

# IDC

## Electrical

### Sheet Index

- G-101 Architectural Titlesheet
- G-103 Efficiency Calculations
- C-101 Site Plan
- A-101 First Floor Plan
- A-102 Second Floor Plan
- A-103 Third Floor Plan
- A-104 Fourth Floor Plan
- A-105 Fifth Floor Plan
- A-106 Sixth Floor Plan
- A-107 Seventh Floor Plan
- A-108 Eighth Floor Plan
- A-201 North Elevation
- A-202 East Elevation
- A-203 South Elevation
- A-204 West Elevation
- A-301 Longitudinal Building Section
- A-302 Transverse Building Section
- A-303 Wall Section
- A-304 Wall Section
- A-305 Stair Section
- A-401 Enlarged Core Plan
- A-402 Enlarged Service Plan
- F-101 Standpipe Location & Coverage
- F-102 First Floor Egress Plans
- F-103 Second Floor Egress Plans (Typical)
- E-001 Electrical Titlesheet
- E-101 Enlarged Electrical & Generator Plans
- E-102 Enlarged Fire Command Center & Electrical Rooms
- E-601 One Line Diagram
- S-001 Structural Titlesheet
- S-002 Structural Calculations
- S-003 Structural Calculations
- S-004 Structural Calculations
- S-005 Structural Calculations
- S-101 Foundation Plan
- S-102 Second Floor Framing Plan
- S-103 Third Floor Framing Plan
- S-104 Fourth Floor Framing Plan
- S-105 Fifth Floor Framing Plan
- S-106 Sixth Floor Framing Plan
- S-107 Seventh Floor Framing Plan
- S-108 8th Floor Framing Plan
- S-201 Northern Structural Elevation
- S-202 Eastern Structural Elevation
- S-203 Southern Structural Elevation
- S-204 Western Structural Elevation
- P-001 Plumbing Titlesheet
- P-901 Plumbing Riser
- M-001 Mechanical Titlesheet

- M-002 Mechanical Calculations
- M-101 Cogeneration System
- 4K-A-001 4K Titlesheet
- 4K-A-101 4K Floor Plans
- 4K-A-301 4K Sections
- 4K-A-401 4K Ceiling Plan
- 4K-F-101 4K Sprinkler System
- 4K-E-101 Receptacle Plan
- 4K-E-102 Lighting Plan
- 4K-M-101 4K HVAC Layout

## Electrical Narrative

Our HVAC system is based on cogeneration in collaboration with a water source heat pump. It uses a Black Hawk helicopter turbine engine as the boiler. It is a self-contained unit. The excess heat from the super-heated exhaust is transferred through a tube to a heating coil into water. The water runs through the building to the heat pumps. The water then makes its way back to the chiller from the heat pumps. The process is repeated since it is a closed system. The air conditioning is run using steam from the heat exchanger located in the thermal mass.

### Biodiesel Collection, Production & Use:

The turbine engine is fueled by biodiesel converted from waste cooking grease from local restaurants. The waste grease is collected from several local sources within a mile radius, including the Washington Nationals Ballpark. The waste grease is brought back to the Boeing Building. It is fed up through a 2 hour fire-rated pipe system leading from the service area to the 2 hour fire rated storage tank room via an enclosed 2 hour fire-rated chase. The pipe system will need boosters in order to get the grease to the roof. The storage tank room is climate controlled due to the biodiesel's nature to gel at 61° F. Climate control prevents gelling and the clogging of fuel filters and fuel injectors. Climate control also prevents condensation. Water in the biodiesel can cause serious mechanical problems for the turbine engine. The storage tank room has also been equipped with four louvers to provide adequate ventilation for the space.

There are five 4,000 gallon storage tanks in the room. Three tanks are dedicated to biodiesel fuel storage. The remaining two are for holdings and processing grease. The tanks have been sized based on calculations of projected daily grease collection. Baseball season significantly impacts the weekly grease collection. The grease intake tank is directly connected to the piping from the chase. Grease is processed there then transferred to the biodiesel tanks. The B100 pure biodiesel is what is produced in this process. The biodiesel is then fed directly to the turbine engine above the storage tank room on Level 8. The fuel then enters the combustion chamber via fuel injection. Biodiesel is like diesel in that it needs to be compressed rather than ignited like jet fuel.

There will be no odor from the biodiesel combustion like there is in a vehicle. Because the exhaust is super-heated, it is hot enough to burn any trace of odor emitting from the engine. This also means that no noxious odors will enter the building. Biodiesel is also safe to handle and transport because it is as biodegradable as sugar, 10 times less toxic than table salt, and has a high flash point of about 300° F compared to petroleum diesel fuel, which has a flash point of 125° F. This is a significant fact that will aid in determining fire ratings of the pipe chase and storage tanks. We used 2 hour fire-ratings to be on the cautious side.

### Turbine Engine:

The Black Hawk turbine engine can be broken down into two sections. The cold section is where the air flow intake is occurring. The hot section is where combustion occurs and the exhaust exits the engine. The air intake in the engine can be separate into two air flows. The hot blow-off comes through the first set of compressors as cool air, into the combustion chamber, through another set of compressors and exits as super-heated exhaust. The cool blow-off goes through the engine in an interstitial like space between the inner housing and exterior housing. The hot blow-off from the super-heated exhaust is what is funneled into the boiler with the heating coils.

Some modifications may need to be made due to the use of B100 – pure biodiesel. This relates to seals and gaskets for the most part because of certain chemical properties biodiesel lacks. Because it is a helicopter turbine engine, it will not produce a whistling sound that a jet turbine engine produces. Any sound production will be minimal because of biodiesel. We do not have to worry about the exhaust getting into the building and causing any noxious gases and fumes because of the HVAC arrangement. Exhaust eventually is kept to a minimum by going through a thermal mass/boiler and exiting upward through the flue. The exhaust is almost a moot point because biodiesel is nearly carbon neutral.

### Electricity Production:

The turbine engine is originally intended to produce thrust in order to fly. The turbine engine is stationary and securely mounted to our building. Instead of producing thrust to fly, the turbine engine is using the horsepower to produce kW of electricity. The turbine engine produces 1,466.66 kW of electricity at 1940 hp. This is more than enough to provide power for the entire building. We will also be sending electricity back to the grid. A customized generator needs to be configured into the cogeneration system in order to harness the electrical production.

A rectifier needs to be used in order to use to electricity the turbine engine produces. The rectifier will convert DC to AC. The rectifier is then connected to the Main Distribution Panel. Then, the electricity is distributed throughout the building. The electrical room on the floor below the helicopter turbine engine also needs to be slightly larger to accommodate the rectifier.

### Biodiesel Savings:

We are collecting grease from approximately 50 restaurants within a mile radius of site B. It costs \$250.00 to empty a 1000 gallon grease receptacle every six months. We are collecting weekly, but will be charging customers \$150.00 every six months except the Washington Nationals. The Washington Nationals Organization will be charged on a pro-rated amount. An estimate would be 2140 gallons per game amounting to \$321.00 per game. Our annual profit from grease collection based on these figures is \$38,001.00. This figure could increase or decrease based on the Nationals yearly performance. If they are doing well, surrounding businesses will be doing well also because of increased attendance.

The amount of biodiesel necessary to fuel our helicopter turbine engine in annually is 695,290 gallons. Our calculations show that our annual collection and production of biodiesel is 253,786 gallons. This leaves us with a 253,786 gallon surplus. The current cost per gallon in the East Coast – Central Atlantic region of the United States is \$4.046. We stand to make a \$1,026,818.16 profit annually. This could potentially be even more due to our conservative calculations and other socioeconomic factors that are not able to be accounted for without highly detailed research.

### Electricity Savings:

Electricity in the Washington D.C./Baltimore area costs \$0.125 per kW hour. The turbine engine produces 1940 hp (=1,446.66 kW). Using a square footage of 250,000 SF and 5 watts per square foot, 196.6 kW (4,718.4 kWh/day) are sent back to the power grid. Since our helicopter turbine engine produces 1,446.66 kWh, its output is 35,184 kWh/day. That is an annual total of 12,842,160 kWh. Taking the annual total and multiplying it by the current cost of electricity per kW hour (\$0.125) and our annual electricity savings are \$1,605,270.00.

### Cost of Maintenance:

The cost of maintaining the helicopter turbine engine is difficult to calculate. The turbine engine runs 24 hours a day, 7 days a week. This will cause wear and tear to occur at an accelerated rate compared to a turbine engine in actual use on a Black Hawk helicopter. Our aeronautics specialist, Dave Aston, said it may be difficult for him to even gauge what the maintenance cost would be given that we are using it for something other than its intended purpose.

### Late Project Addition:

Two days before our black and whites were due our detail oriented designer came up with an idea that another unconventional sustainable design idea that required the installation of a second turbine engine that would use the remainder of the surplus of the biodiesel the Boeing company produces their in house grease production. Because of its design intent to run at a consistent temperature constantly at all times and be above the boiling point of water, it is perfectly fine to run at 57.5% percent of its maximum horsepower of 1940. With the addition of the second turbine engine comes additional revenue from electricity sent to the grid, but that is off-set by the money lost from not being able to sell the biodiesel on the open market. The money that the Boeing building saves in water and sewage is a significant net gain for the company. The addition of a second turbine engine requires a second rectifier to run to the Main Distribution Panel.

### Symbol Legend

-  Emergency Light
-  Standard Receptacle
-  GFCI
-  Ground-Fault Circuit Interrupter Receptacle
-  Single Pole Switch
-  Dimmer Switch
-  Three-Way Switch

### Consultants

- Structural Engineer  
Hollee Becker
- Mechanical Engineer  
Matthew Setzekorn
- Electrical Engineer  
Jim Stadelman
- Aeronautics Specialist  
David Aston

### Contract Information

Forest City  
Washington  
1615 L Street NW,  
Suite 400  
Washington, DC  
20036

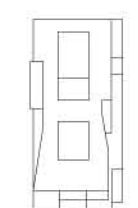
Phone: 202-406-6600  
www.dowashington.com

Kent State University  
College of  
Architecture &  
Environmental Design

### Client



### Key Plan



Date: 4/11/2011  
Drwn by: Esposito  
Chkd by: Harker  
Sheet Title:  
Titlesheet