TECHNICAL NOTE 15-01
WATER RESTRAINT SYSTEM
Maintenance Procedure for
Danfoss Pilot valves
December 27, 2001

Introduction

This technical note provides instructions for servicing Danfoss pilot valves of the Water Restraint System (WRS). Pilot valves can be affected by buildup of water-borne rust and particulates. Faulty pilot valves can dramatically affect operation of the primary WRS water valves. Faulty pilot valves can cause erratic or inoperative cannon operation such as reduced shot volume or unstoppable water flow.

There are two primary water valves used to control water pressure and to direct the flow of water within the WRS. The two valves are Bermad, Inc. 700 Series Control Valves. Each Bermad is controlled by two Danfoss pilot valves.

One of the Bermad valves is used to bypass water from the outlet of the water pump back into the water tank. The other Bermad valve is used to control water flow into the WRS cannon subassembly. Used in combination these two valves provide control for issuing either a high-pressure or low-pressure water stream at the WRS cannon nozzle.

The primary valves are actuated by applying or relieving pressure on an internal diaphragm of the valve assembly. Diaphragm pressure is applied or relieved by a set of Danfoss A/S pilot valves that are actuated by way of 24-vdc electrical solenoids. See Photos 1 and 2 below.

Photo 1. Danfoss Pilot Valves, Lower Bermad

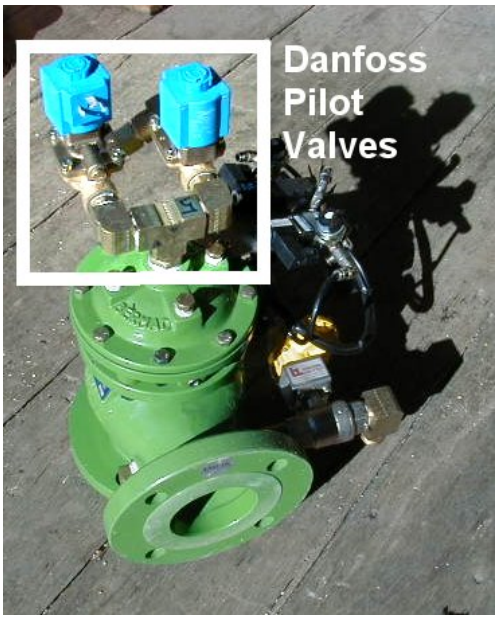

Photo 2. Danfoss Pilot Valves, Upper Bermad

One pilot valve of each set is configured as a normally/open valve while the other valve of each set is configured as a normally/closed valve. Valve configuration depends on the type of solenoid installed on the Danfoss valve body.

Photo 3 below shows an easily noted difference between the two pilot valves. The normally/open pilot valve has a longer solenoid plunger that can be readily identified by the bushing placed under the solenoid-coil lock nut.

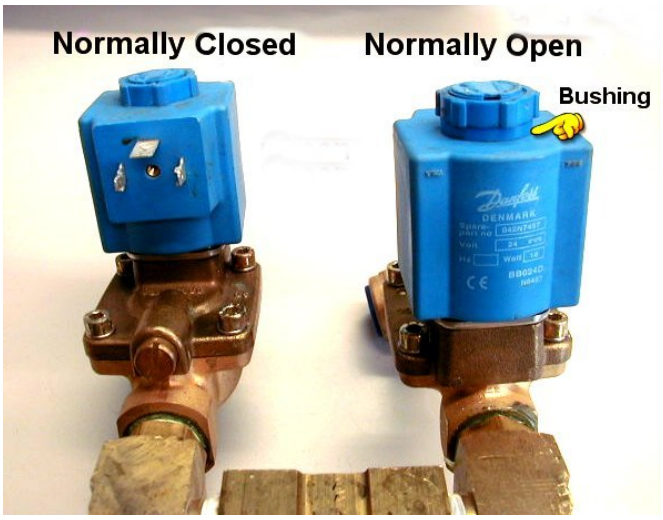

Photo 3. Valve Solenoids, Upper Bermad

For an upper Bermad Photo 4 below shows that the normally/open pilot valve is installed with the flow-direction arrow cast into the body of the Danfoss valve oriented for water flow toward the controlled Bermad diaphragm.

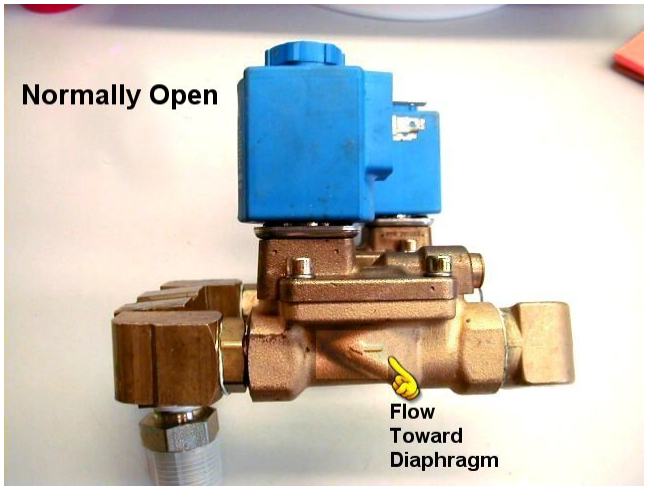

Photo 4. Flow Toward Upper Bermad – Danfoss Normally Open

The normally/closed pilot valve has a shorter solenoid plunger and a flow arrow that is oriented for venting the controlled Bermad diaphragm. See Photo 5 below.

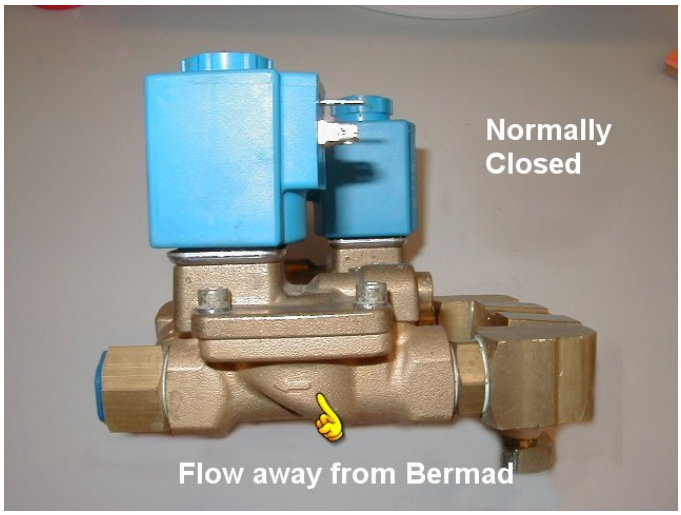

Photo 5. Flow Away From Upper Bermad – Danfoss Normally Closed

Installation of the Danfoss valves on the lower Bermad is opposite from the upper Bermad. For the lower Bermad the normally/closed Danfoss valve provides flow into the Bermad diaphragm and the normally/open valve vents the diaphragm.

Both sets of Danfoss solenoids are wired in parallel and each set is controlled in tandem by a dedicated control signal. The control signal for the upper Danfoss valves is initiated from the joystick firing-button of the Operator Control Panel.

The control signal for the lower Bermad valve is initiated from the Water Pressure switch of the Operator Control Panel.

Operational control events for an **upper Bermad valve** are as follows:

a. If no control-voltage is present on the solenoids the normally/open Danfoss valve passes water through to the upper Bermad diaphragm and the normally/closed Danfoss valve blocks the diaphragm from venting into a water-return line that leads to the WRS water tank. Water pressure applied to the diaphragm locks the upper Bermad valve in closed position to prevent water flow through the WRS nozzle assembly.

b. If 24-vdc is applied to the upper Danfoss valves then the normally/open Danfoss valve closes to block water flow into the upper Bermad diaphragm chamber, and the normally/closed Danfoss valve opens to vent the diaphragm chamber. Under this condition the upper Bermad valve is free to open if water-line pressure is high enough to overcome a small preload level of about 7-psi. With the upper Bermad valve in opened condition the WRS water pump supplies water at about 165-psi to the WRS nozzle assembly.

Operational control events for a **lower Bermad valve** are as follows:

a. If no control-voltage is present on the solenoids the normally/closed Danfoss valve blocks water from the controlled Bermad diaphragm and the normally/open Danfoss valve vents the diaphragm into a water-return line that leads to the WRS water tank. Under this condition the lower Bermad valve is free to open if water-line pressure is high enough to overcome a small preload level of about 5-psi. With the lower Bermad valve opened water is taken from the WRS water pump outlet and returned to the water tank.

b. If 24-vdc is applied to the lower Danfoss valves then the normally/closed Danfoss valve opens to allow water flow into the lower Bermad diaphragm chamber and the normally/open Danfoss valve closes to seal the lower diaphragm chamber. Water pressure applied to the diaphragm locks the lower Bermad valve in closed position to prevent water flow back into the WRS water tank.

From a systematic point of view the 24-vdc Danfoss control signal for the upper Bermad valve is initiated by pressing the joystick firing-button at the Operator Control Box. Note that the firing button is interlocked to prevent firing during the WRS water-pump startup period.

The 24-vdc Danfoss control signal for the lower Bermad valve is activated by selecting either Water Pressure High or Low at the WRS Operator Control Box.

Maintenance

Over time Danfoss valves accumulate rust deposits and particulate matter even though screen filters are provided. Accumulation can reach a point that will interfere with Bermad valve operation. Fault conditions include:

- Holding the Bermad valve open for unintended continuous cannon firing.
- Restricting the Bermad valve opening causing reduced flow through the water cannon.

Photos 6, 7, and 8 below show examples of deposits within faulty Danfoss valves.

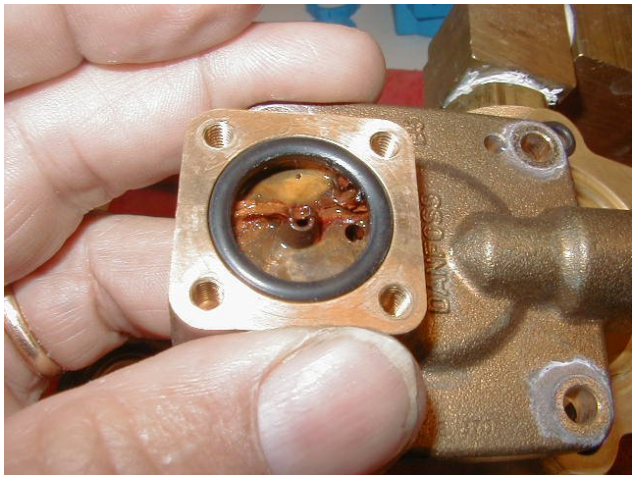

Photo 6. Control Chamber Deposits

Photo 7. Solenoid Plunger Deposits

Photo 8. Valve Needle Deposits

Maintenance of Danfoss valves amounts to disassembling a faulty valve, cleaning out deposits using rotary brass brushes, and replacing damaged or worn parts. Refer to Photo 9 below for relationship of valve parts.

a. Unscrew and remove the valve-needle for cleaning. After cleaning reinstall the needle valve and retest for proper WRS system operation. If that fails –

b. Unscrew the solenoid lock nut and remove the valve solenoid.

c. Remove four slotted fasteners and remove the solenoid plunger housing. Set aside the control chamber O-Ring. Clean the solenoid plunger and the valve control chamber using a rotary brass brush.

d. Remove the four Allen-Head fasteners that secure the valve cover to the valve body.

e. Remove the valve cover and set aside the valve spring and diaphragm. Remove deposits from the valve cover and valve body using a rotary brass brush. Inspect and clean the screen filter that can be seen inside the valve-inlet fitting.

f. Inspect and determine condition of valve O-Rings and diaphragm. Replace worn or damaged items.

g. Reassemble the valve and retest for proper operation.

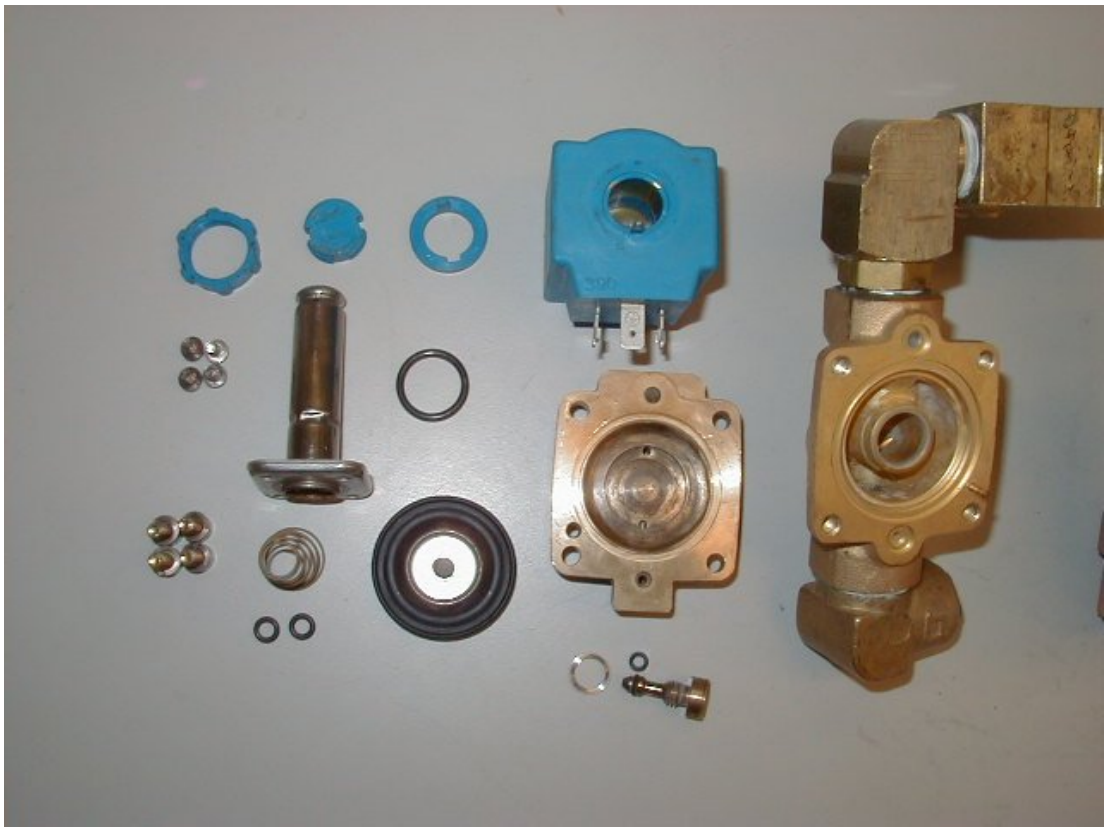

Photo 9. Danfoss Valve Parts

Logistic Support

For replacement parts and further technical assistance call the Hydro-Force office on (619) 478-2600 voice or (619) 478-2555 facsimile.