ThermoFisher
S C I E N T I F I C

Trace elemental analysis

The Thermo Scientific Hawk Consumables and Maintenance Assistant and Instrument Performance Monitoring

Author
Shona McSheehy Ducos
Thermo Fisher Scientific

Keywords
Maintenance, productivity, performance, Access Control, ICP-MS, consumable monitoring

Introduction

There are multiple challenges for busy, analytical testing laboratories today, putting the successful analysis of important samples at risk. Many laboratories run with a limited number of staff and use several analytical technologies, such that the analysts need to be familiar with the operation of different instruments. Typically, there are also high numbers of samples to analyze within a specific turnaround time, putting pressure on the instrument and analyst to deliver reliable results without delay.

Ideally, laboratories would be able to run all their samples each day, consistently, with no interruptions. However, this may be difficult to achieve if the system does not undergo necessary routine maintenance and cleaning. For many laboratories however, it is not always obvious when or what maintenance should be performed to keep the system running smoothly, resulting in performance deviations due to lack of maintenance or investing unnecessary time in maintenance that is not required. A system that is not well maintained may see an overall reduction of uptime, affect productivity, impact reliability of the sample data, and ultimately affect profitability.

Deviations from optimal instrument performance and other system issues are most often caused by overdue maintenance. Unplanned maintenance is highly disruptive as the laboratory manager must reschedule any planned analyses and the analyst or technician then needs to troubleshoot the issue and determine what maintenance is required. Deviations from expected performance are equally painful as additional time needs to be allocated to re-tune the system or troubleshoot the cause. This unplanned downtime can cause interruptions to productivity and potentially lost revenue. Regular maintenance of an instrument prevents unplanned downtime and maintains consistent performance.

ACT.
The Environmental
Impact Factor Label

thermo scientific

The Thermo Scientific™ Hawk™ Consumables and Maintenance Assistant within the Thermo Scientific™ Qtegra™ Intelligent Scientific Data Solution™ (ISDS) Software supports the laboratory by keeping track of and displaying notifications when important maintenance activities are recommended. This is possible through a suite of alerts that can be customized to the standard operating procedure (SOP) of the laboratory.

The Thermo Scientific Instrument Performance Monitoring tracks performance status, providing valuable insights into the status of the system and increased confidence in analysis batches. Any negative trends or deviations in performance expectations can indicate when a maintenance action may be necessary.

Use of these tools together or independently can ensure maintenance is performed to keep the system operating within the expected performance range, resulting in more consistent instrument uptime and efficiency.

Hawk Consumables and Maintenance Monitoring

The Consumables and Maintenance Assistant is based on a suite of alerts that inform analysts when specific maintenance activities should be performed. Default alerts are provided, but these can be user modified and new alerts can be created according to the protocols and needs of the laboratory, including user defined alerts. Alerts are based on the combination of a category and a counter, with limits and an action step. For example, Figure 1 illustrates alerts for changing peristaltic pump tubing and checking the cones, two routine activities required for ensuring ideal instrument performance.
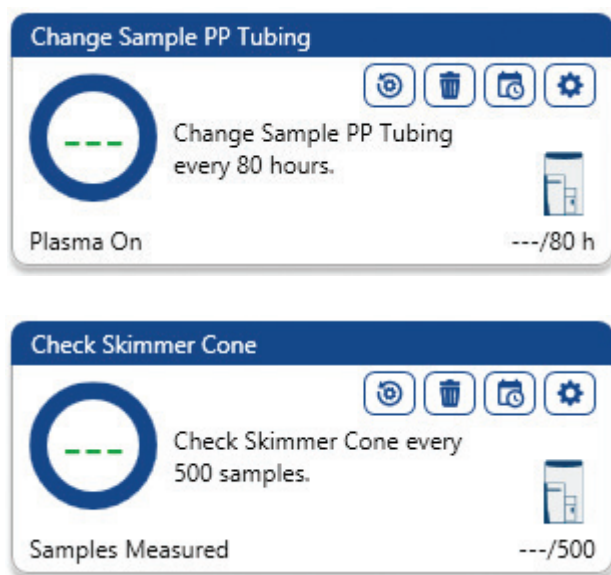

Figure 1. Example alerts for changing sample peristaltic pump tubing and checking the skimmer interface cone

The counter type used can be selected according to what is most suitable for the part and action. For example, as the peristaltic pump is constantly running during instrument operation, the degree of wear, is based on the number of hours that the plasma is on, and is therefore the ideal counter for this alert. ICP-MS interface cones degrade from wear and sample deposition proportional to the number of samples analyzed, so the ideal counter for these alerts is numbers of samples measured.

Limits for each alert counter reflect how often each maintenance activity should be performed. Each alert has a warning limit and an action limit. The warning limit, often set to approximately 80–90% of the action limit, provides a notification ahead of time so that the analyst can plan for the maintenance accordingly. The action limit indicates that the entirety of the counter has run its course and the maintenance action is due.

Typically, it is recommended to change the peristaltic pump tubing used for sample delivery every week and change the peristaltic pump tubing responsible for the draining of the spray chamber every other week in a laboratory working an 8-hour shift, 5 days a week. The Thermo Scientific™ iCAP™ RQplus ICP-MS peristaltic pump has a unique design with automatic tensioning that promotes extended tubing lifetime and so the default action limits for the counters are set to 80 and 160 hours, respectively. Additionally, the peristaltic pump does not require the analyst to de-tension the arms after analysis. User-selectable pump movement profiles after completed sample sequences save the tubing from cavitation and mitigate the need for the analyst to be present when the analysis finishes. For the interface cones, the default alert has an action limit of 500 samples. These limits and limits in other default alerts or new alerts can be adjusted according to the sample type, level of total dissolved solids (TDS) and acids in the sample matrix, the number of samples a laboratory is typically running, or how long the instrument is typically operated each day.

Examples of other alerts that can be activated or created include:

- When to change the argon supply (based on an argon gas consumption counter)
- When to refill internal standard vessels
- When to check the inventory of laboratory supplies
- When to schedule preventive maintenance

A range of counters and full user flexibility for creation of categories and actions ensures that the tool can be used for a wide range of instrument or laboratory activities.

Alerts can also be set up without specific maintenance actions. This type of alert is useful for tracking general laboratory activities that are not associated with maintenance activity on the instrument, as the alert will still trigger notifications but without specific maintenance actions.

In total, eight default alerts have been provided with the iCAP RQplus ICP-MS to help get the laboratory started with minimum effort. These can be easily edited, or new alerts created as needed.

When warning and action limits are reached, the counter changes color from green to yellow and red, respectively (Figure 2). The alerts can be ordered in the Maintenance view with respect to the severity of the limits triggered and in order of the percentage that the counter has run (Figure 3).

In addition to color coding of the alerts in the Maintenance view, notifications when alerts are triggered are carried through into the Qtegra ISDS Software Dashboard (Figure 4). The Dashboard collates the whole system status (including interlocks and other system notifications) into one view, so that during automated analysis, the Dashboard provides all essential feedback at a glance.
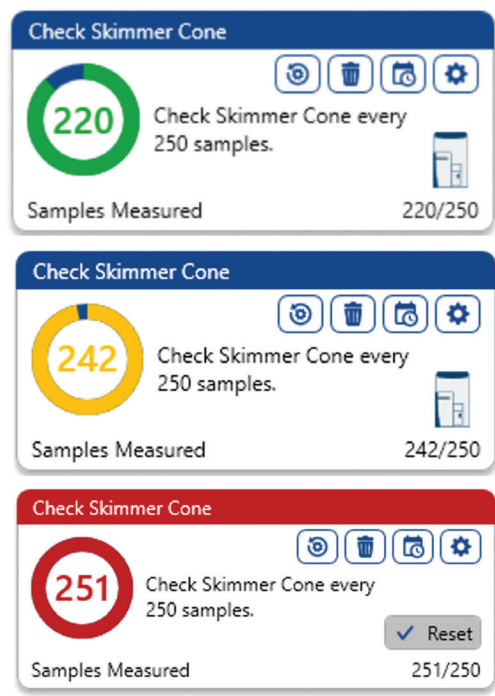

Figure 2. Skimmer cone alerts illustrating the color code change when the alert has (from top to bottom) no limit triggered (green), warning limit triggered (yellow), and action limit triggered (red)
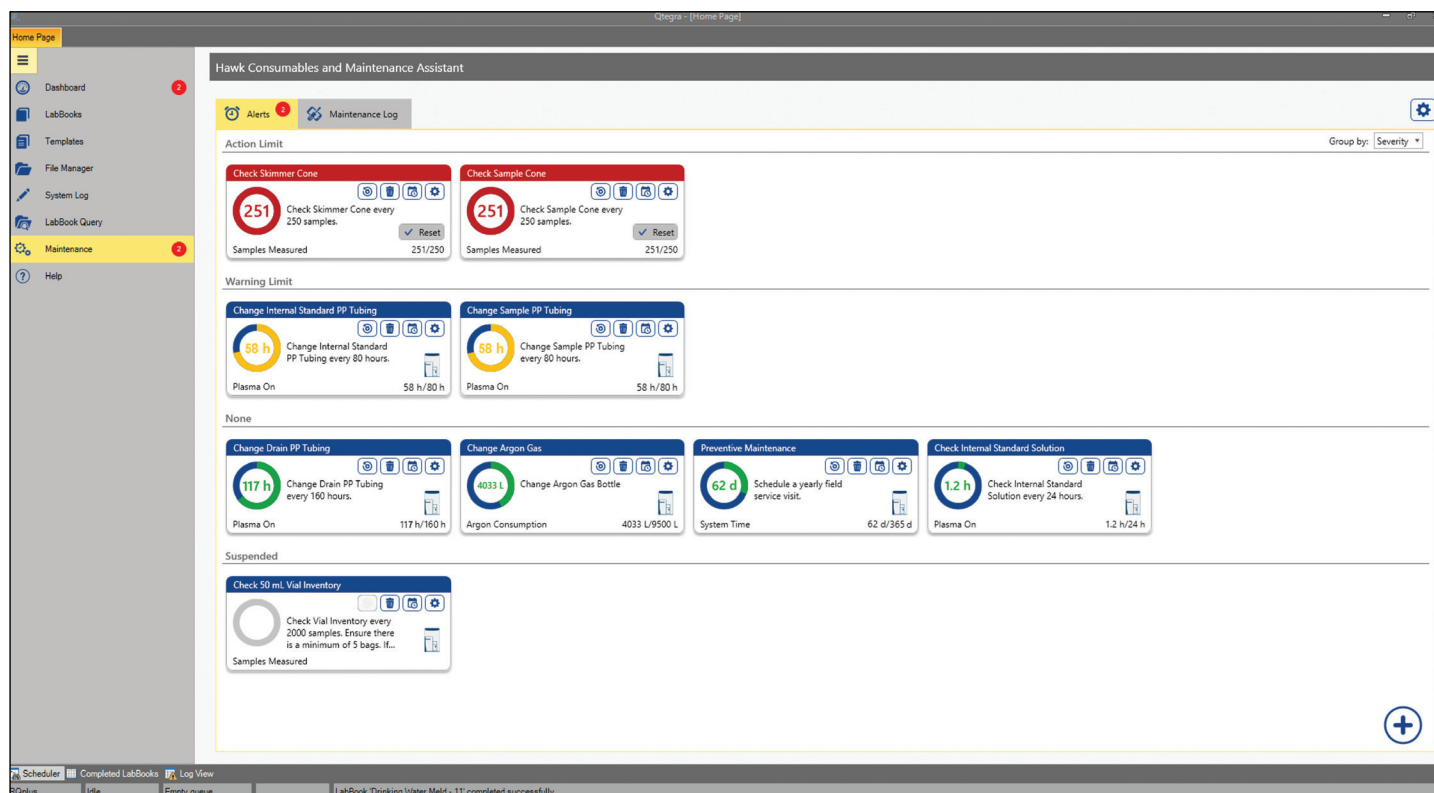

Figure 3. Alerts in the Maintenance view, ordered with respect to severity (i.e., percent of counter already completed). Note, alerts can also be suspended when not in use and grouped underneath active alerts in the Maintenance view.
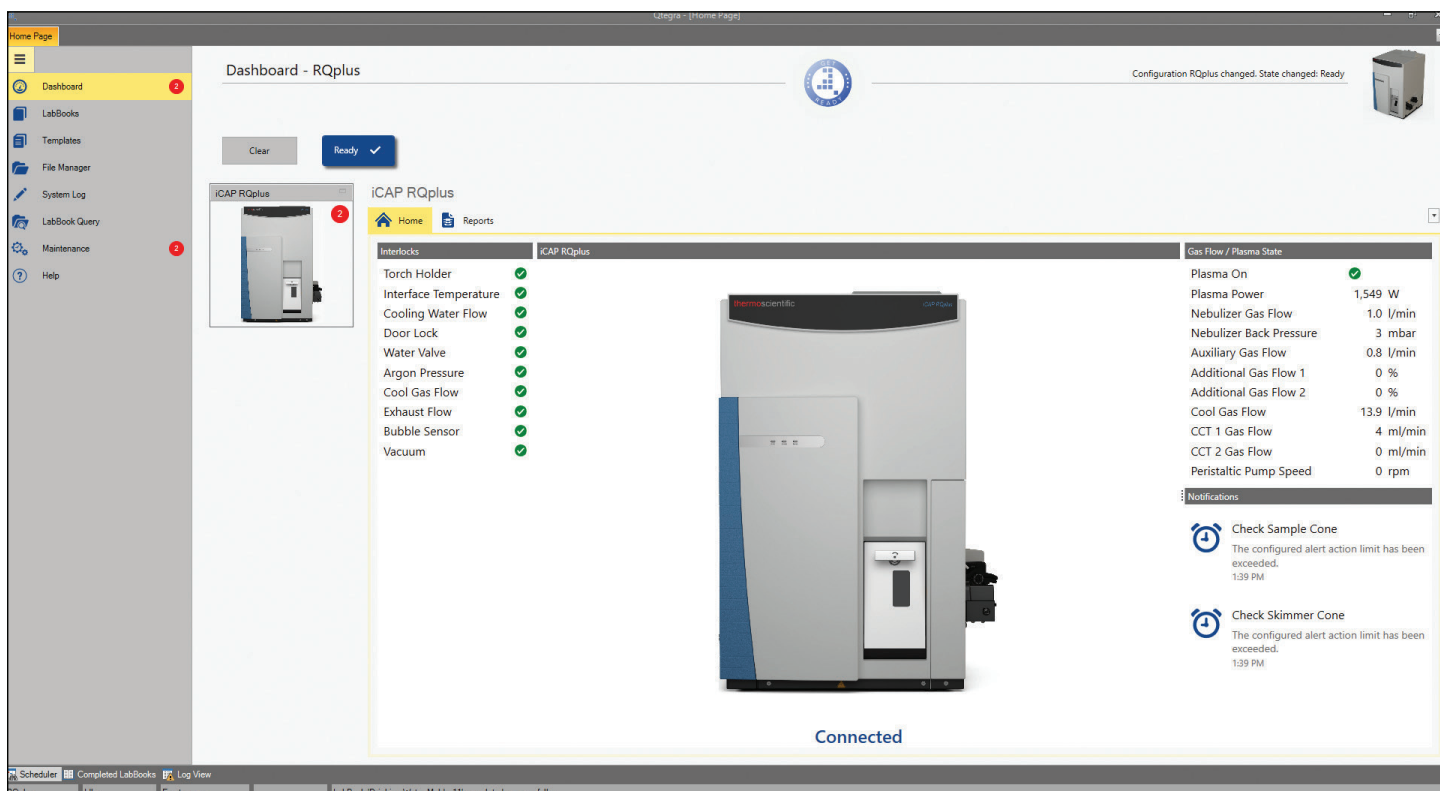
Figure 4. Warning and action notifications can be set to appear in the Notification section of the Dashboard (bottom right). Warning limit notifications can be cleared, whereas action limit notifications can only be cleared from this view by resetting the alert.

Alerts can be created with one or multiple potential recommended actions. This allows the laboratory protocol to dictate whether a specific action must always be performed, or provide the ability to select from one of the options when an alternative to the principal action is required. For example, a skimmer cone alert may prompt actions "check", "clean" or "change".

When maintenance is actioned, the alerts can be reset, and details of the action (Figure 5) archived in the Maintenance Log (Figure 6). Details captured include the action, the component concerned, any component identification (such as serial number, where relevant), and an optional comment along with the date, time stamp, and user identification.
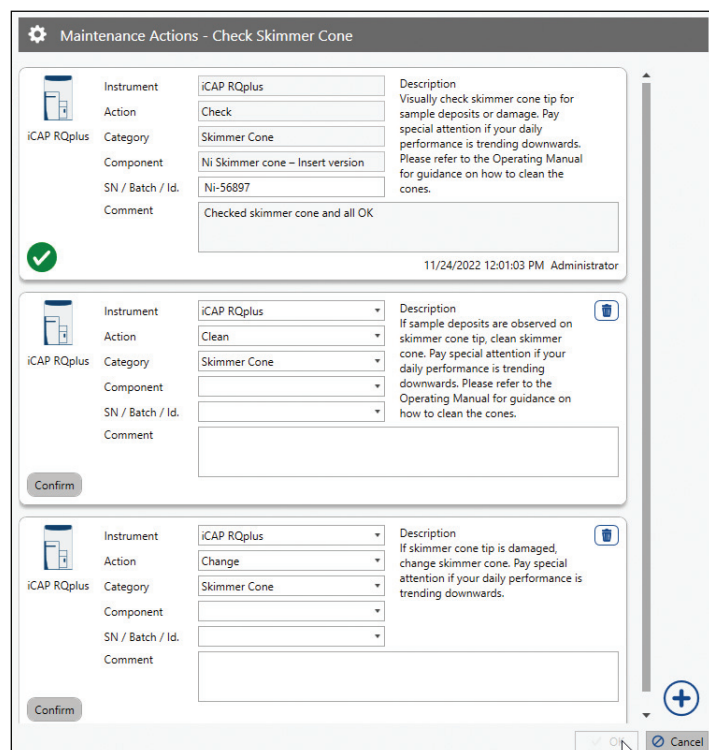

Figure 5. Maintenance action options are displayed and details of the component and maintenance activity performed are captured when resetting the alert.

Hawk Consumables and Maintenance Assistant

Alerts | Maintenance Log

Export | Report | Filter ▾   ⏮ ◀ 1 2 ▶ ⏭ Page 1 of 2

Timestamp	User	Instrument	Action	Category	Component	SN / Batch / Id.	Comment
11/24/2022 3:18:06 PM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Refill	Internal Standard Solution	100 ppb 6Li, 50 ppb Sc, 5 ppb Y, Bi		Changed bottle and filled with IS for soils, sludges w...
11/24/2022 3:17:02 PM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Check	Sample Cone	Ni Sample cone	Ni-46874	Checked cone, looks ok
11/24/2022 3:16:39 PM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Check	Skimmer Cone	Ni Skimmer cone – Insert version	Ni-56897	Checked cone, looks ok
11/24/2022 3:16:04 PM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Change	Peristaltic Pump Tubing - Sample	PVC standard pump hose - ID 0.381 mm - orange / green(3 bridges, flared end)	Batch-4578	Changed tubing
11/24/2022 3:15:33 PM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Change	Peristaltic Pump Tubing - Internal Standard	PVC standard pump hose - ID 0.381 mm - orange / green(3 bridges, flared end)	Batch 28765	Changed tubing
11/24/2022 3:14:03 PM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Check	Sample Cone	Ni Sample cone	Ni-46874	Checked cone, looks good
11/24/2022 3:13:38 PM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Check	Skimmer Cone	Ni Skimmer cone – Insert version	Ni-56897	Checked cone, looks ok, no deposits
11/24/2022 3:12:48 PM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Refill	Internal Standard Solution	50 ppb Sc, 10 ppb Ga, Rh, Tl		Refilled IS bottle
11/24/2022 3:09:07 PM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Change	Sample Cone	Ni Sample cone	Ni-46874	Changed cone with a new on as the orifice looked a l...
11/24/2022 3:08:05 PM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Check	Skimmer Cone	Ni Skimmer cone – Insert version	Ni-56897	Checked cone, looks good, no deposit
11/24/2022 12:14:56 PM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Change	Argon Gas	Argon gas bottle(purity 99.996 % or better)		Changed gas bottle
11/24/2022 12:07:02 PM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Refill	Internal Standard Solution	Internal Standard Solution	<Solution 1	Refilled solution with 50 ppb Sc, 10 ppb Ga, Rh, Tl
11/24/2022 12:03:58 PM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Check	Sample Cone	Ni Sample cone	Ni-36145	Checked sample cone and orifice looks a little frayed...
11/24/2022 12:01:03 PM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Check	Skimmer Cone	Ni Skimmer cone – Insert version	Ni-56897	Checked skimmer cone and all OK
11/24/2022 10:05:02 AM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Check	Internal Standard Solution	Internal Standard Solution	<Solution 1	Checked \internal \standard level, all ok for analysis t...
11/24/2022 10:01:46 AM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Change	Peristaltic Pump Tubing - Drain	Santoprene™ tube - ID 1.295 mm - gray / gray(3 bridges, straight end)	Batch 524	Changed drain PP tubing - only minimal wear
11/24/2022 9:59:26 AM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Change	Peristaltic Pump Tubing - Internal Standard	PVC standard pump hose - ID 0.381 mm - orange / green(3 bridges, flared end)	Batch 28765	Changed IS peri-pump tubing
11/24/2022 9:43:34 AM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Check	Internal Standard Solution	Internal Standard Solution	<Solution 1	Filled IS solution
11/9/2022 10:26:44 AM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Check	Internal Standard Solution	Internal Standard Solution	<Solution 1	checked it and refilled
11/9/2022 10:15:11 AM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Execute	Preventive Maintenance			FSe JOhn on site - PM conducted and all performanc...
11/9/2022 10:13:56 AM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Check	Internal Standard Solution	Internal Standard Solution	<Solution 1	changed it again
11/9/2022 10:11:50 AM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Clean	Skimmer Cone			
11/9/2022 10:11:45 AM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Check	Skimmer Cone	Ni Skimmer cone – Insert version	12435	Cone checked, no cleaning needed
11/9/2022 10:11:51 AM	OPTIPLE-JJ0P95L\Administrator	iCAP RQplus	Change	Skimmer Cone			

Figure 6. Details of the maintenance activity are automatically archived in the Maintenance Log when resetting the alert.

The Maintenance Log captures and archives the details of maintenance activity, building up a history of all maintenance performed. Actions are recorded in chronological order and can be filtered, exported, and reported.

Filtering the Maintenance Log therefore provides valuable insight to maintenance performed for a specific component or within a specific time frame when, for example, correlating instrument performance with maintenance actions.

Maintenance Configuration contains an exhaustive list of default components (Figure 7), while providing flexibility to add new customized components. Components are set up within a structure of:

- the category of the component (alerts are set up for specific category)

- the component itself, which can be different types of consumables within a category (and where only one type of part or component can be installed in the system at any one time)

Actions are similarly housed in the Alerts view of Maintenance Configuration (Figure 8) where default actions are provided, and new actions can be created as needed.
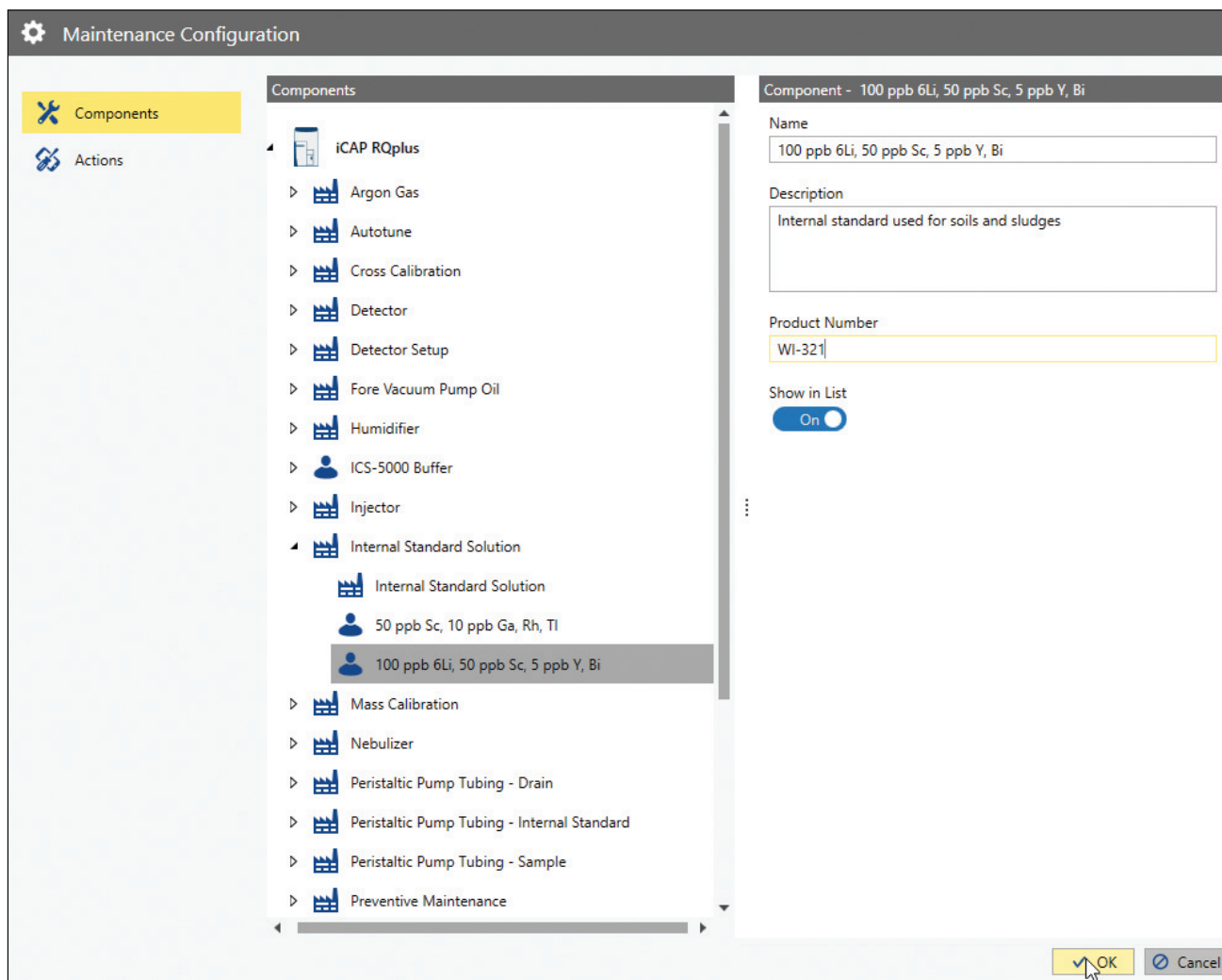
Figure 7. The Components view within Maintenance Configuration displays default (factory icon) and customized (user icon) categories and components.
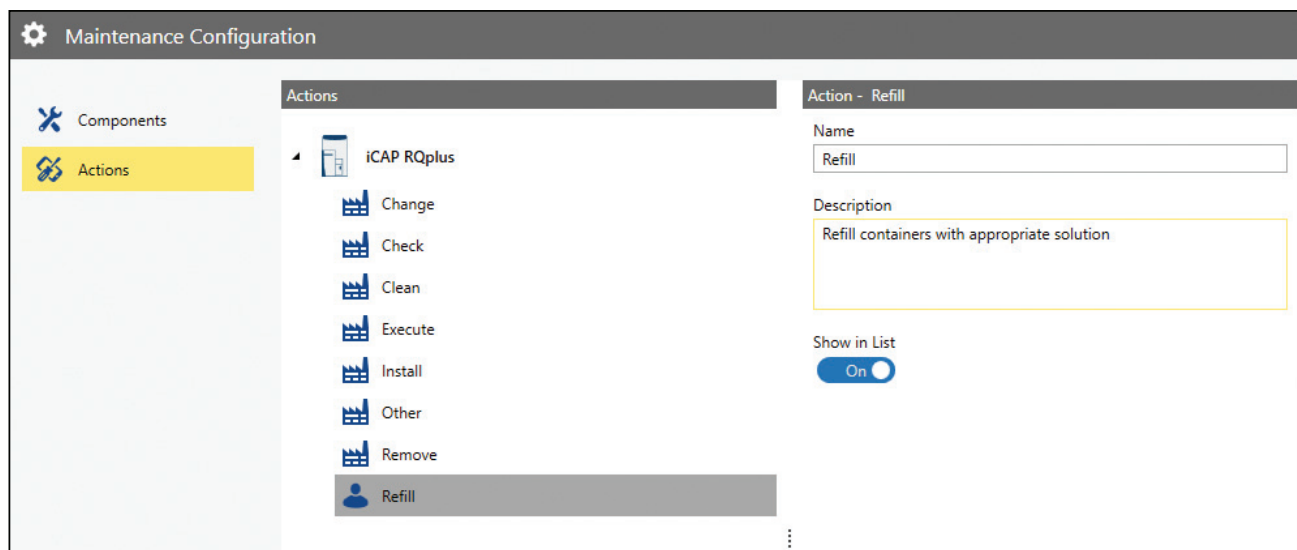

Figure 8. The Action view within Maintenance Configuration displays default (factory icon) and customized (user icon) actions.

The high flexibility of the tool allows a quick and effortless implementation by using default alerts through to a fully customizable suite of alerts tailored to your laboratory SOPs.

Instrument Performance Monitoring

The Instrument Performance Monitoring tool charts and monitors trends in performance over time and is complementary to the Hawk Consumables and Maintenance Assistant.

Performance reports and autotune files are collected and archived in one handy tool that makes it easier to find and plot specific performance data. Analyte performance data can be viewed in a table or chart (Figure 9), and filtered based on a specific time, whether the reports passed or failed, and which measurement mode was used.

Data can be exported as an image or as a CSV for off-line archiving or for illustrating that instrument performance is fit for purpose, for example, as part of an internal validation or an audit.

Performance monitoring is equally useful for monitoring performance trends. Some laboratories may prefer to use instrument performance as an indicator of when maintenance activities should be performed, rather than setting up specific alerts in the Hawk Consumables and Maintenance Assistant.

The laboratory can therefore choose only to perform impromptu maintenance activities if there is a deviation in the expected performance. Any impromptu maintenance activities can be added manually to the maintenance log and tracked accordingly.

Access Control

Access Control for creating, editing, and deleting rights facilitates implementation in a busy laboratory with different user levels (Figure 10). Access Control, for example, ensures that laboratory managers have full control over creating and editing alerts, while technicians, often responsible for operating several different types of instrumentation, can rely on the alerts and focus on performing the activities on time and resetting them accordingly.
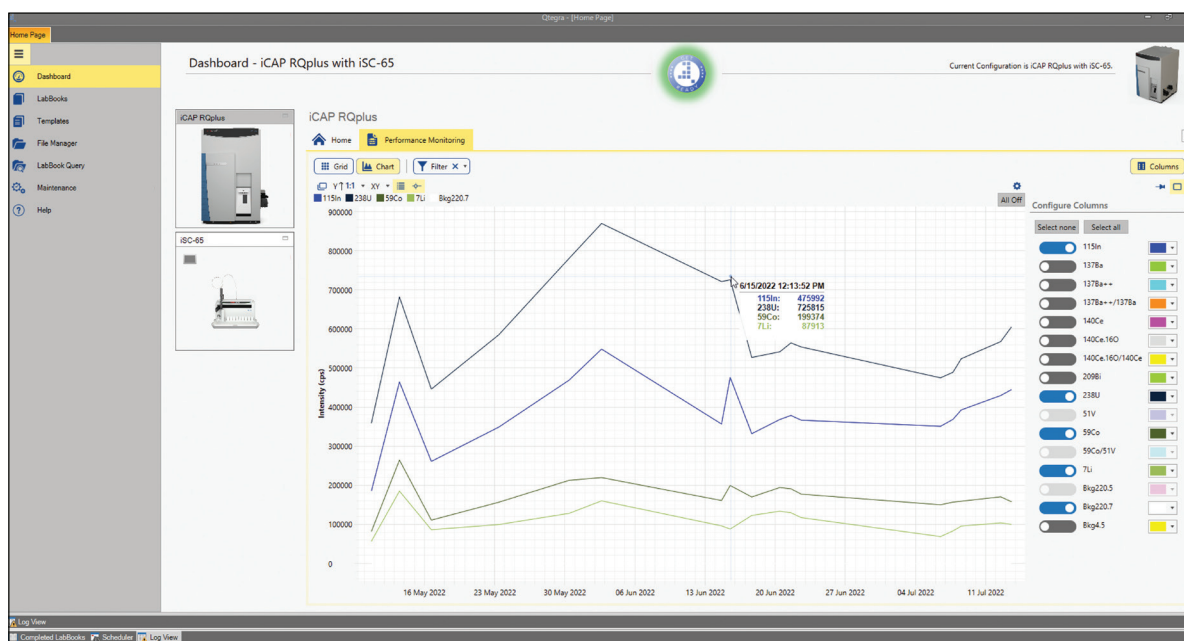

Figure 9. The Performance Monitoring view showing ^{7}Li, ^{59}Co, ^{115}In, and ^{238}U performance report data for STD mode over a period of 3 months

Figure 10. Access Control applet for the Hawk Consumables and Maintenance Assistant

Summary

The Hawk Consumables and Maintenance Assistant ensures that instrument maintenance to help keep your instrument up and running and laboratory activities to secure smooth operation are regularly scheduled. Laboratory personnel do not need to spend time planning and can focus on more important tasks. The flexibility of Hawk Consumables and Maintenance Assistant and the Instrument Performance Monitoring provides the laboratory with many options for using the Qtegra ISDS Software tools to best fit the laboratory's needs:

- Simply activate the default alerts provided to start leveraging the features with minimal effort.

- Edit the alerts as you go according to the pace of your work and the needs of the laboratory.

- In a well-established testing laboratory, tailor the alerts to your specific SOPs to optimize regular maintenance.

- Leverage Access Control to allow laboratory managers to edit or create new alerts while letting operators focus on performing the maintenance tasks at hand.

- Use the flexible alerts to manage general laboratory activities such as checking consumable inventories or expiration dates.

- Use Hawk Consumable and Maintenance Assistant and Instrument Performance Monitoring independently or in unison to track performance and plan maintenance activities to suit your laboratory needs.

Regular maintenance and scheduling of important laboratory activities prevents unplanned downtime and promotes consistent instrument performance, enabling more reliable analysis and ultimately, providing more efficiency and profitability.

Learn more at **thermofisher.com/ICP-MS**

thermo scientific