



# **Guidelines for Computing within Fermilab's Computing Centers**

**Computing Sector, Office of CIO**

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## Overview

In order to provide reliable, safe and secure computing centers, certain practices must be instituted and enforced. This document establishes guidance, standards and procedures for Fermilab computing centers. This guidance and these procedures apply to all authorized Fermilab employees as well as authorized business partners and affiliates of Fermilab, including contractors and vendors. Fermilab managers may solicit the Computing Sector Data Center Manager for exceptions to any of these procedures.

This document also provides an overview of the computer rack Power Distribution Units (PDUs) and computer racks currently in use within the Fermilab Computing Centers. The configuration and external features of rack PDUs and computer racks are important in providing optimal power, cooling efficiency and floor space within each computing center. This document provides configuration and external feature recommendations of preferred computer racks and rack PDUs. This document also includes guidance on rack cable management, and rack doors/locks and labels and other relevant areas.

The TIA-942 Telecommunications Infrastructure Standard from Data Centers and ANSI/BICSI 002-2011 Data Center Design and Implementation Best Practices are useful standards to obtain additional best practices.

## Installations, Modifications and Changes

All modifications and changes within the Fermilab computing centers including but not limited to infrastructure modifications, commissioning and decommissioning of computing equipment, scheduled preventive maintenance and emergency maintenance of equipment, and testing of back-up systems must be scheduled according to change management procedures (if applicable), and must be coordinated with the Computing Sector Data Center Manager or computing center planner (Facility Operations).

Any new computing equipment or modifications to existing computing equipment should not require alterations to existing building, computing facility, electrical power or distribution or cooling systems. Any proposal for alterations must be pre-approved by Facility Operations.

All changes within the computing centers are subject to approval of Facility Operations and the associated units affected. Any work performed within the computing centers must be pre-approved by Facility Operations. All space allocations within the computing centers will be the responsibility of Facility Operations. All special projects must be coordinated with the Data Center Manager.

All equipment must be rack-mountable. Exceptions must be approved by the Facility Operations. Racks used in the computing centers must be assigned by Facility Operations.

## **Decommissioning Equipment**

Removal of all decommissioned equipment must be coordinated with Facility Operations. The computing center planner will schedule a removal date and coordinate the equipment's disposition with the owner and service provider, if one is used.

All decommissioned/ abandoned equipment will be removed from the computing centers and mission critical facilities within 60 days of notification and excessed using the approved Fermilab processes.

All decommissioned communications cabling--including voice, data and fiber cabling--must be removed from the computing centers by the appropriate party within 60 days of notification that the surplus process has been completed. Decommissioned cables are defined as cables that are abandoned or no longer to be used in the center centers.

Power cords should be unplugged from rack PDUs and removed from the rack at the time computing equipment is decommissioned and powered off for removal

## **General Specifications and External Features Recommendation for Computer Racks**

Computer racks deployed with the Fermilab's Computing Centers must conform to the computer room requirements for optimal cooling and space utilization. The following list of recommendations will provide standardization of color and help with overall cooling reliability and efficient computer room floor space utilization. Recommended rack features, such as, color and structural stability will also apply to networking type racks.

### **Recommended Rack Features**

- ✚ Color – Black is the current standard (when an opportunity is present to provision an entire room, white is preferred)
- ✚ Removable top panel
- ✚ Structural Stability to withstand the imposed static and dynamic loads
- ✚ Solid side panels for computer racks on end of rows

- ✚ Front and rear doors should be removed
- ✚ Filler panels for unused slots on the front of computer racks
- ✚ Four heavy-duty swivel casters and four stabilizing feet or
- ✚ Flush mount to the floor
- ✚ Electronic Industries Alliance (ECA) EIA/ECA-310-E: Cabinets, Racks, Panels, and Associated Equipment. EIA-310-E is intended to provide overall design requirements for Cabinets, Panels, Racks and Subracks

**PDU Functional Recommendation**

- ✚ Metered PDU with an amp meter on the strip to maintain proper loading for each circuit
- ✚ Monitored PDUs to provide remote monitoring of amperage and other critical measurements
- ✚ Rack PDUs must be a UL or other NRTL (Nationally Recognized Testing Laboratory) approved device

**Recommended Configuration Guideline for Computer Racks and PDU Units  
(and Computing Center Clearance Limitations)**

Data Center (DC)	PDU	Internal Height	Overall Width	Depth	Average Overhead Cable Tray Height Clearance	Minimum DC Entry Door Height Clearance
<b>GCC-TRR</b>	<b>Metered / Monitored</b>	<b>44U / 47U</b> (1)	<b>24"</b>	<b>36" - 42"</b>	<b>91"</b> (87 3/4" yellow fiber-duct)	<b>82.5"</b> (hallway double fire doors)
<b>GCC-CRA</b>	<b>Metered / Monitored</b>	<b>47U</b> (1)	<b>24"</b>	<b>36"</b>	<b>90"</b>	<b>91"</b>
<b>GCC-CRB</b>	<b>Metered / Monitored</b>	<b>47U</b> (1)	<b>24"</b>	<b>36" - 42"</b> (2)	<b>94"</b>	<b>90"</b>
<b>GCC-CRC</b>	<b>Metered / Monitored</b>	<b>47U</b> (1)	<b>24"</b>	<b>39" - 42"</b>	<b>~93"</b>	<b>90"</b>
<b>FCC2</b>	<b>Metered / Monitored</b>	<b>44U</b> (1)	<b>24"</b>	<b>36" - 42"</b> (2)	<b>~87"</b>	<b>83.5"</b> (elevator doors)
<b>FCC3</b>	<b>Metered / Monitored</b>	<b>47U</b> (1)	<b>24"</b>	<b>42"</b>	N/A (3)	<b>95.25"</b> (glass entry doors)

1. The height of computer racks is restricted by the space clearance underneath the overhead cable and power distribution trays and by the

space clearance underneath the overhead fire sprinkler heads, which must be a minimum 18-inch clearance.

2. Some existing rack locations will not support spacing for 42" or larger depth racks, please contact Facility Operations Department for recommendations.
3. Racks already have cable tray clearance since all available rack positions are populated with racks which are installed and bolted to a steel platform

## **Fundamentals of Rack Power Distribution Units (PDUs)**

PDU Fundamentals: A rack PDU is mounted within a computer rack and provides electrical power to the various computing equipment. There are a several types of rack PDUs in used today. Listed below is a brief summary of some of the most common types of PDUs.

### **Basic PDUs**

Basic PDUs are power strips which provide electric distribution within a computer rack, but do not have metering or monitoring functionality. Basic PDUs do not meet the Computing Sector's minimum functional recommendations for rack PDUs.

### **Metered / Monitored PDUs**

Metered / Monitored PDUs visually display the electrical draw and internally monitor electrical parameters which can be read out by computers. They provide actual and real-time power usage at the rack level.

### **Switched PDUs**

Switched PDUs provide controlled on/off switching of the individual outlets and load metering at the PDU level. They typically allow remote power on/off capabilities, outlet-level switching and sequential power-up.

### **Intelligent PDUs**

Intelligent PDUs can be controlled remotely. They are remotely accessible via a Web browser or other customized interface. Models typically include all the features of the switched PDUs, plus remote real-time power and environmental monitoring.

# Overview of IT/Data Enclosure Systems Currently in Use

## Grid Computing Center (GCC)

Consult with Facility Operations for rack heights other than 47U.

- ✚ Tape Robot Room  
ISM/AMCO Racks  
44U (height) x 24" (width) x 36" (depth)  
44U (height) x 24" (width) x 39" (depth)  
47U (height) x 24" (width) x 42" (depth)
  
- ✚ Computer Room A  
IMS/AMCO Racks  
47U (height) x 24" (width) x 36" (depth)  
44U (height) x 24" (width) x 36" (depth)
  
- ✚ Computer Room B  
IMS/AMCO Racks  
47U (height) x 24" (width) x 39" (depth)  
47U (height) x 24" (width) x 36" (depth)  
44U (height) x 24" (width) x 39" (depth)  
44U (height) x 24" (width) x 42" (depth) - Consult with Facility Operations
  
- Dell Racks  
42U (height) x 24" (width) x 39" (depth)
  
- ✚ Computer Room C  
IMS/AMCO Racks  
47U (height) x 24" (width) x 39" (depth)  
44U (height) x 24" (width) x 36" (depth)
  
- HP  
47U (height) x 24" (width) x 48" (depth) - Consult with Facility Operations

## Feynman Computing Center FCC2

Consult with Facility Operations for rack heights other than 44U

- IMS/AMCO, Dell, Hitachi, HP, Chatsworth and various other racks
- 44U (height) x 24" (width) x 30" (depth)
- 44U (height) x 24" (width) x 36" (depth)
- 44U (height) x 24" (width) x 42" (depth)
- 42U (height) x 24" (width) x 36" (depth)
- An assortment of less than 42U (height) x 24" (width) x 30" (depth)

## Feynman Computing Center FCC3

- IMS/AMCO Racks
- 47U (height) x 24" (width) x 42" (depth)

## Table of Power Distribution for Each Computer Room

Computer Room	Total Racks In Room	Receptacle Count <i>Typical</i>	Receptacle Type <i>Typical</i>	Rack Power (Max/Avg)
GCC-CRA	77	5/3	L5-30R (120V) / L6-30R (208V)	10kW
GCC-NRA	15	2+	L6-20R (208V) L6-30R (208V) 5-20R (120V)	5kW/2kW*
GCC-TRR	10	4	L5-30A (120V)	4kW/3kW
GCC-CRB	84	5/3	L5-30R (120V) / L6-30R (208V)	10kW
GCC-NRB/C	16	2+	L6-30R (208V) 5-20R (120V)	5kW/2kW*
GCC-CRC	64	3	L6-30R (208V)	14kW
FCC2	~200	2	L6-30R (208V) 5-30R (120V) L5-20R (120V)	5kW/3kW
FCC3	72	4	L6-30R (208V)	6.6kW
FCC3-NR	6	2+	L6-30R (208V)	5kW/4kW
WH8-FC	7 <sup>1</sup>	1+	L6-20R (208V) L5-30R (120V)	4kW/1.5kW

*Note:* Data shown is estimated or nominal and may vary within the room. Please refer back to Power Studies and Cooling Studies for more precise information.

\* limited by cooling

<sup>1</sup> Fiber Central has 14 racks, but only 7 are active

## Upgrading legacy rack PDUs

The preferred PDU is an intelligent type with a metered power display. The Sector requires retirement of older PDUs when there is a significant alteration or refresh within the rack. However, responsible service organizations need to plan to proactively replace older PDUs with new PDUs whenever there is a scheduled outage or downtime.

## **Weight Restrictions for Racks**

Detailed requirements for the computing center raised floor loading and rack weight limits can be found in the [Access Floor Systems in the Fermilab Computing Sector Computing Centers](#) documentation CS-doc-2721.

## **Rack Configuration Guidance**

A basic goal of installing equipment in computing racks is to ensure the center of gravity is not too high, resulting in a rack stability hazard. Not all racks are secured to each other or the floor. Some basic tips for installation include loading heaviest items first (in bottom) and then proceed up from there. Load hardware from the bottom up for greatest overall stability. Loading hardware higher than the 22U position is usually allowed, but ensure that maintenance and removal of the computing will be safe and effective for the computing at the top of the rack.

## **Labels on Computing Racks**

Rack number labels are assigned and affixed to racks by Facility Operations. These labels will appear like FCC-2-1433. This is the label used the racks in CMDB and other databases, service desk tickets, etc.

It is desirable to have a small label indicator for experiments and service groups. One has to be careful with this type labeling since stakeholder data changes often and rapidly. The recommendation is a label of approximately 2"x3" or smaller in the upper left corner on the front of the rack.

The Computing Sector supports strategically located documentation that describes the purpose of the rack or services provided by the equipment within the rack. Coordinate with Facility Operations to determine the appropriate fire retardant approach. The information contained on the signage must be maintained and kept up to date.

## **Cable Management Policy**

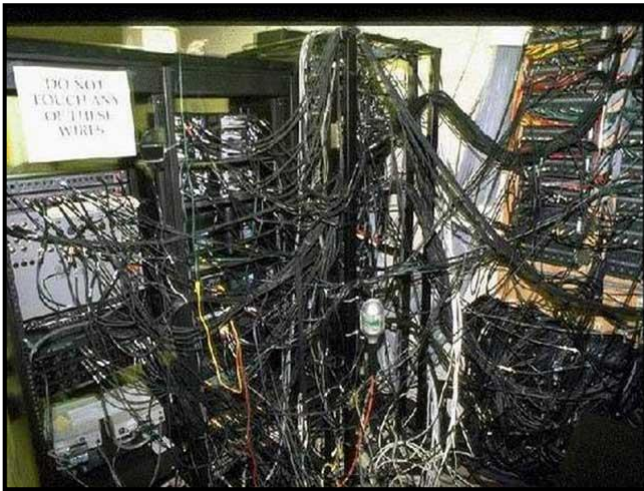
There are many reasons why computer rack cable management is important to the Computing Sector and the operation of the computing centers. Installing cabling with an organized and consistent approach facilitates better air flow. Minimal clogging of air ways in back of the rack allows hot air from the back of the server to escape better. Any improvements with air management result in increased energy efficiency. There is better operation of the cable management



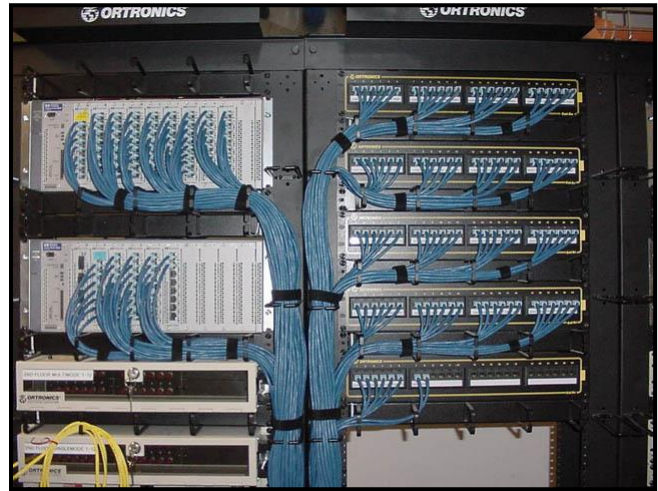
arm when extending the server out of the rack for service. One should be able to pull the server out 1000 times and the cabling remains neat and enacted.

It looks professional. There is a sense of pride when your multi-million dollar computing center looks like a multi-million dollar computing center. There are many standards and industry good practices for cabling, TIA/EIA-568, ISO/IEC IS 11801, and TIA-942, to name a few.

## Cable Management



Bad Example



Good Example

### Tips

- Generally, don't run your AC power cables on the same side of the rack as your Ethernet/communication cables
- Avoid running cables between the sides of adjacent racks. If this is the only alternative, the cables need to be properly dressed (cable tied), labeled and must not block air flow. The cables should be visibly traceable between racks
- When possible, label cords and cables. Use a label printer and just put a number on both ends of any cable
- Color coding a/b power paths can be helpful, even if it is as simple as marking both ends of each black cable, including the ones supplying power to each UPS, with either red (UPS), blue (utility) or yellow (second source) electrical tape

- Procure 1 and 2-foot cables and run to the vertical PDUs located on the left and right sides of the rear of the cabinet, since the power supplies are usually biased towards the left or right side of the server chassis

## **Air Management of Computing Racks**

The stakeholder who is responsible for the rack will ensure approved rack plating is installed, modified, and maintained during the life cycle of the computing – installation, refreshes, and retirement. Often this is accomplished by the service provider or vendor performing the installation, modification or decommissioning. Managing blanking panels is especially important in hot/cold aisle environments. Any opening between the hot and cold aisle will degrade the air management program.

All open U positions on the front of racks shall be closed using approved rack plating or fire retardant plastic sheeting to ensure proper airflow.

## **Under Floor Air Management**

Upon the completion of the ARRA project in 2010, all electrical and communications cabling to the computing rack is expected to be done above the rack in the FCC and GCC Computing Centers. Any deviation from this guidance requires consultation with Facility Operations.

The air plenum beneath the floor is used for cooling and the cooling in the rooms depends on the least number of obstructions for adequate cooling and energy efficiency. There are also Fire Suppression concerns with cabling under the raised floor.

## **Doors and Locks on Computing Racks**

Less than 1% of the racks in computing centers require doors. Security concerns occasionally do require lockable doors on racks housing equipment and cross connects. Doors, however, must not obstruct airflow and this is particularly concerning with high power density racks. At a minimum, the doors should offer a minimum of 50 percent open perforations, although 65 percent or better is preferable.

If your rack requires a door or lock, please consult Facility Operations. A request should include supporting documentation, labeling on the rack, adequate ventilation and air management, visible PDU power metrics or rack power data available on the web.

# Connecting & Disconnecting Rack PDUs or Computing Equipment to and from the Computing Center Electrical Distribution

The work rules listed below are extracted from the “Procedures for Performing Work in CD Computer Rooms” (Docdb 628)

<https://cd-docdb.fnal.gov:440/cgi-bin/ShowDocument?docid=628>

## Work Rules

1. Persons in computer rooms must not touch breakers and controls on any electric distribution panel, power distribution unit, UPS or air conditioning unit. These are both safety and operational hazards. You should never reset a tripped electrical breaker. You should always contact Facility Operations (see contact list below).
2. Plugging or unplugging of computers into power outlets must be arranged in advance with Facility Operations.

## Power Receptacles for Computing Racks

The typical power distribution to each rack ranges between two to five receptacles. Each computer room has a different prescribed power density for each rack. The PDUs need to conform to the electrical distribution present in the computer room.

Below is a table showing the input rating vs. the de-rated Output rating for several standard receptacles in use within the computing centers:

De-Rated Wattage 80% Values for Common PDUs

<i>NEMA Connector</i>	<i>De-Rated Wattage</i>
L5-20	1920W
L5-30	2880W
L6-20	3328W
L6-30	4992W

The 120V convenience outlets above racks in the power tray are to be used for temporary power for diagnostics, maintenance and repair activities. They are not designed for permanent installations.

## Dual Cording / Dual Power Sourcing

All power to computing racks will have a primary source of electrical power. This primary source in FCC, GCC, and WH8-FC will be UPS power. A secondary power source may be provided from an approved secondary UPS or unconditioned utility power. In all cases, the UPS power will be from production UPS systems maintained and operated by Facility Operations.

Dual cording or dual sourcing power to critical computing equipment can get complex quickly. By implementing this strategy, the equipment can continue to operate with a failure at any point in either power path. Provisioning two sources of electrical power to equipment not only increases reliability of the equipment, but allows preventative maintenance of the electrical system to be performed without disruption to vital services. Even devices that do not have two power supplies can be configured with an electrical transfer switch that enables the dual cording configuration.

Most mission critical networking equipment, storage devices, and servers do have fully redundant input power supplies and dual power cords. Other equipment may also be dual corded and take advantage of the redundant power.

Consult with Facility Operations prior to implementing a dual cording strategy. It is critical to maintain the ability to failover to either source which requires maintaining less than 50% load on either source, below the de-rated power. Misconfiguring the dual cording infrastructure can result in overloading of circuit breakers which can have drastic results, including tripping off the power to the rack or an entire electric panel.

## Furniture and Carts

All furniture items within the computing centers, including desks, chairs, tables, and shelving and server cabinets, are the responsibility of Facility Operations. Furniture items may not be added, removed or relocated without Facility Operations approval.

As an energy efficiency measure a number of years ago, the recommended display for crash carts is a flat screen or similar display.

## General Safety Guidance

- Loose hardware, cables, tools, etc... shall not be stored within the rack enclosures within the computing centers

- The rack leveling feet must be extended to the floor before installing equipment. The full weight of the rack must rest on the leveling feet
- Only one computing equipment chassis is extended at a time during serving. A rack may become unstable if more than one chassis is extended for any reason
- Install heavy servers and other heavy computing equipment in the lower half of the rack. This will save having to lift the servers too high. It will also help the stability of the rack ensuring that the rack does not become top heavy
- When installing more than one item of computing equipment, install the first item in the lower bottom section of the rack, and then install additional items by moving up the rack to the next available opening
- Computing Equipment shall not extend out beyond the rear of the rack enclosure

Additional Safety Guidance can be found in “Procedures for Performing Work in CD Computer Rooms” (Docdb 628)

## 120V Convenience Outlets above Racks

By design the 120V convenience outlets above the computing racks are meant only for temporary use. The receptacles are ganged together on one circuit, consistent with temporary and light use by crash carts or diagnostic gear.

There is no power monitoring for the convenience outlets and therefore it would be possible to overload the single circuit. In this case of unintended use, it creates a single point of failure that can impact multiple racks.

All computing equipment within a given rack should be connected to power within the rack. Temporary loads may be connected to convenience outlets and be assured that the temporary work will not impact the critical load.

## Rack Numbering – Naming Convention

Room	Syntax	Range	Racks
GCC-Tape Robot Room	GCC-TR-XXXX	0500-0507	8
GCC-Network Room A	GCC-NRA-00XX	N1-N15	15

GCC-Computer Room A	GCC-CRA-XXXX	2000-2076	77
GCC-Computer Room B	GCC-CRB-XXXX	3000-3083	84
GCC-Network Room B	GCC-NRB-00XX	N1-N16	16
GCC-Computer Room C	GCC-CRC-XXXX	3700-3763	64
FCC2-Computer Room	FCC-2-XXXX	~11XX-17XX	~185
FCC3-Computer Room	FCC-3-XXXX	1001-1072	72
FCC3-Network Room	FCC-3-NRXX	N1-N6	6
Wilson Hall 8 – FC	WH-8FC-XXXX		14

## Summary

The recommended specifications and features listed throughout this document are intended to provide optimal power, cooling and space utilization for a computer rack installation. For rack installations which cannot conform to these recommendations, please contact Facility Operations.