ATTACHMENT C

Detailed Description of ISTR Treatment System Components

The ISTR treatment system consisted of the following components:

Vacuum Blowers - Positive displacement or induced draft vacuum blowers were used to create the vacuum in the wellfield and to create a high enough pressure to complete the remaining process steps. The vacuum blowers caused the vapor phase temperature to increase as a result of raising the pressure level.

Moisture Separator - Vapors extracted from the wellfield were drawn through a moisture separator to remove condensate and entrained liquid droplets. Water collected in the moisture separator pot were pumped to the oil/water separator for treatment prior to discharge.

Heat Exchanger - The vapors from the wellfield were initially processed in a pair of heat exchangers to knock down the incoming steam and reduce the moisture content of the vapor stream for the remaining steps in the process. The vapors entering the heat exchangers were cooled using a recirculating loop of water supplied by a cooling tower. The cooling tower released the heat removed from the vapor stream into the ambient air through evaporation of supplied water. The cooling tower loop circulation rate was adjusted to only reduce the temperature of the vapor stream to the point required to remove moisture from the wellfield vapors, with minimal or no COC removal/condensation. Both the vapor and liquid side of the heat exchangers were instrumented with temperature indicators to allow adjustment of the recirculation loop flow to maintain proper moisture removal.

Cooling Tower - The cooling tower supplied a cooled liquid stream to the heat exchanger. In general, the temperature of the cooled liquid would rise about ten degrees Fahrenheit as it passes through the heat exchanger. The returning liquid was delivered to the top of the cooling tower where it was cooled by evaporation and contact with ambient air. The cooled water was collected at the bottom of the tower and returned to the heat exchanger.

Moisture Separator - After exiting the heat exchangers, the cooled vapor stream was drawn through a moisture separator to remove condensate and entrained liquid droplets. Water collected in the moisture separator was pumped to the oil/water separator for treatment prior to discharge.

Duct Heater - Exiting the second moisture separator, the combined vapor stream was heated approximately 14 to 20°C (25 to 35°F), to adjust the temperature above the dew point of the stream by approximately 19°C (35°F) and minimize condensate formation in the oxidizer. The duct heater operated automatically based on a thermostat and SCR power controller, utilizing input from a downstream temperature sensor.

Combustion Blower - Supplemental combustion/dilution air was needed in the oxidizer. The combustion air performed two functions, ensuring that the LEL is below 25% and providing enough total air flow so that the evaporation in the quench can sufficiently reduce the oxidizer outlet gas temperature. The combustion blower needs to be able to produce a discharge pressure equal to or greater than the vacuum blowers in order to ensure that the combustion/dilution air can overcome the existing system pressure.

Thermal Oxidizer - The thermal oxidizer was the primary component of the proposed vapor treatment system. The proposed thermal oxidizer was a nominal 1100 SCFM oxidizer, with a rated hydrocarbon Destruction/Removal Efficiency (DRE) greater than 99%. The oxidizerwass designed to automatically maintain a specific temperature profile within the thermal reaction zone (the oxidation chamber), typically in the range of 800°C (1,500°F), which is above the auto-ignition point for natural gas.

The oxidizer automatically maintained the temperature profile through a proportioning valve that adjusts the mixture of extracted vapors, combustion air, and supplemental fuel (natural gas) to maintain the reaction zone temperature profile. Within the reaction zone, the oxidizer destroys COC vapors, yielding carbon dioxide, water vapor, and HCl. The concentration of the HCl produced depends on the concentration of the chlorinated COCs in the vapors entering the unit.

Scrubber - The acid-laden gases entered the scrubber through a vertical quench section mounted directly to the scrubber gas inlet. As the hot gases entered the quench section, a water/caustic solution spray rapidly cooled them, resulting in a cooler, reduced volume saturated vapor stream. Some portion of the cooling spray was evaporated as a result of the flash cooling. Liquid condensate drained by gravity into the scrubber sump. The cooled vapors continued to a counter-current packed tower scrubber section. The vapors flowed upward through polypropylene packing media while a caustic solution is introduced through a series of spray nozzles at the top of the scrubber tower. The caustic solution flows downward through the tower packing media, countercurrent to the acidic vapors. The surfaces of the packing media provided a large contact surface area for the caustic solution to neutralize the acid gases. The scrubbing solution continued to fall through the packing media and return to the scrubber sump, typically at a lower pH and containing mineral salts that precipitate out as products of the neutralization reaction.

The pH of the scrubbing was automatically adjusted using a 50% sodium hydroxide solution (NaOH) to maintain the pH of the scrubbing liquid within the range necessary for effective neutralization of the acid gases. The scrubber pH controller automatically maintains the pH in the scrubber sump between 5.5 and 9.0 pH units.

Liquid Treatment

Water from various sources, including the moisture separator and scrubber was treated prior to discharge to the POTW sewer. The peak estimated flow rate was approximately 60 gpm based on the mass and energy balance. The liquid treatment system depicted on the PFD consisted of the following major components:

- Moisture separator(s)
- Oil/Water separator
- Bag filter(s)
- Air stripper
- Granular activated carbon vessel(s)

Specific components of the liquid treatment system are described below.

Moisture Separator(s) - The moisture separators collected condensate generated in the vapor heat exchangers as described in the previous sections. This condensate was primarily water, but also contained some LNAPL and a small portion of DNAPL. The accumulated condensate will be sent to the oil/water separator periodically as determined by the level sensors in each moisture separator.

Oil/Water Separator - The oil-water separator is a HydroQuip model AG-4CS-HP-1H, parallel-corrugated plate coalescing oil water separator rated for a 30 gpm flow rate. The separator is designed to remove oil droplets larger than 20 microns with specific gravity ranging from 0.9 or less to greater than 1.1. The separator body is constructed of epoxy-coated carbon steel for improved corrosion resistance, with polypropylene coalescing plates. The unit is equipped with separate LNAPL and DNAPL accumulation areas, by virtue of an underflow weir and overflow weir. The separator has a vapor-tight cover, with appropriate vents that are connected to the vapor treatment system to capture emission from the separator. During peak operation, approximately 30 gallons of LNAPL was generated per day. Accumulated LNAPLed by gravity into 55 gallon drums and removed by a licensed waste hauler as hazardous waste. Accumulated DNAPL was automatically transferred from the separator to the NAPL accumulation tank by pneumatic diaphragm pumps, operated by an intrinsically-safe conductivity level controller. Effluent water from the final clear-water stilling chamber of the oil/water separator was pumped to the bag filters and air stripper for further treatment.

Bag Filter(s) - A Rosedale Model 6 duplex bag filter was installed downstream of the oil-water separator to remove emulsion globules or particulates prior to entering the air stripper.

Air Stripper - The air stripper for this project was a shallow-tray style air stripper, rated for a minimum flow rate of 1 gpm. Water exiting the bag filters was introduced at the top of a stack of perforated air stripper trays, and forced to follow a convoluted path through the stripper housing while a countercurrent air steam was passed upward through the flowing water. This creates a turbulent flow condition within the air stripper housing, inducing the VOCs in the liquid to partition to the vapor phase. The air stripper achieved 99.9% or greater removal of VOCs from the liquid phase. The elevated temperature of the water entering the air stripper during the high COC mass removal periods, estimated to be approximately160˚F, further enhanced the vapor phase partitioning within the air stripper.

The air stripper operated continuously and was equipped with appropriate flow, temperature, pressure and level controls and alarm interlocks, and also provided with duplex pumps and blowers serving as an installed spare in the event of a problem with the primary pump/blower.

Granular Activated Carbon Vessel(s) - Two liquid phase activated carbon absorbers were installed downstream of the air stripper to provide a final effluent polish prior to discharging to the POTW. The carbon absorbers contained 2000 pounds of carbon and rated for a flow rate greater than 80 gpm. The carbon beds provided additional effluent polishing downstream of the air stripper. The carbon bed was equipped with isolation valves, pressure gauges and sample ports.

Backup Granular Activated Carbon Vessel(s) - A backup granular activated carbon (GAC) system was installed as a contingency to failure of the oxidizer or components. The GAC system consisted of two vessels configured and piped to operate in a lead/lag scenario. The backup GAC system was in operation for approximately 2 weeks during the shutdown of the oxidizer.