

General Specifications

For GC8000
Gas Chromatograph
AI Maintenance Support

GS 11B06H01-01EN

■ GENERAL

To minimize downtime and optimize the maintenance of Process gas chromatograph, it is effective to prevent measurement abnormalities in advance through Condition-Based Maintenance (CBM). Maintenance personnel familiar with analyzers and measurements must frequently check chromatograms and other measurement data. They need to detect changes in measurement conditions and signs of abnormalities.

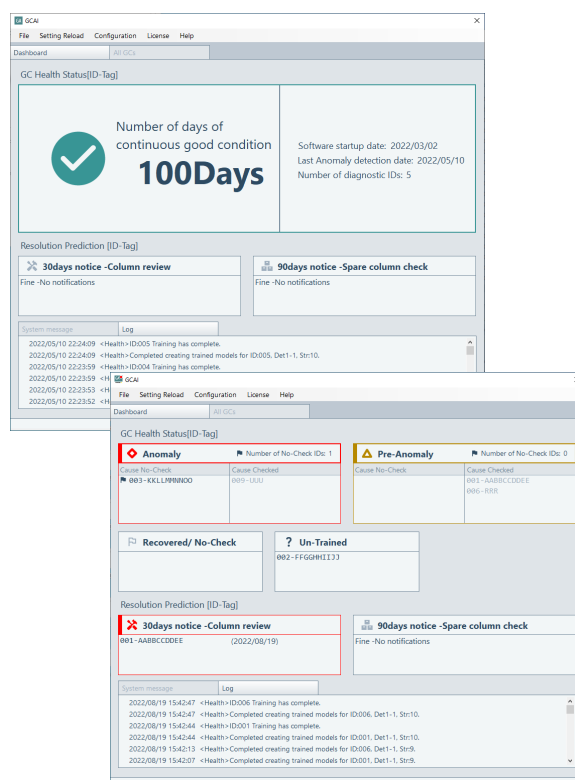
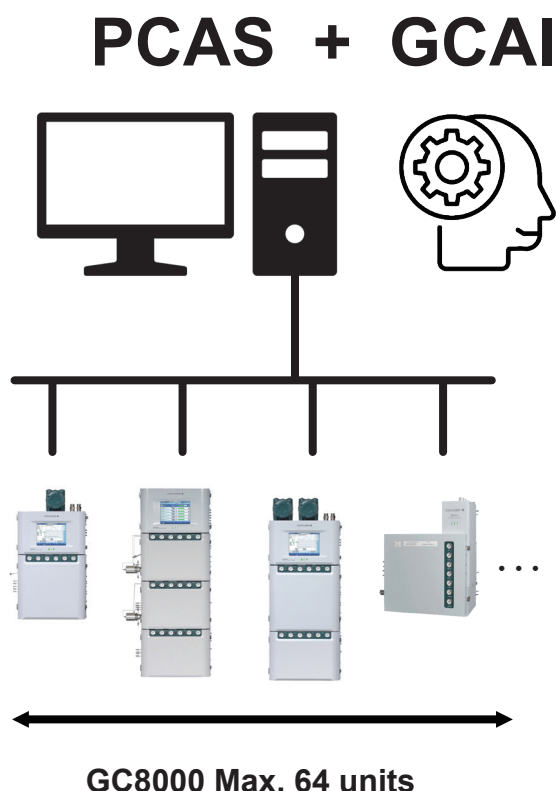
Process gas chromatograph require a lot of time and technical know-how to read signs of anomalies because chromatograms vary depending on the measurement specifications and columns used.

However, maintenance personnel resources tend to be scarce, and it is difficult for maintenance personnel to check and analyze data frequently.

Gas Chromatograph AI Maintenance Support (GCAI) is a data monitoring software for our GC8000 Process gas chromatograph.

GCAI can detect "unusual" measurement conditions from chromatograms of GC8000 connected to our analyzer server software(PCAS). The software helps you deal with malfunctions in advance and realize prompt maintenance response in the event of a malfunction. It also predicts the future resolution state of measured peaks and helps optimize column replacement timing.

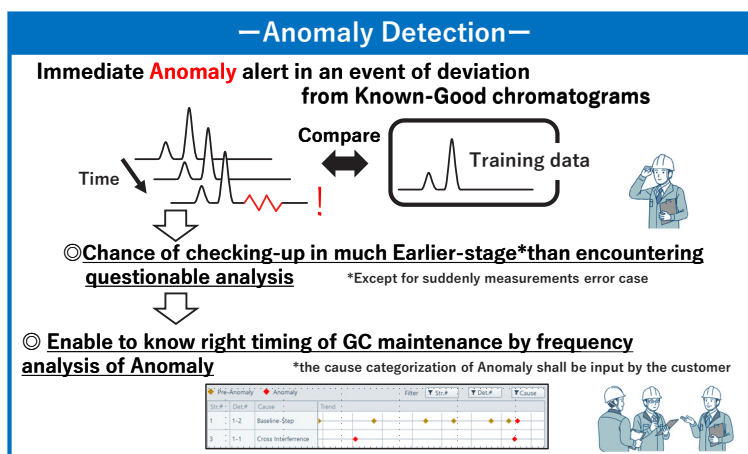
GCAI can be deployed in the form of a one-year subscription license for each GC8000 to be monitored. 3-month free license is available for trial.



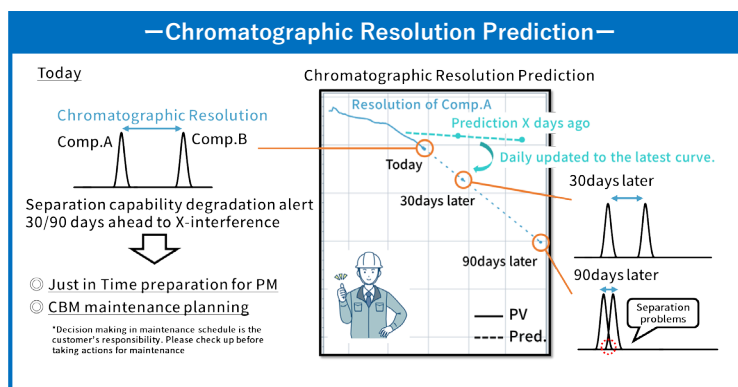
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■ FEATURES

- **Preventive maintenance with real-time monitoring and predictive detection of chromatograms using AI.**
GCAI uses machine learning models built for each monitored GC8000 to detect changes in chromatograms that differ from normal measurements and notify users of "anomalies" (abnormalities). Maintenance measures can be taken from the detection of anomalies. This is expected to prevent breakdowns and reduce downtime.



- **Optimization of column replacement timing by prediction of measurement peak resolution**
GCAI visualizes the transition of the resolution state of measured component peaks through monitoring. Displays resolution predictions after 1 day, 30 days, and 90 days based on the separation trends to date. Optimization of maintenance plans, such as parts and column replacement, can be expected in accordance with the transition of the separation state of the measured peaks.



- **Simple setup and start of machine learning model**
No difficult operations are required to build machine learning models or to set up future predictions; machine learning models can be built simply by specifying GCAI's normal measurement data.
A simple mode is also available to build a model from the previous day's measurement data.
- **Accumulation of information on measurement status for subsequent operation**
The detected anomalies can be recorded and managed together with the actual measurement data by entering the cause information.
On the GCAI screen, you can easily identify the frequency of change and trends by cause on the GCAI screen.
Information such as failure trends and separation levels up to column replacement, which could not be quantified in the past, can be accumulated and used to quickly respond to similar events when they occur.
Information can be smoothly passed between maintenance personnel.

■ STANDARD SPECIFICATIONS

1. Number of process gas chromatographs that can be monitored and their specifications

Model: GC8000 (Firmware Rev.2.02.02 or later)

Measurement specification

To ensure the GCAI calculation processing time, the GC8000 to be monitored must satisfy the following conditional equations.

There are no restrictions on the measuring component or measuring range.

$$\frac{\text{Analysis cycle (sec)}}{\text{Number of detectors}^{*1}} \geq 10 \quad \text{..... Conditional Equation A}$$

*1: The number of detectors refers to the number of chromatograms output in a single analysis.

Number of monitored units: up to 64

To ensure processing time for GCAI calculations, set the number of GC8000 units to be monitored to the extent that the following conditional equation is satisfied.

$$\frac{\text{Total number of analysis cycles of all GC8000 to be monitored (sec)}}{\text{Total number of detectors for all GC8000s to be monitored}^{*2}} \geq 5 \quad \text{..... Conditional Equation B}$$

*2: The total number of detectors refers to the total number of chromatograms output per analysis by all GC8000s to be monitored.

<Example of Conditional Formula Calculation>

The following is a calculation example for the case where the following two GC8000 units are to be monitored.

1: Analysis cycle: 300 seconds Number of chromatograms monitored per analysis: 3

2: Analysis cycle: 60 seconds Number of chromatograms monitored per analysis: 2

Conditional equation A: 1) 300 sec ÷ 3 = 100 ≥ 10

2) 60 sec ÷ 2 = 30 ≥ 10

Conditional equation B: (300 seconds + 60 seconds) ÷ (3 + 2) = 72 ≥ 5

As described above, these two GC8000s can be monitored by GCAI because the conditional equations A and B are satisfied.

<Note>

GCAI calculations may take longer processing time depending on the CPU load status of the PC. Even if the above conditional equations A and B are satisfied for calculation processing, please use the free license described below to confirm that GCAI operates properly for the monitored GC8000 when considering the introduction of GCAI. (For details, please also refer to the Installation and License Guide (TI 11B06H01-01EN).

2. Function

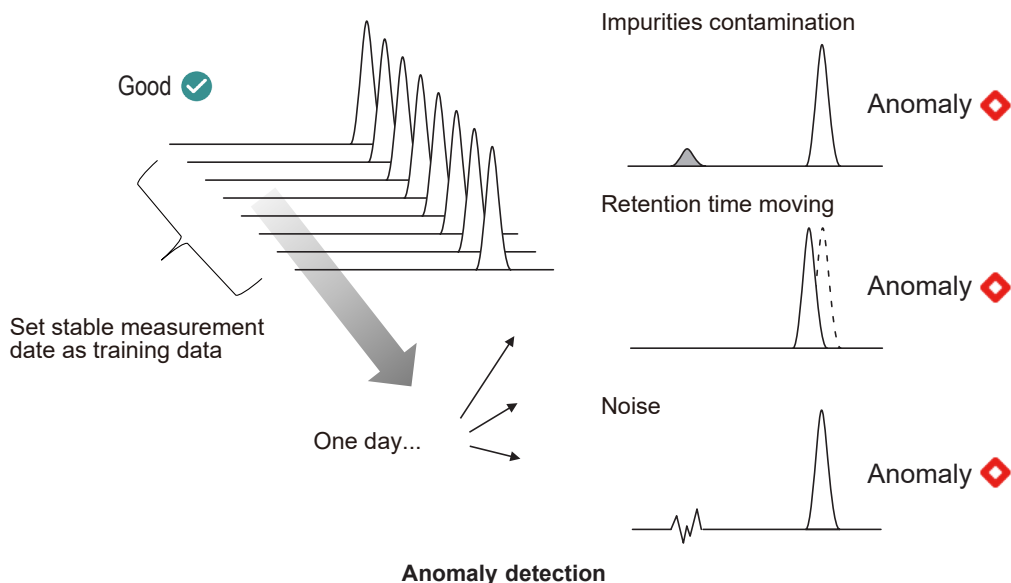
● Anomaly detection

This function detects and visualizes which GC/measuring stream/detector has "anomaly" events such as unknown peaks, changes in retention time, baseline noise, etc., from GC8000 chromatograms stored in PCAS.

Anomaly detection performs each time a chromatogram of the measuring stream configured for the monitored GC8000 is uploaded to PCAS.

<How it works>

In Anomaly detection, the baseline region of the chromatogram (region other than the measurement peak) is monitored by a machine learning model generated from "training data," which is chromatogram data of normal measurements. The machine learning model outputs the "healthiness" of the chromatogram as a parameter corresponding to the degree of change from the training data. If the health level exceeds a preset threshold, it is detected as anomalies and notified on the GCAI screen.



<Health level threshold>

Two health thresholds can be set: Pre-Anomaly (moderate discomfort) and Anomaly (severe discomfort). Any possible cause can be entered and recorded each time an anomaly occurs.

<Training data settings and detection mode>

There are two modes of anomaly detection depending on how to set the training data.

- (1) Default mode : The anomaly is detected using a training model generated by considering the previous day's measurement results as training data. Anomaly detection can be used easily as no training data needs to be specified. The machine learning model is updated at midnight.
- (2) Manual mode : Anomalies are detected by machine learning models generated using manually selected normal measurement dates as training data. Compared to the default mode, more training data can be specified, so more advanced and accurate anomaly detection can be expected. See GCAI Operation Guide (TI 11B06H01-02EN) for further information.

<Note>

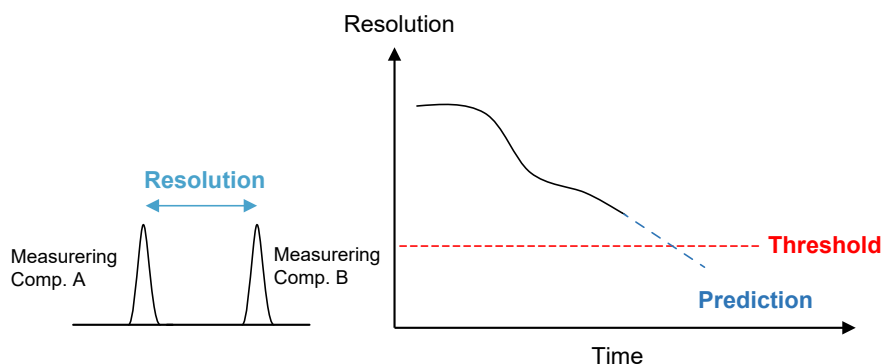
- Anomaly detection is a function that detects changes in chromatograms based on training data and does not guarantee the detection of all abnormalities in the monitored process gas chromatographs.
- The accuracy of anomaly detection can be improved by enhancing the training data. Please refer to the instruction manual to add or review the training data. Contact Yokogawa sales representatives for the training on how to set up.

● Resolution Prediction

Resolution is an indicator of the resolution between adjacent peaks and is calculated from the retention time and half width of the peaks.

Estimates and outputs the resolution after 1, 30, and 90 days from the transition of the resolution of the measured peak. Notifies the GCAI screen when the predicted resolution after 30 or 90 days exceeds the predefined thresholds.

The prediction runs on a daily basis and the prediction results are updated at 12:00 midnight.



<Note>

- Resolution prediction is reference information and is not a function to guarantee accurate prediction of future resolution transition. We do not guarantee any damages that may occur in the event that the prediction is not correct.
- The resolution calculation requires two or more non-zero concentration measurement peaks in a single chromatogram. If the measurement peak is single, or the concentration is 0%, this function is not available. The separation of measured and non-measured peaks cannot be reflected.
- This function is not suitable for use when multiple components are measured at once using a single peak setting, as appropriate prediction calculations cannot be made.
- If the composition of the sample changes significantly during a single measurement channel (e.g., the largest concentration component changes to another component), the retention time of the measured component may change and the resolution may increase or decrease rapidly. In such cases, the proper resolution cannot be predicted.

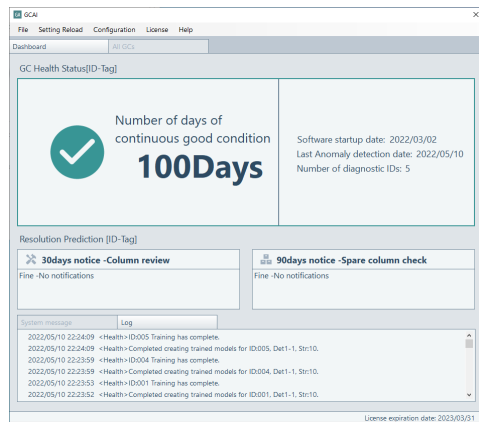
The table below shows the amount of data required for each monitoring function.

Monitoring function name	Amount of data required	Recommended data size*
Anomaly detection	Analysis results for one day as training data	Analysis results for 30 days or more (number of analyses: 4000 or more) as training data
Resolution Prediction	Results of the analysis on the last consecutive 14 days	Results of analysis over the last 44 days

* Recommended data volumes are reference values because they vary depending on measurement specifications and chromatograms.

• Data browsing, saving and notification

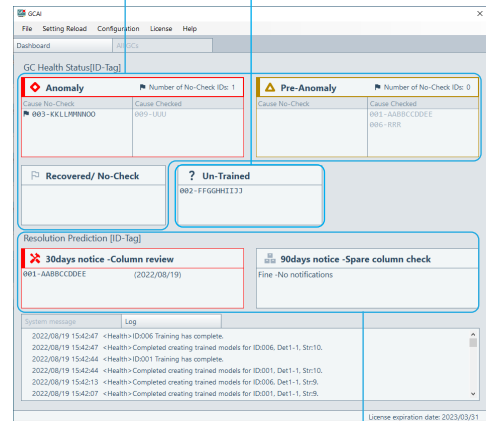
Main window - in continuous good condition



Main window - when anomaly is detected

Display the GC8000 occurred Anomaly by ID and Tag#

Display GC8000 with untrained detection model

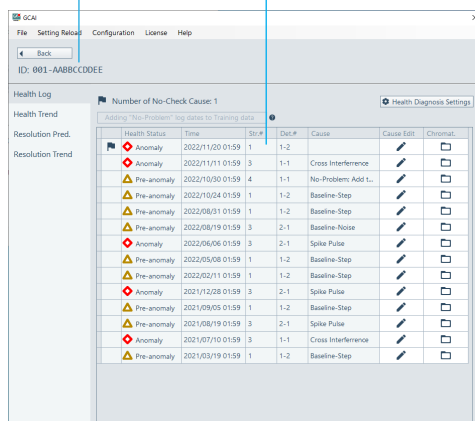


Display GC8000 with 30/90 day prediction below threshold in Resolution prediction

Health Log

Displays the type of Anomaly, date and time, stream, detector, and cause
(Upper display limit: latest 200 data per GC8000)

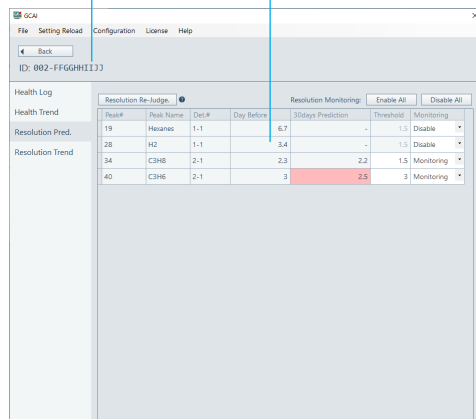
GC8000 ID-Tag#



Resolution Prediction

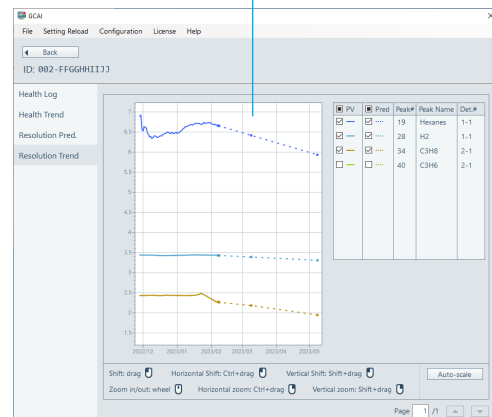
Displays peak information, actual resolution value/predicted value after 30 days/threshold (Upper limit: 98 peaks)

GC8000 ID-Tag#



Health Trend

Displays measured resolution values (past 270 days) and predicted resolution values (1 day/30 days/90 days) graphed in time series.



Resolution Trend

Displays measured resolution values (past 270 days) and predicted resolution values (1 day/30 days/90 days) graphed in time series.

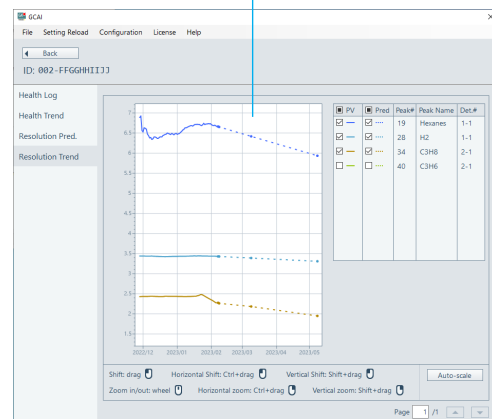


Table 1 Save record and notification

Function	Save record (File output)	Notification
Anomaly detection	<ul style="list-style-type: none"> • Save log: Date and time, stream number, health status by detector number, and entered cause are saved in xml format (Max. 10000 data per GC8000) * The data is automatically saved when the health level changes to Pre-Anomaly or Anomaly. 	<ul style="list-style-type: none"> • When the health status changes to Pre-Anomaly or Anomaly, GC8000 (instrument ID and tag name) is displayed on the main screen dashboard to notify you. You can also setup beep sound notifications. * The GCAI does not have a function to output a notification of anomaly occurrence to external equipment from the PC running the GCAI.
Resolution prediction	<ul style="list-style-type: none"> • Save prediction results: Save the 30-day fluctuation averages of the resolution actual based on the last 74 days and the predicted resolution in xml format. • Save skip prediction result: 7 Save daily resolution prediction results in xml format *Automatically saves when the resolution prediction is updated. 	<ul style="list-style-type: none"> • Notifies when the resolution prediction value after 30 or 90 days falls below a predefined threshold by displaying the relevant GC8000 (instrument ID and tag name) on the main screen dashboard. * The GCAI does not have a function to output a notification of the reduced resolution externally from a PC running the GCAI.

3. System requirements

GCAI must be installed and used on PCAS (Ver. 3.01.01 or later) where PCAS is running. For PC and network specifications, refer to PCAS's General Specifications "GC8000 Analyzer Bus System" (GS 11B06A02-01E).

Hard disk storage capacity to install GCAI: 50 MB

Data-Capacity Stored in GCAI: As a guide, approx. 150 MB per GC unit.*

*: It is a reference value when the analysis period is 10 minutes (number of peaks per measurement is 6, number of monitoring chromatograms is 9), and the storage period is 1 year for the anomaly detection data, and the storage period is 5 years for the resolution prediction data.

4. License status

• Software

You can download the software from the dedicated website. Please contact YOKOGAWA sales representative in charge for the URL.

After the software is downloaded, install and use it on a PC where PCAS is running.

• License

To use the GCAI functions, a license must be purchased for the number of GC8000 unit to be monitored and an authentication (activation) must be performed for each GC8000. For example, three licenses are required to monitor three GC8000 units, even if you use only one GCAI.

For the GC8000 to be monitored for the first time, it can be activated with a 3-month free license.

Free Trial license :

This is a 3-month free trial license to use GCAI on a trial basis, enclosed in GCAI software download package.

All GCAI functions are available.

You can activate any GC8000, but you cannot activate the same GC8000 multiple times

During the free license period, refer to the check items listed in the GCAI Installation and License Guide (TI 11B06H01- 01EN) to verify that the GC8000 in operation is suitable for monitoring by GCAI.

Paid license:

A license to continue using GCAI after the free license period. The types of licenses are shown in the table below.

You need a "request file" to quote.

1. Select the GC8000 you wish to monitor on the GCAI license activation screen.

2. The license type and duration are automatically selected and a "request file" is generated.

To request a quote for a paid license, please contact YOKOGAWA partner in charge with this request file and GCAI Application Form. The GCAI application form can be obtained from the aforementioned dedicated website.

Refer to the GCAI Initial Installation and License Guide (TI 11B06H01-01EN) for license details.

Table 2 License

Type	Description	Effective
New	To add a new GC8000 while no paid licenses are applied in GCAI	12 months from GCAI activation
Renewal	To extend the usage period of a paid-license GCAI currently supporting at least one GC8000.	12 months from the license-expiration date of a GC8000 being monitored
Additional	To add a new GC8000 while a paid-license GCAI is currently supporting at least one GC8000.	Until the license-expiration date of GC8000 already being monitored

5. Notes before purchasing or ordering

- Before using GCAI, be sure to read the "Basic Terms and Conditions for license of Gas Chromatograph AI Maintenance Support" posted on our dedicated website.
- When purchasing a license for GCAI, please be sure to read the "Basic Terms and Conditions for Quotations and Contracts for Gas Chromatograph AI Maintenance Support" on our product website and the "GCAI Application Form" on our dedicated website.
- Installation and configuration of this software should be performed by the customer after reviewing the related documents listed in the table below.

Purpose	Document Number
To confirm how to install GCAI and licenses	Gas Chromatograph AI Maintenance Support Installation and License Guide (TI 11B06H01-01EN)
To confirm the operation of GCAI.	Gas Chromatograph AI Maintenance Support User's Manual (IM 11B06H01-01EN)
To confirm the detailed system of GCAI's anomaly detection and resolution prediction, and the concept of various settings.	Gas Chromatograph AI Maintenance Support Handbook (TI 11B06H01-02EN)

6. Warranty Scope

- We guarantee the operation of the product when it is performed as described in the IM and TI. If the operation does not work as described, please contact the local service representative.
- Yokogawa and its partners do not guarantee the accuracy of the anomaly detection, as it depends on the setting data.

■ MODEL AND CODES

Model	Suffix code	Option code	Article
GCAI	.....	.....	GC AI Maintenance Support
License Type	-A	.....	New licence
	-B	.....	Renewal license
	-C	.....	Additional license
Validity Period (*1)	-01	.....	1 Month
	-02	.....	2 Months
	-03	.....	3 Months
	-04	.....	4 Months
	-05	.....	5 Months
	-06	.....	6 Months
	-07	.....	7 Months
	-08	.....	8 Months
	-09	.....	9 Months
	-10	.....	10 Months
	-11	.....	11 Months
	-12	.....	12 Months
—	-N	.....	Always -N
—	-N	.....	Always -N

*1: Only -12 (12 months) is selectable for new/renewal licenses.

For an additional license, validity period is automatically selected to match existing license in GCAI.

■ RELATED DOCUMENTS

- Process gas chromatograph GC8000(GS 11B08A01-01E)
- GC8000 Analyzer Bus System (GS 11B06A02-01E)