

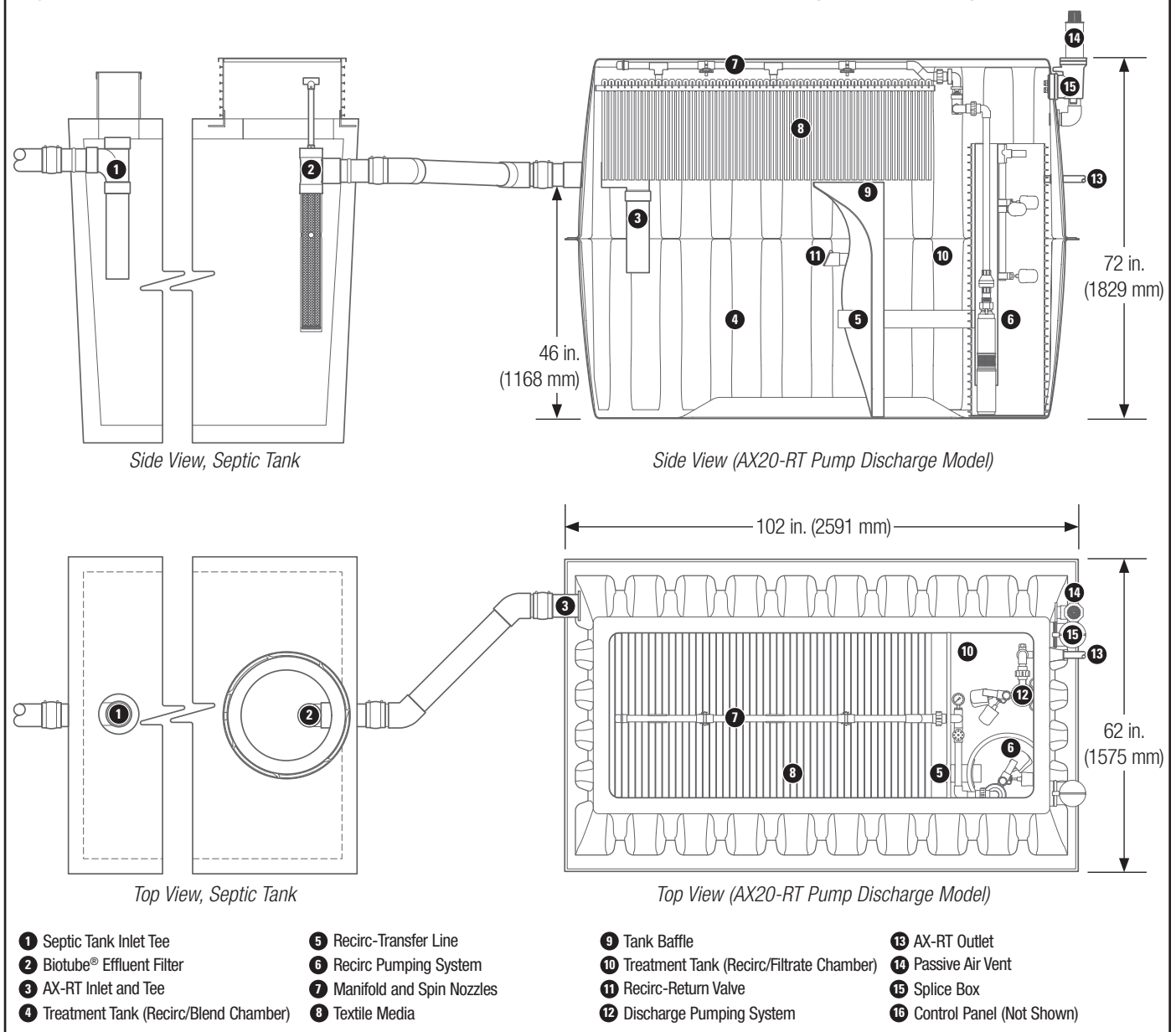
# AdvanTex® AX-RT Treatment Systems

## For Single-Family Home Applications

### System Description

The AdvanTex® 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 Treatment System.

Figure 1. AdvanTex® AX-RT Functional Areas, Components, and Selected Dimensions (AX20-RT Shown)



**Treatment Process**

AdvanTex AX-RT Treatment Systems use the same recirculating textile filter technology as Orengo’s AdvanTex AX20 textile filter, but they combine the textile filter media, recirculation tank and discharge pump system into a single, shallowly buried unit. The AX20-RT is designed to provide treatment for homes with 1-4 bedrooms and the AX25-RT is designed to provide treatment for homes with 5-6 bedrooms. Figure 2 shows a standard flow path for the AX-RT.

Here’s how it works: raw sewage enters the septic tank through its inlet tee. In the septic tank, the raw sewage separates into three distinct zones — a scum layer, a sludge layer, and a clear zone. Effluent from the clear layer passes through a Biotube® effluent filter and is discharged by gravity to the recirc/blend chamber of the AX-RT unit. The effluent then flows through the recirc transfer line to the recirc pumping system.

The recirculation pump is timer-controlled to ensure that small, intermittent doses (micro-doses) of effluent are applied to the textile sheets throughout the day. This ensures an aerobic, unsaturated environment for optimal treatment to occur. A manifold with distribution nozzles distribute the effluent evenly over the textile.

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

The baffle is fitted with a recirc-return valve for equalization during low-flow periods. Under low daily flow conditions, the valve allows

100% of the filtrate to be returned to the recirc/blend chamber for continued recirculation. The recirc-return valve is similar to a check valve in that it allows preferential flow in one direction only — in this case, from the recirc/filtrate chamber to the recirc/blend chamber.

The recirc-return valve closes when the liquid head on the recirc/blend side is equal to or greater than the liquid head on the recirc/filtrate side. When the liquid head on the recirc/filtrate side is higher, the pressure differential pushes the recirc return valve open for filtrate to pass back to the recirc/blend side of the baffle, thus providing for continued recirculation during periods of low or no inflow. Flow from the recirc/blend chamber can pass to the recirc/filtrate chamber only through the treatment media.

**System Requirements**

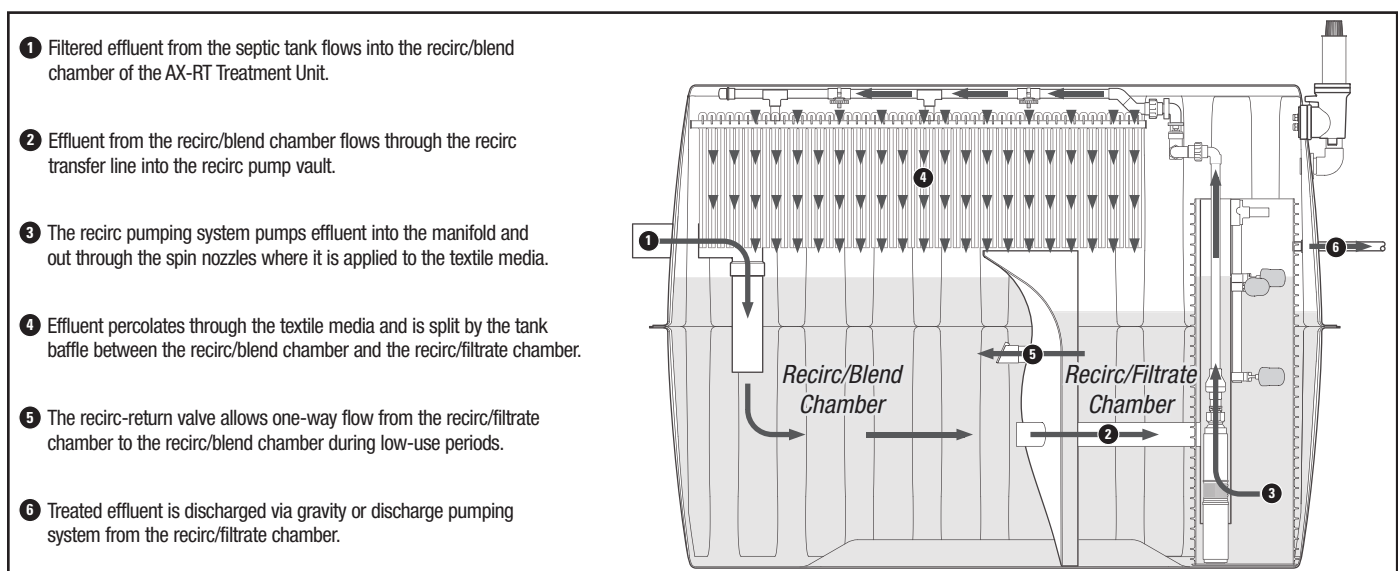
**Residential Strength Wastewater**

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

**Table 1. Residential Strength Wastewater (Septic Tank Effluent Characteristics)<sup>1</sup>**

Characteristic	Average (mg/L)	Weekly Peak (mg/L)	Rarely Exceed (mg/L)
<b>CBOD<sub>5</sub></b>	130	200	300
<b>TSS</b>	40	60	150
<b>TKN</b>	65	75	150
<b>G&amp;O</b>	20	25	25

<sup>1</sup> Maximum allowable wastewater strength into AdvanTex 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.



**Figure 2. AdvanTex AX-RT Treatment Path and Process (AX20-RT Pump Discharge Model Shown)**

**Septic Tank**

The septic tank preceding an AX-RT unit requires a minimum usable volume of 1000 gallons (3800 liters) for the AX20-RT and 1250 gallons (4732 liters) for the AX25-RT; it must also incorporate an effluent filter at its outlet. All septic tanks must meet Orengo’s minimum structural requirements, be completely watertight, and pass a watertight test including the riser/tank connection. The septic 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. For detailed specifications, see structural and watertightness criteria in Orengo’s *General Specifications*, NSP-EFS-SPEC-1; *Acknowledgment of Minimum Tank Requirements — AX-RT*, SLD-TNK-SPEC-2; and the tank specifications checklist in Orengo’s *Concrete Tank Questionnaire*, NCL-TNK-TNK-1.

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

For existing tanks that are buried too deep to provide sufficient fall to the AX-RT, a grade ring can be installed on the AX-RT unit to allow for deeper burials. In extreme cases, a pumping system may need to be installed in the septic tank to move the filtered effluent to the AX-RT unit. (Contact Orengo for design assistance.)

Water softener backwash from a salt-type water softener must not be plumbed into the septic tank or AX-RT unit, as this will void the system’s warranty. See the Orengo white paper, *Water Softeners and Wastewater Treatment Systems*, CWP-SOFT-1, for more information.

**Biotube Effluent Filter**

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

**Recirc Pumping Equipment**

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

**Design Loading Rates**

Orengo’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 (50-60 gpd/person or 189-227 L/day/person) as shown in Table 2.

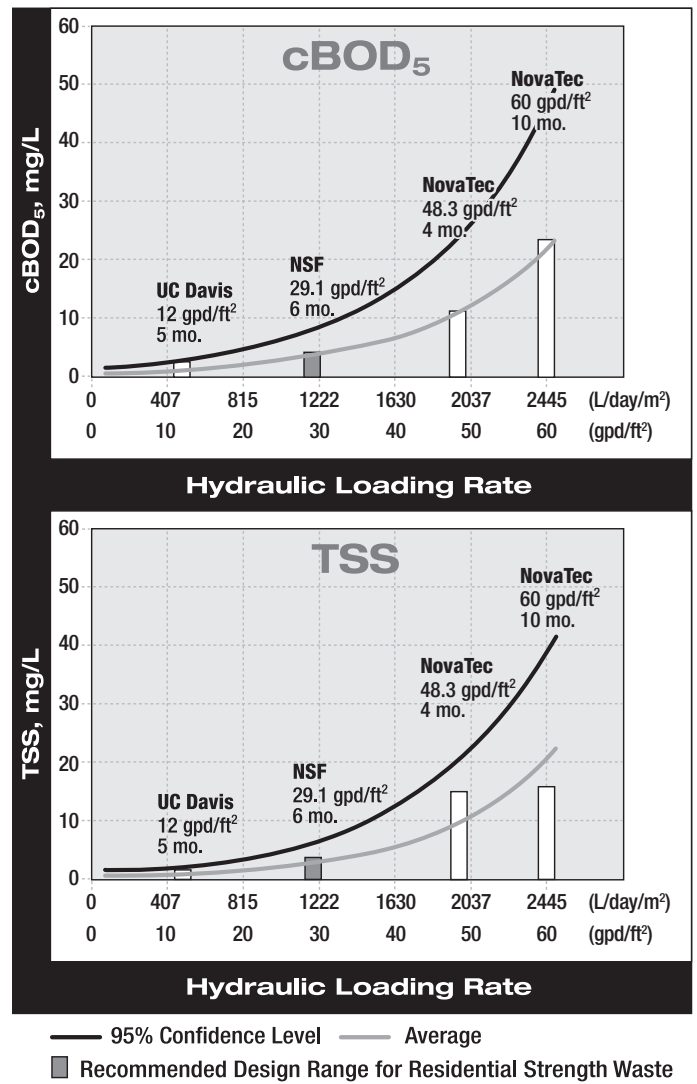
The information in Table 2 is based on a mean hydraulic loading rate of 29.1 gpd/ft² (1184 L/m²/day) for all residential AX-RT units. The nominal hydraulic loading rate is 25 gpd/ft² (1019 L/m²/day).

**Table 2. Treatment Unit Recommendations**

Number of Bedrooms	Number of Occupants	Septic Tank Size, gal. (L)	AX-RT Model
1-4	8	1000 (3800)	AX20-RT
5	10	1250 (4732)	AX25-RT
6	12	1500 (5678)	AX25-RT

In jurisdictions where the nominal hydraulic loading rate does not exceed 500 gpd (2000 L/day), a single AX20-RT unit may be used as long as the system’s anticipated treatment levels (see Figure 3) meet local requirements. For homes with more than 6 bedrooms or homes that are larger than 5000 ft² (465 m²), contact Orengo.

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



**Figure 3. Effluent Quality vs. Hydraulic Loading Rates Third Party, NSF/ANSI Standard 40 Testing Results**

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. Orengo's AX-RT units are listed as NSF/ANSI Standard 40 Class I Treatment Units and are suitable for residences with up to 6 bedrooms. For applications with more than 6 bedrooms, contact Orengo.

**Manifold Pressures**

A manifold pressure of 3 to 3.5 psi (20.7 to 24.1 kPa) is used to determine the initial timer settings. Orengo Spin Nozzles typically operate at a flow rate of about 6 gpm (0.38 L/sec.) The AX20-RT and AX20-RTUV Treatment Units have two nozzles on the manifold; AX25-RT Treatment Units have three nozzles on the manifold.

**Table 3. Recommended Timer Settings for New Systems**

Models AX20-RT, AX20-RTUV	Number of Residents	Time On Setting Min (Sec)	Avg Daily Flow gpd (L/day)	Time Off Setting Min
	2	0.8 (45)	100 (379)	30
	3	0.8 (45)	150 (568)	20
	4	0.8 (45)	200 (757)	15
	5	0.8 (45)	250 (946)	15
	6	0.8 (45)	300 (1136)	10
	7	0.8 (45)	350 (1325)	10
	8	0.8 (45)	400 (1514)	8
Model AX25-RT	Number of Residents	Time On Setting Min (Sec)	Avg Daily Flow gpd (L/day)	Time Off Setting Min
	2	1.0 (60)	100 (379)	40
	3	1.0 (60)	150 (568)	30
	4	1.0 (60)	200 (757)	20
	5	1.0 (60)	250 (946)	15
	6	1.0 (60)	300 (1136)	15
	7	1.0 (60)	350 (1325)	10
	8	1.0 (60)	400 (1514)	10
	9	1.0 (60)	450 (1703)	8
	10	1.0 (60)	500 (1893)	8
	11	1.0 (60)	550 (2082)	7
	12	1.0 (60)	600 (2271)	7

• Assumes water usage of 50 gal. (190 L) per person per day and a return recirculation ratio of 3:1. (Filter recirculation ratio of 4:1.)

• Override OFF cycle time is set at one-half of the OFF cycle time. Override ON cycle time is set the same as the ON cycle time.

**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 4:1 (filter recirculation ratio). Table 3 provides recommended timer settings. If flows vary significantly from expected flows, timer settings should be adjusted accordingly. Contact Orengo for more information.

**AdvanTex Control System**

Critical to the success of the AdvanTex 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 and is treated by naturally occurring microorganisms that populate the filter. During periods of high flow, a timer override float 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 Orengo's VeriComm® control panels. (MVP control panel option 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 Web site.

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 Web site 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 CBOD<sub>5</sub> and TSS of about 5 mg/L average, while higher loading rates produce CBOD<sub>5</sub> and TSS in the range of 15-25 mg/L.

Field testing of systems in real-world conditions shows similar results, with CBOD<sub>5</sub> and TSS of <10 mg/L. (See *AX Performance Summary*, AHO-ATX-PERF-1.)

Nitrogen reduction in standard AX-RT systems will typically exceed 60%, with total nitrogen (TN) in the filtrate ranging between 20-35 mg/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, 7.14 mg/L of alkalinity as CaCO<sub>3</sub> is needed to nitrify 1 mg/L of NH<sub>4</sub><sup>+</sup>. (See *AX Performance Summary - Nutrient Reduction*, AHO-ATX-PERF-TN-1.) Where nitrogen limits are more restrictive than 20 ppm TN, a lower loading rate has to be used.

### Discharge Equipment

Treated effluent can be discharged to the drainfield by means of a discharge pump system or by gravity discharge.

#### 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 40½ inches (1013 mm) below the top of the unit and 31½ inches (800 mm) above the bottom of the unit. The invert of the outlet inside of the unit is 37 inches (940 mm) below the top of the unit and 35 inches (889 mm) above the bottom of the unit.

#### Pump Discharge to Final Dispersal

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

Tables 4a and 4b show discharge dose volumes for AX-RT Treatment Systems.

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

Pump Model gpm (L/sec)	Factory Float Setting in. (mm)	Lowest “Off” 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 Volume: AX20-RTUV**

Pump Model, gpm (L/sec)	Factory Float Setting in. (mm)	Lowest “Off” 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 units equipped with UV disinfection, the effluent passes through the UV treatment unit before being pumped or flowing by gravity to final dispersal.

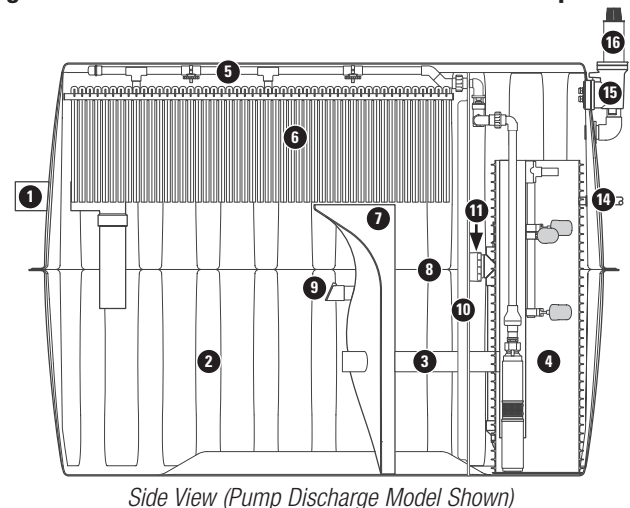
### UV Disinfection

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

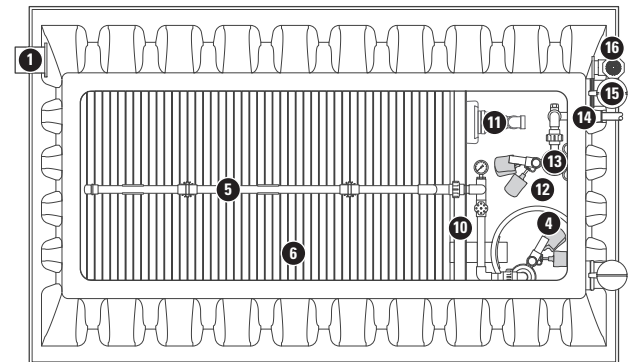
Treated effluent flows by gravity through the contact chamber and around the UV lamp where it is disinfected in a 360-degree contact zone. The unit uses no chemicals and has no moving parts. It requires cleaning yearly and a lamp replacement every two years.

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, manufactured by Orengo.

**Figure 4. AdvanTex® AX20-RTUV Treatment Unit Components**



Side View (Pump Discharge Model Shown)



Top View (Pump Discharge Model Shown)

- 1 AX-RT Inlet and Tee
- 2 Treatment Tank (Recirc/Blend Chamber)
- 3 Recirc Transfer Line
- 4 Recirc Pumping System
- 5 Manifold and Spin Nozzles
- 6 Textile Media
- 7 Tank Baffle
- 8 Treatment Tank (Recirc/Filtrate Chamber)
- 9 Recirc-Return Valve
- 10 Divider Wall
- 11 Orengo UV Disinfection Unit
- 12 Treatment Tank (Disinfection/Discharge Chamber)
- 13 Discharge Pumping System
- 14 AX-RT Outlet
- 15 External Splice Box
- 16 Passive Air Vent
- 17 Control Panel (Not Shown)



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.

The lamp used in the disinfection unit is rated at 125  $\mu\text{W}/\text{cm}^2$  intensity. 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 80% lamp degradation:

- 270,000  $\mu\text{W}\cdot\text{s}/\text{cm}^2$  at 1 gpm (0.06 L/sec)
- 55,000  $\mu\text{W}\cdot\text{s}/\text{cm}^2$  at 5 gpm (0.32 L/sec)
- 28,000  $\mu\text{W}\cdot\text{s}/\text{cm}^2$  at 10 gpm (0.63 L/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. For residential applications, AX20-RT and AX25-RT units have 135 gallons (511 liters) of surge volume, with an additional 75 gallons (284 liters) 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 500 gallons (1893 liters). 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 1000-gallon (3785-liter) septic tank is required to precede the AX20-RT unit and a minimum 1250-gallon (4732-liter) 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 1000-gallon tanks hold about 200 gallons (760 liters) and 1500-gallon tanks hold about 300 gallons (1140 liters) between the invert of the outlet and the inside top of the tank.

Most 3- or 4-bedroom homes produce about 150-200 gallons (570-760 liters) of wastewater each day (3-4 occupants at 50-60 gallons or 190-230 liters per occupant per day) as a conservative estimate. Between the septic tank and the AX-RT unit, there is approximately 700-800 gallons (2650-3028 liters) 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 percent to around 100 gpd (473 L/d) 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 (250 gallons or 950 liters) 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 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.