MA-3 *Solo* Service Manual

Nippon Instruments Corporation

Technical Service Group

	Date	Prepared	Checked	Approved
First Edition	2020/2/19	Kinoshita	-	Noda

MA-3 *Solo* - Service Manual

Contents

1. Introduction

Ensure to refer to this service manual before conducting the inspection, repairs, or maintenance of Mercury Analyzer MA-3 Solo. This service manual is intended for engineers who will have proper training and conduct the inspection, repairs, or maintenance of the Analyzer.

1.1. Safety instructions

To safely handle this product, observe the following instructions.

1.1.1. Meaning of safety alert symbols

DANGER	Denotes that incorrect handling may put the user in imminent danger of death of or a serious injury.
WARNING	Denotes that incorrect handling may result in the user's death or a serious injury.
CAUTION	Denotes that incorrect handling may result in the user's injury or property damage.

1.1.2. Cautions on installation

DANGER	Do not place anything flammable or combustible around the Analyzer. Otherwise, a fire may result.
WARNING	In the course of thermal decomposition analysis, some measurement samples may generate gas harmful to the human body. Therefore, we recommend connecting the Analyzer to exhaust equipment/facilities.
CAUTION	➢ Be sure to use the supplied power cable. Using another cable may lead to a failure. ➢ Observe the specified installation environment and power specifications. Otherwise, a failure may result. ➢ Install the Analyzer on a flat and horizontal surface of a workbench with adequate strength. Otherwise, the Analyzer may tip over or fall, thus leading to a minor injury and/or a failure. ➢ Provide at least 150 mm space from the back of the Analyzer to vent heat from the upper back section of the Analyzer (venting to general atmosphere) as well as to secure workspace so that the operator can turn on/off the power.

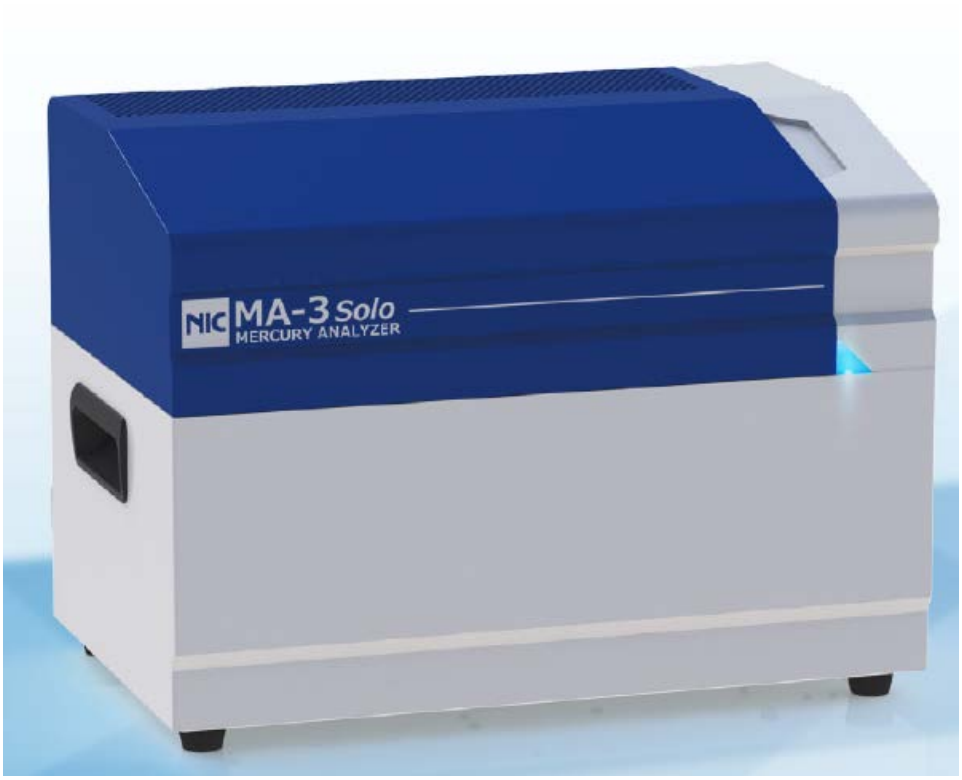
	➢ Always avoid a room where halide reagents such as an organochlorine solvent or potassium iodide are used. In addition, avoid a room into which such a reagent gas may flow. Failure to observe this may cause trouble such as the drop in the Analyzer's sensitivity.

1.1.3. Cautions on operations and handling

⚠ **WARNING**	➢ The area around the sample inlet becomes hot. Wear protective equipment such as heat-resistant gloves, and be careful not to burn yourself. Never manually release the solenoid lock during measurement because it is very dangerous. ➢ Be careful not to burn yourself when touching the sample boat, the mercury collector tube, or the like for measurement or other work. If you need to handle them, use boat tongs and wear protective equipment such as heat-resistant gloves. ➢ Heat is vented (venting to general atmosphere) from the upper back section of the Analyzer. Be careful not to burn yourself. ➢ When touching the Analyzer during maintenance, be sure to confirm that it has been sufficiently cooled. In addition, use protective equipment such as heat-resistant gloves when touching it. Otherwise, you may burn yourself. ➢ When you power off the Analyzer, the surfaces of its housing may become hot because of remaining heat from the heater. ➢ Ensure that the filter of the rear fan is free of dust. A clogged filter may cause an abnormal temperature rise at the Analyzer, thus leading to great danger. ➢ Use a reagent after obtaining and managing its safety data sheet (SDS). Be careful not to burn yourself and ensure not to place any objects on the housing. ➢ Before conducting any maintenance, remove the power cable from the Analyzer. Failure to observe this may cause an electric shock as well as a short circuit, which leads to a failure. ➢ Do not directly measure any samples decomposed by nitric acid. Otherwise, heat may be generated from the activated carbon filter on the exhaust side. Dilute nitric acid until its concentration drops to 5 wt% or less.

1.2. Overview of the Analyzer

The thermal decomposition mercury analyzer MA-3 *Solo* allows the amount of mercury contained in liquid samples such as wastewater or crude oil or in solid samples such as coal or soils to be quickly measured with high sensitivity and high accuracy.



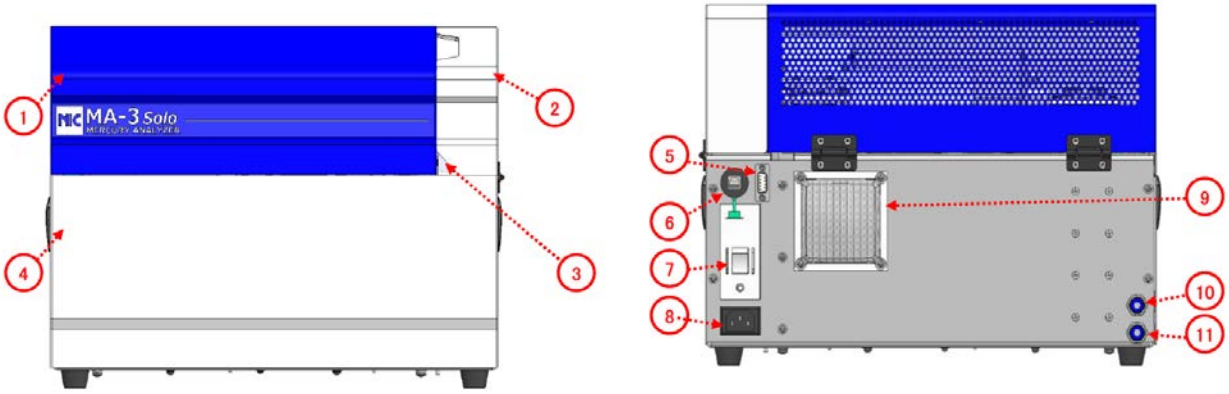
1.2.1. Basic configuration of this system

This analyzer system consists of the following components:

the mercury analyzer,
the data analysis/analyzer control software,
the standard accessories, and
a personal computer.

1.2.2. Appearance of the Analyzer

1.2.2.1. Front, back

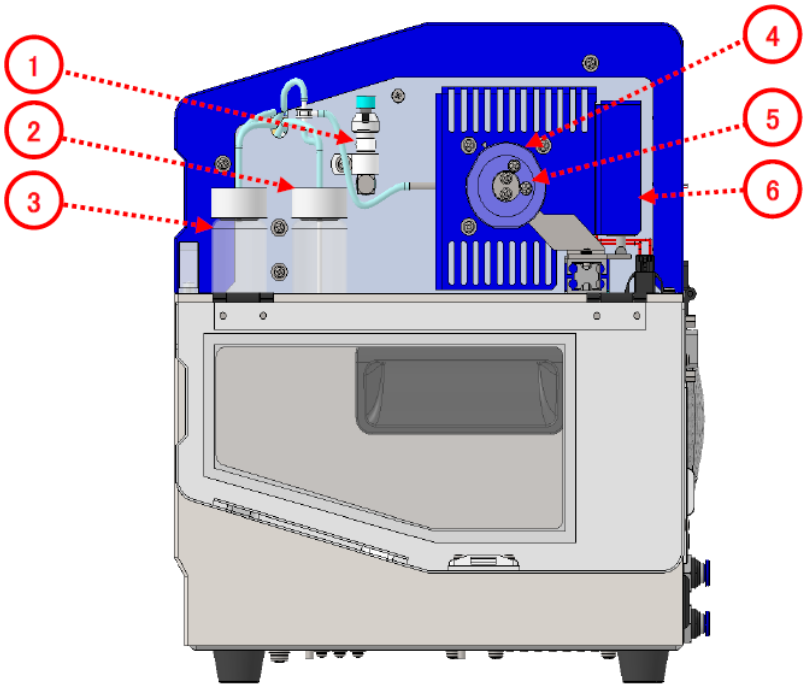


No.	Name	Description
1	Top cover	This cover is opened during maintenance.
2	Side cover	This cover is opened during measurement.
3	Status indicator	Indicates the state of the Analyzer. (*)
4	Front cover	This cover is opened during the update of the firmware.
5	I/F connector	Used for connection to an optional device.
6	USB port	Used for connection to a PC.
7	Power switch	Has a built-in ground fault interrupter.
8	AC inlet	Used for the connection of the supplied power cable.
9	Rear fan	Comes with a mesh cover.
10	Vent port	Used for the connection of 6mm diameter tube
11	Intake port	Intake port for carrier gas

(*) The status indicator indicates the following states.

State	State of status indicator	Description
OFFLINE	Blinking at intervals of 1 second	The communication is not established between the PC and the Analyzer.
MAINTE	Blinking at intervals of 1 second	One of the ribbon menu items is being executed on the Maintenance screen.
READY	Steady light	The system is READY (normal state).
MEAS	Blinking at intervals of 0.1 seconds	A sample is being measured.
ERROR	Blinking at intervals of 0.3 seconds as many times as the number of the error code (Repeating at 3 second intervals)	An error has occurred.

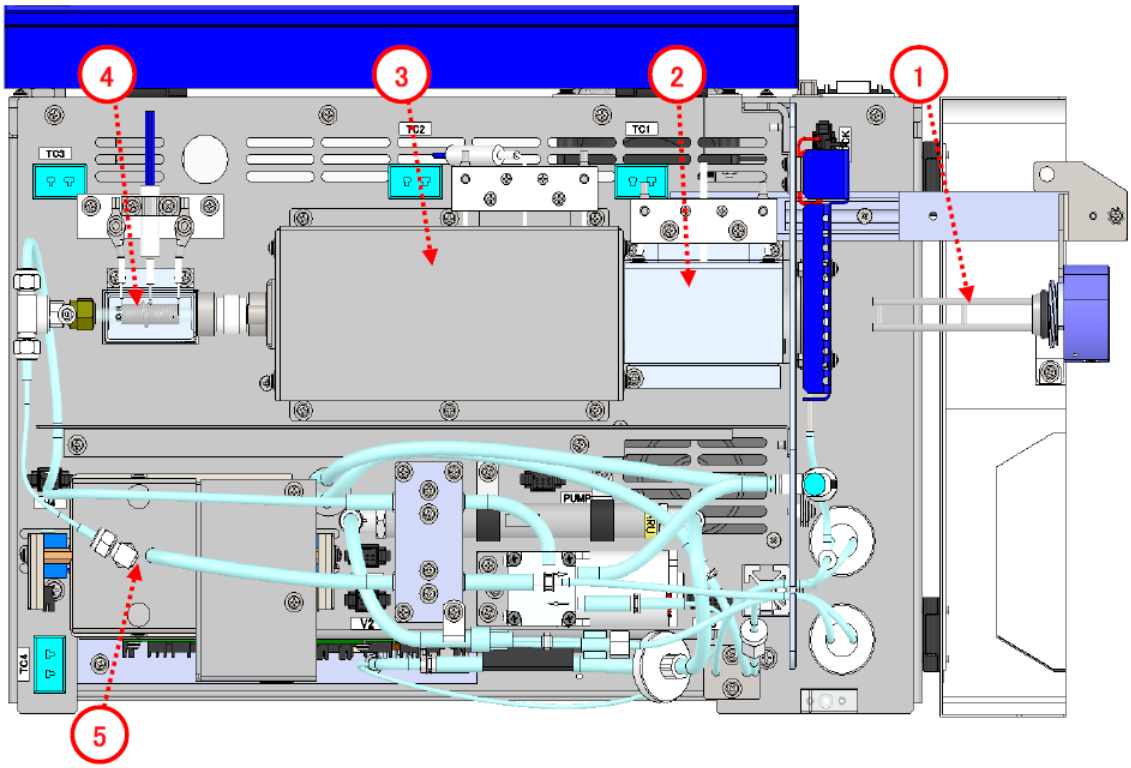
1.2.2.2. Side



No.	Name	Description
1	Flowrate control valve	Turn the knob to adjust the flow rate.
2	Humidification bottle	Feeds pure water into the bottle so that carrier gas contains saturated water vapor.
3	Drain bottle	Collects effluent produced during measurement.
4	Sample inlet knob	Turn this clockwise to close the inlet.
5	Sample inlet	A sample is charged into this place.
6	Solenoid lock	This is locked during measurement to prevent the sample inlet from being opened by mistake.

1.2.2.3. Top

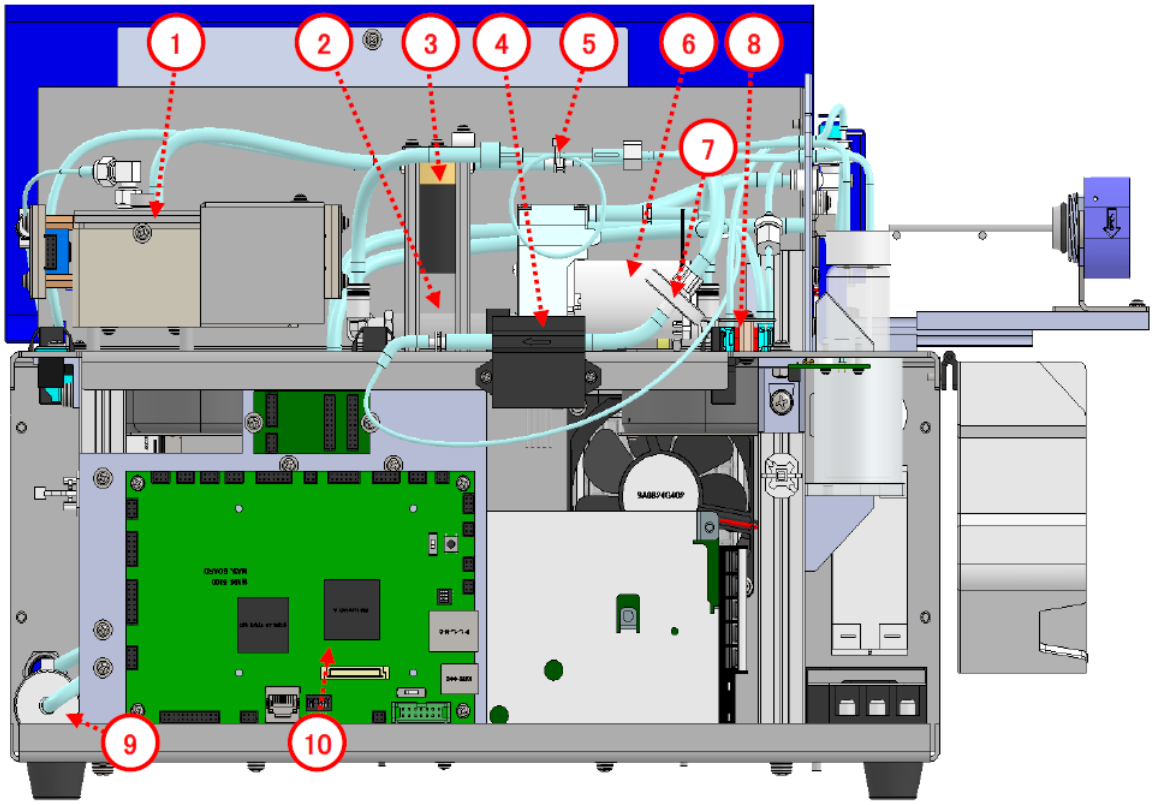
* The figure below shows that the top cover, the side cover, and the sample inlet are open.



No.	Name	Description
1	Boat handling tool	Supports the boat; and seals the system when it is inserted.
2	Heater H1	Heats a sample. A fan is fitted to its lower section to cool the heater after measurement.
3	Heater H2	Heats an oxidation catalyst and an acid gas removal agent.
4	Heater H3	Controls the temperature of the mercury collector tube. A fan is fitted to its lower section to cool the heater after measurement.
5	Heater H4	Heats the absorption cell to 150°C.

1.2.2.4. Front

* The figure below shows that the top cover, the side cover, the front cover, and the sample inlet are open.



No.	Name	Description
1	Optical unit	Consists of the absorption cell, the mercury lamp, and the detector.
2	Activated carbon filter	An activated carbon column for removing mercury from exhaust gas
3	Valves V1 and V2	Valves for switching between the decomposition tube and the measurement tube
4	Flow rate sensor	A sensor for controlling the flow rate
5	Nafion tube	Removes water vapor from exhaust gas.
6	Air pump	Takes in carrier gas.
7	Filter unit	This filter protects the flow rate sensor.
8	Valve V3	A valve for switching between normal gas and humidified gas
9	Activated carbon filter	An activated carbon filter for removing mercury from carrier gas
10	Main board	A board for controlling the Analyzer.

2. Maintenance

2.1. Components and parts recommended for periodic replacement

Shown below is a list of components and parts recommended for periodic replacement. The replacement intervals are shown only as a guide; and their actual service lives depend on the condition of use. Scheduled maintenance should be proposed based on this list.

Item	Recommended replacement interval and guideline
Sample heating tube	2,000 hours, or in the event of an abnormal measurement value * If you measure samples with a high halogen content or by an inappropriate method, its service life becomes shorter.
Mercury collector tube	When its quartz wool becomes discolored, or if abnormal measurement is not corrected by wiping deposits off the tube.
Activated carbon filter	1 year, or the amount of adsorbed mercury reaches 1,500 mg.
O-ring at sample inlet	1 year, or in the event of leakage * It deteriorates faster if you use a method which requires high temperatures for a long time.
O-ring at boat handling tool	1 year, or in the event of leakage
Measurement line	1 year, or in the event of an abnormal measurement value
Air pump	1.5 years or 2,000 hours
V1 and V2 valves	3 years, or in the event of switching error
V3 valve	3 years, or in the event of switching error
Flowrate control valve	3 years, or in the event of control error
Boat handling tool	When it is heavily contaminated or is damaged
Nafion tube	3 years
Filter unit	1 year, or when the flow rate becomes low
Humidification bottle, drain bottle	1 year
Mercury lamp	2 years or 5,000 hours

2.2. Preventive maintenance

This section describes the components and parts to be replaced at minimum to achieve stable use of the Analyzer, as well as the replacement procedures and the inspection items. This work is fundamental to maintenance.

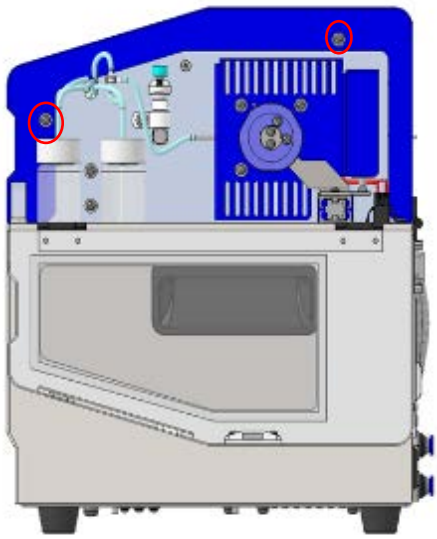
2.2.1. Parts and components to be replaced on preventive maintenance

No.	Name	Part No.	Q'ty	Remarks
①	Joint set for MA-3 Solo	S-W012-0100	1	O-ring for inlet O-ring for boat handling tool Filter unit 1 set of internal tubing 1 set of joints for internal tubing
②	Activated carbon filter	W139-1120	1	
③	Air pump	W166-6205	1	
④	Mercury collector tube	W139-2300	1	
⑤	Sample heating tube(Normal)	W139-1360	1	

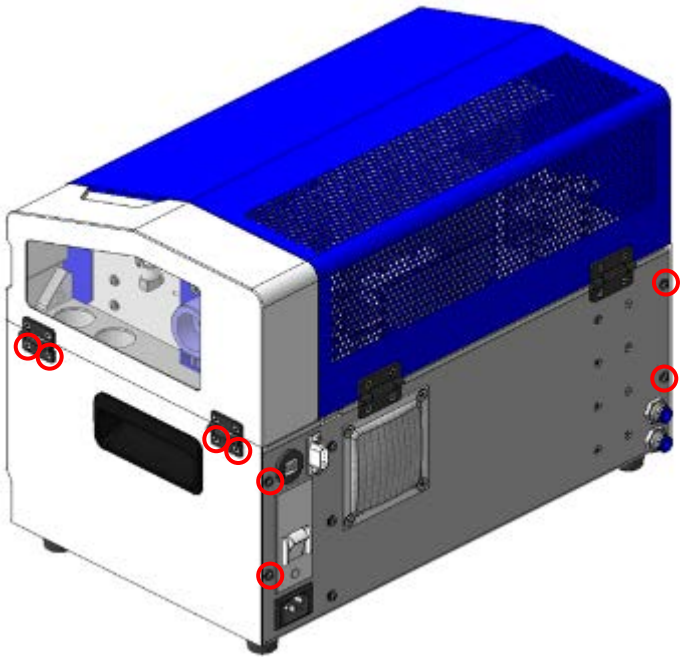
* Confirm the state of the Analyzer and the value of the GLP counter from your customer in advance, and replace any components and parts other than the above depending on the state.

2.2.2. Removing the cover

Remove the two screws, and open the top cover.



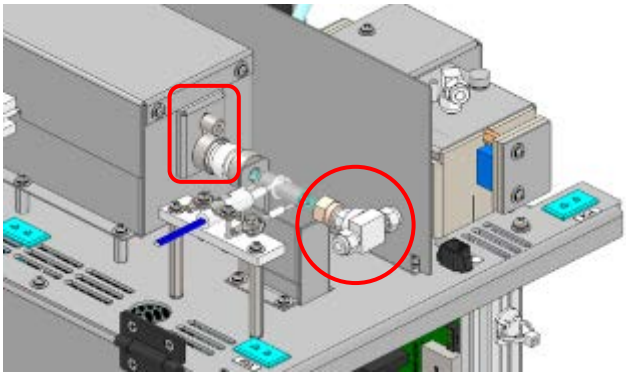
Remove the four countersunk screws for holding the side cover, and remove the side cover. Then remove the four screws from the back plate, and remove the front cover while paying attention to the handle part and the cover holding part. Now, you can conduct maintenance work on the internals of the Analyzer.



2.2.3. Removing the sample heating tube and mercury collector tube

Loosen the nut of the reducing joint connecting to the mercury collector tube, and remove the reducing joint.

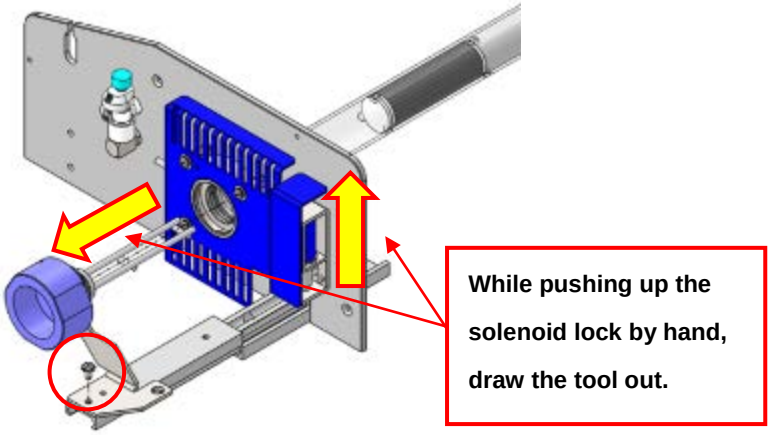
Loosen the screw for the sample heating tube holder, and remove the sample heating tube holder.



Turn the sample inlet knob counterclockwise.

While pushing up the solenoid lock (which locks the boat handling tool in place) by hand, draw out the boat handling tool.

Remove the screw for holding the boat handling tool, and remove the boat handling tool.

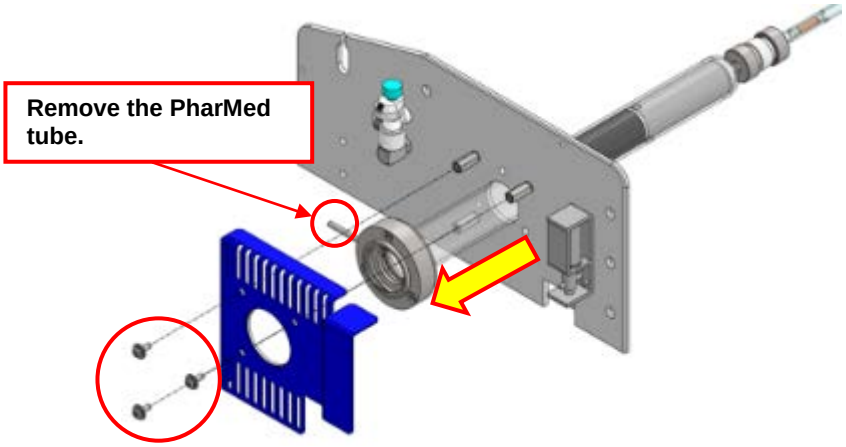


Remove the PharMed tube connected to the sample inlet.

In addition, unscrew the three screws holding the sample inlet cover and the sample inlet, and remove the sample inlet cover.

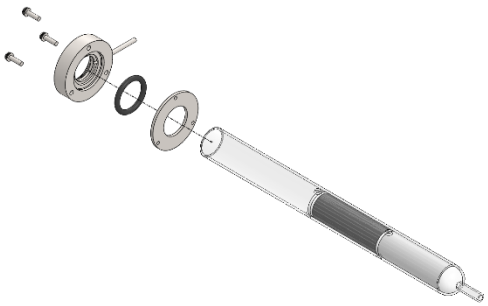
Pull out the sample heating tube.

While turning the assembly of the sample heating tube and the mercury collector tube, slowly draw out the assembly from the front.

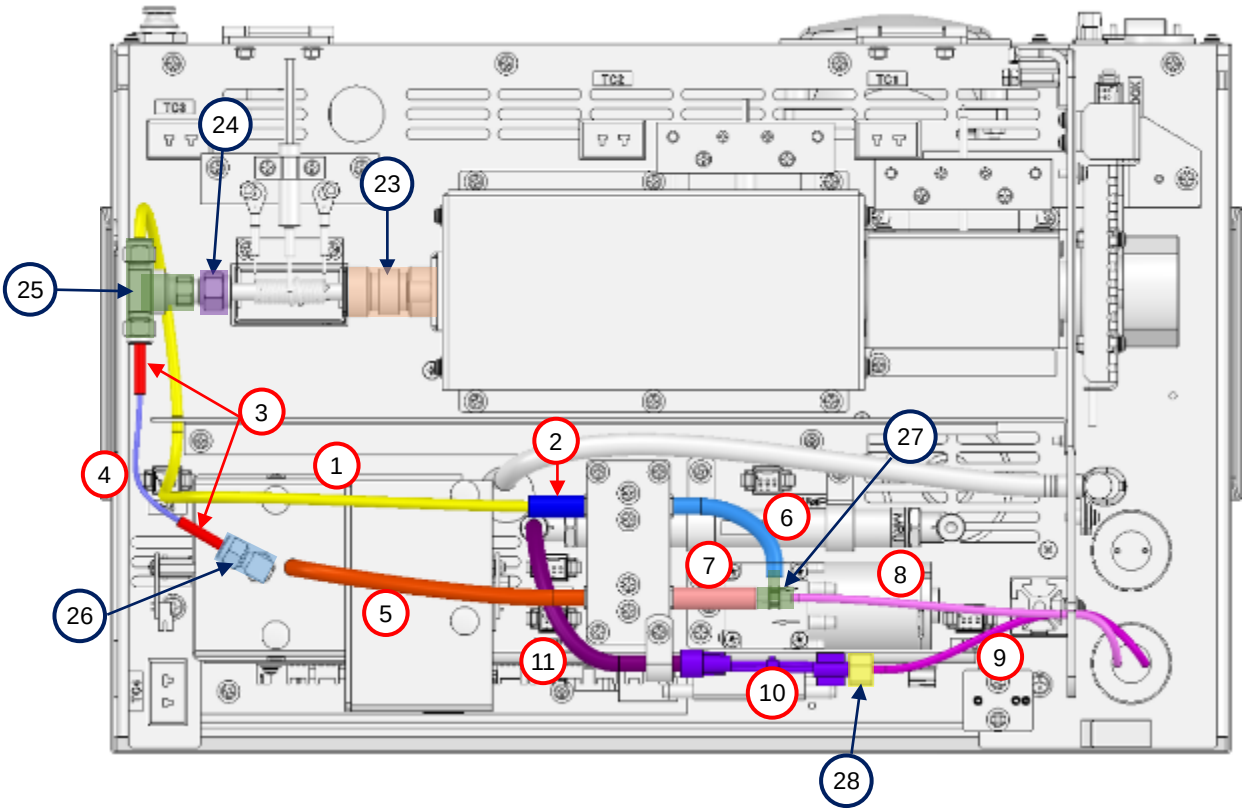


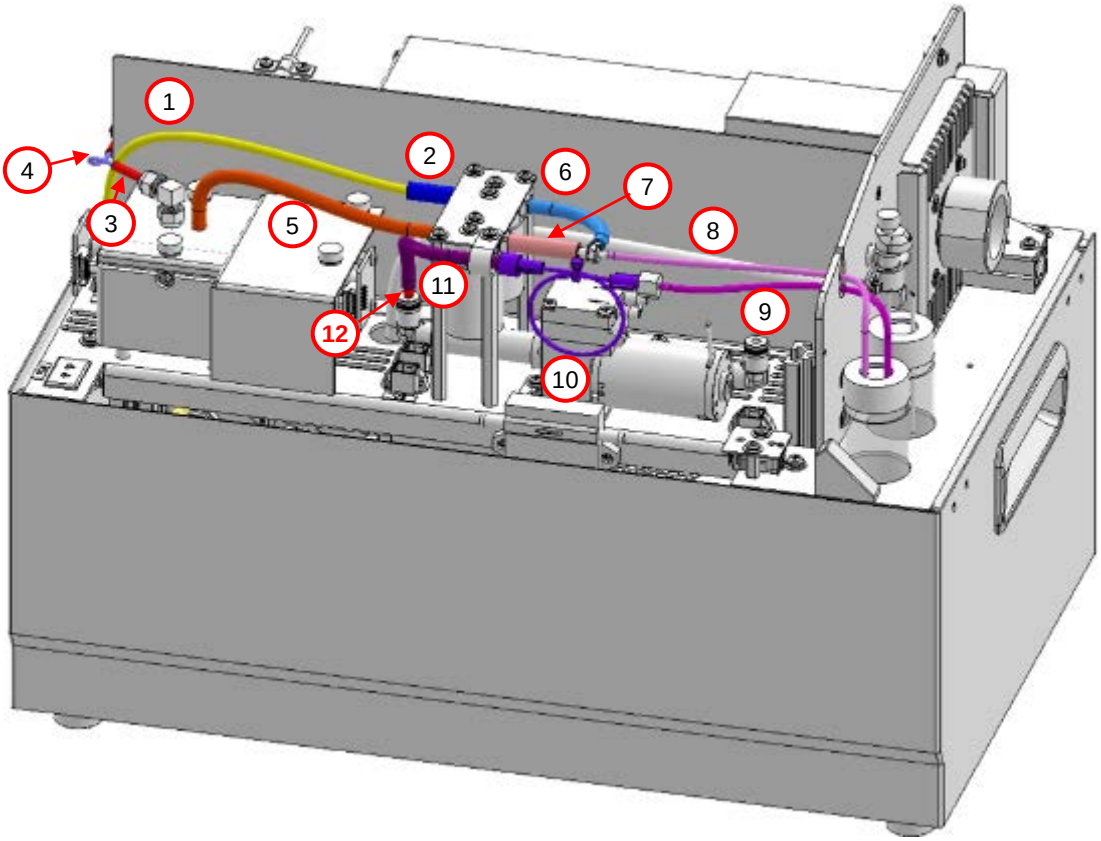
Loosen the cap nut of the Teflon joint, and remove the joint.

Remove the three screws for the sample inlet, and remove the sample inlet from the sample heating tube.

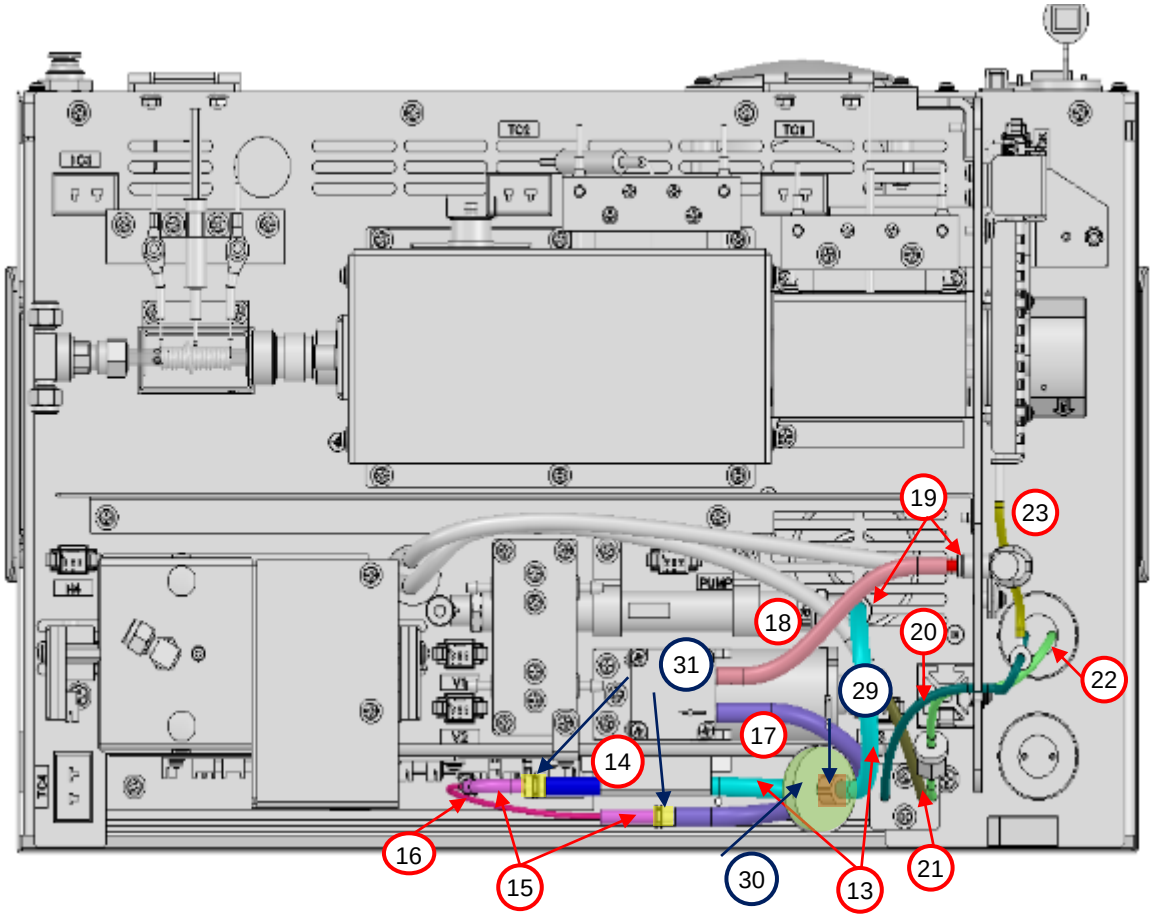


2.2.4. Replacing tubes, joints, etc.





No.	Tubing/joint name	Model	Length (mm)/pc
1	Teflon tube 2×4	2×4	320
2	Tygon tube 1/8×1/4	ACFJ00007	20
3	Teflon tube 2×4	2×4	15
4	Teflon tube 1×2	1×2	110
5	Tygon tube 1/8×1/4	ACFJ00007	130
6	Tygon tube 1/8×1/4	ACFJ00007	70
7	Tygon tube 1/8×1/4	ACFJ00007	50
8	PharMed tube 1/16×1/8	AY242002	170
9	PharMed tube 1/16×1/8	AY242002	170
10	Nafion Tube	-	1 pc
11	Tygon tube 1/8×1/4	ACFJ00007	50
12	Teflon tube 2×4	2×4	30
23	Teflon joint 6φ	41663	1 pc
24	PEEK nut	N16-2A0019-00	1 pc
25	Female T joint with male connector	30-4FBT2-C	1 pc
26	Elbow joint	30-4UE-C	1 pc
27	T-connector	MCT223030V	1 pc
28	Lure fitting	LM31	1 pc



No.	Tubing/joint name	Model	Length (mm)/pc
13	Tygon tube 1/8×1/4		50
14	Tygon tube 1/8×1/4		20
15	Tygon tube 1/16×3/16		20
16	Teflon tube 0.5×2		100
17	Tygon tube 1/8×1/4		250
18	Tygon tube 1/8×1/4		90
19	Teflon tube 2×4		30
20	PharMed tube 1/16×1/8		200, 15
21	PharMed tube 1/16×1/8		50
22	PharMed tube 1/16×1/8		200, 20
23	PharMed tube 1/16×1/8		110
29	Lure fitting	VRM306	1 pc
30	Membrane filter	φ25	1 pc
31	Mini connector	MCS2230	2 pc

While referring to the figures above, cut the tubes of the joint set to the specified lengths, and replace the tubes, the joints, and other parts.

* After replacing the nut attached to Part No.25 (Female T joint with male connector) with the Part No.24 (PEEK nut), install the joint.
* The Part No.10 (Nafion Tube) is not included in the joint set. When it is time to replace the tube, purchase a new tube separately and replace it.
* The Parts No.20 to No.22 are not included in the joint set because sample gas does not pass through them. Unless they are degraded or damaged, there is no need to replace them in principle.

2.2.5. Replacing the activated carbon filter

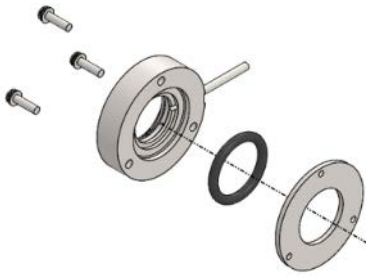
Refer to 2.3.1. Replacement of Activated carbon filter.

2.2.6. Replacing the air pump

Refer to 2.3.2. Replacement of Air pump.

2.2.7. Attaching the sample heating tube and mercury collector tube

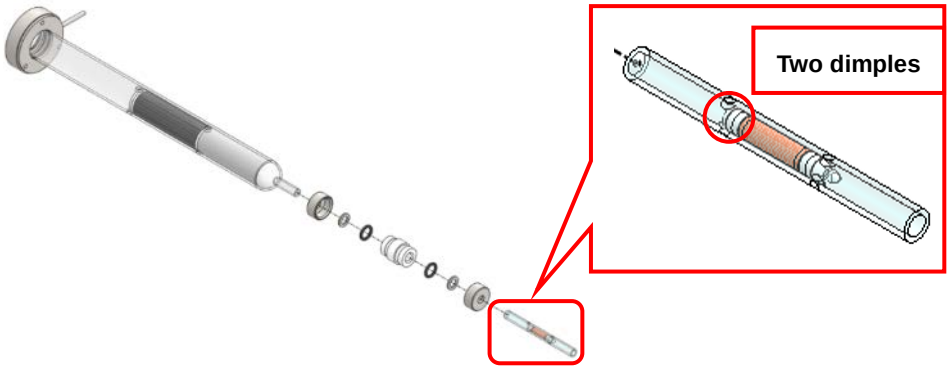
1) Get the O-ring for the sample inlet, the 6φ Teflon joint, and the mercury collector tube.
2) As shown below, slightly tighten the sample inlet, the O-ring, and the sample inlet ring with the three screws.
   Gradually retighten the three screws in turn until the O-ring can be fixed in place.
   * Note that if you fully tighten them at this point, the sample heating tube will not fit into place at a later step.



3) Place the sample inlet on a desk, and insert the sample heating tube from above.
   Twist and push the tube to make it easier to insert.
   * Pay attention not to damage the sample heating tube.
4) Confirm that the sample heating tube has been inserted up to the groove of the sample inlet.

5) Retighten the three screws at the sample inlet.
Gradually retighten the screws in turn until the gap is eliminated between the sample inlet and the sample inlet ring.

6) Attach the Teflon joint and the mercury collector tube to the sample heating tube.
You need to attach the mercury collector tube so that its two dimples are located on the sample heating tube side.
Do not insert the joint deeply at this point to make the subsequent adjustment easy.
The thread on the Teflon joint is easily damaged. Confirm that the joint turns smoothly. If the cap nut is engaged with the thread at an angle, leakage may result.

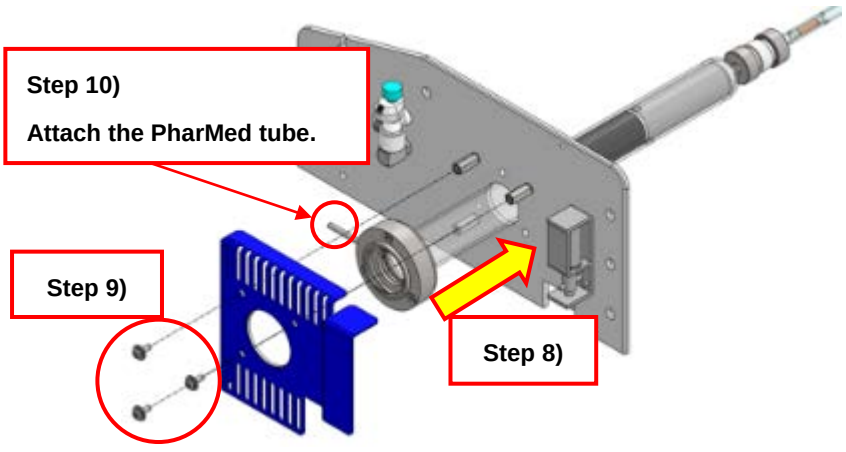


7) With alcohol, wipe the outside of the sample heating tube and the mercury collector tube.

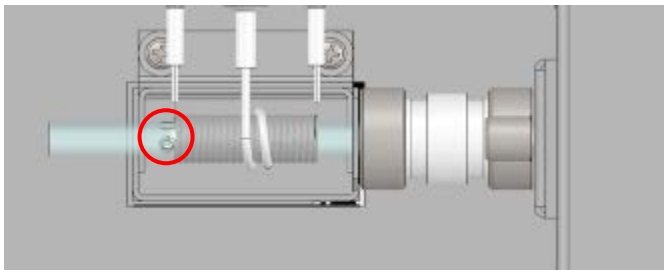
8) Insert the assembly of the sample heating tube and the mercury collector tube while slightly turning them rightward and leftward.
* Forcibly pushing the assembly may deform the heater.

9) Fix the sample inlet and the sample inlet cover in place by tightening the three screws.

10) Attach the PharMed tube to the sample inlet.



11) Adjust the position of the mercury collector tube.
Align the end of the heater with the dimples of the mercury collector tube. Adjust the tube position with the insertion depth of the Teflon joint. Firmly tighten the Teflon joint.

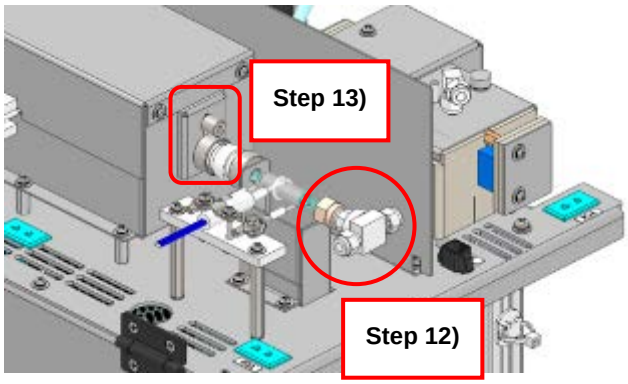


12) Connect the reducing joint to the mercury collector tube, and tighten the nut.

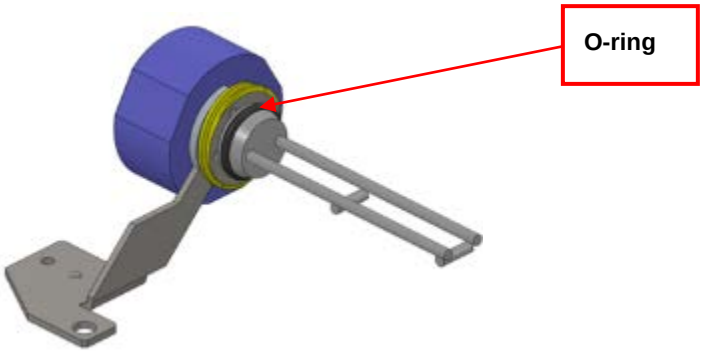
After slightly tightening the reducing joint by hand, retighten it 60-90 degrees with a wrench.

* Excessively tightening the joint may damage it.

13) Attach the sample heating tube holder.

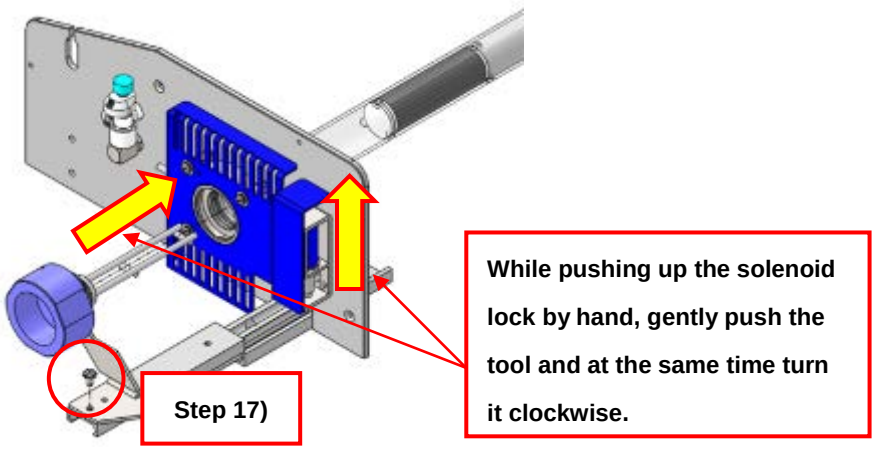


14) Replace the O-ring located on the boat handling tool side.



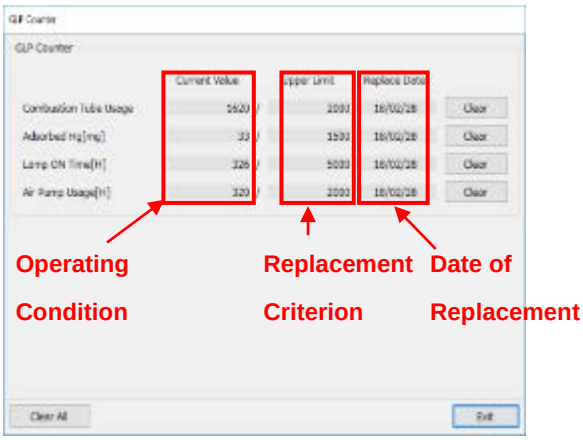
15) Slightly fix the boat handling tool with the screw.

16) While lifting the solenoid lock (which locks the boat handling tool in place), gently push the boat handling tool and at the same time turn it clockwise. Adjust its position so that the boat handling tool is not in contact with the sample inlet and that the door knob can be smoothly turned. Then fasten the screw.



17) From the Maintenance screen, clear "Combustion tube Usage," "Adsorbed Hg," and "Air Pump Usage" in the GLP Counter window.

* If you have replaced the mercury lamp, also clear “Lamp ON.”



2.2.8. Executing the self-check

After replacing the components and parts, start the Analyzer and execute the self-check. The self-check allows the user to check the operation of the components such as the heaters and the valves.

2.2.9. Manual leak check

Conduct the leak check, referring to 2.6.2. Manual leak check.

2.2.10. Verifying the performance

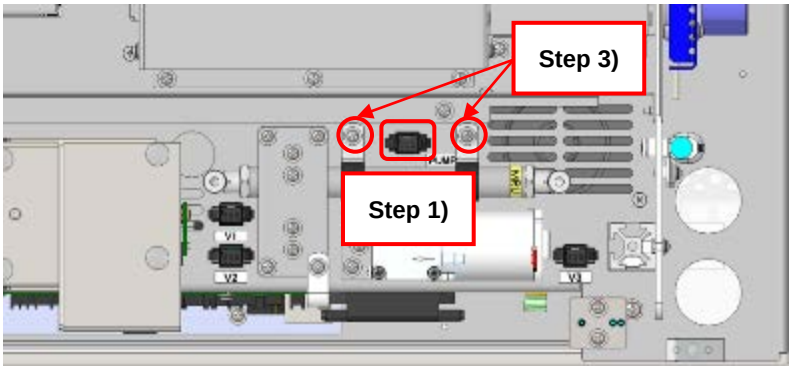
Create a calibration curve, and verify its linearity and reproducibility. For verification items and criteria, refer to the OQ and PQ sections of the separate sheet "IQ/OQ/PQ."

2.3. Replacement of components and parts

2.3.1. Activated carbon filter

This is a consumable part. Replace it once a year.

1) Disconnect the connector for the air pump.
2) Remove the tube connected to the activated carbon filter.
   While pushing the quick-change joint by hand, pull the tube to remove it.
3) Unscrew the two screws from the bracket of the activated carbon filter, and remove the activated carbon filter.

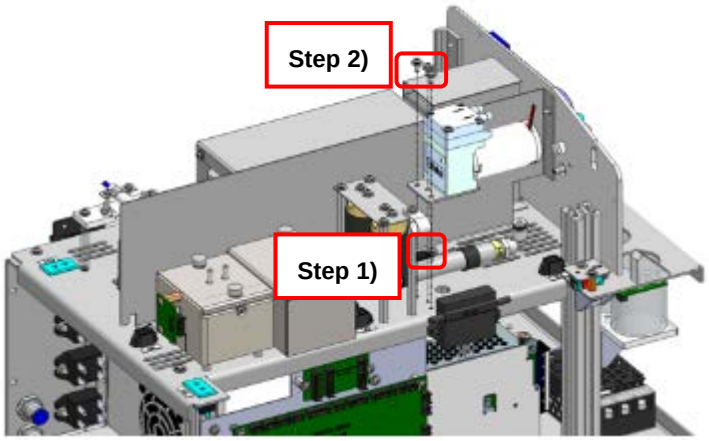


4) After replacing the activated carbon filter, connect it by reversing the removal procedure.
   * You need to attach the activated carbon filter in the correct orientation.
     Attach the activated carbon filter using the sticker marked as “MRU” as a guide.
5) When you have replaced the filter with a new one, clear "Adsorbed Hg" in the GLP Counter window.

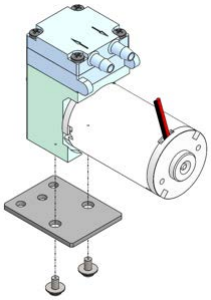
2.3.2. Air pump

This is a consumable part. Replace it once every 18 months or if the total operating hours exceed 2000.

1) Disconnect the connector for the air pump.
2) Remove the three screws from the fixing plate of the air pump.



3) Unscrew the two screws for holding the air pump, remove the air pump, and replace it.

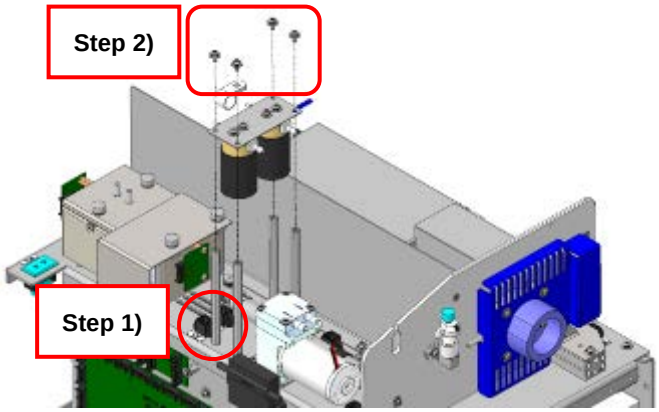


4) Attach it by reversing the removal procedure.
5) When you have replaced the filter with a new one, clear "Air Pump Usage" in the GLP Counter window.

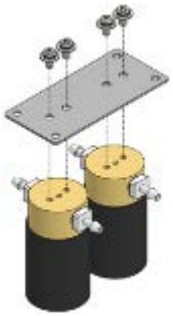
2.3.3. V1 and V2 valves

Replace the valves once every three years or if the clogging of the valves is suspected because the opening checks of the V1 and V2 have resulted in NG during the self-check.

1) Disconnect the connectors for the V1 and V2 valves.
2) Remove the fixing plate of the V1 and V2 valves by unscrewing the four screws.



3) Unscrew the screws from the valves, and remove the valves.

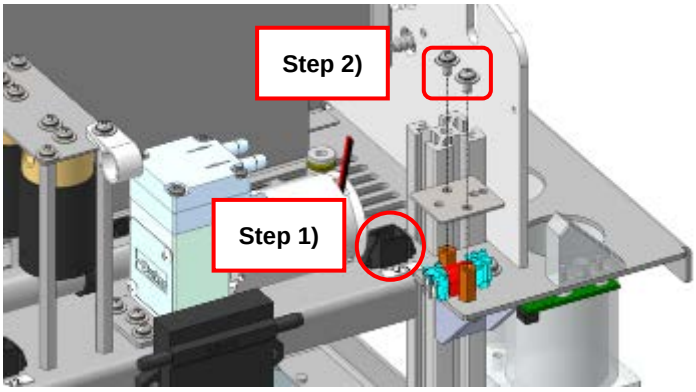


4) Attach the valves by reversing the removal procedure.

2.3.4. V3 valve

Replace it once every three years or if the clogging of the valve is suspected because the opening check of the V3 has resulted in NG during the self-check.

1) Disconnect the connector for the V3 valve.
2) Unscrew the screws for the plate fixing the PharMed tube in place, and remove the plate and the PharMed tube from the valve.

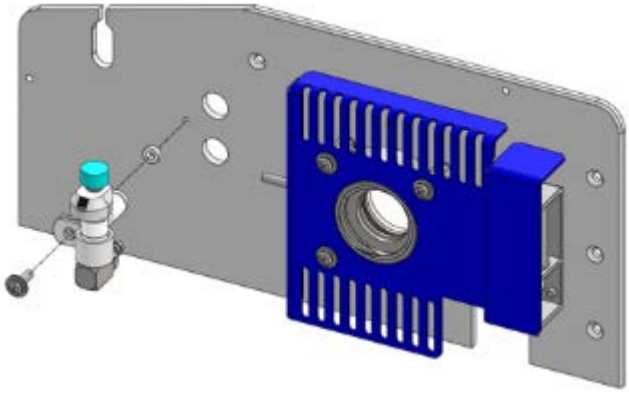


3) Replace the valve, and attach the parts by reversing the removal procedure.

2.3.5. Flowrate control valve

Replace it once every three years or if the flow rate cannot be adjusted.

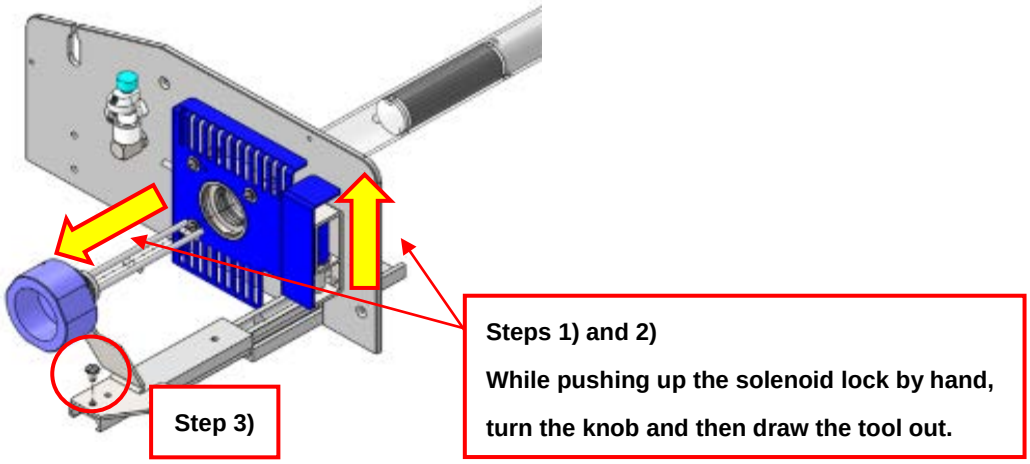
1) Remove the tube connected to the flowrate control valve.
2) Remove the screw shown below, and replace the flowrate control valve.



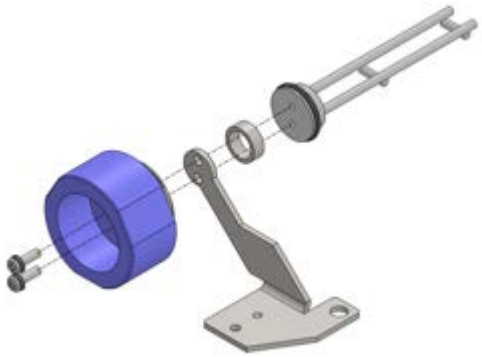
2.3.6. Boat handling tool

Replace it if it is heavily contaminated or is corroded.

1) While lifting the solenoid lock (which locks the boat handling tool in place), turn the sample inlet knob counterclockwise.
2) Draw out the boat handling tool.
3) Remove the screw for holding the boat handling tool, and remove the boat handling tool.



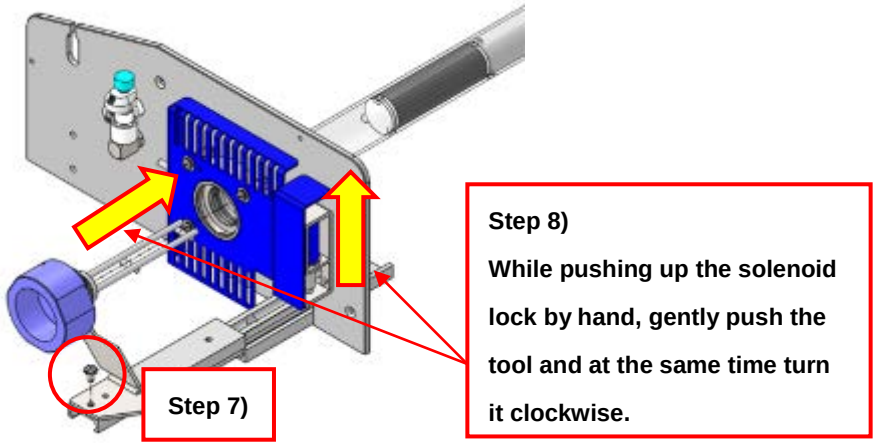
4) Remove the two screws for holding the boat handling tool, and replace or wash it.



5) Wipe any dirt off with alcohol.
   To further wash it, cut and remove the O-ring, immerse the metal part in nitric acid with a concentration of 1% (w/v) or less, and wash it in an ultrasonic cleaner for 30 minutes.
   After washing it, rinse it with pure water, and dry it sufficiently. Then fit a new O-ring in the groove.
6) Tighten and fix the two screws for holding the boat handling tool.
   * Pay attention to the orientation of the boat handling tool.
7) Fix the boat handling tool with the screw.
8) While lifting the solenoid lock (which locks the boat handling tool in place), gently push the boat handling tool and at the same time turn it clockwise.

If the sample inlet cannot close, slightly loosen the screw for holding the boat handling tool, and gently shake the sample inlet knob.

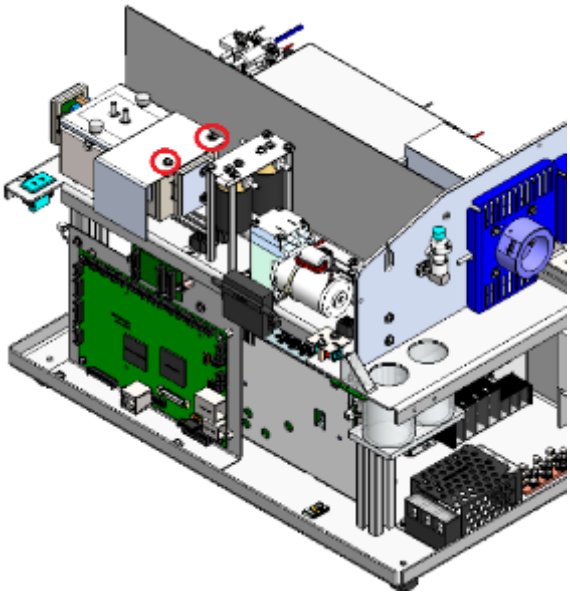
After shaking it, tighten the screw again, turn the sample inlet clockwise, and confirm that the sample inlet can close.



2.3.7. Mercury lamp

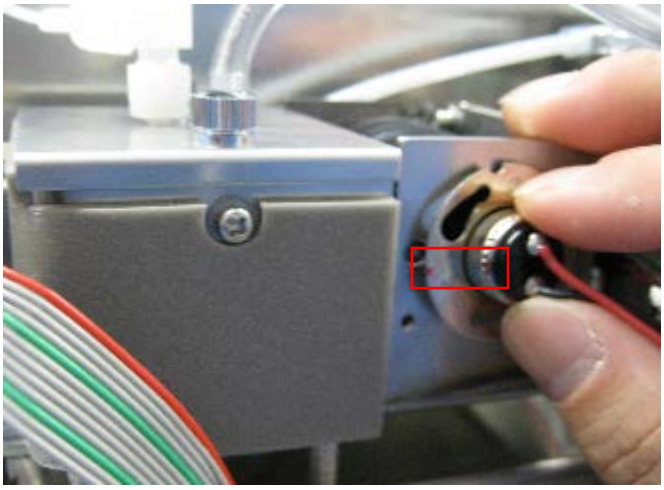
Replace it once every two years or if the total lamp active time exceeds 5000 hours.

1) Remove the top, side, and front covers. Remove the two screws, and remove the lamp cover.



2) Disconnect the connector (CN12) from the power board located on the back side of the main board.
3) Remove the two screws, and remove the lamp.

4) Attach a new lamp. Attach the new one so that the red marker is located on the cell side.

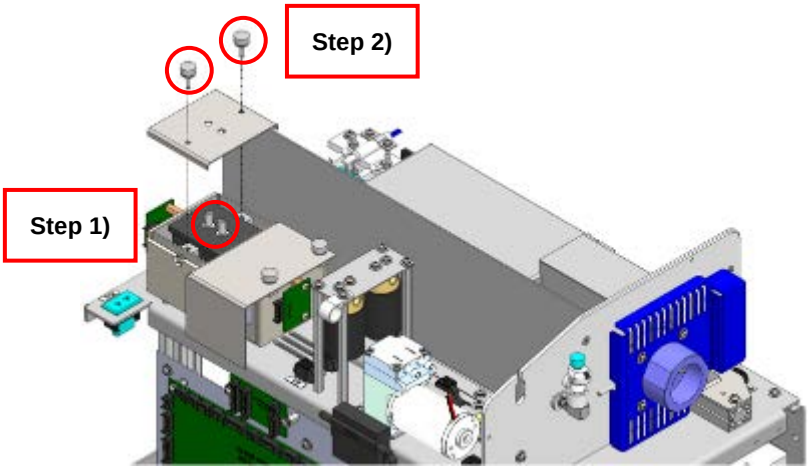


5) After the replacement, calibrate the optical unit, and confirm that the voltage reads 4.0V±0.1V.

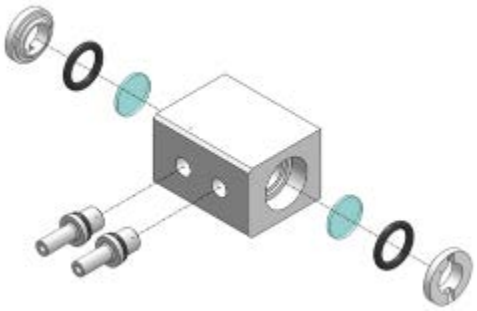
2.3.8. Cell unit

Replace the cell unit if it is heavily contaminated.

1) Remove the Tygon tube connected to the absorption cell.
   Remove the L-joint by unscrewing the nut.
2) Unscrew the two knurled screws, and remove the cover from the absorption cell.



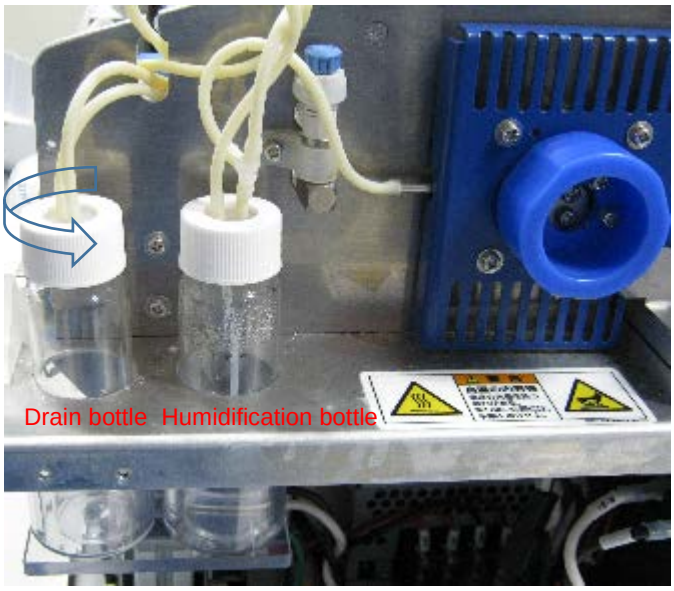
3) Take out the absorption cell, and replace it.
4) If you wish to wash the cell, unscrew the screw for holding the cell window, with a coin or the like.



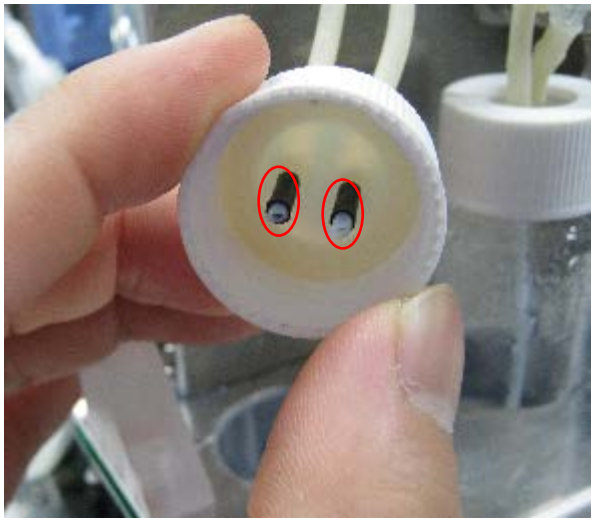
5) To wash the cell, follow the procedure specified in the upcoming section “2.4. Washing the absorption cell and joints.”
6) Attach the absorption cell by reversing the removal procedure.

2.3.9. Drain bottle and humidification bottle

1) Remove its cap.



2) Remove the black tubes for holding the Teflon tubes.

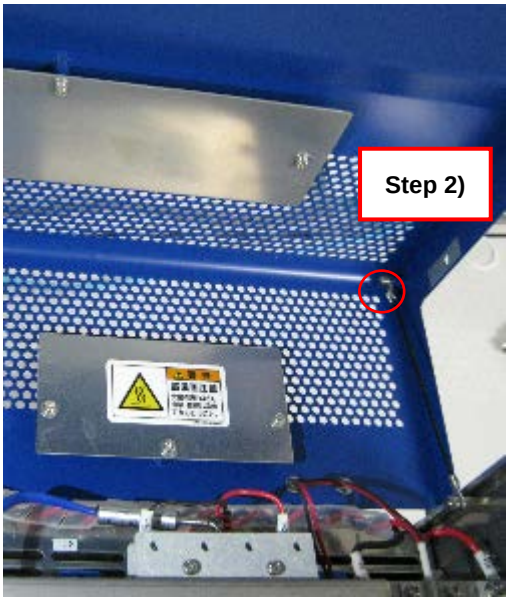


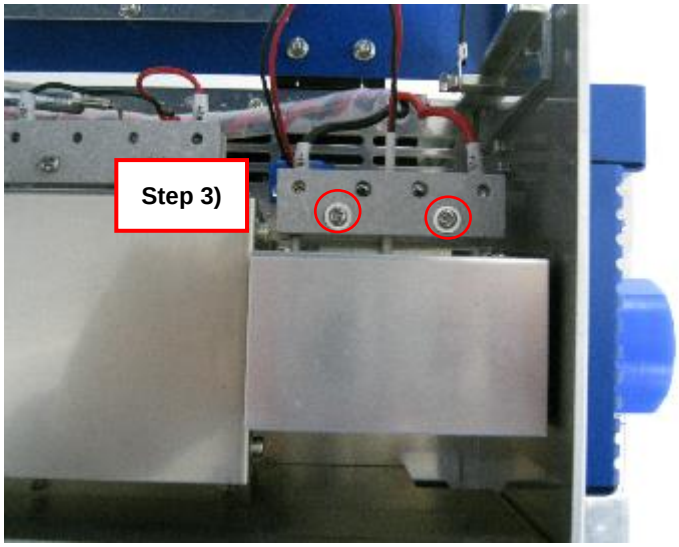
3) Pull out the inserted Teflon tubes. Replace the bottles, the caps, and the packing. Reuse the black tubes removed in the previous step.

2.3.10. H1 heater

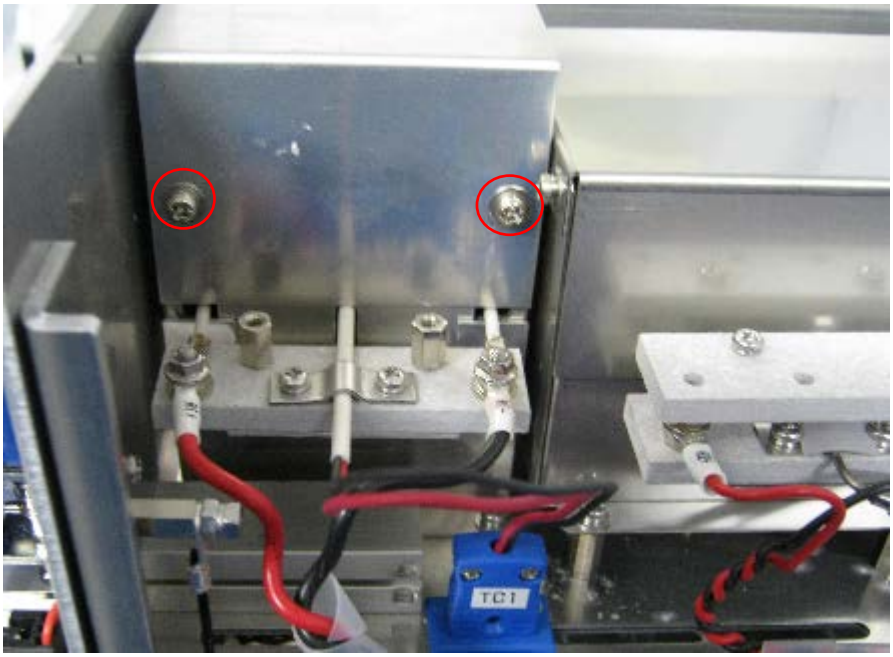
If a temperature rise error is generated for the H1 heater, check the resistance between the terminals with a multimeter. If you find a broken wire, replace the heater. (Standard values: 6.1–7.1 Ω)

1) Remove the sample heating tube and the mercury collector tube. (Refer to 2.2.3. Removing the sample heating tube and mercury collector tube.)
2) Open the top plate. Remove the screw and remove the stopper so that the top plate is fully opened.
3) Remove the two screws and remove the cover from the terminal block.

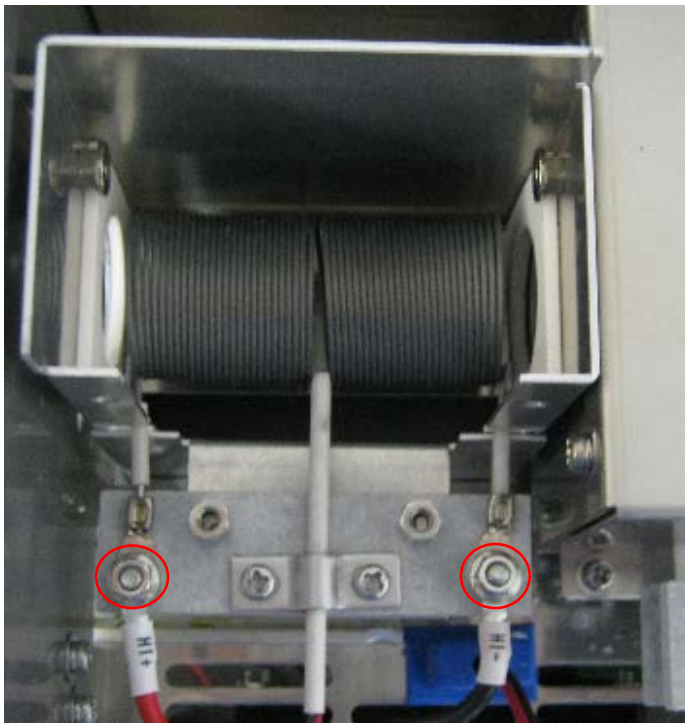




4) Remove the two screws, and remove the H1 heater cover.



5) Loosen the nuts for holding the cables, and remove the cables. In addition, remove the nuts for holding the heater, and replace the H1 heater.



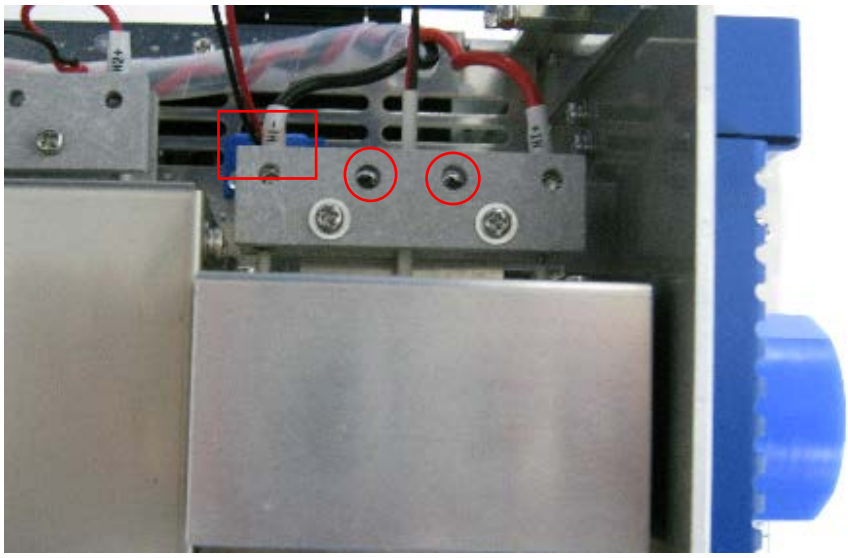
6) Put it back in place by reversing the removal procedure.

* In some cases, you need to change some parameters of the heater. Take down the serial number of the equipment, and contact us for advice.

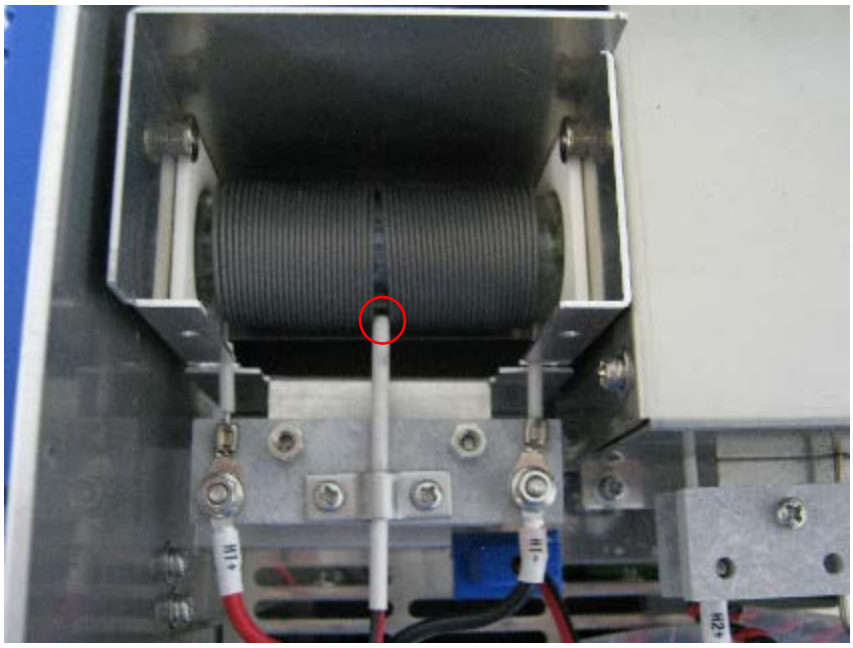
2.3.11. H1 thermocouple

If an abnormal temperature error is generated for the H1 heater even though there are no problems with the switching power supply voltage (48V) or the SSR1, replace the H1 thermocouple.

1) Unscrew the two screws for holding the thermocouple, disconnect the connector, and pull out the H1 thermocouple.



2) When attaching a new one, open the heater cover, and adjust its position so that the tip of the thermocouple comes into contact with the sample heating tube.

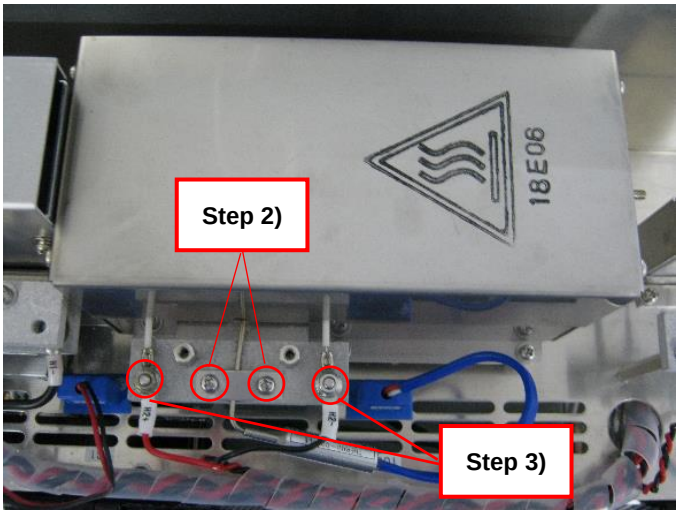


3) Put it back in place by reversing the removal procedure.

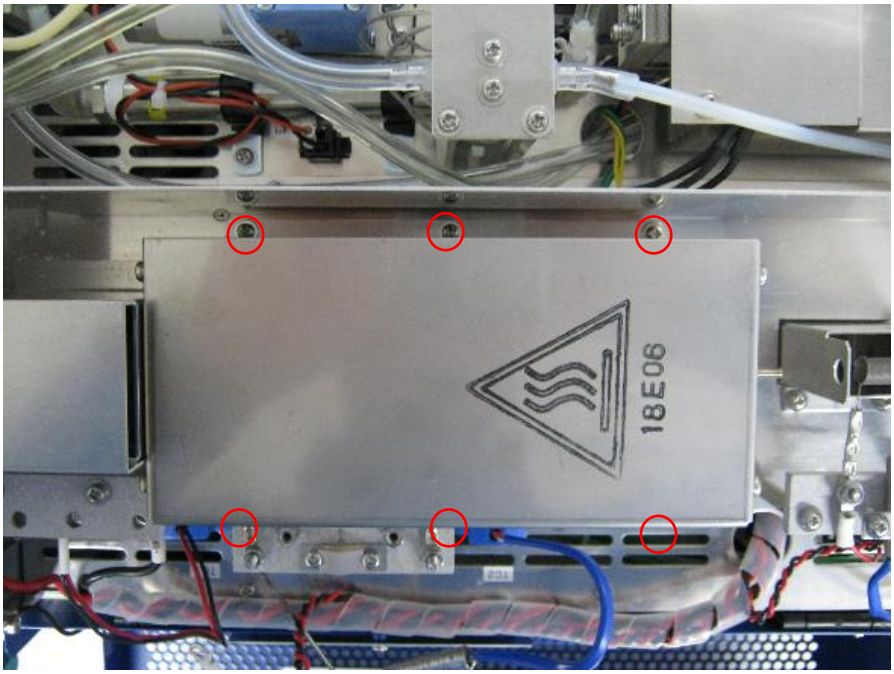
2.3.12. H2 heater unit

If a temperature rise error is generated for the H2 heater, check the resistance between the terminals with a multimeter. If you find a broken wire, replace the heater. (Standard values: 10–12 Ω)

1) Remove the sample heating tube and the mercury collector tube. (Refer to 2.2.3. Removing the sample heating tube and mercury collector tube.)
2) Unscrew the two screws, and pull out the H2 thermocouple.
3) Remove the nuts for holding the cables, and remove the cables.

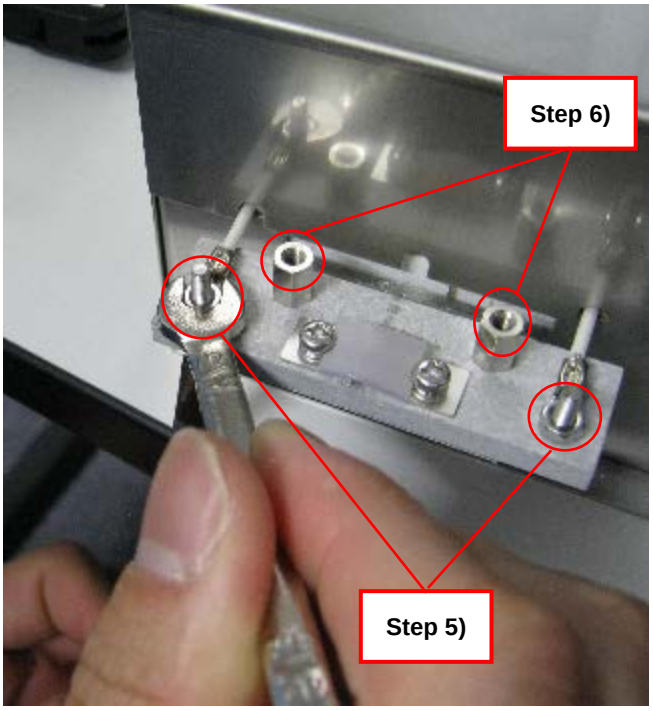


4) Remove the six screws for holding the H2 heater unit, and remove the H2 heater unit.



5) Remove the nuts for holding the cables.
   * To prevent the heater from bending, fix the upper nuts with a wrench, and loosen and remove the lower screws with a screwdriver.

6) Remove the spacers, and remove the terminal block.

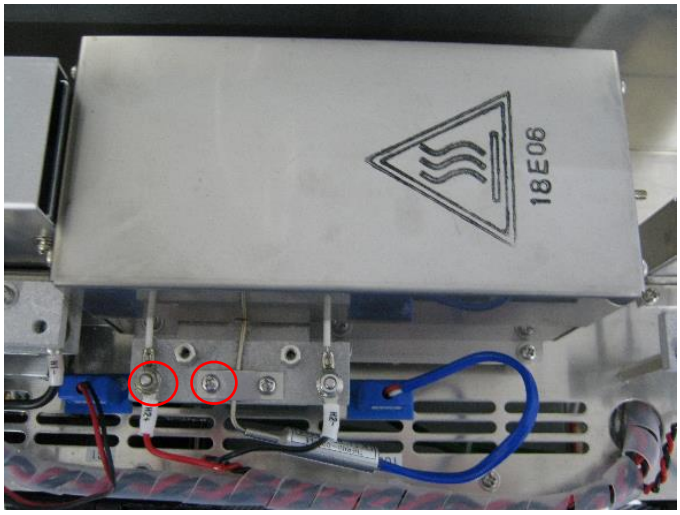


7) Replace the H-2 heater unit, and attach the parts through the reverse procedure. Insert the H-2 thermocouple to the point where its tip comes into contact with the H-2, and then fix it in place.

2.3.13. H2 thermocouple

If an abnormal temperature error is generated for the H2 heater even though there are no problems with the switching power supply voltage (48V) or the SSR2, replace the H2 thermocouple.

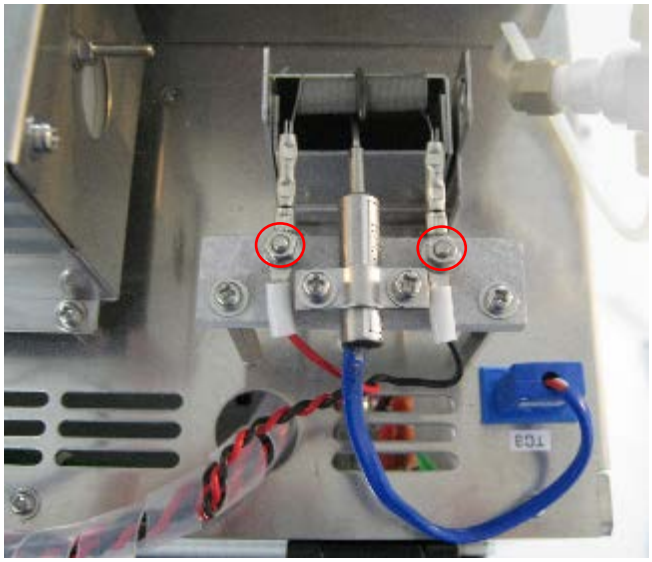
1) Disconnect the connector, unscrew the two screws, and pull out the H2 thermocouple.
2) Attach a new thermocouple. Insert it to the point where its tip comes into contact with the H-2, and then fix it in place.



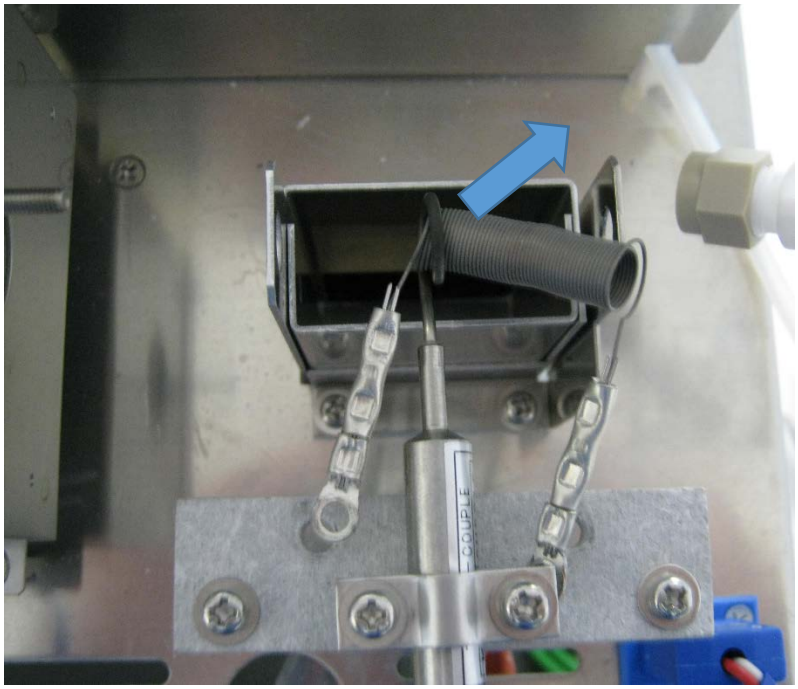
2.3.14. H3 heater

If a temperature rise error is generated for the H3 heater, check the resistance between the terminals with a multimeter. If you find a broken wire or any deformation, replace the heater. (Standard values: 7.9–9.9 Ω)

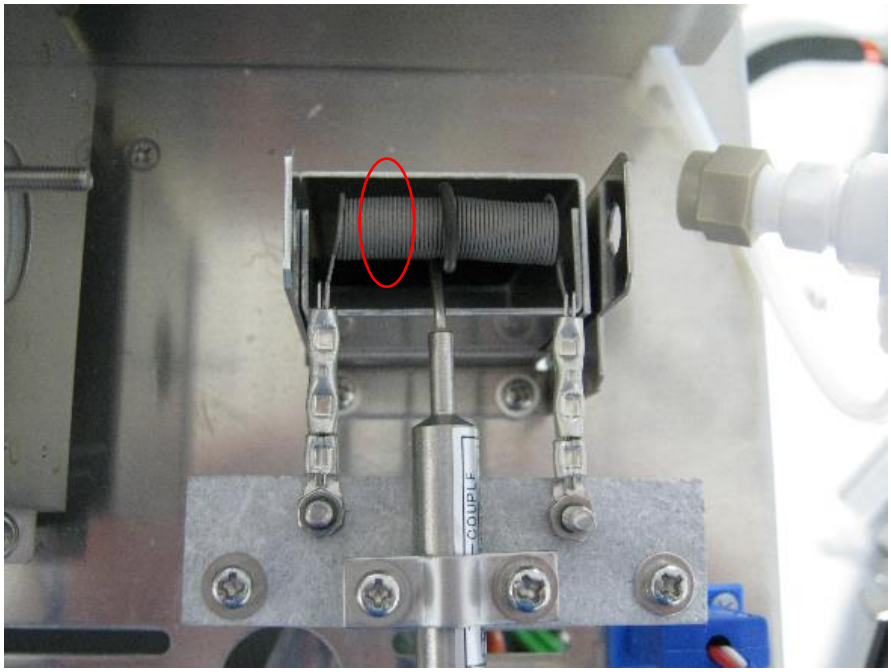
1) Remove the sample heating tube and the mercury collector tube. (Refer to 2.2.3. Removing the sample heating tube and mercury collector tube.)
2) Loosen the nuts for holding the cables, and remove the cables. In addition, remove the nuts for holding the heater.



3) Remove the H3 heater coil by passing it through the ring of the H3 thermocouple.



4) Replace the H3 heater coil. Adjust the position of the heater coil so that the thermocouple is located at the center of the heater, and then fix it in place. Confirm that the collector tube can pass smoothly.



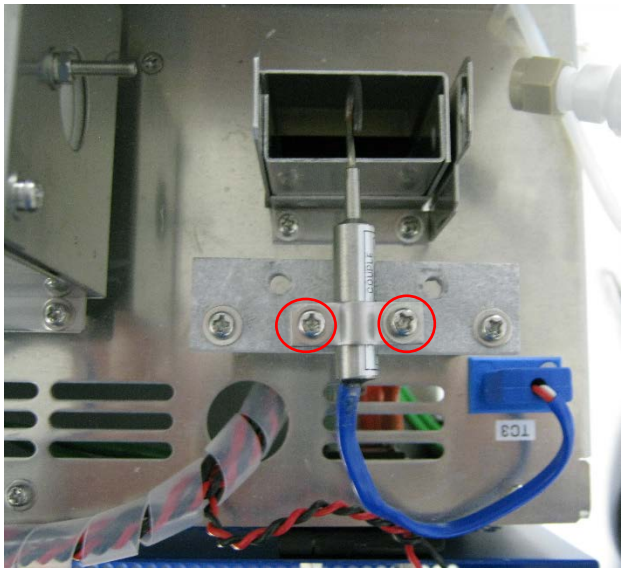
5) Attach the cables and the sample heating tube by reversing the removal procedure.

* In some cases, you need to change some parameters of the heater. Take down the serial number of the equipment, and contact us for advice.

2.3.15. H3 thermocouple

If an abnormal temperature error is generated for the H3 heater even though there are no problems with the switching power supply voltage (24V) or the SSR3 and even though there are no deformation of the H3 heater coil, replace the H3 thermocouple.

1) Remove the H3 heater through the procedure specified in 2.3.14. H3 heater.
2) Unscrew the two screws, and replace the H3 thermocouple.



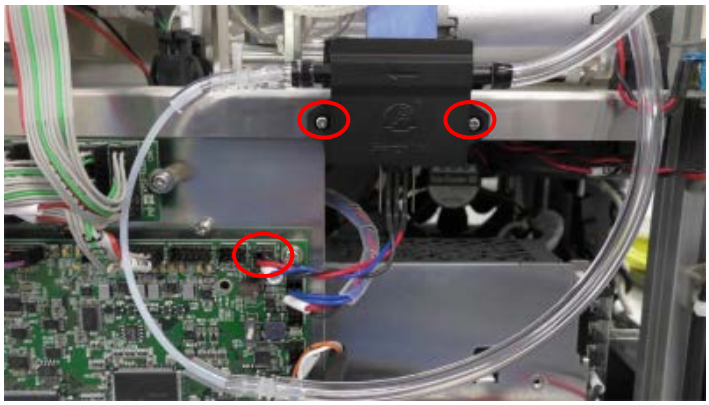
3) As with the section 2.3.14. “H3 heater,” adjust the position so that the thermocouple is located at the center of the heater coil.
4) Put it back in place by reversing the removal procedure.

* In some cases, you need to change some parameters of the heater. Take down the serial number of the equipment, and contact us for advice.

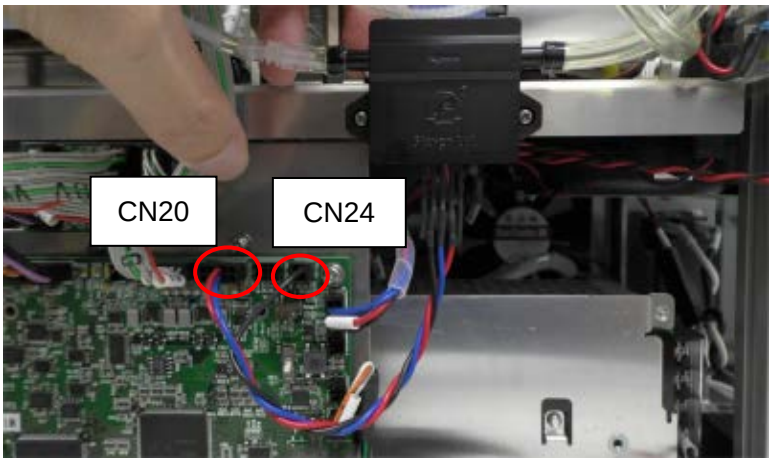
2.3.16. Flow sensor

Replace the flow sensor once every three years or if the flow rate is not indicated normally.

1) Remove the front cover.
2) Remove the two screws, and disconnect the connector (only CN24 or CN20 and 24).



3) Remove the Tygon tube, and replace the flow sensor. Connect the connectors to CN20 and CN24.

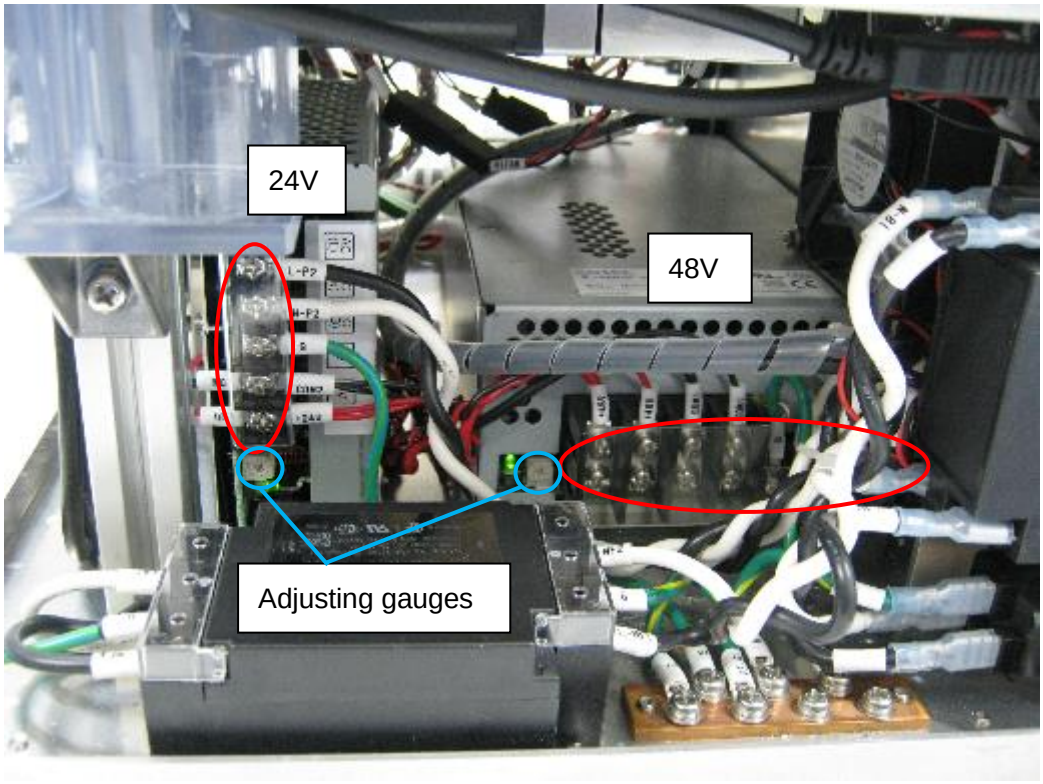


4) Put it back in place by reversing the removal procedure.

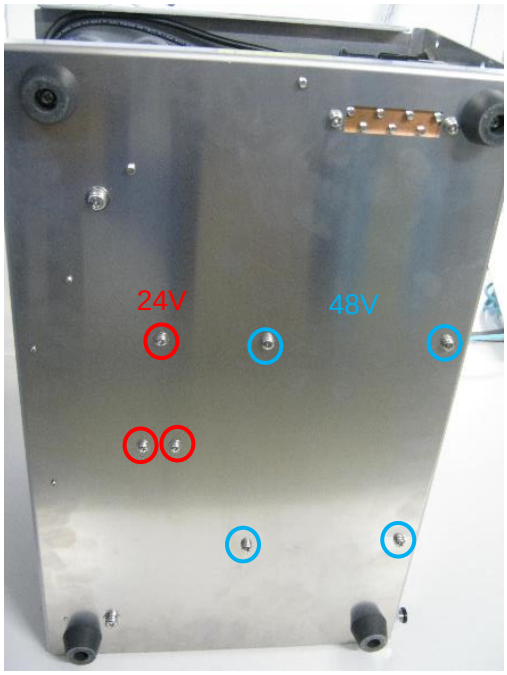
2.3.17. Switching power supplies

If the output voltages are abnormal, replace the switching power supply units (24V and 48V).

1) Remove the front cover.
2) Remove the cables from each terminal block.



3) Place the Analyzer on its side to face the bottom, remove the corresponding fixing screws, and replace the switching power supplies.

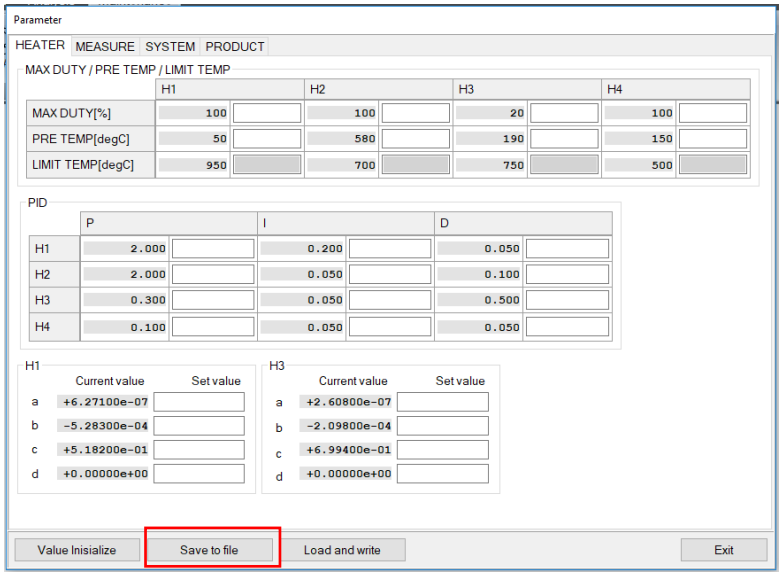


4) Put them back in place by reversing the removal procedure, and check the output voltages. If the voltage is not 24V or 48V, adjust it with its adjusting gauge.

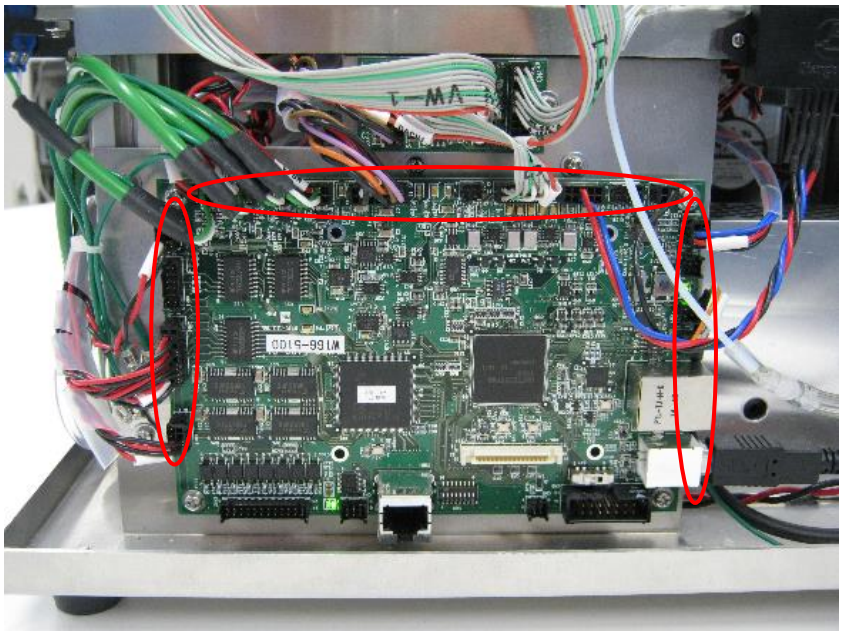
2.3.18. Main board

Replace the main board if it has failed.

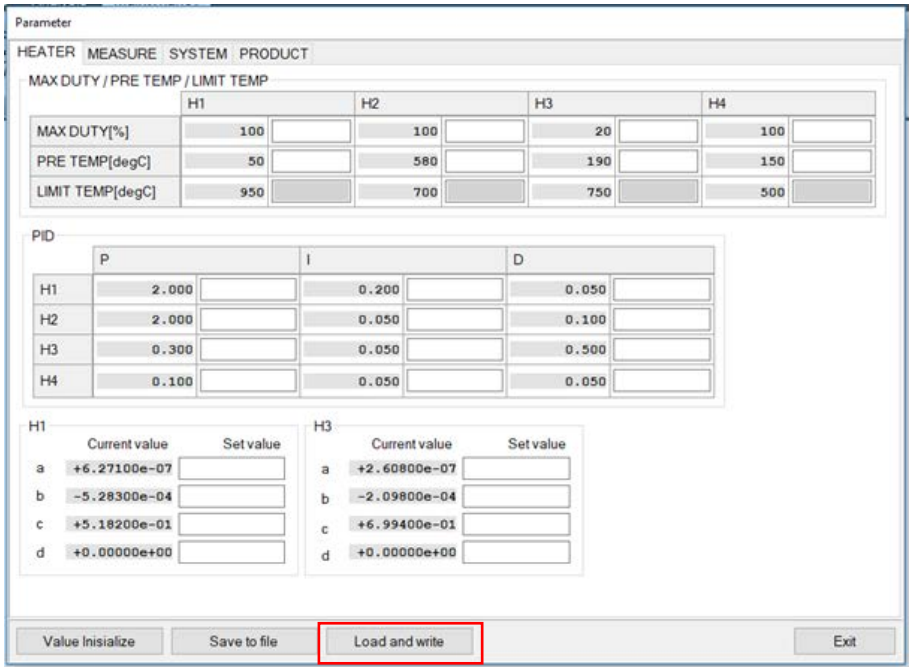
1) Save the parameters. If you can still access the Parameter screen (Maintenance → Parameter [Password: 0219]), click Save to file to save the parameters before replacing the main board. * If you cannot access the screen, contact us for advice. (You can also use the data saved at the time of delivery.)



2) Remove the front cover, remove the cables connected to the main board, and replace the main board.



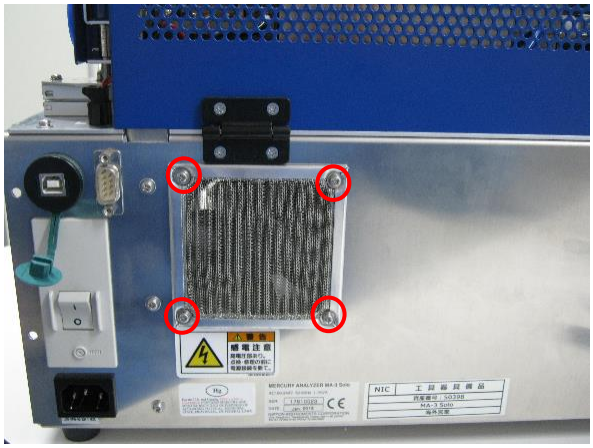
3) Now, you load the saved parameters. Open the Parameter screen through Maintenance → Parameter (Password: 0219), click Load and write, select the saved parameters, and write them. If you cannot load the parameters, contact us for advice and manually input the parameters that are instructed.

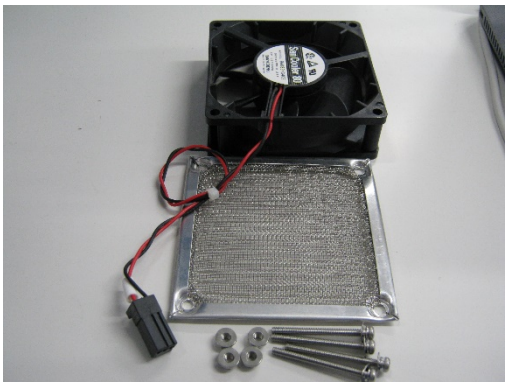


2.3.19. Case fan

Replace the case fan once every five years or if it is not running properly.

1) Remove the front cover; and while holding the nuts located inside the Analyzer, remove the four screws.



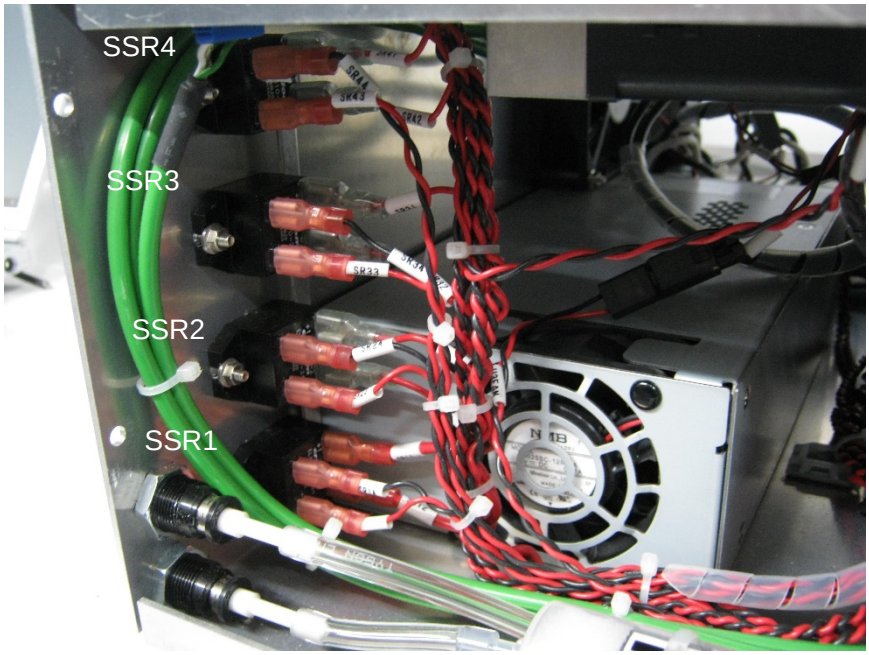


2) Disconnect the connector, and remove the case fan. Attach a new one by reversing the removal procedure.

2.3.20. SSR

For how to check the SSRs, refer to the separate document.

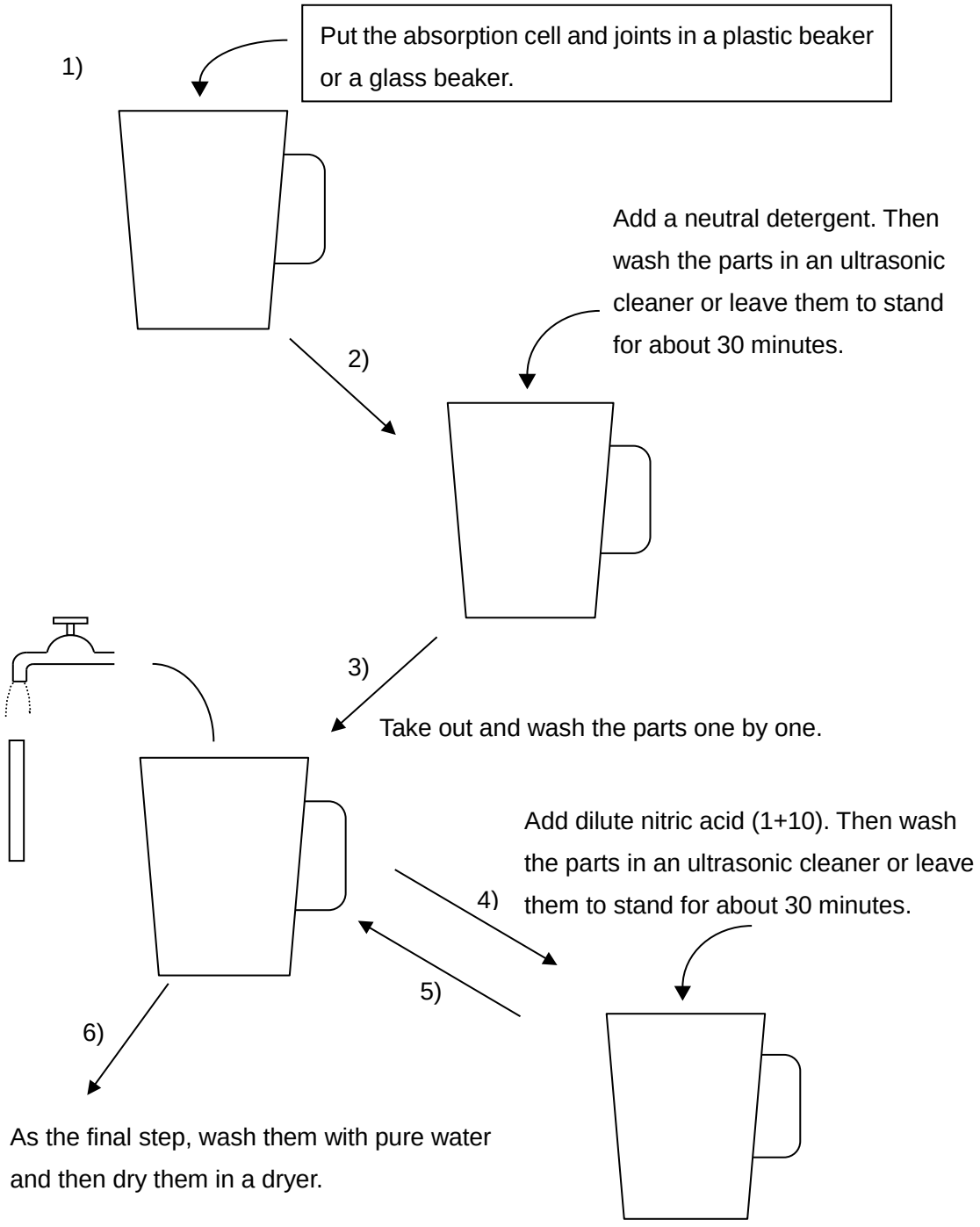
Remove the front cover. Disconnect the cables, remove the fixing screws, and replace them.



2.4. Washing the absorption cell and joints

If those parts are contaminated or the blank value has increased, conduct the following work.

Wash the removed absorption cell and joints through the following procedure.



* After the parts are washed with dilute nitric acid (1+10) in the above step, you may only rinse the parts with pure water instead.

2.5. Applying grease to the sample inlet

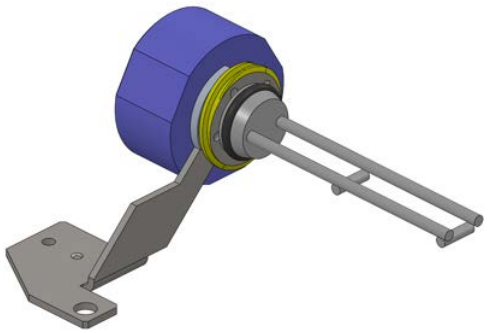
Conduct this work if the door knob is getting stiff to turn.

Use the following grease or other grease having the equivalent performance (NLGI: No.2, service temperature: -20 to 200 °C) and made of the same ingredient (lithium complex soap grease containing an organic molybdenum compound).

Note that if you use any grease other than the following, we cannot guarantee normal operation of the parts.

- Grease containing heat-resistant organic molybdenum No.2 (Product number TCG80M-2) by TRUSCO NAKAYAMA CORPORATION
- Sumiplex MP No.2 by Sumico Lubricant Co., Ltd.

1) Remove the boat handling tool.
2) Wipe off old grease with paper or cloth.
3) Apply grease to the thread shown below (in yellow).
   Use a cotton swab or the like. Pay attention not to apply grease to any other parts.



4) Put the boat handling tool back in place by reversing the removal procedure.

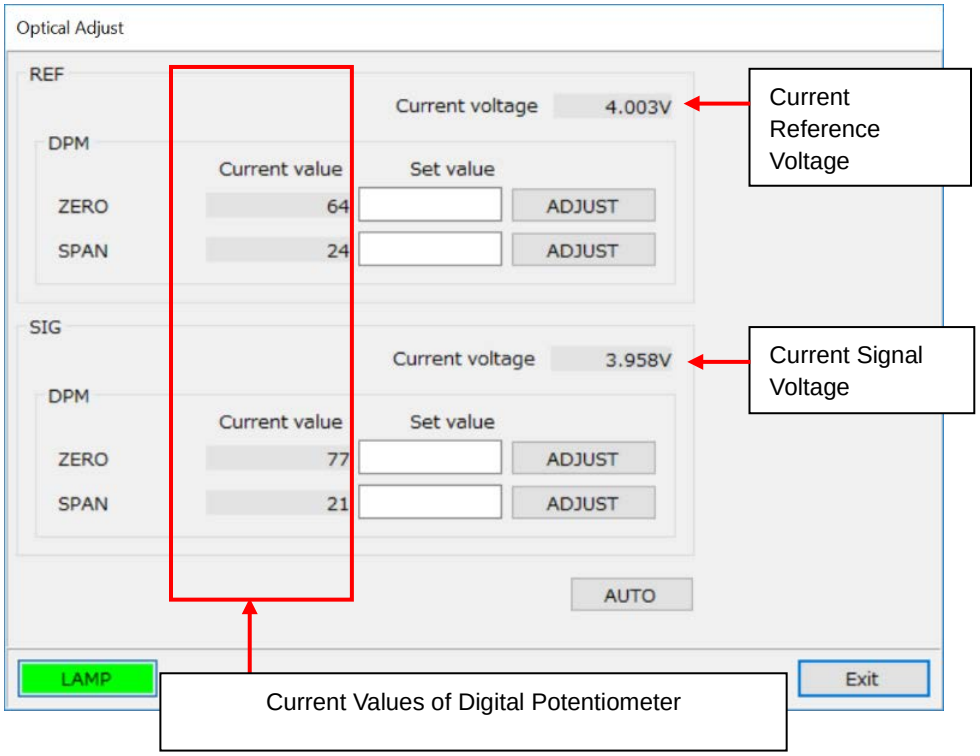
2.6. Procedures for various adjustments and checks

2.6.1. Adjusting the optical unit

In the case of “AD FULL”, “LAMP BROKEN” or “NG” for the “REF” or “SIG” voltage in the instrument check, make the voltage adjustment of the optical system.

1) Click the “Maintenance” tab in the upper part of the screen, and then click 

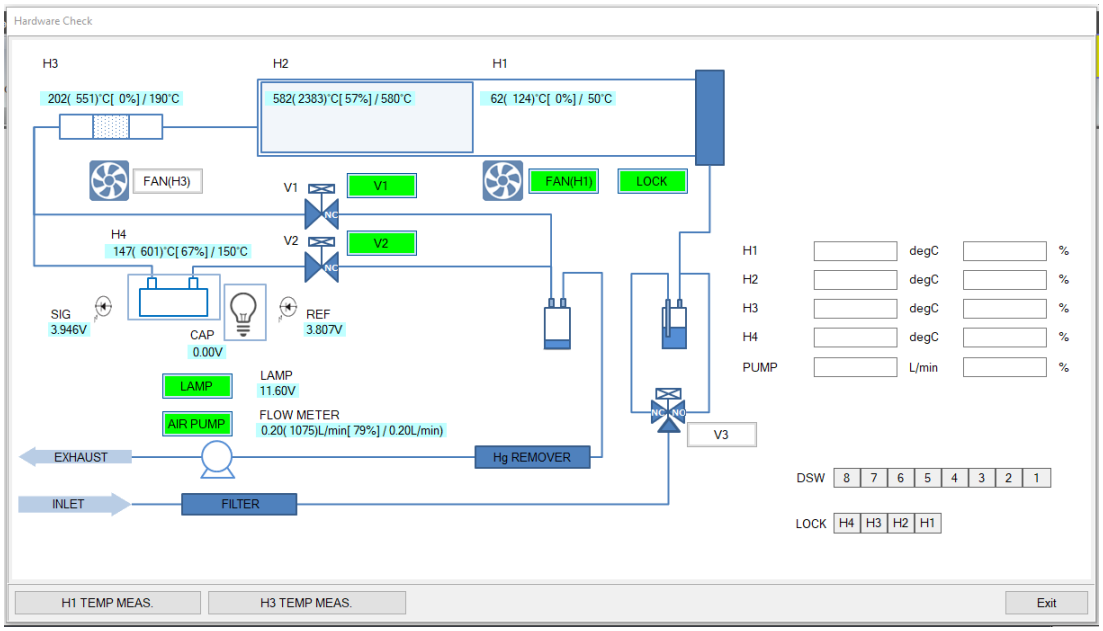
.
2) Click “AUTO” in the lower right part of the displayed screen, and the adjustment of the optical system will be automatically made.



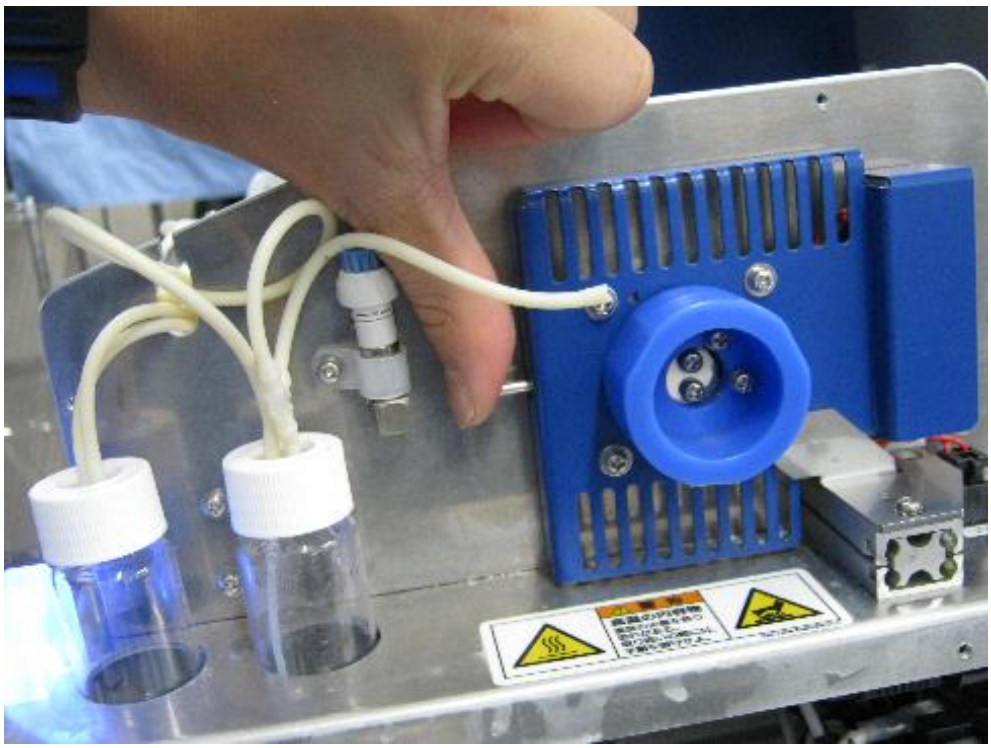
2.6.2. Manual leak check

Conduct this work if bubbling does not occur or is weak in the humidification bottle during the leak check of the self-check, or to identify any leaking areas.

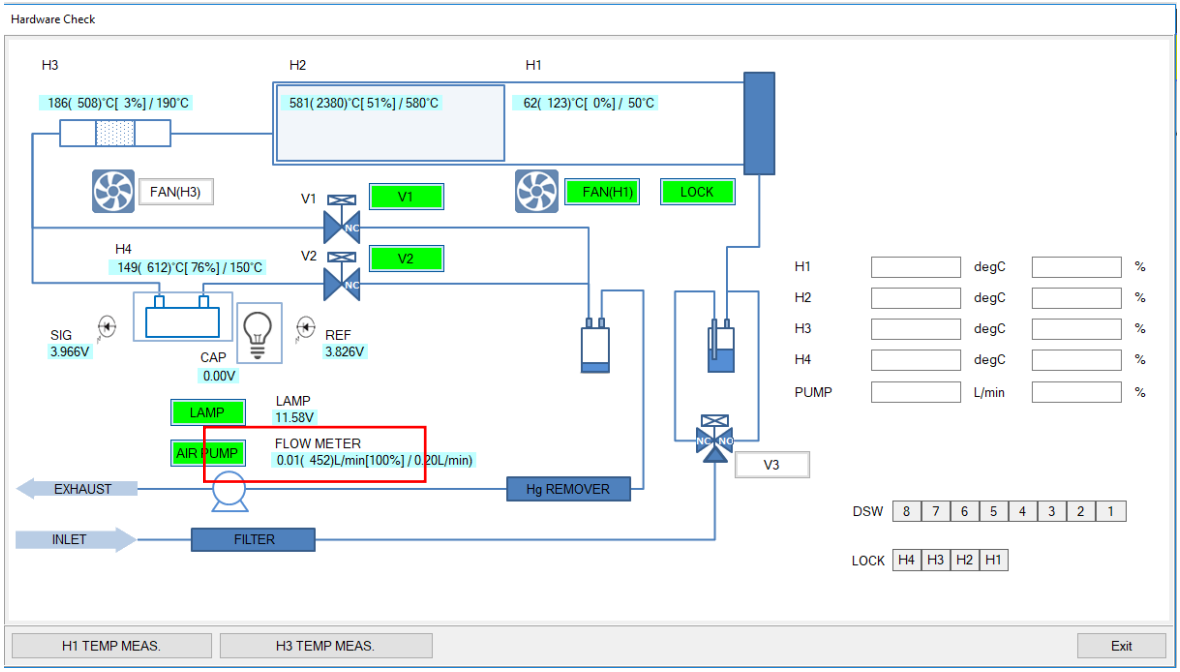
1) Open the Maintenance screen, and open "Hardware Check." Then click V2 on the screen.



2) Remove the PharMed tube connected to the sample heating tube, and plug the port with a finger.



3) If the flow rate gradually drops to 0.01 L/min or less, there is no leak. This check detects any leak between the sample heating tube and the flow sensor. If a leak is found, shift the spot of plugging with a finger to the collector tube outlet, the cell inlet, and other spots located further downstream to identify the leaking area.



2.6.3. Procedure for identifying the cause of a heater error

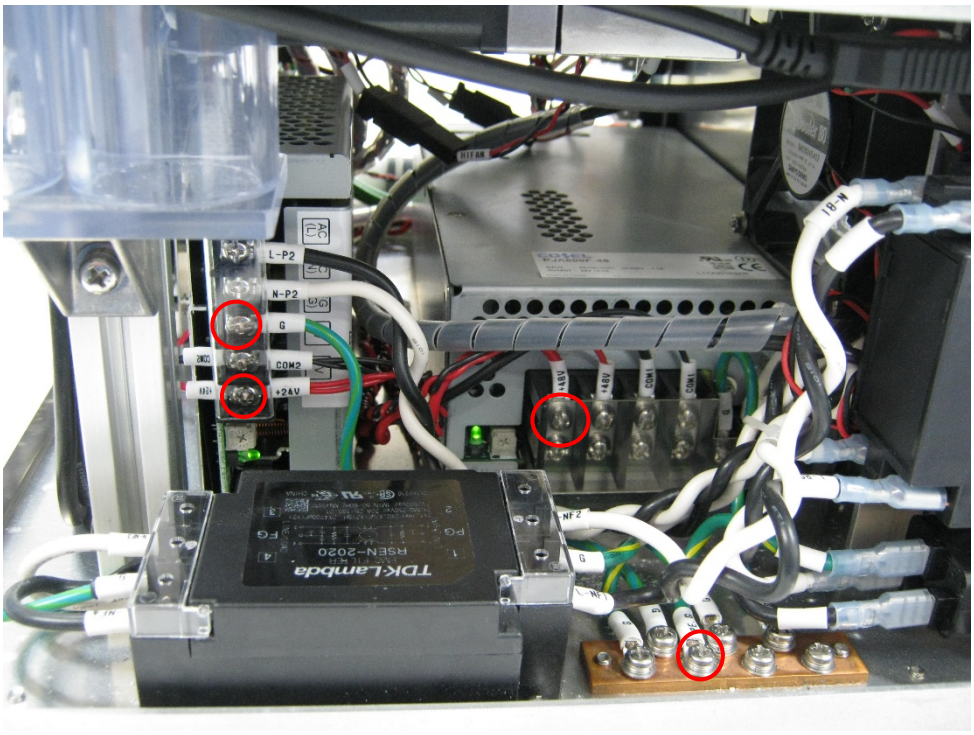
Heater temperature errors can result from various causes. Identify the cause through the following procedure.

The following table shows the type, power supply voltage, controlling SSR, and resistance of each heater.

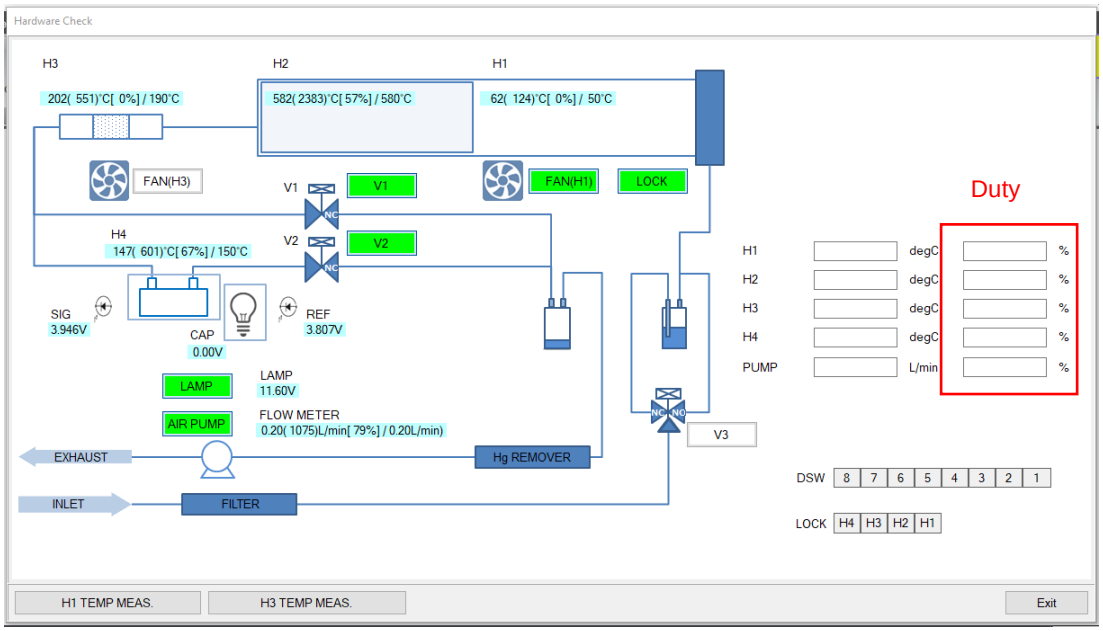
	Heater type	Power supply voltage	Heater control	Resistance
H1	Coil	48V	SSR1	6.1−7.1Ω
H2	Coil	48V	SSR2	10−12Ω
H3	Coil	24V	SSR3	7.9–9.9Ω
H4	Ceramic	24V	SSR4	20−40Ω

1) Check the resistance of each heater. Using a multimeter, measure the resistance at the terminal block of the heater. If measurement indicates infinite resistance, the heater has a broken wire. In such a case, replace the heater.

2) Check each power supply voltage. If the power supply voltage is abnormal, adjust or replace the switching power supply unit.



3) Open the Maintenance screen, and open "Hardware Check." Input ***100*** in Duty field of the heater which has an error, and then press Enter. Measure the voltage at the terminal block. If the measured voltage is clearly lower than its power supply voltage, replace the SSR.

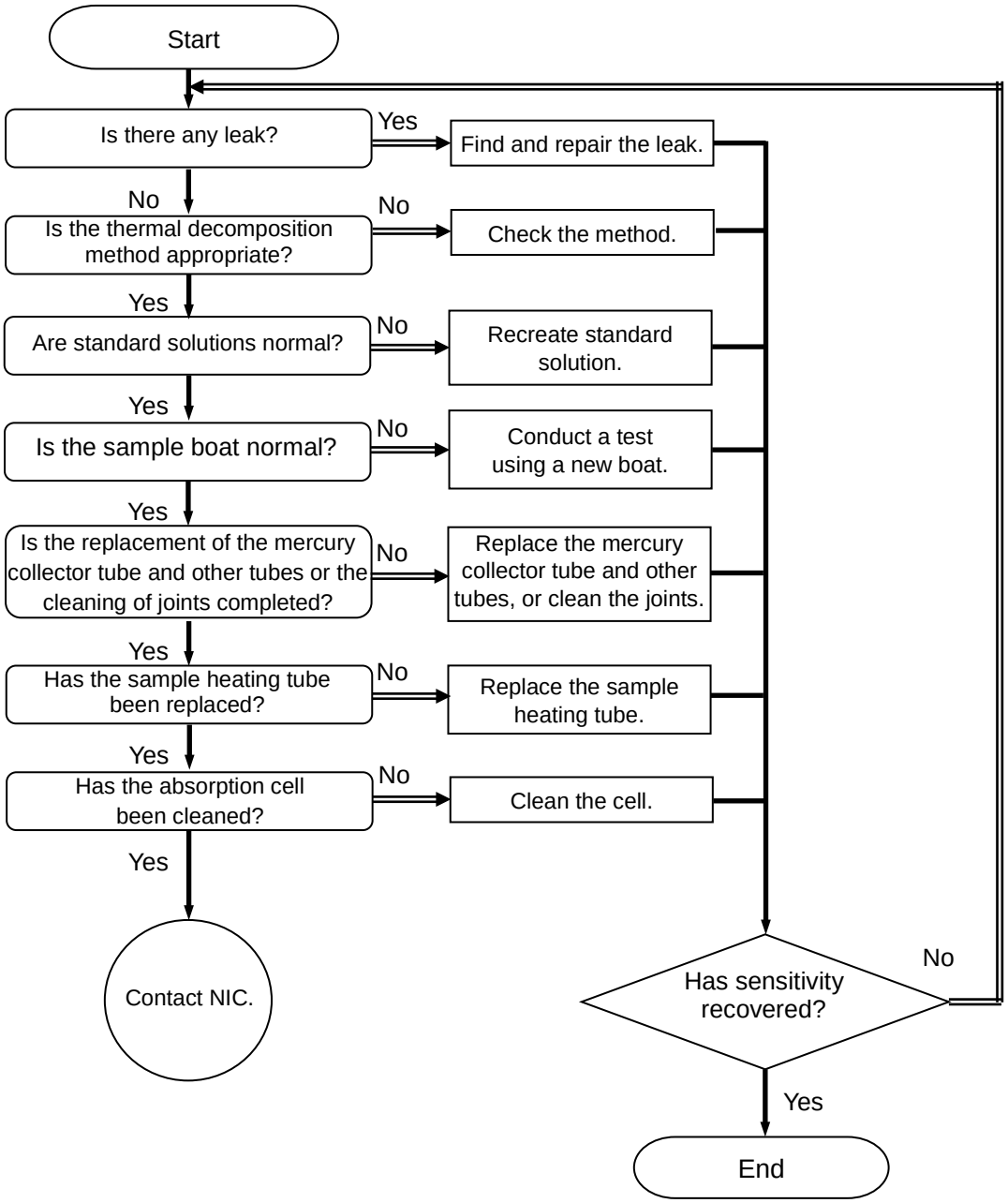


4) If no problems are detected in the above checks 1)-3), replace the thermocouple. If the problem persists, replace the main board.

3. Troubleshooting

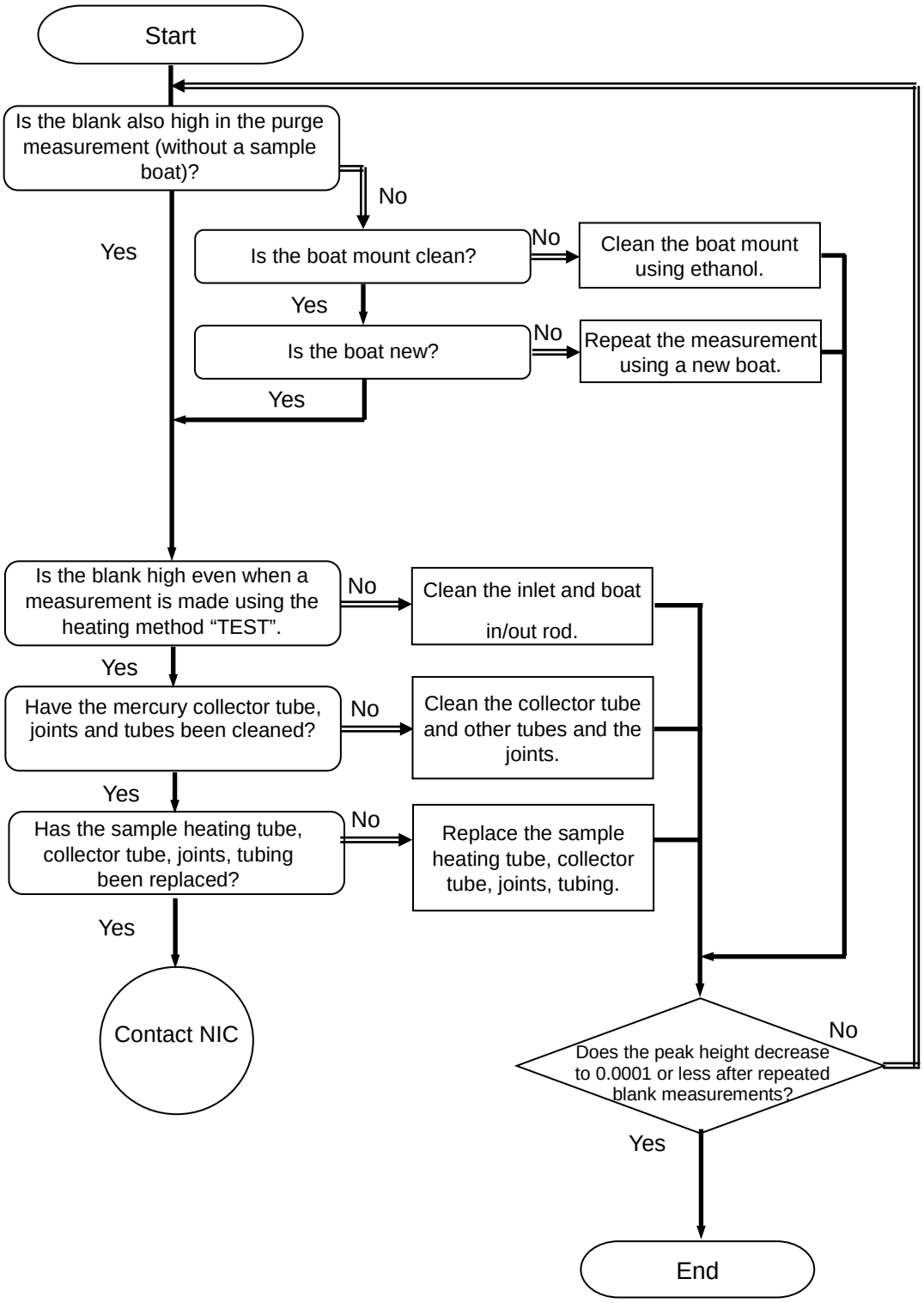
3.1. Fall of sensitivity

If it is impossible to restore the normal sensitivity even after standard mercury solution is measured repeatedly, make a check according to the following procedure:



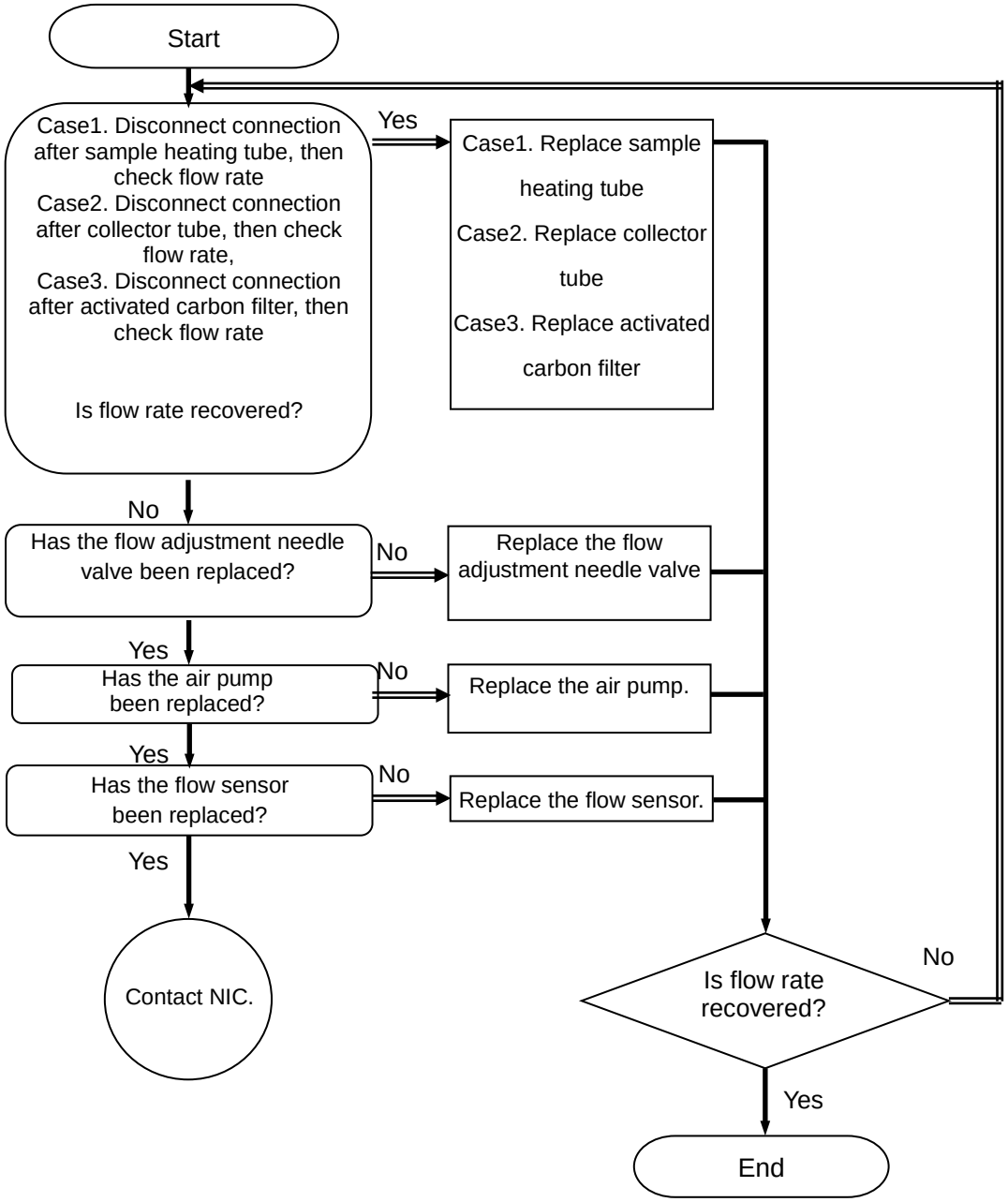
3.2. Abnormal blank value

If a blank value is abnormally large (for example, 1 to 2 ng) and does not fall easily even after the sample boat is cleaned and blank measurements are made repeatedly, make a check according to the following procedure.



3.3. Flow error

If flow error is generated or it is unable to adjust 0.20L/min during self-check, make a check according to the following procedure.



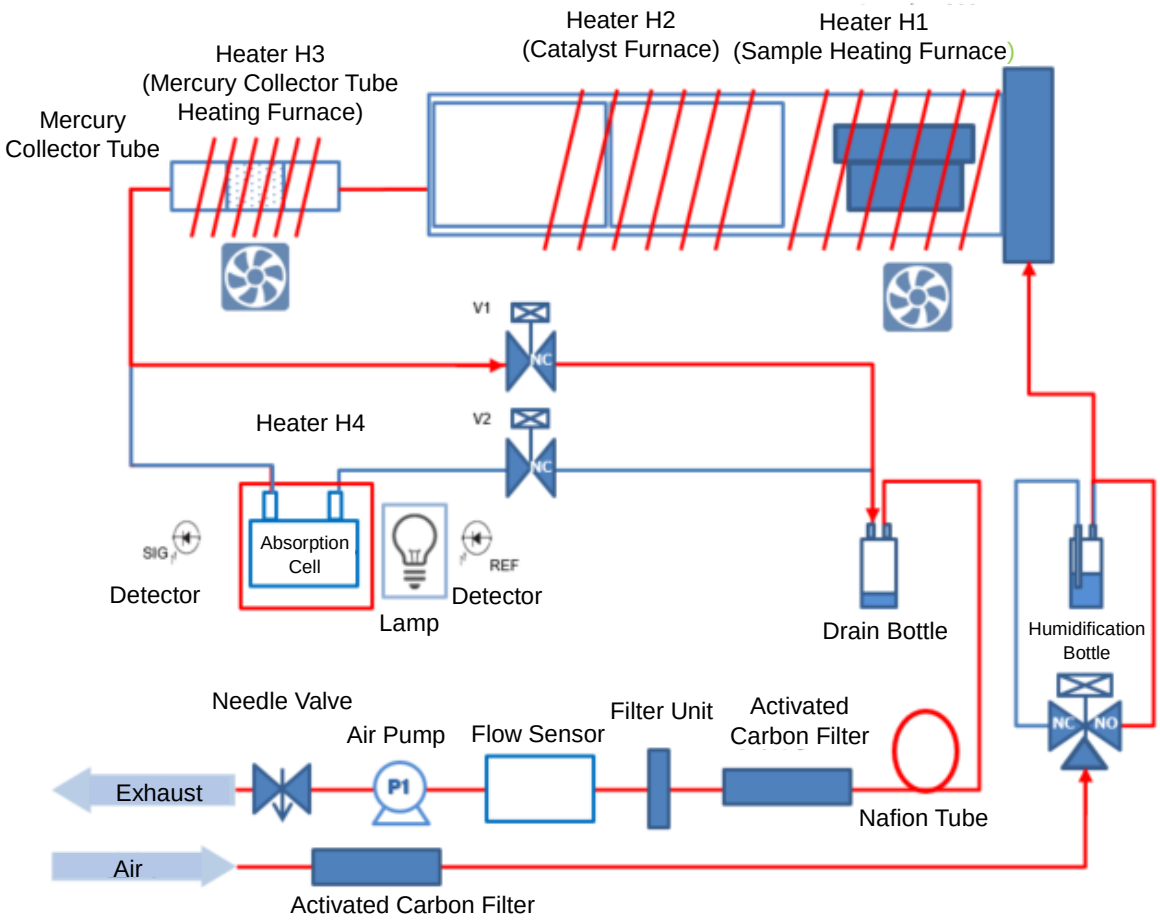
4. Error messages and their conditions

No.	Type	Message	Occurrence condition
1	AD FULL	The voltage of the AD converter of the optical system exceeds the predetermined value. Perform “Optical Adjust”.	This error occurs if the Sig or Ref voltage continues to be 4.7 V or more for at least 5 seconds.
2	LAMP BROKEN	The light quantity of the lamp (REF voltage) is the predetermined value or less. Turn off the power and check the wiring of the lamp and optical system.	This error occurs if the Ref voltage continues to be 0.5 V or less for at least 5 seconds.
3	CELL DARK	The cell is dirty. Clean the cell.	This error occurs if there is a three-fold or larger difference between Ref and Sig.
4	FLOW ERROR	The flow rate has decreased to 1/2 of the preset value or less. Make sure whether the piping has been clogged or not.	This error occurs if the flow rate continues to be half the setup flow rate or less for at least 10 seconds.
5	THERMOCOUPLE ERROR H1	The thermocouple has broken.	If the detected temperature is 960°C or more, the system determines it to be a broken wire and generates this error.
6	THERMOCOUPLE ERROR H2	The thermocouple has broken.	If the detected temperature is 960°C or more, the system determines it to be a broken wire and generates this error.
7	THERMOCOUPLE ERROR H3	The thermocouple has broken.	If the detected temperature is 960°C or more, the system determines it to be a broken wire and generates this error.
8	THERMOCOUPLE ERROR H4	The thermocouple has broken.	If the detected temperature is 960°C or more, the system determines it to be a broken wire and generates this error.
9	H1 ERROR	The temperature of the H1 does not rise to the preset temperature.	This error occurs if the H1’s temperature does not reach 70% of the final control temperature after the completion of ATOMIZE.
10	H3 ERROR	The temperature of the H3 does not rise to the preset temperature.	This error occurs if the H3’s temperature does not reach 70% of the final control temperature after the completion of ATOMIZE.
11	Abnormal H1 Temperature Detected	Please shut down and consult technical assistance.	This error occurs if the temperature exceeds 900−950°C.
12	Abnormal H2 Temperature Detected	Please shut down and consult technical assistance.	This error occurs if the temperature exceeds 700°C.
13	Abnormal H3 Temperature Detected	Please shut down and consult technical assistance.	This error occurs if the temperature exceeds 800−850°C.
14	Abnormal H4 Temperature Detected	Please shut down and consult technical assistance.	This error occurs if the temperature exceeds 180°C.
15	H2 HEATING ERROR	The temperature of H2 does not rise.	This error occurs if the temperature does not reach 90% of the setup preheating temperature even after 30 minutes.
16	H3 HEATING ERROR	The temperature of H3 does not rise.	This error occurs if the temperature does not reach 90% of the setup preheating temperature even after 30 minutes.
17	H4 HEATING ERROR	The temperature of H4 does not rise.	This error occurs if the temperature does not reach 90% of the setup preheating temperature even after 30 minutes.

5. Appendix

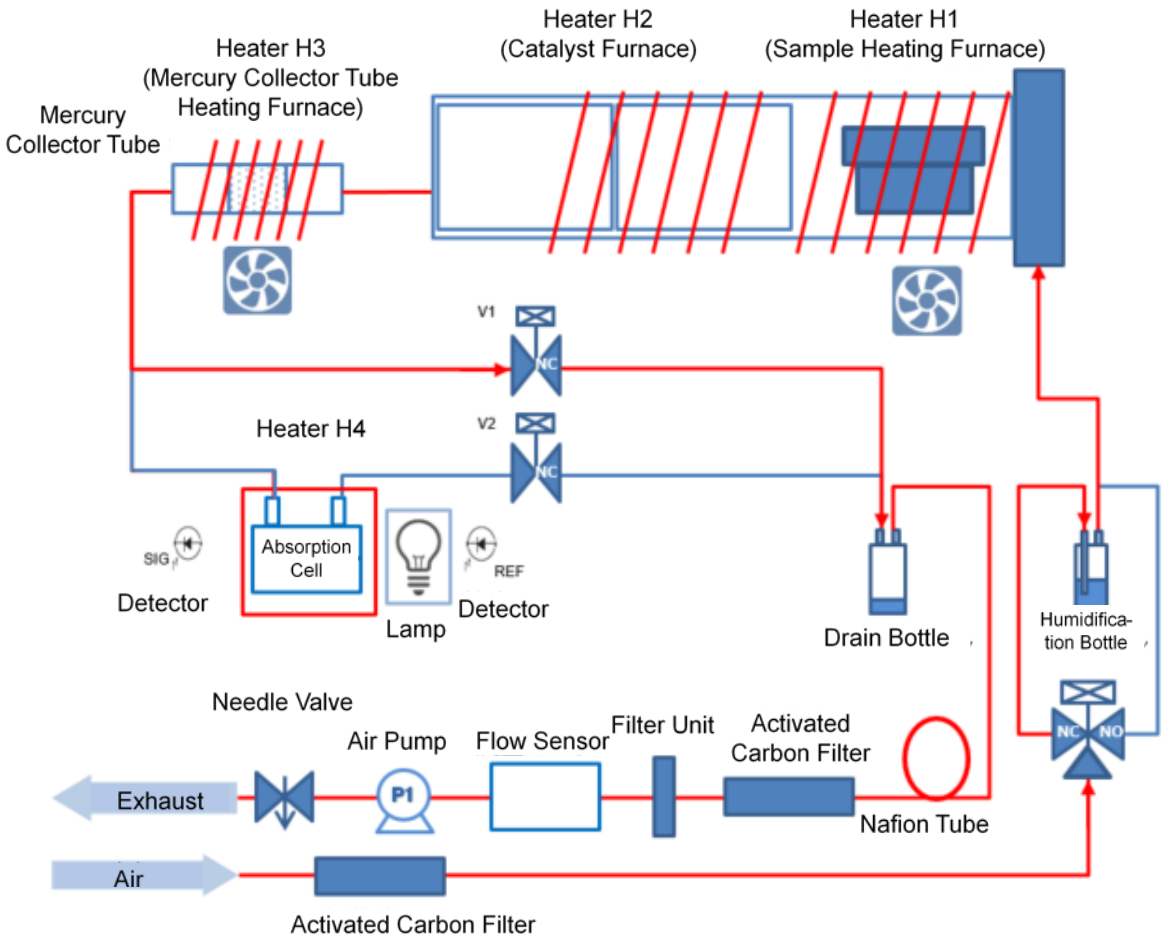
5.1. Flow path during atomize step (without humidification)

The V1 is turned on, the V2 and V3 are turned off and ordinary air flows through the path indicated with the red lines. Water produced from sample is removed by the drain bottle, and gas is discharged through the purge line.



5.2. Flow path during atomize step (with humidification)

The V1 and V3 are turned on, the V2 is turned off and carrier gas containing saturated steam flows through the path indicated with the red lines. Water produced from sample is removed by the drain bottle, and gas is discharged through the purge line.



5.3. Flow path during Purge/Measure/Meas Purge

The V2 is turned on, the V1 and V3 are turned off and gas containing mercury flows to the absorption cell through the path indicated with the red lines.
Gas passes through the absorption cell, mercury in it is removed by the activated carbon filter, and the gas is discharged from the exhaust port.