

**Baltimore Ravens NFL Stadium (M&T Bank Stadium)**  
**Maryland Stadium Authority**  
**Baltimore, Maryland**

**Design Firm:**  
RMF Engineering

**Firm Responsibility:**  
Mechanical, Electrical,  
Plumbing, Civil (field  
drainage), Energy,  
Lighting

**Project Owner:**  
Maryland Stadium  
Authority  
Baltimore, Maryland

**Completion Date:**  
1998

**Project Cost:**  
\$220,000,000



**Overview**

RMF was the MEP design consultant for the construction of M&T Bank Stadium and renovation to the Camden Yards Central Utility Plant. The Camden Yards Complex consists of Oriole Park at Camden Yards, still considered one of the top baseball stadiums in the country, the Camden Warehouse Office/Entertainment Facility and M & T Bank Stadium. M & T Bank Stadium is a 1.6 million square foot facility that hosts many sporting events and social gatherings throughout the year. The main function of the 68,000 seat stadium is to act as home field for the NFL Baltimore Ravens. In addition, the facility hosts a multitude of sporting events which include high school and college football games, World Cup Soccer exhibitions and the NCAA Lacrosse Championships. The stadium also functions as a multi-use entertainment venue for City sponsored Fund Raising events, job fairs, concerts, sports camps, private rentals, etc. and was even the site for the movie "The Replacements". With the completion of Ravens Stadium and the Camden Yards Complex, the city of Baltimore became revitalized and secured it's transformation back to a national sports town.

The stadium's architectural and structural design was one of the first to incorporate the "notched out" corners of the sideline and end zones upper seating bowl. This architectural feature permits viewing of the Baltimore skyline, while maximizing preferred seating locations.

Design consultant provided the design for all mechanical, electrical and plumbing (MEP) engineering for the 68,400 seat, 1.6 million SF stadium. The scope of services included:

**Mechanical & Plumbing**

- Central Heating and Cooling Plant
  - Heating and Ventilation
  - Comfort Cooling
  - Vehicle Exhaust and Ventilation
  - Atrium Smoke Exhaust
  - Sanitary Drainage
  - Storage Drainage
  - Domestic Water - Cold, Hot or Tempered
  - Emergency Generator Support Systems
  - Acoustic and Vibration Control for Mechanical Systems
  - Energy Management and Control Systems
  - Sprinkler and Standpipe Systems
  - Food Service Concessions
  - Field Drainage and Turf Heating
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The HVAC systems for the new stadium include forty (40) total air handling systems of which four (4) built-up air handling systems (30,000 CFM each) deliver low temperature (45°F) air to the club and suite levels.

HVAC design provides over 600,000 cfm of air conditioning or ventilation air for the facility. Over 100 fan coil units are used throughout the stadium to serve suites, offices and other interior spaces. Fan coil systems were utilized to permit off hour, non-event day use of individual spaces without causing the operation of major air handling systems. All of the HVAC systems are selected for use with 36°F glycol based chilled water.

The plumbing design included domestic water and sanitary systems for 68,000 spectators, 2 main kitchens, 60 Concessions, 140 Luxury Boxes. The plumbing design included the following systems:

- Domestic Water System
- Sanitary Drainage System
- Storm Drainage System
- Turf Drainage System

The cooling medium is generated at the Camden Yards Chilled Water/Ice Storage plant (1500 tons – stadium only). The heating medium is high pressure steam, purchased from South Baltimore Trigen Seam generation plant (60,000 mbh – stadium only).

Of particular interest, was the engineering design for the domestic water and sanitary drainage which serves 70 rest room facilities, representing 1,074 toilets/urinals and 688 sinks. The challenges for designing the plumbing were primarily its size. The use of rest rooms during a football game is heaviest at half-time and there is no "industry standard" design criteria for such a large system. The design involved sizing the systems for the high instantaneous demand at half time while maintaining efficient sporadic use 80% the rest of the time.

### **Electrical**

The electrical system for the stadium originates from two redundant 15 KV Baltimore Gas and Electric Company (BGE) feeders. The service switchgear incorporates automatic transfer capabilities to switch between these two feeders in the event of a failure. From the main service switchgear, 15 KV feeders are distributed to 14 substations with a total capacity of 24 MVA. These substations are located in each quadrant on the press level and serve as a major distribution points for vertical supply to stacked electrical rooms on all levels. Thirty-two 1,200 amp switchboards and 350 panelboards provide low voltage distribution throughout the stadium.

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The emergency electrical loads for the stadium are supplied from a utility company generator plant which is located on the site outside of the building. This plant houses multiple generators which supply 15 KV power to the football stadium and is also utilized for peak shaving at both the football stadium and the adjacent baseball stadium.

Lighting for the stadium is typically high efficiency fluorescent and metal halide sources. The sports lighting utilizes 1,500 watt metal halide fixtures.

Approximately 10% of the sports lighting fixtures are equipped with instant restrike technologies to provide emergency lighting. The facility includes a microprocessor based lighting control system for all public space lighting.

### Additional Engineering Highlights:

- The design team focused on maintaining the Camden Yards/South Baltimore industrial heritage.
- Field Heating System – Steam/Hot Water Convertors to a multi-zone, pumped distribution system.
- The Club Level can be utilized year round, which includes a self-contained kitchen and indoor bar areas.
- The 140 luxury boxes, that are located on two Suite levels, are recognized as some of the widest and most accommodating suites in sporting venues.
- The electrical distribution system included fourteen (14) facility owned and maintained 4,160 volt substations located throughout the stadium to reduce voltage drop problems.
- Fan-Powered VAV units (Club Level) and Fan Coil Units (Suites) were utilized to permit off-hour, non-game day use while maintaining design conditions during unoccupied modes without initializing major air handling systems.
- Segregated HVAC and plumbing systems to maximize energy savings during specific usage and unoccupied modes.

### 2005 Renovations

In 2005 RMF was asked to provide some improvements to the stadium in the form of adding additional seating, renovating the Owners' suites, adding additional suites, changing signage, concourse restroom improvements, lighting improvements, and improvements to the security command center.

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