Design and Construction Overview

Building Systems

Excavation

Overall, the job site did not require any significant excavations, aside from the sump pits and fuel oil tanks. A standard lay back method at 1:1 was utilized for any area requiring excavation. Trench boxes were used for the installation of deep underground electrical conduit. For Phase 2 fuel oil tanks excavation, a sheeting and shoring method was employed. The shoring was driven 23'-0" into the ground for the 18'-0" pit.

Fortunately, the groundwater was located well below the initial job site excavation, thus not requiring a dewatering system. Several months into the project, a few precast columns and caissons had shifted (reason unknown) and required the remaining caissons along that line to be removed and better supported. This excavation came upon water about 12'-0" below grade and was removed via pumps to dry the pits and place the footings and piers.

Precast Concrete

The building envelope and structure consist primarily of precast pre-stressed concrete columns, beams, insulated exterior spandrels, shear walls, and pre-stressed double tees. There is grout in all open spaces, keyways, connections, and joints to provide as a sealant. Precast members have typical connections using anchor bolts, bearing pads, steel plates, and field welding. See Table 1 below for strength and size information for all precast members.

Table 1 - Precast Concrete Strengths

Type	Strength	Size
Pre-stressed Column	5000 psi	24" x 24"
Inverted Tee Beams	5000 psi	3'-4"W x 4'-0"D
Ledger Beams	8000 psi	2'-0"W x 4'-0"D
Spandrels	8000 psi	8"T x 12'-0"W x 8'-5"H 8"T x 12'-0"W x 11'-5"H
Double Tees	5000 psi	12'-0"W x 32" D

Precast members are manufactured by The Shockey Precast Group located in Winchester, Virginia. In order to erect the precast pieces, Shockey utilized two Manitowoc Model 2250 Series 3 cranes. The cranes can carry a 66,000lb load at 120'-0" radius on jib. One crane was set up to place members between column lines A-D for the entire length of the building, while the other team was to place members between column lines D-G. Please see Appendix B for a more detailed precast erection plan.

Cast-in-Place Concrete

MADC5 incorporated cast-in-place concrete for caissons, spread and strip footings, foundation walls, slab on grade, and topping slab. The following table provides a summary of the mentioned concrete structures. See Table 2 below for a breakdown of the various concrete utilized on the job.

Table 2 - CIP Concrete Details

Type	Formwork	Reinforcing	Strength	Placement
Caissons ***(31) 30" dia.*** ***(139) 48" dia.*** ***(39) 60" diam.***	Earth (typ.) Steel Casings (few)	Vertical: #7,10,11 Ties: #3 @ 14" OC #4 @ 18" OC	3000 psi	Pump
Footings	Stick Built	#4 Bars (typ.)	3000 psi	Pump
Foundation Walls	Stick Built	#5 Bars (typ.)	3000 psi	Pump
Slab on Grade ***6"***	Stick Built	10 ga. WWM 6x6 W4.0xW4.0	3000 psi (inside) 3500 psi (outside)	Belt
Topping Slab ***3"***	Pour Stops	4 ga. WWM 10x10 W6.0xW6.0	5000 psi	Crane & Bucket

Mechanical System

Adequate air conditioning and humidity control are two vital processes that must be maintained within a data center; therefore this center has implemented a system with N+1 redundancy. MADC5 has two chiller plants located in the north-central area of the building, with each plant servicing half of the building. The plants operate independently of one another, however in case of emergency there is an automated interconnection valve allowing one plant to support the other with up to three chillers. This condenser water and primary/secondary chilled water system is comprised of (16) chillers, (16) cooling towers, (16) condenser water pumps, (32) chilled water pumps, and (2) thermal energy storage (TES) tanks. The TES tank is a 500,000 gal chilled water storage tank housing chilled water and emergency makeup water. It is designed to provide emergency make up water without exhausting storage for the chilled water. The piping for this system within the computer rooms is located in the trenches below the raised floor. This provides more underfloor and overhead room for other MEP equipment.

Air handling equipment with chilled water cooling coils provide for the air conditioning system. There are approximately 480 computer room air handlers (CRAH) that supply cool air to the computer rooms, UPS rooms, and electric rooms. Within the computer rooms, the cool air is supplied through the raised floor plenum and is distributed to the computer equipment via grates within the access floor. In the office area, there is one variable air volume (VAV) central station air handling unit (AHU) per floor. In addition, each chiller plant has one constant volume central AHU.

The heating system consists of four 1670Mbh input/1369Mbh output gas fired finned tube boilers, two for each half of the building, that are size to support peak loads at N+N redundancy. The remaining heating loads are supplied by electric heating.

Electrical System

Total utility power will service the data center at 34.5kV in two locations. Both locations will house a 34.5kV, 1200A medium voltage switchgear which will feed power into one of (16) 5MVA pad-mounted transformers. Each pad-mounted transformer steps down the utility power to 345/600V, 3-phase, 4-wire power and feeds its own electrical room which includes two switchboards, MxA and MxB. The switchboards contain a 3000A main breaker servicing the essential bus at 600V, 3-phase/3-wire and the uninterruptible power supply (UPS) bypass and an emergency main breaker served by backup engine-generators. Each electrical room is assigned two engine-generators rated at 2500kW, which are located directly above on the second floor, to backup its system. The Rotary UPS system, one dedicated to each switchboard, is supplied with a flywheel energy storage system capable of supporting the starting of the system's backup engine-generator for at least ten seconds. Electrical rooms also feed four distribution panels, two for critical power loads and two for essential A/C loads, in each adjacent computer room. Computer room capacity is configured for a power density of 200W/SF with the ability to grow to 232W/SF. Operating at this load puts the system at N redundancy, meaning no spare system capacity in the computer room power distribution panels. The entire electrical system is protected by a high-resistance grounding that limits the maximum ground fault current to 15A.

Overall, the electrical system is configured into an Iso-Parallel system with an N+2 redundancy. This system allows all UPS units to share the loads equally via a ring-bus. A system connected to the ring-bus will automatically support the failure of another system connected the ring-bus without adversely affecting any other system, thus isolated.

Curtain Wall System

The curtain wall system accounts for only a small portion of the building envelope. This façade is located on the southwest corner of the office area, which is on the south-central side of the building, and spans the full height, two floors. The curtain wall is intended to add aesthetic appeal to a rather mundane building by differentiating the office area from the rest of the data center. It creates a more pleasing view for the main entry of the building.

Like most curtain wall designs, this system was designed by a specialty contractor, Vistawall Architectural Products, who requires that the architect approves the shop drawings and information. The system includes an aluminum wall system for 1" glazing, storefront framing for ¼" glazing, and medium style doors for ¼" glazing. Another supplier provides the glazing to be used with the system, which consists of coated vision glass, spandrel glass, and bullet resistant glass outside of the conference rooms. Other materials required by this system are sealants, steel clips and anchors, fasteners, gaskets, and aluminum cladding. It is a typical installation for the Vistawall curtain wall.

Fire Protection

Fire Alarm System

Fire alarm panels and electronic detection systems create the fire alarm system for MADC5. Located within each computer room near the main exit there is an emergency response kiosk. The kiosk contains a fire alarm control panel for all devices in the room, underfloor/above floor annunciator panel, a fire extinguisher, a tile puller for the access floor, a phone, and a flashlight.

The electronic detection system includes photoelectronic smoke detectors which are mainly located in the computer rooms, both underfloor and above floor. These detectors are capable of determining the exact location of a possible fire situation within a room.

Suppression Systems

There are four systems utilized within MADC5, including preaction sprinklers, wet-pipe sprinklers, dry system, and portable fire extinguishers. The preaction sprinkler system, 27 zones in the building, is provided in the switchboard rooms, computer rooms, generator rooms, and other rooms deemed critical. This system consists of double interlocked, electric/pneumatic release valves supplied from an air compressor loop. Valves, which are located within preaction closets within each zone, are double interlocked to avoid a charging of the pipes without a fire emergency. The wet-pipe sprinkler system, total of 7 zones, is provided in all remaining, non-critical areas including corridors, administration rooms, offices, and chiller plants. Valves for this system are located within the sprinkler room. A dry system is only in effect in the loading dock area.

Local Conditions

The site is in Ashburn, Virginia approximately 7 miles north of Washington Dulles International Airport along VA State Highway 28. Ashburn is presently a rural area, thus there is little site congestion and constricted roads for trucks to travel. Aside from the small residential community to the northwest, the area is predominantly commercial creating minimal pedestrian traffic near the site. The project's exact location is within the Ashburn Corporate Center which currently includes three completed data centers built for DuPont Fabros. All three data centers are similar in nature and approximately the same overall height. Following the completion of MADC5, a proposed MADC6 is to be built within the same site adjacent to MADC5. Currently, the construction team is utilizing the MADC6 location as a laydown and parking location. A brief site plan can be viewed in Figure 3 below. For a more detailed existing conditions site plan, please see Appendix A.

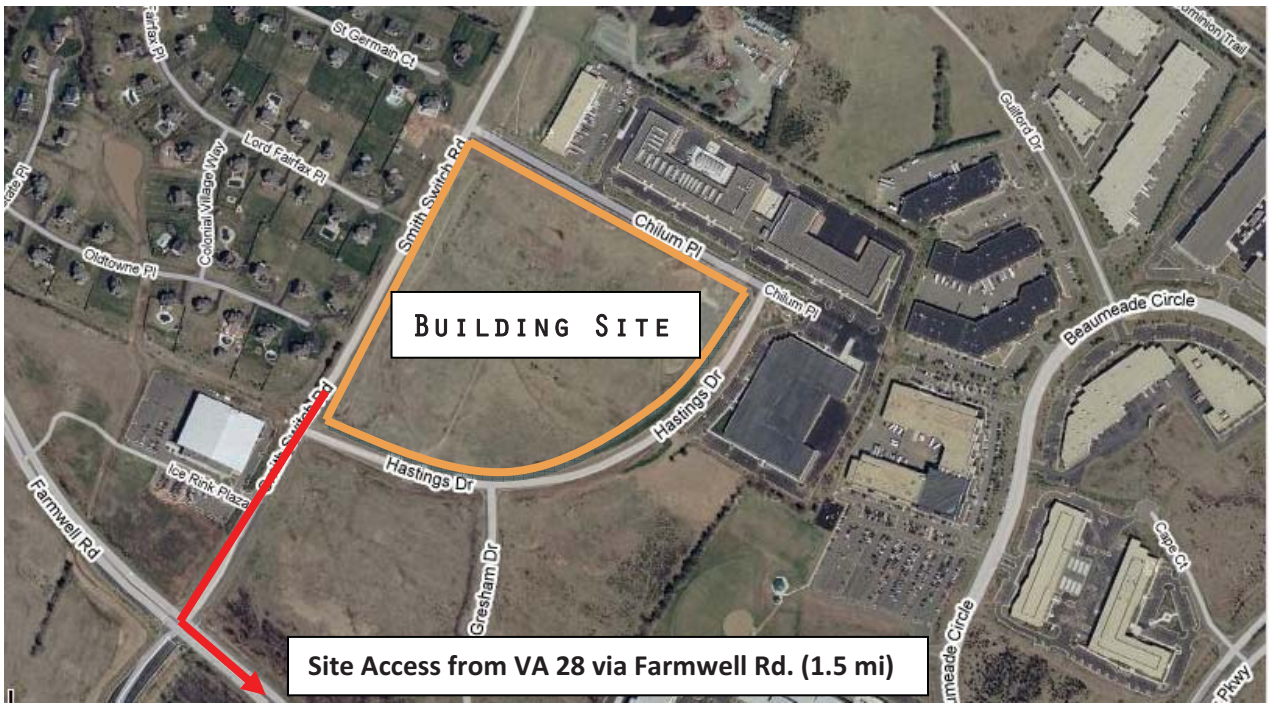

Figure 3 - MADC5 Site Overview

Site Plan of Existing Conditions

MADC5 is located on a 33 acre site in Loudoun County, VA approximately 30 miles west of Washington, D.C. Unlike the D.C. Metro area, there are not many preferred construction methods for Loudoun County. As a result, the building uses precast concrete shear walls, cast in place concrete, and glazing for its design.

The actual site location in Ashburn is bounded by Hastings Dr. to the south, Smith Switch Rd. to the northwest, and Chilum Place to the northeast. The large site is beneficial for the construction process for several reasons. First, a majority of the soil can be stock piled onsite to be reused in other areas. Secondly, most materials can be stored on site including precast concrete panels, double tees, conduit, piping, etc. Another important benefit is that there is a decent amount of space for job site trailers (Owner, Engineer, Contractor, and most of the Subcontractors). This allows for easier lines of communication between the project teams. On both sides of the trailers there are parking spaces available for the construction team staff. The workers, however, are to park their vehicles along Hastings Dr. and Chilum Place.

Recycling and Tipping Fees

Recycling for MADC5 is somewhat of a unique process and highly necessary since the project is pursuing LEED Gold certification. All parties involved with the project throw their trash and recycling into three dumpsters, one for trash and construction waste and two for concrete. If necessary, a steel bin can be brought onsite, however there has yet to be enough steel waste to have a dedicated dumpster. The recycling service, IDS, then comes to the site, removes the dumpsters, and hauls all of the trash back to their recycling center to separate everything. This process allows for the recycling to be thoroughly separated. As a result, the job site has a 98% recycling rate, which qualifies for two credits under MR 2.1 and MR 2.2.

The tipping fees for IDS are as follows:

Mixed Bins: $300/4 tons
($53/ton extra for amount over the 4 tons)
Concrete Bins: $210/20 yards
*No rental fees or fuel surcharges

Soil Type

The natural soils within the proposed project area primarily consist of residual clayey or silty soils with minor amounts of fine sand. Generally, as the depth increase, the residual soils become more granular and rock fragments become more abundant. Overall, as seen in Table 3 below, the soils tend to have a fair to very poor potential for general site development.

Table 3 - Soil Type Characteristics, Loudoun County

Soil Group	Typical Terrain	Parent Rock	Problems/ Limiting Factors	Soil Class
Ashburn Silt Loam	Sloping Landscapes	Siltstones	Wetness, Low Bearing Capacities	II
Dulles Silt Loam	Nearly Level Landscapes	Siltstones and Shales	Low Soil Strength and Prolonged Perched Water Table	IV
Albano Silt Loam	Drainage Swales	Siltstones and Shales	Seasonal Perched Water Table	IV

Subsurface Conditions

According to the soils survey, all boring locations indicated 0-6 inches of topsoil. The layers beneath the top soil consisted of the natural residual soils mentioned above. As the auger penetrated deeper, the soil became denser. Refusal depths ranged from 2.5'-8.6' below the existing ground surface. Shallow weathered siltstone bedrock was reached between 1'-0" to 7'-0" below the ground surface.

Groundwater Conditions

While drilling the boring holes, groundwater did not flow into the bore holes, which determines the groundwater position. As a result, the only groundwater conditions on the site will only be influenced by rainfall and surface water runoff.

Site Layout Planning

As mentioned in the previous section, the project site is quite large allowing for plenty of room to maneuver within the site. As a result, the site logistics were quite identical throughout the main construction phases – excavation, erection, and interior work. Laydown, material storage, and contractor parking remained in the same location, the future site for ACC6, for the duration of the project. Likewise, the jobsite trailers, dumpsters, project gates (six), and traffic flow pattern all remained the same.

For more detailed site layout plans, please see Appendix A.

Excavation Site Layout

Excavation for this project was extensive in the amount of land that needed to be cleared and graded; however, deep excavation was not truly an issue. The only locations of deep excavation were the caissons, sump pits, UPS Rooms, and retention ponds. The remaining areas were shallow excavation mainly for underground MEP conduit.

Erection Site Layout

Crane locations and paths are the two main differences with the erection site layout plan. There are two paths within the building footprint corresponding to two Manitowoc cranes utilized for precast concrete erection. The crane to the north, crew 1, started slightly ahead of the second crane in order to avoid collision.

Interiors Site Layout

The remaining site layout plan depicts the site plan that would be nearly identical to the finished product. One key feature for this layout is the location of the loading docks within the new building, which is centrally located on the project-east side of the office building. Loading docks and scissor lifts can be employed to unload equipment into the building for installation.