

Theory of Operations

This section describes the overall operation of the InkCenter™ Refill System and the processes within each of the system's major components. Information is organized into the following topics:

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1.1 System Overview

This section contains an overview of the Retail Inkjet Solutions InkCenter™ refill system. It includes brief descriptions of major system components and outlines the operation of each subsystem.

1.1.1 System Components

The Retail Inkjet Solutions (RIS) InkCenter refill system is a self-contained, integrated system for refilling inkjet cartridges. The system consists of the following components:..

Adapters

The system employs two sets of adapters. Refill adapters are used in the drill, prep, and fill stages of the process. Test adapters are used in the final testing stage.

Drill Station

The drill station contains a drill press used to drill holes into inkjet cartridges. The electrical drill is controlled by the computer system and by a microswitch attached to the slide mechanism.

Prep Station

The prep station empties residual ink from the cartridge and cleans the printhead in preparation for refilling. This station employs vacuum lines to remove ink from the cartridge, cleaning solution, an optical sensor board that monitors the process, and a reed sensor that detects the presence of an adapter in the station.

Fill Station

The fill station fills the cartridge with ink in a sealed vacuum chamber. This station employs a vacuum line to take a vacuum on, and vent the chamber, proximity sensors that indicate when the injectors are seated in the holster, a reed sensor that detects the presence of an adapter, an RFID tag reader that identifies the adapter type, and dispense lines that convey ink to and from the fill chamber.

Tester Station

This station electrically checks the TSR (thermal sense resistor) circuit in the cartridge, and confirms cartridge quality by printing a test pattern on a strip of paper.

System Computer

A single board computer with a touchscreen LCD interface controls and monitors all system functions.

Maintenance Drawer

The lower left drawer of the system contains cleaning fluid, a waste container, and a clean-up vacuum wand.

Ink Drawers

The remaining four lower drawers contain ink. Each drawer contains up to seven ink reservoirs, except the black drawer which contains six, and each is dedicated to a different color. A long circuit board attached to the top of each ink drawer connects to a float sensor in each ink nest. The board indicates the ink levels in the nests via an LED.

Top Drawers

The left drawer contains refill adapters, the right drawer contains test adapters, and the center drawer contains the HP 02 vent covers, and space for storage of gloves and miscellaneous supplies.

Table 1.1 outlines the operation of the refill process. For detailed instructions on system operation, see *Using the RIS Inkjet Refill Center*.

1.1.2 Inkjet Cartridge Theory

The system RIS InkCenter Refill System fills three types of inkjet cartridges:

- HP 15/45 cartridges
- Integrated print head cartridges (Currently HP, Lexmark, Dell, and Canon)
- Ink tanks

The first two types of cartridges use the same process for printing. The cartridge contains the print head, which is fired by super-heating a resistor that creates a bubble. This bubble forces the ink out through the printing nozzles. Most cartridges have several hundred nozzles. It is important that when any color runs out that printing is stopped. If printing continues without ink to cool the resistors, the cartridge will be permanently damaged. These cartridges have small vent holes on the top that allow air to enter so that the ink can flow out. When filling a cartridge, these vent holes cannot be covered.

The third type of cartridge is only an ink tank, and does not have a print head integrated into the cartridge. In systems that use this type of cartridge, the print head is part of the printer and is not removed.

HP 15/45 cartridges use a spring-loaded bag device. As the ink is depleted, the spring causes the bag to deflate until the cartridge is empty. That is why these cartridges can be filled through the print head and it is not necessary to pull a vacuum in order to get a complete fill.

Integrated print head cartridges and tanks use foam inserts in the cartridge that absorb the ink. This facilitates an even flow of ink through the cartridge. In order to get a complete fill of the cartridge, it must be filled in a vacuum. No air can be in the cartridge or it will not be able to be filled to 100% capacity.

It is important that the electrical contacts on the cartridges be clean and free from damage for the cartridge to perform properly. All integrated print head cartridges must pass a pre-screening test before they can be filled.

1.1.3 Operational Overview

The following table provides an overview of the refill process.

Table 1.1:InkCenter Refill Process

Station	Process
Drill Station	<ol style="list-style-type: none"> 1 The operator inspects the cartridge to be sure it is supported by the system and capable of being refilled. 2 The operator places the cartridge into an appropriate refill adapter and moves the drill flap into position. 3 The operator lines up the drill bit with the appropriate drill bushings in the adapter and drills into the cartridge.
Prep Station	<ol style="list-style-type: none"> 1 The operator moves the fill and prep flap into position on the adapter and inserts the adapter into the prep station. 2 The system automatically empties any remaining ink from the cartridge and cleans the printhead. 3 The operator removes the adapter from the prep station and wipes off any excess ink.
Fill Station	<ol style="list-style-type: none"> 1 The operator moves the prep flap into position behind the adapter and inserts the adapter into the fill station. 2 The operator selects the appropriate cartridge on the touchscreen and inserts the appropriate color-coded injectors into the cartridge. 3 The operator closes the fill station door. 4 The system automatically runs the fill process, creating a vacuum in the chamber and injecting ink into the cartridge. 5 The operator removes the adapter and cartridge from the station, removes the cartridge from the adapter, and wipes away any excess ink.
Tester Station	<ol style="list-style-type: none"> 1 The operator inserts the cartridge into an appropriate test adapter and inserts the adapter into the tester station. 2 The operator selects the appropriate cartridge on the touchscreen and the system prints a pattern of stair-step grids and blackout plots. 3 The operator evaluates the printout to be sure the cartridge is functioning properly.

1.2 Drill Station

The drill station consists of a lever activated drill press used to drill holes into cartridges through which the refill ink is injected.

1.2.1 Overview of Drill Operation

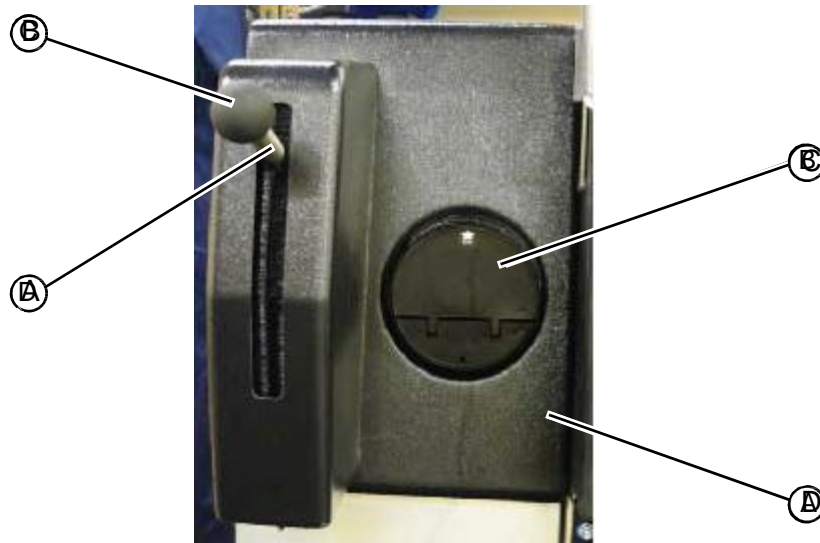
The drill station is activated when an operator logs on to the system. The I/O board supplies +24 Vdc to the drill motor and +5 Vdc to a microswitch attached to the drill slide mount.

An operator inserts a cartridge into an appropriate refill adapter and aligns the retractable guide on the drill bit assembly with the appropriate concave drill bushing located on the drill flap of the refill adapter.

When the operator pulls down on the drill press lever, the microswitch activates and sends a signal to the control system. If a user is logged on and the station is not disabled, the control system supplies power to the drill motor, causing it to rotate the drill bit. When the operator releases pressure on the lever spring and allows the lever to return to up position, the microswitch opens and the control system turns off power to the motor.

1.2.2 Drill Station Components

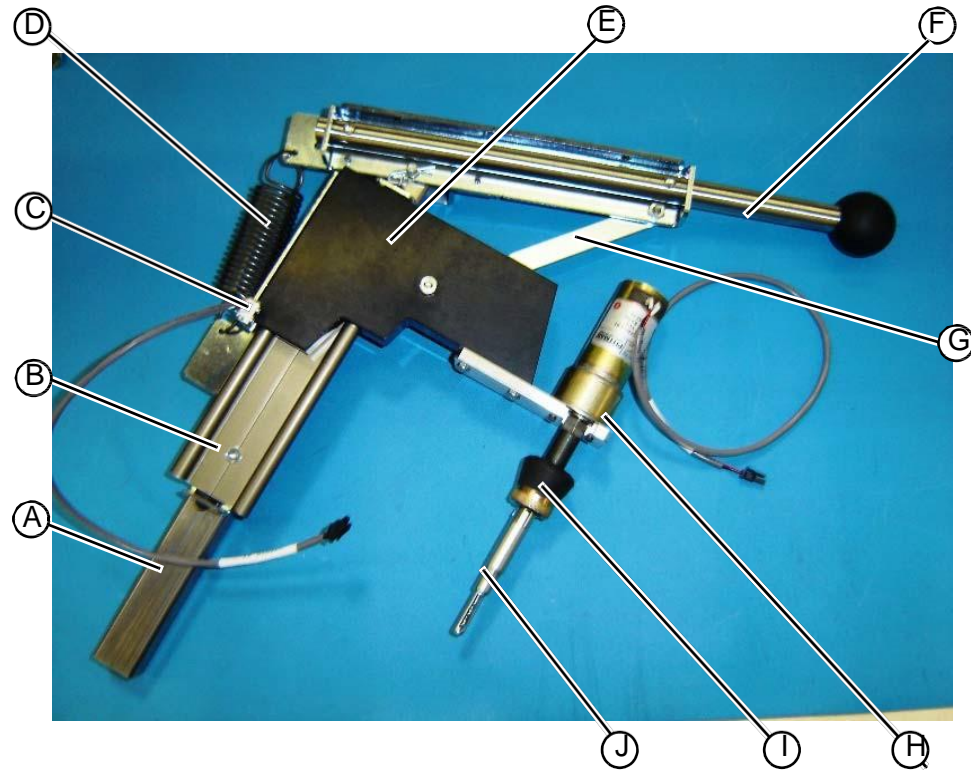
Figure 1.1: Drill side fascia



Callout	Component
A	Drill lever arm
B	Drill ball knob
C	Towel wipes container
D	Drill side fascia

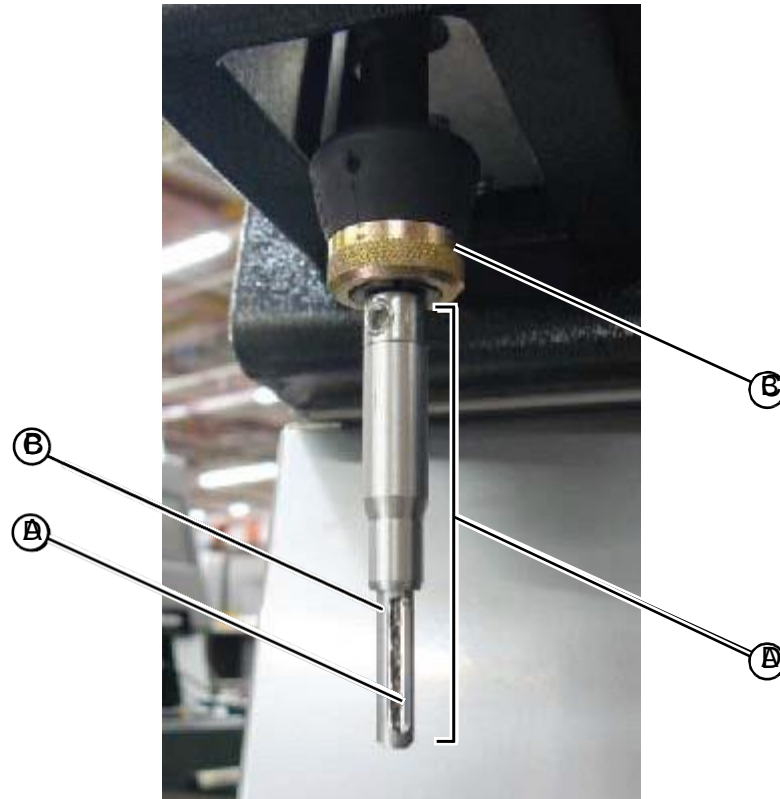
Figure 1.1: Drill bit assembly is a sheet metal and plastic fascia located in the front, upper left section of the system. The fascia is secured to the system with a single fastener and four mounting hooks that fit into corresponding slots in the system frame.

Figure 1.2: Drill press assembly



Callout	Component
A	Drill post
B	Drill slide
C	Microswitch
D	Drill spring
E	Drill slide mount bracket assembly
F	Drill lever arm
G	Drill arm linkage
H	Drill motor assembly
I	Quick release drill chuck
J	Drill bit assembly

Figure 1.3: Drill bit assembly



Callout	Component
A	Drill bit (7/64")
B	Retractable drill bit guide
C	Quick release drill chuck
D	Drill bit assembly

The drill bit assembly features a spring loaded, retractable drill bit guide that fits into hole markers located on the refill adapters. As the operator moves the drill lever down, the guide retracts up into the drill bit barrel. When the drill press moves back into the up position, the guide springs back down over the drill bit.

The drill bit assembly snaps up into the keyless chuck. To release the drill bit assembly, the operator pushes up on the chuck.

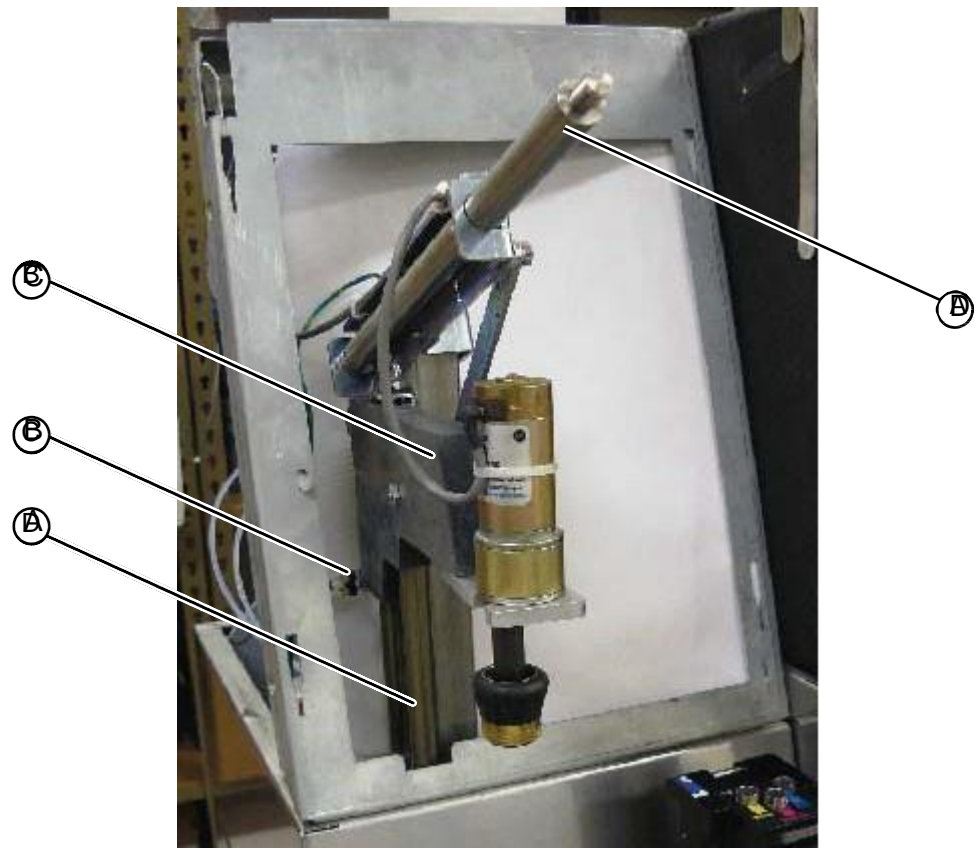
Figure 1.4 Drill slide mount assembly



Callout	Component
A	Motor mount plate
B	Drill slide mount bracket assembly
C	+24 Vdc cable
D	Drill motor
E	Quick release drill chuck

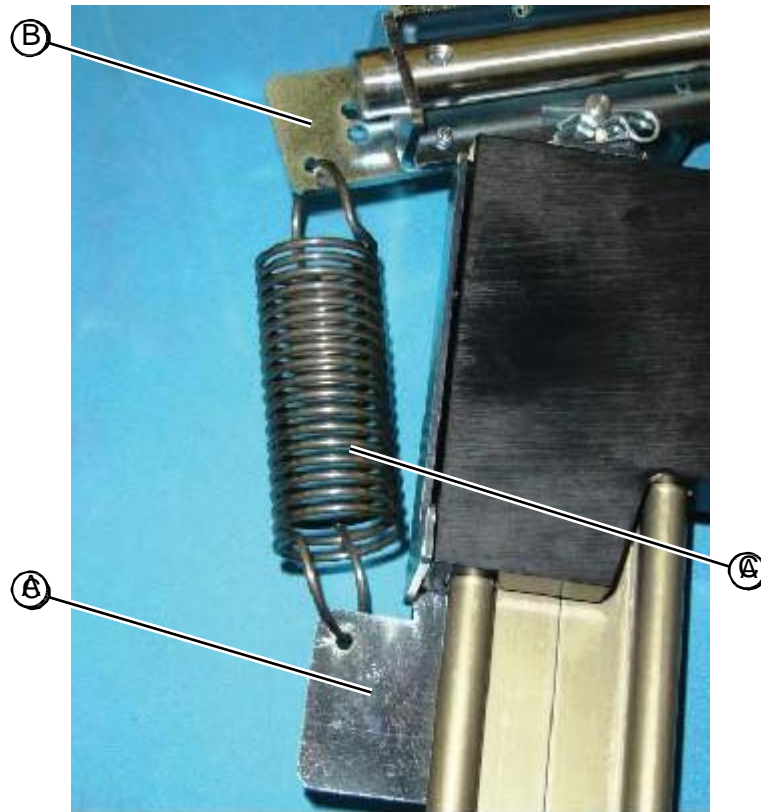
The drill motor assembly is secured to the drill slide mount bracket with two 8-32X1/8 T-20 torx fasteners.

Figure 1.5 Drill slide mount assembly



Callout	Component
A	Drill slide
B	Microswitch
C	Drill slide mount bracket assembly
D	Drill lever assembly

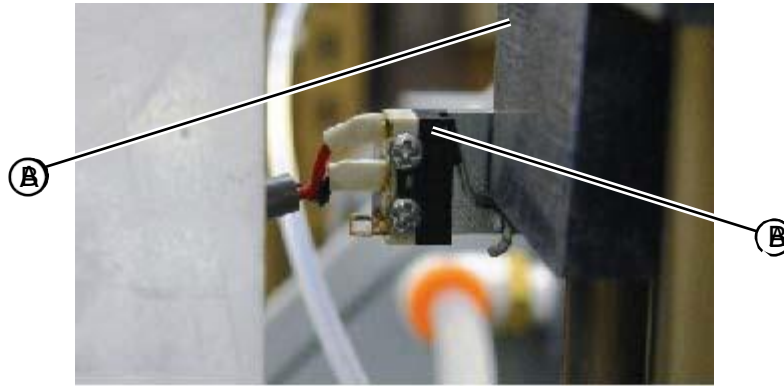
Figure 1.10Drill microswitch



Callout	Component
A	Drill slide mount bracket
B	Drill lever arm
C	Drill spring

When the operator pulls down on the drill press lever, the microswitch activates and sends a signal to the control system. If a user is logged on and the station is not disabled, the control system supplies power to the drill motor, causing it to rotate the drill bit. When the operator releases pressure on the lever spring and allows the lever to return to up position, the microswitch opens and the control system turns off power to the motor.

Figure 1.11 Drill microswitch



Callout	Component
A	Drill slide mount bracket
B	Drill microswitch

RELATED LINKS:

- “Drill Side Fascia” on page 5-5
- “Drill Motor Assembly” on page 5-28
- “Drill Press Assembly” on page 5-31

1.3 Prep Station

The prep station removes ink remaining in the inkjet cartridge and cleans the printhead.

1.3.1 Overview of Prep Station Operation

The operator moves the prep flap on the refill adapter into position on the bottom of the adapter. This brings a seal on the prep flap into contact around the cartridge printhead. The operator hooks the front adapter bar onto the prep station hooks, and snaps the back of the adapter down into a spring latch on the station. In this position, the bottom of the prep flap is pressed against a seal on the prep station.

A reed sensor detects the presence of a magnet in the refill adapter prep flap and automatically launches the prep station procedure. A vacuum line removes residual ink from the cartridge. The system pumps cleaning fluid into the station to wash the cartridge printhead and drains the fluid out through the vacuum line. A solenoid-controlled vent port helps sweep residual ink and fluid away from the printhead and out of the tubing during the rinse process.

A thru-beam sensor monitors the ink in the vacuum line and signals the process to conduct a final cleaning. The system prompts the operator to remove the refill adapter from the prep station.

1.3.2 Prep Station Components

The InkCenter refill system is available with either one or two prep stations. In systems with two prep stations, the station closest to the back of the unit is Station A and the one closest to the front of the unit is Station B. The stations are complete, independent units that can operate simultaneously.

Figure 1.8:Dual prep station configuration

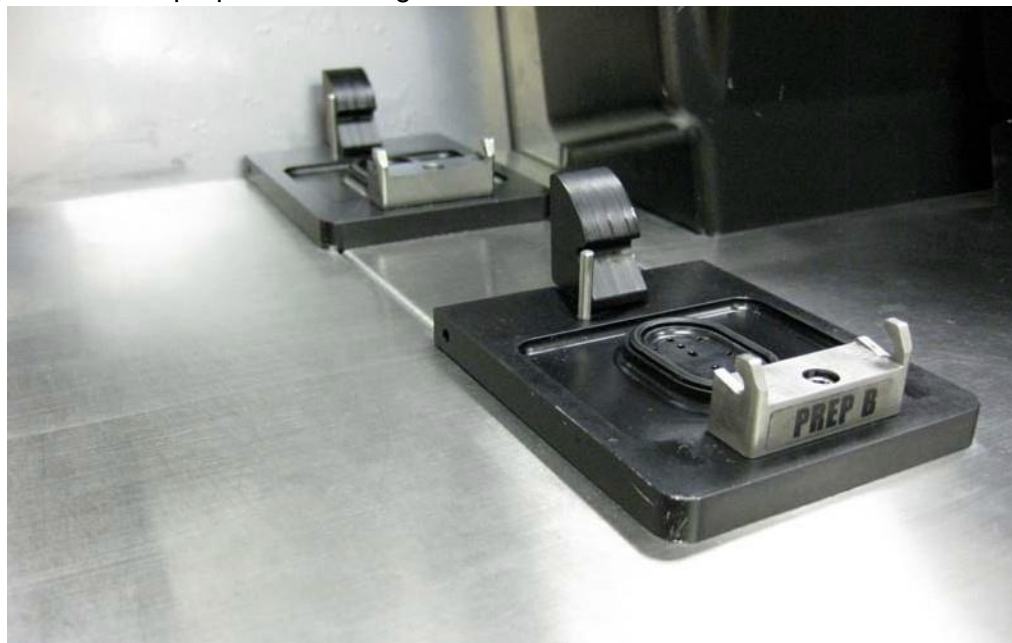
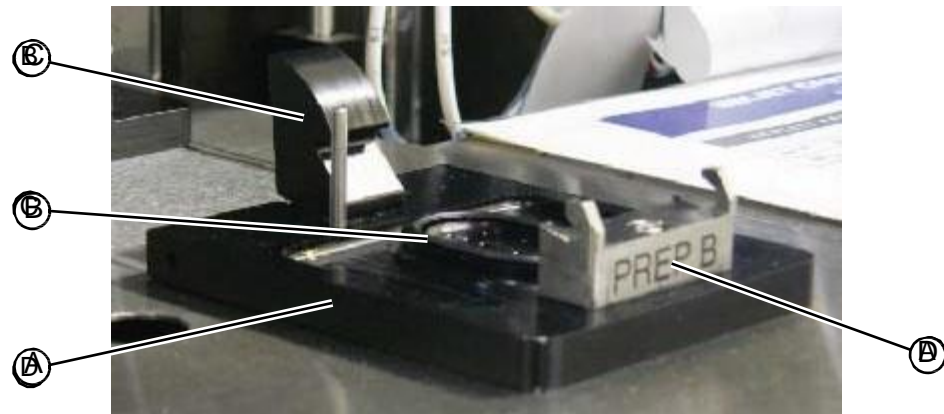


Figure 1.9:Prep station adapter housing

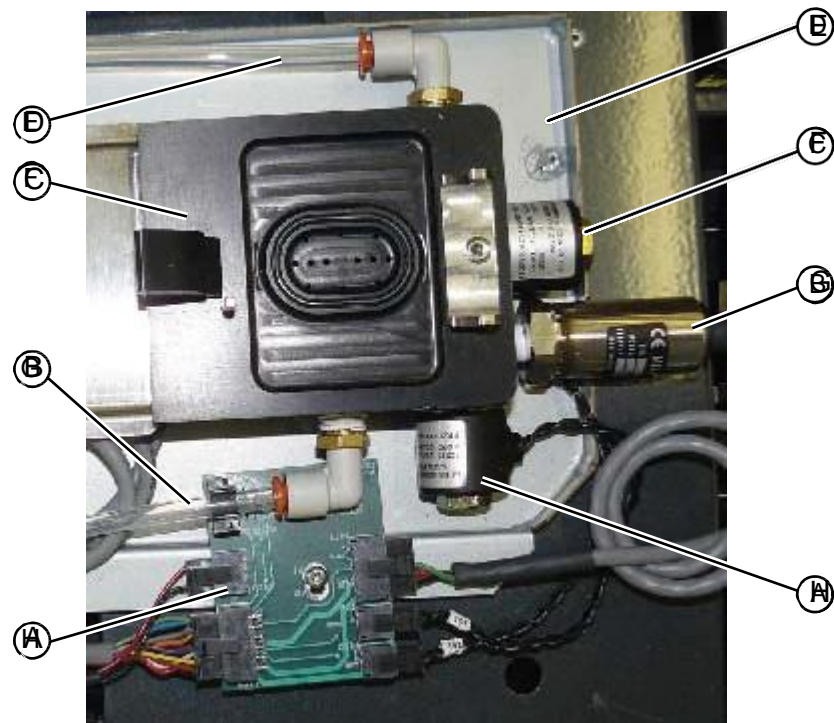


Callout	Component
A	Prep station assembly
B	Prep station seal
C	Spring receiver latch
D	Stationary receiver latch

When the refill adapter snaps into place, the prep station adapter housing presses the print cartridge nozzle securely into a seal on top of the prep station manifold. This seal is necessary to achieve necessary vacuum levels and to prevent leakage of fluid during the cleaning process.

Magnets attached to the adapter prep flap activate a cylindrical reed sensor embedded in the prep station. The sensor sends a +5 Vdc signal to the fluid sensor PC board located under the work surface, within the prep station. The signal is relayed to the main I/O PC board which notifies the single board computer of the presence of the adapter at the prep station. The system then automatically initiates the prep cleaning cycle.

Figure 1.10:Prep station manifold assembly



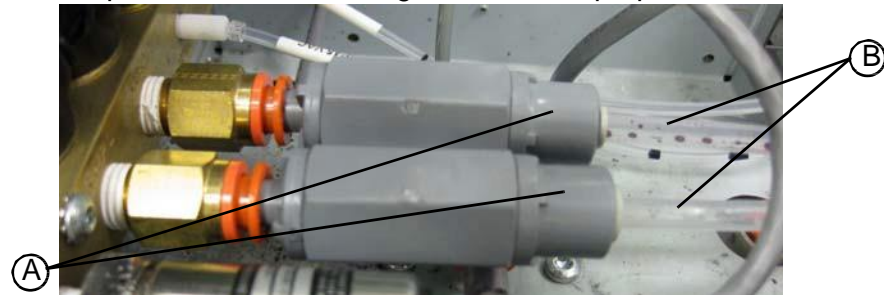
Callout	Component
A	Fluid sensor PCA board
B	Vacuum/waste outflow tubing
C	Prep station assembly
D	Cleaning fluid inflow tubing
E	Prep station tray
F	Fluid solenoid
G	Pressure transducer
H	Vent solenoid

The main portion of the prep station manifold is housed beneath the work surface. The manifold is secured to the prep station tray, a sheet metal container that supports the manifold and serves to collect any fluids that may overflow during the prep process.

The system initiates a process that employs a vacuum line and a cleaning fluid line connected to the prep station manifold which removes ink remaining in the cartridge and cleans the cartridge head. A +24 Vdc pressure transducer attached to the prep station manifold monitors the vacuum during the process. During this process, the system pumps cleaning fluid into the prep station manifold through tubing attached to the right side of the manifold (when viewed from the front of the system). Vacuum tubing attached to the left side of the manifold removes the fluid and waste from the prep station. The vacuum tubing from each prep station connects

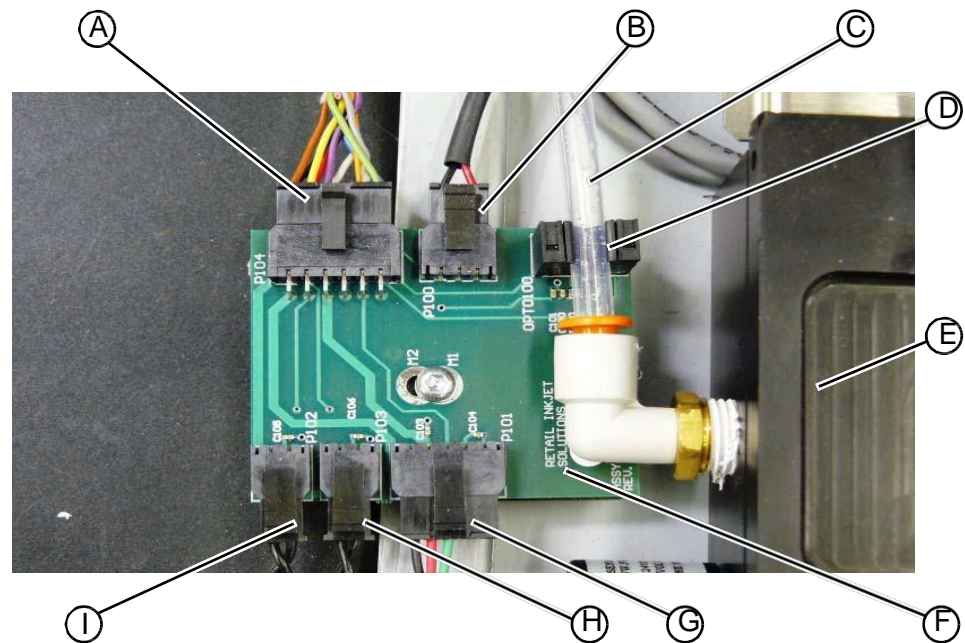
to a vacuum filter attached to the vacuum distribution manifold, located on the rear wall of the plumbing tower.

Figure 1.11:Prep station vacuum tubing connected to prep station vacuum filters



Callout	Component
A	Prep station vacuum filters
B	Prep station vacuum tubing

Figure 1.12:Prep station fluid sensor PB board



Callout	Component
A	Cable to main I/O PC board
B	Cable to prep station reed sensor
C	Prep station vacuum tubing
D	Optical fluid sensor
E	Prep station manifold assembly

Callout	Component
F	Fluid sensor PCA board
G	Cable to prep station pressure transducer
H	Cable to prep station vent solenoid
I	Cable to prep station fluid solenoid

The vacuum tubing snaps into an optical sensor on the fluid sensor PC board. This sensor monitors the opacity of the liquid flowing out of the prep station manifold. When the fluid becomes clean, the fluid sensor PCA board signals the system to end the cleaning process and prompt the operator to remove the cartridge from the prep station.

RELATED LINKS:

- “Fluid Sensor PC Board” on page 5-37
- “Prep Station Manifold” on page 5-42
- “Prep Station Reed Sensor” on page 5-46
- “Prep Station Vacuum Filters” on page 5-49

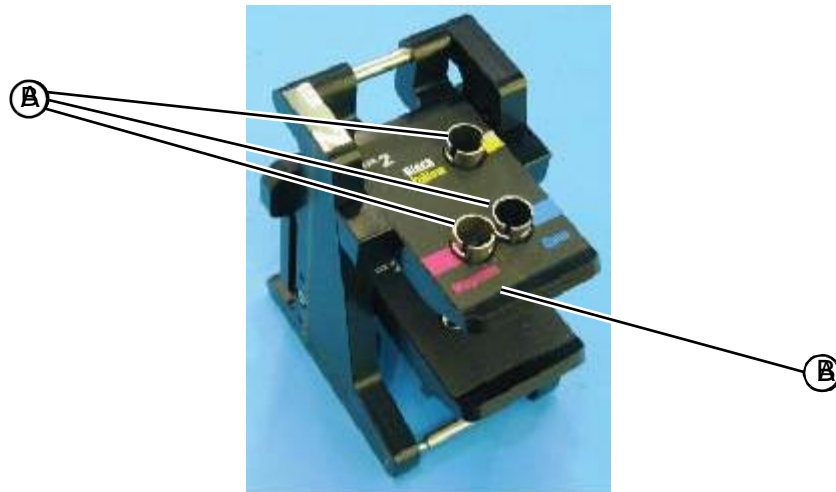
1.4 Fill Station

The InkCenter fill station contains two substations—a station dedicated to prepping and filling HP45/HP15 cartridges and a vacuum chamber in which all other cartridges are filled. HP45/HP15 cartridges contain a spring activated reservoir which does not require vacuum to obtain optimum fill levels. All other cartridges serviced by the InkCenter are filled under vacuum.

1.4.1 Overview of Fill Station Operation

After successfully prepping a cartridge, the operator flips the prep flap to the back of the adapter and latches the refill adapter into the receiver plate located inside the vacuum chamber. In this position, a soft seal pad on the receiver plate seals the cartridge printhead. A reed sensor behind the vacuum chamber detects the presence of the adapter and triggers the host PC to initiate an RFID read of the refill adapter’s RFID tag. The system looks up the RFID code in a database to determine the adapter type and then the host PC presents the operator with a list of cartridges on the touchscreen. After selecting the appropriate cartridge, the operator inserts and locks the appropriate color coded ink injectors into the bayonet mounts on the refill adapter fill flap. Injectors fit only into their appropriate mountings.

Figure 1.13: Refill adapter



Callout	Component
A	Bayonet mountings for ink injectors
B	Refill adapter tab

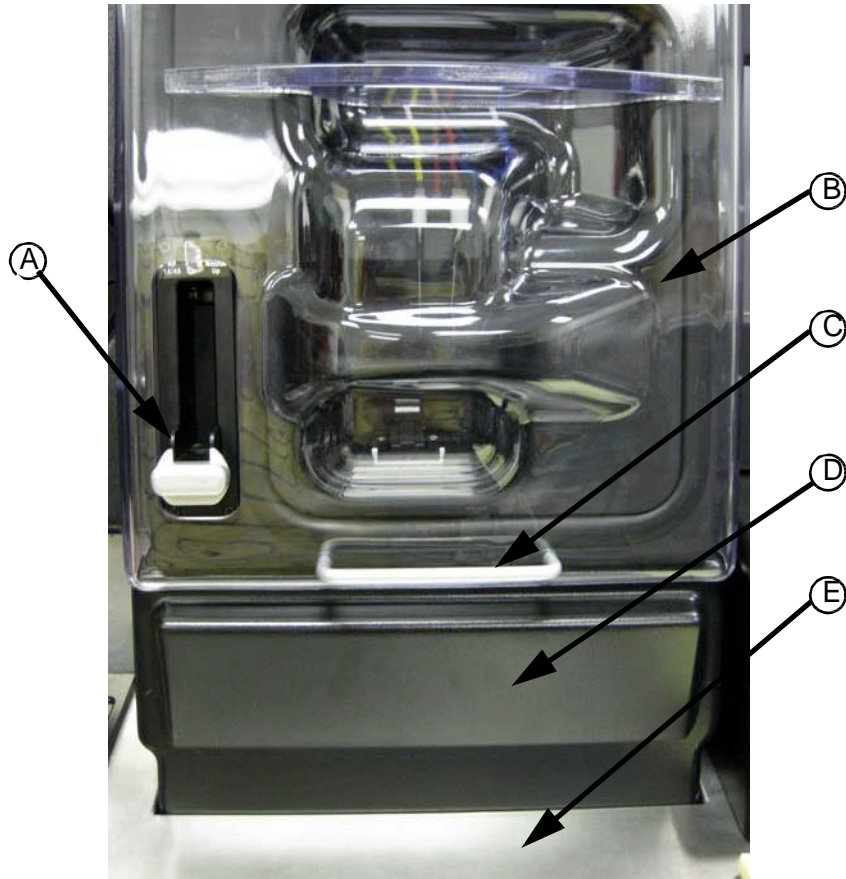
One proximity sensor detects the presence of each ink injector in its holster. When the operator deploys the correct injectors for the selected cartridge, the system prompts the operator to close the vacuum door. When a second proximity sensor detects that the door has been closed, the system applies a vacuum to the chamber and initiates the fill process. Achieving excellent vacuum in the chamber plays a critical role in the fill process. Vacuum leaks at any point in the system can result in system failures. During the fill process, a vacuum sensor monitors the condition of the vacuum inside the chamber.

Once the process is complete, the system releases the vacuum and prompts the operator to remove the cartridge from the fill station.

1.4.2 Fill Station Components

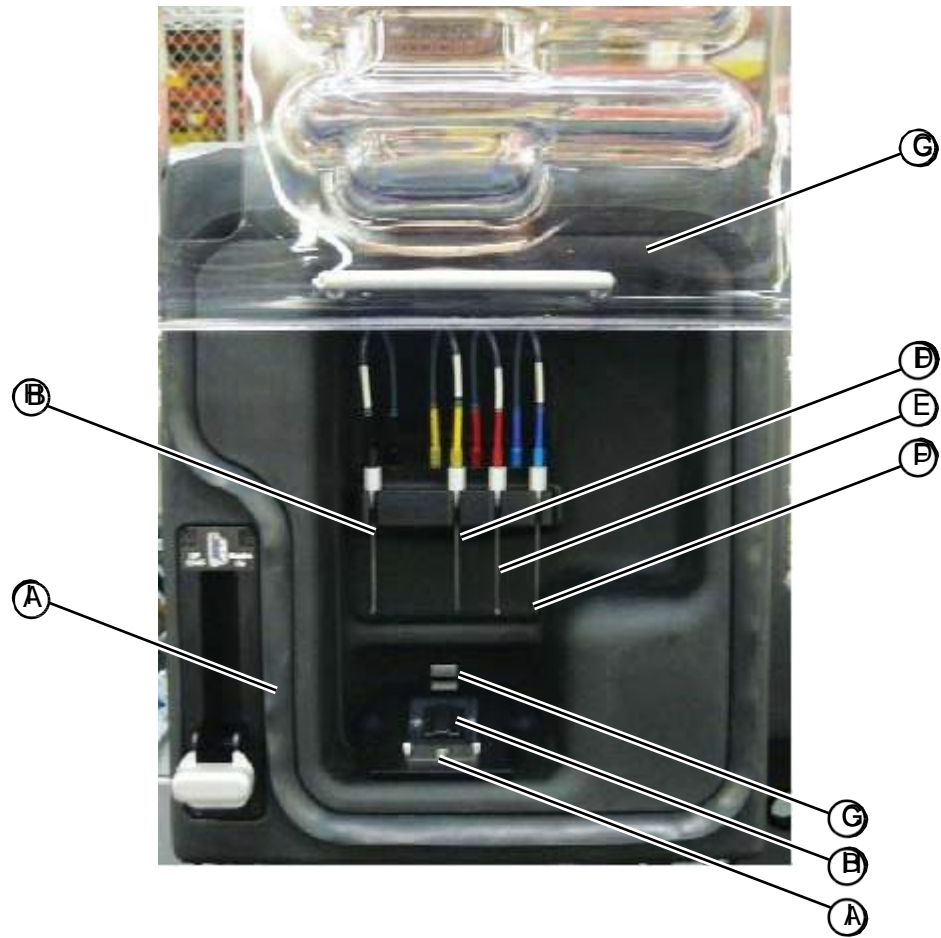
The fill station occupies the central portion of the system.

Figure 1.14: Fill station with vacuum chamber door closed



Callout	Component
A	HP45 station assembly
B	Vacuum chamber door
C	Vacuum chamber door handle
D	Syringe shield (attached to work surface)
E	Work surface

Figure 1.15: Fill station with vacuum chamber door opened



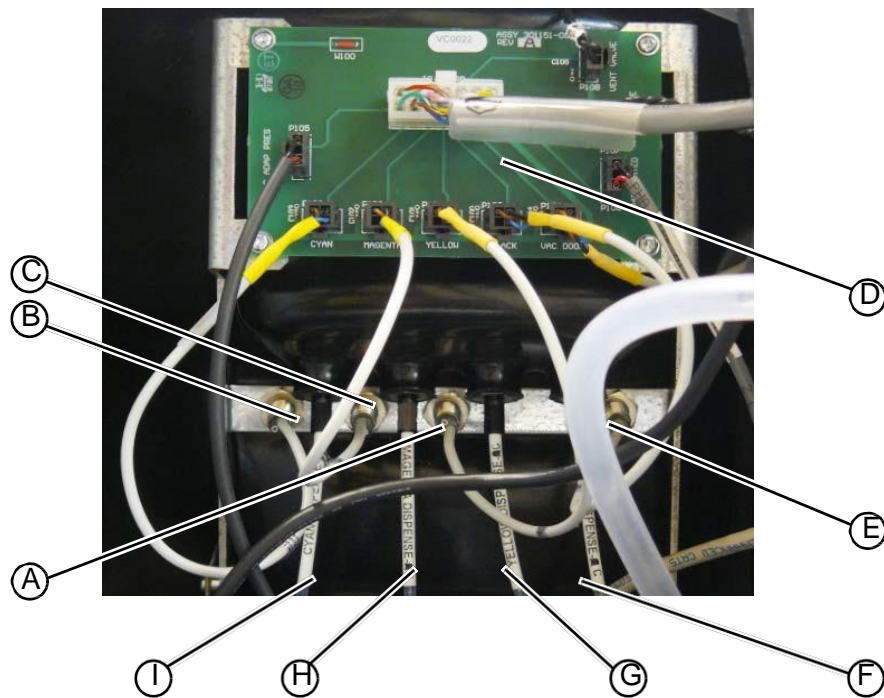
Callout	Component
A	Vacuum chamber door gasket
B	Black ink injector/tubing assembly
C	Vacuum chamber door
D	Yellow ink injector/tubing assembly
E	Magenta ink injector/tubing assembly
F	Cyan ink injector/tubing assembly
G	Vacuum chamber receiver latch assembly
H	Ink fill seal
I	Vacuum chamber receiver plate assembly

When the cartridge adapter snaps into place, the fill station adapter housing presses the print cartridge nozzle securely into a seal on top of the vacuum chamber receiver plate assembly. This seal prevents ink from leaking out of the nozzles during the fill process.

Several sensors monitor activity within the chamber and trigger events in the fill process. A cylindrical reed sensor at the back of the vacuum chamber, towards the bottom of the assembly, detects the presence of the refill adapter. This sensor sends a +5 Vdc signal to the vacuum chamber PC board located on the back of the vacuum chamber assembly. The signal is relayed to the main I/O PC board which notifies the single board computer of the presence of the adapter at the prep station. The system then initiates the fill process by prompting the operator to select the proper cartridge on the touchscreen.

A proximity sensor is attached behind the black ink injector holder. This sensor detects the presence of the injectors in their holders and ensures the injector holsters are secure inside the vacuum chamber. A second proximity sensor detects the closed position of the vacuum chamber door.

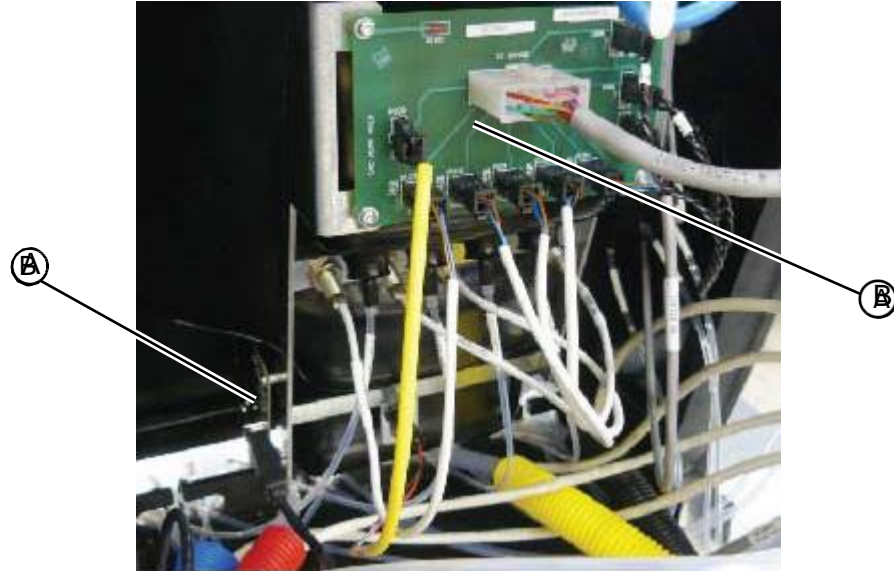
Figure 1.16: Back of vacuum chamber assembly



Callout	Component
A	Yellow ink needle sensor cable
B	Cyan ink needle sensor cable
C	Magenta ink needle sensor cable
D	Vacuum chamber PC board
E	Black ink needle sensor cable
F	Black ink dispense line
G	Yellow ink dispense line
H	Magenta ink dispense line

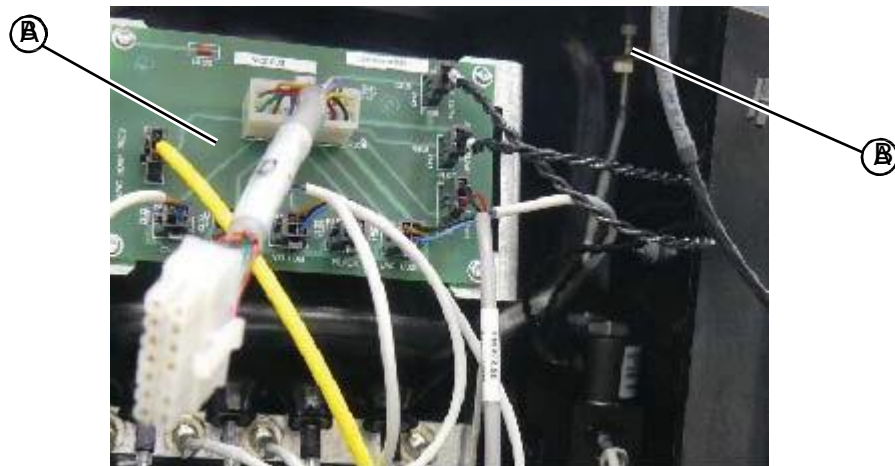
Callout	Component
I	Cyan ink dispense line

Figure 1.17:RFID reader



Callout	Component
A	RFID reader
B	Vacuum chamber PC board

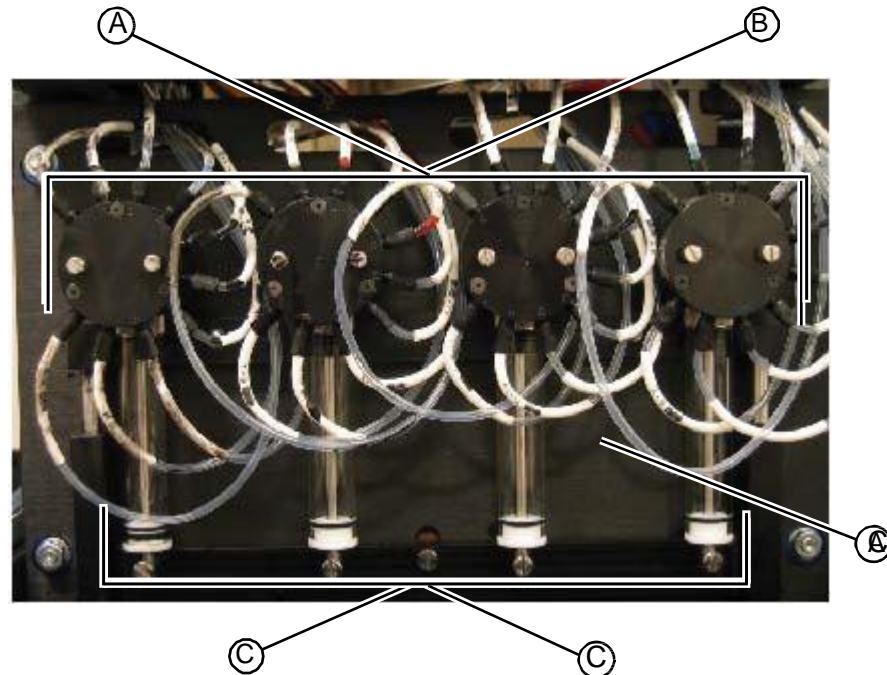
Figure 1.18:Vacuum door sensor



Callout	Component
A	Vacuum chamber PC board
B	Vacuum chamber door sensor

During the fill process, the infusion pump drive system draws the appropriate types of ink through a set of fluid distribution valves and into a set of 10 ml syringes. The system pumps the ink from the syringes into the ink injectors and into the inkjet cartridge.

Figure 1.19: Ink infusion system



Callout	Component
A	Fluid distribution valves
B	Ink infusion pump drive system
C	Ink syringes

During a fill operation, the system moves the syringes between their fully extended bottom position and a *home* position which is set slightly below their absolute top position. Removing and replacing a drive system, a fluid valve, or an ink syringe introduces the possibility of changing this travel distance. The slightest change in this distance can result in serious damage to the system. **Therefore, each time you remove and/or replace a drive unit, fluid valve, or syringe, you must calibrate the syringes.**

RELATED LINKS:

- “Vacuum Chamber” on page 5-52
- “Vacuum Chamber Door” on page 5-59
- “Fill Chamber Receiver Latch” on page 5-66
- “Fill Chamber Receiver Plate” on page 5-67
- “Fill Chamber Seal Pad” on page 5-69
- “Fill Chamber Seal Plate” on page 5-71
- “Fluid Distribution Valve” on page 5-87
- “Vacuum Chamber Reed Sensor” on page 5-72
- “HP45 Station Assembly” on page 5-75

- “HP45 Station Seal” on page 5-80
- “Infusion Pump Drive System Assembly” on page 5-90
- “Fill Station Syringe” on page 5-95
- “Vacuum Chamber Upper Hinge Arms” on page 5-98
- “Vacuum Chamber Gasket” on page 5-102
- “Vacuum Chamber Spring Arm Rod” on page 5-106
- “Vacuum Chamber Spring Arm Tubing” on page 5-111
- “Vacuum Chamber Spring Lever” on page 5-112
- “Ink Drawer PC Board” on page 5-113
- “Vacuum Chamber Injector and Door Sensors” on page 5-117
- “Ink Nest Assembly” on page 5-122

1.5 Tester Station

The InkCenter tester station has two functions. One function is to verify that the refilled cartridge is fully operational by first electrically testing the TSR (thermal sense resistor) and then printing out a test strip. This test strip consists of blackout patterns and stair-step grids that demonstrate whether all the nozzles are firing properly. The second function is to program ink tanks that have replaceable chips so they are reusable after refilling.

1.5.1 Overview of Tester Station Operation

After removing the cartridge from the refill adapter, the operator wipes the printhead to verify that all inks are properly flowing from the cartridge.

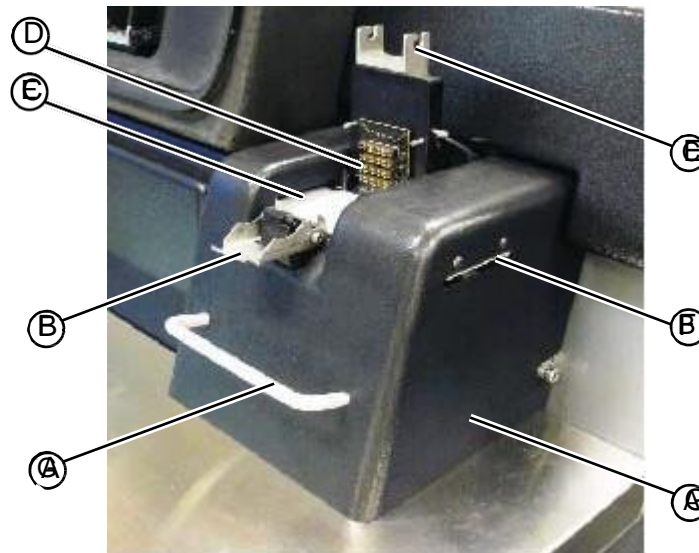
If the cartridge successfully leaves ink tracks on the wipe, the operator inserts the cartridge into an appropriate test adapter and latches the unit into place in the tester station. The operator selects the cartridge on the touchscreen and the system signals the cartridge to print out a test pattern strip.

The operator removes the adapter from the tester station and inspects the test pattern strip. The cartridge evaluation criteria is based on the number of missing nozzles per grid, indicated by breaks in a line. (See *Using the RIS Inkjet Refill Center* for test evaluation criteria.)

1.5.2 Tester Station Components

The tester station is located on the right side of the system, directly below the touch screen monitor.

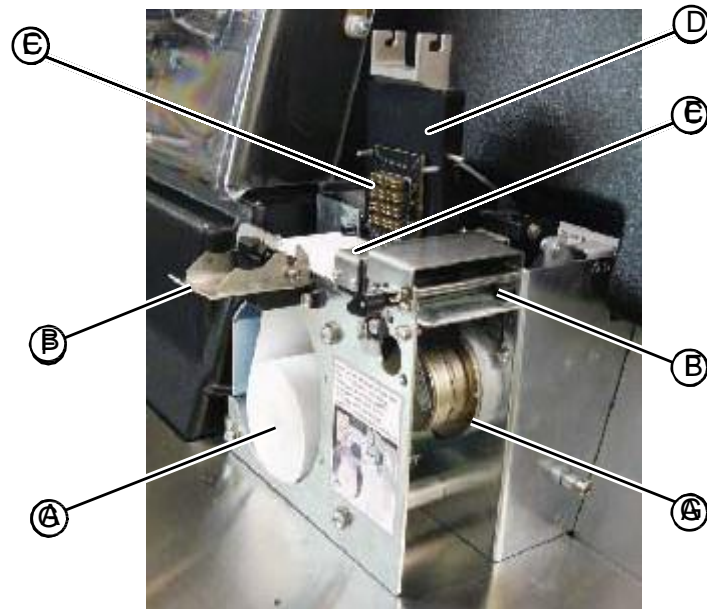
Figure 1.20:tester station with tester cover in place



Callout	Component
A	Tester cover handle
B	Tester latch assembly

Callout	Component
C	Tester paper
D	Interconnect PC board
E	Test adapter hook
F	Tester paper strip cutter
G	Tester cover

Figure 1.21:Tester station with tester cover removed

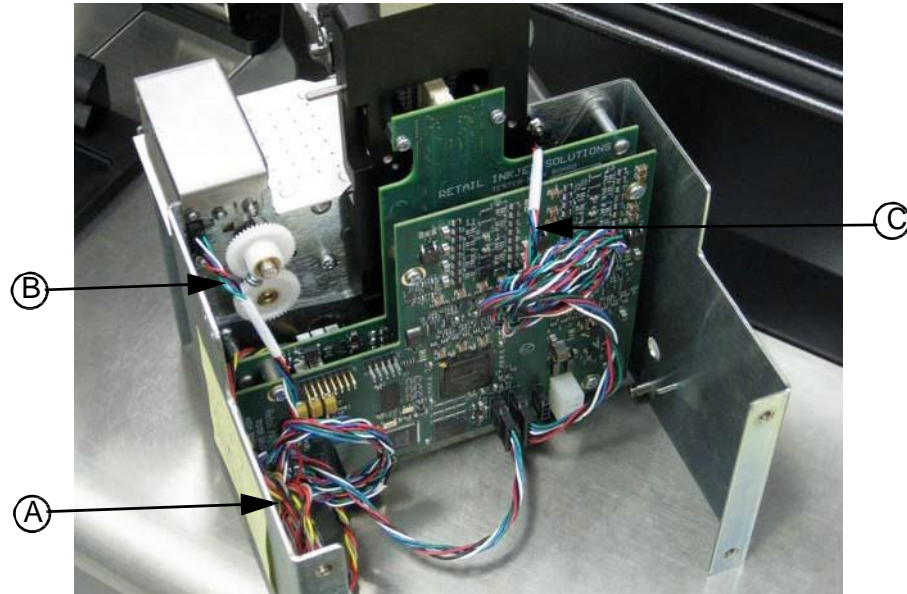


Callout	Component
A	Paper roll
B	Tester latch assembly
C	Interconnect PC board
D	Tester interface assembly
E	Scanner module assembly
F	Paper release lever
G	Stepper motor

The operator inserts the top bar of the test adapter into the tester top latch and then gently raises the tester latch until the tab on the end of the latch is vertical. When the operator latches a tester adapter into place, the cartridge printhead is positioned above the test paper strip and the contacts on the adapter are positioned against the interconnect PC board. The system reads a series of ID bits in the adapter circuit to determine its identity and then presents the user with a list of possible cartridges. When the operator selects the cartridge on the touchscreen, the tester

board activates the stepper motor and signals the cartridges to fire in a sequence to produce the test strip print. A vacuum line connected to the tester station holds the paper in proper position as it moves under the printhead. Two thru-beam paper sensors located at the left and right sides of the top paper path monitor the presence of paper and trigger an alert if paper is not detected.

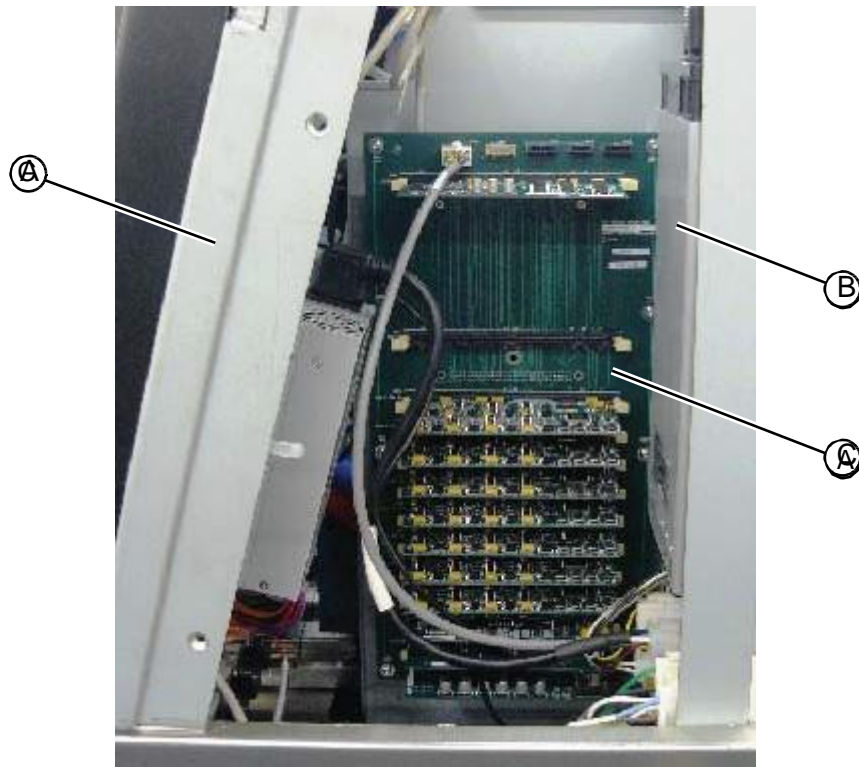
Figure 1.22:Rear inside view of tester station (NEW)



Callout	Component
A	Tester motor cable
B	Paper sensor cable
C	Paper sensor cable

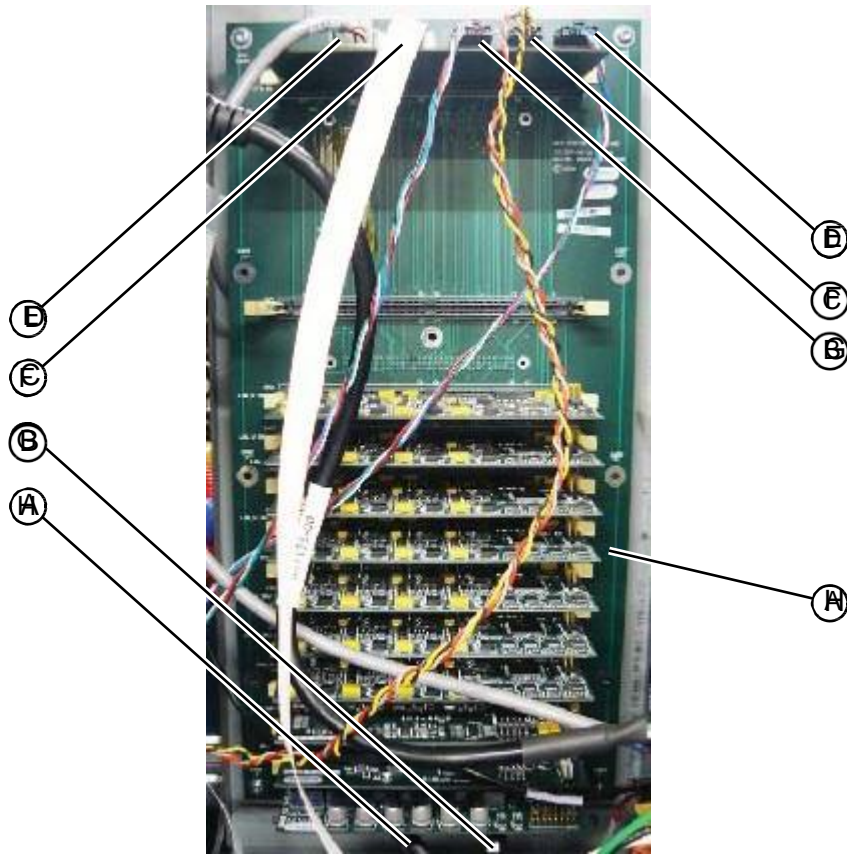
The tester board set, located behind the touchscreen assembly on the interior wall of the electrical tower, controls all test operations. It connects to the system's single board computer through a CAT5E crossover cable and a DB9 serial cable. The two paper sensors, the scanner, and the stepper motor connect to the tester board set through +5 Vdc cables. The tester board set receives +24 Vdc, +5 Vdc, +32 Vdc, and +19 Vdc power from the DC side of the AC/DC power board.

Figure 1.23: Tester PC board set (OLD)



Callout	Component
A	Front system frame
B	DC power supply
C	Tester board set

Figure 1.24: Cable connections at the tester PC backplane board. (OLD)



Callout	Component
A	Cable 2 from interconnect board (part of tester assembly)
B	Cable 1 from interconnect board (part of tester assembly)
C	Cable from tester scanner
D	Cable from AC/DC distribution board
E	Cable from paper sensor (interchangeable with B)
F	Cable from tester motor (part of tester assembly)
G	Cable from paper sensor (interchangeable with D)
H	Tester Board Set

RELATED LINKS:

- “Tester Assembly” on page 5-131
- “Tester Fixture Cover” on page 5-137
- “Tester Interconnect PC Board” on page 5-139
- “Tester Latch Assembly” on page 5-142
- “Tester Front Paper Guide” on page 5-144
- “Tester Thru-beam Paper Sensors” on page 5-147
- “Tester Scanner Cable” on page 5-149
- “Tester Top Latch” on page 5-151

1.6 Plumbing System

The self-contained plumbing system of the Retail Inkjet Solutions InkCenter includes a pumping system that distributes cleaning fluid to the prep and fill stations, and a vacuum system that operates within the prep, fill, and tester stations.

1.6.1 Cleaning Fluid System

The system uses cleaning fluid to remove ink from and clean the printheads of cartridges during the prep process. Cleaning fluid also is used to prevent ink residue from building up on components within the fill station.

Cleaning fluid is stored in a 9L carboy container located in the system maintenance drawer. A siphon assembly within the container provides a conduit for fluid into the system. This assembly also contains level sensor that monitors the fluid level within the container and sends a +5 Vdc signal to the main I/O PC board when the fluid needs to be replaced.

Figure 1.25: Cleaning fluid container located in the maintenance drawer



Callout	Component
A	Level sensor/siphon assembly
B	Cleaning fluid container

An AC-powered, relay controlled fluid pump located on the floor of the plumbing tower pumps cleaning fluid into the into the fluid distribution manifold.

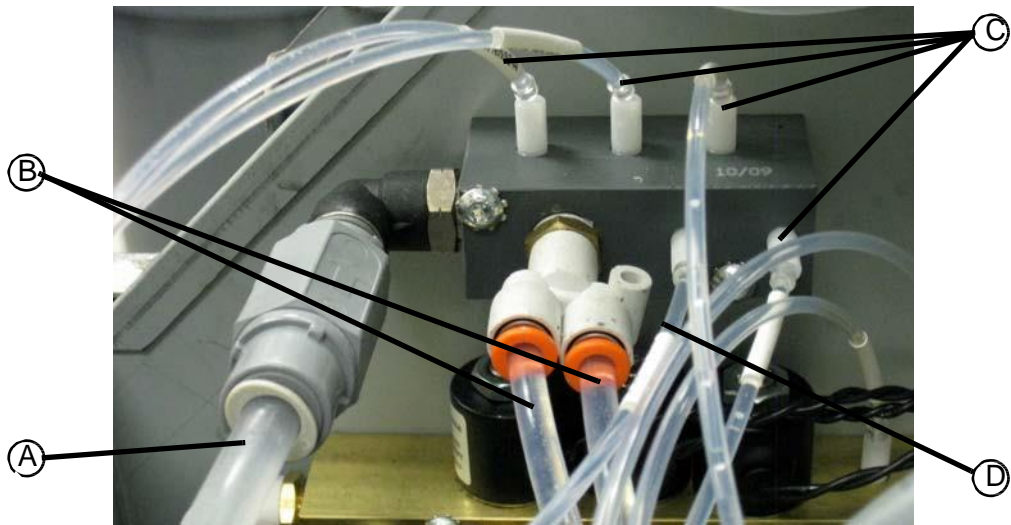
Figure 1.26:Fluid pump



Callout	Component
A	Fluid pump
B	Tubing to fluid distribution manifold

The fluid distribution manifold, mounted on the rear wall of the plumbing tower routes cleaning fluid to the prep station (or stations on a dual prep system), the fill station syringe pumps, and to the HP45 manifold.

Figure 1.27:Fluid distribution manifold



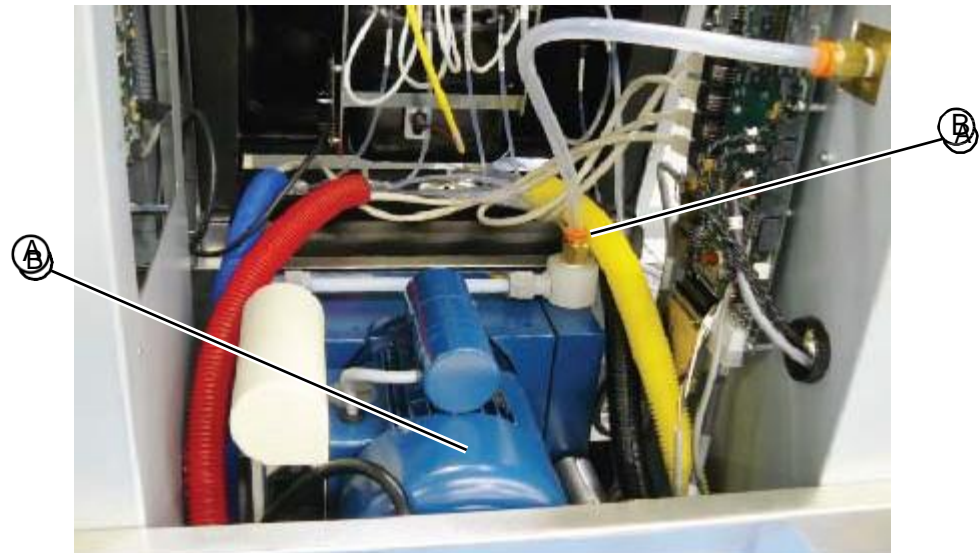
Callout	Component
A	Tubing to fill station fluid distribution valves
B	Tubing to the HP45 station
C	Tubing to the fluid pump
D	Tubing to the prep stations

1.6.2 Vacuum System

The InkCenter vacuum system plays a central role in the operation of the prep, fill, and tester stations. Vacuum leaks at any point in the system can result in system failures.

The vacuum pump is located behind the vacuum chamber. It receives AC power through a cable connected to the AC/DC power distribution PC board. A 15" length of tubing connects the vacuum pump to the primary vacuum manifold, located in the plumbing tower.

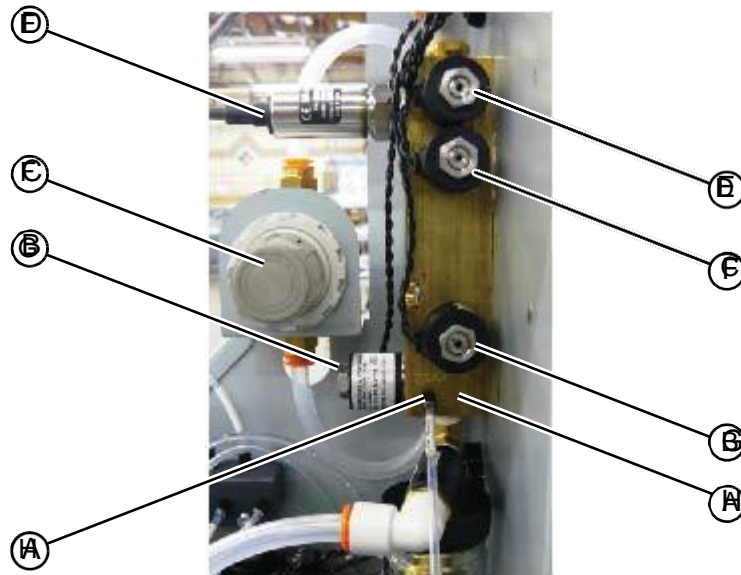
Figure 1.28: Vacuum pump



Callout	Component
A	Vacuum pump
B	Tubing to main vacuum manifold

The main vacuum manifold is connected directly to the vacuum regulator, and, through solenoid valves, to the vacuum chamber, and the tester assembly. It also connects through the water trap assembly to the liquid separator located beneath the plumbing chamber. A system vent solenoid valve on the main vacuum manifold releases the vacuum throughout the system, allowing the liquid separator to drain into the waste tank. A vacuum chamber vent solenoid on the main vacuum manifold releases the vacuum in the fill chamber.

Figure 1.29: Main vacuum manifold



Callout	Component
A	Tester vacuum tubing
B	Tester vacuum solenoid
C	Vacuum regulator
D	Vacuum chamber vacuum sensor
E	Vacuum chamber vent solenoid valve
F	Vacuum chamber vacuum solenoid valve
G	System vent solenoid valve
H	Main vacuum manifold

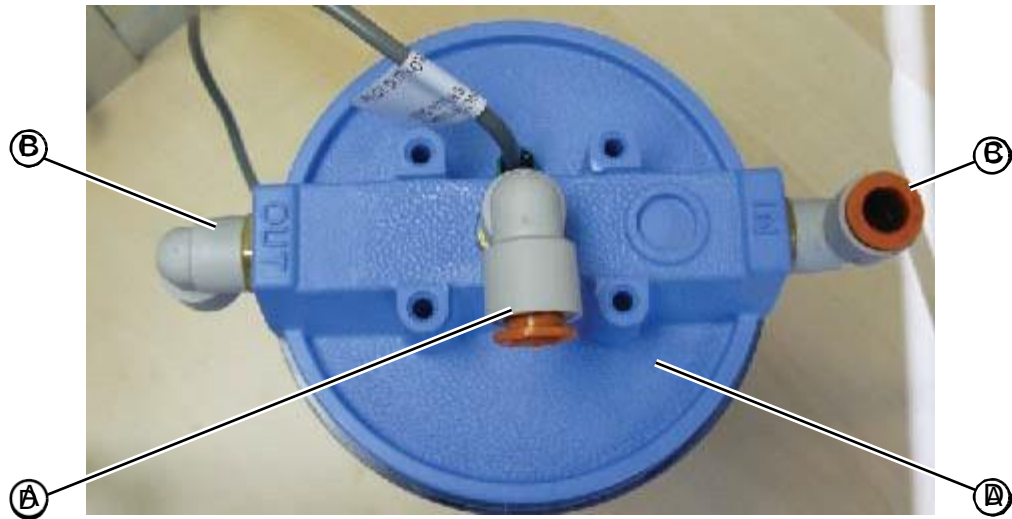
Figure 1.30: Main vacuum manifold water trap



Callout	Component
A	Water trap connected to main vacuum manifold
B	Connection to liquid separator

The liquid separator collects waste fluids from the prep stations and the syringe pumps through a connection to the vacuum distribution manifold. It also collects fluids through a direct connection to the cleanup wand located in the maintenance drawer.

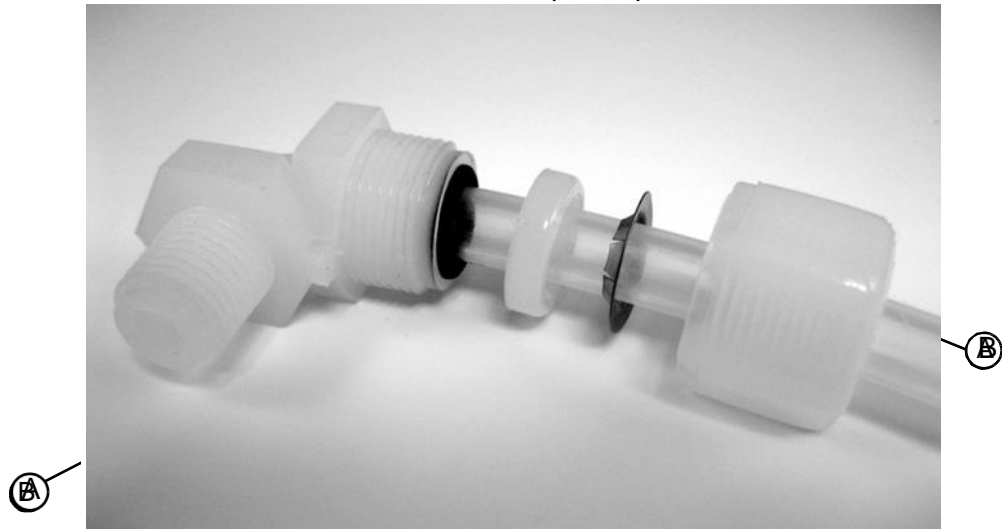
Figure 1.31: Connectors on the top of the liquid separator



Callout	Component
A	Connector for tubing to vacuum distribution manifold
B	Connector for tubing to cleanup wand
C	Connector for tubing to water trap on main vacuum manifold
D	Liquid separator cap

Tubing connected to the bottom of the liquid separator leads to a waste valve in the maintenance drawer.

Figure 1.32:Connector on the bottom of the liquid separator



Callout	Component
A	Connector to bottom of liquid separator
B	Tubing to waste valve in maintenance drawer

Float sensors attached to the liquid separator cap monitor the fluid level within the container. The sensors trigger an alert when the fluid reaches a maximum level, instructing the operator to drain the contents of the liquid separator into the waste tank located in the maintenance drawer.

Figure 1.33:Waste container and waste valve



Callout	Component
A	Waste drain valve
B	Waste container

If the liquid separator reaches an overflow level, fluid backs up into the water trap attached to the main vacuum manifold. If the water trap fills, a float sensor halts system operation.

1.7 Networking of the InkCenter Machines

1.7.1 Machine Connections

Machines are typically connected to the internet using an ethernet connection on the back of the machine. Some machines are connected using a wireless modem.

1.7.2 Data Collection

Regardless of the connection mechanism, the machines use a secure shell "tunnel" to communicate with our server. The machines send two sets of logging information:

- a record of every time a fill is processed (in the fill chamber or the HP 15/45 station).
- a much more verbose log recording key events on the machine, including:
- routine events such as adapters being inserted and removed from each station
- key metrics of behavior such as maximum pressures in the fill chamber
- abnormal behaviors such as error codes, program errors and processing errors.

We use this information to

- monitor the hardware behavior and to track the development of failures, such as cracks in the fill chamber door, or buildups of waste material in the prep stations.
- to prioritize both software and hardware changes, ideally to find solutions to developing problems, and to validate changes made are having the desired effect.
- to identify issues with the usage of the machine, such as sites, and operators with low yield.

1.7.3 Troubleshooting

The machines also have a Virtual Network Connection (VNC), that allows a remote computer to see the same screen contents of any machine that the user is seeing, and to control the machine through the GUI. This enables, for example, access to the Tech Pane to run tests on the machine, or to walk through operations with the user and ensure that they are not the cause of reported errors.

There is also remote access to a secure shell that allows access to the machine at the operating system level, and can be used to alter the machines local databases, restart software components, and access a more detailed and more up to date event log than is available on our server.

1.7.4 Software Updates

Software and firmware (print-tester and ioboard) updates are done remotely via a server.

1.7.5 Communication with Operators

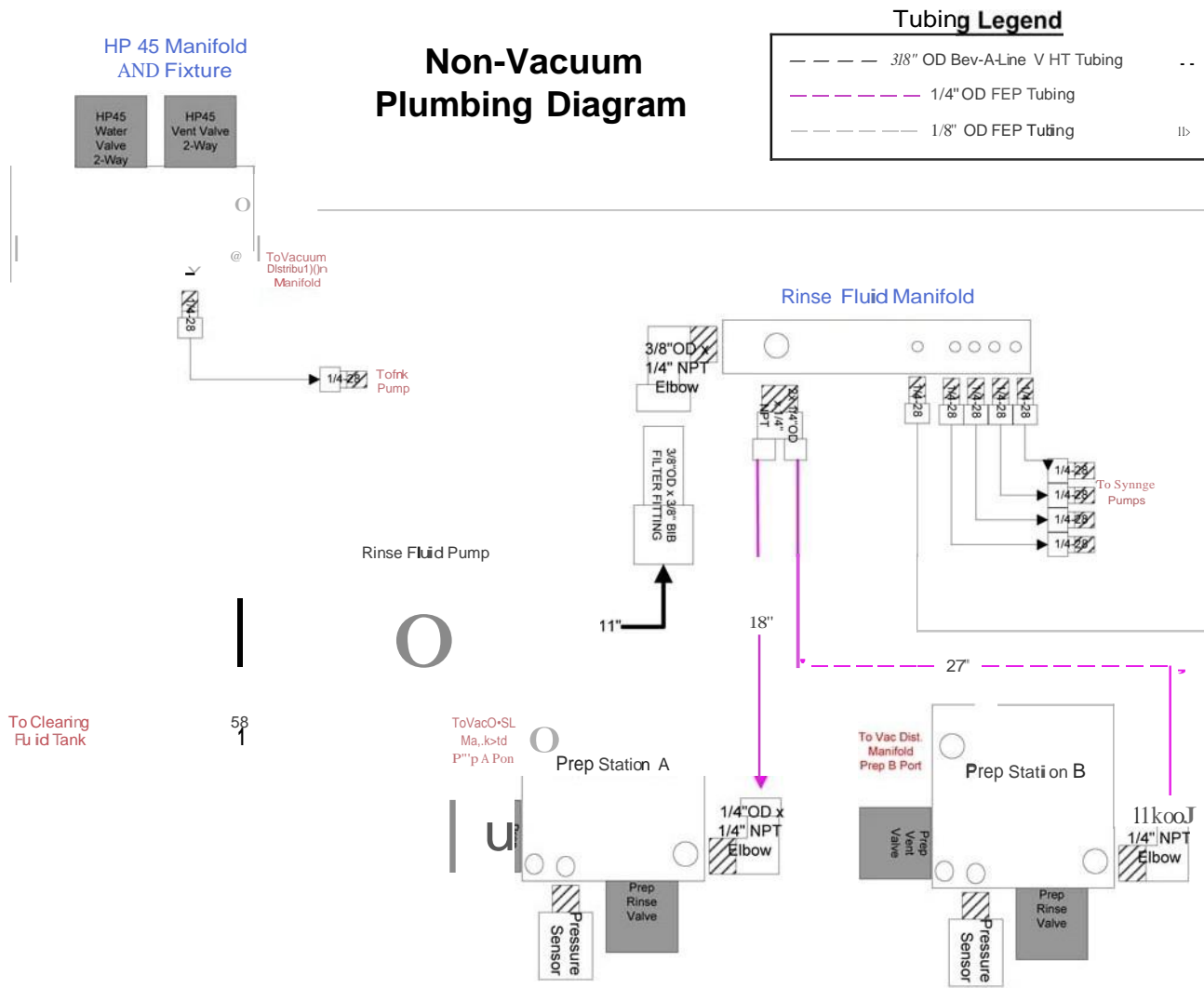
Account managers can send messages, called “RISe-mail” to operators of the machine, providing hints on how to use the machine, announcements of future changes etc.

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Non-Vacuum Plumbing Diagram



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