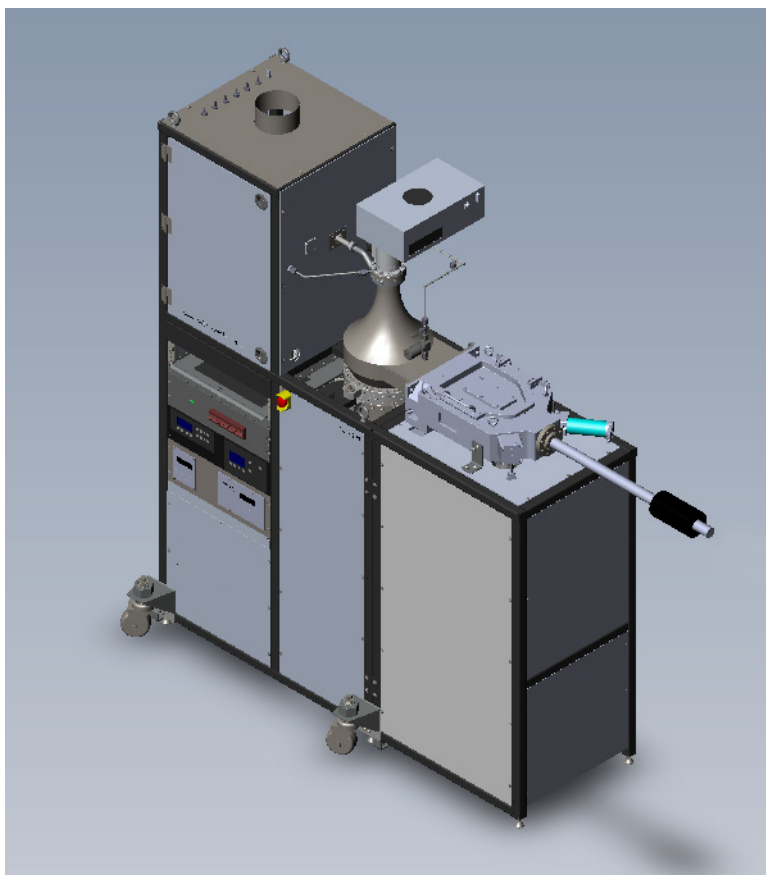


Fiji F200

Atomic Layer Deposition System

Maintenance Manual V2 July 21, 2009



Cambridge NanoTech Inc. welcomes requests for information, comments and inquiries about its products.

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This manual is also available in other languages upon written request.

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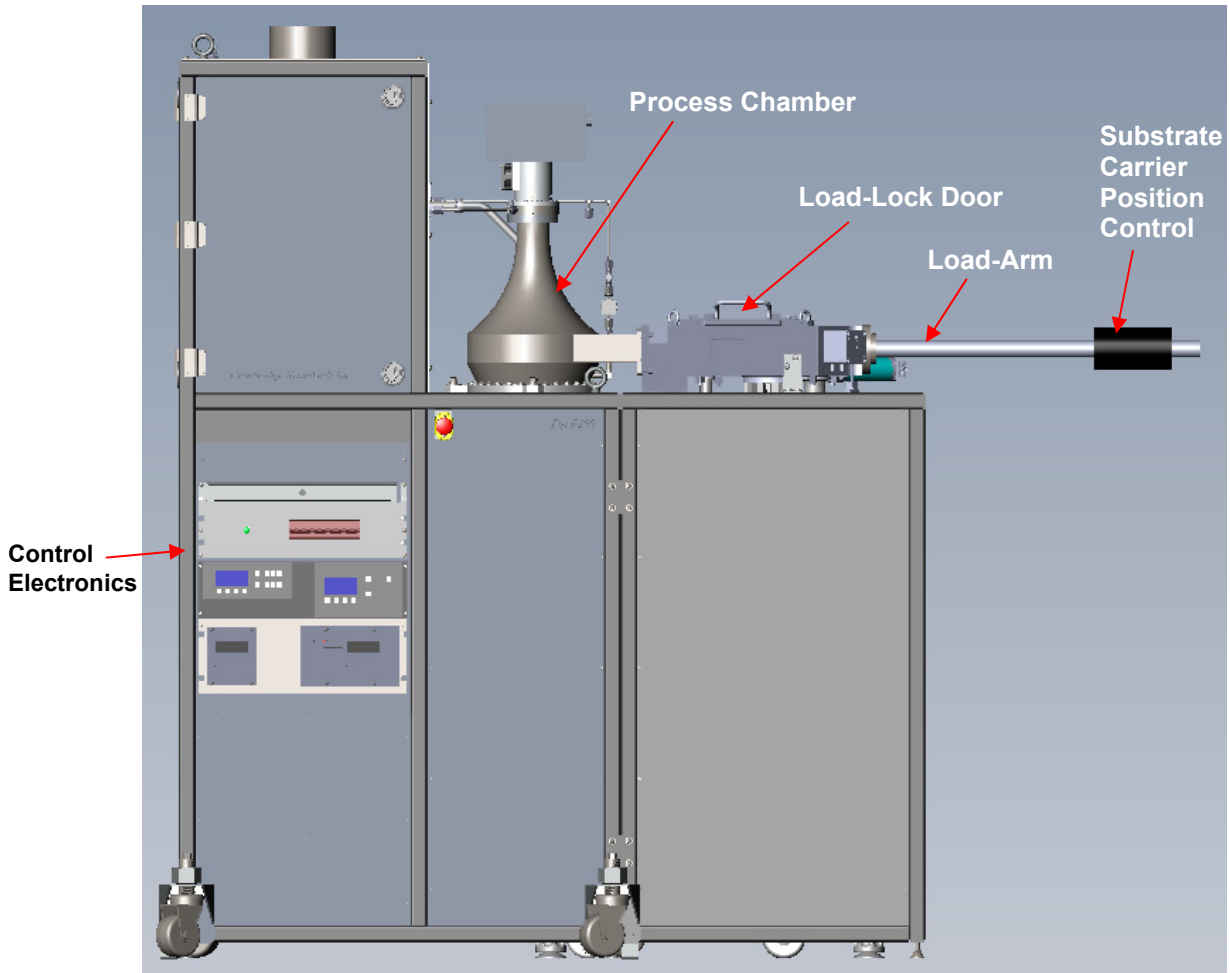
Section 1 System Overview

System Description

The Cambridge NanoTech Fiji F200 series is our most advanced ALD research and development system. The Fiji is a modular high-vacuum ALD system that accommodates a wide range of deposition modes using a flexible system architecture and multiple configurations of precursors and plasma gases. The result is a new generation ALD platform capable of doing thermal as well as plasma-enhanced deposition.

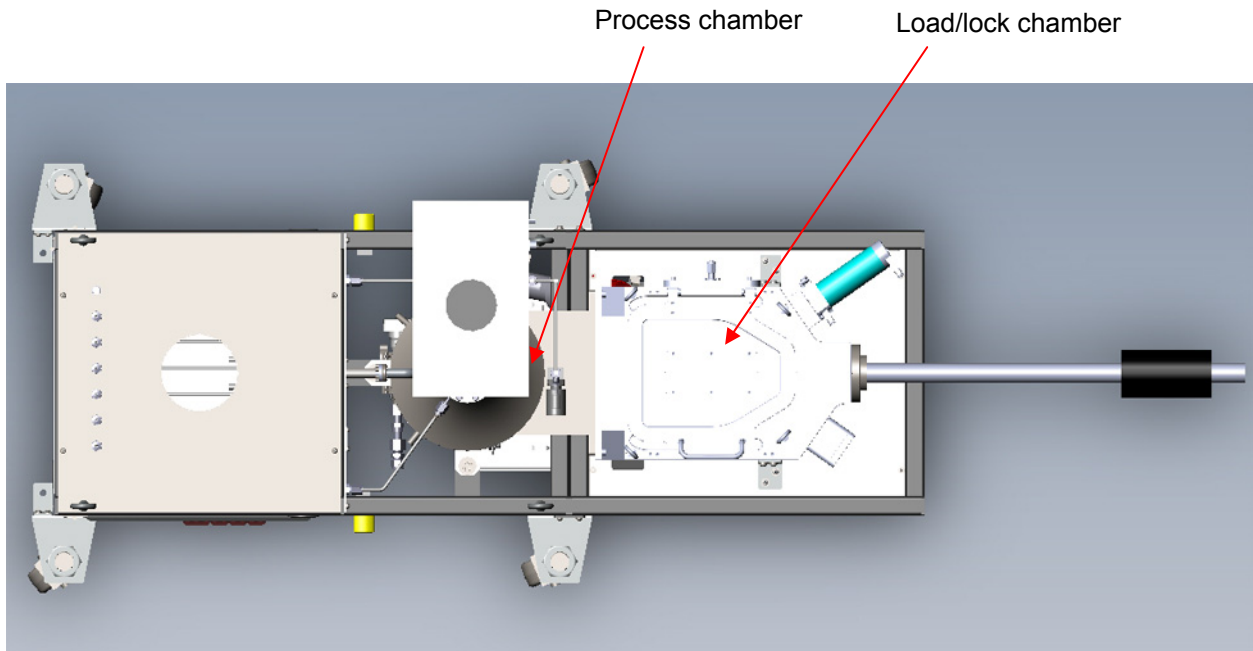
Cambridge NanoTech has combined its leading ALD expertise with advanced Computational Fluid Dynamics analyses to optimize Fiji F200 ALD process chamber, heater and trap geometry. The hyperboloid chamber geometry combined with the paraboloid substrate heater creates a laminar precursor and remote plasma generated radical flow. This type of design that you can only get from knowledgeable ALD experts, optimizes deposition uniformity and minimizes cycle time and precursor use.

The Fiji F200 is available in several different configurations. The system can be configured with multiple heated precursor lines and plasma gas lines, offering the greatest experimental flexibility in a compact footprint. **This manual covers the Single-Chamber, manual load-lock system shown below:**

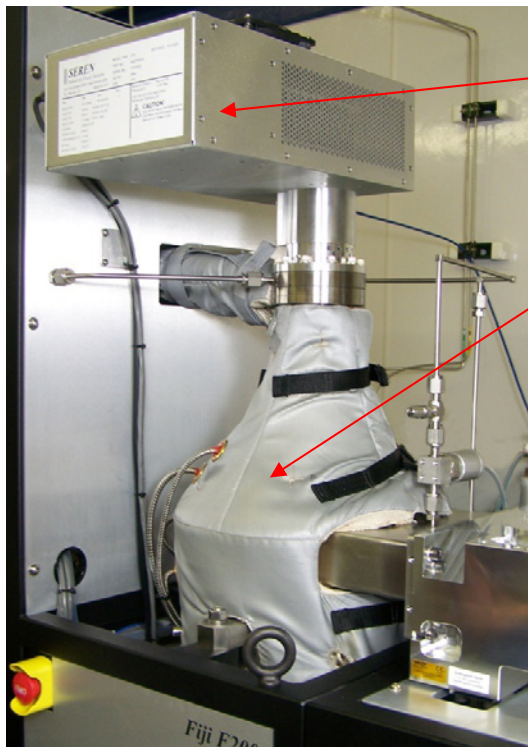


Fiji F200 System

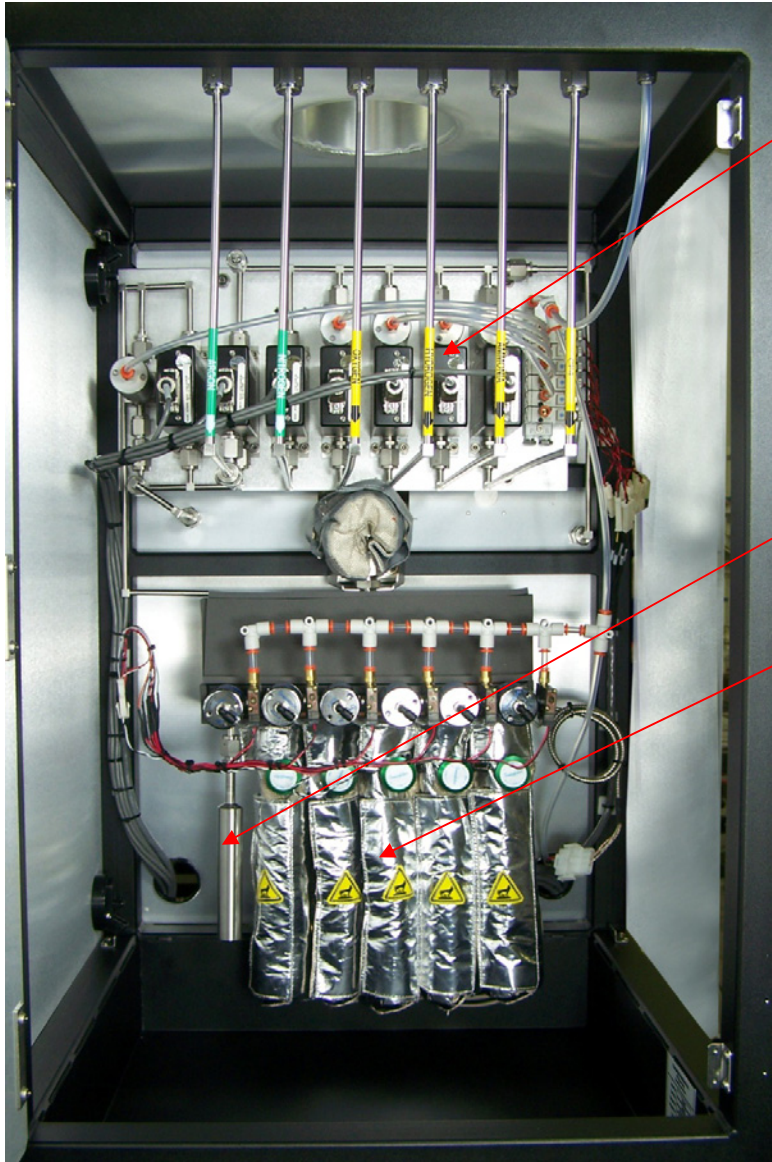
The system contains a load/lock chamber for loading substrates external to the process chamber. The process chamber has a gate-valve to maintain optimum process conditions and minimizing temperature cycling times. EMO buttons are provided on the front and rear of the system.



Top View



Process Chamber



Mass Flow Controllers
System Gases

Unheated water cylinder

Precursors with heated
jackets on cylinders

Gas Box – Inside View

Section 2 Maintenance

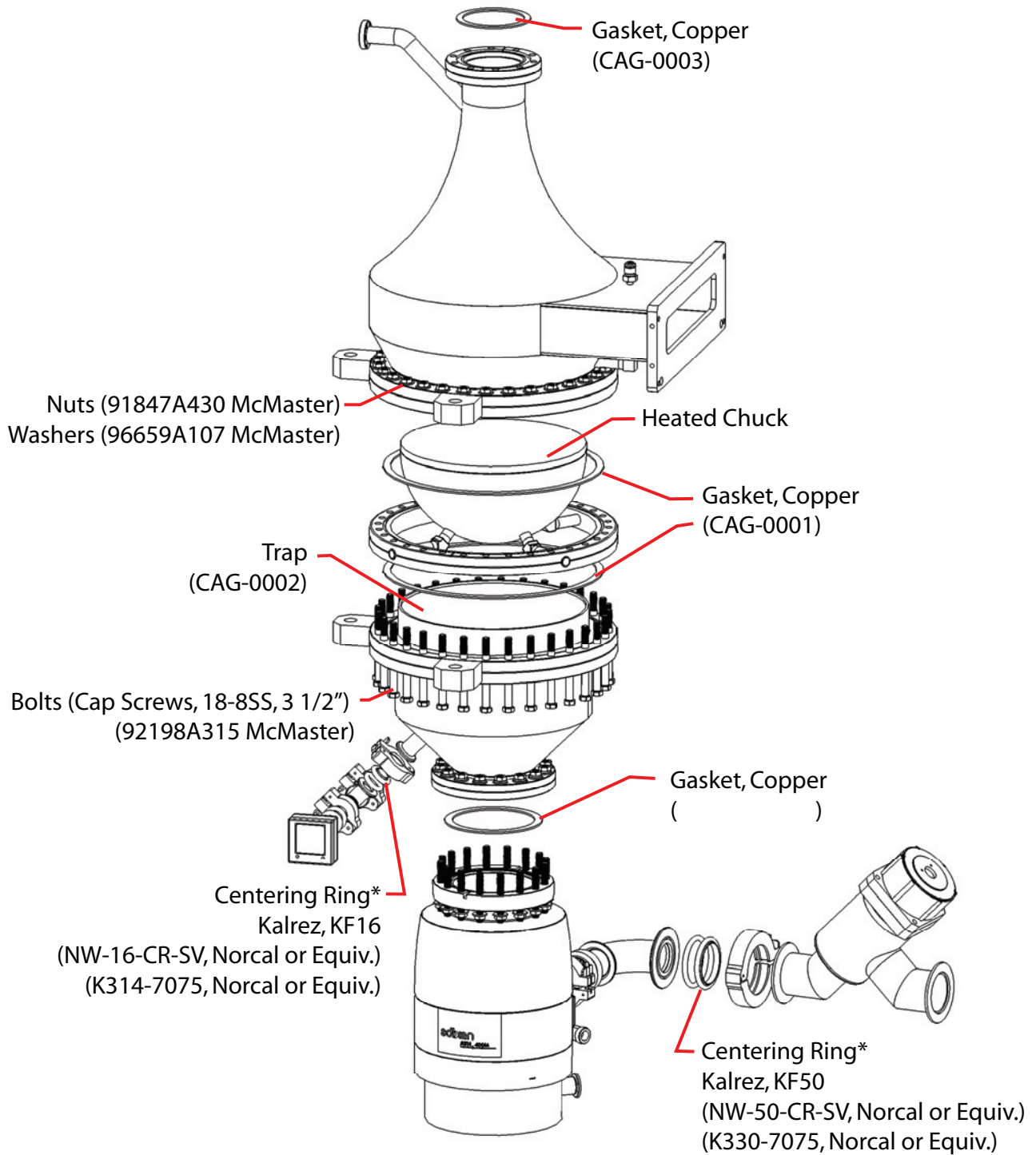
Most maintenance procedures may require the removal of panels, as necessary to access system components. Use care in storing the panels when not on the machine. Never lay a panel flat on a floor where it can serve as a trip hazard and/or be damaged.

Maintenance Schedule

Required Maintenance	Quarterly	6 Months	12 Months	As needed
Refill the H ₂ O Cylinder				X
Replace precursor cylinders				X
Replace the Trap		X	X	
Clean the Substrate Carrier and Transfer Chamber		X	X	
Backup Recipe and System Data		X	X	X
Swapout chamber, chuck, & trap cone*				X
Service vacuum gauge			X	

*Process dependent, may need to be replaced/cleaned due to excessive particle count.

Fiji F200 - Process Chamber Components



*Discard o-rings provided with Centering Rings and replace with separately ordered Kalrez® o-rings.

Fiji F200 - Trap replacement procedure

Required Parts

Part Number	Description	QTY
CAG-0001	Gasket, Copper, Chuck	2
CAG-0002	Trap	1
	Gasket, Copper, Turbo Pump Connection	1
NW-50-CR-SV (Nor-Cal or equiv.) K330-7075 (Nianic or equiv.)	*Centering Ring, Kalrez®, KF50	1
NW-16-CR-SV (Nor-Cal or equiv.) K314-7075 (Nianic or equiv.)	*Centering Ring, Kalrez®, KF16	1
92198A315 (McMaster)	Chuck Retention Bolts, 10-24, 4"	32
96659A107 (McMaster)	Chuck Retention Washers	32
91847A430 (McMaster)	Chuck Retention Nuts	32
CAG-0003	Gasket, Copper, Plasma connection	1
2-258	Viton® o-ring	2

*Remove and discard non-Kalrez® o-ring, install and use Kalrez® o-ring.

Required Equipment/Tools

- ½" open end and box wrenches
- ½" socket wrench and ratchet driver
- Standard wrench kit

Safety Cautions



WARNING: CHEMICAL HAZARD! Wear chemical-resistant garments and eye protection while performing system maintenance. Avoid skin contact and inhalation of any component exposed to process chemicals/gases.

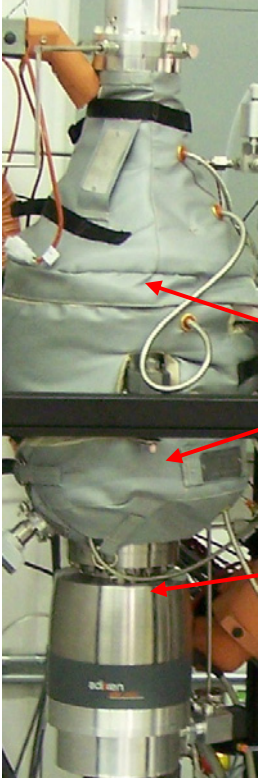





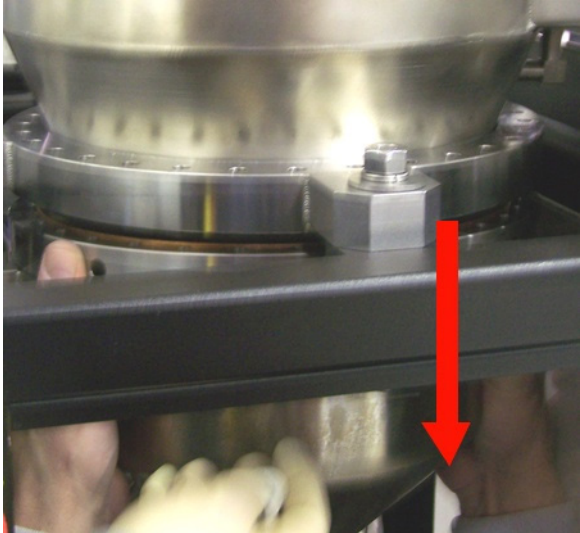
WARNING: BURN HAZARD! Allow system components to properly cool prior to performing maintenance to avoid personal injury.

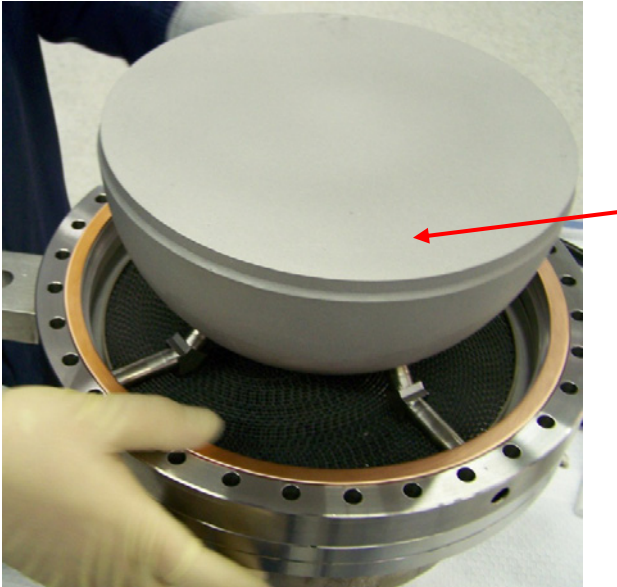
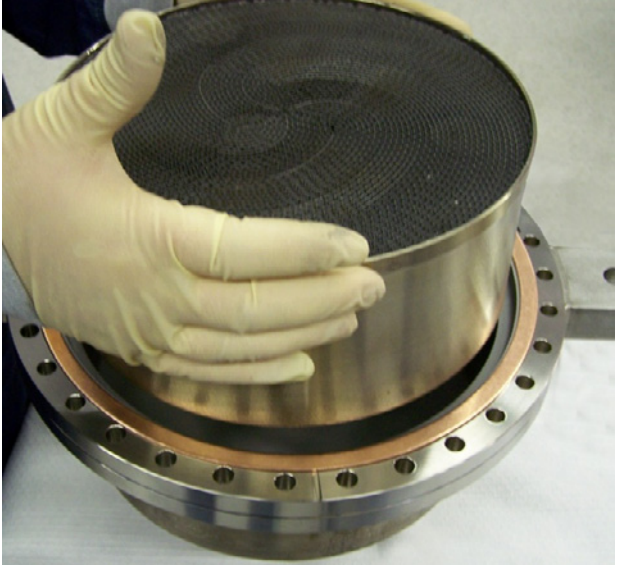
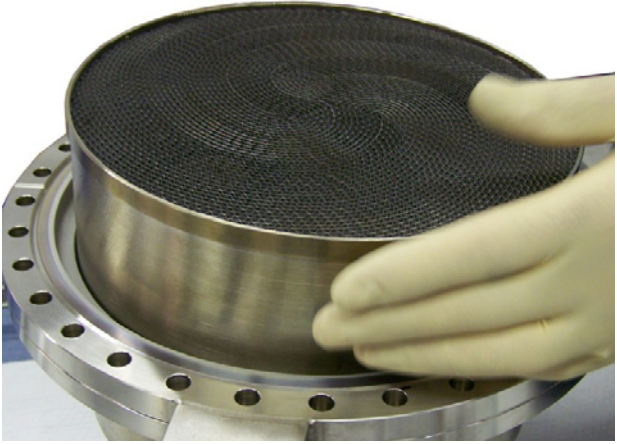


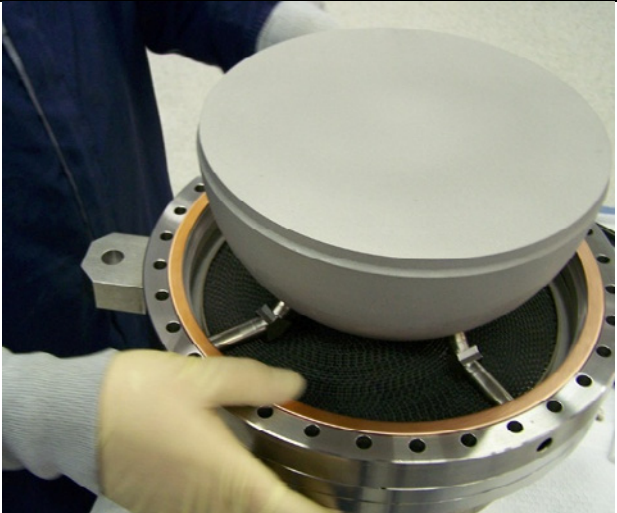
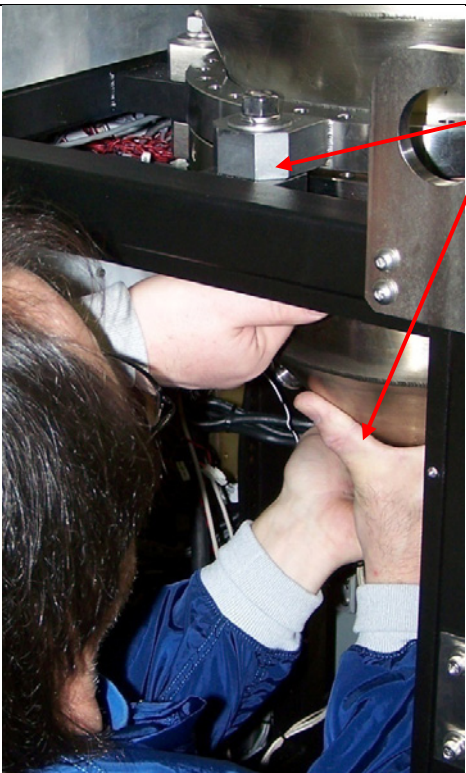
CAUTION! LIFTING HAZARD! Two people are required to perform this procedure due to the weight and location of the process chamber components.

Step	Action	Details
1.	Refer to the system operation	NOTE: In this procedure, you will be replacing copper gaskets,

	<p>manual to turn OFF all system heaters and allow the process chamber to cool.</p>	<p>flange rings, and the process chamber trap. Bolts should also be replaced on a period basis due to thermal stress which will weaken the bolts over time. Please refer to the following instructions.</p>
<p>2.</p>	<p>Remove the heater blankets as necessary to access the turbo pump and process chamber bolts. Use caution to prevent damage to any wire or component. Refer to the process chamber illustration on the previous page for details.</p> <p>Blankets are attached with Velcro[®] and straps. Use extreme care to prevent damage to electrical wires and sensors.</p>	 <p>Remove heater blankets to access chamber bolts.</p> <p>Remove all connections (flanges) from turbo pump to remove pump (see below).</p>
<p>3.</p>	<p>Remove all connections to the process chamber:</p> <p>Remove the pressure gauge and the gray heater blankets. Remove the vacuum lines and valve.</p> <p>The orange jalapeno heating jacket can remain on the valve, but disconnect the jacket's power connection.</p> <p>Be sure to disconnect the chuck RTD and heater wires</p> <p>Refer to system illustration on previous page.</p>	 <p>Remove clamp and slide gauge out of chamber.</p>

<p>4.</p>	<p>Remove all connections to the turbo pump, then remove nuts as necessary to gently remove the turbo pump from the system.</p> <p>Discard the copper gasket.</p>		<p>Remove nuts to gently lower turbo pump off system.</p>
<p>5.</p>	<p>To aid in reassembly, it is useful to draw a line across the three flanges (reactor, chuck, and cone) using a permanent marker. This helps to align the flanges correctly when the chamber is re-assembled.</p>		
<p>6.</p>	<p>The heated chuck and lower assembly flange is very heavy. Use extreme care when removing bolts. Two people are required to support the assembly during this procedure.</p> <p>Carefully remove the 32 long bolts, nuts and washers which hold the lower section of the process chamber in place.</p> <p>The weight of the trap cone and chuck will be supported by the three large retaining bolts. While someone else supports the weight, remove the three retaining bolts.</p>		<p>CAUTION! LIFTING HAZARD! Two people are required to perform this procedure due to the weight and location of the process chamber components.</p> 

<p>7.</p>	<p>Carefully move the assembly to a work bench and remove the chuck from the assembly.</p> <p>Discard the copper gasket.</p>	<p>CAUTION! TIP/DROP HAZARD! Take extreme care when the cone and chuck are being removed as they are not physically attached to each other. The chuck could fall off if the cone is tipped.</p>  <p>Lift chuck assembly off of trap assembly.</p>
<p>8.</p>	<p>Remove the used trap. The used trap can be cleaned or discarded according to your local and facility's safety and disposal regulations. Discard the second copper gasket.</p>	
<p>9.</p>	<p>Install a new trap and new copper gasket.</p> <p>Verify that the copper gasket will fit in the groove without modification.</p> <p>CAUTION! LEAK HAZARD NEVER RE-USE copper gaskets or the system will leak.</p>	

<p>10.</p>	<p>Re-install the chuck heater onto the assembly and install a new copper gasket on the top of the assembly as shown.</p> <p>Make sure the gasket will fit the reactor's gasket groove without modification.</p> <p>Use the mark made on the side of the flanges to align the chuck to the cone. This ensures that the chuck's RTD and heater wires are in the correct position.</p>	 <p>Note: A new chuck heater is shown. The chuck will discolor when heated. This is normal.</p>
<p>11.</p>	<p>Re-install the assembly into the machine.</p> <p>Use two people: one to hold the assembly, the other to bolt the assembly to the machine frame.</p> <p>Install the 3 large bolts on the flange to hold the system loosely in place.</p>	 <p>One person holds assembly in place while second person secures assembly with 3 large bolts on flange.</p>

12.	<p>At first, install 4 bolts on opposite corners of the flange, to slightly tighten the flange in place.</p> <p>Continue to install and tighten each of the 32 bolts in a star-cross pattern, going back and forth from one side of the flange to the other, fully tightening the bolts, then re-tighten each bolt.</p> <p>Check the final tightness of each bolt 3 times to ensure proper tightness of the assembly.</p>	<p>It is recommended that you REPLACE all 32 bolts and nuts either every time you replace the assembly or every other time you replace the assembly.</p> <p>The bolts and nuts are subject to thermal stress and need to be replaced on a periodic basis.</p>
13.	Install components as necessary to pull vacuum on the chamber.	Connect the system to a vacuum source.
14.	Once under vacuum, re-tighten each bolt.	
15.	Re-install the turbo pump, vacuum flanges and components from the lower assembly. Use new o-rings each time you replace the trap.	Centering rings typically ship with Viton o-rings. You must REPLACE the Viton o-rings with Kalrez o-rings, or the system will leak. Kalrez o-rings are required for the short and long-term heat exposure from the system.
16.	Re-install heater blankets and re-connect heater leads.	

Vacuum Gauge maintenance procedure

Overview

Due to its location in the pumping system, the vacuum gauge is susceptible to deposition of ALD film. While the vacuum gauge is fairly robust, it will become increasingly inaccurate as the amount of precursor is deposited on it increases.

The pressure read by the gauge will slowly rise over time as film builds up on the gauge. As the lifetime of the gauge is dependent on precursor overdosing, it is difficult to assign a lifetime on the vacuum gauge. Using minimal precursor overdoses is recommended for elongating the lifetime of your pump and gauge.

Using Alcatel ACP 120G pumps, a typical base pressure of a new system ranges between 6 and 15 mTorr (0.006 to 0.015 Torr; $6e^{-3}$ to $1.5e^{-2}$ Torr). When the pressure on the gauge rises to, 60-80 mTorr, replacement of the gauge is recommended.

As degraded performance of the vacuum pump and gauge go hand-in-hand, it is recommended to have a replacement gauge to verify the calibration of the in use gauge. This can be done by connecting the backup gauge to the pump to determine its base pressure.



Vacuum gauge with extensive film buildup

The vacuum gauge is an:

Edwards Vacuum

APGX-H Active Linear Convection Gauge NW 16 ST/ST

Item Number: D023-95-00

Replacements can be ordered from Cambridge Nanotech or via your local Edwards Vacuum distributor.

Often the entire gauge does not need to be replaced. Only the gauge “tube” needs to be swapped out and fitted onto the electronics box.



Edwards APGX-H NW 16 Vacuum Gauge



Edwards APGX-H NW 16 Tube Spare

Required Parts

Part Number	Description	QTY
D023-95-801	APGX-H Active Linear Convection Gauge Tube Spare NW 16 ST/ST	1

Required Equipment/Tools

- Phillips head screwdriver
- O-ring pick

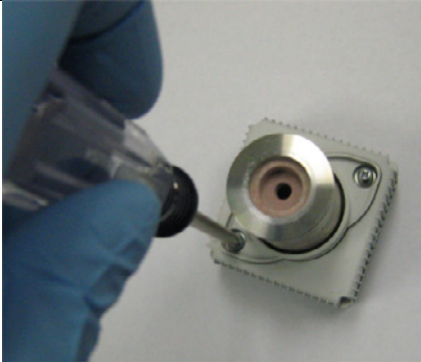
Safety Cautions


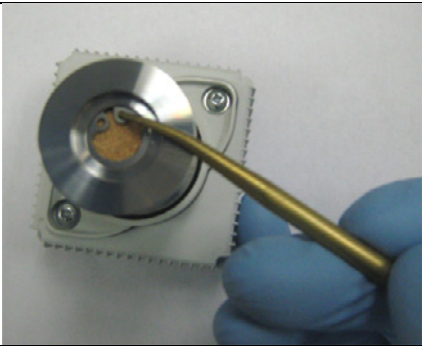



WARNING: CHEMICAL HAZARD! Wear chemical-resistant garments and eye protection while performing system maintenance. Avoid skin contact and inhalation of any component exposed to process chemicals/gases.



WARNING: BURN HAZARD! Allow system components to properly cool prior to performing maintenance to avoid personal injury.

Step	Action	Details
1.	Refer to the system operation manual to turn off the heating jacket for the stopvalve/vacuum gauge. Turn off the heating line for the pump line bellows	
2.	Turn off the vacuum pump.	
3.	Disconnect the RJ-45 cable from the gauge.	
4.	Remove the NW16 clamp and examine the vacuum gauge. If you can see sufficient buildup inside the gauge tube, it is time to replace the gauge. If replacing the entire tube, go to step 9.	
5.	Loosen the screws from the vacuum gauge electronic box	

6.	Remove the tube by pulling it away from the electronics box.		
7.	Insert a new tube into the electronics box by matching up the port connections and the alignment tab.		
8.	Fasten the screws back into the electronics box		
9.	Remove the copper filter from the gauge by compressing the circular ring. If left in, the filter will quickly plug with deposited film and prevent the gauge from accurately reading the pressure.		
10.	Reconnect the vacuum gauge onto the pumping line using the O-ring, gasket and NW-16 clamp. A new NW-16 O-ring and gasket may be required if significant buildup has accumulated on the parts.		

Fiji F200 - Substrate Carrier and Transfer Chamber Cleaning

Required Parts

None

Required Equipment/Tools

Cleaning solutions/wipes.

Safety Cautions



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WARNING: BURN HAZARD! Allow system components to properly cool prior to performing maintenance to avoid personal injury.

Step	Action	Details
1.	Turn OFF system heaters and allow the system to cool.	
2.	Refer to the operation manual to bring the transfer chamber to atmospheric pressure.	
3.	With the load arm fully retracted, open the transfer chamber and remove the substrate carrier from the end of the transfer arm.	
4.	Clean the substrate carrier and the interior of the transfer chamber according to your standard practices.	Consult Cambridge NanoTech for advice on any cleaning protocols.
5.	Re-install the substrate carrier: Fully seat the carrier square against the back of the transfer arm's end.	

Precursor Cylinder Replacement Procedure

Required Parts

Part Number	Description	QTY
SS-4-VCR2 or SS-4 VCR-2-GR (with retaining clip)	1/4" metal VCR gaskets	1 per bottle

Required Equipment/Tools

- 3/4" open end wrench
- 13/16" open end wrench

Safety Cautions



WARNING: CHEMICAL HAZARD! Wear chemical-resistant garments and eye protection while performing system maintenance. Avoid skin contact and inhalation of any component exposed to process chemicals/gases. NEVER open a gas cylinder unless it is properly attached to a degassed plumbing system.



WARNING: BURN HAZARD! Allow system components to properly cool prior to performing maintenance to avoid personal injury.



DANGER: FIRE HAZARD! Follow instructions carefully. Never open any valves until specifically directed to do so. Certain precursors will ignite upon exposure to air.

Manual Valve Selection

The green headed ball valve (SS-4H-VCR) is a ball valve and can be heated to 220°C. The valve should be assembled with the arrow facing down into the cylinder. This configuration leaves a smaller dead space between the ALD valve and the manual valve and helps to minimize clogged lines once installed into the system.

While Cambridge NanoTech systems ship with SS-4H-VCR ball valves, an optional bellows valve SS-42GVCR4 can also be used. These valves are not for use with precursors requiring heating over 120°C.

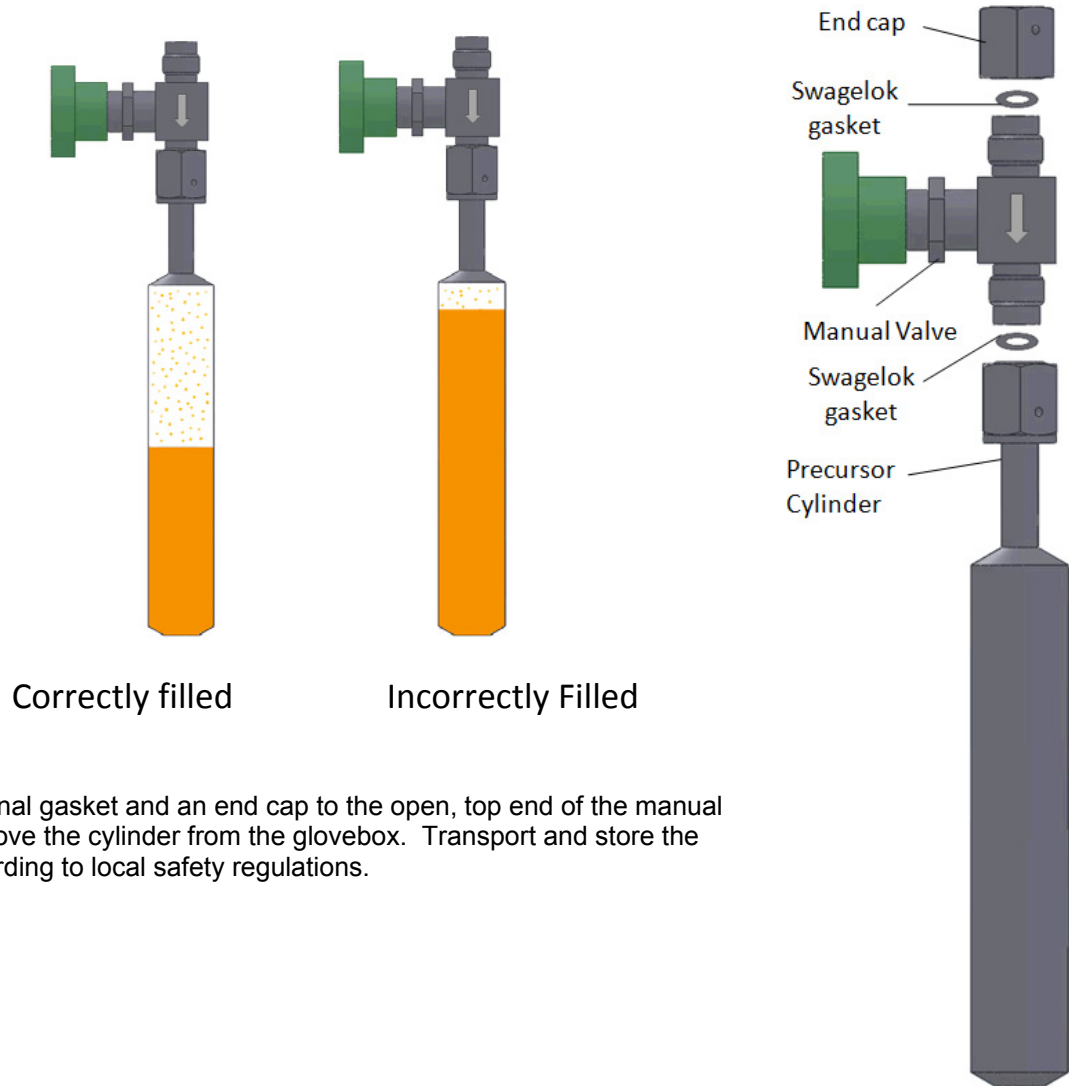
Filling the ALD Precursor Cylinder

Many ALD precursors are air sensitive and/or pyrophoric. Therefore, precursors should be filled in inert atmosphere, such as a glovebox. Remember to consult the MSDS sheets for each precursor to determine the precautions required. Chemical suppliers, such as Strem Chemicals, Sigma-Aldrich, Rohm & Hass, Gelest, etc. can provide services of empty precursor cylinders. Sigma-Aldrich sells some common precursors pre-packaged in cylinders. Strem Chemicals sells a compatible cylinder which can be custom filled.

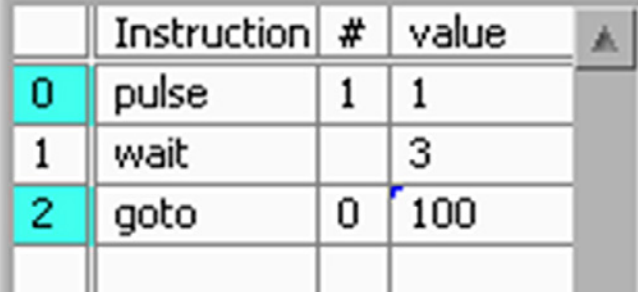

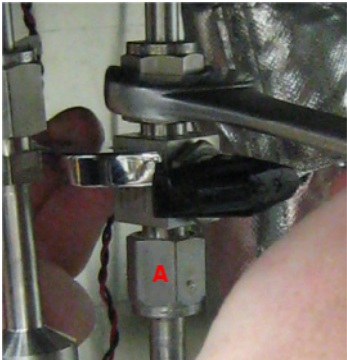
After removing the manual valve and gasket from the empty precursor cylinder, bring the items into a glovebox according to established procedures. Once inside the box, dispense the precursor into the cylinder using a pipette, funnel or other device so that precursor does not remain on the VCR fitting. Insert a new gasket and re-attach the manual valves, using a 3/4" and a 13/16" wrench to turn the valve one quarter turn past finger tight.

Precursors should be dispensed into the cylinder so that they are no more than half full (or 25cc of material). This allows sufficient room for the precursor to volatilize. As the precursor dose is based on the vapor phase in the cylinder, if the cylinder is filled more than half full the precursor dose may be smaller than expected. This may result in no film growing.

CAUTION: OVERFILLING THE CYLINDER MAY RESULT IN LIQUID BEING PULLED INTO THE SYSTEM.



Add an additional gasket and an end cap to the open, top end of the manual valve and remove the cylinder from the glovebox. Transport and store the cylinders according to local safety regulations.

Step	Action	Details																
1.	Close the manual valve on the precursor bottle you will replace. DO NOT REMOVE THE BOTTLE AT THIS TIME!	CAUTION: HOT SURFACE! If the precursor cylinder is hot, use thermal resistant gloves to close the manual valve. Close the valve by turning the valve head in the direction indicated.																
2.	With the precursor bottle valve closed, purge the space between the manual valve and the ALD valve as follows: Setup and run a pulse-purge recipe as follows (where X is the cylinder to be removed). Set the recipe to "open" the valve "X" for 1 second <table border="1"> <thead> <tr> <th></th> <th>Instruction</th> <th>#</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Pulse</td> <td>X</td> <td>1</td> </tr> <tr> <td>1</td> <td>Wait</td> <td></td> <td>3</td> </tr> <tr> <td>2</td> <td>Goto</td> <td>1</td> <td>100</td> </tr> </tbody> </table> Pulse time. Set the Wait time to 3 seconds and the Ar carrier gas Flow to 100 sccm. Repeat 100 times with the "goto" command.		Instruction	#	Value	0	Pulse	X	1	1	Wait		3	2	Goto	1	100	 Sample recipe shown above.
	Instruction	#	Value															
0	Pulse	X	1															
1	Wait		3															
2	Goto	1	100															
3.	Continue to purge the headspace until the base pressure during this run is the same as the base pressure of the system.	Approximately 100 cycles will be required to purge the cylinder's headspace. Ensure that the pressure plot does not have any peaks for the last few pulses. If not, repeat the program to ensure the space is evacuated.																
4.	If applicable, turn off the power to the precursor heating jacket by setting the temperature value to 0. This can be done by using the heater command in a recipe or by putting the cursor in the appropriate heater box and entering 0.																	
5.	When cool, remove the precursor heating jacket from the cylinder.																	
6.	Again verify that the precursor valve is closed.																	
7.	Use two wrenches to remove the bottle: one on each end of the VCR fitting.  DANGER! Pay special attention to NOT turn the VCR fitting below the manual valve!	Remove the cylinder by gripping the square of the manual valve with a 13/16" wrench and the ALD valve connection with a 3/4" wrench. Rotate the top 3/4" wrench clockwise. CAUTION! Do not twist the bottom connection to the precursor cylinder (labeled "A") in figure. This will disconnect the manual valve from the precursor. 																

	<u>Installing a new Cylinder</u>																	
1.	In the empty precursor port, add a new precursor cylinder with a new, genuine Swagelok gasket (SS-4-VCR-2) or (SS-4-VCR-2-GR) on top of the connection.	Use a new metal gasket each time you open the VCR fitting.																
2.	Tighten the cylinder by gripping the square of the manual valve with a 13/16" wrench and the ALD valve connection with a 3/4" wrench. Tighten the fitting hand-tight, then 1/4" turn past hand-tight.	CAUTION! LEAK HAZARD! DO NOT OVER-TIGHTEN or the fitting will leak!																
3.	Degas the headspace between the ALD and manual valve of the precursors by writing and executing the instruction set (recipe) below. "X" corresponds to precursor cylinder #. Pulse time of 1 second, and the Wait time set to approximately 15 seconds. Keep the manual valve on the precursor <u>closed</u> , while degassing. <table border="1" data-bbox="386 968 787 1131"> <thead> <tr> <th></th> <th>Instruction</th> <th>#</th> <th>value</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Pulse</td> <td>x</td> <td>1</td> </tr> <tr> <td>1</td> <td>Wait</td> <td></td> <td>15</td> </tr> <tr> <td>2</td> <td>Goto</td> <td>0</td> <td>100</td> </tr> </tbody> </table> <p><i>Precursor Cylinder degas recipe</i></p>		Instruction	#	value	0	Pulse	x	1	1	Wait		15	2	Goto	0	100	
	Instruction	#	value															
0	Pulse	x	1															
1	Wait		15															
2	Goto	0	100															
4.	When the base pressure during this run is the same as the base pressure of the system then this area has been degassed. Approximately 100 cycles will degas a precursor headspace.	Note: Degas the headspace of atmospheric gases before opening the manual valve every time the space between manual and ALD valves has been exposed to air. Also degas this area after closing the manual valve if the ALD valve is to be removed.																
5.	Open the manual valve.																	
6.	Reinstall the precursor heating jacket (if applicable).																	
7.	Follow the instructions in your operation manual to restore heat to any heater blankets.																	

Refill the DI Water Cylinder

Required Parts

Part Number	Description	QTY
SS-4-VCR2 or SS-4 VCR-2-GR (with retaining clip)	1/4" metal VCR gaskets	1 per bottle

Required Equipment/Tools

- 3/4" open end wrench
- 13/16" open end wrench

Safety Cautions



WARNING: CHEMICAL HAZARD! Wear chemical-resistant garments and eye protection while performing system maintenance. Avoid skin contact and inhalation of any component exposed to process chemicals/gases. NEVER open a gas cylinder unless it is properly attached to a degassed plumbing system.



WARNING: BURN HAZARD! Allow system components to properly cool prior to performing maintenance to avoid personal injury.

Step	Action	Details																				
1.	Use two wrenches to remove the bottle: one on each end of the VCR fitting.																					
2.	Remove the DI water cylinder and refill.																					
3.	Re-install the filled DI water cylinder with a new, genuine Swagelok gasket (SS-4-VCR-2) or (SS-4-VCR-2-GR) on top of the connection.	Use a new metal gasket each time you open the VCR fitting.																				
4.	Tighten the cylinder fitting hand-tight, then 1/4" turn past hand-tight.	CAUTION! LEAK HAZARD! DO NOT OVER-TIGHTEN or the fitting will leak!																				
5.	Purge the sample space between the ALD valve and the water cylinder by running the pulse-purge recipe again: <table border="1" data-bbox="289 1539 683 1713"> <thead> <tr> <th></th> <th>Instruction</th> <th>#</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>pulse</td> <td>1</td> <td>0.1</td> </tr> <tr> <td>1</td> <td>wait</td> <td></td> <td>10</td> </tr> <tr> <td>2</td> <td>goto</td> <td>1</td> <td>10</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>		Instruction	#	Value	0	pulse	1	0.1	1	wait		10	2	goto	1	10					
	Instruction	#	Value																			
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2	goto	1	10																			

Fiji F200 – Process Component Swap-out for Cleaning

Overview

Regular maintenance is key to prolonging the lifetime of any system, Cambridge Nanotech recommends having the process chamber and components cleaned yearly, or on a periodic schedule based on system usage. The chamber may need to be cleaned sooner depending on the type of film grown or if the conditions of use are abnormal.

Required Parts

Part Number	Description	QTY
CAG-0001	Gasket, Copper, Chuck	2
CAG-0002	Trap	1
	Gasket, Copper, Turbo Pump Connection	1
NW-50-CR-SV (Nor-Cal or equiv.) K330-7075 (Nianic or equiv.)	*Centering Ring, Kalrez®, KF50	1
NW-16-CR-SV (Nor-Cal or equiv.) K314-7075 (Nianic or equiv.)	*Centering Ring, Kalrez®, KF16	1
92198A315 (McMaster)	Chuck Retention Bolts, 10-24, 4"	32
96659A107 (McMaster)	Chuck Retention Washers	32
91847A430 (McMaster)	Chuck Retention Nuts	32
CAG-0003	Gasket, Copper, Plasma connection	1
2-258	Viton® o-ring	2

*Remove and discard non-Kalrez® o-ring, install and use Kalrez® o-ring.

Required Equipment/Tools

- 3/4" open end wrench
- 5/8" open end wrench
- Standard wrench set

Safety Cautions



WARNING: CHEMICAL HAZARD! Wear chemical-resistant garments and eye protection while performing system maintenance. Avoid skin contact and inhalation of any component exposed to process chemicals/gases. NEVER open a gas cylinder unless it is properly attached to a degassed plumbing system.



WARNING: BURN HAZARD! Allow system components to properly cool prior to performing maintenance to avoid personal injury.

Step	Action	Details
1.	Open the process chamber door/s while warm then turn off all heater and allow all components to cool. Remove heater jackets and all connections.	
2.	Refer to the Fiji F200 Trap Replacement Procedure to remove all system process chamber components. Additionally, remove the plasma source and all gas connections to the process chamber and remove the process chamber from the system.	
3.	Replace process components with spare set and re-assemble.	Refer to component cleaning procedure for cleaning guidelines.

Fiji F200 – Process Component Cleaning

Overview

Regular maintenance is key to prolonging the lifetime of any system, Cambridge Nanotech recommends having the process chamber and components cleaned yearly, or on a periodic schedule based on system usage. The chamber may need to be cleaned sooner depending on the type of film grown or if the conditions of use are abnormal.

Please refer to the Trap Replacement Procedure and Trap Cleaning Procedure for related information.

Any bead-blast and/or surface cleaning procedure is recommended for use by professional machine and/or vacuum repair shops and not the average user. **Do not attempt these cleaning procedures if not properly trained or qualified to use the equipment described below.** Follow local laws and guidelines for proper disposal of hazardous materials including cleaning media, material and films/particulate that have accumulated inside of the reactor chamber.

Sandblasting and nickel plating the reactor chamber and/or lid is not recommended by Cambridge Nanotech. If nicks, scrapes or burrs occur in the reactor chamber it is recommended that replacement parts be obtained from Cambridge Nanotech.

Required Parts

Required Equipment/Tools

Safety Cautions



WARNING: CHEMICAL HAZARD! Wear chemical-resistant garments and eye protection while performing system maintenance. Avoid skin contact and inhalation of any component exposed to process chemicals/gases. NEVER open a gas cylinder unless it is properly attached to a degassed plumbing system.

Step	Action	Details
1.	Protect all fittings and seal surfaces by capping the KF & VCR [®] fittings with sacrificial O-rings, connectors, flanges, or VCR [®] gaskets. Tape is not recommended as it can be extremely difficult to remove and residual organics may burn / outgas in the subsequent steps.	The heated chuck has holes for RTDs embedded into the unit. Care must be taken to ensure that any cleaning of the chuck surface does not damage the chuck nor the RTD holes.
2.	Bead blast the chamber surfaces with aluminum oxide glass bead Specs: 80 grit, 40 psi pressure max .	
3.	Perform a light air-blow down on the chamber to remove loose beads.	
4.	Process for 10 to 15 min in a citric based metal cleaner bath (i.e Cita-sol)	
5.	Rinse in DI water.	
6.	Clean via ultrasonication in DI water.	
7.	N ₂ blow dry; followed by a bake in flowing N ₂ at 105°C.	

Fiji F200 – Trap Cleaning Procedure

Overview

Periodic cleaning of the trap is suggested with a concentrated basic solution. Consult appropriate MSDS sheets and take proper safety precautions before using caustic solution. Do not attempt to follow these cleaning procedures if not properly trained for handling such chemicals.

Please refer to the Trap Replacement Procedure for related information.

Required Parts

Required Equipment/Tools

Safety Cautions



WARNING: CHEMICAL HAZARD! Wear chemical-resistant garments and eye protection while performing system maintenance. Avoid skin contact and inhalation of any component exposed to process chemicals/gases. NEVER open a gas cylinder unless it is properly attached to a degassed plumbing system.

Step	Action	Details
1.	Prepare a 25% by weight KOH etch solution. Ensure there is enough to fully submerge the trap. Heat the solution to 80°C.	
2.	Place the trap in solution for 5 to 10 minutes.	
3.	Submerge the trap in DI rinse water.	
4.	Cleaning via ultrasonication is recommended if available.	
5.	Submerge the trap in fresh DI water again.	
6.	Blow dry internal matrix with N ₂ .	
7.	(optional) Bake in flowing N ₂ at 105°C	
8.	Thoroughly dry before reinstalling trap.	

Backup Recipe and System Data

Cambridge NanoTech recommends that you adopt a scheduled strategy for periodic backup of all system configuration, recipe, and process run data information.

Your backup protocol can be as simple as downloading data to a flash drive, or connecting your system to an external hard drive or a network server to ensure no loss of data.

You should monitor the hard disk usage, and delete any old process information which is no longer required. A minimum of 4 GB of free hard-drive disk space should be maintained on the system all times to all proper operation.

Appendix A Manual General Information

General Notes

The manufacturer reserves the right to make changes to the product covered in this manual to improve performance, reliability or manufacturability. Although every effort has been made to ensure accuracy of the information contained in this manual, the manufacturer assumes no responsibility for inadvertent errors. Contents of the manual are subject to change without notice.

Using this Manual

Purpose

This manual provides the following information for the Fiji F200:

- System safety
- System description
- Maintenance procedures
- Reference schematics

Scope

This manual covers the Fiji F200 V2 system only.

Revision History

Revision	Date	Changes
1.0		

Related Documents

Please refer to the *Fiji F200 Installation and Use Manual* for details on system installation and operation.

Recommended Training for Maintenance Personnel

All maintenance personnel should be familiar with the system operation and documentation, and possess a thorough understanding of the safety considerations and system startup/shutdown procedures. Topics of focus should include:

- System safety
- System/component review
- System startup (see operation manual)
- Software operation (see operation manual)
- System maintenance
- System shutdown (see operation manual)
- Equipment location lockout/tagout procedures (consult your facility safety dept.)

All items are covered in detail in this manual or in related documents to ensure that experienced maintenance personnel can safely and efficiently perform each task.

Appendix B Safety

Introduction

Read and follow these safety instructions. Task and equipment specific warnings, cautions, and instructions are included in equipment documentation where appropriate.

Make sure all equipment documentation, including these instructions, is accessible to persons operating or servicing equipment.

Qualified Personnel

Equipment owners are responsible for making sure that Cambridge NanoTech Inc. equipment is installed, operated, and serviced by qualified personnel. Qualified personnel are those employees or contractors who are trained to safely perform their assigned tasks. They are familiar with all relevant safety rules and regulations and are physically capable of performing their assigned tasks.

Intended Use

Use of Cambridge NanoTech Inc. equipment in ways other than those described in the documentation supplied with the equipment may result in injury to persons or damage to property.

Some examples of unintended use of equipment include:

- using incompatible materials
- making unauthorized modifications
- removing or bypassing safety guards or interlocks
- using incompatible or damaged parts
- using unapproved auxiliary equipment
- operating equipment in excess of maximum ratings

Regulations and Approvals

Make sure all equipment is rated and approved for the environment in which it is used. Any approvals obtained for Cambridge NanoTech Inc. equipment will be voided if instructions for installation, operation, and service are not followed.

Client Modifications





Modifications to the system including, but not limited to changes to vacuum hardware, electronics, and software, void all warranty and liability.



Definitions for Signal Words

The following are definitions for signal words for this system:

Label	Meaning
DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or damage to equipment.

Safety Symbols

Symbol	Meaning
	<p>SHOCK HAZARD Electric voltage present. Take appropriate measures to protect yourself from electrical shock.</p> <p>The “lightning bolt within a triangle” symbol (reference IEC Publication 417, Symbol No. 5036, and ISO Publication 3864, No. B.3.6) is used in and/or on the equipment to alert the user, operator, or service personnel to the presence of un-insulated voltage within the enclosure of sufficient magnitude to constitute a risk of electric shock. <u>Only authorized service personnel with a thorough knowledge of the voltages existing within the equipment shall remove covers or panels from the product bearing this symbol.</u> This symbol is also used within the product manual itself to identify important operating and/or maintenance instructions, which, if not followed carefully, could result in personal injury or even death.</p>
	<p>RISK OF FIRE The “flame within a triangle” symbol (reference IEC Publication 417, and ISO Publication 3864) is used in and or on the equipment to <u>alert the user, operator, or service personnel to the potential of fire hazard, including that caused by gases which may ignite upon contact with air (pyrophoric gases). Only authorized service personnel with a thorough knowledge of the gases existing within the equipment shall remove covers or panels from the product bearing this symbol.</u> This symbol is also used within the product manual itself to identify important operating and/or maintenance instructions, which, if not followed carefully, could result in personal injury or even death.</p>
	<p>PINCH HAZARD This symbol is used in the product manual to identify a pinch hazard such as a door, panel, fixture, or overall system handling which could cause a pinch or crushing hazard.</p>
	<p>TOXIC MATERIAL HAZARD This symbol is used in the product manual to identify sources of toxic gas materials. While the system is NOT shipped with any precursors or other gases, the customer and end-user must be aware of on-site gas usage and its resulting hazards.</p>

	<p>BURN HAZARD This symbol is used in the product manual to identify sources of burn hazards. Do not touch hot surfaces! Allow the system components to properly cool before performing maintenance tasks or touching hot parts.</p>
	<p>HEAVY/AWKWARD OBJECT LIFT HAZARD! This symbol is used in the product manual to identify procedures where a minimum of two people are required to lift a heavy or unbalanced/awkward object.</p>

Personal Safety

To prevent injury follow these instructions:

DANGER: Do not operate or service equipment unless you are qualified and have fully read and understood the manual and warning labels on the system. Contact Cambridge NanoTech Inc. with any questions in case of uncertainties.

DANGER: Removal of power cables from the system must be performed by a trained and licensed electrician or service personnel.

DANGER: Obtain and read Material Safety Data Sheets (MSDS) for all materials used. Follow the manufacturer's instructions for safe handling and use of materials, and use recommended personal protection devices.

WARNING: Do not operate equipment unless safety guards, doors, or covers are intact and automatic interlocks are operating properly. Do not bypass or disarm any safety devices.

WARNING: Before adjusting or servicing equipment, or touching any of the parts, turn off the heaters in the software, wait until all temperature sensors are at room temperature, then shut off the power supply and unplug the main power and wait until all unmonitored parts have cooled down. Lock out power and secure the equipment.

WARNING: Relieve (bleed off) pneumatic pressure before adjusting or servicing pressurized systems or components, such as gas cylinders. Never disconnect high pressure gas cylinders without specific knowledge. Refer to your supplier for instructions.

WARNING: To prevent injury, be aware of less-obvious dangers in the workplace that often cannot be completely eliminated, such as hot surfaces, sharp edges, energized electrical circuits, and moving parts that cannot be enclosed or otherwise guarded for practical reasons.

CAUTION: DO NOT use this equipment in any manner not specified by the manufacturer. If the equipment is used in a manner other than as specified in this document, the safety protections may be impaired.

CAUTION: Fittings and components damage easily: handle all components with extreme care. DO NOT scratch or over-tighten any component.

CAUTION: End of life statement. De-commissioning of, or any part of, the system shall be in a manner that is consistent with appropriate regulations and guidelines.

Equipment Safety Labels Locations

System hazards are identified via safety labels attached to the cabinet, modules and components of the system where appropriate. Labels help to identify potential system hazards. They do not replace the safety rules and regulations established at the customer's facility. The labels and their location on the cabinet vary with component configuration, but are always placed on panels to alert the trained maintenance technician to a potential hazard.

EMO, Safety Switches

An Emergency Power Off switch is provided on the front panel of the system and on the right and left sides of the system. Pressing the EMO switch shuts down power system. CAUTION: Live feed power remains internal to the system!



DANGER ELECTROCUTION HAZARD!

Pressing an EMO button disables power to the system components and shuts-down the system (turns off plasma generators, returns valves to their default states, removes power from electronics, computers, heaters, etc.). Live power to the system remains at the main power inlet connection and at transformer and main breaker panels. You must lock and tagout power at the facility's remote panel to remove all power from the system. Qualified, trained maintenance electrical technicians must verify the removal of voltage with an appropriate meter prior to working to the system's power supply prior to performing any required work.

Fire Safety

To avoid a fire or explosion, follow these instructions.

- Do not place flammable materials underneath, on or near the unit. Do not place paperwork, clothing etc. on or near the unit.
- Do not run the system unattended. Note that in standby mode, all heaters are at process temperatures with the door/s closed and under vacuum.
- Do not heat materials to temperatures above those recommended by the manufacturer. Make sure heat monitoring and limiting devices are working properly. Note the maximum temperature settings for different parts.

Heater Location	Max. Temperature	Notes
ALD Pulse Valves	200°C	ALD pulse valves are rated to 200°C and should not be heated above that temperature.
Process Chamber	250°C	The heaters are rated at 300°C, but cannot be set higher than 250°C because of the Kalrez™ O-rings.
Trap Heater, Cone Heater	250°C	
MKS Jalapeno Valve	150°C	
Chuck	500°C	Typical setting is 250°C.
Precursors	200°C See WARNING!	WARNING: Temperature of the precursors should not exceed safety or decomposition temperature of the chemical used.

- The pump may exhaust small amounts of unreacted precursor. Since Cambridge NanoTech Inc. does not supply the chemicals, responsibility for safe venting and exhausting lies with the customer. General exhaust recommendations include using inert pumping fluid such as Fomblin SV, fireproof metallic exhaust lines to prevent fire. Refer to local codes or your material MSDS for guidance. Minimize precursor use. Do not add vapor traps in the pumping line, upon exposure to air, large amounts of trapped precursor may ignite or cause chemical burns.

- The system exhaust (6"dia, 200CFM @ .5" W.C.) must be connected to a facility thermal exhaust system. Refer to facility requirements drawing for specifications.
- Know where emergency stop buttons, shutoff valves, and fire extinguishers are located.
- Clean, maintain, test, and repair equipment according to the instructions in your equipment documentation.
- Use only replacement parts that are designed for use with original equipment. Contact your Cambridge NanoTech Inc. representative for parts information and advice.

Electrical Safety

To avoid electric shocks, follow these instructions.



- At the time of installation the stainless steel system cabinet must be grounded by attaching the supplied ground wire to the facilities grounding loop.
- Turn off and unplug the electronic control unit prior to connecting or disconnecting any sensor, heater, valve or other components.
- Do not disconnect live electrical circuits while working with flammable materials. Shut off main power first to prevent sparking

Mechanical Hazards

Mechanical Hazard Locations

The system can cause crushing or pinching hazards, including pinch hazards from the panels during installation/maintenance and doors during operation. Heavy components such as the process chamber pose a potential for injury during system maintenance as these internal system components are heavy. Care must be taken during maintenance to prevent damage or injury.

The system must be secured to the floor with proper seismic tiedowns to prevent tipping.

Electrical Hazards

- F200: 4 wire 220 VAC 60 Hz **50A**. Connections = (L1 = 110 VAC 60 Hz (line 1 = red), L2 = 110 VAC 60 Hz (line 2 = black), N (neutral = white), G (ground = green) [color scheme by US National Electrical Code])
- Europe. (220VAC is one line at 230 VAC 50 Hz)
F200: 3 wire 220 VAC 50 Hz **50A**. (L1 = 220VAC 50 Hz (line 1 = Brown), N (neutral = Blue), G (ground = green-yellow) [color scheme by IEC (International Electrotechnical Commission)])

Wire must be 6-8 AWG stranded. Current <35 Amps in continuous operation.

The main input power connection is located at the top of the system. The system may contain transformer/s and power conditioners which present live electric power hazards.



DANGER: Electrical Hazard. DO NOT OPEN COVERS to access electrical equipment with the power on, unless you are certified to perform specific troubleshooting/repair tasks.

Chemical Hazards

To avoid chemical hazards, follow these instructions.

Precursors Fire Hazards

- Know the nature of the precursors you are working with (read MSDS).



DANGER! FIRE HAZARD

Some precursors such as trimethylaluminum (TMA) are pyrophoric—they burn upon exposure to air. Precursors should never be disconnected from the manual valve they were supplied with. Make sure that manual valve is closed before removing the precursor-valve combination from the system.

Pump/purge the space between ALD valve and manual valve before disconnecting any precursor. Always wear proper protection equipment when removing precursors. Precursor replacement should only be conducted by qualified personnel. Read the section on precursor removal before proceeding. Cambridge NanoTech Inc. can be reached for safety assistance with precursor replacement/removal procedure, although the final responsibility lies with the user.

Location of Chemical Supplies

All chemical/gas connectors are located at the top of the system, or through the rear of the system (precursor cylinders). The manufacturer does not supply process chemicals with this system.

Material Safety Data Sheets

Material Safety Data Sheets (MSDS) for every chemical used with the system should be available to all users of the system at all times. Each user should be trained on the specific gases/chemicals used with the system, and be certified in safe operation of the system. The MSDS covering all materials used in the process must be prominently displayed in the immediate vicinity of the machine.

Recommended Practices

Operational Notes

System with Turbo Pumps

WARNING! POTENTIAL DAMAGE TO TURBO PUMPS

Excessive dosing of precursors like Trimethylaluminum (TMA) can result in precursor gases escaping the Fiji's integrated vapor trap causing deposits to form in the turbo pump. Film deposits in the turbo pump will greatly shorten the life of the turbo pump. It is recommended that the proper precursor dosage be determined by starting with the lowest precursor pulse time and increasing pulse times only as necessary. Please use standard Cambridge NanoTech Fiji recipes as a guide or contact Cambridge NanoTech support (support@cambridgenanotech.com) for consultation.

Best Practices

- Connect all input gas and electrical lines according to the manufacturer specifications or best commercial practice. Always check the fittings before operating.
- USE THE BUDDY SYSTEM: ALWAYS perform maintenance procedures in teams of two or more people; one to monitor the surrounding systems, the maintenance environment, your actions and to ensure all documentation and safety steps are followed.
- ALWAYS observe all warning labels.

Help

Always work in teams of two or more when performing any tasks which require the removal of system panels.

Always seek additional help when:

- You are instructed by any procedure.
- You see an emergency or dangerous situation.
- You are not trained or qualified/certified to perform a task.
- You feel uncomfortable performing a task.

Evacuations

In case of an emergency evacuation:

- EXIT the building through the nearest exit and report to your assigned evacuation area.
- DO NOT stop to turn off any machines.
- DO NOT move any carts or equipment during evacuation.
- Obey all commands from the emergency response team.
- Return to the building ONLY AFTER being instructed to do so by the emergency response team.

Action in the Event of a Malfunction

If a system or any equipment in a system malfunctions, shut off the system immediately and perform the following steps:

- Disconnect and lock out system electrical power. Close valves and relieve pressures.
- Identify the reason of the malfunction and correct it before restarting the system

Disposal

Dispose of equipment and materials used in operation and servicing according to local codes.