Dewberry

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Generator Replacement

September 26, 2023

Middle Tennessee Mental Health Institute

State of Tennessee

Department of Mental Health & Substance Abuse Services

Nashville, Davidson County, TN

SBC Proj # 529/000-02-2019-17

Programming

Dewberry Engineers, Inc.

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Dewberry Proj. # 50167418

Nashville, Tennessee

Executive Summary:

A. STATEMENT OF NEED:
   a. The current generator is aging and will not power all of the facility which may be a requirement by 2025.

B. OVERVIEW
   a. The State of Tennessee engaged Dewberry Engineers to evaluate the emergency power system. The Middle Tennessee Mental Health Institute (MTMHI) consists of the Main Hospital building, Forensic building, and Dietary building. The scope of this program focuses on the Main Hospital and Forensic building and excludes the Dietary building as its use is being phased out. The Main Hospital and Forensic building were constructed in 1994 and 1995 and are located at 221 Stewarts Ferry Pike in Nashville, TN.
   b. The existing facilities were surveyed to ascertain the extents and condition of the existing emergency power system at the two buildings.
   c. The main hospital's emergency power is provided by a single 750 kW generator and three automatic transfer switches. All are original to the building and have reached the end of their useful life. During a power failure, only loads required by prior codes are provided with power.
   d. The forensic building's emergency power is provided by a single 300 kW diesel generator and three automatic transfer switches. The generator is original to the building. The transfer switches were replaced in the past several years; however, the transfer switches are mounted in the same room as the normal power switchboard in violation of current codes.

C. RECOMMENDATIONS:
   a. In order to replace aged equipment, provide a current code compliant solution, and provide sufficient system capacity to provide power to the entire facility as may be required by 2025, the existing generators and transfer switches should be replaced.
   b. The new system for the hospital will be provided with two generators and associated generator paralleling gear to increase reliability and offer a degree of redundancy to the required emergency power loads.
   c. For both buildings a reworked utility service will be required to accommodate the new system.
   d. For both buildings the system will be configured to provide separate fire rated rooms to house the generators, required emergency power equipment, and normal/optional power equipment.
   e. For each of the buildings, the existing diesel generators and automatic transfer switches should be replaced. Each building will require a new electrical powerhouse structure to house new generator(s) with separate

rooms for the generator(s), required emergency power switches, and normal power switchboards and optional loads switch.

f. New conductors and raceway should be installed to connect the new equipment to the existing power distribution system.
g. The new powerhouses should be equipped with new HVAC and fire protection systems.
h. New fuel tanks should be provided to accommodate increased fuel demands.

D. PROBABLE COST
   a. The probable cost through 2027 for the proposed scope of work is $9,835,097.

E. SCHEDULE
   a. The proposed design schedule is 200 days without considering review times.
   b. The proposed construction duration is 550 days.

Recommendations:

Electrical Recommendations:

The existing electrical system is recommended to be modified as outlined below.

A. Codes and Standards:

- International Building Code (2012)
- International Energy Conservation Code (2012)
- National Electric Code (2017)
- NFPA 101 - Life Safety Code (2012)
- Facility Guidelines institute Guidelines for Design and Construction of Hospitals (2022)

B. **Main Hospital Emergency Power System**

1. New diesel fueled standby generators shall be provided. The generators shall be rated 1000 kW, 480/277 Volt along with all required appurtenances. There shall be a total of two (2) of these generators. Generators shall be housed in a new powerhouse building.
2. The new diesel generators shall be connected to new paralleling switchgear. This switchgear will provide for automatic control and parallel connection of the two generators. The switchgear will be rated for 2000 Amps, 480/277 Volt. The switchgear will contain the overcurrent protection to serve the emergency side of the new automatic transfer switches and one generator main breaker for each generator. A separate switchgear section will be provided for the life safety overcurrent device to provide required separation. The optional branch overcurrent device should likewise be housed in a separate switchgear section to provide separation from the emergency system feeds. The paralleling gear will be located in a new emergency power electrical room in the new powerhouse building.
3. A total of four new automatic transfer switches will be provided. A new 250 Amp, 4 pole, bypass isolation switch will be provided to serve life safety branch loads. A new 800 Amp, 4 pole, bypass isolation switch will be provided to serve the critical branch loads. A new 800 Amp, 4 pole, switch will be provided to serve the equipment branch loads. A new 2000 Amp, 4 pole, switch will be provided to serve the optional loads.
4. The life safety, critical, and equipment branch switches will be located in the new emergency power room in the new powerhouse. The optional branch switch shall be located in a new normal power room in the new powerhouse.
5. The new life safety, critical, and equipment branch transfer switches will serve the existing associated branch distribution panels.
6. The new optional branch switch shall serve the existing main switchboard.

7. Connected to the paralleling gear shall be a 1600 Amp, exterior mounted, dual purpose docking station. This docking station will provide a means to connect a load bank or a temporary portable generator to the paralleling switchgear. The docking station shall be located on the exterior of the new powerhouse building.

C. Main Hospital Normal Power Upgrades

1. The existing service entrance from the existing 3000 Amp storm switch to the existing switchboard shall be removed.
2. A new service entrance consisting of 8 sets of 500 MCM shall be extended from the existing storm switch to a new 3000 Amp switchgear. This new switchgear shall be located in a normal power electric room in the new powerhouse building.
3. The new switchgear shall serve the normal power side of the new transfer switches.
4. The existing normal power services to the existing transfer switches contained in the existing switchboard shall be removed once the new service, emergency power system, transfer switches, and back feed of existing switchboard have occurred.

D. **Main Hospital New Powerhouse Building**

1. A new powerhouse building will be constructed in the vicinity of the existing generator and main electrical rooms. The new building will be CMU construction on a concrete slab with a membrane roof. See Figure 1 for the proposed layout.
2. For the new powerhouse, one of the rooms should house the new generators, one room will house the paralleling gear and transfer switches, and one room will house the normal power switchgear and optional loads transfer switch.
3. The building will be ventilated, cooled, and fully sprinklered as more fully described below.
4. The existing fire alarm system will be expanded to provide smoke, heat, and indicating appliances as required.

Refer to Main Hospital One-line for more detail on the power distribution system.

E. **Forensic Building Emergency Power System**

1. New diesel fueled standby generator shall be provided. The generator shall be rated 500 kW, 480/277 Volt along with all required appurtenances. The generator shall be housed in a new powerhouse building.
2. The new diesel generator shall be connected to new generator distribution panel. The generator panel will be rated for 800 Amps, 480/277 Volt. The panel will contain the overcurrent protection to serve the emergency side of the new automatic transfer switches. A separate panel section will be provided for the life

safety overcurrent device to provide required separation. The optional branch overcurrent device should likewise be housed in a separate panel section to provide separation from the emergency system feeds. The generator panel will be located in a new emergency power electrical room in the new powerhouse building.

3. A total of four new automatic transfer switches will be provided. A new 150 Amp, 4 pole, bypass isolation switch will be provided to serve life safety branch loads. A new 250 Amp, 4 pole, bypass isolation switch will be provided to serve the critical branch loads. A new 250 Amp, 4 pole, switch will be provided to serve the equipment branch loads. A new 600 Amp, 4 pole, switch will be provided to serve the optional loads.
4. The life safety, critical, and equipment branch switches will be located in the new emergency power room in the new powerhouse. The optional branch switch shall be located in a new normal power room in the new powerhouse.
5. The new life safety, critical, and equipment branch transfer switches will serve the existing associated branch distribution panels.
6. The new optional branch switch shall serve the existing main switchboard.
7. Connected to the generator panel shall be an 800 Amp, exterior mounted, dual purpose docking station. This docking station will provide a means to connect a load bank or a temporary portable generator to the generator distribution board. The docking station shall be located on the exterior of the new powerhouse building.

F. Forensic Building Normal Power Upgrades

1. The existing service entrance from the existing 1200 Amp storm switch to the existing switchboard shall be removed.
2. A new service entrance consisting of 2 sets of 500 MCM shall be extended from the existing storm switch to a new 800 Amp switchboard. This new switchboard shall be located in a normal power electric room in the new powerhouse building.
3. The new switchboard shall serve the normal power side of the new automatic transfer switches.
4. The existing normal power services to the existing transfer switches contained in the existing switchboard shall be removed once the new service, emergency power system, transfer switches, and back feed of existing switchboard have occurred.

G. Forensic Building New Powerhouse Building

1. A new powerhouse building will be constructed in the vicinity of the existing generator and main electrical rooms. The new building will be CMU construction on a concrete slab with a membrane roof. See Figure 2 for the proposed layout.

2. For the new powerhouse, one of the rooms should house the new generator, one room will house the generator panel and transfer switches, and one room will house the normal power switchgear and optional loads transfer switch.
3. The building will be ventilated, cooled, and fully sprinklered as more fully described below.
4. The existing fire alarm system will be expanded to provide smoke, heat, and indicating appliances as required.

Refer to Forensic Building One-line for more detail on the power distribution system.

Mechanical Recommendations:

The new mechanical systems shall comply with the following Codes and Standards:

- International Energy Conservation Code (2012)
- International Mechanical Code (2012)
- International Building Code (2012)
- International Fire Code (2012)
- National Electric Code (2017)
- NFPA 101 - Life Safety Code (2012)

The following items are necessary to support the Electrical recommendations of the new powerhouses noted above

1. Heating and ventilation systems should be provided to maintain space conditions, when the emergency electrical system is not energized, in accordance with the generator manufacturer's requirements.
2. For emergency operation, proper ventilation should be provided to support the combustion-air intake and heat rejection ventilation processes. Adequate intake and exhaust openings, ductwork, and controls should be provided in coordination with the generator manufacturer's requirements for combustion-air intake, ventilation, exhaust, space temperature conditions, etc. The flue exhaust duct system should be provided with a muffler for noise reduction and should be insulated to minimize heat gain and noise.
3. Cooling should be provided for the electrical rooms adjacent to the generator rooms with wall-mounted, ductless, mini-split systems. Condensate from the mini-splits should be disposed of at the nearest floor drain. An electric unit heater should be provided to keep the fire protection riser room from freezing.

Fire Protection Recommendations

The new fire protection systems in the new powerhouses shall comply with the following Codes and Standards:

- International Energy Conservation Code (2012)
- International Mechanical Code (2012)
- International Building Code (2012)
- International Fire Code (2012)
- National Electric Code (2017)
- NFPA 101 - Life Safety Code (2012)

1. The new powerhouses shall be fully sprinklered. The new system wet sprinkler system piping will include the following materials: For pipe sizes 2 ½" and larger, the system shall be constructed using schedule 10 black steel piping with welded or Victaulic- type joints depending upon the size of the piping. For Pipe sized smaller than 2 ½", schedule 40 black steel piping shall be utilized. All sprinkler heads in areas without finished ceilings shall be brass upright heads with temperature ratings as conditions dictate. All new fire protection systems to conform to all requirements of NFPA 13, and 24, all local, county and state regulations, as well as the insurance underwriter. Coordinate with electrical contractor for connecting wiring of the various new zone tamper and flow switches.

Fuel Oil System Recommendations

A new fuel oil systems to serve the new generators for each of the new powerhouses shall comply with the following Codes and Standards:

- International Energy Conservation Code (2012)
- International Mechanical Code (2012)
- International Building Code (2012)
- International Fire Code (2012)
- National Electric Code (2017)
- NFPA 101 - Life Safety Code (2012)

1. New above ground diesel fuel tanks shall be provided: a 10,000-gallon tank for the Main Hospital, and a 2,500-gallon tank for the Forensic Building. The fuel system shall consist of tanks, fuel management system with monitoring, underground piping, above ground piping, transition vault, day tanks and piping accessories. Tanks shall be compliant with UL 142 Above Ground Flammable Liquid Tanks and UL 2085 Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids. Diesel fuel will be a No.2 fuel oil NFPA Classification Class 2. Underground piping shall be double wall carrier pipe with a containment pipe. The interstitial space of tank and piping shall be monitored with a leak detection system. The above ground piping shall be a single wall carbon steel pipe. The system shall be sized to 8ft/second maintaining a minimum of 15"Hg Column.

Phasing Considerations

The existing facility will continue to operate as a mental healthcare facility during this project. As such, electrical outages must be kept to a minimum and carefully coordinated with the owner. To facilitate this goal, general phasing should include:

1. For each of the two buildings, the new powerhouse should be constructed first.
2. New generators, switchgear, automatic transfer switches and all associated equipment should be installed, tested, inspected, and accepted.
3. The back feeds for each of the existing essential power branch panels should be coordinated to minimize the outage time for each branch.
4. Once the back feeds for each of the existing essential power branch panels is completed, the existing transfer switches and associated feeders can be removed.
5. The back-feed of the existing switchboards and demolition of the existing service entrance conductors, and demolition of the existing generators will occur as a final phase.

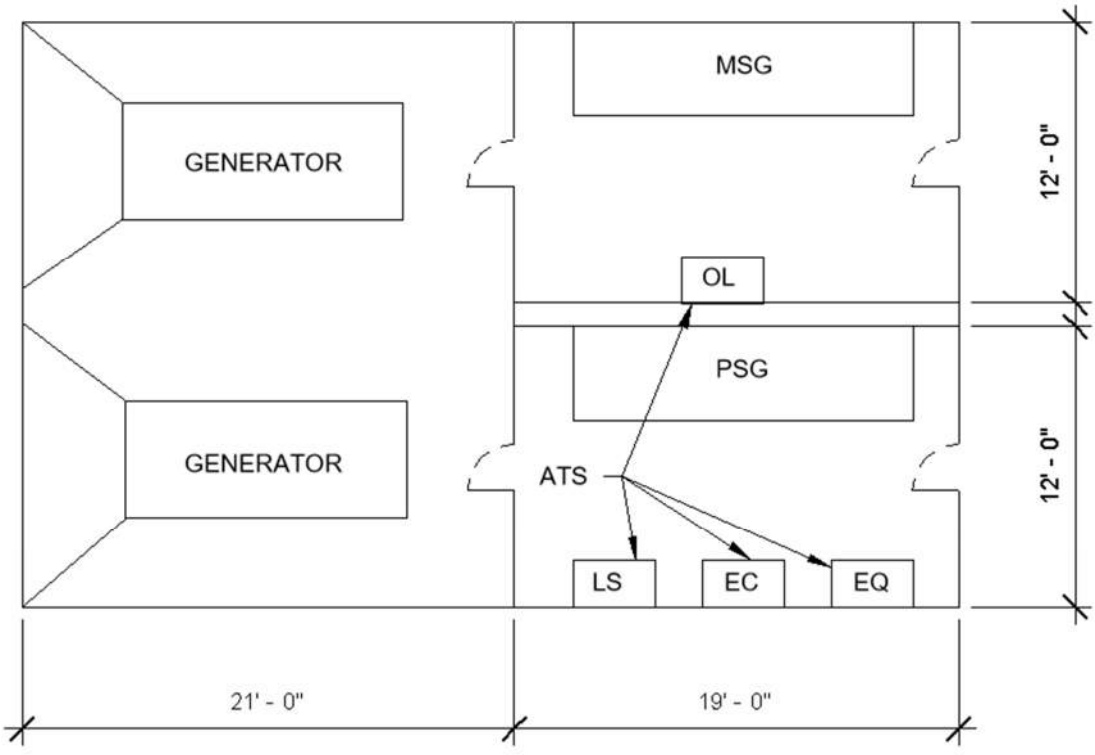


Figure 1: Proposed layout of new powerhouse for the Main Hospital.

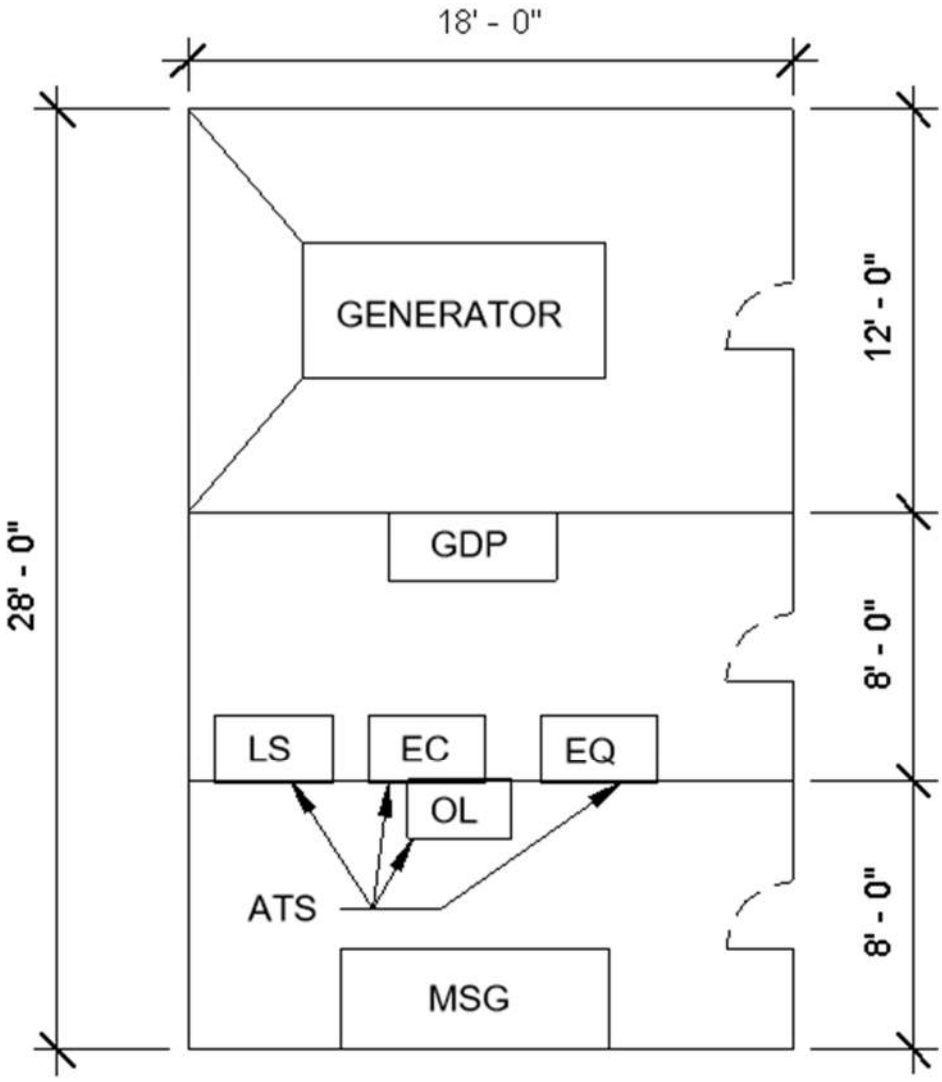
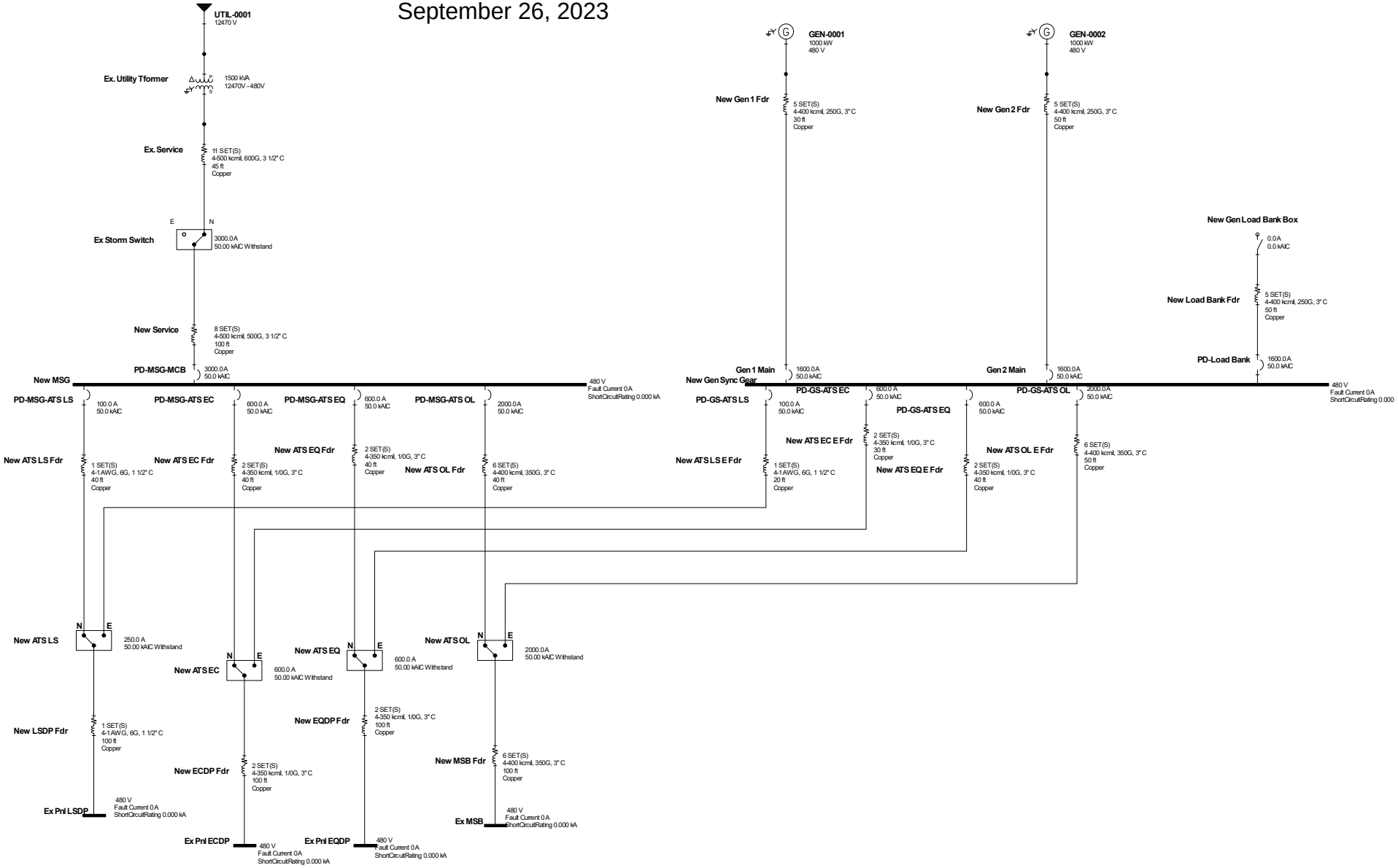
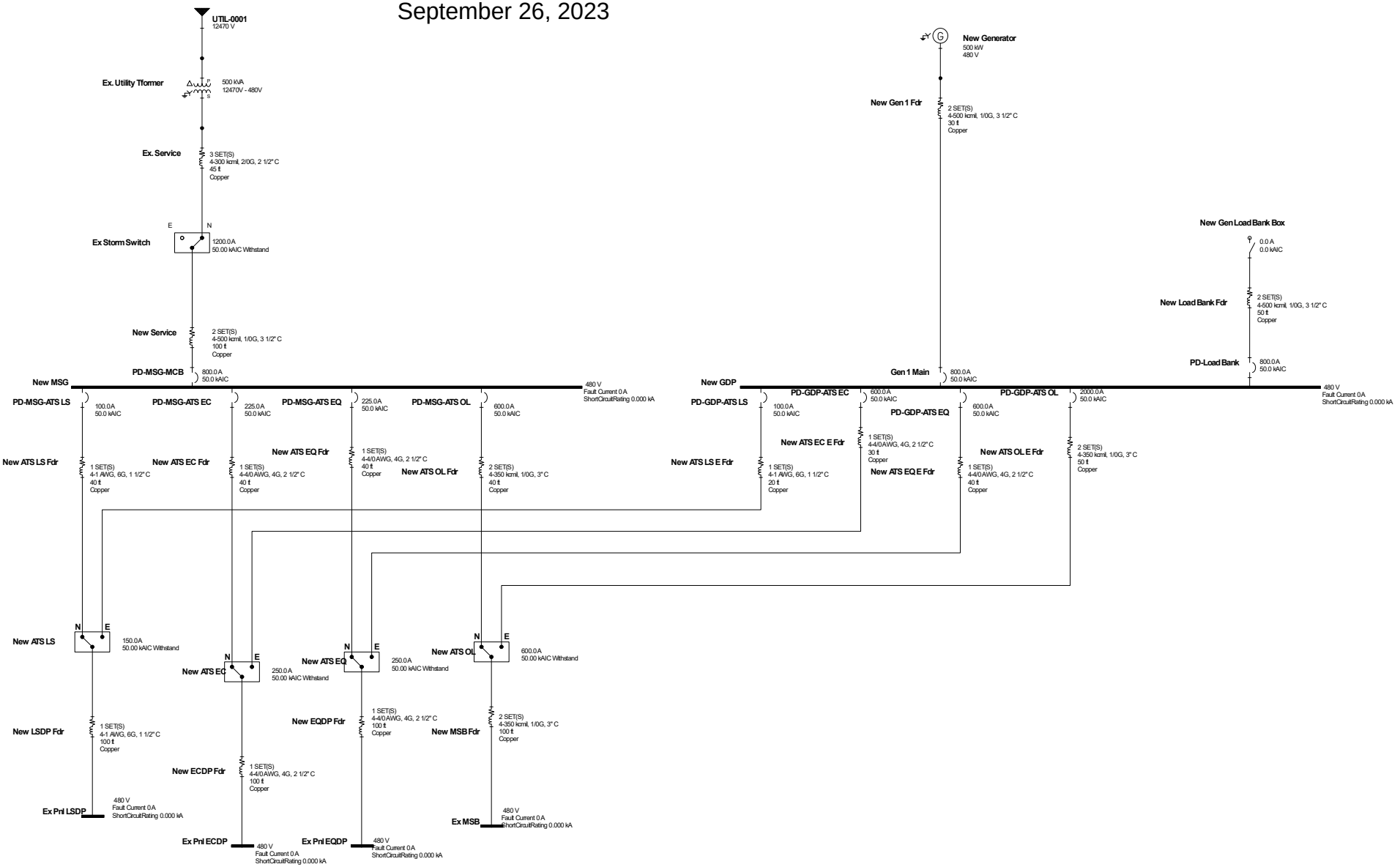


Figure 2: Proposed layout of new powerhouse for the Forensic Building.



Main Hospital One Line Diagram



Forensic Service One Line Diagram

Design Schedule

The proposed design schedule is as follows:

Program Verification	25 days
Schematic Design	25 days
Design Development	45 days
Construction Documents	60 days
Bidding/Negotiation	45 days

Construction Schedule

The proposed construction schedule is 550 days.

Attachment A: Opinion of Probable Cost Estimate

Opinion of Probable Cost
Phase: Programming

Project Name: Middle Tennessee Mental Health Institute
Generator Upgrades
Davidson County, Tennessee
Dewberry Project
Number: 50164078
SBC No: 529/000-02-2019
Date: 8/24/2023

Divisional Breakdown			
		Cost Per GSF	Estimate Amount
Division 1	General Requirements	NA	$ 398,300.00
Division 3-9	Gear/Generator Building Construction (1@1000sf, 1@500sf)	$ 288.78	$ 433,173.78
Div 21	Fire Protection	NA	$ 13,695.00
Div 22	Plumbing - Fuel Oil	NA	$ 224,384.88
Div 22	Underground Tank Remidiation/Removal	NA	$ 50,000.00
Div 23	HVAC	NA	$ 308,431.25
Div 26	Electrical	NA	$ 2,718,557.60
Div 28	Fire Alarm	NA	$ 16,450.00
	Subtotal Direct Cost of Work		**$ 4,162,992.51**
General Conditions - 10% of Subtotal Direct Cost of Work			$ 416,300.00
Permitting - 0.5% of Subtotal Direct Cost of Work + General Conditions			$ 22,897.00
	Subtotal with Direct Overhead		**$ 4,602,189.51**
General Contractor Overhead - 10% of Subtotal with Direct Overhead			$ 460,219.00
General Contractor Profit- 5% of Subtotal with Direct Overhead + GC Overhead			$ 253,121.00
	Subtotal with General Contractor's Markup		**$ 5,315,530.00**
Construction Contingency - 10% of Subtotal with GC's Markup			$ 531,553.00
Design Contingency - 15% of Subtotal with GC's Markup			$ 797,330.00
	Subtotal with Construction Contengiency		**$ 6,644,413.00**
Builder's Risk Insurance - 0.5% of Subtotal with Construction Contingency			$ 33,223.00
Performance & Payment Bond - 0.6% of Subtotal with Construction Contingency			$ 39,867.00
	Total Construction Cost		**$ 6,717,503.00**
Escalation - 4 Years at 10% of Total Construction Cost Per Year		46%	$ 3,117,594.00
	Total Escalated Construction Cost to the Year 2027		**$ 9,835,097.00**

Attachment B: Observation Summary Narrative

The following observations were made:

Main Hospital:

1. The existing generator is mounted indoors and manufactured by Caterpillar, rated for 750kW at 480V, 3-phase (see Photo B1). The generator is believed to be original to the facilities construction.

2. The fuel source is diesel. The fuel tank is in-ground with a capacity of 8,000 gallons.

3. The existing room housing the generator has a width of 16.5ft., a length of 22.5ft., and a height of 13.5ft (see Figures B2 and B3).

4. The main service entrance to the building is rated for 4,000A. A storm switch rated for 3,000A is planned to be installed under a currently ongoing project. This switch will be connected between the utility transformer and the main service switchboard. The main service panel serves the normal side of the automatic transfer switches.

5. The generator serves an emergency panelboard MSE which in turn serves the emergency side of the three automatic transfer switches.

6. The facility has three automatic transfer switches, one each for equipment branch, critical branch, and life safety branch power.

7. All loads not connected to the three required branches (normal power loads) are without power in the event of loss of utility power. This includes all chillers, chilled water pumps, non-patient care area air handlers, and selected lighting and receptacle power.

8. The equipment, critical, and life safety branches are connected to the normal power switchboard via breakers rated for 600A for equipment and critical branches, and 100A breaker for life safety branch (see Photo B2).

9. Panel MSE is powered from the generator and serves the emergency side of the automatic transfer switches. The equipment, critical, and life safety branches are connected to the emergency power panelboard via breakers rated 600A for the equipment and critical branches and 100 Amps for the life safety branch.

10. MSE panelboard is rated for 1200A (see Photo B3).

11. The existing ATS's are believed to be original to the building construction (see Photo B4).

12. Information provided by Nashville Electric Service from their meters indicate a total building peak power (30-minute peak) from July 2022 to July 2023 ranged from 538kW to 757kW, with an all-time high of 1,101kW.

13. The normal power switchboard, automatic transfer switches, and emergency power switchboard are all located in one electrical room and do not provide rated separation as is currently required by code.

Forensic Building:

1. The existing generator is mounted indoors and manufactured by Caterpillar, rated for 300kW at 480V, 3-phase (see Photo B6). The generator is believed to be original to the facilities construction.

2. The fuel source is diesel. The fuel tank is in-ground with a capacity of 2,500 gallons.

3. The existing room housing the generator has a width of 9.5ft., a length of 17.5ft., and a height of 12ft (see Figure B4).

4. The main service entrance to the building is rated for 800A. A storm switch rated for 1,200A has been installed between the utility transformer and the main service equipment (see Photo B5). The normal side of the transfer switches is served from the service entrance panel.

5. The generator serves an emergency panel EDP which in turn serves the emergency side of the automatic transfer switches.

6. The facility has three automatic transfer switches, one each for equipment branch, critical branch, and life safety branch power.

7. All building loads not connected one of the three transfer switches (normal power loads) are without power in the event of loss of utility power. This includes all chillers, chilled water pumps, non-patient care air handlers, and selected lighting and receptacle power.

8. The equipment, critical, and life safety distribution panelboards receive power from the service entrance panelboard. The equipment and critical panelboards

are each connected to 225A breakers, and the life safety panelboard is connected to a 30A breaker.

9. Panel EDP is powered from the generator and serves the emergency side of the automatic transfer switches. The ATS for the critical and equipment panelboards are connected to 225A breakers, and the life safety ATS is connected to a 30A breaker. The EDP panelboard is rated for 400A (see Photo B7).

10. The existing ATS have been replaced and are in good working order (see Photo B8).

11. Information provided by Nashville Electric Service from their meters indicate a total building peak power (30-minute peak) from July 2022 to July 2023 ranged from 97kW to 184.2kW, with an all-time high of 223kW.

12. The normal power switchboard, automatic transfer switches, and emergency power panel are all located in one electrical room and do not provide rated separation as is currently required by code.

Figure B1: Overall site plan of MTMHI. Building 1 is the Main Hospital. Building 2 is the Forensic building.

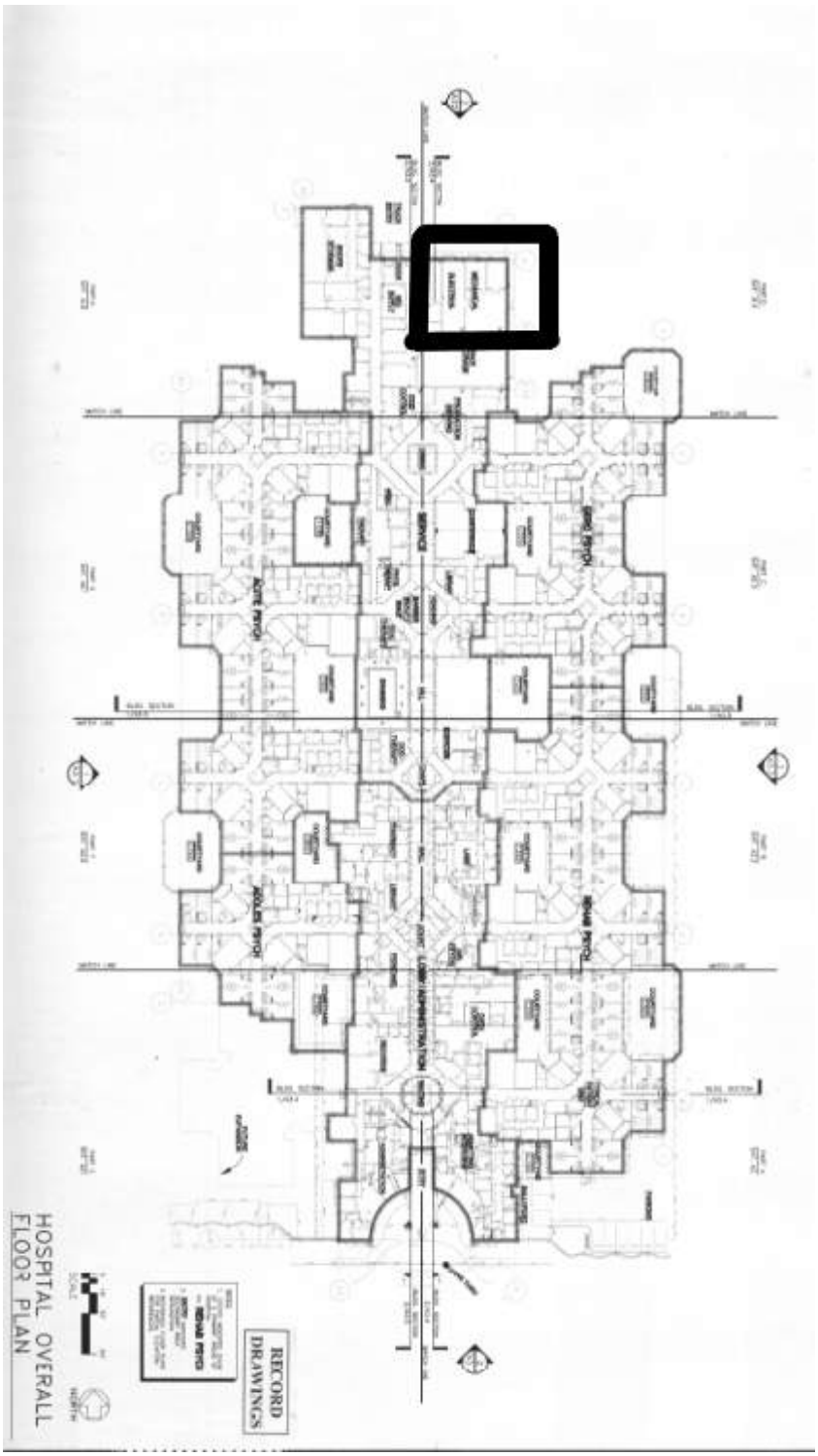


Figure B2: Main Hospital floor plan, with location of Electrical and Generator Rooms shown in the box.

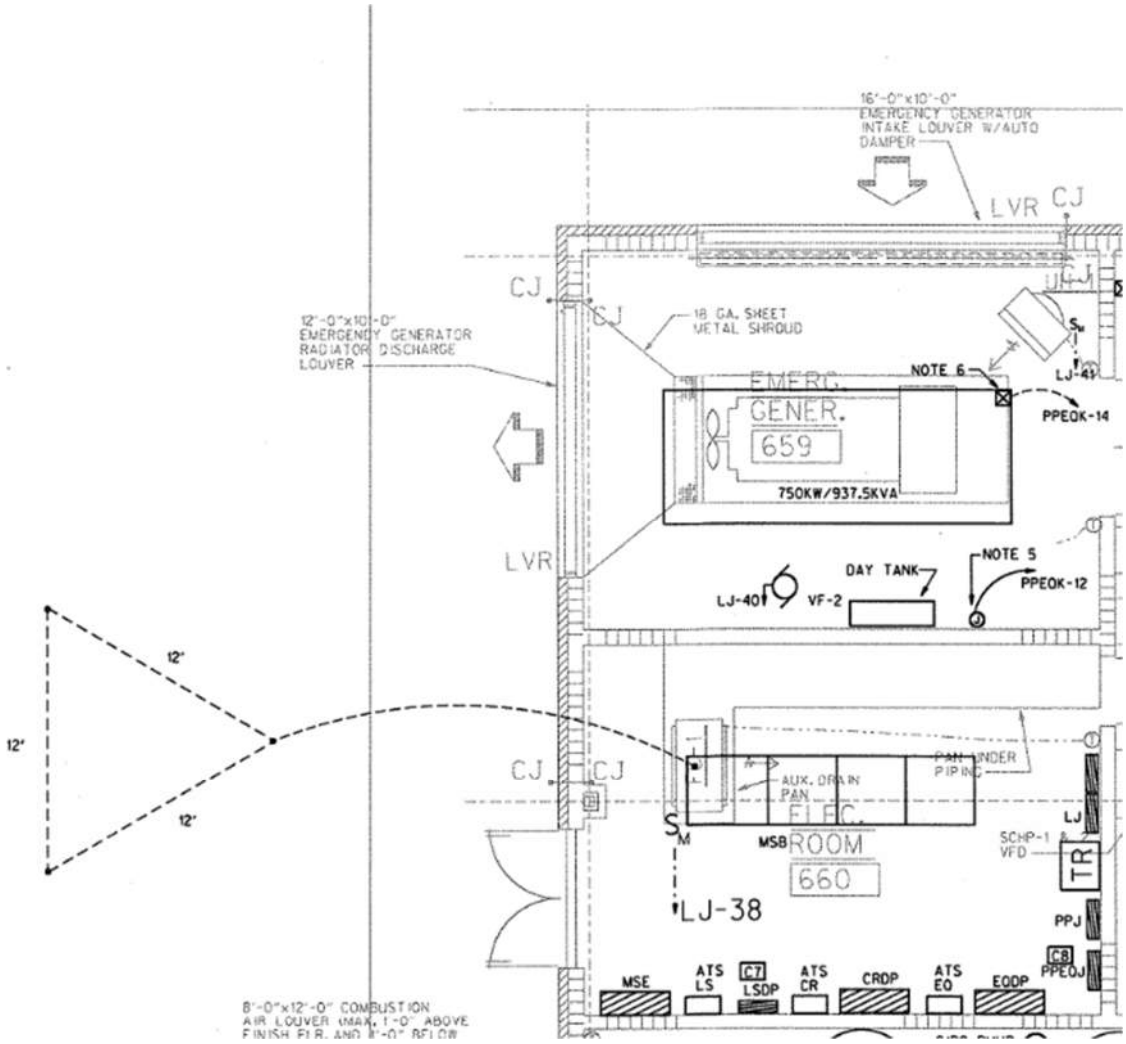


Figure B3: Floor plan of Electrical and Generator rooms.

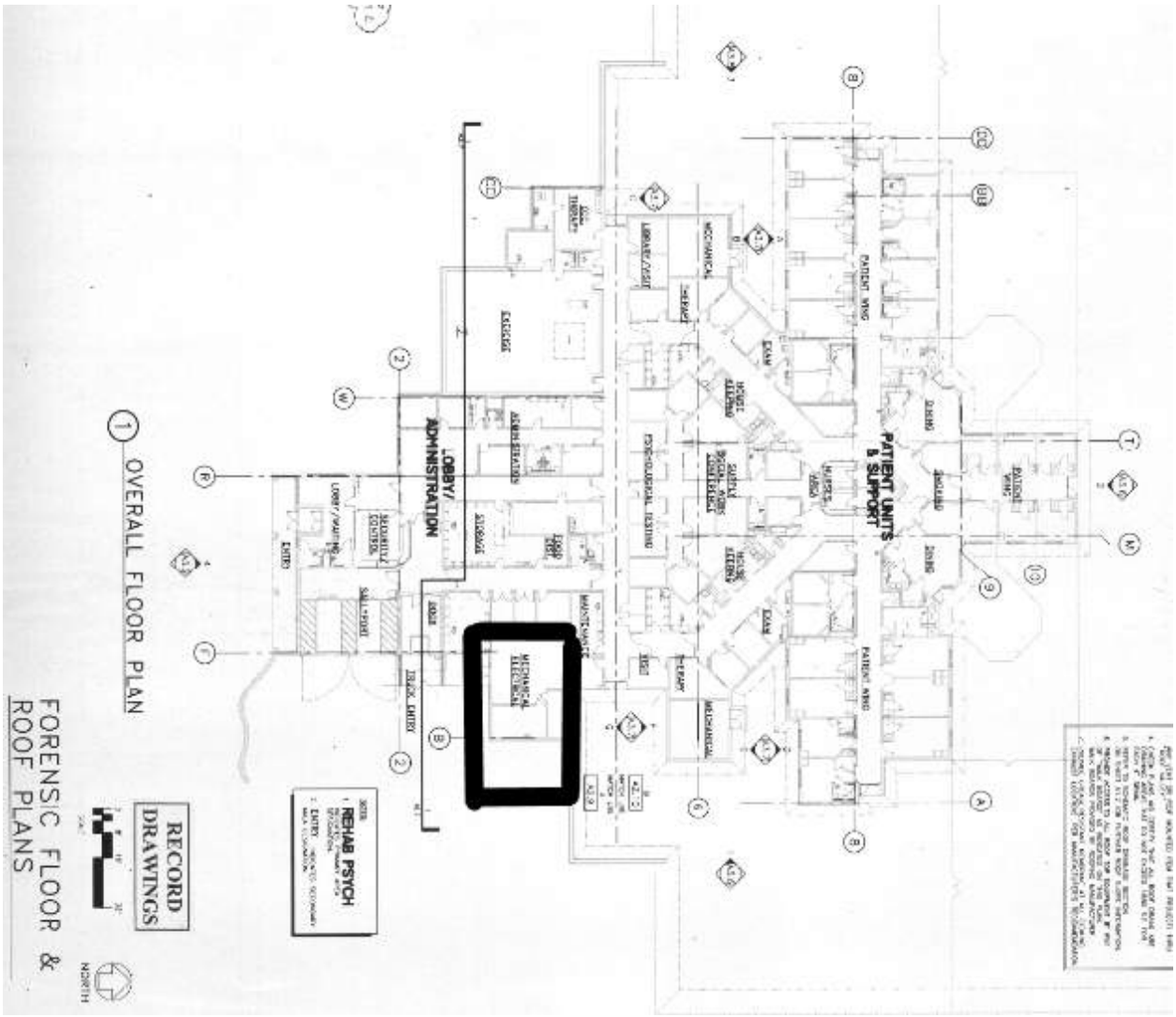


Figure B4: Forensic building floor plan. Electrical and generator rooms are inside the box.

Photo B1: Main Hospital 750kW Generator

Photo B2: Main Hospital Main Switchboard

Photo B3: Panel MSE

Photo B4: CRDP Transfer Switch

Photo B5: Existing 1200A Storm Switch

Photo B6: Forensic Building 300KW Generator

Photo B7: Forensic Building Electrical Room

Photo B8: CRDP ATS