. Design the ADC to obtain the lowest PUE possible. Strive for a 1.5 PUE, where a PUE of 1.0 is not readily obtainable.
   a. PUE = Total Facility Power/IT Equipment Power.
   b. DCiE = 1/PUE = IT Equipment Power/Total Facility Power x 100%.
   c. IT Equipment Power: includes the load associated with all of the IT equipment, such as compute, storage, and network equipment.
   d. Total Facility Power: this includes everything that supports the IT equipment load. Total Facility Power includes: UPS, switch gear, generators, PDUs, batteries, distribution losses external to the IT equipment, chillers, CRACs, DX units, pumps, cooling towers, compute, network, storage, and miscellaneous component loads such as data center lighting.

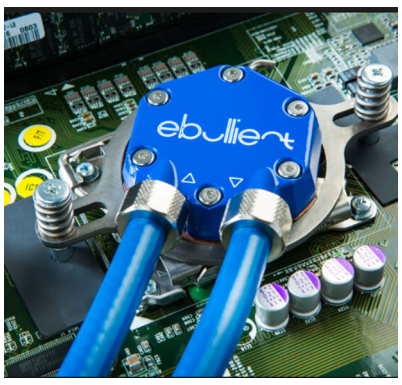
I. ADC power planning numbers.
1. Initial W/ft^2 may be around 150 W/ft^2.
2. Gross W/ft^2 may exceed 250 W/ft^2.
3. Power typically consumed by rack type:
   a. Single telecom rack: 5 kW/hr.
   b. Single server rack: 12 kW/hr.
   c. Single HPC rack: 25 kW/hr.

4.5 HEATING, VENTILIATION, AIR CONDITIONING (HVAC)

A. Provide redundant chilled water sources.
1. CUP chilled water is desired as the ADC's primary source.
2. A suitably sized chiller water farm placed near the ADC is desired.
3. Redundant underground chilled water feeds to the ADC building should be placed a minimum of 66 feet apart.

B. Provide row or rack cooling to support the pods' thermal requirements.
1. OIT currently uses row cooling pods, but rack cooling may be required.

C. Provide room cooling for utility support units such as transformers, power panels and for people working in the ADC.
1. Provide redundant 6-ton FCU for room cooling support.
2. Install the FCU overhead mechanical gear outside of the ADC's perimeter wall.



D. There are four types of data center cooling: room, row, rack, and direct-to-chip cooling (as portrayed to the right). The ADC shall initially contain room and row cooling, with the HVAC design

aimed at supporting future rack and direct-to-chip cooling. The ADC HVAC design should incorprate support for innovative cooling technology.

E. Each pod shall possess exterior cold aisles and an enclosed hot aisle to contain the thermal load.

F. Chilled water leak detection is required.

G. Air filtering is desired to remove harmful contaminants in the ADC.

H. Mechanical infrastructure supporting the ADC should be isolated from the building's mechanical infrastructure.
   1. No water pipes, sewer pipes, gas lines, et cetera should be run in the ADC unless they directly support the ADC.

I. Label all ADC HVAC components as specified by OIT or CU Facilities.

J. Place all active cooling components on the backup generators and UPS.

K. Cooling planning numbers.
   1. Power in equates to heat out.
      a. Single fully filled telecom rack: up to 5 kW/hr.
      b. Single fully filled server rack: up to 12 kW/hr.
      c. Single fully filled HPC rack: up to 25 kW/hr.

4.6 GROUNDING AND BONDING

A. Grounding systems throughout the ADC shall not measure greater than 5 ohms to earth ground as measured by the four-point fall-of-potential method.

B. Provide the following:
   1. Place a TGB in the ADC and ground all active components to the TGB, this serves as a signal ground.
   2. Ground the ADC floor to the TGB to preclude ESD.
   3. Ground the computer room racks to the TGB for personnel safety.
      a. ADC racks, cabinets, overhead cable trays, cable ladders, and wiring troughs shall be bonded throughout their entire structure and bonded to the ADC's TGB.
   4. Ground pathways to the TGB for personnel safety.
   5. Ensure the TGB is permanently grounded to the building's TMGB.

C. Place redundant humidification devices in the ADC to maintain a relative humidity from 35% to 45% to preclude ESD.

D. ADC static electricity shall be controlled by the use of moisture barrier protection.

4.7 FIRE PROTECTION

A. The ADC fire suppression system shall be independent of the building system.
   1. The ADC fire suppression system shall appear as a single alarm point on the CCPM Building's main fire alarm panel.

B. Place the following fire detection systems in the ADC:
   1. VESDA fire detection system.
   2. Both heat and smoke detection capabilities are desired.

C. Provide the following fire suppression systems in the ADC.

1. DuPont FM-200 (HFC227ea), 3M Novec 1230, Inergen (IG541) or other inert or synthetic fire suppression system, as recommended by the DCDC and selected by OIT.
    a. The fire suppression system shall be activated by the initiation of any two cross-zoned smoke detectors or by manually activating the pull station.
    b. Upon discharge of the fire suppression system, the EPO system shall be automatically activated.
2. Preaction water fire suppression system with high-temperature caged or recessed heads.
    a. Preaction water systems should have rack troughs installed to preclude accidental water damage to the ADC equipment.
3. Class C (or A-B-C rated clean-agent) handheld fire extinguishers shall be placed inside the ADC near the doors and other areas as required by the AHJ.
    a. Place a handheld fire extinguisher at 50 foot intervals.
    b. Place a minimum of two handheld fire extinguishers in the ADC.

D. Place the following fire signaling systems in the ADC.
1. Fire alarm pull stations shall be placed at all ADC doors.
2. Provide EPO switches connected to the preaction water fire suppression system.
    a. The EPO switch shall, upon activation, shut down all mechanical and electrical systems including the closure of fire and smoke dampers.
        1) The EPO button, when activated, shall de-energize the IT equipment in the computer room prior to water release.
    b. The EPO switch shall disconnect power to all data center electromagnetic door locks, disabling them in the unlocked, open position.
    c. EPO button shall sound a local horn and light alarm when the EPO protective cover is lifted.
    d. EPO horn and light alarm shall not resemble the fire annunciation horn and light alarm.
    e. EPO buttons are required at each ADC door.
3. EPO buttons and fire alarm pull stations shall have safeguard features to preclude accidental activation, release, or discharge.
4. Label all stations to campus standards.

E. The OIT TNI directorate shall place emergency telephones in the ADC.
1. Emergency telephones shall be located adjacent to any clean agent fire suppression abort switch.
2. Emergency phones shall be located at each data center exit adjacent to the EPO switches.
3. Place an emergency telephone adjacent to the fire panel.

F. Place the fire protection panel and annunciator near the ADC's front door or where stipulated by the AHJ.

G. Perimeter walls shall extend from the floor slab to the ceiling slab.
1. ADC perimeter walls shall have a minimum 1-hour fire-rating or as specified by the AHJ.
2. ADC interior walls shall have a minimum 1-hour fire-rating or as specified by the AHJ.

H. A minimum of two doors for egress are required in the ADC or as specified by the AHJ.

I. Place all fire protection equipment on the backup generators and UPS, if possible.

4.8 ELECTRONIC BUILDING SECURITY

A. Place the following security controls in the ADC:
1. University-issued badge card readers at every door, with PIN pad.
    a. Door locks should fail secured (fail closed).
2. Install University Electronic Building Security cameras to monitor cold aisle and hot aisle personnel actions.
3. Place cameras to monitor all ADC doors.
4. Hot aisle doors may be lockable, but they must have an emergency override function.
5. Racks should be equipped with a university-issued card access control system.

6. Install access card readers with PIN pad in the auxiliary OIT office area adjacent to the ADC:
    a. ADC Operations Center.
    b. ADC supply and storage room.
    c. ADC shipping, receiving, and equipment staging area.

B. Place all Electronic Building Security infrastructure components on the backup generators and UPS, if possible.

4.9 PERSONNEL SAFETY

A. Place a safety board in the ADC.
1. Place a first aid kit on the safety board.
2. Place a dispenser for disposal ear plugs.
3. Position an ESD wrist strap dispenser in the ADC on the safety board.
4. Place a wooden cane on the safety board.

B. Ensure high-powered electrical systems are labeled for arc flash safety.

4.10 OIT TELECOMMUNICATIONS and NETWORKING INFRASTRUCTURE (TNI)

A. The project will provide redundant underground telecommunications pathways and feeds to the ADC building placed a minimum of 66 feet apart.

B. The OIT TNI directorate shall design, build, commission, administer, validate, and label the redundant networking and telephony services placed in the ADC, NIC.
1. Provide a VoIP telephony system.
2. Design, develop, and coordinate a network data center support topology.
3. Provide redundant Cisco core capabilities in the ADC.
4. Provide a Cisco IEEE 802.11ac wireless overlay inside the ADC.
    a. Consider deploying a minimum of three APs in the ADC.
5. Provide a Corning MobileAccess DAS to extend the CDAS into the ADC.
    a. Consider adding a minimum of two antennas in the ADC.
6. Funding provided by the ADC project.

C. The RCDD/DCDC shall recommend a structured cabling system for implementation in the ADC.
1. Recognized media includes:
    a. Single mode fiber.
    b. Laser-optimized 50µ multimode fiber.
    c. Category 6 or Category 6a UTP, as specified by the OIT TNI directorate.
    d. Other media as explicitly approved by the OIT TNI or OIT Data Center directorates.
2. Hot aisle cable management preferred.

D. Place all OIT TNI telecommunications hardware on the redundant backup generators, UPS, and PDUs.

4.11 OIT SECURITY

A. The OIT Security directorate shall design, build, commission, administer, validate, and label a firewall and IPS in the ADC, NIC.
1. Funding provided by the ADC project's budget.
2. Place all OIT Security directorate firewalls and IPS on the redundant backup generators, UPS, and PDUs.

4.12 OIT COMPUTING INFRASTRUCTURE (CI)

A. The OIT CI directorate shall design, build, commission, administer, validate, and label the computing environment consisting of servers and HPC placed in the ADC, NIC.
   1. Provide a virtual environment to support the ADC's computing environment.
   2. Funding provided by the ADC project's budget.
   3. Place all OIT CI directorate computing solutions on the redundant backup generators, UPS, and PDUs.

B. The OIT CI directorate shall design, build, commission, administer, validate, and label the storage solution placed in the ADC, NIC.
   1. Provide a scalable SAN to support the ADC's storage requirements.
   2. Provide a scalable backup strategy and solution, if required.
   3. Funding provided by the ADC project's budget.
   4. Place all OIT CI directorate storage hardware on the redundant backup generators, UPS, and PDUs.

4.13 OIT DATA CENTER ADMINISTRATION

A. The OIT Data Center (DC) directorate will design administer, configure, and maintain the ADC.
   1. The OIT DC directorate shall develop ADC policies and work rules and train ADC users on the policies and rules.
   2. The OIT DC directorate will provide periodic training to ADC users on the fire protection systems and other pertinent systems.
      a. Identify the Facilities phone number users should use for calling-in outages.
      b. Ensure the OIT DC directorate is notified of these outages.
   3. Post critical ADC operating procedures so they are readily available for review.
   4. The OIT DC directorate will setup procedures for doing routine preventative maintenance on the fire protection system, generators, CRACs, and UPSs.
      a. Schedule routine ADC cleaning.
   5. Identify spare parts desired for the UPS, metered power strips, and other ADC systems.
   6. The OIT DC directorate will assign equipment placement locales to ADC tenants by rack and pod. They will inspect all equipment installation efforts to ensure they comply with OIT safety, cleanliness, and aesthetic standards.
      a. Installations that are not approved by the OIT DC directorate because of OIT safety, cleanliness, or aesthetics issues will be denied commissioning.
   7. The OIT DC directorate shall maintain the overall appearance of the ADC so it projects competency and professionalism.
   8. Develop an ADC fee-for-service cost model in conjunction with the OIT CI directorate.

B. The RCDD/DCDC designer shall recommend a Data Center Infrastructure Management (DCIM) system to the OIT DC directorate for possible procurement.

C. Place a sign-in log at the ADC entrance.
   1. University badged employees who have access to the ADC do not need to sign-in. All others do.
      a. Tours led by an authorized user with ADC access do not need to be logged in.
   2. Escort all vendors who need access to the ADC after they have signed in.
   3. Maintain the sign-in logs for one year.

D. The ADC will generally be staffed from 8 am to 5 pm, on regular AMC business days.

E. Ensure all racks, PDUs, CRACs, UPS, and other significant components are labelled to university and OIT standards.

END OF SECTION 27 62 01