Immersion Cooling Tank with CorTex™ Technology

INSTALLATION, OPERATION & MAINTENANCE MANUAL

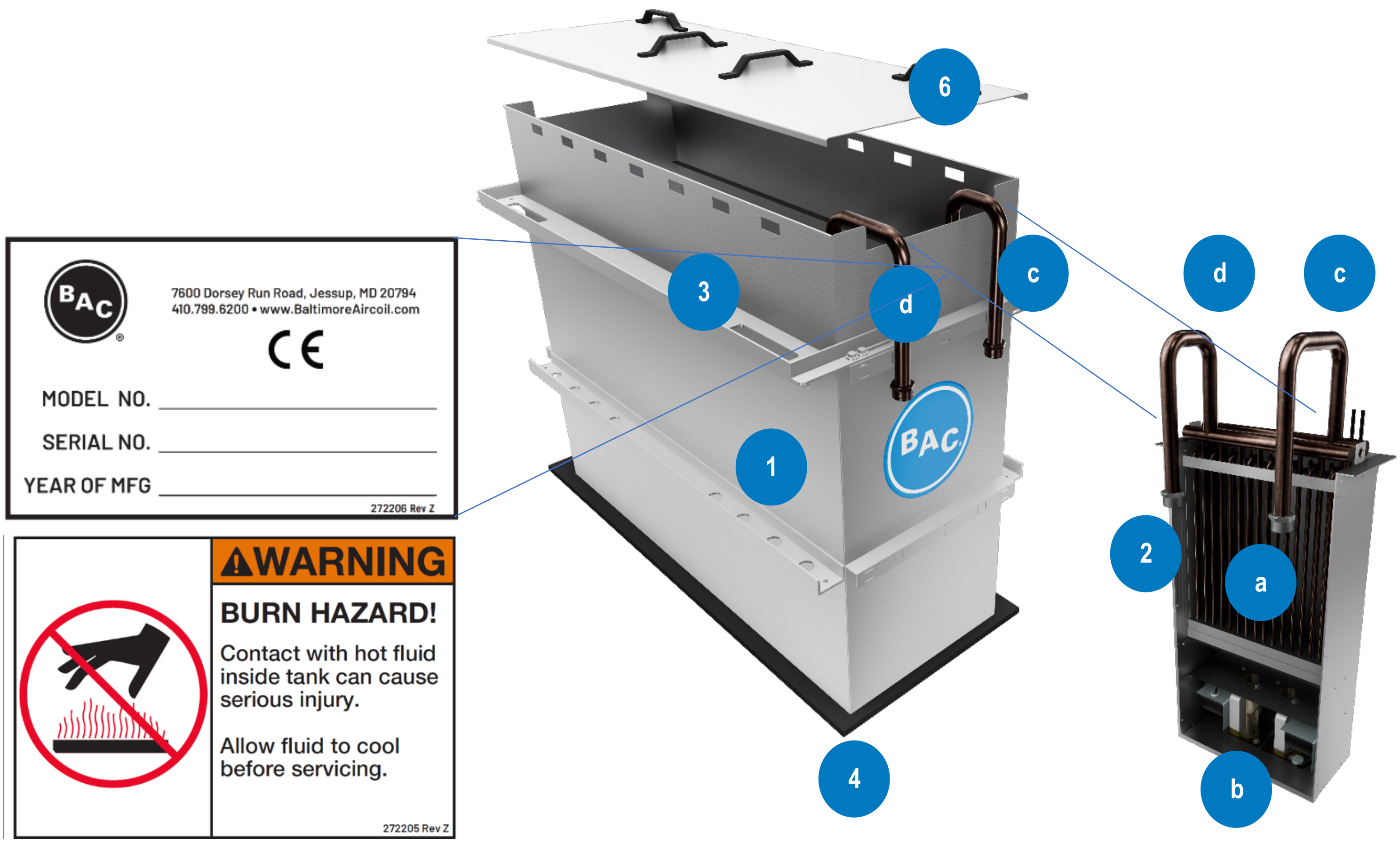
Contents

1. Recommended Maintenance Intervals

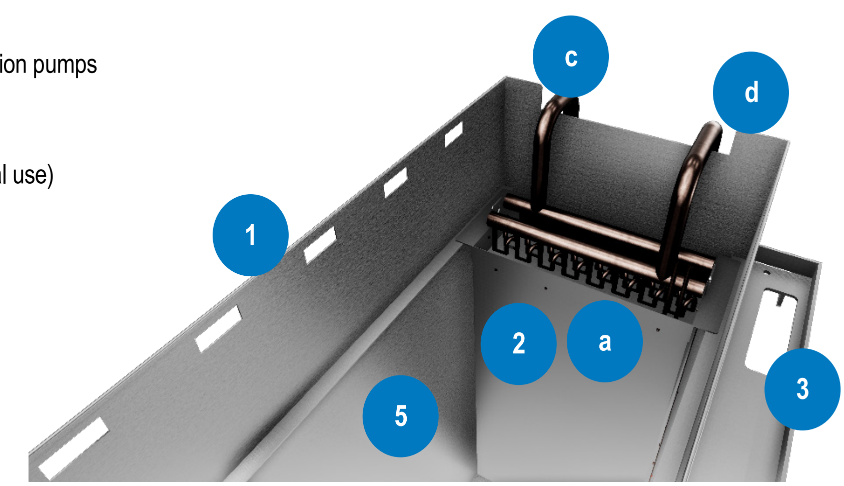
Dielectric Cooling Fluid Related [1]:	Start-Up	Regularly	Annually	Every 5 Years	10+ Years
Inspection of dielectric cooling fluid – checking volume and condition	✓	✓			
Sampling of dielectric cooling fluid – confirm thermal conductivity and dielectric strength are within tolerance			✓		
Replace dielectric cooling fluid					✓
Tank and Mechanical Equipment Related [1]:	**Start-Up**	**Regularly**	**Annually**	**Every 5 Years**	**10+ Years**
Pressure test cooling water circuit	✓				
Inspection of pump operation – observe convection currents of dielectric cooling fluid and pump power consumption.	✓	✓			
Inspect integrity of the tank and heat exchanger – leaking, corrosion or damage[2]	✓	✓	✓		
Inspect grounding wires	✓		✓		

[1] Recommended service intervals are the minimum for typical installations. Fault events may require more frequent servicing.
[2] The quality of the cooling water will affect the service life of the heat exchanger.

2. Equipment Overview



1. Immersion Cooling Tank
2. Fluid Control Module (FCM) Components:
    a. Heat Exchanger
    b. Two Dielectric Cooling Fluid circulation pumps
    c. Cooling Water Inlet (part of FCM)
    d. Cooling Water Cutlet (part of FCM)
3. Power Distribution Unit (PDU) Bracket (optional use)
4. Rubber Mat
5. Dielectric Cooling Fluid (not pictured)
6. Lid (optional)



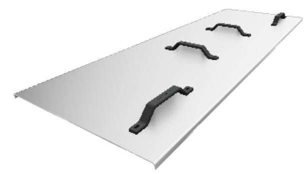
Fluid Control Module (FCM)

The Fluid Control Module (FCM) is the large heat exchanger unit that sits at the end of each tank. The FCM provides the heat exchange function between the dielectric cooling fluid in the tank and the cooling water supplied by the external heat rejection equipment.

Two (2) pumps are located at the bottom of the FCM to induce fluid flow from the top of the tank, through the heat exchanger fins and out into the bottom of the tank. As the dielectric cooling fluid heats up, it rises through the servers, is pulled across the top of the tank and back into the FCM to complete the cycle. See Section 4, Method of Operation.

The maximum pressure from the cooling water circuit to the FCM should not exceed 145 psi (1,000 kPa).

Lid (Optional)



An optional lid is available to prevent dust and debris from potentially entering the immersion tank. It is light enough for one person to maneuver and will not interfere with power or network cabling.

Dielectric Cooling Fluid

Dielectric cooling fluid or DCF is generally a non-flammable, non-conductive, and non-toxic fluid. It acts as an electrical insulator and coolant, directly cooling the immersed IT hardware. DCF comes in various formulas and is selected based on the IT hardware application.

3. Safety Warnings & Notices

It is important that anyone performing work on the equipment first become familiar with the following warnings and notices and take appropriate action to guard against identified hazards

⚠ DANGER Performing work on energized equipment poses the risk of electrocution. To avoid death, serious injury, and/or property damage, do not perform any service on the unit without first ensuring the unit is de-energized and appropriate lock-out/tag-out procedures are followed.

⚠ DANGER Failure to use proper care, procedures, tools, and designated lifting points during lifting and handling of this equipment can cause a dropped load, resulting in severe injury, death, and/or property damage. Lifts must be performed by qualified personnel using appropriate equipment, following the instructions in this manual and generally accepted lifting practices.

⚠ WARNING Tank contains up to ~200 gal (750 L) of dielectric fluid. To avoid a drowning hazard and risk of serious injury or death, do not walk on top of tank (with or without lid) and exercise caution near tank if the lid is absent or has been removed.

⚠ WARNING An explosion or uncontrolled release of hot liquid can result if the heat exchanger coil becomes over pressurized by the cooling water system or through thermal expansion, resulting in death, serious injury, or property damage. Ensure controls exist (such as pressure relief valves in the cooling water circuit) to prevent the simultaneous closure of the input and discharge cooling water valves while servers in the tank are running.

⚠ WARNING When the equipment is operating, the fluid inside the tank is at an elevated temperature and can cause serious injury on contact. Perform maintenance work after the unit has stopped operating and the fluid has cooled to a safe temperature.

⚠ WARNING To prevent death, serious injury or property damage, only qualified personnel should undertake the installation, operation, maintenance, and repair of this equipment. All such personnel must be thoroughly familiar with the equipment, the associated system and controls, and the procedures set forth in this manual before engaging with the equipment.

⚠ CAUTION This equipment contains a rotating impeller in the fluid control module pump that could cause serious injury on contact. Do not place any part of your body within the pump casing.

⚠ CAUTION Spilled fluid poses a slip hazard and risk of serious injury. Promptly clean up spills of cooling water and dielectric fluid. Use slip resistant shoes and spill trays to contain dielectric cooling fluid during hardware removal or servicing.

NOTICE Read and follow the directives of the Material Safety Data Sheet (MSDS) and Technical Data Sheet (TDS) for the dielectric fluid that you select for your tank.

NOTICE The fluid control module that shipped with your unit can only be used with the supplied tank. Please contact BAC for replacement parts.

NOTICE To avoid damage to the tank's finishing surface, do not use harsh chemicals to clean the tank.

NOTICE Ensure a proper air purging of the system prior to operation. Entrained air can restrict the capacity of the cooler, resulting in higher processing temperatures.

NOTICE Test all piping connections to ensure they are leak-free.

NOTICE To prevent damage to the equipment, do not run the pump without fluid in the tank.

NOTICE Pressure spikes and entrained air can result in damage to the heat exchanger coil. Ensure adequate protection devices are in place to prevent this and inspect the heat exchanger thoroughly for damage if a fault event occurs.

4. Method of Operation

BAC Immersion Cooling Tank with CorTex™ Technology is a fluid cooled system. As illustrated in *Figure 1*, there are two different cooling circuits.

Dielectric Cooling Fluid Circuit

1. Cool dielectric cooling fluid circulates to cool servers in tank
2. Warm dielectric cooling fluid in tank cooled by heat exchanger
3. 2 pumps circulate dielectric cooling fluid in tank

Cooling Water Circuit

A. Cool cooling water enters heat exchanger
B. Warm cooling water exits heat exchanger to return to outdoor heat rejection equipment

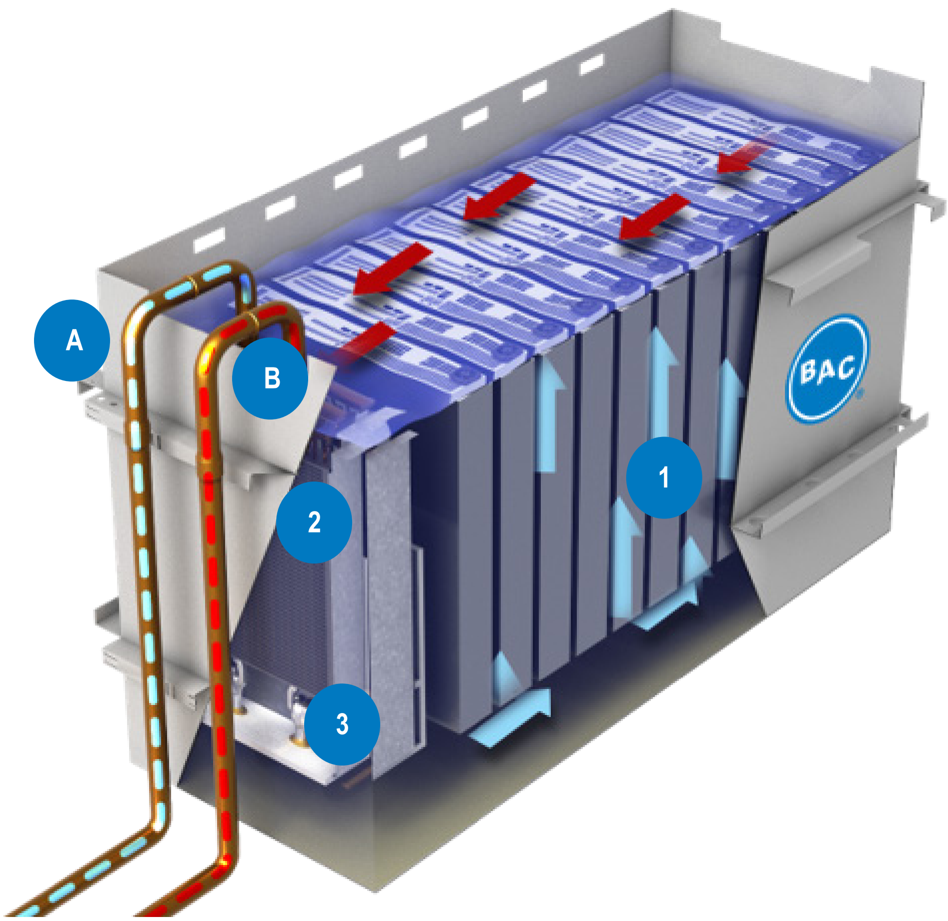


Figure 1: BAC Immersion Cooling Tank with CorTex™ Technology showing the two separate cooling circuits.

5. Install Site Considerations & Layout

Installation Location Considerations

Considerations for tank install location include:

- Ensure the floor can support the tanks' weight. Each tank is approximately:
  - 265 lbs. (120 kg) empty
  - 1650 lbs. (750 kg) with fluid
  - 2500 lbs. (1135 kg) when filled with fluid and servers
- Access requirements for equipment operators and maintenance
- Orientation of the tank with respect to networking and power services
  - Note the upper rail differs on the left and the right
  - The rail with the two long rectangular and the two circular cutouts is intended for network switches (see *Figure 3*)
  - The rail with the two short rectangular cutouts and no circular cutouts is intended for the PDU, with or without the PDU bracket (see *Figure 2*)
- The tank must be level for proper operation
- Location of the cooling water services
- Location and capacities of lifting aids (e.g., maintenance crane)
- Location of PDU(s) and network switches and whether any PDUs are shared between two tanks

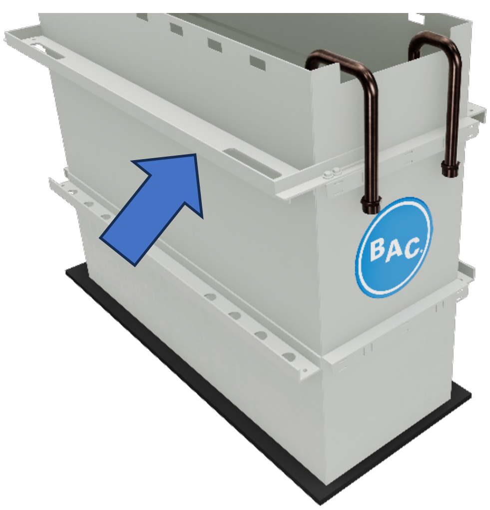


Figure 2: Arrow highlighting rail on long side intended for PDU. This illustration shows the optional PDU bracket installed.

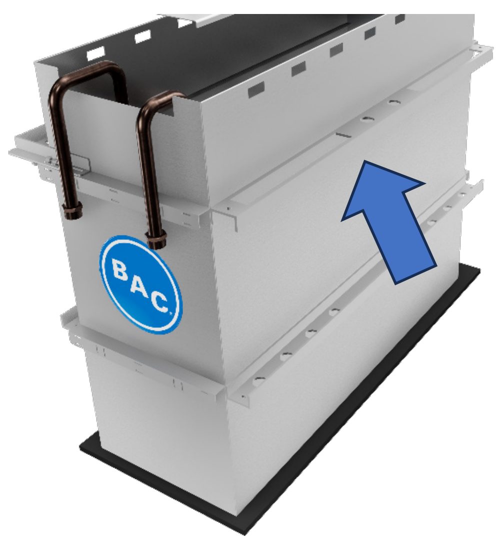
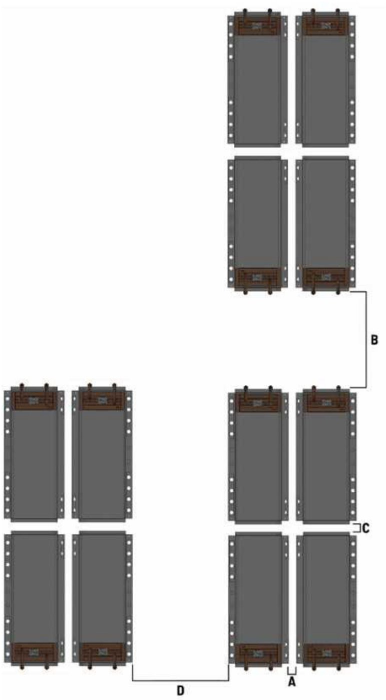


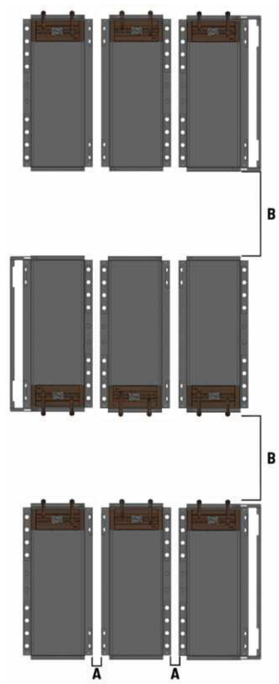
Figure 3: Arrow highlighting rail intended for network switch

Recommended Tank Layout

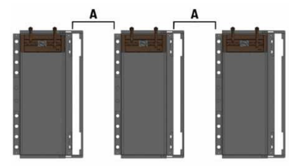
BAC recommends the following layouts for the positioning of Immersion Cooling Tanks (*Figure 4*):



Layout 1: Side access



Layout 2: End access



Layout 3: Single tank** layout OR 4-sided access layout

Interval A* = approx. 7 ¼" (185 mm) - 9 ¼" (235 mm) minimum

Interval B = 40" (1000 mm) minimum

Interval C = 4" (100 mm) minimum

Interval D = 40" (1000 mm) minimum

Figure 4: Recommended tank layouts

*The minimum tank spacing (Interval A) should be approximately 7 ¼" (185 mm) - 9 ¼" (235 mm) from the adjacent tank where PDU is to be situated, depending on the room design, access to utilities, size and number of PDUs.

** For a single tank configuration or where the gap between two tanks is too wide to support the PDU on the support ledges of adjacent tanks, the PDU can be installed using the PDU bracket that comes with each tank (See *Figures 7 and 8* below, and see Section 6, Receiving Tank & Installation, Step 6 on Installing PDU Bracket).

Certain installation configurations will not require use of the PDU support bracket (see *Figures 5 and 6*).

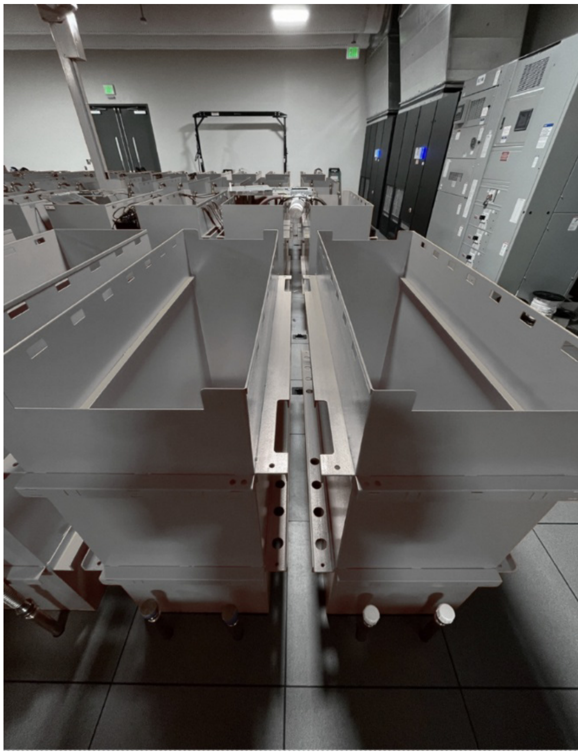
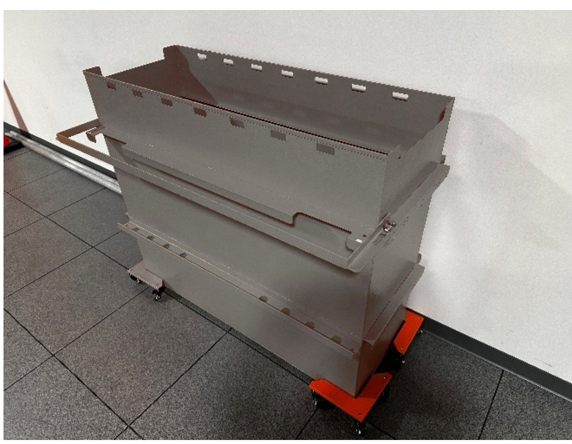


Figure 5: Example of adjacent tank spacing not using PDU bracket, before installation of PDU. The rails for PDU support do NOT have the circular cutouts.

Figure 6: Example of adjacent tank spacing not using PDU bracket, after installation of PDU



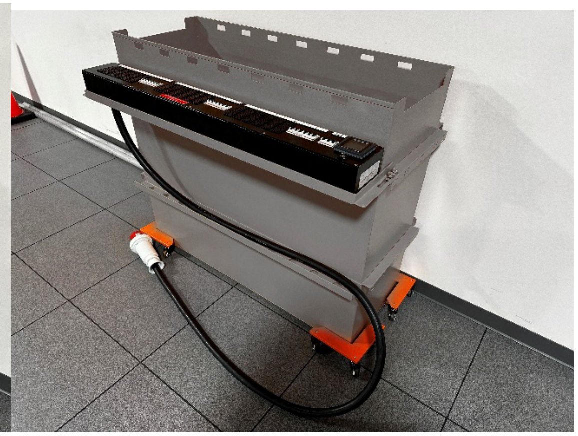


Figure 7: Example of single tank using optional PDU bracket, before installation of PDU

Figure 8: Example of single tank using optional PDU bracket, after installation of PDU

6. Receiving Tank & Installation

⚠ DANGER **Failure to use proper care, procedures, tools, and designated lifting points during lifting and handling of this equipment can cause a dropped load, resulting in severe injury, death, and/or property damage. Lifts must be performed by qualified personnel using appropriate equipment, following the instructions in this manual and generally accepted lifting practices.**

⚠ WARNING **Tank contains up to ~200 gal (750 L) of dielectric cooling fluid. To avoid a drowning hazard and risk of serious injury or death, do not walk on top of tank (with or without lid) and exercise caution near tank if the lid is absent or has been removed.**

Receiving Tank

For delivery, the tank(s) are strapped onto a wooden heat-treated pallet, packed one to three tanks per pallet and wrapped with plastic (see *Figure 9* below).

The FCM and cooling water connections are stored inside the tank for protection during transport.

Multiple rubber mats may be shipped together inside one tank.

When the tank(s) are delivered to the job site, they should be checked to ensure all required items (see *Table 1* below) have been received and are free of shipping damage prior to signing the bill of lading.

Figure 9: Three (3) tanks in shrink wrap, strapped on pallet

Installation Preparation

This manual assumes that qualified personnel have properly installed outdoor heat rejection equipment, skid pumps, piping, and valves and have established cooling water access according to applicable codes.

Before starting installation, ensure the floor area where the tank(s) will be situated is clean and accessible.

Do not fill the tank with dielectric cooling fluid before positioning the tank.

Step 1: Remove the plastic wrapping and straps around the tank(s) (see *Figure 9* above) and perform an inspection of the components (listed in *Table 1)*. All components should be inspected for general damage as well as for the specific areas of damage noted in *Table 1*.

Receiving / Inspection	Areas to Check for Damage
Tank	Powder Coat, Welded Seams, Holes
Fluid Control Module (FCM)	Copper Pipes including connections and caps, Cables from Pumps
Rubber Mat	General damage
Bracket and Bolts for Power Distribution Unit (PDU)*	Powder Coat, Holes
Lid (if selected as an option)	Handles, Finish

Table 1: Tank and Components (see Section 2: Equipment Overview for images)

* The PDU is supplied by a third-party.

Step 2: Remove the rubber mat and PDU bracket from the tank they were shipped in.

Step 3: Position the rubber mat on the floor (see *Figure* 8 below).

For each tank to be installed, lay down a rubber mat in the desired installation location to align with the non-FCM end of the tank. The rubber mat should be placed approximately 2"– 2 3/8" (50–60 mm) from the cooling water inlet and outlet piping connections (see *Figure 10* below).

Figure 10: Rubber mat positioned on floor before tank installation

Step 4: Carefully remove the FCM from the tank by first unscrewing the shipping screws holding the FCM to the tank. The FCM is approx. 80 lbs. (36 kg) empty. Using a maintenance crane, lift the FCM by both of its two lifting lugs – like the removal of a server (see *Figure 11*).

Step 5: Set the FCM aside in a safe location until after the tank has been properly positioned (see *Figure 12*).

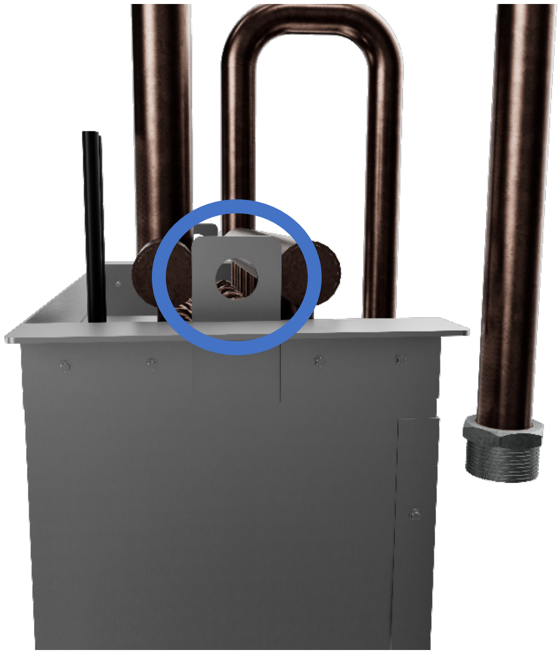


Figure 11: FCM lifting lug (one of two visible)

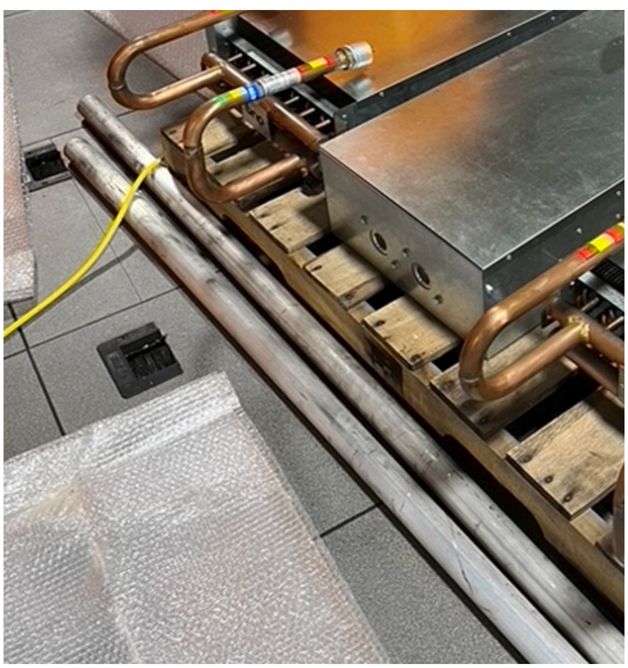


Figure 12: Example of FCMs removed from tank, laid on wooden pallet

Step 6 (Optional): If your installation configuration requires use of the included PDU bracket, attach the bracket to the upper rail with the supplied hardware (see *Figure 13* below with arrow).

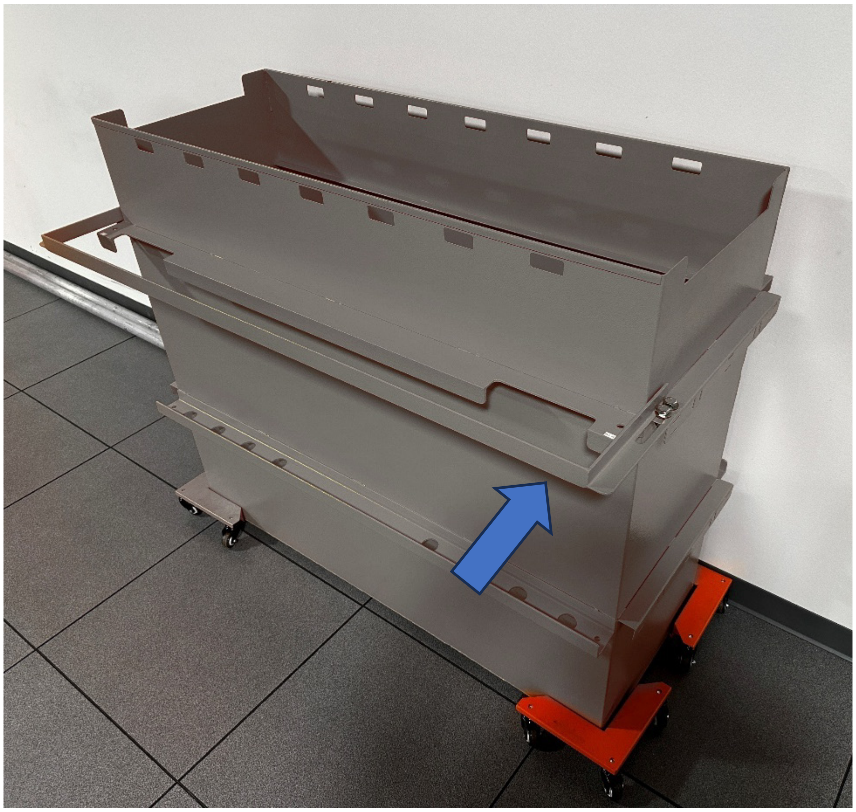


Figure 13: Optional installation of included PDU bracket

Positioning the Tank(s) for Installation

After the FCM has been removed and the rubber mat has been installed:

Step 1: Position the empty tank alongside the desired installation location using a pallet jack or skids. Ensure the tank is empty and evenly supported during movement to prevent damage.

Step 2: Lift the tank into position using appropriate mechanical aids, such as a mechanical crane with lifting jig.

Step 3: Carefully set the empty tank down on the rubber mat. See *Figure 14*.

Step 4 (if needed): If repositioning is required, lift the tank in a manner that ensures the rubber mat stays in place. Do not attempt to slide the tank into position once on the floor, as pushing or pulling the top edge of the tank may cause it to deform.

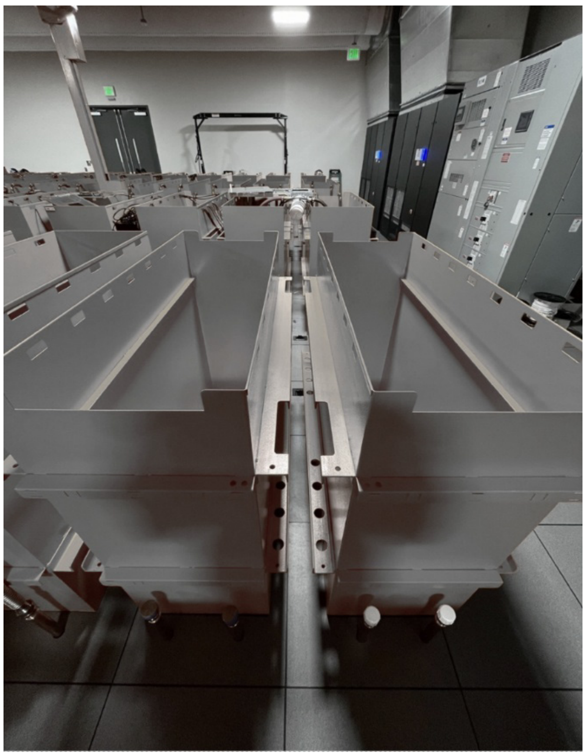


Figure 14: Tanks in place after positioning on respective rubber mats

Tank Grounding

⚠ DANGER Performing work on energized equipment poses the risk of electrocution. To avoid death, serious injury, and/or property damage, do not perform any service on the unit without first ensuring the unit is de-energized and appropriate lock-out/tag-out procedures are followed.

After tanks are positioned correctly, the tanks must be electrically grounded by a licensed electrician, who must connect each tank to the grounding wire. Failure to properly ground the tank poses a risk of severe injury from electrocution; electrical component failure can cause conductivity of the tanks.

To ensure a proper ground connection is made, prior to attaching the grounding wire, a small amount of powder coating will need to be removed from the tank where the grounding wire will be connected. In *Figure 15* below, the grounding connection is made on the lower rail. Failure to remove the powder coating will result in no grounding connection.

Proper testing should be conducted after installation and grounding to ensure connectivity to the building's grounding system.

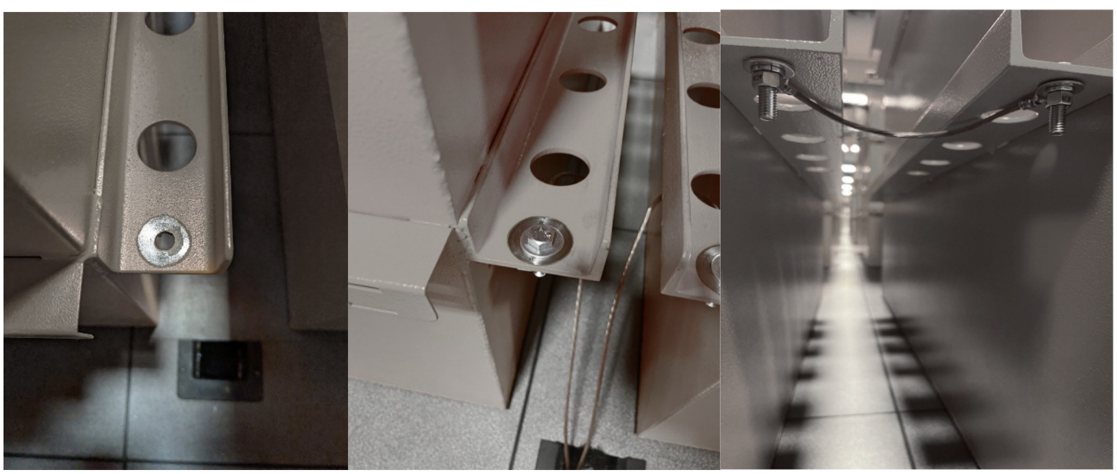


Figure 15: Examples of tank grounding connections made on the bottom rail. Powder coating has been removed under the washer.

Installation of Fluid Control Module (FCM)

After the tanks have been properly grounded and the grounding has been inspected and tested, the next step is to install the FCM.

Step 1: Using a maintenance crane, position the FCM inside the tank against the short side of the tank. The tank is fully reversible so either short side can be used. The cooling water inlet and outlet pipes should hang out over the notch in the tank's edge (see *Figure 16 below*) and line up with the external cooling water circuit pipes coming out of floor (see *Figure 17*).

Figure 16: FCM inside tank with cooling water inlet and outlet pipes hanging over notch on short side of the tank

Figure 17: Cooling water piping to be attached to cooling water inlet and outlet connections of FCM

Step 2: Ensure the FCM is evenly supported on the tank's internal railing (see *Figure 18* below).

Figure 18: FCM properly supported over tank's internal railing

Step 3: Confirm again the external cooling water circuit connections (see *Figure 16*) are aligned with the FCM's cooling water inlet and outlet (see *Figure 17*).

Step 4 (Optional): Affix the FCM to the tank using self-tapping screws (not supplied) (see *Figure 19*). Ensure all swarf and metal filings are removed from the tank before moving onto the next step.

Figure 19: FCM mounted on tank's internal rails. Note screw holes for optional self-tapping screws and lifting tab.

Step 5: FCM pipework may get distorted and bent out of position during pressure-testing or due to pressure differentials in the cooling fluid circuit. This step will help retain pipework in position. Cut clear vinyl 1-1/2" (38mm) ID tubing (not supplied) to a length of 1-5/8" (40mm) and then cut through one side of the circumference. Do this twice so that you end up with two pieces of tubing. Wrap the tubing around the pipework of the FCM. Secure the tubing to the tank using an 11" (280 mm) stainless steel cable tie (not supplied) fed through the slots in upper rail on the tank for cabling (see *Figure 20*).

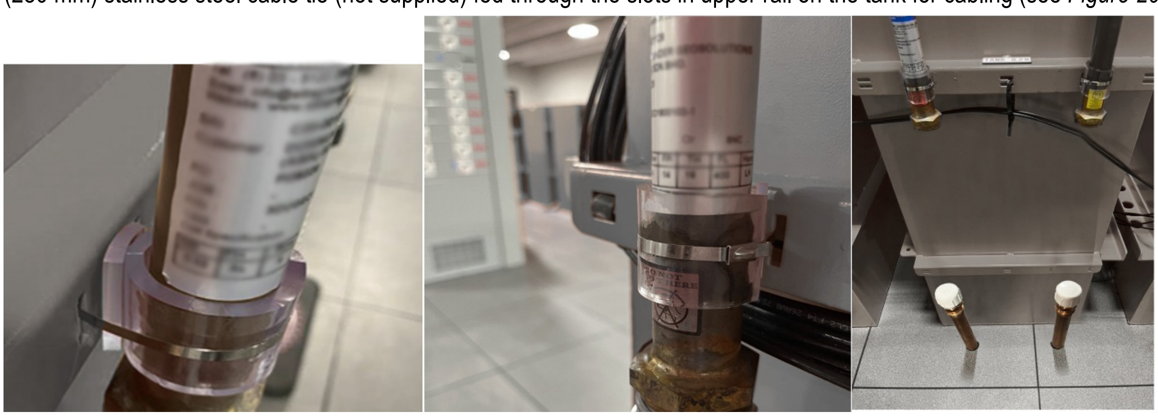


Figure 20: FCM cooling water inlet or outlet pipe secured to tank's upper rail by vinyl tubing and stainless steel cable tie

Installation of Flex Hoses

WARNING **An explosion or uncontrolled release of hot liquid can result if the heat exchanger coil becomes over pressurized by the cooling water system or through thermal expansion, resulting in death, serious injury, or property damage. Ensure controls exist (such as pressure relief valves in the cooling water circuit) to prevent the simultaneous closure of the input and discharge cooling water valves while servers in the tank are running.**

NOTICE **Test all piping connections to ensure they are leak-free.**

NOTICE **Ensure proper air purging of the system prior to operation. Entrained air can restrict the capacity of the cooler, resulting in higher processing temperatures.**

The cooling water inlet and outlet pipes of the FCM are shipped with end caps fitted with a Schrader valve (see *Figure 21*) and are pressurized to 30 PSI (207 kPa).

Step 1: Before removing the end caps, ensure the pressure is released by depressing the pin retained in the Schrader valve and holding the valve open until all air pressure is relieved.

Step 2: After the FCM is depressurized, remove the end caps on the cooling water inlet and outlet pipes. Ensure the cooling water inlet and outlet pipes are clear and free of any debris.

Figure 21: FCM cooling water inlet and outlet fitted with end caps with Schrader valve

Step 3: Prior to connecting the cooling water system to the FCM, flush the FCM with water using a hose and bucket to ensure the coil is clean.

Step 4: Apply PTFE thread tape to the cooling water inlet and outlet connections at both the FCM and cooling water circuit ends.

Step 5: Using flexible hoses (not supplied), connect the FCM cooling water inlet and outlet pipes to the external cooling water circuit. Ensure the pipe/hose connections are securely tightened (see *Figure 22* below). Both inlet and outlet shut off valves should remain closed at this time (see *Figure 23* below).

Figure 22: Flexible hoses (not supplied) connecting the FCM's cooling water inlet and outlet to the cooling water loop

Figure 23: Example of cooling water circuit with both shut off valves visible in closed position

Step 6: Slowly open the cooling water inlet shut off valve to pressurize the FCM. The outlet side shut off valve should remain closed (see *Figure 24* below). Check all piping for leaks. If leaks are found, close the cooling water inlet valve and repair the leak.

Figure 24: Example of cooling water circuit with inlet shut off valve open (on left), and outlet shut off valve in closed (on right)

Pressure Testing the Cooling Water Circuit

⚠ WARNING **An explosion or uncontrolled release of hot liquid can result if the heat exchanger coil becomes over pressurized by the cooling water system or through thermal expansion, resulting in death, serious injury, or property damage. Ensure controls exist (such as pressure relief valves in the cooling water circuit) to prevent the simultaneous closure of the input and discharge cooling water valves while servers in the tank are running.**

NOTICE **Test all piping connections to ensure they are leak-free.**

NOTICE **Ensure a proper air purging of the system prior to operation. Entrained air can restrict the capacity of the cooler, resulting in higher processing temperatures.**

The instructions in this section are for a single tank test. Multiple tanks may be tested simultaneously using hydraulic hoses. Contact BAC for more information.

Step 1: With the water outlet's shut off valve still closed (*Figure 23* above), the cooling water circuit should be pressurized to determine whether any faults or leaks exist with the FCM piping or cooling water pipes.

Step 2: Using a hydrostatic pressure tester and a pressure gauge (not supplied), connect the line of the tester to a tap in point after either the cooling water inlet or outlet's shut off valve (see *Figure 25 and 26* below).

Step 3: Once the gauge and tank are installed, open the inlet and outlet shut off valves to allow air to forced from the system, then close both shut off valves again.

Step 4: Pump the FCM up to 115 psi (793 kPa).

Step 5: Maintain this pressure for 1 hour with both shut off valves still closed.

Figure 25: Hydrostatic pressure tester attached to tap in valve to pressurize the FCM circuit. Note the black hose connected.

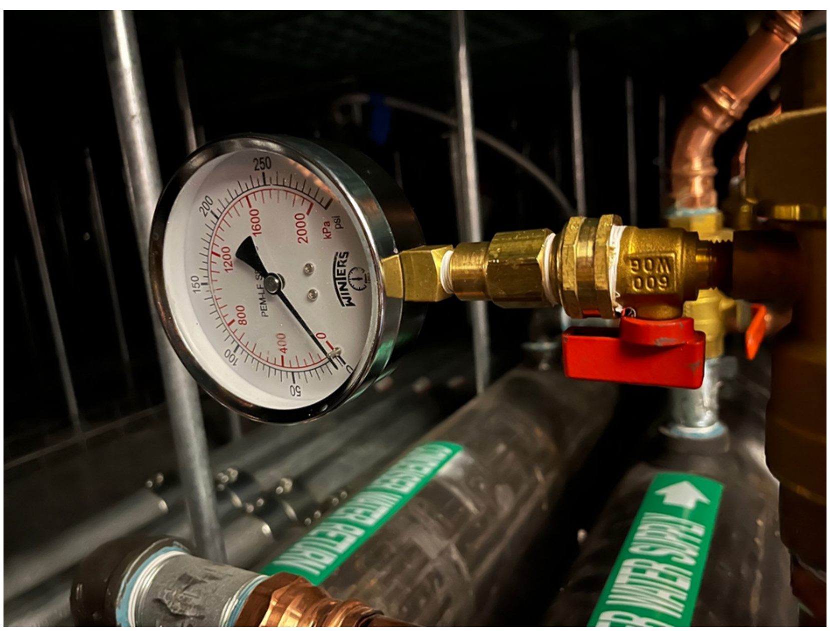


Figure 26: Pressure gauge installed to cooling water circuit, before hydraulic pressure testing is enabled

Step 6: If no leaks are found after testing, ensure pressure has been relieved from the hydrostatic pressure tester and the cooling water circuit.

Step 7: To relieve the pressure, first remove the gauge and hydraulic pressure tester.

Step 8: Next, slowly open the outlet water shut off valve.

Step 9: Next, slowly open the inlet water shut off valve, so both shut off valves are open (see *Figure 27* below).

Step 10: Continue to monitor the FCM for leaks for a minimum of 10 minutes.

Figure 27: Both inlet and outlet shut off valves are open, with testing equipment removed and caps reinstalled

Installation of Power Delivery Unit (PDU)

⚠ DANGER Performing work on energized equipment poses the risk of electrocution. To avoid death, serious injury, and/or property damage, do not perform any service on the unit without first ensuring the unit is de-energized and appropriate lock-out/tag-out procedures are followed.

The PDU is not supplied by BAC; it is supplied by a third-party manufacturer. The PDU will sit on the outside of the tank, either on the upper rail when positioned between two tanks, or optionally, with the included PDU bracket (see *Figure 28* below). The PDU supplies the power to the immersed servers in the tank and to the FCM's two dielectric cooling fluid pumps. Start with the PDU disconnected from power.

Figure 28: Example of PDU installed on included PDU bracket

Step 1: Before installing the PDU, ensure all connections are de-energized and an extension cable (not supplied) is on hand for each FCM pump (see *Figure 30* below). The FCM pump cables only reach to the top of the FCM housing (see *Figure 29* below), so use of an extension cable is necessary for connection to the PDU.

Step 2: Insert the extension cable leads into the pump cables; run the cabling through the cabling slots in the tank side panel; and plug into the PDU with the socket bank breakers switched to the off position. Do not stretch the FCM pump cables as this may cause damage at the connection point between the cable and the pump motor or to the cable itself.

Figure 29: Two FCM pump power cables on top of FCM, before connection of extension cables

Figure 30: An extension cable running from the PDU to one of the two FCM pump power cables

Step 3: For configurations involving an even number of tanks, the PDU can be installed between two tanks on facing support ledges as shown in *Figure 32* below. It is important to ensure that the PDUs are installed on the correct support ledge. The support ledge on one side of the tank has specific rectangular and circular cut outs for the network routers that must remain unobstructed and should not be used for the PDU. See *Figures 2* and *3*.

For a single tank configuration or where the gap between two tanks is too wide to support the PDU on the support ledges of the two adjacent tanks, the PDU can be installed using the PDU bracket that comes with each tank (see *Figure 31* below).

The maximum size capacity for a single PDU bracket is up to 7.5” (190 mm) W x 55” (1400mm) L. The maximum weight-bearing capacity of a PDU bracket is 300 lbs. (136 kg.) when used for a single tank and 600 lbs. (272 kg.) when the bracket is shared by two tanks.

Figure 31: Tank with PDU bracket and PDU installed

Figure 32: *PDU on support ledge between two tanks, not using PDU bracket*

Bump Test FCM Pumps

NOTICE **To prevent damage to the equipment, do not run the pump without fluid in the tank.**

After the PDU is installed, it is possible to do a bump test to ensure that both FCM pumps are operating correctly.

Step 1: Double check cabling connections between the PDU and the FCM pumps (see *Figure 33* below). With the breakers feeding the FCM pumps remaining off, energize the PDU.

Step 2: For each pump, one at a time, quickly switch the breaker to the "on" and then "off" position to allow the motor and pump to activate for a short time. Listen for the motor turning on when power is applied to ensure it is operating correctly, then quickly switch it off.

Step 3: Repeat the above steps for the other FCM pump.

If the pump does not function, double check that it is getting power. If power is confirmed and pump is still not working, contact BAC or your sales representative.

Do not leave the pumps on without fluid. FCM pumps are not designed to run dry (without fluid), so running the pumps for an extended time may result in damage to internal components.

Figure 33: One of two FCM pumps plugged in using extension lead connected to PDU, ready for bump testing

7. Dielectric Fluid Fill and IT Hardware Installation

Dielectric Cooling Fluid Overview

NOTICE **Read and follow the directives of the Material Safety Data Sheet (MSDS) and Technical Data Sheet (TDS) for the dielectric fluid that you select for your tank.**

WARNING **Tank contains up to ~200 gal (750 L) of dielectric cooling fluid. To avoid a drowning hazard and risk of serious injury or death, do not walk on top of tank (with or without lid) and exercise caution near tank if the lid is absent or has been removed.**

CAUTION **Spilled fluid poses a slip hazard and risk of serious injury. Promptly clean up spills of cooling water and dielectric fluid. Use slip resistant shoes and spill trays to contain dielectric cooling fluid during hardware removal or servicing.**

Read the MSDS and TDS for the immersion dielectric cooling fluid and ensure required controls are in place.

Before filling a tank with dielectric cooling fluid, inspect the tank to ensure it is clean, dry, and free of debris and moisture.

It is important to ensure the dielectric cooling fluid temperature in the tank remains above the install location's ambient dew point temperature. If this is not the case, water can be absorbed into the dielectric cooling fluid, which will impact the equipment's performance and reduce the dielectric cooling fluid's dielectric properties, exposing the immersed hardware to damage.

Filling Tanks with Dielectric Cooling Fluid and Leak Testing

Each tank holds approximately 185 gallons (700 L) of dielectric cooling fluid with some variance depending on the number of servers immersed.

Step 1: Using an electric oil fluid transfer pump (see *Figure 34*), fill each tank with dielectric cooling fluid until it reaches to approximately 44" (1120 mm) from the bottom of the tank (see *Figures 35 and 36*).

Step 2: Allow the tank to sit for an hour and carefully check for leaks, particularly around the seams at the bottom.

Step 3: If no leaks are detected, in preparation of installing servers, use the electric oil fluid transfer pump to reduce the volume to 30" (760 mm) from the bottom of the tank.

Figure 34: Example electric fluid oil pump and dielectric cooling fluid bulk container

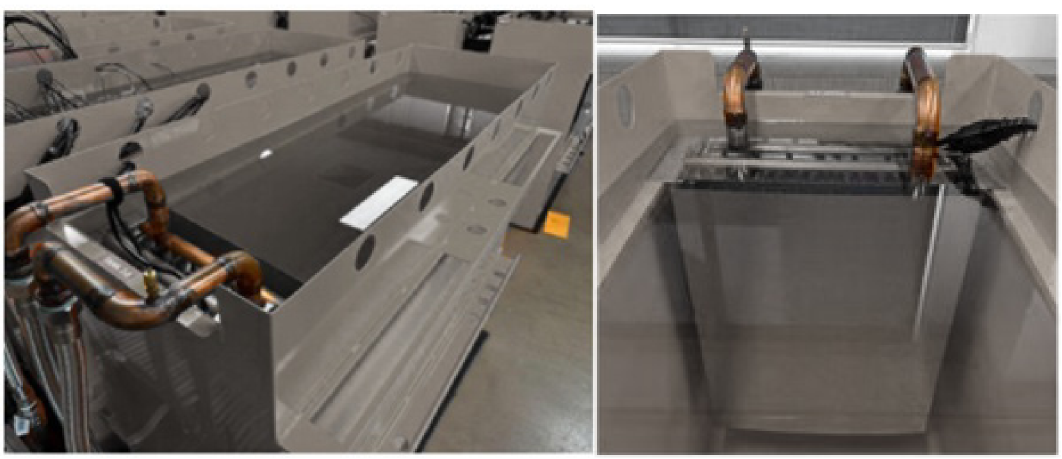


Figure 35: Tank initially filled at a high level for leak testing before fluid level reduction and installation of servers

Figure 36: Tank initially filled at a high level for leak testing before level reduction and installation of servers

IT Hardware Installation and Startup

IT Hardware/servers can now be installed based on the user's requirements and server manufacturer's guidance.

During immersion, each server must be supported evenly on the tank's internal support rails. For optimal cooling, IT hardware should be installed from the non-FCM side first – i.e., starting on the side furthest from the FCM. Servers should be installed flush against each other without gaps (see *Figure 37* below).

When a tank is not completely filled with server racks and gaps are present, a blanking cover plate (not supplied) must be installed in the blank spaces to maintain proper fluid flow (see *Figure 37* below, noting the arrows).

Step 1: After the IT hardware is installed inside the tank, ensure the dielectric cooling fluid level is approximately 4" (100 mm) above the top internal rail, and covers the top of the FCM by a height of 1¼" (32 mm). When the FCM pumps are turned on and begin to run, the dielectric fluid level will decrease slightly.

Step 2: After the installed IT hardware is wired, the FCM pumps can be turned on by switching the breakers of the PDU to the "on" position. Observe the flow of dielectric fluid as it is drawn in through the top of the FCM (see *Figure 38* below). You are looking for two vortexes indicating flow of both pumps.

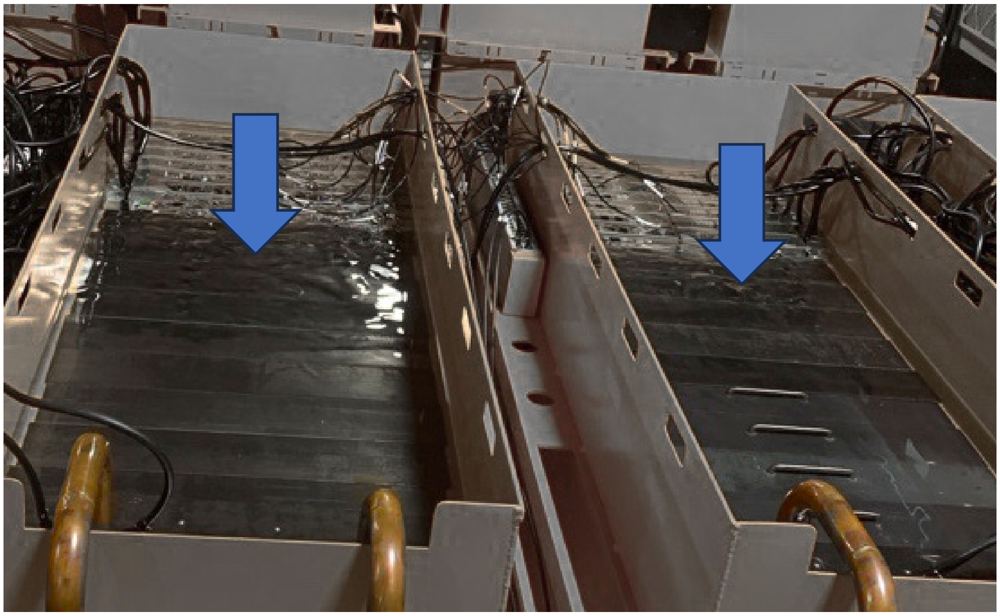


Figure 37: Example of tanks partially filled with servers—starting from the end farthest from the FCM. The arrows indicate black blanking panels (not supplied) installed between FCM and servers. Note the dielectric cooling fluid has vortexes indicating pumps running.

Figure 38: Close up of vortex in immersion cooling fluid indicating that pumps are running.

Step 3: Next, double check that both cooling water shut off valves are completely open. If not, slowly open the cooling water inlet shut off valve, followed by the cooling water outlet shut off valve.

Step 4: With the FCM pumps running and the cooling circuit in service, the BAC Immersion Cooling Tank is now in operation and ready for operation with activated servers.

Dielectric Cooling Fluid Monitoring

The dielectric cooling fluid level should be checked regularly to ensure the pumps are running and that there is no change in level or appearance (see Recommended Maintenance and Troubleshooting sections).

If the fluid level has dropped and there were no known changes to the system (e.g., replacement of server), investigate for potential leaks.

An unexpected rise in the fluid level may indicate a leak from the heat exchanger or an FCM pump. In this scenario, the fluid will likely become cloudy. The system will need to be shut down, and the heat exchanger inspected, repaired, or replaced. The dielectric cooling fluid will need to be replaced as well.

8. Troubleshooting

Condition	Possible causes	Possible Remedy
Tank temperature exceeds design setpoint.	Circulating pump failure	Replace FCM.
	Power loss to circulation pump(s)	Check PDU to see if the breaker has tripped. Check integrity of power lead. Note: The breaker may trip due to a seized pump condition.
	Cooling water circuit operating outside tolerance	Inspect cooling circuit pumps/set-point and ensure water is being delivered to specification.
	Cooling water circuit isolated	Inspect isolation valves for feed/discharge water and ensure they are open.
Immersion fluid is opaque or exhibits a reduction in clarity.	Condensation forming on the cooling system and dripping into the tank.	Ensure room temperature is less than the cooling water inlet temperature.
	Leak from the cooling water circuit into the tank.	Inspect FCM. If FCM is broken, replace it and replace the dielectric cooling fluid.
	FCM pump has failed	Inspect operation of both FCM pumps. If a pump is broken, replace it and replace the dielectric cooling fluid.
	Contaminants within the dielectric cooling fluid from installed IT hardware.	Ensure servers have been properly prepped for immersion.
Sudden loss in tank volume.	Leak in the tank structure.	Inspect the tank for damage, paying close attention to seams and welds.

BAC Immersion Cooling Tank with CorTex™ Technology

INSTALLATION, OPERATION & MAINTENANCE MANUAL

BaltimoreAircoil.com