# PGDP Utilities Descriptions

## PGDP Electrical System

A new Tennessee Valley Authority (TVA) 14kV substation (C-538) was recently commissioned, which provides primary power to the Paducah site. The C-538 substation is located on the east side of the plant outside of the limited area, east of Dyke Road and north of McCaw Road.

The C-538 substation is fed by two 161kV transmission lines from TVA's power grid. Eight 14kV feeders run underground from the C-538 substation to the PGDP and tie-in to a load break station located inside the limited area. From the load break station the feeders interface with overhead raceway, existing termination boxes, and the C-531 switch house ACB cabinets for power distribution to the PGDP. The Paducah DUF6 facility is also provided power through two metered 14kV feeders.

## PGDP Water System

The PGDP currently receives and treats raw river water from the Ohio River. River water is pumped from a channel at the Tennessee Valley Authority (TVA) Shawnee Fossil Plant pump deck via DOE-owned/TVA-operated 9,000 gal per minute (gpm) capacity pumps. Of the six pumps, four are operable. A project is ongoing to replace one of the raw water pumps with a smaller 3,500 gpm pump to size appropriately for PGDP's current demands. River water is pumped to the C-611 water treatment facility where it passes through a chemical/mechanical process to soften and treat the water to meet drinking water quality standards.

Cold lime-soda process, using calcium oxide, sodium carbonate, and ferric sulfate are utilized for water softening. A cation polymer can be used as a coagulant aid when required. Softening is performed in C-611-X and C-611-U units. Softening is followed by flocculation and pre-disinfection in the C-611-C and/or C-611-Z flocculator basins. Ferric sulfate is added for flocculation and chlorine for pre-disinfection. After flocculation, water flows into settling basins for velocity reduction to allow for settling of floc. Settled floc is allowed to accumulate up until the basin is isolated, drained and cleaned.

Treated water is delivered from C-611 through the PGDP sanitary and fire water system (SFWS) for domestic use, fire water use, and equipment use. The average daily demand of sanitary water is around approximately 2.5 MGD, with low demand of approximately 1.8 MGD occurring in fall/spring months; and a high demand of approximately 3.5 MGD occurring in the summer. Maximum capacity of the sanitary water system is approximately 7.5 MGD. The sand filter system is the limiting factor for the sanitary water system.

PGDP currently is licensed and permitted as its own water district by the Commonwealth of Kentucky.

Potable (sanitary) water is supplied to the PGDP SFWS distribution piping where supply demands are met through an elevated water tank, C-611-O (250,000-gal capacity), which supplies water for the following end uses:

- Domestic use (drinking water, restrooms, showers, etc.);
- Fire water use;
- Equipment use (i.e., steam generation or cooling water);
- C-103 DOE Building; and
- Depleted Uranium Hexafluoride Conversion Facility ($DUF_6$).

$DUF_6$ is an end user of water from the SFWS for domestic, fire water, and equipment water. The SFWS distribution supplies makeup water to the High-Pressure Fire Water System (HPFWS), which is a separate fire water system that has its own elevated water tank, C-611-R (300,000-gal capacity), that distributes water at approximately 135 pounds per square inch gauge (psig) to specific process facilities at the Paducah Site.

The dry-hybrid system installation will eliminate the need for auxiliary heating in the process buildings ultimately eliminating the need for the HPFWS. The dry-hybrid conversion from the HPFWS was completed for the C-333 Process Building in FY 2020 and will be completed for the remaining site Process buildings by the end of FY 2022. The HPFWS will not be needed after FY 2022.

**PGDP Sewer System**

The sanitary sewage collection and treatment system is a primary utility of the Paducah Site. The system supports site needs for treating sanitary sewage from administrative facilities, locker rooms, restroom facilities, break rooms, and other wastewater discharged to the collection system. The sewage treatment system is required to support the near-term mission of deactivation and remediation and continued Depleted Uranium Hexafluoride Conversion Services Plant operations. DUF6 ties into the system between C-302 and C-710.

The collection system is designed to collect and convey sanitary sewage and wastewater to the C-615 Sewage Treatment Plant (STP) for treatment. Collection system components include pipes, valves, pumps, lift stations, manholes, force mains, cleanouts, and flush tanks. There are two flush tanks located at points of low-flow to prevent solid buildup in the piping. The drainage system requires a Class 2 Sewage Collection license to operate the lift stations and collections stations.

The C-615 treatment plant includes a comminutor (shreds various solids), primary basin, secondary basin (precipitation of solids), trickling filter, digester, and drying beds. The influent waste waters flow through the comminutor and grit basket for size reduction into the primary basin. Liquid from the primary basin is pumped to the trickling filter. From the trickling filter, a portion of the liquid flows to the primary basin for recycle and a portion flows to the secondary basin. The effluent from the secondary basin is chlorinated in the chlorine contact chamber (weir box) and flows to Outfall 004. Drying beds are cleaned out every 3 to 5 years and the waste is disposed as low-level radioactive waste. The C-615 STP is designed to treat up to 500,000 gal per day (gpd). C-615 is pushed to capacity (500K GPD) with a 2 inch rainfall in a 24 hour time period due to the inflow/infiltration.

The system uses gas chlorination and de-chlorination to disinfect the effluent prior to release into Bayou Creek. The C-615 chlorine feed facility houses the chlorinator, chlorine containers, exhaust fan, and chlorine gas detection system. Two chlorine containers are connected to the feed system. One is normally in use and the other is in standby ready to be automatically put into service upon depletion of the in use container. Each container is connected to a vacuum regulator that feeds chlorine gas to the chlorinator at a vacuum, avoiding pressurized lines. The C-615 treatment plant requires a Class 2 Waste Water Treatment System License to operate.

The C-615 Facility also takes leachate from the U-landfill when excessive rainfall is present and other contractor work such as asbestos shower tanks. This waste water is pumped and delivered to the treatment plant by mobile tanks.

**PGDP Natural Gas System**

The Paducah Site's natural gas supply line originates from the Atmos Energy main line near Ogden Landing Road on the north side of the plant. This supply line travels southwest from Ogden Landing Road to a valve station just outside the limited area fence and north of the C-757 Solid and Low Level Waste Process Facility. At this point, the natural gas line branches into two lines: (1) a 6 inch line that travels southward paralleling 10th street to a metering station just east of the C-600 Steam Plant; and (2) a 3-inch line that travels south to the C-757.

At the C-600 metering station, the 6-inch line branches over to the C-600 No. 1 boiler (out of service), the package boiler station, and to a 3-inch line that travels back north and then west to the C-752A Waste Storage Facility and C-746A North Warehouse.

The current uses of the natural gas include:

- Fuel for the ultra-low NOx package boilers
- Facility heat at C-752-A
- Facility heat at C-757

**Steam Boiler/Distribution**

The plant steam system consists of two natural gas low NOx emission package boilers, each capable of providing up to 20,000 lbs/hr and are tied into the main steam distribution system. These package boilers are installed on a concrete pad located just east of the C-600 coal conveyance system, which allowed ready access for connections to the plant natural gas, sanitary water supply, and the steam distribution systems.

As deactivation activities have progressed, the need for steam usage has decreased. Currently, one package boiler is capable of providing the steam required for the site. Since the purpose of the steam system has been reduced to comfort heating, the boiler operation is needed only during the cold weather months (usually from November to early March). During this period, the plant steam system is used to provide steam heat directly to steam heaters and heat exchanger systems for specific areas in occupied facilities. There is a large heat exchanger located east of the package boiler pad that heats water for the recirculating heating water system. This system provides heated water to the heating systems in numerous occupied facilities.

# C-600 Chilled Water System

## Background:

The C-600 chilled water system supplies water at approximately 42°F for air conditioning and humidity control equipment in the C-100, C-101, C-102, C-200, C-205, C-300, C-600, C-709, C-710, and C-720 buildings.

## Description:

### *Chillers*

In 1997 two chillers were installed in the C-600 area. Both chillers are operable at a capacity of 700 to 800 tons (name plate indicates 800 tons) each, depending on the water inlet temperature. The total load for buildings served is assumed to be approximately 775 tons. Most of the year a single chiller is required to run. However, during the middle of summer both chillers run at approximately 80% load.

### *Distribution System*

The closed system chilled water distribution system starts at the wet well in C-600. Three vertical-type centrifugal pumps, rated at about 1200 gallon/min. at 162 ft. total discharge head, pump water from the wet well through the chillers. The chillers cool the water to about 42°F for distribution. A network of distribution piping (6 inch to 20 inch) route chilled water to buildings serviced. After passing through heat transfer equipment in the buildings, the chilled water enters the return piping that runs parallel to the supply mains and returns to the C-600 wet well at about 50°F.

In addition, the above ground supply and return piping is insulated and the piping below ground is wrapped for protection from external corrosion. Internal corrosion protection for equipment and piping is provided by a high-molybdate based treatment maintained in the chilled water system.

# Sewage Treatment System

## Background:

The sanitary sewage generated at the Paducah Gaseous Diffusion Plant (PGDP) originates from various plant areas. These include, but are not limited to sanitary conveniences, shower water, floor drains in some buildings, and small users of once-through cooling water. The sanitary sewage treatment system is used to process sanitary wastes produced within the plant at the C-615 Sewage Treatment Facility prior to discharge through Outfall 004, which then discharges through Outfall 008. Outfall 008 effluents discharge into Big Bayou Creek. Because of the natural slope of the terrain, the sewage plant is located at the west end of the developed site. The basic system and drainage system was designed and constructed as part of the original plant. $DUF_6$ ties into the system between C-302 and C-710.

## Description:

### *Drainage System*

The sanitary sewage drainage system consists of gravity drain lines (vitrified clay), flush tanks, and lift stations. The drainage system requires a Class 2 Sewage Collection license to operate the lift stations and collections stations. Drainage includes all Laboratory drains from C-710 (Laboratory drainage goes to the C-712 separation/neutralization pit located on the south west corner of C-710 prior to discharge to the sanitary sewage drainage system)

The drainage system is designed as a gravity drain system with lift stations as needed to maintain gravity flow in the system (all lift stations have backup pumps except C-615-H2) with the exception of three forced mains; DUF6, C-615-H1 and C-615-H discharge. The primary lift station for the system is C-616-G which is located along the main water line (12 inch) flowing to the C-615 treatment facility (Lift station is located at 8th and Ohio streets). Flush tanks are located at points of low flow to prevent solid buildup in the piping. In addition to the central treatment system the sanitary sewage system consist of the following:

- *2 Septic/Aerator Systems (C-333-A and C-337-A) – Discharge from these Aerator system drain to storm sewer system.*
- *3 Septic Tanks/Drain Fields (C-633-1, C-637-1, and C-611 Area)*

The C-615 Facility also takes leachate from the U-landfill when excessive rainfall is present and other contractor work such as asbestos shower tanks. This waste water is pumped and delivered to the treatment plant by mobile tanks. The sewage drainage system has the following two known/suspected areas where the lines have or appear to be collapsed:

- *8 inch line north of C-102.*
- *Drain line from C-400 south side*

All of the drainage system manholes are located and identified except one in the area of C-410 southeast corner. The manholes appear to be the major source of inflow/infiltration. One manhole in

the area of C-400 appears to have significant inflow. The drainage system has a total of 10 lift stations (See Facilities table below)

### *Treatment System*

The C-615 treatment facilities consist of various components. The C-615 treatment plant requires a Class 2 Waste Water Treatment System License to operate.

The C-615 treatment plant includes a comminutor (shreds various solids), primary basin, secondary basin (precipitation of solids), trickling filter, digester, and drying beds. The influent waste waters flow through the comminutor and grit basket for size reduction into the primary basin. Liquid from the primary basin is pumped to the trickling filter. From the trickling filter, a portion of the liquid flows to the primary basin for recycle and a portion flows to the secondary basin. The effluent from the secondary basin is chlorinated in the chlorine contact chamber (weir box) and flows to Outfall 004. Drying beds are cleaned out every 3 to 5 years and the waste is disposed as low-level radioactive waste. Currently the drying beds have not been cleaned out since 2007. Attachment 1 and 2 provide basic flow schematics for the C-615 treatment plant.

The C-615 chlorine feed facility, located in a separate room on the southwest corner of the building, houses the chlorinator, chlorine containers, exhaust fan, and chlorine gas detection system. The room houses ten 150 lb. chlorine containers with two containers connected to the feed system. One is normally in use and the other is in standby ready to be automatically put into service upon depletion of the in use container. Each container is connected to a vacuum regulator that feeds chlorine gas to the chlorinator at a vacuum, avoiding pressurized lines.

C-615 contamination is likely present in the digester and sludge. Previous sludge that was removed contained radiological contamination and was shipped to Energy Solution for disposal. One of the pumps in the C-615 facility is known to contain fixed contamination.

## Facilities:

| Facility # | Facility Name | Nuclear Hazard Category |
|---|---|---|
| C-615 | Sewage Treatment Plant | Radiological |
| C-615-A | Primary Settling Basin | Radiological |
| C-615-B | Final Settling Tank – Secondary Basin | Radiological |
| C-615-C | Oil Control Building | Radiological |
| C-615-D | Digester | Radiological |
| C-615-E | Trickling Filter | Radiological |
| C-615-F | Trickling Filter Sludge Beds | Radiological |
| C-615-G | Sewage Lift Station | N/A |
| C-615-H | Sewage Lift Station (C-635 Area) | N/A |
| C-615-H1 | Sewage Lift Station (C-360 Area) | N/A |
| C-615-H2 | Sewage Lift Station (East West Ditch C-616 Area) | N/A |
| C-615-H3 | Sewage Lift Station (C-755 Trailers) | N/A |
| C-615-H4 | Sewage Lift Station (C-103 Area) | N/A |

| | | |
|---|---|---|
| C-615-H5 | Sewage Lift Station (C-755 Trailers) | N/A |
| C-615-H6 | Sewage Lift Station (Demolished) | N/A |
| C-615-H7 | Sewage Lift Station (Between C-335/C-337 14th Street) | N/A |
| C-615-H8 | Sewage Lift Station (Post 48) | N/A |
| C-615-J | Lift Station (Abandoned) | N/A |
| C-615-K | Chromate Lift Station (Abandoned) | N/A |

## Capacity:

The design capacity of the sanitary system is 500K GPD. Currently, the system handles approximately 280K GPD (without infiltration). An estimated 50% of the flow in the sanitary sewer system is infiltration/inflow of storm water. This appears to be mainly associated with the condition of manholes and lines of the drainage system. C-615 is pushed to capacity (500K GPD) with a 2 inch rainfall in a 24 hour time period due to the inflow/infiltration.

Drainage system does not appear to have major connections to non-sanitary drainage (i.e. roof drains). No clear estimate of the sanitary sewer system flow after shutdown has been developed. However, infiltration/inflow is not expected to change.