

Orenco AdvanTex® AX-RT Residential Treatment

Introduction

This design criteria covers Orenco's AdvanTex AX-RT Wastewater Treatment Systems used in applications for single-family residential treatment.

System Description

The AdvanTex AX-RT Wastewater Treatment System is a multiple-pass, packed-bed aerobic wastewater treatment system specifically designed and engineered for long-term processing of residential strength wastewater. The treatment media is an engineered textile, which has an extremely high void capacity, moisture-holding capacity, and surface area per unit volume. Consequently, AdvanTex treatment systems are capable of processing residential strength wastewater to better than secondary standards. Figure 1 shows a basic overview of the AX-RT Wastewater Treatment System.

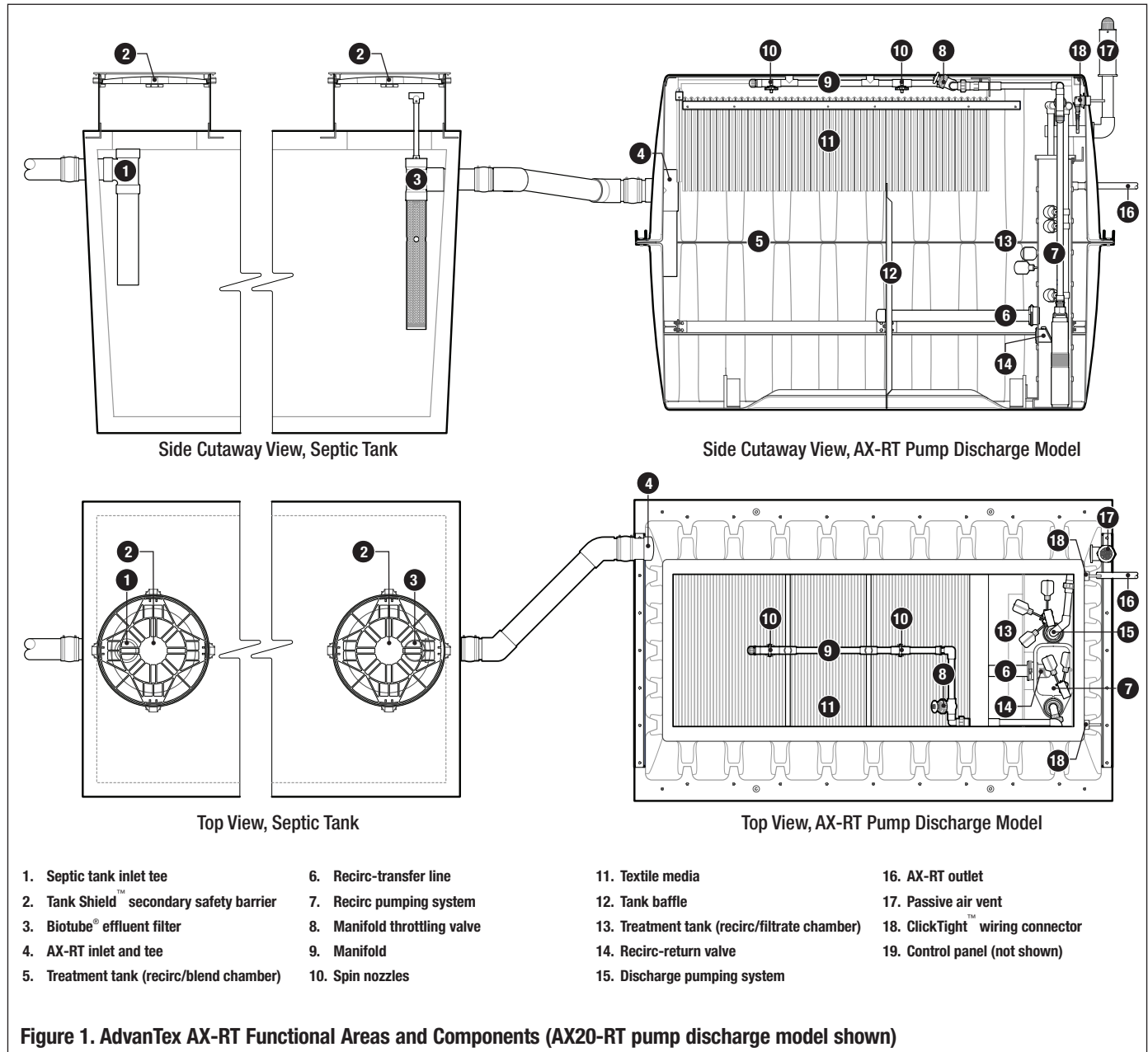


Figure 1. AdvanTex AX-RT Functional Areas and Components (AX20-RT pump discharge model shown)

Treatment Process

AdvanTex AX-RT Wastewater Treatment Systems use the same recirculating textile filter technology as Orenco's AdvanTex AX20, but the sheets of textile filter media, the recirculation tank, and the discharge pumping system are combined into a single unit with an at-grade access lid. The AX20-RT is designed for 1-4 bedroom homes; the AX25-RT is designed for 5-6 bedroom homes.

Figure 2 shows the flow path for a standard AX-RT: raw sewage enters the septic tank through its inlet tee. In the septic tank, where passive primary treatment occurs, the raw sewage separates into three distinct zones – a scum layer, a sludge layer, and a clear zone. Effluent from the clear zone passes through a Biotube effluent filter and is discharged by gravity to the AX-RT unit's recirc/blend chamber. From there, the effluent is drawn through the recirc transfer line to the recirc pumping system.

The timer-controlled recirc pump applies small, intermittent doses (micro-doses) of effluent to the textile sheets throughout the day. This ensures an aerobic, unsaturated environment for optimal treatment. A manifold and spin nozzles distribute the effluent evenly over the textile sheets.

The effluent then percolates down through the sheets and is distributed between the recirc/blend and recirc/filtrate chambers by means of a tank baffle between the unit into different sections. The sheets are suspended from the top of the treatment unit, with a portion positioned over the recirc/blend chamber. The remainder is positioned over the recirc/filtrate chamber, from which filtrate (treated effluent) recirculates and discharges.

The recirc pump vault's recirc-return valve provides equalization during low-flow periods and during recirculation pumping events. Similar to a check valve, it allows preferential flow in one direction only – from the recirc/filtrate chamber to the pump vault. The recirc/blend chamber and the pump vault are hydraulically connected; their liquid levels balance when the pump is off. When the pump is on, the liquid level in the pump vault drops rapidly, drawing blended effluent from the recirc/blend chamber into the vault. Under low daily flow conditions, the valve allows 100% of the filtrate to be returned to the recirc/blend chamber for continuous recirculation.

When the liquid head in the pump vault is equal to or greater than the liquid head in the recirc/filtrate chamber, the recirc-return valve closes. When the liquid head in the recirc/filtrate side is higher, the pressure differential opens the recirc-return valve for filtrate to pass back to the pump vault, providing for continued recirculation during periods of low or no inflow. Flow from the pump vault can pass to the recirc/filtrate chamber only after passing through the treatment media.

System Requirements

Residential-Strength Wastewater

Residential wastewater must meet the criteria listed in Table 1. Consult Orenco or your AdvanTex dealer for larger treatment system designs or for designs with higher-strength influent.

Table 1. Residential-Strength Wastewater (Typical Septic Tank Effluent Characteristics)¹

Characteristic	Average (mg/L)	Weekly Peak (mg/L)	Rarely Exceed (mg/L)
cBOD ₅	130	200	300
TSS	40	60	150
TKN	65	75	150
G&O	20	25	25

¹ Maximum allowable wastewater strength into AdvanTex Wastewater Treatment System is "Residential-Strength Wastewater." Residential-strength wastewater is defined as primary sewage effluent from a septic tank that does not exceed the above parameters.

Septic Tank

The septic tank preceding an AX-RT unit requires a minimum usable volume of 1000gal (3785L) for the AX20-RT and 1250gal (4732L) for the AX25-RT. It must also incorporate an effluent filter at its outlet.

All tanks must meet Orenco's minimum structural requirements, be completely watertight, and pass a watertightness test that includes the riser-to-tank connection.

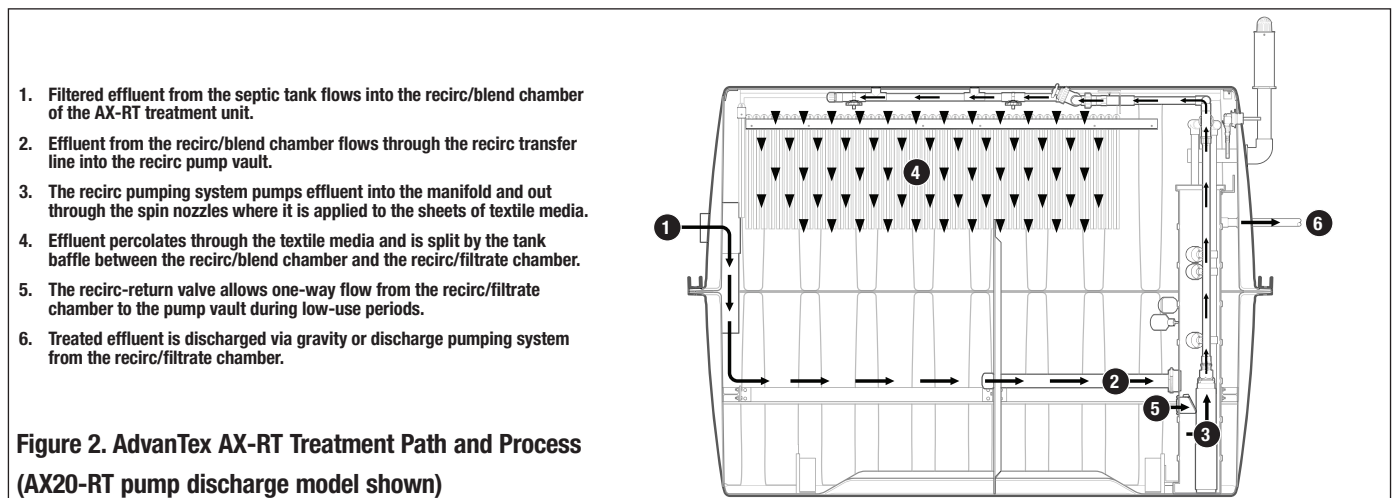


Figure 2. AdvanTex AX-RT Treatment Path and Process (AX20-RT pump discharge model shown)

Septic Tank, cont.

The tank should include an at-grade access, with a securable and removable lid to allow access to the effluent filter and inlet tee of the tank. See [NSP-ATX-AXR-2, Concrete Tanks for Orenco AdvanTex AX-RT Systems, Residential Specifications](#), and the tank specifications checklist in [NCL-TNK-TNK-1, Concrete Tank Questionnaire](#), for detailed structural and watertightness criteria.

The AX-RT's invert of inlet is 26in (660mm) below the top of the unit and 46in (1168mm) above the bottom of the unit. The top of the AX-RT should be 2in (51mm) above final grade. A minimum slope of 1/8in per foot (10mm per meter or 1%) from the tank's outlet to the AX-RT's inlet is required for all tanks that will flow via gravity to an AX-RT unit.

For existing tanks buried too deep to provide sufficient fall to the AX-RT, a pumping system can be installed in the tank or a grade ring can be installed on the AX-RT to accommodate the deeper tank burial. (Contact Orenco for design assistance.)

Water softener backwash brine from a salt-type water softener must not be plumbed into the tank or the AX-RT unit; doing so will void the system's warranty. See Orenco's white paper, [CWP-SOFT-1, Water Softeners and Wastewater Treatment Systems](#), for more information.

Biotube Effluent Filter

An Orenco Biotube effluent filter is required to be installed on the septic tank outlet preceding an AX-RT unit. The effluent filter should have a minimum surface area of 5ft² (0.46m²). Any of the following Orenco effluent filters can be used: FT0822-14B, FTW0444-36V, FTS0444-36V, PSCS0621-18, or PSCW0621-18.

Recirc Pumping Equipment

The AX-RT unit includes an Orenco recirculation pumping system, consisting of an Orenco multi-stage effluent pump and a float switch assembly, housed in an integral pump vault.

Design Loading Rates

Orenco's suggested design loading rates are based upon the average influent strength characteristics shown in Table 1 and occupancy or typical per capita flow rates (50-60gpd/person or 189-227L/day/person) as shown in Table 2. The information in Table 2 is based on a mean hydraulic loading rate of 29.1gpd/ft² (1186L/m²/day) for all residential AX-RT units. The nominal hydraulic loading rate is 30gpd/ft² (1222L/m²/day).

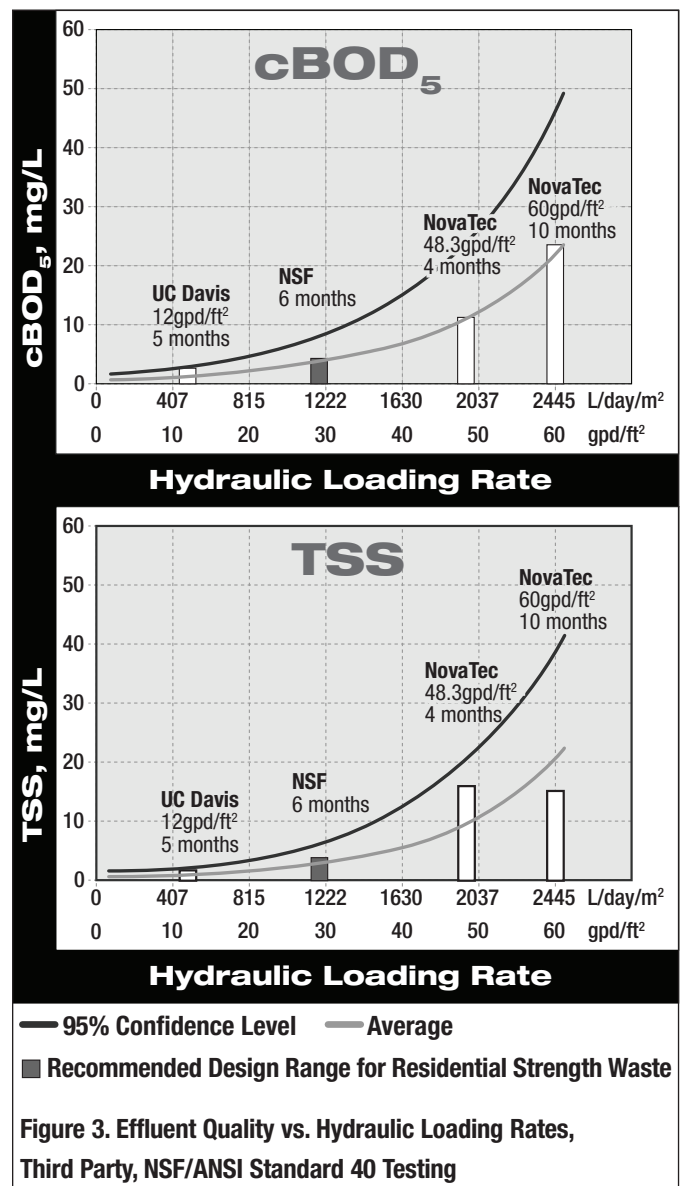
Table 2. Treatment Unit Recommendations

Number of Bedrooms	Number of Occupants	Septic Tank Size, gal (L)	AX-RT Model
1-4	8	1000 (3785)	AX20-RT
5	10	1250 (4732)	AX25-RT
6	12	1500 (5678)	AX25-RT

Performance is a function of the expected typical loads with periodic weekly highs. Typically, the daily mass loading is based on the expected daily flows and actual strength. Orenco's AX-RT units are listed to NSF/ANSI Standards 40 and 245 for Class I Systems and are suitable for residences with up to 6 bedrooms. For homes with more than 6 bedrooms or that are larger than 5000ft² (465m²), contact Orenco.

In jurisdictions where the nominal daily flow rate does not exceed 600gpd (2271L/day), a single AX20-RT unit may be used as long as the system's anticipated treatment levels (see Figure 3) meet local requirements.

Peak flow rates may reach 1000gpd (3785L/day). Hydraulic loading rates may need to be adjusted to compensate for high organic or nitrogen influent concentrations.



Manifold Pressures

Manifold pressure is calibrated in-field by visually assessing effluent distribution to the splash guards on the sides of the textile. Consistent distribution to the splash guards targets about 7gpm to 8gpm per nozzle flow rate (about 4psi residual head measurement), used in the timer setting calculation. AX20-RT treatment units have two nozzles on the manifold, AX25-RT treatment units have three nozzles on the manifold.

Recirculation Ratios and Timer Settings

Initial timer settings for an AX-RT should be established based upon expected average daily flows and a recirculation ratio of 7:1 (filter recirculation ratio). Table 3 provides recommended timer settings. If flows vary significantly from expected flows, timer settings should be adjusted accordingly. Contact Orenco for more information.

Table 3. Recommended Timer Settings for New Systems, in Min¹

Models AX20-RT, AX20-RTUV ²	Number of Occupants	Avg Daily Flow, gpd (L/day)	Timer OFF	Timer ON	Timer OVR OFF	Timer OVR ON
	2	100 (379)	24.2	1	7.4	1
	3	150 (568)	15.8	1	4.6	1
	4	200 (757)	11.6	1	3.2	1
	5	250 (946)	9.1	1	2.4	1
	6	300 (1136)	7.4	1	1.8	1
	7	350 (1325)	6.2	1	1.6	1
	8	400 (1514)	5.3	1	1.5	1

Model AX25-RT ³	Number of Occupants	Avg Daily Flow, gpd (L/day)	Timer OFF	Timer ON	Timer OVR OFF	Timer OVR ON
	2	100 (379)	36.8	1	7.4	1
	3	150 (568)	24.2	1	4.6	1
	4	200 (757)	17.9	1	3.2	1
	5	250 (946)	14.1	1	2.4	1
	6	300 (1136)	11.6	1	1.8	1
	7	350 (1325)	9.8	1	1.4	1
	8	400 (1514)	8.5	1	1.1	1
	9	450 (1703)	7.4	1	1.1	1
	10	500 (1893)	6.6	1	1.0	1
	11	550 (2082)	5.9	1	1.0	1
	12	600 (2271)	5.3	1	1.0	1

¹ Assumes 7:1 recirc ratio.
² Assumes 14gpm (0.9L/sec) for the AX20-RT.
³ Assumes 21gpm (1.3L/sec) for the AX25-RT.

AdvanTex Control System

Critical to the success of the AdvanTex Wastewater Treatment System is the method by which the effluent is loaded onto the textile sheets. Over the past three decades, timer-controlled applications have played an essential role in optimizing the performance of both fixed and suspended-growth biological systems. A timer-controlled pump in the treatment tank periodically doses effluent to the distribution manifold over the textile sheets. The effluent then percolates through the textile media sheets and is treated by naturally occurring microorganisms that populate the filter. During periods of high flow, a timer override float switch will temporarily modify the timer settings to process the additional flow. Conversely, during periods of low flow, the timer settings can be modified to reduce loading onto the filter.

AdvanTex treatment systems are paired with Orenco's VeriComm® control panels. (An Orenco MVP control panel option is also available.) VeriComm is a web-based monitoring system that monitors the AdvanTex system 24 hours per day, seven days per week. It provides an automatic alarm communication, an escalating alarm response process, and a secure, password-protected website.

Key functions of the VeriComm Monitoring System include:

- Automatic notification of alert and alarm conditions for service providers
- Self-adjustment based on trend data of system use, compensating for greater-than-average and less-than average flows
- Remote adjustment of settings
- Standard monthly call-in to website under normal operation

Typical Effluent Quality

Effluent quality is dependent on several factors, including influent characteristics and loading rates. Figure 3 shows third party, NSF/ANSI Standard 40 testing results. The results demonstrate that moderate loading rates typically produce cBOD₅ and TSS of about 5mg/L average, while higher loading rates produce cBOD₅ and TSS in the range of 15-25mg/L.

Field testing of systems in real-world conditions shows similar results, with cBOD₅ and TSS of <10mg/L. (See [AHO-ATX-PERF-1, AdvanTex Treatment Systems Performance Summary.](#))

Nitrogen reduction in standard AX-RT systems will typically exceed 60%, with total nitrogen (TN) in the filtrate ranging between 20-35mg/L. Nitrogen reduction in AX-RT systems configured for enhanced nitrogen reduction can reach 70% or better (TN 20 ±), depending on wastewater strength and other characteristics such as grease and oils, pH, and alkalinity concentrations.

Nitrification can be inhibited if the buffering capacity (alkalinity) of the wastewater is too low. Theoretically, 7.14mg/L of alkalinity as CaCO₃ is needed to nitrify 1mg/L of NH₄⁺. (See [AHO-ATX-PERF-TN-1, AX Performance Summary – Nutrient Reduction.](#))

Discharge Equipment

Treated effluent can be discharged to the drainfield by means of a discharge pump system or by gravity discharge. Tables 4a and 4b show discharge dose volumes for AX-RT Wastewater Treatment Systems.

Gravity Discharge to Final Dispersal

AX-RT units with a gravity outlet simply discharge when the level of treated effluent in the recirc/filtrate chamber is at the level of the outlet.

The invert of the outlet at the wall penetration is located 39-1/2in (1003mm) below the unit's top and 32-1/2in (826mm) above the unit's bottom. The invert of the outlet inside of the unit is 37in (940mm) below the unit's top and 35in (889mm) above the unit's bottom.

Pump Discharge to Final Dispersal

For sites where gravity discharge is not an option, an Orenco pumping system is incorporated into the recirc/filtrate chamber of the AX-RT unit. The "High Level Alarm" and "ON" float switches for the discharge pump are factory-set and are non-adjustable. Discharge dose volume is determined by adjustments to the "OFF" float switch.

Table 4a. Discharge Dose Volumes: AX20-RT & AX25-RT

Pump Model gpm (L/sec)	Factory "Off" Float Switch Setting in (mm)	Lowest "Off" Float Switch Setting in (mm)	Maximum Dose Volume gal (L)
PF1005, 10 (0.6)	31 (787)	16 (406)	156 (591)
PF2005, 20 (1.3)	31 (787)	18 (457)	139 (526)
PF3005, 30 (1.9)	31 (787)	20 (508)	123 (466)
PF5005, 50 (3.2)	31 (787)	24 (610)	90 (341)

Table 4b. Discharge Dose Volumes: AX20-RTUV

Pump Model gpm (L/sec)	Factory "Off" Float Switch Setting in (mm)	Lowest "Off" Float Switch Setting in (mm)	Maximum Dose Volume gal (L)
PF1005, 10 (0.6)	31 (787)	16 (406)	78.0 (295)
PF2005, 20 (1.3)	31 (787)	18 (457)	69.5 (263)
PF3005, 30 (1.9)	31 (787)	20 (508)	61.0 (231)
PF5005, 50 (3.2)	31 (787)	24 (610)	45.0 (170)

For UV disinfection-equipped units, effluent passes through UV disinfection before being pumped or flowing by gravity to final dispersal.

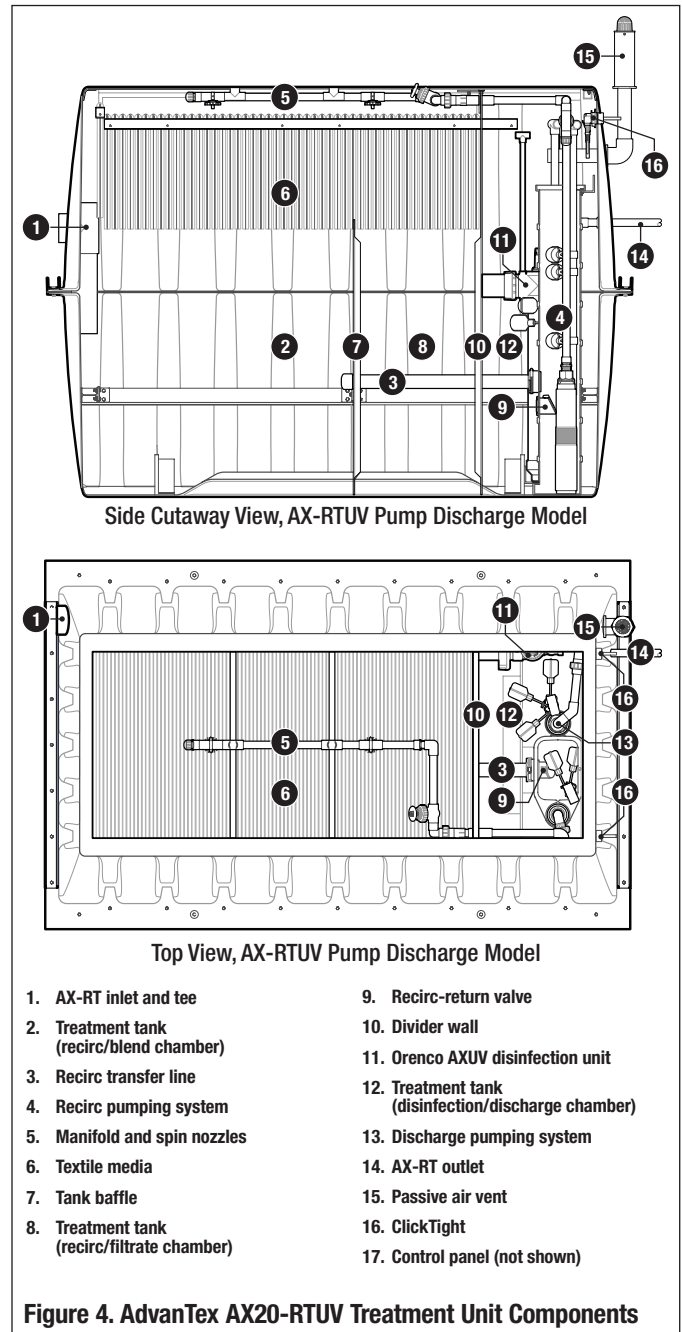
UV Disinfection

In areas that require disinfection before dispersal, an AX20-RT unit is available with integral UV disinfection provided by an Orenco AXUV disinfection unit. (See Figure 4.)

Treated effluent flows by gravity through the contact chamber and around the UV lamp where it is disinfected in a 360-degree contact zone. The unit uses no chemicals and has no moving parts. It requires a yearly cleaning and lamp replacement.

The AXUV disinfection unit comes with a power ballast and a lamp current sensor, housed in either an MVP digital programmable control panel or VeriComm remote telemetry control panel.

These panels prevent discharge of non-disinfected effluent due to lamp failure or control panel failure. The current sensor monitors lamp function. In the event of lamp failure, the discharge pump is automatically disabled until the lamp is replaced. With MVP-equipped systems, an audible and visual alarm is activated. With VeriComm-equipped systems, an e-mail alert is sent to the service provider.



UV Disinfection, cont.

The lamp used in the disinfection unit is rated at 125mW/cm² intensity at one meter. In a 2011 NSF® comparative test procedure, the AXUV reduced bacteria by 99.999% (5 logs), meeting or exceeding the performance of other residential UV disinfection units.

The AXUV disinfection unit provides the following contact chamber doses at 65% transmittance and 20% lamp degradation:

- 270,000mW-s/cm² at 1gpm (0.06L/sec)
- 55,000mW-s/cm² at 5gpm (0.32L/sec)
- 28,000mW-s/cm² at 10gpm (0.63L/sec)

Surge Volume/ Emergency Reserve Volume

The surge volume in an AX-RT is the volume between the low liquid level and the override timer float switch. For residential applications, AX20-RT and AX25-RT units have 135gal (511L) of surge volume, with an additional 75gal (284L) of surge volume above the override activation point.

AdvanTex AX-RT systems have designed-in emergency storage to account for power outages and mechanical malfunctions. In the US, power outages occur infrequently and typically last from a few hours to 1-2 days. Downtime associated with mechanical malfunctions is limited due to the robustness of the mechanical components of the AX-RT.

The total emergency storage capacity of an AX-RT, measured from the recirculating high water alarm up to the inside top of the unit, is approximately 500gal (1893L). On units configured for gravity discharge, wastewater will discharge as designed during a power outage or mechanical component failure and no back-ups will occur.

A minimum 1000gal (3785L) septic tank is required to precede the AX20-RT unit, and a minimum 1250gal (4732L) septic tank is required to precede the AX25-RT. As water rises above the invert of the inlet in the AX-RT unit, the water will back up into the septic tank. Consequently, the liquid capacity available in the septic tank can also provide storage during emergencies. The available capacity will vary depending upon the tank design but typically 1000gal tanks hold about 200gal (757L) and 1500gal tanks hold about 300gal (1136L) between the invert of the outlet and the inside top of the tank.

Most 3- or 4-bedroom homes produce about 150-200gal (568-757L) of wastewater each day (3-4 occupants at 50-60gal or 189-227L per occupant per day) as a conservative estimate. Between the septic tank and the AX-RT unit, there is approximately 700-800gal (2650-3028L) of emergency storage capacity, which equates to more than 4 days' emergency reserve.

Power Outage

During a power outage, water usage is significantly reduced because water heaters, dishwashers, and laundry equipment aren't used. Under these conditions, it is realistic to estimate that water usage will be reduced by 50% to around 100gpd (379L/day) and the emergency storage capacity available in the system will increase to approximately 8 days. Since power outages typically last less than 2 days, the emergency storage capacity of the system is more than adequate.

Mechanical Malfunction

Failure of a pump or electrical component may cause the system to stop operating, requiring some amount of emergency storage volume. If the system is equipped with a VeriComm monitoring system, the service provider is immediately notified of the alarm condition and the potential cause of the alarm. This allows the service provider to respond very quickly with the correct replacement components necessary to fix the problem. In most cases, no more than one day (250gal or 946L) would be needed for the service provider to respond and get the system running again. Therefore, the emergency storage capacity available in the AX-RT treatment system during a mechanical malfunction, more than 4 days' worth, is quite adequate.

Cold Weather Considerations

AX-RT units can be manufactured with an insulated-core lid. Installing insulation around the sides of the filter pod is optional and is done on-site as needed. Other cold weather considerations include allowing all lines to drain between doses, backfilling the risers with pea gravel if frost heave is a concern, and extending the passive vent filter above the highest level of snow pack during winter months to ensure adequate airflow.

Additionally, the discharge line to final dispersal can be configured with an outlet below the frost line, for extreme cold conditions. Contact Orenco for more information on cold weather options.