

# **FERNOX**

## **MAKES WATER WORK**

### **Fernox Powerflow Flushing Pump MKIV**

### **Installation, Operating, and Maintenance Manual for Hydronic Systems**



Part # 240190  
Rev.02MAY2017

**Closed Loop Flush Cart for Hydronic Systems**

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## NOTES:

This guide provides the installer with instructions specific to the Fernox Flush Cart. Please refer to your heat pump manufacturer's instructions or IGSHPA guidelines for additional detailed flushing, purging, and installation information. Please review the entire IOM document before proceeding with the installation.

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## General Description

The Fernox Flush Cart is the professional's choice to purge air and flush debris from residential and light commercial hydronic systems. The Flush Cart includes all of the important features required to safely flush and purge the closed loop piping system, including power flushing, power draining, pump and dump, and debris filtering. Its compact design utilizes standard components which allows for easy field service. The high-head/high flow self-priming 120V pump is mounted above the cart's axle providing a well-balanced system that is easy to maneuver.

## Technical Data

### Features

The Fernox flush cart has many features geared towards the HVAC professional, which are outlined below.

- ETL Safety Listing (Listed to UL standard 778)
- Tank: 10" Diameter, 13 gallon capacity
- Hand Truck: P-Handle, powder-coated steel
- Tires: 10" Pneumatic
- Wiring: 20' 12/3 SJO cord with 15 Amp male plug, 120V
- Power Switch: Weatherproof switch box with 20 Amp GFCI protected switch
- Filter: Removable/reusable, 31" long, 100 micron, 90 GPM max. (standard); optional 1 micron add-on
- Power Flush Valve: Brass, 2" Full port
- Dead-Head Valve: Brass, 1.5" Full port
- Hose Connections on cart: 1.5" CAM male quick-connect
- Hoses: (2) 1.5" ID, Flexible PVC hose with rigid PVC helix with 1.5" CAM
- Female quick connect fittings (pump side) and 1" CAM fittings (system side)
- Power Drain Valve: Brass, ½" Full port with garden hose swivel connection
- Pump & Dump Valve: Brass, ½" Full port with garden hose swivel connection
- Fill Valve: Brass, ½" Full port with garden hose swivel connection
- Pump Case Drain Port Valves: (2) ¼", Brass
- PT Port: Located on return piping; allows pressure measurement during dead-head and power flushing
- Pump/Tank Connection: 2" flexible wire reinforced hose
- Sight Tube: Flexible with O-ring; allows fluid level monitoring during dead-head
- Additional hydronic accessories included: set of 1" CAM x 3/4" garden hose adapters, set of 1" MPT x Flo-Link double O-ring female adapters, and set of Flo-Link double O-ring x 1" CAM elbows.

Physical Data

Table 1 shows physical data for the flush cart.

Pump Data

The flush cart pump is a self-priming Munro LP series 1.5 HP pump, constructed of heavy-duty cast iron with a brass impeller. The motor is a heavy-duty cap start type. Two drain ports ensure complete drainage. Maximum case pressure is 150 psi. Connections are as follows: 2" suction, 1.5" discharge ports.

The Munro pump was selected based upon its ability to provide the high head and flow rates required for purging air from the ground loop, and to flush debris from hydronic systems. Figure 1 includes the performance curve.

Cart Assembly: 23" Wide x 48" Tall x 24" Deep  
Hoses: 10' long

ITEM	WEIGHT (lbs)
Flush Hoses	5 (each)
Flush Cart Assembly	158
Total	168
Shipping Weight*	247

Table 1: Physical Data

\*Includes pallet and packaging materials required for shipping.

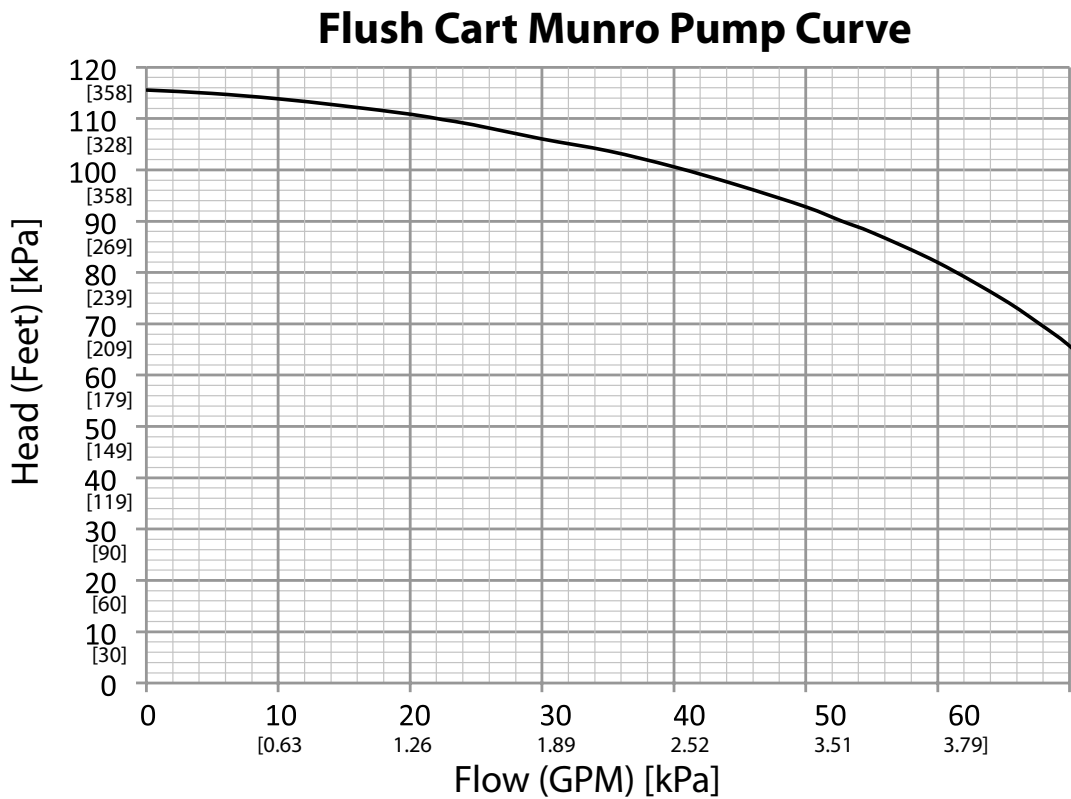


Figure 1: Munro LP Series performance curve

## Pump Motor Electrical Data / Safety Listing

Table 2 includes electrical data for the Munro flush cart pump. The Fernox flush cart includes an ETL safety listing for UL Standard 778. A UL listed flush cart is required in some U.S. states. Check local/state/provincial codes for compliance.

HP	Voltage	Hz/Phase	RPM	FLA
1.5	120 VAC	60/1	3450	11.03

**Table 2: Flush Cart Power Data**

## Flush Cart Safety Information



**WARNING:** RISK OF ELECTRIC SHOCK. THIS PUMP IS SUPPLIED WITH A GROUNDING CONDUCTOR AND GROUNDING-TYPE ATTACHMENT PLUG. TO REDUCE THE RISK OF ELECTRIC SHOCK, BE CERTAIN THAT IT IS CONNECTED ONLY TO A PROPERLY GROUNDED, GROUNDING-TYPE RECEPTACLE.



**WARNING:** ONLY USE PREMIXED ANTIFREEZE IN A NON-FLAMMABLE STATE. FAILURE TO OBSERVE SAFETY PRECAUTIONS MAY RESULT IN FIRE, INJURY, OR DEATH. ACCEPTABLE ANTIFREEZE SOLUTIONS INCLUDE ETHANOL, METHANOL, AND PROPYLENE GLYCOL. SEE SECTION ON ADDING ANTIFREEZE FOR MORE INFORMATION.



**WARNING:** NEVER HANDLE OR MIX METHANOL OR ETHANOL IN AN ENCLOSED SPACE. PURE METHANOL AND ETHANOL ARE EXTREMELY FLAMMABLE AND THE FUMES CAN IGNITE. EXTREME CARE MUST BE EXERCISED WHEN HANDLING THESE CHEMICALS. SEE SECTION ON ADDING ANTIFREEZE FOR MORE INFORMATION.

**CAUTION:** USE APPROPRIATE SAFETY DEVICES, INCLUDING EYE PROTECTION, WHEN HANDLING AND MIXING ANTIFREEZE SOLUTIONS.



**Figure 1: Flow regulator installed in 1-1/2" cam supply**

## Flow Limiting Device

This ETL listed flush cart is equipped with a removable flow regulator installed in the 1-1/2" supply cam fitting (see Figure 1) on the discharge of the pump. This flow regulator is intended to limit the starting amps to below 12 A to satisfy ETL requirements limiting amp draw for a device connected to a 15 amp circuit. Removing the flow regulator with a 3/8" square drive tool (such as a 3/8" drive socket wrench) will result in maximum performance of the pump as indicated by the pump performance curve. The same amp-limiting result can be achieved by closing the 1-1/2" supply valve prior to starting the pump, or by applying resistance to flow (head) such as when the flush cart is connected to a hydronic system during normal operation of the flush cart.



## Flush Cart Diagram



## Water Circulation

Water may be:

- Completely re-circulated around the system with no water being dumped
- Directed fully to drain so that no water is re-circulated
- Partially re-circulated and partially dumped to balance fill water

In the last case, the rate of dumping can be continuously varied to match the available fill water rate to balance the level of water in the tank of the Powerflow unit by limiting flow using the dump valve.

## Preliminary Checks on the System

### 1. Condition of the system

Identify symptoms that indicate whether the system is contaminated with sludge. i.e., cold radiators, cold spots on radiators, blockages in pipe work boiler noise. (We have enclosed technical data sheets that illustrate how sludge causes circulation problems within systems). A high iron concentration, dirty system water, or an acidic pH (measured using a Fernox Analysis Test Kit) may also indicate that the system needs cleaning.

It is important to note that the choice of Fernox cleaning agent you use should take into account the age and general condition of the system. Systems more than about 10 years old may be susceptible to leaks if acid cleaned and any system containing aluminum components should not be acid cleaned for more than four hours.

There are four options for system treatment:

- System condition is so bad that cleaning is impractical and replacement is the only viable option – replace system and clean with Fernox Cleaner F3.
- System is under 10 years old and requires vigorous cleaning to remove obstructions or deal with heavy scale deposits – use Fernox DS40 or DS3 and Neutralizer (Cleaner product is acidic)
- For all other conditions, including pre-commissioning of new systems, use Fernox Cleaner F3.

### 2. Boiler changes

In the event that a boiler upgrade is necessary but the existing boiler is still operational, Fernox recommends that power flushing is undertaken before replacement.

### 3. Before starting

Turn off all electrical controls and electrically isolate the system.

Ensure that all radiator wheel head and lock shield valves are fully open. Make a note of the position of lock shield valves (number of turns to open) so that the system balance can be reset after cleaning. Check that all thermostatic radiator valve (TRV) heads are either set to maximum, or removed and that all zone valves and three port valves are locked open.

Any anti-gravity valves should be bridged, by-passed or temporarily removed.

Cap off, or temporarily link together, the cold feed supply and open vent of open vented systems. If the system is fitted with a Primatic or similar single feed cylinder, the flow and return to the cylinder must be either capped or temporarily joined together. Thermal store cylinders must also be isolated prior to power flushing. No alterations are required for sealed pressurized systems.

Refer also to later section “Consideration of system design” for full details.



#### 4. Connections

Decide on the best position to locate and connect the Fernox Powerflow flushing pump to the system. This will vary depending on the system to be flushed and availability of suitable connection points.

The unit should be located within easy reach of a suitable drain, or waste, and near to a convenient mains cold water supply.

Always employ best practice protecting customer's property for wet works. Stand the Powerflow flushing pump on a waterproof sheet or in a tray during use.

Check the condition of all hoses and connections for damage prior to commencing every job.

#### Setup for Flushing

Connect the Fernox Powerflow flushing pump to the system:

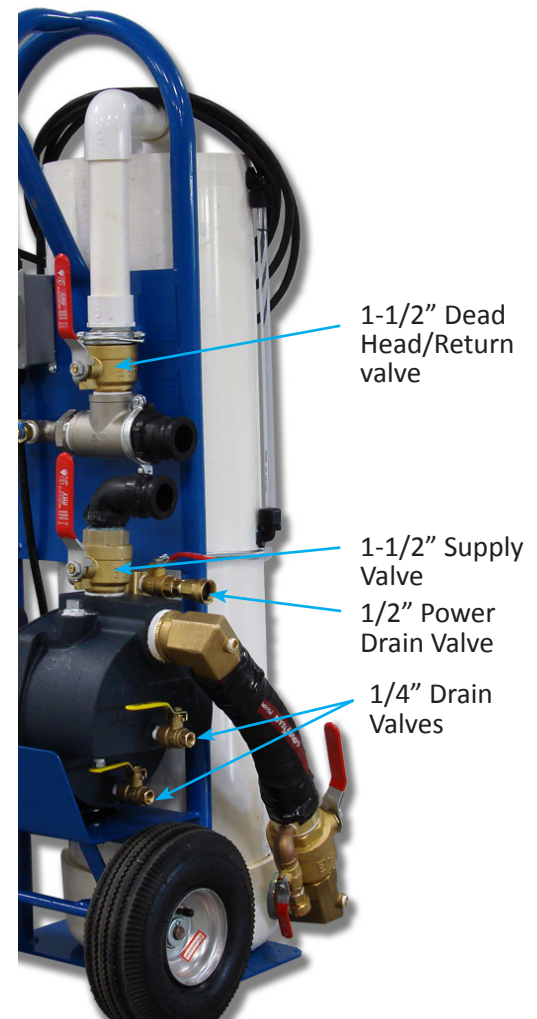
1. Using the brass cam-lock fittings attach a garden hose (Figure 2).
2. Connect to the system finding a supply and return connection to create a loop.
3. Connection to a boiler and individual zone drains help to isolate individual loops to be cleaned.
4. Adding a cleaner on a prior visit -- The following sequence of flushing can be applied to most installations where cleaner is added a few days prior to flushing:
  - a. Drain out any previous treatment and add Fernox cleaning agent (as per product instructions).
  - b. Circulate for the duration indicated in the cleaner instructions.
  - c. Connect the Powerflow flushing pump
  - d. Purge system (see next section) to remove cleaner.
  - e. Dynamic flush to remove sludge (see next section).
5. Cleaning with a single visit to site -- Where only one visit to site is to be made, the following procedure may be adopted:
  - a. Connect up Fernox Powerflow flushing pump
  - b. Purge system to remove previous treatment.
  - c. Add a Fernox cleaning agent (as per product instructions) and circulate hot for at least one hour.
  - d. Purge again to remove cleaner.
  - e. Dynamic flush to remove sludge.
  - f. Empty the tank and disconnect the Powerflow flushing pump.
  - g. Re-fill the system.
  - h. Add Fernox Protector F1.



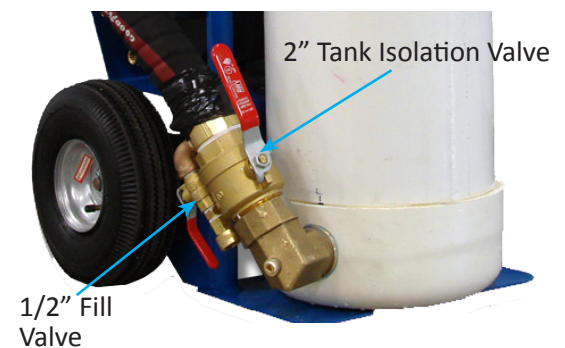
**Figure 2: Connections from flush cart hoses to garden hose**

## General Pump Operation

1. Attach garden/utility hose to 1/2" fill valve (Figure 4). Attach other end of hose to acceptable municipal water supply.
2. Ensure that the bag filter is in place on the return PVC pipe. Fernox recommends looping the filter bag strap over the top of the return piping.
3. Close 2" tank isolation valve (Figure 4) and open the 1-1/2" dead-head valve (Figure 3). Open 1/2" fill valve (Figure 4) and allow the loop to fill. Watch the fluid level in the tank via the sight tube. When the tank is nearly full, shut off the 1/2" fill valve and 1-1/2" supply valve (Figure 3).
4. Open the 2" tank isolation valve (Figure 4) and energize the pump. Slowly open the 1-1/2" supply valve (Figure 3) approximately 1/4 to 1/2 open. Air and debris will be pushed through the return piping. Debris will be captured in the bag filter and air will be released to the atmosphere.
5. Regulate the fluid level in the tank with the 1/2" fill valve (Figure 4) and the 1-1/2" supply valve (Figure 3) while the pump is running. Do not allow the fluid in the tank to drop too low or air will be pushed back into the loop extending flushing time.
6. When the fluid level remains relatively stable ensure that the 1-1/2" supply valve (Figure 3) is fully open.
7. While the pump is running, "dead-head" the pump by turning off the dead-head/return valve (Figure 3). Then, quickly reopen the valve allowing the fluid to return to the tank. This process drives the loop pressure up thereby compressing any air remaining in the loop. Quickly opening the valve creates a sudden high velocity surge that helps dislodge air into the fluid stream where it can be returned to the tank.
8. Repeat the dead-head process 2-3 times over a period of 15 minutes. If necessary, add more fluid to the tank so the fluid level is visible in the sight tube.
9. With the pump continuing to run, mark the fluid level in the tank with the O-ring on the sight tube.
10. Close the 1-1/2" dead-head valve (Figure 3) while watching the fluid level in the sight tube. The fluid should not drop more than about 3/8" to 3/4" on a typical residential system.
11. Open the 1-1/2" dead-head valve (Figure 3) and allow the fluid to continue to circulate.



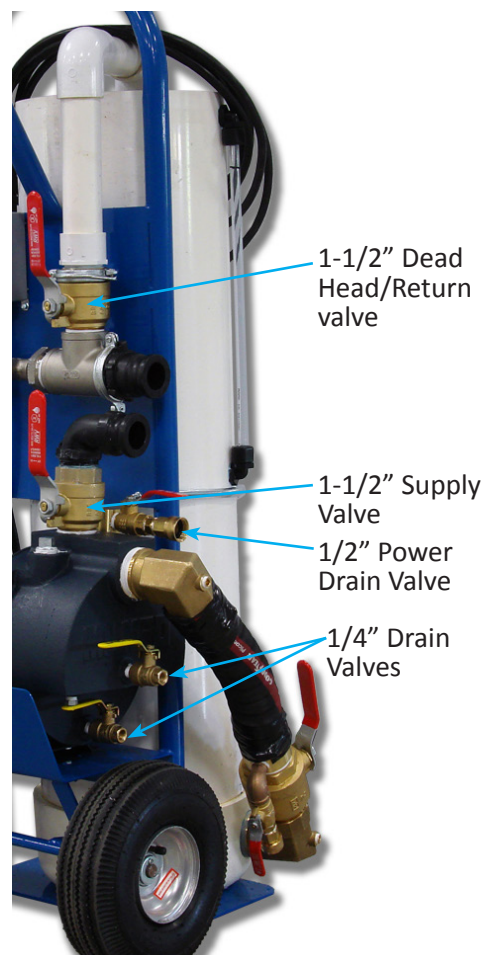
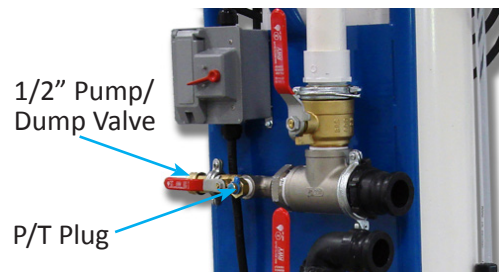
**Figure 3: Flush Cart Valves in flushing steps**



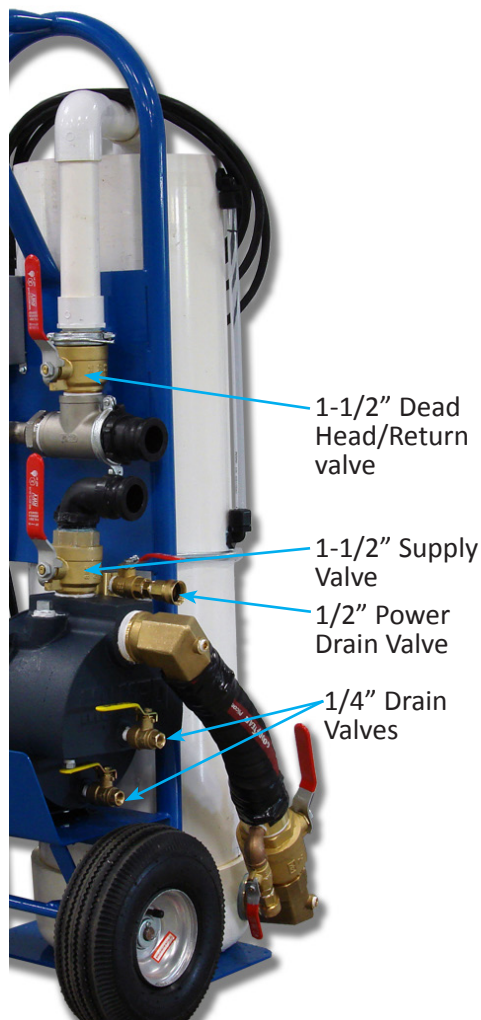
**Figure 4: Fill Valve/Tank Isolation Valve**

## Flushing and Dumping

1. Attach a hose to the 1/2" pump & dump valve (Figure 5). Direct the opposite end of the hose to an appropriate drain.
2. Open the 1-1/2" supply valve (Figure 5).
3. Close the 1-1/2" dead head valve (Figure 5). This prevents fluid from returning to the tank.
4. Slightly open the 1/2" pump & dump valve (Figure 5).
5. Slightly open the 1/2" fill valve (Figure 4).
6. Energize the pump. The water from the tank/loop is pumped to the drain. Closely monitor the fluid level in the tank as water is being fed into the tank, water from the system is being dumped. Continue flushing until the water being dumped is clear. A TDS reading of the fill water compared to the dump will verify that all of the cleaner is out of the system.



**Figure 5: Flush Cart Valves in adding antifreeze steps**



**Figure 6: Flush Cart Valves in emptying the tank**

## Emptying the Tank

After the flushing/purging procedure is complete, fluid will remain in the flush cart. This fluid must be disposed of in an environmentally friendly way and must follow state/provincial and local codes.

1. Connect a garden or transfer hose to the 1/2" power drain valve (Figure 6) on the pump. Direct the other end of the hose to an appropriate disposal area or storage tank.
2. Close the 1-1/2" supply valve (Figure 6).
3. Open the 1/2" power drain valve (Figure 6).
4. Energize the pump until nearly all fluid is emptied from the tank.
5. Any remaining fluid in the tank can be removed by carefully tipping the cart on its side.

## Maintenance

After each use, thoroughly clean the bag filter and tank with clean water. Be sure that all debris is cleaned from the tank and hoses. Drain all water from the tank and pump. Open both 1/4" drain valves (Figure 6) on the pump to ensure that all fluid has exited the pump housing. Failure to complete this step could result in the pump housing cracking if the fluid inside freezes.

The flexible sight tube can be replaced by loosening the two compression nuts and removing the tube. This may be necessary if the tube becomes badly stained. Be sure to reinstall the O-ring marker if the site tube is replaced.

## Power Flushing Process in Detail

There are several methods that can be employed to flush systems. The most appropriate method is often dependent on the characteristics of the system being flushed. A combination of the techniques listed below is usually employed.

### 1. Purging - used to remove old system water and cleaners

- Purging introduces fresh water and pumps it through the entire system. The system is kept filled during purging and virtually no water is re-circulated back to the Powerflow flushing pump after passing through the radiators.
- Purging is used to rapidly remove old inhibitor and cleaning agents but is not so effective at removing sludge (see Dynamic Balanced Flushing). It should be carried out prior to a dynamic flush.
- During the purging procedure all control valves the system should be fully open and the dump must be discharged to foul drain.

Turn on the Powerflow flushing pump and open the mains water inlet valve fully. At the same time, open the dump valve and adjust to maintain a constant level of water in the tank. If the water level cannot be maintained with the mains water full on, reduce the dump rate by partially closing the dump valve. If the water level rises, reduce the mains water inlet rate. Try to avoid running the water level right down to empty because if circulation is broken, then the pump will need to be turned off momentarily to re-commence pumping.

Monitor the discharge at the drain and continue purging until the water runs clean. Use a Fernox TDS meter to check the cleanliness of the rinse water.

At the end of the process, close the dump and mains valves. Circulate, top-up with water and vent as necessary to refill the system.

### 2. Cleaning with Fernox Cleaner F3 and Fernox Cleaner F5

Fernox Cleaner F3 or Fernox Cleaner F5 may either be added a few days before flushing, or circulated on the day of the flush for a minimum 4 hours.

If cleaning on the day of the flush, begin with the Powerflow flushing pump connected. Purge the system of previous treatments before adding the cleaner. Open the system flow/ return connections and circulate.

Circulate the cleaning agent with all radiators and zone valves fully open at this stage.

After circulation, purge and then dynamically flush to remove the cleaner and sludge.

Use of a Fernox TDS meter to monitor the condition of the water going to drain during dynamic flushing will reduce time on site and ensuring that a thorough job is done.

### 3. Dynamic balanced flushing - the prime means of sludge removal

- Dynamic balanced flushing differs from purging only in that it maintains maximum flow through one specific part of the system at a time. An example would be a zone of radiant tubing.
- This is the most effective method for removing corrosion sludge after cleaning as it maintains a high circulation velocity to keep sludge in suspension.



Shut off all except one of the zones in the system. With the system filled and the Powerflow pump running, circulate. Slightly open both the dump valve and the mains inlet valve. The dump must be discharged to foul drain. Gradually open the dump valve further, balancing the water lost by increasing the flow from the mains inlet as for the Purging procedure. Aim for the maximum discharge rate that can be made up by the mains supply available. Continue to circulate with the pump throughout the flushing process. Try to avoid running the water level right down to empty because if circulation is broken, then the pump will need to be turned off momentarily to re-commence pumping.

Monitor the discharge at the drain and continue flushing until the discharge water runs clear. This will probably take 3-5 minutes. Then check with a TDS meter. At this point you will close that zone and move on to the next one.

4. Repeat the Dynamic flushing process for all radiators, zones and other parts of the system. Parts of the system further from the boiler will require longer flushing times.

After dynamically flushing the final zone, open all values and continue to flush the whole system until the Fernox TDS meter indicates that the water is free of dissolved contaminants.

5. Adding inhibitor and leaving the system

After disconnecting the Fernox Powerflow flushing pump and re-commissioning the system, the system may need to be re-balanced. Once satisfactory operation is achieved, the system should be dosed with Fernox Protector F1 or Fernox Alphi 11 inhibited antifreeze.

Re-set controls and test run the system.

## Power Flushing Consideration of System Design

### Pipe work and system design

The maximum flow rate through a pipe at a given starting pressure varies depending on its diameter and resistance due to its length. Where flow checks have been installed to, these will need to be removed if reverse flushing is to be achieved. Otherwise flush only in the normal flow direction.

Microbore piping reduces overall flow rates significantly, so particular care will be needed to ensure that all parts of a microbore system are adequately flushed.

Single pipe systems may also be flushed using the Fernox Powerflow flushing pump but the results may be less satisfactory than with two-pipe construction. Greater reliance needs to be placed on the effectiveness of any cleaning agent used to ensure a reasonable end result.

Under floor heating systems can be cleaned very effectively by dynamic balanced flushing. Use this method on each individual pipe run in turn, isolating the remaining pipe runs at the manifold. Ensure that the under floor circuit does not exceed the design temperature because this could distort the floor surface.



## De-scaling

### Principles of boiler/heat-exchanger de-scaling with Fernox DS40 or DS-3

Scale is deposited by the action of heat. It can be re-dissolved with acid de-scaling agents giving off gas as a by-product of the reaction. The gas produced during de-scaling is carbon dioxide and is a non-toxic. Gas is produced in the form of bubbles that may be observed in the Powerflow tank. When gassing ceases, this is a good indication that either: the de-scaling agent is exhausted, in which case more de-scaler will be required; or the boiler is clean and all the lime scale has been dissolved.

Fernox DS-40 and DS-3 contain a pH indicator that changes color when the product is exhausted. This gives a further indication of the progress of the cleaning operation and to aid neutralization with Fernox System Neutralizer.

#### Method statement

1. It is NOT normally necessary to remove the boiler/heat-exchanger in order to carry out de-scaling.
2. Determine the location of the inlet from the boiler/heat-exchanger. Disconnect the inlet and outlet from the boiler/heat-exchanger. The residual water in the adjacent pipe work will need to be drained at this point.
3. Fit up the main flow and return hoses on the Powerflow unit with appropriate size adapter fittings as required. The mains fill and dump assemblies are used only to neutralise and rinse out the appliance after de-scaling. Test Flow and Return pipes for fit to boiler before final assembly.
4. Connect the Powerflow to the boiler. Make note of the supply and return hoses from the machine, making sure they are in the correct alignment.
5. Fill the Powerflow with water to midway of the tank, then add roughly 4 lbs of Fernox either DS-40 or DS-3 de-scaling agent.
6. Begin circulating the solution. De-scaling a boiler/heat-exchanger will take approximately 1-2 hours, depending on the severity of scaling.
7. When satisfied that the boiler is clean, add approximately 1.5kg (3.3 lbs) of Fernox System Neutralizer, or add until the color of the solution turns a pale yellow or greenish-blue. Dynamically flush the heat exchanger/boiler until the water runs clear. Turn off the Powerflow, allowing any residual water in the boiler/heat-exchanger to drain back into the unit.
8. Empty the tank, disconnect the Powerflow and refit boiler/heat-exchanger connections.

## Specific De-scaling Applications

### 1. Secondary hot water heat- exchangers in combination boilers

The method statement described in section (1) should be followed. The heat exchanger can be cleaned with the boiler in situ. Disconnect the cold water inlet and hot water outlet from the combination boiler and connect on the Powerflow.

It is particularly important to rinse the boiler after cleaning.



### 2. Primary side of central heating boilers (Boiler only)

The primary central heating side of a domestic boiler is susceptible to fouling both from lime scale deposition in hard water areas and from baked on corrosion sludge. Both these deposits form a hard rock-like scale that cannot be flushed out by pressure or water flow alone. Scaling is one of the primary causes of boiler noise and fuel wastage.

Sludge (black or red) is formed by the corrosion of steel radiators and cast iron boilers. Corrosion debris will either be dissolved directly by the de-scaling agent or released as loose sludge that can be flushed out when any lime scale that is present is dissolved.

Lime scale is deposited by the action of heat. It can be re-dissolved with acid de-scaling agents giving off gas as a by-product of the reaction.

Again, the method statement described can be used to de-scale boilers and remove the contaminants that lead to noise.

# Manual Updates Table

Date	Description of Changes	Pages
02MAY2017	First published	All



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