NMCI Server Farm Technology Design Standards and Specifications: Increments 1 and 2

Document Release Information

Document Change History

Rev #	Date	Author	Section	Reviewer	Nature of Change
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2.10.4_NS	5/28/02	PM	All	PM/JH/KS	Secure label; Sec. 19.5 reference to Cable Plant, Updated MDF design
2.10.5_NS		PM/AD	All	PM/AD/JH/MD/ TL	Removed Section 10.5: Cable Trays (published separately)
2.10.6_NS					Name change due to standard revision
2.10.7_NS	11/22/02	JH	2,6,7,21	JH/TN	Seat counts are removed and verbiage is corrected
2.11.1_NS	11/25/02	JH/PM	All	JH/TN	Removed dry retardant system references and emergency power-off switch references; Removed references to “tile cut” designs; edited to conform to overall design changes in progress and added definitions.
2.11.2_NS	12/02/02	MT	1.1	MT/TN	Updated the Dell PowerEdge model numbers and added the Sun Fire 280R to the list of rack mount servers; added 4 Xeon processors to the PowerEdge 6450/6650; added the Dell FC4700

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					and Dell DAE to the list of SAN equipment; added the Dell FC4700 to the Dell PowerVault 650F/DAE description; added the Dell DS-128-B2, Dell DS-32, Cisco 3550, Cisco Catalyst 6506, NetScreen- 500, and Crossroads 10000 to the list of switching/routing equipment.
2.11.2_NS	01/06/03	PM	19,20	PM/TN/AD/MT	Added disclosure information; removed sections replaced by Rack Standards document (upcoming publication).
2.11.3_NS	01/23/03	TN	19.6, 19.10, 19.15, 22.1.5	PM	Added illustrations of floor plan example, cable plant materials references sample, and tile cut example with explanations. Removed section 22.1.5. Edited section 21.2.2.
2.11.4_NS	01/24/03	TN	17.4.1	PM	Renamed file to conform to current document file naming conventions. Updated Document Properties. Edited verbiage in Section 17.4.1.
2.11.4_NS	02/04/03	TN	19.7, 19.9, 19.11, 19.12, 19.13, 19.15	PM	Updated the following diagrams: Cable Matrix Example (Figure 2), Logical Backbone Diagram (Figure 4), Receptacle Location Plan (Figure 6), Patch Field Schematic (Figure 7), Cable Trays (Figure 8), and Tile Cut Diagram (Figure 10).
2.11.4_NS	03/11/03	TN	All	PM	Added “rough draft” to the cover page, Document Properties page, and footers. Deleted the following from reference material: Data Storage Power Redundancy Requirements (publication); Installation Notes for Seismic Bracing (publication); NMCI ISF Facilities Specification (standard); NMCI ISF Server Farm Grounding (standard); NMCI ISF Server Farm Rack Standards: Common Rack Mounting Standards (Pub. Date 1/15/03); Rack Power Labeling (standard); and Server Farm Layout Requirements (standard). Added “miscellaneous” to Reading a Cable Matrix (PowerPoint) and Understanding the Patch Field Schematic (publication); renamed NMCI Naming Standards (DEV 400-SP-ISS-39001 Naming Standard 8.1 to DEV400-SP-ISS-39001 NMCI Naming Standards v. 8.4 (400 series document).
11.5	03/19/03	TN	All	PM	Replaced NMCI logo with EDS logo on cover pages and in footers of document.
2.12.1	04/18/03	PM	All	PM	Removed ISF in all instances, included title change, revisions to all sections where ISF was noted.

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Revision Process

The contents of this document are of special interest to NMCI and those team members should be notified when any updates are made or related documents are created.

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Table of Contents

List of Figures

List of Tables

List of Appendices and Reference Material (Available on nmci.idc-mcs.com)

Appendices to this document:

APPENDIX: NMCI NAMING CONVENTION
APPENDIX: NMCI ACRONYMS AND ABBREVIATIONS (NAVIGATION TOOL GLOSSARY)
APPENDIX: NMCI SERVER FARM CABLE TRAYS STANDARD

Reference material:

- Reading a Cable Matrix (PowerPoint - miscellaneous)
- Understanding the Patch Field Schematic (publication - miscellaneous)
- DEV 400-SP-ISS-39001 Naming Standards v8.10 (400 series document)

1. Overview

This document, prepared for the Navy Marine Corps Internet (NMCI), is a template or guide to the minimum information technology (IT) infrastructure design standards of NMCI Server Farm facilities. IT infrastructure includes equipment and rack spacing and layout, cabling and patch field wiring, and equipment placement within the rack. The IT infrastructure design predicates and drives the supporting facilities infrastructure (mechanical, electrical, plumbing [MEP]) engineering.

This document is *general* in nature and is a guide to the minimum design standards and specifications for a specific Server Farm type. Each Server Farm design will have separate site-specific documentation.

This document is part of a secure website knowledge base contained on the NMCI Website. Access to the website may be requested by completing the NMCI Website Access Request Form (available at https://nmci.idc-mcs.com).

1.1 Purpose

1.1.1 The NMCI Infrastructure Design Team created this document as the authoritative reference for specific Server Farm designs. This document is a guideline in evaluating ***existing*** facilities and a template for ***new*** facilities. XXXXXX

1.1.2 We expect circumstances to arise requiring variances to the design plans. Design changes are requested via the *Infrastructure Configuration Control Board Request Form*, and managed by the *Infrastructure Configuration Control Board Process*; related documentation changes are requested via the *Document Change Request.* All of these documents are available from the NMCI Website (https://nmci.idc-mcs.com).

1.1.3 There are references in this document written in United States (U.S.) standards, and it will be necessary to revise them converting or substituting the appropriate voltages, frequencies, regulations, etc., as necessary, to correspond with the needs of the project. All design and construction must conform to all jurisdictional codes and ordinances.

1.2 Vision

1.2.1 The Navy and Marine Corps Intranet (NMCI) is a Department of Navy (DoN) initiative to deliver comprehensive, end-to-end information services through a common, secure computing and communications environment. This environment enhances system and software security and interoperability, and improves the information exchange capability among users within the NMCI environment and to tactical/business partners in the deployed forces and Joint environment. The NMCI mission is to plan, coordinate and align the entire information infrastructure (to include enterprise systems and data) under a single, coherent and forward-looking management strategy. The information infrastructure must support the warfighters and decision-makers by enabling the right information to be

available at the right place and time. Therefore, the NMCI solution and strategy must be aligned with and support both current and future DoN tactical and business process and operational concepts.

1.2.2 The capability and performance of NMCI will extend to all United States Navy (USN) and US Marine Corps (USMC) bases, posts, camps, stations, activities and locations. NMCI service area includes: the Continental United States (CONUS), including Alaska, Hawaii, and Puerto Rico; and Outside CONUS (OCONUS), including Cuba, Japan and Iceland; for an estimated 411,000 Navy and Marine Corps uniformed and civilian workforce members, including reservists. NMCI infrastructure and services will not extend to afloat or deployed units. NMCI's infrastructure and services end-point is the physical interface with the tactical or operational connection available to afloat and/or deployed units provided by the Defense Information Systems Network (DISN). Navy and Marine Corps units that embark aboard deploying afloat units may be provided with NMCI transportable hardware and software.

1.3 Design Assumptions

1.3.1 One Global Network Operation Center (GNOC), four regional Network Operation Centers (NOCs), and 66 Server Farms are in the planned implementation.

1.3.2 NOC connectivity to each Server Farm shall be DS-3 raw bandwidth (minimum). Additional assumptions:

- Attachment 15 of the NMCI request for proposal (RFP) defines the size of the user community for each location.
- Desktop standardization and administrative control shall be based on requirements of the USN and the USMC, as well as particular Commands within each branch of service.
- Replication of directory changes must be completed within four (4) hours.
- Server Farms are designed with enough surge capacity to function as emergency backup for other Server Farms key services and for short periods of time.
- Each Server Farm shall have defined classified and unclassified areas with separate IT infrastructure connectivity.
- Storage requirements in each Server Farm are designed with 25% additional space for growth and 25% for surge space.
- Server Farms have unclassified and classified areas for the appropriate related equipment.
- Backup is designed to handle up to 25% of changed data daily with two weeks of recoverable data available in tape silos.
- Server Farms shall have storage area network (SAN) configurations for external storage. The SAN is fault tolerant utilizing a redundant array of independent disks (RAID) and multiple redundant power supplies.

1.4 Design Objectives

1.4.1 Statement of Objectives: To design Server Farms based on industry standard platforms with proven technology that will integrate seamlessly with the network infrastructure to provide the performance and availability necessary to meet the NMCI contracted Service Level Agreements (SLAs).

1.4.2 The following design objectives were observed in the creation of this design:

- Highly available and redundant
- Performance
- Scalability
- Component redundancy
- Industry Best Practices
- Industry Sizing Tools
- The design should scale to the eventual size of NMCI
- The design should be flexible to meet the needs of the DoN.

2. Server Farm Description

A *Server Farm* is a group of networked servers housed in one location. A Server Farm streamlines internal processes by distributing the workload between the individual components of the farm and expedites computing processes by harnessing the power of multiple servers. The farms rely on load-balancing software that accomplishes such tasks as tracking demand for processing power from different machines, prioritizing the tasks and scheduling and rescheduling them depending on priority and demand that users put on the network. When one server in the farm fails, another can step in as a backup.

2.1 Server Farm Design Consolidation

2.1.1 EDS has taken the steps to consolidate services across the continental United States. This massive NMCI project is to replace over 300 disparate networks within the USN and USMC with one seamless network. This single system shall provide greater network security; improve the flow of information between ships and bases, and save money and time.

2.1.2 EDS shall consolidate services from the largest bases down to the very smallest. The core services for each user are file, print, e-mail, web, and collaboration services such as: conferencing, instant messaging, chat and newsgroups.

Note: All mention of Server Farms refers to unclassified and classified equipment unless specifically stated otherwise.

2.1.3 The NMCI is organized around the concept of a "seat," and covers the cost of providing the network infrastructure as well as the desktop system. The NMCI "seat" includes the cost of the hardware,

troubleshooting, technology refreshment, and training. An NMCI "seat" is the only way to access the corporate network and its services, including e-mail.

2.1.4 NMCI Server Farms are designated as Small (S), Medium (M), Large (L), and Very Large (VL).

2.1.5 Users with an NMCI seat shall be able to log into the network from designated outlets. NMCI portable users, for example, shall be able to plug into NMCI designated active conference room wall plug or NMCI connected vacant docking stations.

2.1.6 NMCI shall use the industry standard for e-mail, 50 megabytes (Mb) per mail account. Currently, e-mail storage limits vary considerably.

2.1.7 NMCI shall rely on a dedicated help desk 24 hours a day, seven days a week, 365 days a year. Help desk analysts shall be available from the Network Operations Centers (NOCs) to assist with network problems.

2.1.8 Users that move between classified and unclassified work have two options for their seat equipment: a single computer with two hard drives that would be rebooted to clean the random access memory when shifting between the two hard drives or two central processing units with a single monitor.

2.2 Assumptions and Clarifications

2.2.1 Definition of a Site: In general, a site can be either an actual military base or one that is military base-like. Only one site can reside per base and, where possible, the name used should be the military standard. Four types of sites have been defined and documented as of 30 November 2000. They are:

2.2.2 **Base/Camp/Station**: A geographically contiguous piece of government real estate comprised of multiple buildings in campus-like infrastructures or point-to-point circuits to a limited number of wide area Points of Presence (POPs) located within the geographical boundary. Examples include: NAVSTA and NAS.

2.2.3 **Complex**: A group of buildings resembling a campus-like infrastructure that may or may not reside on government property. A complex is linked with high-speed service to a limited number of wide area POPs maintained for the campus network. Complexes that reside on bases will be counted with the base. Examples include: GSA furnished space in the Federal Building in Asheville, NC.

2.2.4 **Campus**: Any educational or commercial campus where NMCI connectivity is required. An example would be Duke University.

2.2.5 **Building**: A single, remote building that is connected to the Wide Area Network. This structure is not part of a base, campus, or complex. An example is a RESFOR building servicing 25 users in Oklahoma.

2.2.6 NOTE: Metropolitan areas are NOT treated as sites. They represent a collection of sites such as Norfolk and San Diego, which are classified areas.

2.2.7 Generally, any location that has 1,200 or more users will have a dedicated Server Farm. This has been accomplished by carefully aligning sites, where data seats are located, to the Server Farm sizes. In addition, there are instances when Server Farms are provided where there is less then 1200 seats. This is done for distant or isolated locations.

2.2.8 Small sites were assigned among Server Farms that were geographically closest. The intent is to minimize WAN (Wide Area Network) circuit distances.

2.2.9 All general-purpose servers will be configured with RAID 1 mirrored operating system and two Intel 1000F Gigabit (Gb) cards for high availability.

2.2.10 Server farms were grouped within NOC regions in an effort to balance the number of seats to be managed by each NOC. In an effort to accomplish this task, some Server Farms may be geographically farther from the NOC then might otherwise be done. Where possible, and within each region, the largest Server Farm is co-located with the NOC. Where possible, activities with similar functions were grouped.

2.3 Server Farm Square Footage

2.3.1 The following table identifies the approximate square footage required for each size of Server Farm and a variety of suitable dimensions for each.

Size	Square Feet	Square Foot	Option One	Option Two	Option Three
Small	1,850	43 x 43	37x 50 = 1,850	25 x 75 = 1,850	19 x 100 = 1,900
Medium	3,000	55 x 55	60 x 50 = 3,000	40 x 75 = 3,000	30 x 100 = 3,000
Large	4,850	70 x 70	97 x 50 = 4,850	67 x 75 = 4,875	49 x 100 = 4,900
Very Large	7,250	85 x 85	145 x 50 = 7,200	92 x 75 = 7,275	73 x 100 = 7,300

Table 1: Server Farm Square Footage and Suitable Dimensions by Size

2.4 Server Farm Services

2.4.1 Server Farms consist of the core computing competencies required to support a Naval or Marine base and will serve as the Local Operations Center (LOC). From a basic view each LOC will handle Dynamic Host Configuration Protocol (DHCP), Network Server, Print Server, Global Catalog and Domain Controllers.

2.4.2 Listed below are the names of those servers and services:

- Domain Controllers
- Messaging Servers
- Cluster Exchange Servers
- Front End Exchange Proxy Servers

- Bridgehead Exchange Servers
- Conversational Monitor System (CMS) Exchange Servers
- Multipoint Control Unit (MCU) Exchange Conferencing Servers
- Standby Spare Servers
- File and Print Servers
- Cluster Print Servers
- Cluster File Servers
- Internet Protocol (IP) Load Balancer
- Software Distribution Servers

- Resolution Servers
- DHCP/Windows Internet Naming Service (WINS) Servers
- Domain Name System (DNS) Servers

- Web Function Servers
- Web Crawlers
- Web Servers
- Cache Servers

3. Designation Criteria for Technical Facilities

3.1.1 General capabilities of a Server Farm facility:

- Facility infrastructure systems protect computer equipment against electrical fluctuations and prolonged electrical utility outages
- Standby electrical power generation
- Scheduled maintenance outages are required
- Specialized fire and security systems
- Cooled by Closed Air Conditioning (CAC) systems, with backup N+1.

3.1.2 Components of a facility built to this standard would typically include:

- (2N) Uninterruptible Power Supply (UPS) system, with backup modules connected
- Special electrical switchgear and distribution system with power distribution units
- Standby generator with automatic connection to critical systems
- Surge protection devices
- Lightning protection system on building exterior (where applicable)
- Stand alone CAC units or a central system, with humidity control and a backup air conditioning source
- EDS approved monitoring method for the UPS, CAC systems and power quality
- Specialized fire detection and suppression system
- Equipment grounding system
- EDS approved security access controls and surveillance systems

4. Selection Guidelines – Geographic Location

NMCI program sites are Government Furnished Facilities (GFF), and close attention is paid to the following minimal site considerations:

- The sites should be constructed at ground floor level, or on a floor capable of the equipment load weight required by the NMCI Server Farms.
- The site locations shall be free of hazardous materials, with no abatements required or scheduled.
- The site locations shall be located proximate to communications infrastructures to accommodate the NMCI Server Farms.
- The site locations must be in an area with *sufficient utility support infrastructure* for power, water service, sewers and natural gas (if required). A quantifiable history of reliable utility power to the site location is essential. The potential for increasing power requirements must be available.
- The site locations should be in areas that meet NMCI Server Farm zoning requirements.
- The site locations shall be secured from the possibility of damage due to adjacent influences. These influences include, but are not limited to, railroad tracks, major highways, and major or minor airfield flight paths. Site locations to avoid should include public areas and buildings that may be political or strategic targets for terrorism.
- The site locations shall not be in proximity to major manufacturing, industrial, or utility areas that may cause power instability, radio frequency interference, pollution, vibration, etc.
- The site locations shall allow or have potential for dual communications services from opposing directions.

4.1 Specific Site Selection Guidelines

After validating the facilities geographic location, specific sites shall be evaluated with the following considerations:

4.1.1 A “Level One” environmental survey shall be performed on the new or existing buildings/sites. A level one environmental survey involves a visual inspection of property to discover any possible sources of contamination in soils, water, air, or building materials. Samples are taken and analyzed. A level one survey relies on the accuracy of the building's known history and construction/maintenance records. This includes researching municipal records for evidence of past permits or statements referencing the presence or use of toxic materials on or near the property for the subject address.

4.1.2 Things to look for in a Level One survey include:

- Underground storage tanks (UST) of any type
- Potential sources of lead contamination in domestic water piping and distribution (not uncommon in older buildings);
- Contaminated soil (especially fill material imported to the site during construction).
- Asbestos (most commonly found in the form of vinyl asbestos floor tile and various insulation).
- Volatile airborne compounds, with special attention to those that can leak from faulty mechanical systems such as Heating, Ventilation, Air Conditioning (HVAC) refrigerant and water treatment tanks/injectors.
- Proper use and storage of toxic materials such as paint, cleaners, pesticides.
- Building sanitary systems in good working order. With special attention to makeup air intakes, plumbing traps, plumbing vents, grease traps, sewage pumps, and fire and safety systems.

4.1.3 The United States Environmental Protection Agency banned the use of asbestos-containing-material for building construction in 1989. Any structure built before this date has a chance of containing asbestos in some form. In most jurisdictions the burden of law is upon the building owner to reveal the presence of any known toxic compounds on the property at the time of sale or lease. If asbestos is discovered, or believed to be present, immediately contact an NMCI implementation team representative.

4.1.4 A risk analysis of the site *shall be performed* to ascertain potential risks and determine site viability.

4.2 Selection Guidelines - Existing Building

The most critical areas of selection concern regarding existing buildings include available power, structural capability and ceiling height availability. If an existing multi-tenant building does not have a water sprinkler fire protection system, the building shall not be considered. There are numerous other elements that shall be researched, but these usually restrict the building from being used for enhanced mission critical operations.

4.2.1 Note: NMCI facilities may also reject a multi-tenant building if one of the tenants is a competitor with one of EDS' main lines of business.

4.2.2 If NMCI facilities enter into a contract with a third party to find and identify an existing building for an enhanced data center facility, the third party shall document all discrepancies between these guidelines and the building's actual conditions. The NMCI representative shall evaluate these discrepancies and if the building appears to be a feasible selection, and an NMCI facilities representative will visit the building to make a final analysis. *Existing buildings shall not be accepted without an NMCI facilities representatives' approval.*

4.3 Building Locations - Orientation on the Site

4.3.1 The buildings must be located in areas without the risk of flooding due to excess rains, snow melt or storm drainage from adjacent properties, streams, etc. The Server Farm *shall have its lowest floor level above the 100-year flood plain*.

4.3.2 The buildings should be located in zoned areas *free of noise and environmental restrictions* due to the operation of diesel engine generators (i.e., adjacent to residential areas).

4.3.3 The buildings should be located in areas free of governmental and environmental restrictions related to natural bodies of water, wooded sites, wildlife, historical structures, et al., as may restrict or curtail the construction of the facilities.

4.3.4 The buildings should be located where there is a potential for expansion, if required. The drawings will indicate (via dashed lines) the area where the building(s) can be expanded, if desired. This will illustrate the full potential of the sites.

4.4 Site Design Configuration

The buildings must accommodate the delivery and servicing of equipment. Support for the facilities contractor during NMCI implementation and ongoing operations will require both permanent and temporary space for administration and warehousing. The ideal space would be near the Server Farm to facilitate construction and operations, as well as minimize disruption to base operations.

	Permanent	Temporary	Permanent	Temporary

Server Farm Size	Admin Space	Admin Space	Warehouse Space	Warehouse Space
Small – 1,850 sq.ft.	700 sq.ft.	400 sq.ft.	1,600 sq.ft.	2,000 sq.ft.
Medium – 3,000 sq.ft.	1,100 sq.ft.	1,300 sq.ft.	1,700 sq.ft.	2,500 sq.ft.
Large – 4,850 sq.ft.	2,200 sq.ft.	1,800 sq.ft.	3,000 sq.ft.	3,000 sq.ft.
Very Large – 7,250 sq.ft.	3,000 sq.ft.	2,500 sq.ft.	3,600 sq.ft.	5,000 sq.ft.

Table 2: Space Requirements in Square Footage based on Server Farm Size

4.4.1 The buildings must accommodate the installation of exterior equipment such as transformers, diesel engine generators, microwave, satellite and radio antennas, heat rejection equipment, etc.

4.4.2 The buildings shall accommodate firefighting equipment, per local regulatory requirements.

4.4.3 The buildings shall include 24-hour controlled access security gates and sign-in procedures.

4.4.4 The buildings must have vehicle parking as required for the specific building function as specified by NMCI, and adhere to local ordinances.

4.4.5 The buildings shall have all parking areas and building entrances well lit.

4.4.6 The site locations must be designed with appropriate barriers to restrict the intentional or unintentional damage caused to the buildings or support equipment by vehicular traffic.

4.4.7 Floor loading capacities for the raised floor areas shall be 150 lbs./sq. ft. (732 kg./m^2).

4.4.8 Floor loading capacities for the mechanical, electrical and battery rooms shall be 400 lbs./sq. ft. (1220 kg./m^2).

Note: The floor loading requirements provide for concentrated loads imposed directly under equipment and may be averaged throughout the area in accordance with good structural design practices. *Each specific site is unique and requires the structural integrity to be checked by a qualified structural engineer*.

5. Existing Buildings Guidelines

5.1.1 Buildings being evaluated should have roofs of structural steel beams, trusses/joists with metal decking. Other materials will be considered based on the geographical location of the building. If the building's size warrants, it is preferred the roof be pitched a minimum of 1/8' per foot (1 cm/m), and shall be pitched to the exterior building perimeter walls, to scuppers and downspouts. This eliminates the need for roof drains that drain through roof drainages and storm pipes inside the building. Where interior roof drains are necessary, they shall be strategically placed to minimize the opportunity for leakage into the facility.

5.1.2 Existing concrete roof deck is also acceptable and may be required in tornado and hurricane prone areas. The Architects/Engineers of record shall make recommendations and provide advantages and disadvantages for their selections.

5.1.3 In addition to the normal roof "live load" requirements, the roof structure shall be confirmed to support the load from specific roof top equipment as well as provide support for suspended cabling systems, if required. Walkway surfaces must be provided to all roof top equipment. Roof access shall be from a stairway leading to a secure room within the building. This area shall accommodate lifting supplies to the roof. Section 6.5.6 includes a table referencing ceiling height baselines.

5.1.4 The existing roof structure shall have enough height so the design can provide a minimum of 36" (91cm) of clear space between the lowest part of the structural framing members and the suspended ceiling construction.

6. General Building Guidelines: Floor Plan Layout/Design and Baselines

6.1.1 The building shall have an efficient layout with regard to shape and structural column spacing. It is crucial that an existing GFF building have the required "net" square footage requirements so that all inefficiencies of columns and other obstructions are deducted from the gross square footages.

6.1.2 All attempts must be made to design the data center's IT equipment room areas as close to a square configuration as possible. Note: This is conducive to the data center layout with regard to the 24 in. x 24 in. (61cm x 61cm) raised access floor grid system. Assume that equipment row line-ups are 6-feet center to center, the bay spacing should be on a 6 ft. module; i.e. bays that are 36 ft. x 36 ft. (11.0m x 11.0m) or 42 ft. x 42 ft. (12.8m x 12.8m) as an example. This system allows building columns locations within the IT equipment rows, and not interfering with aisle ways.

6.1.3 Floor plan designs must allow a path from the loading dock to the data center entrance(s), as well as the mechanical and electrical equipment rooms, etc. It shall be direct and of sufficient width to accommodate the passage of large, heavy equipment.

6.1.4 Provide that all critical IT equipment and infrastructure support equipment rooms are in areas not subject to flooding or water infiltration through walls, floors or ceiling. (Areas known to be subject to water infiltration include: basements, spaces beneath toilet rooms, below major piping, near drain lines, water lines, roof drains and water filled sprinkler mains.)

6.1.5 Floor plan designs must allow that IT equipment rooms avoid sources of electromagnetic, electrostatic or radio frequency interference that may be caused by large electric motors (elevators, etc.) transformers, copy machines, power tools and other electric appliances.

6.1.6 Floor plan designs must ensure that mechanical and electrical equipment and computer/ communications equipment is laid out with sufficient aisle space for transporting equipment in and out of

the area. Heavy equipment including air conditioning units (ACUs), UPSs, and power distribution units (PDUs) shall have a minimum three (3) inch clearance from walls.

6.1.7 If the loading dock and equipment rooms (IT equipment rooms as well as mechanical/electrical equipment rooms) are on different floor levels, elevators (lifts) designed to accommodate the largest/ heaviest piece of equipment anticipated shall be provided. For large facilities, freight elevators (goods lifts) shall be provided in addition to required passenger elevators.

6.1.8 Floor plan designs must provide space clearances for maintaining equipment and to meet clearance and workspace requirements as required by regional regulations.

6.1.9 Floor plan designs must give consideration for ambient noise levels and vibration from interior or exterior sources that may affect adjacent areas.

6.1.10 The general office area main entrance (for aesthetic reasons) should be designed to keep exterior mechanical and electrical equipment and the loading dock areas out of view. The main entrance should be of an aesthetically pleasing design.

6.1.11 The general office area may consist of the lobby, offices, conference room(s), break room, toilet rooms, janitor closet and possibly a small mechanical and electrical room. If this area of the building is remote from the main service equipment areas of the building, provide additional toilet rooms at the service equipment areas.

6.2 Concrete Floors

6.2.1 All concrete sub-floors in raised access computer floor areas shall be sealed concrete.

6.2.2 All exposed concrete floors in mechanical and electrical equipment rooms, battery rooms, dock areas, etc. shall be sealed concrete.

6.3 General Area Floors

6.3.1 All office areas shall be carpet tiles.

6.3.2 Toilet rooms shall be ceramic tiles.

6.4 Walls

6.4.1 Walls are not required between classified and unclassified server areas.

6.4.2 Walls separating critical mechanical and electrical equipment rooms shall extend from the floor slab to the bottom of the roof or floor deck above, and shall be constructed with a one hour fire rated assembly to assure a catastrophe within one system cannot physically affect the Server Farm.

6.4.3 Walls surrounding the mission critical equipment data center areas shall extend from the floor slab to the bottom of the roof or floor deck above, and shall be constructed with a one hour fire rated assembly. In addition, sufficient wall insulation shall be installed to ensure that the dew point occurs inside a sealed, dry medium to prevent condensation forming inside the critical room.

6.4.4 Wall surrounding magnetic tape and other media storage shall extend from the floor slab to the bottom of the roof or floor deck above and shall be constructed with a one hour fire rated assembly.

6.4.5 All walls shall have a painted finish.

6.4.6 All gypsum board walls and column enclosures shall have a vinyl or rubber coved base, including the walls within raised access computer floor areas.

6.4.7 All gypsum board walls and column enclosures within raised access computer floor areas shall be caulked at the bottom where the gypsum board meets the concrete sub floor. In general, caulking shall be installed at all locations where dissimilar materials meet.

6.5 Ceilings

6.5.1 National Fire Code requirements dictate the distance between the tops of any equipment or racks and the ceiling shall be a minimum of 18 in. (45cm).

6.5.2 With the exception of mechanical and electrical equipment rooms, all areas shall have a 2 ft. x 4 ft. (60cm x 1.2m) suspended lay-in acoustical ceiling panel system and shall be a minimum of 9’0” in height from finished floor. Ceiling panels in the raised access floor areas (mission critical data center areas) shall be a vinyl coated type, similar to Armstrong World Industries, Inc., ‘Clean Room VL – Non-perforated’ type. The ceilings shall have one hour rated tiles and one hour rated ceiling grid.

6.5.3 As an alternative to the ceiling type listed above, an exposed-construction, or ‘no ceiling’ scenario will be considered. This will be a site-specific decision based on aesthetic, fire protection, cost or cleanliness requirements. If this alternative is selected, then the exposed-construction must be painted and the appropriate lighting, fire detection and fire suppression systems must be installed. If the structure above the raised floor area is structural steel with a sprayed-on fireproofing material, then a suspended ceiling is required with ducted supply return air conditioning.

6.5.4 For areas containing a suspended ceiling system, the ceiling height in data center areas shall be 12 ft. 0 in. (3.7m). In existing buildings where this height is not feasible, the minimum height shall never be less than 9 ft. 0 in. (2.7m). The clear height in equipment rooms between the floor and bottom of the exposed structure shall not be less than 15 ft. 0 in. (4.6m).

6.5.5 All general office areas shall have 2 ft. x 4 ft. (60cm x 1.2m) standard suspended lay-in acoustical ceiling systems. The ceiling height shall be 10 ft. 0 in. (3.0m).

6.5.6 All equipment rooms shall have painted exposed-construction ceiling areas.

6.5.7 A typical Server Farm has the following elevation requirements to properly support its functions and must, at a minimum, meet the following criteria to be accepted as an available candidate:

Raised Flooring Height	Rack / Cabinet Height	Sprinkler Clearance	Lighting Clearance	Overhead Utility Distribution	Total Slab to Understructure Clearance Required
18" – 24"	84"	18"	12"	12"	150" or 12½'

Table 3: Ceiling Height Baselines (Clearance Requirements)

6.6 Doors

6.6.1 Interior doors in general office areas shall be solid core wood with laminated plastic finish.

6.6.2 Interior doors in fire-rated walls shall be painted hollow metal with fire ratings to match the wall construction.

6.6.3 Exterior doors shall be painted, insulated, hollow metal.

6.6.4 The door(s) into the general office/lobby area shall match the entrance design curtain wall system.

6.6.5 Doors to mechanical and electrical equipment rooms shall be in pairs of doors, to form a nominal opening of 8 ft. 0 in. (2.4m) wide x 8 ft. 0 in. (2.4m) high.

6.6.6 Doors to computer equipment rooms (where equipment is to be brought into the room) shall be in pairs of doors, to form a nominal opening of 8 ft. 0 in. (2.44m) wide x 8 ft. 0 in. (2.4m) high.

6.6.7 Pedestrian doors shall be a minimum of 3 ft. 0 in. (92cm) wide x 7 ft. 0 in. (2.1m) high.

6.7 Utility Power Baselines

Servers Farms will have high-density equipment installed in high concentration rows and require extensive utility power. This includes (but is not limited to) all air condition units (ACUs), Uninterruptible Power Supplies (UPSs) and lighting equipment. The base is responsible for providing the primary power to the facility, and the NMCI facilities implementation team shall install the power distribution within the facility as needed.

6.7.1 The following tables represent the minimum dedicated baseline requirements for the utility criteria in site selection:

Server Farm Size	Size in Sq. Ft.	Primary Voltage	Secondary Voltage	Utility Full Load Amperage
Small	1,850	480, 4160, or 12.5	480	380
Medium	3,000	480, 4160, or 12.5	480	634
Large	4,850	480, 4160, or 12.5	480	1200
Very Large	7,250	480, 4160, or 12.5	480	1740

Table 4: Minimum Baseline Voltage Requirements for Server Farms by Size

POP Size	Primary Voltage	Secondary Voltage	Utility Full Load Amperage
Up to 48	120	120	40
49 – 100	120	120	60
101-200	480	120/208	100
201 – 1000	480, 4160, or 12.5	480	180
1000 +	480, 4160, or 12.5	480	250

Table 5: Minimum Baseline Voltage Requirements for Points-Of-Presence by Seats

IDF/MDF	Primary Voltage	Secondary Voltage	Utility Full Load Amperage
IDF Cabinet	120	120	40
MDF Cabinet	208	208	40

Table 6: Minimum Baseline Voltage Requirements for IDF/MDF

6.7.2 Consideration is given as to the capability of the local Public Works Office/Naval Facilities (PWO/NAVFAC) organizations to provide utility services within the time frame necessary to support the facility build out and completion time frames. The baseline requirement is the utility power shall be made available to the NMCI Facilities Architectural and Engineering (A&E) Design/Build Teams within 75% of the projects completion duration.

6.7.3 Typical project time frames from site survey to project complete are as follows:

Server Farm Size	Duration in Days
Small	119
Medium	139
Large	173
Very Large	216

Table 7: Server Farm Completion Time Frame by Size

6.8 Standby Generator Baselines

Server Farms shall have an NMCI facilities provided, locally approved and compliant standby generator(s) to ensure that an N+1 utility support with a minimum of 24 hours of fuel capacity is provided. In order to comply with this requirement, the GFF site selection shall ensure that the following minimums are met:

6.8.1 A location for the standby generator(s) is within close proximity to the Server Farm.

6.8.2 The local Authorities Having Jurisdiction (AHJ) will allow a standby generator to be installed.

6.8.3 These jurisdictions may include, but not be limited to the following:

- Regional Air Quality Management District
- Regional / Local Noise Attenuation Restrictions
- Local / Regional Fire Marshals / Base PWO
- Local / Regional Coastal Commissions

6.8.4 Fueling and re-fueling can be accessed by mid- to large- sized trucks.

6.8.5 Soil conditions shall be adequate for the NMCI facilities teams to design and install the generator pads sufficient enough to support the weights.

6.8.6 Typical standby generator pad sizes are as follows, in which physical space shall be made available to the NMCI construction team:

Server Farm Size	Pad Square Feet (includes Clearances)
Small	450
Medium	450
Large	550
Very Large	1100

Table 8: Standby Generator Pad Sizes by Server Farm Size

6.9 Fire Suppression / Life Safety Baselines

Where not already present, the NMCI Facilities Design/Build team(s) will be installing or retrofitting the sprinkler system to a “pre-action”/dry pipe sprinkler system.

6.9.1 An HSSD, or High Sensitivity Smoke Detection shall be installed. These systems operate by constantly sampling the air for traces of smoke through a detector unit where air is sampled.

These systems will be designed and installed to the National Fire Protection Association 75 as well as comply with most of the NAVFAC requirements to ensure an overall system is installed that meets commercially acceptable standards.

6.9.2 As a part of the GFF site assessment, a determination shall be made concluding that the building already has a sprinkler riser in the building, or a connection can be made within close proximity.

6.10 Air Conditioning Baselines

In order for the NMCI Design / Build team(s) to ensure proper cooling is present or needs to be enhanced, space needs to be allocated for heat rejection. The heat reject units are air-cooled (DX) type condenser units and need space allocated for placement.

6.10.1 Following are the minimum dedicated space criteria in site selection:

Server Farm Size	Pad Square Feet (includes Clearances)
Small	500
Medium	600
Large	700
Very Large	1000

Table 9: Air Conditioning Space Criteria

6.10.2 The placement of these condenser units can be either on grade or roof mounted depending on the structural capacities of the roof structure.

6.10.3 Following are the minimum pounds per square foot loading requirements if there is no grade location available and the condensers must be roof mounted:

Server Farm Size	Roof Structure – Pounds / Square Foot
Small	35
Medium	40
Large	45
Very Large	50

Table 10: Roof structure loading requirements

6.11 Point of Presence (POP) Baselines

The NMCI Site Point of Presence (POP), including the Information Assurance (IA) boundary, WAN, Core and Distribution Switching will require permanent space for the support of its infrastructure and equipment. The ideal space will be near the site's existing main point of entry (MPOE) for telecommunications infrastructure. In some situations, the POP may not appear in the Server Farm template. When a POP is not co-located its critical systems UPS is N+1, with no generator.

Site Size in Seats	Sq.Ft.-Unclassified	Sq.Ft.-Classified	Racks-Unclassified	Racks-Classified
Up to 48	60 sq.ft.	60 sq.ft.	1	1
49 – 100	80 sq.ft.	80 sq.ft.	2	2
101-200	200 sq.ft.	200 sq.ft.	5	5
201 – 1000	280 sq.ft.	280 sq.ft.	7	7
1000 +	360 sq.ft.	360 sq.ft.	9+	9+

Table 11: POP Square Footage (sq.ft.) Requirements by Seats

6.12 Intermediate and Main Distribution Frame (IDF & MDF) Baselines

The NMCI access and distribution level switches (Intermediate and Main Distribution Frames [IDF & MDF]) comprising the Base Area Network requires permanent space for the support of its infrastructure and equipment. The ideal space for a typical MDF is near the site building's existing main point of entry (MPOE) for telecommunications infrastructure. The ideal space for a typical IDF is within 55–60 meter radius of the seats/users to be served.

Site Size in Seats	SQ.FT.-IDF	Racks-Unclassified	Racks-Classified
Up to 48	8sf/can be wall mounted	1	1
49 – 100	8sf	1	1
101-200	16sf	2	2

Table 12: IDF Space Requirements by Seats Served

6.12.1 The typical MDF includes three (3) racks (2 racks for distribution switches – 1 rack for patch panels). The MDF requires a 24 sq.ft. footprint.

7. Uniform Federal Accessibility Standards (UFAS)

The UFAS is an Executive Branch standard to make federal facilities accessible, and it is roughly equivalent to the Americans with Disabilities Act (ADA). Facilities that do not meet current UFAS requirements must be upgraded to compliance as part of major facilities improvement or repair. The NMCI contract obligates the Government to provide adequate GFF space. This means that the Government will provide facilities appropriate for the intended purpose. The buildings that are being provided for NMCI must either be accessible or have accessibility added prior to NMCI cutover for that facility. (Contracting Officer's position reached 22 Mar 02. Also concurred by SPAWAR counsel, PMO and Southwest Division, NAVFAC.)

NMCI shall comply with all UFAS standards and shall incorporate the American Disabilities Act (ADA) in its designs. It is crucial that the sites being considered for GFF site selection be able to meet UFAS and ADA minimum requirements.

8. Site Access

Site access and construction activities, as well as normal post construction operations, require semi-truck deliveries and contractor lay down areas. It is necessary to provide road and transport access to accommodate this vehicular and personnel traffic.

8.1 Site Issues: Baselines

8.1.1 Hazardous materials: Because of the nature of asbestos, or any other significant environmental concerns that require government abatement, a site in which the aforementioned is present should be chosen with extreme caution. Since it is the responsibility of the government to provide NMCI facilities with a hazardous material free environment, time and cost to remove must be considered.

8.1.2 Relocation of existing personnel or assets: Careful consideration of the cost and time to relocate either existing computing hardware, or existing personnel if the chosen site has such existing, should be taken. Any asset or personnel that resides in a chosen site MUST be relocated prior to the NMCI Design / Build Team(s) start date in order to meet their timelines.

8.1.3 Significant command, PWO or organizational approvals: If the site selected poses significant issues related to seeking and receiving approval to start construction from multiple entities, then a clear path of process and approval needs to be articulated and proven viable.

9. Reliability Requirement

9.1.1 In general, NMCI recognizes the utility as (N) and the standby generator as (+1).

9.1.2 The NMCI program requires an N+1 for all air conditioning. 2N will be supported where required for all power related support.

9.1.3 The Uninterruptible Power Supply design requires a 2N design scheme as well. Two individual (or multiple Uninterruptible Power Supplies if the load requires) Uninterruptible Power Supply units are designed and installed so that each Uninterruptible Power Supply is capable of carrying the entire load. **All mission critical equipment shall be supported 2N.**

9.1.4 Each Uninterruptible Power Supply will support a Power Distribution Unit (PDU) or multiple units as required, supporting an outlet to each rack. The end configuration will be two Uninterruptible Power Supplies, feeding two PDUs supporting two outlets to each rack for complete and total redundancy.

9.1.5 Design the facility infrastructure systems to protect mission critical equipment against prolonged utility outages.

9.1.6 Provide duplicate or redundant equipment or paths so that maintenance outages are not required to maintain any section of switchgear, safely.

9.1.7 **Note**: To utilize the full potential of the electrical redundant power sources, the computer/communications equipment (provided by the user) will require dual power supplies.

10. Utility Services

All feeders between the utility, transformers, generators and main switchgear shall be underground. If and where bus duct is used, it must be enclosed in weather tight enclosures with heaters controlling condensation. **A single utility feed is an accepted NMCI design.**

10.1 Automatic Transfer Switches

All automatic transfer switches (ATSs) or separate circuit breakers that configures an automatic transfer switch operation shall have a complete isolation by-pass. This by-pass allows alternate paths and maintainability without a power outage to the source that it feeds.

10.2 Main Switchgear Distribution

10.2.1 The main switchboard shall be a square D or equal and shall have a Kaic rating of 65,000 unless site conditions dictate otherwise.

10.2.2 Refer to the Transient Voltage Surge Suppression and Monitoring sections of this document for additional requirements.

10.3 Secondary Distribution Panels

10.3.1 Secondary Distribution panel boards for lighting, normal building power, and air conditioning (A/C) should each shall have the appropriate Kaic rating and bolt on circuit breaker configurations.

10.4 Mission Critical Power Distribution

10.4.1 The UPS output critical distribution board should provide power to multiple power distribution units located throughout the raised floor area.

10.4.2 Provide a minimum of two (2) critical power distribution units per Uninterruptible Power Supply each with digital metering, minimum of 126, maximum 210 branch circuit spaces, 480-120/208 VAC transformer (or per regional voltages), sized per load requirements.

10.4.3 Branch circuits from the power distribution units shall be extended under the floor, via conductors in sealtite flexible conduits, to the mission critical equipment. All items of mission critical equipment are equipped with two power supplies. For this equipment, two circuits must be provided, each from separate power distribution units, supported by separate Uninterruptible Power Supplies.

10.4.4 A cable tray system must be designed for the under floor data cable distribution. A basket tray type system is preferred to affords better access for cables and better air movement through the under floor area.

General: Provide wire basket of types and sizes indicated; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces, in compliance with applicable standards and with the following additional construction features.

10.5 General (non-UPS) Power Distribution in IT Equipment Room Areas

In addition to the critical UPS protected circuits for the IT equipment room areas, provide general-purpose receptacles as required per code. As a minimum, provide one, double duplex, general purpose, non-UPS protected receptacle at 12 feet centers within the raised floor area. Install at 18 inches above the finished floor.

10.6 Server Farm Telephone Placement

Two 2-line wall phones are to be installed in each Server Farm. They are to be hard wired (not radio) and placed at each end of each Server Farm floor. These are to be located a minimum of one (1) meter from classified equipment or cabling.

11. Uninterruptible Power Supply (UPS) Protection

11.1.1 The Server Farm areas that contain mission critical computer and communications equipment are designed to the following specifications:

Description	Unit	Small	Medium	Large	Very Large
Gross Raised Floor Area	SF	1,850	3,000	4,850	7,250
Design computer equipment load density	Watts/Sq.Ft.	85	80	83	83
Minimum Utility Capacity	kVA	425	548	880	1366
Minimum Utility Amps	Amps	639.906	824.955	1324.844	2056.854

This equipment load is for the IT equipment only, and does not include the facility infrastructure such as lighting and air conditioning, which is not supported by the Uninterruptible Power Supplies. The requirements for this 'Enhanced' facility include two (2) stand alone UPS systems for an end redundancy of (N+1) as described above. Each of the two stand-alone UPS systems shall be designed to support the entire designated watts/sq.ft. loads based on the size of the Site. In the event of a power failure, the UPS system maintains power to the IT equipment loads without interruption. Exterior maintenance bypass shall be provided.

11.1.2 The UPS system shall consist of a control cabinet, UPS modules, and batteries as described:

- Batteries – Cabinet mounted applications: Sealed, flame retardant, valve regulated, low maintenance, lead acid batteries shall be used for the specified UPS system. The batteries must be housed internal to a UPS matching battery cabinet, and sized to support the UPS at rated load and power factor. No back or side clearance shall be required for the cabinets. The ambient temperature shall be between 68° and 86° F (20° and 30° C), for a minimum of 10 minutes reserve time. Each battery string shall be provided with an independent battery disconnect. The expected life of the batteries shall be 10 years.

- Batteries – Rack mounted applications: Sealed, flame retardant, lead calcium batteries shall be used for the large specified UPS system. The batteries must be housed in freestanding racks that reside in a separate battery room. The batteries sized to support the UPS at rated load and power factor, in an ambient temperature between 68° and 86° (20° and 30° C), for a minimum of 10 minutes reserve time. Each battery string shall be provided with an independent battery disconnect. The expected life of the batteries shall be 20 years.

- Battery Racks – Provide rigid steel racks (for non-cabinet enclosed applications) that are designed specifically for the battery cell type being furnished. Battery racks shall meet all seismic design

requirements for the region where installed. The racks must be two-tier type and shall not extend closer than within 36" of the ceiling. The rack system must be provided with pre-applied insulation, acid resisting, and epoxy paint.

11.1.3 Refer to the Transient Voltage Surge Suppression and Monitoring sections of this document for additional requirements.

11.2 Diesel Engine Generator Protection

11.2.1 Provide stand-by diesel generator systems (1), to operate the entire 'Enhanced' facility, or multiples in order to achieve the necessary rated design capacity to support the load. Generator switchgear shall be provided for paralleling generators to supply building loads, in which a single standby generator cannot provide the necessary power to support the calculated loads. Provide the capability of transferring the power from the utility to generator and generator to utility without interrupting the building load (a closed transition system).

11.2.2 [1]The engine-generator(s) will consist of a diesel powered engine, 3-phase generator, system control panel, cooling system, critical muffler exhaust system, isynchronous governers, dual starters, battery and battery chargers, battery heaters, engine block heaters, generator heaters, and a 24 hour fuel tank (with double wall) to support the calculated load for a 24-hour period and remote status panel, located in the Server Farm.

11.2.3 Provide leak detection alarms/monitoring per the requirements of the regional jurisdiction.

11.2.4 Provide diesel fuel storage tanks large enough to operate the engines at full load without refueling for a minimum of 24-hours. Double walled skid mounted fuel storage tanks are preferred. Fueling contracts with local providers shall guarantee four (4) hour response time.

11.2.5 Provide weatherproof, sound attenuated enclosure(s) applicable for the site conditions and authorities having jurisdiction for engine generator sets installed outdoors.

11.2.6 Detailed diesel-engine generator specifications shall be established based on the specific project requirements. Generator standard manufacturer will be Caterpillar Corporation.

[1] Network Operations Centers: The generator paralleling switchgear (if applicable) shall contain controls for the paralleling of the generator(s) with the building load. The controls shall consist of circuit breakers, protective relays, monitoring equipment and programmable logic controllers. Provide also circuit breakers for load bank testing.

11.3 Transient Voltage Surge Suppression

11.3.1 Transient voltage surge suppressors are to be provided on the main switchboards to protect equipment from externally or internally induced transient power surges. Transient voltage surge suppression may be an integral part of switchboards.

11.4 Lightning Protection

11.4.1 Please refer to NMCI ISF Facilities Specifications Section 16020 – Electrical Design paragraph *2.8 Power Quality Considerations* for complete requirements.

11.4.2 Lightning Risk Assessment shall be performed in accordance with NFPA 780, "Lightning Protection Systems," Appendix H. In the formula of:

$$R = \frac{A + B + C + D + E}{F}$$

Where:
R = Risk Index
A = Type of Structure
B = Type of Construction
C = Relative Location
D = Topography
E = Occupancy and Contents
F = Isoceraunic Level

The index value of "A" (Type of Structure) shall be = 8; and "E" (Occupancy and Contents) shall be = 9.

12. Grounding/Earthing

12.1.1 An equi-potential plane ground system shall be provided in accordance with applicable articles of the latest approved edition of the NEC, NFPA 70, or per regional regulations. This ground system will include a signal reference ground to be installed beneath raised floor areas of all IT equipment rooms. The signal reference ground shall consist of a perimeter grid of #6 copper conductor bolted to the raised floor pedestals and bonded to a structural steel column within the IT equipment room.

12.1.2 Grounding shall conform to ANSI/TIA/EIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications, National Electrical Code® and manufacturer's grounding requirements as minimum. Ground equipment racks, housings, messenger cables, and raceways.

12.1.3 Connect cabinets, racks, and frames to single-point ground which is connected to building ground system via #6 AWG green insulated copper grounding conductor.

Please refer to NMCI ISF Facilities Specifications Section 16020 – Electrical Design part 2, paragraph *2.7 Grounding* (inclusive) and Section 16060 – Grounding and Bonding for NMCI grounding specifications.

13. Power for General Office and Non-Raised Floor Areas

General Office areas shall be designed to support a total load of 10-watts/sq. ft. The electrical requirements shall meet or exceed all regional regulations.

14. Lighting

Please refer to NMCI ISF Facilities Specifications Section 16020 – Electrical Design Part 2, paragraph *2.6 Lighting* (inclusive) for NMCI lighting specifications.

15. Major Equipment Component Testing

15.1.1 All major equipment components shall be thoroughly tested at the factory as well as a complete, thorough and documented by a third party, component and integrated level testing and commissioning at the facility before being placed into service. Please see NMCI ISF Facilities Specifications Section 17100 – Testing and Commissioning, (in addition to factory testing and field startup, for components and systems installed under this section).

15.1.2 Load Bank: Provide the main switchgear and generator switchgear with appropriate circuit breakers so a temporary, portable load bank may be connected to the system for load testing, without the need to shutdown critical equipment. The generator and the UPS system must be able to be taken offline and tested under full-load conditions by means of the load bank. The load bank shall not be purchased, but rented through the approved service organization at the time of scheduled testing.

16. Fire Protection and Fire Detection

In an effort to decrease the risk of losing an entire Server Farm, pre-action (dry-pipe) sprinkler systems shall be installed in each Server Farm (See Section 6.9 for a complete description). Special emphasis was placed on a fire suppression design that mitigates risk of equipment damage and/or loss. Facilities constructed prior to the implementation of this requirement shall be retrofit as funds become available.

16.1 Automatic Flooding System

16.1.1 IT equipment room areas, electrical equipment rooms, battery rooms, and tape or record storage rooms, shall be provided with total flooding gaseous agent extinguishing systems, and dry pipe, pre-

action sprinkler systems with cross-zoned smoke detectors located above the ceiling (if a suspended ceiling is installed), and on the ceiling. This shall be a pre-action dry pipe sprinkler. This configuration allows the sprinkler piping to remain dry until the smoke detection system is activated. Once activated, the pre-action valve opens permitting water to fill the sprinkler pipes.

16.1.2 Water must not flow from the sprinkler heads until ceiling temperatures are high enough to cause the individual fusible link within the sprinkler to operate. This arrangement minimizes the risk of accidental water damage. These pre-action systems shall have supervised air pressure (low-pressure alarm) maintained on the system piping. Pressures shall be maintained per manufacturer's specification with 20 to 30-PSI used as guidelines. Rooms that are not housing mission critical equipment shall be protected with a standard automatic water-based fire suppression system.

16.1.3 Automatic smoke detection equipment shall be installed in all areas including sub-floor areas and above suspended ceilings (where used as a plenum to recirculate air to other parts of the building). The intent is to provide an early warning of fire, heat or existence of products of combustion before a substantial portion of electronic equipment is damaged or destroyed. This system will also be utilized as a life safety tool to notify building personnel of fire related emergencies and the necessity for evacuation of the building.

16.1.4 This system will be an intelligent reporting, microprocessor controlled, fire detection system installed in accordance with the manufacturers specifications and local jurisdictional regulations. All alarms and trouble signals shall be transmitted from the protected premises to a continuously attended supervising station facility. The fire alarm system shall monitor any abnormal conditions within the system, all smoke detection devices, air sampling systems, sprinkler system water flow and supervisory switches, fire pumps (if installed) and manual pull stations. The fire alarm system shall automatically operate alarm notification appliances, release mechanisms for all fire suppression systems, automatic door closures, and where necessary, automatic HVAC shutdown.

16.1.5 Fire suppression and detection systems shall comply with the local standards as directed by NMCI Corporate Security/Fire authorities.

16.2 Hand-held Fire Extinguishers

16.2.1 Wall mounted, type 2A:C rated fire extinguishers shall be provided and installed in such a manner that travel distance to a fire extinguisher shall not exceed 75-ft. (23m). Locations shall be marked with signage for easy access. The 2A rating is for use on fires from ordinary combustibles and the C rating is for use on electrical equipment.

16.2.2 ‘Halontron’ is one extinguisher that carries a 2A:C rating, and ‘CleanGuard’ by Ansul also carries the rating. CleanGuard extinguishers now use Dupont FE-36. ‘Watermist,’ manufactured by Amerex, is also acceptable. This also carries a 2A:C rating and is the most economical of the three. This extinguisher utilizes distilled water combined with a misting effect, which must not conduct electricity. Halon, dry chemical, or carbon dioxide (CO^2) extinguishers shall not be permitted in the raised floor areas if not 2A rated. General office areas and common areas require a 2A rated extinguisher. Monitoring System.

16.2.3 Central monitoring systems will be used for the NMCI program. All devices will be wired for and connected to local Liebert devices for transmission to the Facilities Operations Centers (FOCs). Central monitoring and alarm systems will be connected to all electrical and mechanical systems. This system will be monitored on a 24-hours, 365-days a year basis from a NMCI designated remote monitoring station. Alarms automatically issue pages to assigned technicians, escalating to management based upon service level agreements.

16.2.4 Electrical monitoring capabilities include the ability to remotely read meters and receive alarms on Main Power Switchboards, Stand-by Generators Systems, Main Distribution Panels, Uninterruptible Power Supply Systems, Static Transfer Switches and individual Power Distribution Units including remote side-cars (if used).

16.2.5 Mechanical monitoring capabilities include individual air conditioning settings, supply-return temperatures, and unit alarms. Also outdoor, room and under floor temperature/humidity, and selectable battery cell temperatures.

17. Contract Design Preparation Requirements

17.1.1 The NMCI Infrastructure Design Team creates the computer aided design (CAD) drawings for the NMCI Server Farm infrastructure. The NMCI selected Architect/Engineer, licensed in the jurisdiction where the facility will be constructed, shall create the official Contract Documents. These documents become the official documents of record.

17.1.2 Note: The architect/engineer may be contracted directly by NMCI facilities. They may also be a sub-contractor of a design/build firm, or of a general contractor, if NMCI facilities enters into a contract directly with the design/build firm or a general contractor.

17.1.3 Drawings are created using the computer software application AutoCAD (current version). Drawing sheets shall be 'D' size (24 in. x 36 in.) (60 cm x 90 cm). 'E' size (30 in. x 42 in.) (75 cm x 105 cm) is the largest acceptable size.

17.1.4 Drawings are created using industry standards. Specifications shall be created using the standard format of the Construction Specifications Institute (for US based engineering). When master specifications are used, they are completely edited and made project specific.

17.1.5 If an existing building is to be modified, field measurements and surveys must be completed prior to beginning the drawings. Drawings shall not be developed using the original building drawings as reference. All existing conditions must be completely verified in the field. Existing drawings are not to be assumed to be correct. In addition, if existing materials within the building are to be abandoned or unused, they shall be completely removed from the facility.

17.1.6 Provide electrical load study and also a short circuit coordination study from the utility service point to the mission critical distribution breakers. Calculations shall be in accordance with industry standards.

17.1.7 Provide drawings and details of all electrical aluminum ladders and cable tray systems. These systems shall be installed for all medium voltage conductors located in ceiling spaces, truss spaces and over the roof if required.

17.2 Drawing and Specification Approvals

17.2.1 **Preliminary Design:** The architect/engineer shall work closely with the NMCI facilities representative's during all phases of the project and especially during this initial design phase. The NMCI facilities generic plans shall be used as a guide to begin the design. All architect/engineer recommended revisions must be addressed at the outset with concurrence from NMCI facilities prior to implementation.

17.2.2 **Design Development**: This phase of the design proceeds after NMCI facilities has approved the preliminary design. As a minimum, design development drawings shall be submitted for review to NMCI facilities within seven days after receiving the designs. Submittals shall be made via e-mail. See also "Pre-purchase of Materials."

17.2.3 **Working Drawings and Specifications**: This phase develops the design drawings and specification documentation into official "contract documents." Changes to the original design drawings are submitted using the Infrastructure Configuration Control Board (ICCB) request form available from the NMCI Website (nmci.idc-mcs.com). The changes are reviewed for cost impact and submitted to the NMCI ICCB for approval. Approved requests initiate a revision to the original design drawings and corresponding specification documentation. The latest version of revised drawings and documentation, i.e. "contract documents" are distributed accordingly. The updated designs and corresponding documentation are available on the NMCI Information Strike Force Website (http://nmci.idc-mcs.com).

17.3 Submittals

17.3.1 Provide the following submittals to the NMCI facilities representative, for review and written approval. The architect/engineer or contractor shall not proceed without written approval. The time period allowed for NMCI facilities review of submittals shall be reasonable, and approval decisions will not be unduly withheld. The project master schedule, as developed and agreed to by all parties, must include a specific time allowance for the submission, review and approval of product submittals.

17.3.2 **Drawings**: Submittal drawings may be shop drawings, sketches, electronically created drawings, or other renderings that demonstrate how a portion of the work will be executed or modified.

17.3.3 **Manufacturer's Data**: Provide cut sheets, specification brochures, operations and maintenance manuals, installation guides, dimensions and tolerances.

17.3.4 **Product Samples**: Provide representative pieces, samples or swatches of actual material suitable for visual and tactile inspection. This may include, but not be limited to, building finishes, fixtures, trim, and hardware.

17.3.5 **Mock-Ups**: Scale models or other three-dimensional evaluation tools.

17.3.6 **Certifications**: Provide product certificates for compliance with NMCI facilities, industry, or government regulations; test results for mechanical and electrical devices and systems; registrations for licensed products.

17.4 Drawings of Record

17.4.1 Record drawings shall be created and updated on a continual basis throughout the construction period. All buried cables, conduit, etc., shall be documented with their exact locations dimensioned. All record drawings as well as the original design drawings shall be produced using the most recent version of AutoCAD. Record drawings will be kept current and made available, via e-mail and the NMCI Website, upon request by an NMCI representative.

17.4.2 Upon completion of the project, the architect/engineer shall create a schematic floor plan, an electrical one-line diagram, and a mechanical flow diagram (if required), suitable for framing. NMCI facilities shall duplicate, frame and mount the drawings at pertinent locations within the facility.

17.4.3 Create complete and accurate record drawings of conduits and other items that will be covered up by concrete floor slabs.

17.4.4 Create complete and accurate record drawings of all underground conduit, piping, etc., at the exterior as well as the interior of the building.

17.4.5 In addition to the record drawings, create a ‘scrap’ book of digital photographs of all pertinent information. Clearly label and describe the photo including the location and date the photograph was taken.

17.5 Design Request Fulfillment

The NMCI Infrastructure Design Team submits a design package of Server Farm generic templates based on the reported size estimate. The package includes:

- Technology Floor Plan
- Cable Matrix
- Rack Elevations
- Logical Backbone Diagram
- Cable Plant Materials Reference
- Receptacle Location Plan (Drawing)
- Patch Field Schematic
- Cable Trays
- Rack Priority
- Tile Cuts Diagram

18. Pre-purchase of Materials

The regional General Contractor may choose to pre-purchase certain items and turn them over to the sub Contractor for installation and coordination. This may include such items as the Raised Access Computer Floor System, Diesel Engine Generator systems including Automatic Transfer Switches, Uninterruptible Power Supply systems, Static Switches, Power Distribution Units, Direct Expansion type air conditioners, etc. The decision to pre-purchase items will be based on the schedule, the value added (if any), and logistics. This will be determined on a project-by-project basis.

19. IT Equipment Racks and Cabinets (Classified and Unclassified)

IT equipment racks and cabinets will be laid out in rows on a 6 ft. (1.83 m) center to center row spacing, always maintaining at least 36" aisle ways in between cabinets and/or racks.

19.1 COM Infrastructure Racks

- WAN-Wide Area Network
- OOB CORE - Out Of Band Core
- OOB PP - Out Of Band Patch Panel
- CORE/DIST - Core/Distribution
- CORE/DIS - Core/Distribution Patch Panel
- SAN SW-Storage Area Network Switch
- SAN Switch Patch Panel
- MDF-Main Distribution Frame
- STK-StorageTek
- SCRTY-Security

19.2 Server Racks

- TIV-Tivoli
- VTC-Video Teleconferencing

19.3 Information Assurance (IA)

- ID-Intrusion Detection
- BR-Boundary Rack
- TBR-Transport Boundary Rack

19.4 Dell Server and SAN

- Servers
- SAN Server
- SAN Storage

19.5 LAN Connectivity

19.5.1 Local Area Network (LAN) connectivity is designed by WAMNET. Each server will have two Intel PRO/1000F Gigabit adapters that are configured in Adapter Fault Tolerance (AFT) mode. This feature provides automatic redundancy at the adapter level. If the primary adapter fails, the secondary takes over. Each card will connect to a different switch to provide redundancy and fail over capability.

19.5.2 SAN connectivity will be provided using two host bus adapters (HBA) installed in all SAN connected servers. The HBAs provide dual path and redundant fiber connections to the access SW fiber channel switches.

19.6 Technology Floor Plan

Floor plan designs are generated from “Drawings of Record" (also known as "As Built") architectural site drawings, and illustrate the IT physical layout of the Server Farm. Rows of IT racks and supporting equipment (ACUs, PDUs, UPSs) are specified within the allocated space (see Figure 1).

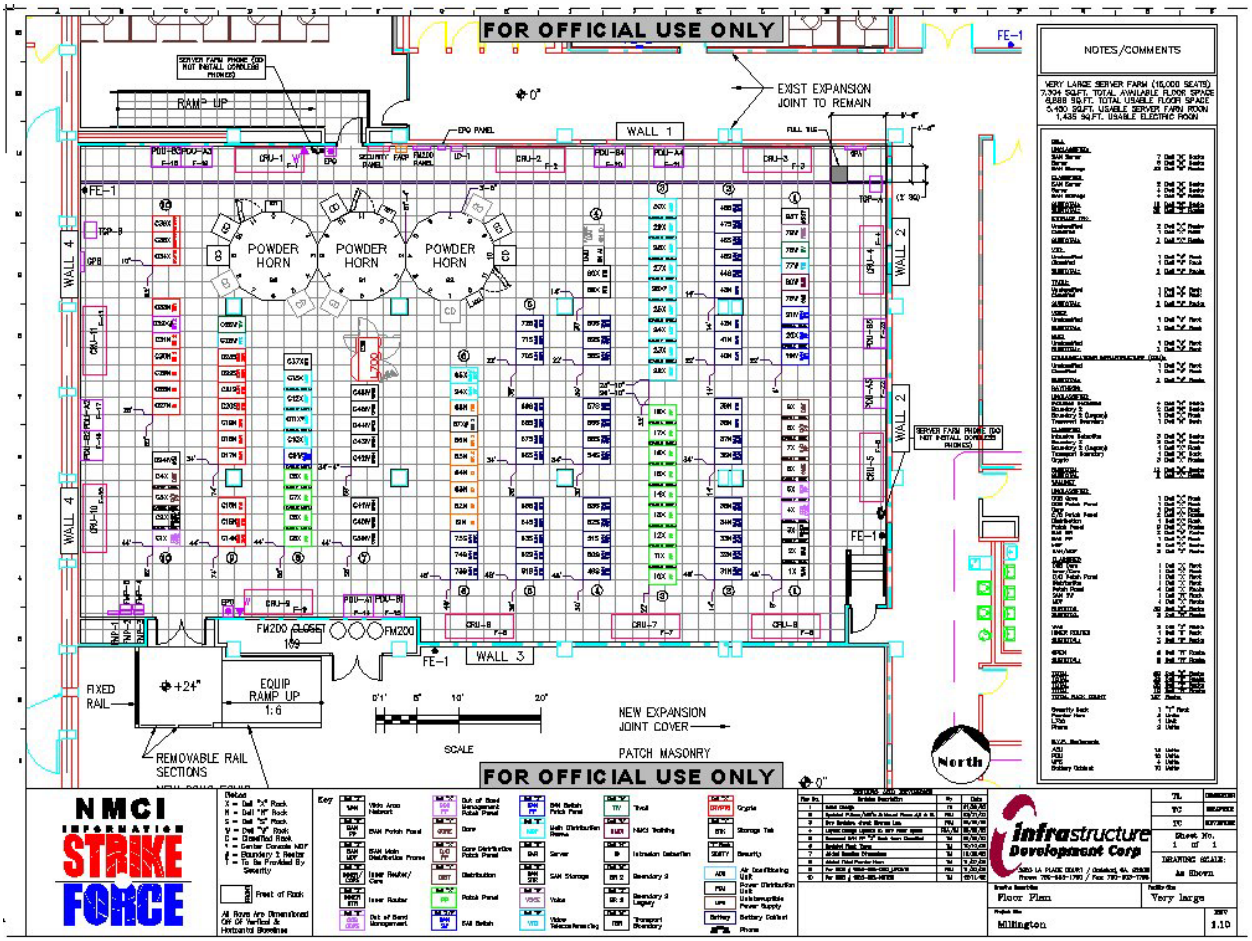

Figure 1: Technology Floor Plan (drawing)

19.7 Cable Matrix

The cable matrix is a document detailing wire connections to each unit in each rack (see Figure 2).

UNCLASSIFIED LARGE GENERIC SERVER FARM CABLE MATRIX (FIBER OPTIC)									
		FROM				TO			
RACK #	PATCH PANEL #	RACK FRONT OR BACK	# OF STRANDS OF FIBER	RACK TYPE	TO	RACK #	PATCH PANEL #	RACK FRONT OR BACK	RACK TYPE
1	1	F	48 (24 S/M, 24 M/M)	WAN		8	4	F	C/D PP
	2	F	24 (12 S/M, 12 M/M)			C44	1	F	CRYPTO
2				BAN PP					
3				BAN MDF					
4				INNER RTR					
5	1	F	24	OOB CORE		10	5	F	PP (SVR)
	2	F	24			11	5	B	PP (SVR)
	3	F	24			12	5	F	PP (SVR)
	4	F	24			13	5	B	PP (SVR)
	5	F	24			14	5	F	PP (SVR)
	6	F	24			15	5	B	PP (SVR)
6				CORE					
7	1	F	72	C/D PP		10	5	B	PP (SW)
	2	F	72			11	5	F	PP (SW)
	3	F	72			12	5	B	PP (SW)
	4	F	72			13	5	F	PP (SW)
	5	F	72			14	5	B	PP (SW)
	6	F	72			15	5	F	PP (SW)
	7	F	24			55	1	B	BR 2
	8	F	24			56	1	B	BR 2
	9	F	24 (12 S/M, 12 M/M)			57	1	F	BR 2
	10	F	24			58	1	B	BR 2
8	1	F	24	C/D PP		59	1	B	BR 2
	2	F	24			60	1	B	TBR
	3	F	24			C3	12	F	C/D PP
	4	F	48 (24 S/M, 24 M/M)			1	1	F	WAN
9				DIST					
10	1	F	72	PP (SVR)		24	1	B	COM
	2	F	72			25	1	B	SAN SVR
	3	F	72			26	1	B	SAN SVR
	4	F	72			16	1	B	SAN PP
	5	F	24			5	1	F	OOB CORE
	6	F	72			27	1	B	SAN SVR
	7	F	72			28	1	B	SAN SVR
	8	F	72			29	1	B	SVR
	1	B	72	PP (SW)		18	1	F	MDF
	2	B	72			20	1	F	MDF
	3	B	72			22	1	F	MDF

Figure 2: Cable Matrix Example

19.7.1 From/To: Designates two halves of the matrix. “From” is the starting point, and “To” is the termination.

19.7.2 Rack #: Designates the rack where the fiber/cable run starts or ends.

19.7.3 Patch Panel #: Designates the patch panel where the fiber/cable run starts or ends.

19.7.4 Front or Back: Describes the placement of the patch panel on the rack.

19.7.5 # of strands of fiber / # of Cat5e cables: Designates the size of the cable/fiber run in strands or cables.

19.7.6 Rack Type: Describes the rack where the cable/fiber run starts or ends.

19.7.7 To read: Begin at the “From” section. Find the rack number, then the patch panel number, front or back. Read over to the “To” section, and find the termination point. Find the “To” rack number on the “From” side, and read over to the “To” section to find the next hop.

19.8 Rack Elevations

Rack elevations are provided to show patch panels, vertical and horizontal wire management, and any specified network equipment (see Figure 3).

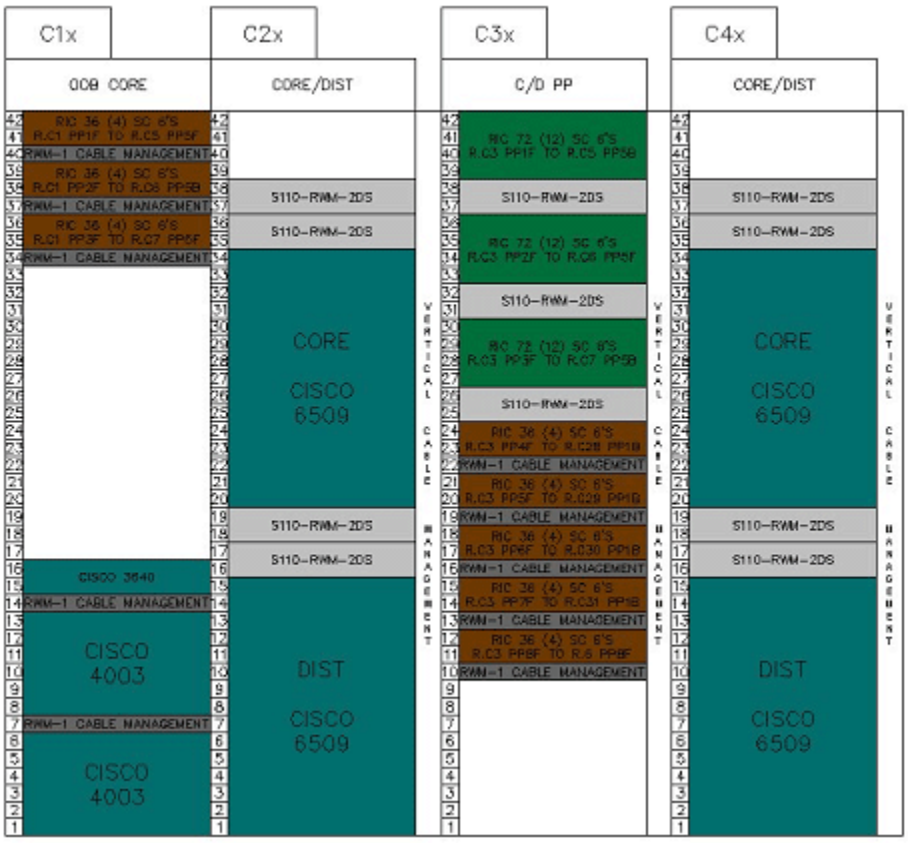

Figure 3: Rack Elevations Drawing

19.8.1 Cable Management is the act of orderly assembling the multitude of cables found in a Server Farm. For the purposes of rack elevations, this is a piece of plastic, 2 units high, that has an oval cut out of the middle to funnel cabling.

19.8.2 The Concept of Units: Rack height is divided into units. A typical rack is 42 units, or 42U high. A Cisco 6509 is 15U, and a 72-port patch panel can be 2U or 4U. Units can also be called RMS, or Rack Mounted Space.

19.8.3 How to read it: Racks are organized per page by row in the Server Farm. Rows are labeled at the top of each page. They appear on the page as the reader would face the rack in the Server Farm.

19.9 Logical Backbone Diagram

A graphic representation of the cable matrix, the logical backbone diagram illustrates the cable runs as one would see with a birds-eye view, assuming the cables were left exposed (see Figure 4).

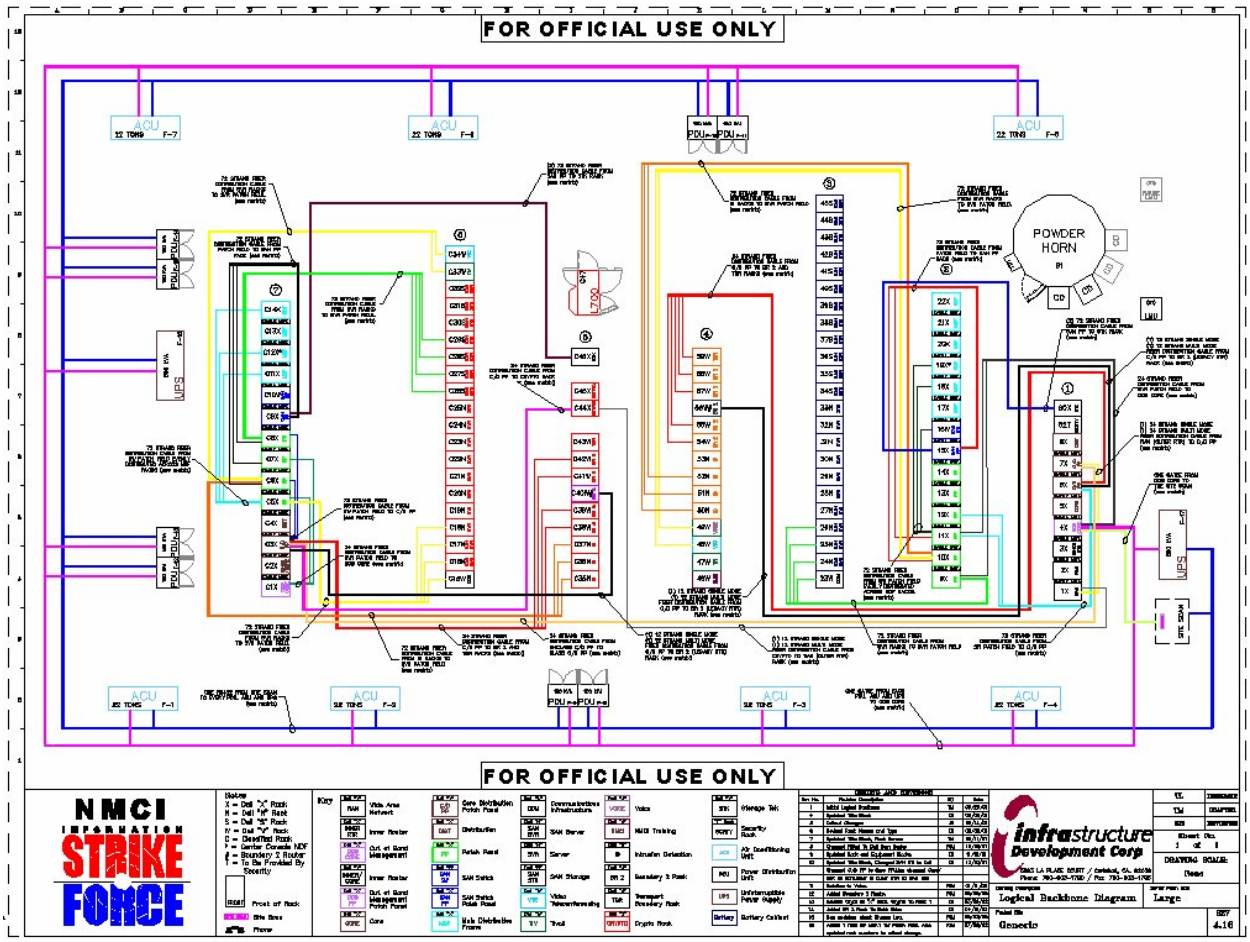

Figure 4: Logical Backbone Diagram

19.9.1 Colors are primarily used for visual organization on the page. They have no bearing on the type of termination, the type of racks, or the type of cable involved.

19.9.2 Key: The key, as well as the structure of the backbone diagram, is generated directly from the floor plan. Use it to identify the types of racks at the cable termination points.

19.9.3 Call Outs: These are the labels printed on the diagram. They are very descriptive, and identify the type of cable run.

19.10 Cable Plant Materials Reference

The Cable Plant Materials Reference is a spreadsheet documenting the brand, model number , and quantity of each type of Rack Mount Interconnect Center (RIC) patch panel, horizontal and vertical cable management, subscriber connector, hook and loop cable manager, and cage nut required for each Server Farm.

At the bottom of the Cable Plant Materials Reference is also a number indicating the total fiber count for the Server Farm, which should match the fiber count number on the Cable Matrix (see Figure 5).

Crane Fiber Material BOM				
Siemon	**Qty.**	**Model Number**		
RIC 72 (Rack Mount Interconnect Center)(12) SC 6's	140	RIC72-F-01		
RIC 36 (Rack Mount Interconnect Center) (4) SC 6's	28	RIC36-F-01		
RIC 36 (Rack Mount Interconnect Center) (4) SC 12's	14	RIC24-F-01		
RIC 36 (Rack Mount Interconnect Center) (6) SC 12's	35	RIC24-F-01		
SC 6 (Subscriber Connector)	1,792	RIC-SC6-F-01		
SC 12 (Subscriber Connector)	266	RIC-SC12-F-01		
1-U Cable Management	110	RWM-1		
2-U Cable Management	109	S110-RWM-2DS		
6" Vertical Cable Mgmt.	30	RS-CNL		
Relay Rack	2	RS 2-07		
Rittal				
Rack With Side Panel	14	996719		
Rack Without Side Panel	33	9967198		
Interconnecting Kits	40	RIC76		
DELL				
Server Racks	23	4210		

Figure 5: Cable Plant Materials Reference Example

19.11 Receptacle Location Drawing

The Receptacle Location Plan (drawing) illustrates the specific location, number and type of power receptacles delivered to the floor of each rack and device requiring power on the Server Farm floor (see Figure 6). Depending on the type of equipment located in the rack the number and type of receptacles will vary from location to location.

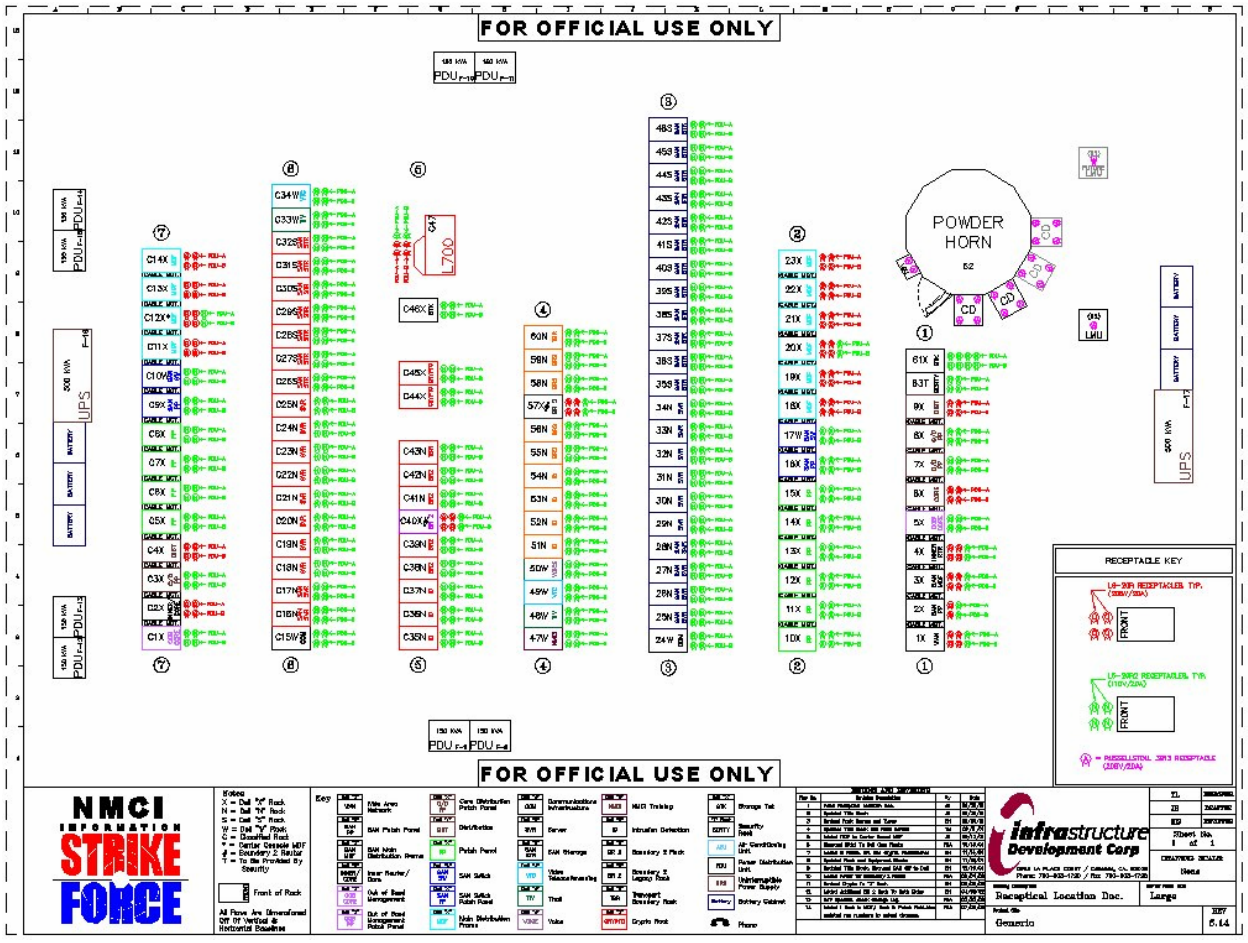

Figure 6: Receptacle Location Drawing

19.12 Patch Field Schematic

The infrastructure cable plant (i.e. the cable and connectors used to "tie" a network together) is organized with "Patch Field" fiber cabling for all Server Farms. Instead of cabling directly "rack to rack," each rack is populated with fiber and connects through a central "Patch Field." This allows reconfiguration by merely manipulating termination points within a patch field, versus rerouting cable runs under the floor between equipment (similar to the old-fashioned telephone switchboard operator "patching" a caller to the intended party). The patch field schematic is an illustration of these interconnecting patch panels (see Figure 7).

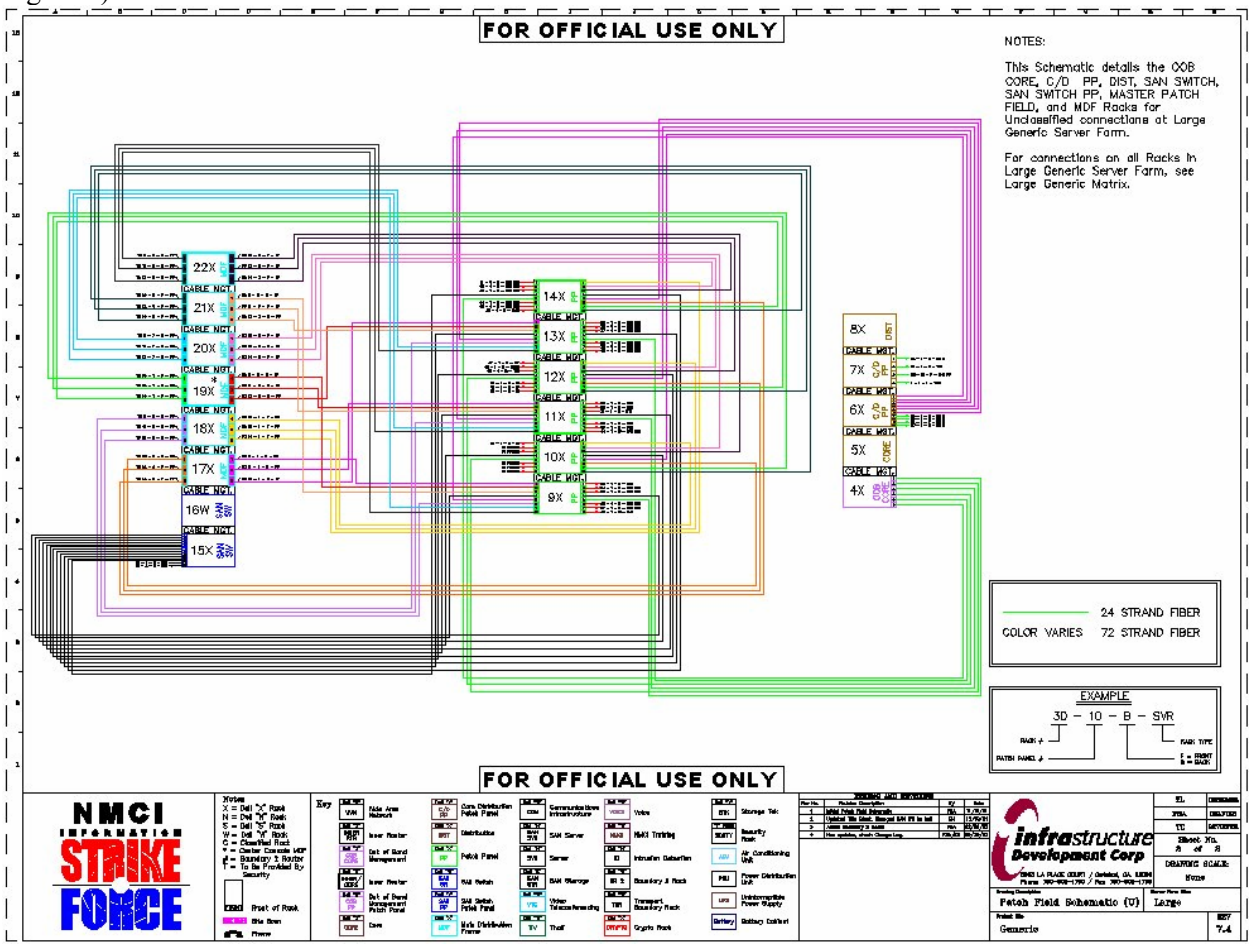

Figure 7: Patch Field Schematic (drawing)

19.13 Cable Tray Diagram

The "Cable Tray Diagram" drawing illustrates the cable trays run under the floor tiles and the corresponding dimension locations indicating exactly where to cut the floor tiles to accommodate the cable (see Figure 8).

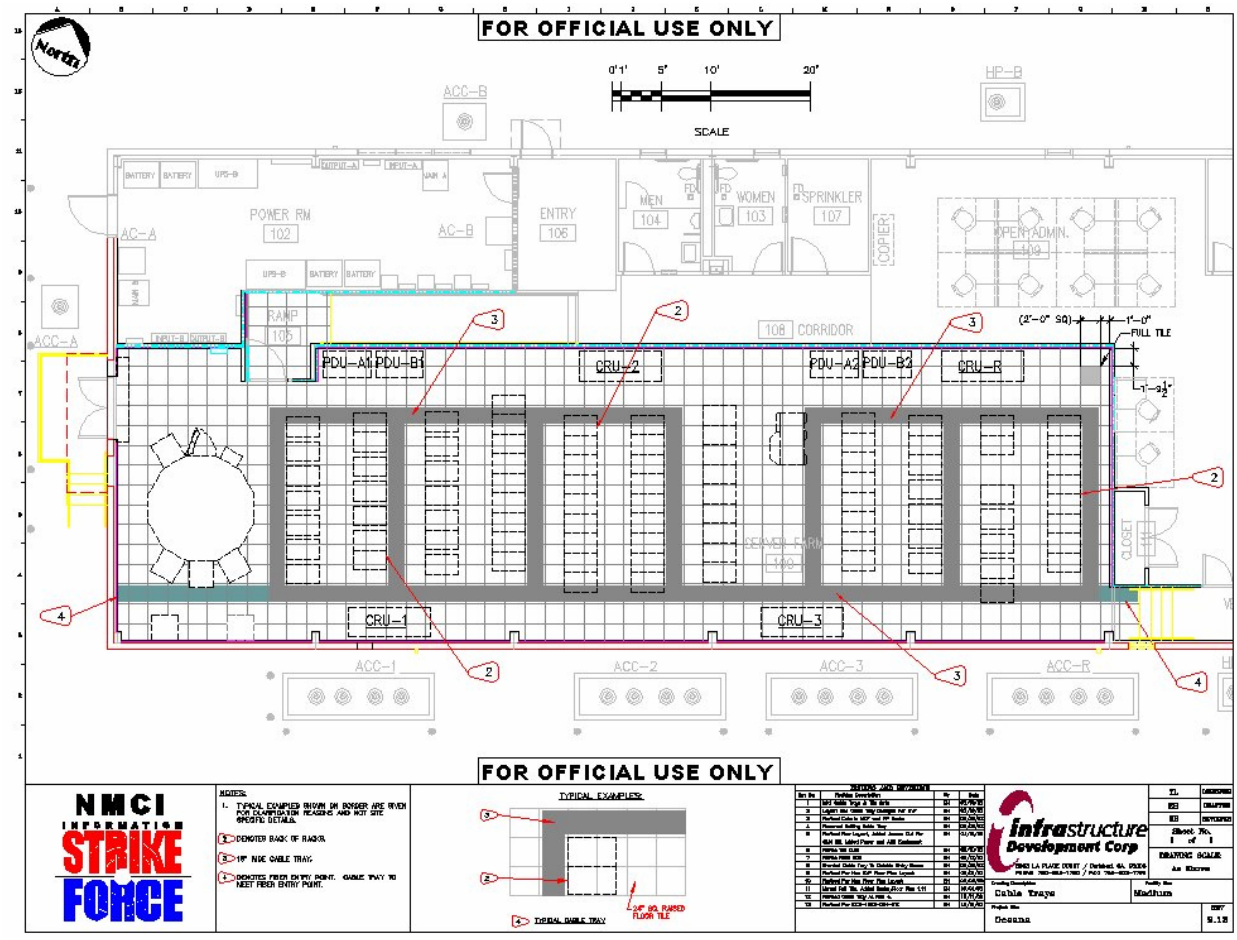

Figure 8: Cable Tray Diagram

19.14 Rack Priority

The "Rack Priority" drawing uses color codes to illustrate the order of rack construction.

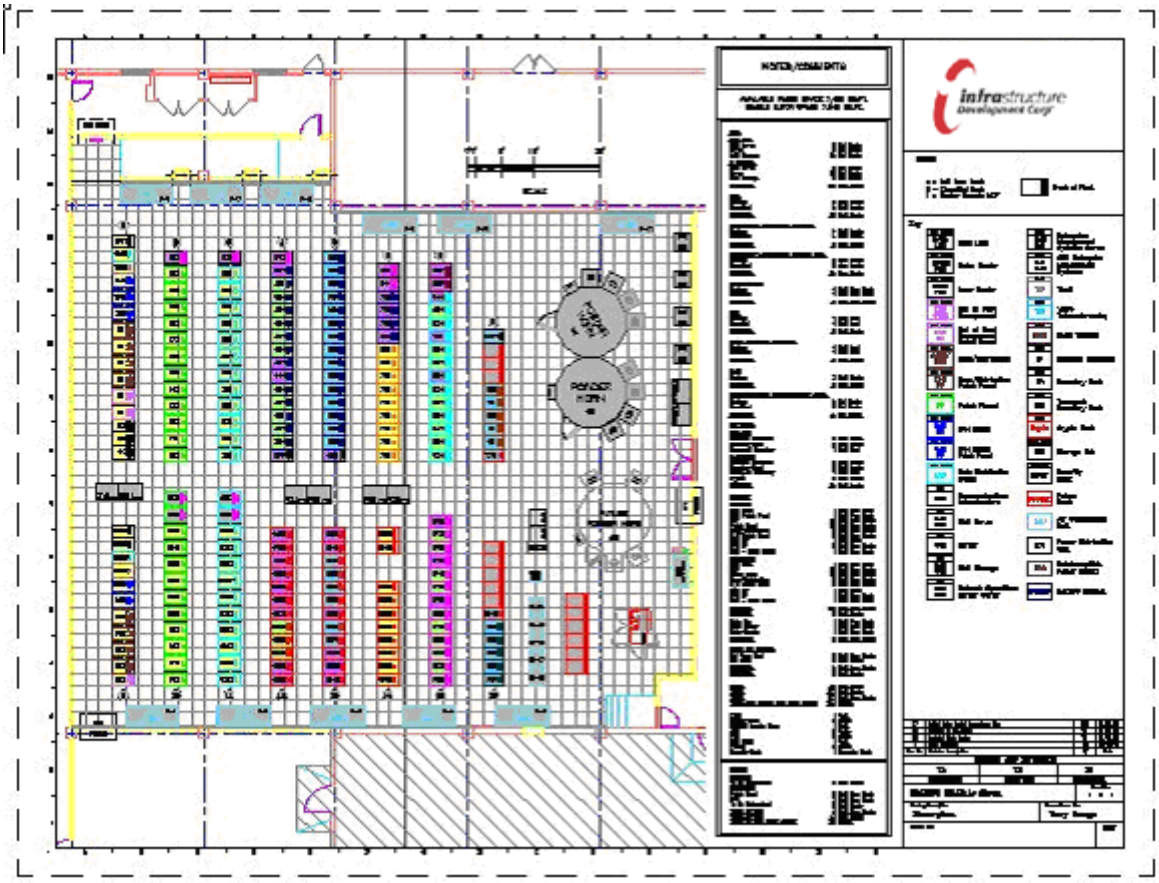

Figure 9: Rack Priority Drawing

19.15 Tile Cut Diagram

The Tile Cuts diagram depicts the exact location of the Server Farm floor tile cuts required, including orientation within the rack base, and notations if the tile cut is within tile boundaries or over raised floor stringers (see Figure 10).

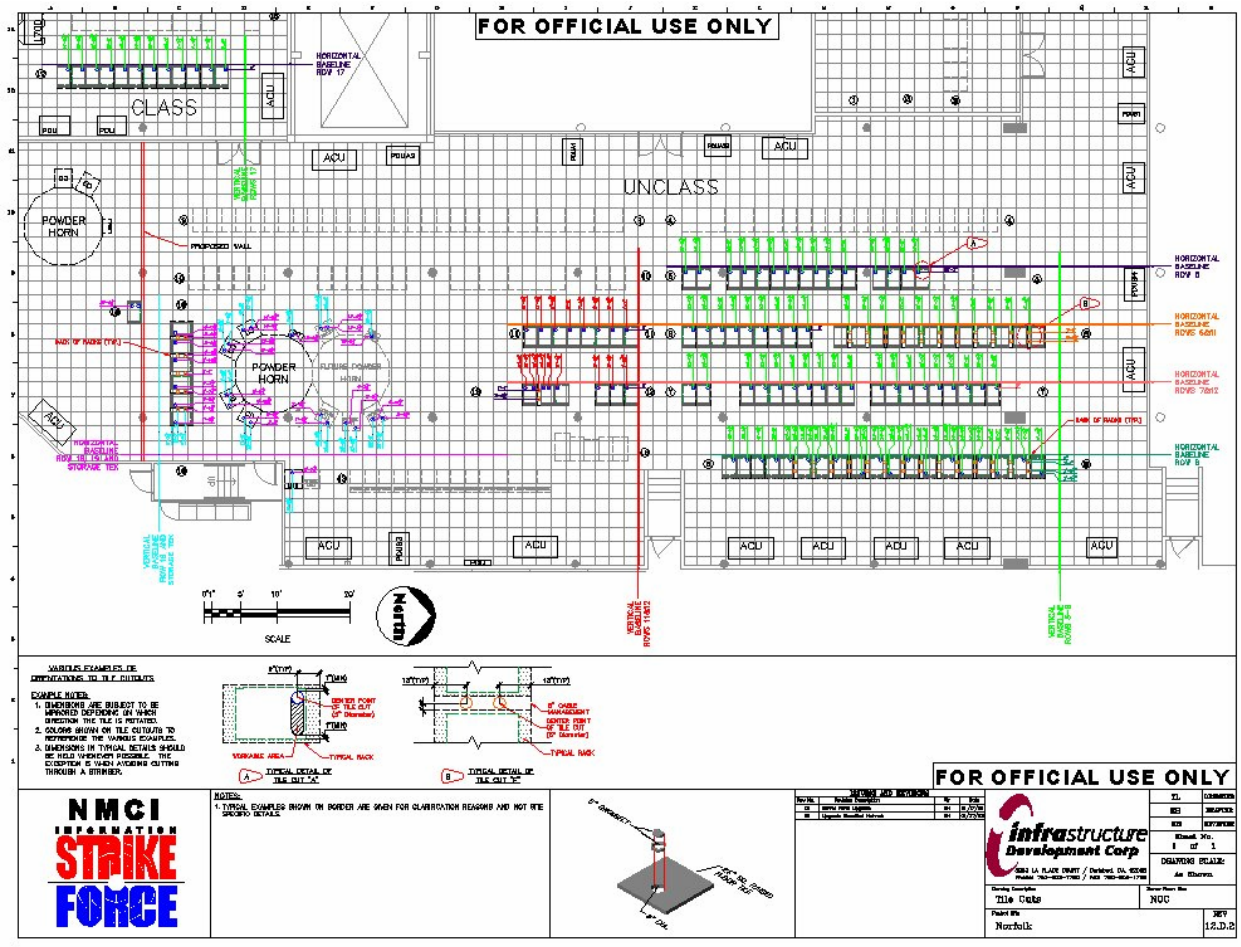

Figure 10: Tile Cut Diagram

20. Data Telecommunications Service Backbone

20.1 Data Station Cable: Fiber

Fiber: Optical fiber (or "fiber optic") refers to the medium and the technology associated with the transmission of information as light pulses along a glass or plastic wire or fiber. Optical fiber carries much more information than conventional copper wire and is in general not subject to electromagnetic

interference and the need to retransmit signals. Single mode fiber is used for longer distances; multimode fiber is used for shorter distances.

- Multimode, 62.5/125 µm diameter, OFNP (OFNP is the designation given by the National Fire Protection Association (NFPA) to interior fiber-optic cables which contain no electrically conductive component, and which are certified for use in plenum applications.) /OFNR (OFNR is the designation given by the National Fire Protection Association (NFPA) to interior fiber-optic cables which contain no electrically conductive component, and which are certified for use in riser applications.), tight-buffered optical fiber, with fiber counts as indicated on drawings, with the following minimum specifications:
- Dual window, 850 nm and 1300 nm
- Minimum bandwidth: 500 MHz-km at 1300 nm, 160 MHz at 850 nm
- Maximum attenuation: 1.5 dB/km at 1300, 3.75 dB/km at 850 nm

20.2 Server Farm Data Cable Connections

20.2.1 Each rack (minus the SAN) requires 32 duplex multimode fiber drops (64 strands) to accommodate the dual Ethernet Gigabyte fiber connections in each device.

20.2.2 Each Server Farm rack will have a 72-strand multimode optical fiber cable terminating in it.

20.2.3 Copper cable that serves the classified equipment shall be separated by one meter from the copper cable serving the unclassified equipment.

20.2.4 The following table provides the approximate number of Category 5E connections and approximate number of multimode optical fiber connections details by Server Farm size.

Server Farm Size	Number of CAT 5E Cables	Number of Multimode Fibers Strands	Number of Multimode Fiber Connections
Small	216	5,796	11,592
Medium	292	7,932	15,864
Large	478	10,320	20,640
Very Large	672	18,120	36,240

Table 13: Server Farm Connection Table

20.3 Termination Blocks

20.3.1 Product(s) approved by the engineer. Please refer to NMCI ISF Facilities Specifications, Section 16120 – Wires and Cables *through* Section 16140 – Wiring Devices.

20.4 Patch Panels and Cable Management

20.4.1 Standard: 19-inch rack-mountable, 24-port, 8-pin modular to insulation displacement connector (IDC) meeting Category 5E performance standards, and pinned to ANSI/TIA/EIA-568-B standard. Typical examples of IDC connections are the 110, BIX, and Krone.

- HD5 24 Port Panel: A 1U rack mount panel segmented into 6 port increments with T568A/B wiring to exceed Category 5e requirements with component and channel performance to 160Mhz.
- Rack Interconnect Center-36: A 2U rack mount fiber management and distribution unit with a sliding tray for access to front and rear connections.
- Rack Interconnect Center-72: A 4U rack mount fiber management and distribution unit with a sliding tray for access to front and rear connections.
- Rack Interconnect Center Adapter Plate-6: A snap-in terminated fiber connector that attaches to the front of the Rack Interconnect Center.
- Rack Interconnect Center Adapter Plate-12: A snap-in terminated fiber connector that attaches to the front of the Rack Interconnect Center.
- S-110-RWM-1 Cable Manager: A 1U horizontal cable manager with cover for routing copper patch cords, cross-connect wires or fiber jumpers.
- S-110-RWM-2DS: A 2U horizontal cable manager with cover for routing copper patch cords, cross-connect wires or fiber jumpers.

20.5 Rack-mounted Optical Fiber Termination Panel

19-inch, rack-mounted, 72-port optical fiber termination panel with cable strain relief, grounding lugs, slack storage, and six 6-port duplex SC connector panels with adapters and provisions for six splice trays.

20.6 Splice Trays

Sized for singlemode and multimode fibers, nonmetallic with clear plastic cover, 12-fiber splice capacity, compatible with splice enclosure and splicing method.

20.7 Optical Fiber Connectors

All fiber is to be fusion spliced and meet ANSI/TIA/EIA 568 specifications. Fusion splicing is the controlled aligning, melting and pushing together of hair-thin strands of glass resulting in a transparent, non-reflective joint.

20.8 Optical Fiber Jumpers

62.5/125-µm multimode optical fiber jumper cable, 1 m long, with 3.0 mm Duplex 586 SC optical fiber connectors on both ends.

20.9 Optical Fiber Pigtails

20.9.1 62.5/125-µm multimode optical fiber pigtail, 1 m long, with 3.0 mm single 586 SC optical fiber connectors on one end. Equipment Racks (Enclosures)

20.9.2 The 19-inch equipment rack shall have the following minimum requirements:

- 73.5 inches of panel space (42 rack spaces) (Each RU [Rack Unit] = 1.75 inches)
- Welded frame construction
- Locking front and rear doors
- Adjustable front and back equipment mounting rails drilled and tapped to EIA standards
- 10-position electrical outlet strip
- Removable side panels
- Top mounted, thermostatically controlled exhaust fan
- Smoked acrylic front door

20.10 Listed Building Entrance Protectors

Building entrance terminal utilizing a two-foot fuse link between the outside cable plant splice and the protector module with IDC type input and output terminals, 100-pair capacity and female mounting base, equipped with 230 volt solid state protector modules. Provide sufficient protector modules to completely populate all building entrance terminals.

20.11 Splice Housing

20.11.1 Encapsulated, re-enterable splice housing, sized as required with bonding straps, accessories, end caps and encapsulant as required.

20.11.2 Splice modules (such as 710 series or MS squared) for use within splice housing.

20.12 Spares

20.12.1 Furnish the following spare equipment and parts:

- Terminal block connectors, if required
- Test set cords, if required
- Install one test cord set in each telecommunications closet
- Five percent of base bid quantity of each type of jack shall be provided
- Five percent of base bid quantity of each type of outlet
- 5000 feet of each type of station cable
- 1000 feet of one-pair cross-connect wire for each telecommunications closet
- 1000 feet of two-pair cross-connect wire for each telecommunications closet
- Five percent of base bid quantity of protector modules

20.12.2 Install materials and equipment in accordance with applicable standards, codes, requirements, and recommendations of national, state, and local authorities having jurisdiction, and *National Electrical Code*® (NEC) and with manufacturer's printed instructions.

20.12.3 Adhere to manufacturer's published specifications for pulling tension, minimum bend radii, and sidewall pressure when installing cables.

20.12.4 Where manufacturer does not provide bending radii information, the minimum bending radius shall be 10 times the cable's diameter. Arrange and mount equipment and materials in a manner acceptable to the engineer and the owner.

20.12.5 Penetrations through floor and fire-rated walls shall utilize intermediate metallic conduit (IMC) or galvanized rigid conduit (GRC) sleeves and shall be fire-stopped after installation and testing, utilizing a fire-stopping assembly approved for that application. Please refer to NMCI ISF Facilities Specifications Section 10050 – Penetrations Through Building Components.

20.12.6 Installation shall conform to the following basic guidelines:

- Use of approved wire, cable, and wiring devices
- Neat and uncluttered wire termination
- Attach cables to permanent structure with suitable attachments at intervals of 48 to 60 inches. Support cables installed above removable ceilings.
- Install adequate support structures for 10-foot cable service loops at each TC.
- Support riser cables every three floors and at top of run with cable grips.
- Limit number of shielded two-pair data riser cables per grip support to twenty.
- Limit number of four-pair data riser cables per grip to fifty.
- Install cables in one continuous piece. Splices shall not be allowed.

20.13 Specialized Equipment in Server Farm

20.13.1 The servers listed below are configurable to function as domain controllers, messaging servers, file and print servers, resolution servers, or web function servers, unless otherwise specified.

- Dell® PowerEdge® 2450/2550/2650 – A 2U rack mount server, with 2 Intel Pentium III processors or 2 P4 processors.
- Dell® PowerEdge® 6450/6650 – A 4U rack mount server, with up to 4 Intel Pentium III Xenon processors or 4 P4 Xeon processors.
- Dell® PowerApp® Big IP® HA+ Controller– A 2U rack mount appliance server dedicated to file and print load balancing.
- Dell PowerApp.web 120/PowerEdge® 1650 – A 1U rack mount appliance server dedicated to web hosting.
- Ezenia Gatekeeper –A 4U rack mount server dedicated to voice and teleconferencing.
- Ezenia Netserver – A 4U rack mount server dedicated to voice and teleconferencing.
- Sun Enterprise™ 220R – A 4U rack mount server dedicated to network monitoring.
- Sun Fire™ 280R – A 4U rack mount server configured to provide IDS (Intrusion Detection Systems) support.

20.13.2 SAN equipment

- StorageTek® Powderhorn Tape Library – A stand-alone storage library unit with a 6000 slot capacity.
- StorageTek® L700e Tape Library – A stand-alone storage library unit with a 678 slot capacity.
- Dell® PowerVault® 650F/Dell FC4700 – A 6.5U rack mount fiber channel RAID storage system that supports up to 10 fiber channel drives internally.
- Dell® PowerVault® 630F/Dell Disk Array Enclosure (DAE) – A 3.5U rack mount expansion enclosure for the Dell PowerVault 650F/Dell FC4700 that provides an additional 10 internal fiber channel drives.

20.13.3 Switching/Routing equipment

- Dell® PowerVault® 56F – A 2U rack mount 16-port, high-speed fiber channel switch for SAN storage and tape backup.
- Dell DS-128-B2 – A 12U rack mount 128-port, high-speed fiber channel switch for SAN storage and tape backup.

- Dell DS-32 – A 2U rack mount 128-port, high-speed fiber channel switch for SAN storage and tape backup.
- Cisco Catalyst® 3524 – A 1U rack mount switch supporting Ethernet connections.
- Cisco 3550 – A 1U or 1.5U (configuration-dependent) rack mount switch supporting fiber-optic and copper Ethernet connections.
- Cisco 3640 – A 2U rack mount router supporting OOB connections.
- Cisco Catalyst® 4003 – A 6U rack mount 3-slot switch supporting OOB connections.
- Cisco Catalyst® 4006 – A 9U rack mount 6-slot switch supporting OOB connections.
- Cisco Catalyst® 6509/6506 – A 14.7U rack mount 9-slot/6-slot switch supporting access, distribution, and core layers.
- NetScreen®-500 – A 2U rack mount multi-port VPN device providing encryption of network traffic.
- Crossroads® 10000™ – A 1U Fiber Channel-to-SCSI bridge with two fiber channel interfaces and up to 12 SCSI interfaces.

20.13.4 Server and supporting equipment specifications.

- Dell 4210 – A 42U rack 23.94 wide x 39.3” deep with numbered mounting holes, locking front door, removable side panels, and a split back door with access through the top, back or side additional depth to accommodate longer products, easily installed Rapid Rails for simplified server insertions.
- Dell Rack Power Distribution Unit (PDU) – A less than 1U rack mount 1000amp circuit breaker and standard grounding strap. It comes with brackets for mounting vertically or horizontally in the 0U side space or rack bottom.
- Dell Keyboard and Flat Panel Monitor – A 1U rack mount system with an integrated 14” monitor, keyboard and trackball.
- Rittal rack (part no. 9967197) – A 42U rack 24” wide x 40” deep without numbered mounting holes, fully perforated front and rear door, a fully perforated roof that allows for cable entry (two 4" round cutouts) and 19" server type rails both in the front and rear for rack mount server applications.
- Sun™ Ultra™ 10 Workstation – UltraSPARC IIi CPU 15.8” high x 6.9” wide x 17.1” deep, dedicated to security functions. When rack mounted with the SharkRack UniTower Rack Mount Kit requires 5U.

- Sun™ Ultra™ 60 Workstation – 2 UltraSPARC III CPUs 17.7" high x 7.7" wide x 19.6" deep, dedicated to security functions. When rack mounted with the SharkRack UniTower Rack Mount Kit requires 5U.

- SharkRack UniTower Rack Mount Kit – A universal base with ball bearing slides to rack mount the Sun Ultra 10 and 60 workstations.

- SharkRack/APC Rackmount LCD Monitor/Keyboard Drawer – A 1U rack mount system with an integrated 15" monitor, keyboard and trackball for the Sun Ultra 10 and 60 workstations.

- Port Millennia KVM Keyboard Video Mouse – A 1U optional rack mount switch for the Sun Ultra 10 and 60 workstations.

21. Infrastructure Design System Testing

All infrastructure design components shall be thoroughly tested at the factory. All systems must be fully tested at the facility before being placed into service.

21.1 Testing Standards

21.1.1 Testing shall conform to TIA/EIA TSB-67 and TSB-95 Transmission Performance Specifications for Field Testing of Unshielded Twisted Cabling Systems and ANSI/TIA/EIA-568-B-5, Propagation Delay and Delay Skew Specification for 100 ohm 4-pair cable. Testing will be accomplished using level II field testers.

21.1.2 **Test each pair and shield of each cable for opens, shorts, grounds, and pair reversal.** Correct grounded and reversed pairs, and examine open and shorted pairs to determine if the problem is caused by improper termination. If termination is proper, tag bad pairs at both ends and note on termination sheets.

21.1.3 Perform testing of copper cables with tester meeting TIA/EIA TSB-67, TIA/EIA TSB-95 and ANSI/TIA/EIA-568-B-5 requirements.

21.1.4 If copper backbone cable contains more than one percent bad pairs, remove and replace entire cable.

21.1.5 If copper cables contain more than the following quantity of bad pairs, or if outer sheath damage is cause of bad pairs, remove and replace the entire cable:

CABLE SIZE	MAXIMUM BAD PAIRS
<100	1
101 to 300	1 – 3
301 to 600	3 – 6
>601	6

21.1.6 If horizontal cable contains bad conductors or shield, remove and replace cable.

21.1.7 Initially test optical cable with a light source and power meter utilizing procedures as stated in ANSI/TIA/EIA-526-14A: *OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant* and ANSI/TIA/EIA-526-7 (currently Standard Proposal Number 2974-B): *OFSTP-7 Measurement of Optical Power Loss of Installed Singlemode Fiber Cable Plant*. Measured results must be plus/minus 1 dB of submitted loss budget calculations. If loss figures are outside this range, test cable with optical time domain reflectometer to determine cause of variation. Correct improper splices and replace damaged cables at no charge to the owner.

- Acceptable data loss for GIG-E is 3.2 dB, end-to-end.
- Cables will be tested at 850 nm and 1300 nm for multimode optical fiber cables. Cables will be tested at 1310 nm and 1550 nm for singlemode optical fibers.
- Testing procedures shall utilize “Method B” – One jumper reference
- Bi-directional testing of optical fibers is required
- Perform optical time domain reflectometer (OTDR) testing on each fiber optic conductor. Measured results will be plus/minus 1 dB of submitted loss budget calculations.
- Submit printout for each cable tested
- Submit 3.5" disks with test results and program to view results
- Where any portion of system does not meet the specifications, correct deviation and repeat applicable testing at no additional cost to the owner.

21.2 Critical Equipment Component Testing

21.2.1 All critical equipment components and integrated systems (e.g. UPS, grounding) shall be fully tested and commissioned by a third party prior to being placed in final operation. The Server Farm testing is tied with the Transition team responsible for performing the Server Farm test cases and manages the schedule for the testing for each Server Farm facility.

21.2.2 Test plans are provided by EO Test Manager and cover the transition area performance deliverable for Contractor Test and Evaluation (CT & E) in the testing of the facility and service infrastructure inside the Server Farm.

22. Commissioning

22.1.1 A comprehensive building-commissioning plan must be developed early in the project, and implemented in phases throughout the design, construction, and acceptance periods. The design of building components and systems shall be conducted with strict attention given to proper interaction, maintainability, and efficient and safe operation of the building as a whole.

22.1.2 Complete checklists will be written before system start-ups to ensure that safe operation can be commenced. The installation tradesmen or factory representatives shall verify that systems are clean, balanced, flushed, lubricated, aligned, in correct rotation, and assembled tightly according to manufacturers' specifications. Specific checks shall be made for correct power connections and complete and functional safety mechanisms.

22.1.3 When systems are ready to operate, they will be started and inspected for defects. Shakedown runs, debugging and related re-calibration shall be performed. Satisfactory operation must be achieved, including all control sequences, alarms, notifications and resets, capacity ratings, sensitivities and settings, and safety features. Proper performance will be achieved, validated, and documented for acceptance records and maintenance logs.

22.1.4 The project contractors will deliver to NMCI facilities full documentation including warranty information, operation and maintenance manuals, test results, and drawings of record.

23. Training

23.1.1 The contractors will provide as an integral part of the project services, complete and comprehensive building system operations training for NMCI technical personnel.

23.1.2 Formal training can be expected by component manufacturers to NMCI facilities tradespeople where required, and NMCI facilities tradespeople will then be certified as factory-trained.

23.1.3 Performance-oriented training must take place on-site, conducted by qualified factory instructors or contractors' installers. NMCI facilities building maintenance technicians will be instructed in all skill sets for system operation, maintenance and repair, tolerances and adjustment, and comprehension of documents and diagnostics.

23.1.4 System training must be conducted for all operating modes including start-up, normal operation, cool-down, alarm conditions, emergency reaction, and remote operation, if applicable.

23.1.5 Training must include a description of ongoing support for technical updates, factory notices, component upgrades, and supplemental documentation.

23.1.6 Additional information regarding training is available from:

24. Acceptance

24.1.1 NMCI and the project contractors will concur on property acceptance, close-out dates and procedures.

24.1.2 Punch list inspections will be conducted and repairs will be completed at no cost to NMCI. NMCI facilities representatives will verify completion of the punch list and document the results to the builder.

24.1.3 Final billing will be reconciled, including all outstanding design and construction charges as agreed to in the contract documents and subsequent approved change orders. Retained amounts from previous invoices will be paid.

24.1.4 In conjunction with final payments, NMCI will receive lien releases from all contractors.

24.1.5 NMCI facilities representatives will review the results of the building testing, commissioning and training programs and approve of them as complete when they are found to be satisfactory.

24.1.6 The contractors are responsible for coordinating and receiving all final building inspections.

24.1.7 The builder, developer, or contractor will be expected to deliver, on time with the project schedule, a certificate of occupancy from the local jurisdictional authority stating that the property is safe and ready for NMCI to occupy and use for its intended purpose.