SUBSTRATE PROCESSING APPARATUS, DEVICE MANAGEMENT CONTROLLER AND RECORDING MEDIUM

TECHNICAL FIELD

[0001] The present disclosure relates to monitoring an operation state of a substrate processing apparatus.

BACKGROUND

[0002] In the field of semiconductor manufacturing, in order to improve the operating ratio and the production efficiency of an apparatus, information of the apparatus is accumulated in a server, the trouble of the apparatus is analyzed, and the state of the apparatus is monitored by using the information. As a basic monitoring means, means for collecting information of a semiconductor manufacturing apparatus by the server and detecting an abnormality of the apparatus by a statistical analysis technique or the like is generally used.

[0003] For example, for production management of a substrate processing apparatus, a technique for managing the integrity of data and a technique for analyzing an abnormality when a data abnormality occurs are provided. They serve to manage the operation state of the substrate processing apparatus by a management device that is connected to the substrate processing apparatus. However, more delicate and elaborate data management is required than ever according to the increase in the amount of data accompanying the miniaturization of devices. Thus, it is hard for the management device that manages a plurality of substrate processing apparatuses to sufficiently cope with such a situation.

[0004] In recent years, there is a demand for production management that self-monitors on the apparatus side without increasing the load on the device manufacturer. Therefore, the device manufacturer quickly specifies the cause of an abnormality, and takes various measures to improve the operating ratio of the apparatus.

Prior Art Document

Patent Document

[0005] Patent Document 1: JP 5855841

Patent Document 2: JP 5546197

SUMMARY OF INVENTION

PROBLEM TO BE SOLVED

[0006] The present disclosure intends to provide a configuration capable of shortening time required for analysis and investigation of an abnormality by monitoring a state of an apparatus.

MEANS TO SOLVE THE PROBLEM

[0007] According to one embodiment of the present disclosure, there is provided a configuration that includes a device-status-monitoring controller that stores, in a storage section, device data generated by the apparatus; an analysis-support controller that acquires the device data related to abnormality analysis information from the storage section based on basic information that includes: information that defines an abnormal event, at least one of the device data corresponding to the abnormal event, and step information indicating a step where the at least one of the device data is generated; and recipe-specific information that includes at least a recipe name; and a display device that displays the device data related to the abnormality analysis information in a manner that goes back to a past time from a time when a latest recipe specified by the recipe name is executed.

EFFECT OF INVENTION

[0008] According to the present disclosure in some embodiments, it is possible to shorten time spent for data analysis at the time of occurrence of abnormality, and to reduce downtime of a device.

BRIEF DESCRIPTION OF DRAWINGS

[0009] FIG. 1 is a perspective view illustrating a substrate processing apparatus suitably used in one embodiment of the present disclosure.

FIG. 2 is a side cross sectional view illustrating the substrate processing apparatus suitably used in one embodiment of the present disclosure.

FIG. 3 is a diagram illustrating a functional configuration of a control system suitably used in one embodiment of the present disclosure.

FIG. 4 is a diagram illustrating a functional configuration of a main controller suitably used in one embodiment of the present disclosure.

FIG. 5 is a diagram illustrating a configuration of a substrate processing system suitably used in one embodiment of the present disclosure.

FIG. 6 is a diagram illustrating a functional configuration of a device management controller suitably used in one embodiment of the present disclosure.

FIG. 7 is a diagram illustrating a functional configuration of a device-status-monitoring controller according to one embodiment of the present disclosure.

FIG. 8 is a diagram illustrating device data acquired by the device-status-monitoring controller according to one embodiment of the present disclosure.

FIG. 9 is a diagram illustrating target device data in data abnormality analysis according to one embodiment of the present disclosure.

FIG. 10 is a process flowchart of data analysis support control according to one embodiment of the present disclosure.

FIG. 11 is a diagram illustrating abnormal-phenomenon-specific information according to one embodiment of the present disclosure.

FIG. 12 is an exemplary example of the abnormal-phenomenon-specific information according to the embodiment of the present disclosure.

FIG. 13 is a display example used for abnormality analysis support according to the embodiment of the present disclosure.

DETAILED DESCRIPTION

(Overview of the Substrate Processing Apparatus)

[0010] One embodiment of the present disclosure will now be described with reference to the drawings. First, in FIGS. 1 and 2, a substrate processing apparatus 1 in which the present disclosure is implemented will be described.

[0011] The substrate processing apparatus 1 includes a housing 2, and a front maintenance port 4 as an opening formed so as to enable maintenance is installed in a lower portion of a front wall 3 of the housing 2 and is opened and closed by a front maintenance door 5.

[0012] A pod loading/unloading port 6 is installed on the front wall 3 of the housing 2 so as to communicate between the inside and the outside of the housing 2 and is opened and closed by a front shutter 7, and a load port 8 is installed on a front side of the pod loading/unloading port 6 and is configured to align pods 9 held thereon.

[0013] Each of the pods 9, which is a sealed substrate transfer vessel, is configured to be loaded into and unloaded from the load port 8 by means of an in-process transfer device (not shown).

[0014] A rotary pod shelf 11 is installed in an upper portion of the housing 2 in a substantially central portion in the housing 2 in the longitudinal direction and is configured to store a plurality of pods 9.

[0015] The rotary pod shelf 11 has a pillar 12 vertically erected and intermittently rotated, and a plurality of stages of shelf boards 13 radially supported on the pillar 12 at respective positions of upper, middle and lower stages. The shelf boards 13 are configured to store the plurality of pods 9, which are held on each of them.

[0016] Pod openers 14 are installed below the rotary pod shelf 11, and are configured to load the pods 9 and to open and close the cover of the pods 9.

[0017] A pod transfer device (vessel transfer mechanism) 15 is installed between the load port 8, the rotary pod shelf 11 and the pod openers 14, and is configured to support the pods 9 to be

moved up and down and moved forward and backward in a horizontal direction so that the pods 9 are transferred between the load port 8, the rotary pod shelf 11 and the pod openers 14.

[0018] A sub housing 16 is installed over the rear end of the housing 2 in a lower portion in a substantially central portion in the housing 2 in the longitudinal direction. A pair of substrate loading/unloading ports 19 for loading and unloading wafers (hereinafter, referred to as substrates) 18 into and from the sub housing 16 are installed to be arranged on the front wall 17 of the sub housing 16 in upper and lower two stages in the vertical direction, and the pod openers 14 are respectively installed for the substrate loading/unloading ports 19 at the upper and lower stages.

[0019] Each of the pod openers 14 includes a mounting stand 21 on which the pod 9 is held and an opening/closing mechanism 22 for opening and closing the cover of the pod 9. The pod opener 14 is configured to open and close the substrate entrance of the pod 9 by opening and closing the cover of the pod 9 held on the mounting stand 21 with the opening/closing mechanism 22.

[0020] The sub housing 16 forms a transfer chamber 23 that is sealed from a space (pod transfer space) in which the pod transfer device 15 and the rotary pod shelf 11 are disposed. A substrate transfer mechanism 24 is installed in the front area of the transfer chamber 23, and includes a required number of (five in the drawing) substrate mounting plates 25 on which the substrates 18 are held and which are horizontally linear-movable, horizontally rotatable, or movable up and down. The substrate transfer mechanism 24 is configured to load and unload the substrates 18 to and from a boat 26.

[0021] A standby part 27, which accommodates the boat 26 so as to be stood by, is formed in the rear area of the transfer chamber 23, and a vertical type process furnace 28 is installed above the standby part 27. The process furnace 28 has a process chamber 29 formed therein, and the lower end portion of the process chamber 29 is defined as a furnace port part. The furnace port part is configured to be opened and closed by a furnace port shutter 31.

[0022] A boat elevator 32 configured to move the boat 26 up and down is installed between the

right end of the housing 2 and the right end of the standby part 27 of the sub housing 16. A seal cap 34 as a cover is horizontally installed in an arm 33 connected to the elevating base of the boat elevator 32. The seal cap 34 is configured to vertically support the boat 26 and to hermetically seal the furnace port part with the boat 26 loaded into the process chamber 29.

[0023] The boat 26 is configured to support a plurality of substrates 18 in a horizontal posture and in multiple stages with the centers of the substrates 18 aligned with one another.

[0024] A clean unit 35 is disposed at a position opposite to the boat elevator 32 side, and is configured by a supply fan and a dustproof filter so as to supply a cleaned atmosphere or a clean air 36 as an inert gas. A notch matching device (not shown) as a substrate matching device for matching positions of the substrates 18 in the peripheral direction is installed between the substrate transfer mechanism 24 and the clean unit 35.

[0025] The clean air 36 discharged from the clean unit 35 is configured to be flowed through the notch matching device (not shown), the substrate transfer mechanism 24 and the boat 26, and then to be sucked in by a duct (not shown) and discharged to the outside of the housing 2 or injected into the transfer chamber 23 by the clean unit 35.

[0026] Next, an operation of the substrate processing apparatus 1 will be described.

[0027] When the pod 9 is supplied to the load port 8, the pod loading/unloading port 6 is opened by the front shutter 7. The pod 9 on the load port 8 is loaded into the housing 2 by the pod transfer device 15 via the pod loading/unloading port 6, and is held on the specified shelf board 13 of the rotary pod shelf 11. The pod 9 is temporarily stored in the rotary pod shelf 11, and is then transferred from the shelf board 13 to one of the pod openers 14 by the pod transfer device 15 and is transferred to the mounting stand 21 or transferred directly from the load port 8 to the mounting stand 21.

[0028] At this time, the substrate loading/unloading port 19 is closed by the opening/closing mechanism 22, and the clean air 36 is flowed through and filled in the transfer chamber 23. For example, when the transfer chamber 23 is filled with a nitrogen gas as the clean air 36, the oxygen concentration is set to 20 ppm or lower, which is much lower than the oxygen

concentration of the interior (air atmosphere) of the housing 2.

[0029] The opening side end surface of the pod 9 held on the mounting stand 21 is pressed against the opening edge side of the substrate loading/unloading port 19 on the front wall 17 of the sub housing 16, and the cover thereof is removed by the opening/closing mechanism 22 to open the wafer entrance.

[0030] When the pod 9 is opened by the pod opener 14, the substrates 18 are discharged from the pod 9 by the wafer transfer mechanism 24 and transferred to the notch matching device (not shown) to match the substrates 18. Thereafter, the wafer transfer mechanism 24 loads the substrates 18 into the standby part 27 at the rear of the transfer chamber 23 and charges (charging) them on the boat 26.

[0031] The wafer transfer mechanism 24, which transfers the substrates 18 to the boat 26, returns them to the pod 9 and charges a next substrate 18 on the boat 26.

[0032] During the charging operation of the substrates 18 on the boat 26 by the wafer transfer mechanism 24 in the pod opener 14 of one side (the upper stage or the lower stage), another pod 9 is transferred from the rotary pod shelf 11 to the pod opener 14 of the other side (the lower stage or the upper stage) by the pod transfer device 15, in which the operation of opening the pod 9 with the other pod opener 14 is performed at the same time.

[0033] If a plurality of substrates 18 is charged on the boat 26, the furnace port part of the process furnace 28 which has been closed by the furnace port shutter 31 is opened by the furnace port shutter 31. Subsequently, the boat 26 is lifted up by the boat elevator 32 and is loaded (loading) into the process chamber 29.

[0034] After the loading, the furnace port part is hermetically sealed by the seal cap 34. Furthermore, in the present embodiment, at this timing (after the loading), a purge step (pre-purge step) is performed in which the process chamber 29 is substituted by an inert gas.

[0035] The process chamber 29 is vacuum-exhausted by a gas exhaust mechanism (not shown) so as to reach a desired pressure (degree of vacuum). In addition, the process chamber 29 is heated by a heater driving part (not shown) to a predetermined temperature so as to have a

desired temperature distribution.

[0036] Furthermore, a processing gas controlled to a predetermined flow rate is supplied by a gas supply mechanism (not shown) to make contact with the surfaces of the substrates 18 while flowing the processing gas through the process chamber 29, and a predetermined process is performed on the surfaces of the substrates 18. The processing gas after the reaction is exhausted from the process chamber 29 by the gas exhaust mechanism.

[0037] When a predetermined processing time has elapsed, an inert gas is supplied from an inert gas supply source (not shown) by the gas supply mechanism, and the process chamber 29 is substituted by an inert gas. Simultaneously, the pressure of the process chamber 29 is returned to an atmospheric pressure (after purge step). Then, the boat 26 is moved down by the boat elevator 32 via the seal cap 34.

[0038] When unloading the processed substrates 18, the substrates 18 and the pod 9 are unloaded to the outside of the housing 2 in reverse order of the above description. The unprocessed substrates 18 are further charged on the boat 26, and the batch processing of the substrates 18 is repeated.

(Functional Configuration of the Control System 200)

[0039] Next, a functional configuration of a control system 200 around a main controller 201 as an operation section will be described with reference to FIG. 3. As illustrated in FIG. 3, the control system 200 includes the main controller 201, a transfer system controller 211 as a transfer control part, a process system controller 212 as a process control part, and a device management controller 215 as a data monitoring part. The device management controller 215 serves as a data collection controller. The device management controller 215 collects device data generated by the substrate processing apparatus 1 and monitors integrity of the device data.

[0040] Here, the device data includes process data, generated by operating each component when the substrate processing apparatus 1 processes the substrates 18, such as data (for example, an actual measurement value or the like) related to substrate processing such as a processing

temperature, a processing pressure, or a flow rate of a processing gas when the substrate processing apparatus 1 processes the substrates 18, data (for example, a thickness of a film as formed, a cumulative value of the film thickness or the like) related to the quality of a product substrate, data (for example, a set value, an actual measurement value or the like) related to components (for example, a quartz reaction tube, a heater, a valve, an MFC and the like) of the substrate processing apparatus 1, and further includes event data related to various device events generated by the substrate processing apparatus. For example, alarm information for generating various alarms is included in the event data.

[0041] Also, statistical data created by processing actual measurement value data at specific intervals, for example, raw waveform data as data at specific intervals (1 second or the like) from the start to the end of a recipe, or actual measurement value data at specific intervals at each step in a recipe may be referred to as the process data as data collected during the execution of the recipe. This process data is included in the device data. The statistical data also includes a maximum value, a minimum value, an average value, and the like. When the recipe is not executed, event data indicating various device events generated, for example, during an idle state in which no substrate is fed to the device, is also included in the device data. For example, data indicating a maintenance history is included as the event data.

[0042] Since the main controller 201 is electrically connected to the transfer system controller 211 and the process system controller 212 via a local area network (LAN) such as, for example, 100BASE-T or the like, it is configured to transmit and receive each device data, download and upload each file, and the like.

[0043] A port serving as an installation part for inserting and removing a recording medium (for example, a USB memory or the like) as an external storage device is installed in the operation section 201. An operation system (OS) corresponding to such a port is installed in the operation section 201. In addition, an external higher computer or a management device is connected to the operation section 201 via, for example, a communication network. Therefore, even when the substrate processing apparatus 1 is installed in a clean room, the higher computer

may be arranged in an office or the like outside the clean room. It may also be configured such that the management device is connected to the substrate processing apparatus 1 via an LAN line, and has a function of collecting the device data from the operation section 201.

[0044] The device management controller 215, which is connected to the operation section 201 via an LAN line, is configured to collect the device data from the operation section 201 and quantify the operation state of the device so as to display it on the screen. The device management controller 215 is also configured to execute each function. Details of the device management controller 215 will be described later.

[0045] The transfer system controller 211 is connected to a substrate transfer system 211A including the rotary pod shelf 11, the boat elevator 32, the pod transfer device 15, the substrate transfer mechanism 24, the boat 26, and the rotation mechanism (not shown). The transfer system controller 211 is configured to control the transfer operation of each of the rotary pod shelf 11, the boat elevator 32, the pod transfer device 15, the substrate transfer mechanism 24, the boat 26, and the rotation mechanism (not shown). In particular, the transfer system controller 211 is configured to control the transfer operation of each of the boat elevator 32, the pod transfer device 15, and the substrate transfer mechanism 24 via a motion controller 211a.

[0046] The process system controller 212 includes a temperature controller 212a, a pressure controller 212b, a gas flow rate controller 212c, and a sequencer 212d. The temperature controller 212a, the pressure controller 212b, the gas flow rate controller 212c, and the sequencer 212d constitute a sub controller, and are electrically connected to the process system controller 212 so that the transmission and reception of each device data, the downloading and uploading of each file, and the like are possible. The process system controller 212 and the sub controller are shown separately, but they may also be integrated.

[0047] A heating mechanism 212A mainly including a heater, a temperature sensor, and the like is connected to the temperature controller 212a. The temperature controller 212a is configured to adjust the internal temperature of the process furnace 28 by controlling the temperature of the heater of the process furnace 28. The temperature controller 212a is also configured to control

electric power supplied to a heater wire by controlling the switching (ON/OFF) of a thyristor.

[0048] A gas exhaust mechanism 212B mainly including a pressure sensor, an APC valve as a pressure valve, and a vacuum pump is connected to the pressure controller 212b. Based on a pressure value detected by the pressure sensor, the pressure controller 212b is configured to control the opening degree of the APC valve and the switching (ON/OFF) of the vacuum pump such that the interior of the process chamber 29 reaches a desired pressure at a desired timing.

[0049] The gas flow rate controller 212c includes a mass flow controller (MFC). The sequencer 212d is configured to control the supplying and stopping of a gas from a processing gas supply pipe or a purge gas supply pipe by opening and closing a valve 212D. Furthermore, the process system controller 212 is configured to control the gas flow rate controller 212c (MFC) and the sequencer 212d (the valve 212D) such that the flow rate of a gas to be supplied into the process chamber 29 becomes a desired flow rate at a desired timing.

[0050] In addition, the main controller 201, the transfer system controller 211, the process system controller 212, and the device management controller 215 according to the present embodiment can be realized by using a general computer system, not by a dedicated system. For example, each controller that executes a predetermined process may be configured by installing a program from a recording medium (a flexible disk, a CD-ROM, a USB memory or the like) storing the program for causing a general-purpose computer to execute the aforementioned process.

[0051] Furthermore, means for supplying such program is optional. The program may be supplied via the predetermined recording medium as described above, and in addition, for example, via a communication line, a communication network, a communication system, or the like. In this case, for example, the program may be posted on the bulletin board of the communication network, and may be superimposed on a carrier wave so as to be provided via the network. By activating the program thus provided and executing it in the same manner as other application programs under the control of an OS, the predetermined process can also be executed.

(Configuration of the Main Controller 201)

[0052] Next, a configuration of the main controller 201 will be described with reference to FIG. 4.

[0053] The main controller 201 is configured to include a main-controller section 220, a hard disk 222 as a main-controller storage section, an operation display section 227 as a display device including a display area for displaying various information and an input area for receiving various instructions from an operator, and a transmission/reception module 228 as a main-controller communication section that communicates with the inside and the outside of the substrate processing apparatus 1. Here, the operator includes a device administrator, a device engineer, maintenance personnel, and a worker, in addition to the device operator. The main-controller section 220 includes a central processing unit (CPU) 224 as a processing part and a memory (a RAM, a ROM or the like) 226 as a temporary storage section 226, and is configured as a computer including a clock function (not shown).

[0054] In addition to each recipe file such as a recipe defining processing conditions and processing procedures of the substrates, a control program file for executing each recipe file, a parameter file defining parameters for executing a recipe and an error process program file and an error process parameter file, various screen files including an input screen for inputting process parameters, various icon files, and the like (none of them are not shown) are stored in the hard disk 222.

[0055] Each operation button as an input area for inputting operation instructions to the substrate transfer system 211A or a substrate processing system (the heating mechanism 212A, the gas exhaust mechanism 212B and the gas supply system 212C) illustrated in FIG. 3 may also be installed on an operation screen of the operation display section 227.

[0056] The operation display section 227 is configured to display the operation screen for operating the substrate processing apparatus 1. The operation display section 227 displays, on the operation screen, information based on the device data generated in the substrate processing

apparatus 100 through the operation screen. The operation screen of the operation display section 227 is a touch panel using, e.g., liquid crystal. The operation display section 227 receives operator's input data (input instruction) from the operation screen and transmits the input data to the main controller 201. The operation display section 227 is also configured to receive an instruction (control instruction) to execute a recipe developed in the memory (RAM) 226 or the like, or any substrate processing recipe (also referred to as a process recipe) among a plurality of recipes stored in the main-controller storage section 222, and to transmit it to the main-controller section 220.

[0057] Furthermore, in the present embodiment, the device management controller 215 is configured to develop each stored screen file and data table by executing various programs or the like when it activated, and to display each screen indicating the health condition (operation state) of the device on the operation display section 227 or a screen display section 215a as described hereinbelow by reading the device data.

[0058] The main-controller communication section 228 is connected to a switching hub or the like. The main controller 201 is configured to transmit and receive various data to and from an external computer or any other controller in the apparatus 1 via a network.

[0059] The main controller 201 also transmits the device data such as the state of the substrate processing apparatus 1 to an external higher computer via a network (not shown). Furthermore, the substrate processing of the substrate processing apparatus 1 is controlled by the control system 200 based on each recipe file, each parameter file or the like stored in the main-controller storage section 222.

(Substrate Processing Method)

[0060] Next, a substrate processing method having a predetermined processing step to be performed using the substrate processing apparatus 1 according to the present embodiment will be described. Here, the predetermined processing step is an example of the case of performing a substrate processing step (here, a film forming step), which is one of the steps for

manufacturing a semiconductor apparatus.

[0061] In performing the substrate processing step, a substrate processing recipe (process recipe) corresponding to the substrate processing to be performed is developed in, for example, the memory such as the RAM in the process system controller 212. Then, an operation instruction is given from the main controller 201 to the process system controller 212 or the transfer system controller 211 as necessary. The substrate processing step performed in this manner has at least a loading step, a film-forming step, an unloading step, and a collecting step.

(Transfer Step)

[0062] An instruction to drive the substrate transfer mechanism 24 is issued from the main controller 201 to the transfer system controller 211. Then, the substrate transfer mechanism 24 starts the transfer processing of the substrates 18 from the pod 9 on a delivery stage 21 as the mounting stand to the boat 26 according to an instruction from the transfer system controller 211. This transfer processing is performed until the charging of all the scheduled substrates 18 on the boat 26 is completed.

(Loading Step)

[0063] If the substrates 18 are charged on the boat 26, the boat 26 is lifted up by the boat elevator 32 that operates according to an instruction from the transfer system controller 211 and is loaded into the process chamber 29 formed in the process furnace 28 (boat loading). When the boat 26 is completely loaded, the seal cap 34 of the boat elevator 32 hermetically seals the lower end of a manifold of the process furnace 28.

(Film-Forming Step)

[0064] Thereafter, the interior of the process chamber 29 is vacuum-exhausted by a vacuum exhaust device so as to reach a predetermined film-forming pressure (degree of vacuum) according to an instruction from the pressure controller 212b. Also, the interior of the process

chamber 29 is heated by the heater to a desired temperature according to an instruction from the temperature controller 212a. Subsequently, the rotation of the boat 26 and the substrates 18 by the rotation mechanism begins according to an instruction from the transfer system controller 211. Then, a predetermined gas (processing gas) is supplied to the plurality of substrates 18 supported by the boat 26 at a predetermined pressure and a predetermined temperature left unchanged to perform a predetermined process (for example, a film forming step) on the substrates 18.

(Unloading Step)

[0065] When the film-forming step is completed on the substrates 18 held on the boat 26, the rotation of the boat 26 and the substrates 18 by the rotation mechanism is then stopped according to an instruction from the transfer system controller 211, and the seal cap 34 is moved down by the boat elevator 32 to open the lower end of the manifold and the boat 26 supporting the processed substrates 18 is unloaded to the outside of the process furnace 28 (boat unloading).

(Collecting Step)

[0066] Thereafter, the boat 26 supporting the processed substrates 18 is very effectively cooled by the clean air 36 discharged from the clean unit 35. Then, when the boat 26 is cooled to, for example, 150 degrees C or lower, the processed substrates 18 are discharged from the boat 26 and transferred to the pod 9, and then, the transfer of new unprocessed substrates 18 to the boat 26 is performed.

(Configuration of the Substrate Processing System)

[0067] FIG. 5 is a diagram illustrating a configuration of the substrate processing system used in the present embodiment. For example, as illustrated in FIG. 5, in this substrate processing system, a master apparatus and repeat apparatuses 1 (1) to 1 (6) are connected via a network. The device management controller 215 stores a device name and an IP address of the master

apparatus in a storage section of the repeat apparatus 1, and the device management controller 215 is configured to perform communication connection with the master apparatus by, for example, the IP address, and then compare a device name of the master apparatus acquired by the communication connection with the device name of the master apparatus stored in a storage section 215h.

[0068] The master apparatus is a substrate processing apparatus having device data as standard. The master apparatus has the same hardware configuration as the substrate processing apparatus 1, and has the device management controller 215. The master apparatus is, for example, a first apparatus of the apparatus 1 adjusted so that the device data is appropriate. The repeat apparatus is, for example, a second or subsequent substrate processing apparatus 1, and after undergoing the comparison process as described above, it receives a copy of various information the master apparatus has from the master apparatus via a network and stores the same in the storage section of each repeat apparatus.

[0069] As descried above, in the present embodiment, the device management controller 215 is installed in the apparatus 1. Furthermore, each apparatus 1 can share various information of the master apparatus by connecting the device management controllers 215 respectively installed in the master apparatus and each apparatus 1 via a network. Specifically, it corresponds to a copy of a file of the master apparatus or a comparison with a file of the master apparatus.

(Functional Configuration of the Device Management Controller 215)

[0070] FIG. 6 shows a diagram illustrating a functional configuration of the device management controller. The device management controller 215 as a health check controller for checking the health condition of the apparatus 1 quantifies information related to various health conditions of the apparatus 1 and monitors whether the apparatus 1 can continue to normally operate. Then, when the health condition is worsened, an alarm is issued (echo of alarm sound, display or the like).

[0071] As illustrated in FIG. 6, the device management controller 215 includes a communication

section 215g for performing the transmission and reception of the device data among the screen display section 215a, a screen display controller 215b, a device-status-monitoring controller 215e, a data-analysis-support controller 215f and the main controller 201, and the storage section 215h for storing the device data. It may also be configured such that the main-controller storage section 222 or the temporary storage section 226 is used instead of the storage section 215h.

(Screen Display section 215a)

[0072] The screen display section 215a is configured to display, for example, an aggregate screen of device health conditions. This functional configuration is an example, and may also be configured to display it using the operation display section 227 of the main-controller section (operation section) 220 instead of the screen display section 215a, or may be replaced by a terminal or the like connected for screen reference. In the present embodiment, when the terminal or the operation display section 227 is used, the screen display section 215a may be omitted.

(Screen Display Controller 215b)

[0073] By executing a screen display program, the screen display controller 215b controls to process the device data into data for screen display to create screen display data, update it and display the same on the operation display section 227.

(Device-Status-Monitoring Controller 215e)

[0074] The device-status-monitoring controller 215e has a device status monitoring program, and executes a device status monitoring function. The device-status-monitoring controller 215e receives the device data of the apparatus 1 from the main controller 201 every moment and updates the device data stored in the storage section 215h, and performs monitoring of the device data of the apparatus 1 every moment based on standard data obtained from the master apparatus, namely standard data (for example, a time-lapse waveform, an upper limit value, a lower limit

value or the like of the reaction chamber temperature) that the apparatus 1 should target. That is, the device data of the apparatus 1 is compared with the standard data and monitored every moment. This makes it possible to realize monitoring of the device status with less false alarm. Details of the device status monitoring function will be described later.

(Data-Analysis-Support Controller 215f)

[0075] The data-analysis-support controller 215f has a data analysis program, and when an abnormal phenomenon (for example, a film thickness abnormality of a substrate as a product) occurs, the maintenance personnel may display analysis data for analyzing the factor of the abnormal phenomenon on the operation display section 227. This contributes to reduction of analysis time and reduction of analysis errors due to variations in maintenance personnel skills. In addition, as will be described later, the data-analysis-support controller 215f is configured to facilitate abnormality factor analysis, device status monitoring, or the like. Details of the data analysis support function will be described later.

[0076] Furthermore, the device management controller 215 has a function as a database that collects the device data and accumulates it in the storage section 215h, and can process the accumulated device data to graph it and display it on the operation display section 227. This makes it possible to improve the work efficiency in a clean room (CR) of the operator (for example, a customer and a fieid service engineer (FSE)) who uses the apparatus 1.

[0077] Furthermore, in the present embodiment, it is configured that the device management controller 215 is installed separately from the main controller 201, but the present disclosure is not limited to such a configuration. Also, in the present embodiment, the functions (for example, the device status monitoring, the data analysis support and the like) of the device management controller 215 may be incorporated in any of the main controller 201 as the operation section, the transfer system controller 211 as the transfer control part, and the process system controller 212 as the process control part.

(Device Status Monitoring Function)

[0078] The device status monitoring program as the device status monitoring function will be described with reference to FIG. 7. The device status monitoring program is stored in, for example, the storage section 215h of the device management controller 215, and realizes the device-status-monitoring controller 215e in the memory 226.

[0079] As illustrated in FIG. 7, the device-status-monitoring controller 215e includes a setting section 311, a band generating section 312, a fault detection & classification (FDC) monitoring section 313, a count display section 314, and a diagnosis section 315. Furthermore, the FDC monitoring section 313 includes a comparison area 313a, a counting area 313b, and a determination area 313c.

[0080] The setting section 311 instructs the band generating section 312, the FDC monitoring section 313, and the diagnosis section 315 to set band management specified according to an input or the like from the operation display section 227.

[0081] The band generating section 312 generates a band based on standard data, an upper limit specified value and a lower limit specified value set by the setting section 311. Here, the band refers to a range determined by giving a margin to a waveform of standard data (data of an apparatus as standard, for example, master data of the master apparatus). Here, it is assumed that the standard data is the master data for description.

[0082] The FDC monitoring section 313 compares the band generated by the band generating section 312 with the device data generated from the apparatus 1 every moment to determine that the device data is abnormal when the device data deviates from the band. Furthermore, when an abnormality is detected, the operation display section 227 is configured to display, for example, that the abnormality is detected.

[0083] The count display section 314 is configured to display, on the operation display section 227, the number of breakaway points for each batch processing, for breakaway points counted by the FDC monitoring section. Here, the data point deviating from the band by comparing the band and the device data is referred to as a breakaway point.

[0084] The diagnosis section 315 diagnoses statistical data out of the device data including the number of breakaway points using an abnormality diagnosis rule. Furthermore, when it is diagnosed as an abnormality, it is configured to display, for example, that the abnormality is detected, on the operation display section 227.

(FDC Monitoring section)

[0085] The FDC monitoring section 313 monitors the device data by comparing the device data received from the main controller 201 with the band generated for the master data as a criterion for determining the device data. It may also be configured such that the band generating section 312 described above is included in the FDC monitoring section 313.

[0086] The comparison area 313a compares whether the device data is out of the band at an interval (e.g., 1 second) between data points constituting the master data, and stores the comparison result in the storage section 215h. The comparison area 313a repeats the comparison between the data points of the device data and the band until the specified device data is not acquired, regardless of the number of data points deviated from the band.

[0087] When the comparison area 313a completes the comparison of all the data points for the set device data, the counting area 313b counts a total number of points deviated from the band based on the comparison result stored in the storage section 215h. Furthermore, the counting area 313b associates the value of the device data, the value of the master data, the band (the upper limit value and the lower limit value of the master data) corresponding to the master data and the counted count value, and stores them as related data in the storage section 215h.

[0088] When the count value counted by the counting area 313b exceeds a predetermined value, the determination area 313c determines that the device data is abnormal, and when the count value is equal to or lower than the predetermined value, it determines that the device data is not abnormal (normal).

[0089] Although the band management as one of the FDCs executed by the device-status-monitoring controller 215e has been described above, the device data focusing on the user side

(device manufacturer side) is a target to be monitored. It may also be configured such that the device data including the statistical data and the comparison result between the standard data and the device data (or the statistical data) are stored in the main-controller storage section 222 instead of the storage section 215h.

[0090] As illustrated in FIG. 8, the device-status-monitoring controller 215e is configured to accumulate the device data of the raw waveform data from the start to the end of the process recipe at specific intervals, and to calculate and accumulate the statistics (for example, the maximum value of the device data, the minimum value of the device data and the average value of the device data) of the section of the statistical data at the end of the step, by executing the aforementioned device status monitoring program. It is also configured to accumulate event data including maintenance information while the process recipe is not executed. The device-status-monitoring controller 215e is configured to store these device data in the storage section 215h as production history information for each batch processing.

[0091] Furthermore, the data may be analyzed using the device data acquired by the device-status-monitoring controller 215e. For example, the cause of abnormality may be specified by comparing the waveform data (the device data at specific intervals) accumulated in the storage section 215h one by one during production (during execution of the process recipe) and confirming a change before and after the occurrence of abnormality (trouble).

[0092] However, as illustrated in FIG. 9, it takes a very long time for the apparatus 1 which has a large amount (types of 500 or more) of process data of recent years. Also, because of the large amount of data, it takes time to specify the cause of abnormality by missing important device data due to the skills of the maintenance personnel who perform the analysis. In addition, since it is not easy to confirm a change over time by the comparison of raw waveform data alone, and gradually changed data also appears as a difference, it is difficult to specify the cause of the abnormality.

[0093] In the method in which abnormality analysis is performed only with the data that is being executed in this process recipe, advanced skills such as changing the content of investigation

according to the event of abnormality are necessary, causing a variation or omission in the analysis according to the skills of the technician.

[0094] Accordingly, the device-status-monitoring controller 215e of the present embodiment is configured to collect the device data even when the process recipe is not being executed. For example, in order to accumulate in the storage section 215h whether or not the maintenance is performed, it may be configured to extract necessary information (events related to the maintenance, for example, door opening/closing of the rear portion of the device) from the event information of the device from the storage section 215h and store it in the storage section 215h. With this configuration, since the relationship between the statistics of the device data and the maintenance work can be displayed on the operation display section 227 or the like and since an event (for example, event data about an event such as the maintenance) which may not be represented by numerical values is displayed, factors other than the variations of the process data may also be confirmed.

(Analysis Support Function)

[0095] Next, a process flow of the analysis support function executed by the data-analysis-support controller 215f will be described mainly with reference to FIG. 10.

(Data-Receiving Step S100)

[0096] First, when receiving from the operation section 201 (condition input by the operator on the operation display section 227) via the communication section 215g, the data-analysis-support controller 215f executes the data analysis program. Then, as will be described later, it is configured to acquire data analysis related information (hereinafter, also referred to as abnormality analysis information) from the storage section 215h.

[0097] Here, the data analysis related information additionally includes at least substrate-processing-specific information that has been processed in the substrate processing apparatus 1 in which abnormality data has occurred, recipe-specific information specifying a recipe that has

been executed in the substrate processing apparatus 1 at the time of data generation, data time information specifying a generation time of data, and abnormal-phenomenon-specific information specifying an abnormal phenomenon. For example, event information including event data indicating information about the generation of an alarm may be added.

[0098] Furthermore, as illustrated in FIG. 11, the abnormal-phenomenon-specific information is information (parameter) including at least an abnormal event, device data (for example, statistical data) necessary for analysis, and a period (for example, step information) acquiring the device data. For one abnormal event, a plurality of device data is selected. It may also be configured such that not only the statistical data but also the event data is selectable. The step information includes not only a period from the start to the end of steps constituting the recipe, but also, for example, step information of the transfer system, specifically, the transfer of cassette, the elevation of the boat, the transfer of the boat, and a period from the start to the end of the transfer of the wafers.

(Recipe-Specific Information Acquisition Step S110)

[0099] Thereafter, the data-analysis-support controller 215f acquires the recipe-specific information based on the basic information including the aforementioned abnormal-phenomenon-specific information and recipe-specific information received as inputs. In addition, information (for example, a defective lot ID) indicating a time (abnormal phenomenon occurrence time) when an abnormal phenomenon as a target has occurred in the basic information may be input.

(Recipe Search Step from Production History Information S120)

[0100] The data-analysis-support controller 215f searches for the presence or absence of the recipe-specific information stored in the basic information by referring to the production history information in the storage section 215h. The search is made, for example, so as to go back to the past recipe from the latest recipe among a plurality of recipes recorded in the production

history information. Then, when the data-analysis-support controller 215f detects the recipe-specific information stored in the basic information from the production history information, it acquires the start time and the end time of the recipe specified by the recipe-specific information. When there is information indicating the abnormal phenomenon occurrence time in the basic information, the data-analysis-support controller 215f is configured to retrieve the recipe that has been executed at the abnormal phenomenon occurrence time and to go back to the past recipe from this recipe.

(Data-Reading Step S130)

[0101] Thereafter, the data-analysis-support controller 215f retrieves and reads data associated with both the recipe-specific information and the abnormal-phenomenon-specific information, which occurred between the acquired start time and end time, from the storage section 215h, from the device data stored by the device-status-monitoring controller 215e.

[0102] In addition, since the device data acquired by the device-status-monitoring controller 215e includes event data generated during 1,000 recipes, when it is defined in association with an abnormal phenomenon in the abnormal-phenomenon-specific information, the event data is also configured to be acquired from the storage section 215h in the same manner as the statistical data. Alternatively, when the event data is defined in the data analysis related information, the event data is also configured to be acquired from the storage section 215h in the same manner as the statistical data.

[0103] When referring to the production history information, if the recipe specified by the recipe-specific information has been executed a plurality of times, the data-analysis-support controller 215f reads device data defined by the abnormal-phenomenon-specific information of a predetermined number of times (for example, 1,000 times going back from the latest recipe). That is, the data-analysis-support controller 215f repeats step S130 a predetermined number of times.

(Graph Creation and Display Step S140)

[0104] Thereafter, the data-analysis-support controller 215f superimposes the data read based on the abnormal-phenomenon-specific information in time series, while arranging the start time of the recipe based on the data time information associated with the data analysis related information, to create a graph for a predetermined number of recipes. Then, the data-analysis-support controller 215f displays the created time series graph on the operation display section 227. At this time, plural device data defined by the abnormal-phenomenon-specific information are configured to be superimposed such that a graph of the plural device data is created. For example, when the event information is associated with the data analysis related information, the data-analysis-support controller 215f is configured to display the process data and the event data separately in time series as illustrated in FIG. 13, which will be described later.

(Examples)

[0105] Next, a case where the abnormal phenomenon is a rod mark particle (PC) will be described with reference to FIGS. 12 and 13.

[0106] In the case of the rod mark PC, since the cause of vibration is large, it is necessary to investigate the timing of the boat vibrating during the recipe execution. Since there are two steps (lifting and lowering) in which the boat vertically moves during the recipe execution, it is necessary to investigate an E axis torque at least at two timings.

[0107] Therefore, as illustrated in FIG. 12, in the abnormal-phenomenon-specific information, the rod mark PC is defined as an event when an abnormality occurs, data of an E axis torque is defined as device data for the event, and boat lifting (for example, a boat-loading step) and boat lowering (for example, a boat-unloading step) are defined as target data of the E axis torque.

[0108] When the basic information including the abnormal-phenomenon-specific information illustrated in FIG. 12, the lot ID (defective lot ID) at the time of occurrence of abnormality, and the recipe name is input, the data-analysis-support controller 215f is configured to acquire the data analysis related information via the communication section 215g. By executing the data

analysis program by the data-analysis-support controller 215f, the maintenance personnel may display information necessary for analysis on the operation display section 227 merely by inputting the minimum condition at the time of occurrence of abnormality.

[0109] In addition, a combination of device data storage and device data management is specified as the input abnormal-phenomenon-specific information. The defective lot ID specifies a time when the abnormal phenomenon has occurred. In addition, the recipe name is set so that it is narrowed down by the same recipe by taking into consideration a case where the statistical information varies depending on the recipe. Here, the lot ID is an identifier for specifying the substrate 18. By specifying this in the present embodiment, the data-analysis-support controller 215f can acquire the substrate processing (batch processing) in the apparatus 1 related to the substrate 18 specified by such defective lot ID from the production history information in the storage section 215h.

[0110] As illustrated in FIG. 13, 1,000 times going back to the past from the batch processing (new batch processing) at the time of occurrence of abnormality are displayed. Although not defined in the abnormal-phenomenon-specific information, a pipe temperature is also displayed in the form of a graph. Since the alarm information is defined in the data analysis information, the data-analysis-support controller 215f is configured to retrieve the production history information in the storage section 215h as the alarm information generated for a period defined by information indicating the occurrence time of abnormality and to display the pipe temperature which causes this alarm is displayed as one item because the occurrence of the alarm is caused by a temperature error of the pipe (pipe temperature error).

[0111] Also, since the alarm information is defined in the data analysis information as well as the event data such as the alarm occurrence history and is generated like the pipe temperature error, the data-analysis-support-controller 215f is configured to retrieve the production history information stored in the storage section 215h and display it.

[0112] When the information indicating the abnormality occurrence time is input as the basic information, even if the alarm information is not defined in the data analysis information, the

data-analysis-support controller 215f of the present embodiment may also be configured to retrieve the production history information stored in the storage section 215h by the device-status-monitoring controller 215e and extract an alarm generated at the time of the occurrence of abnormality. Then, it may be configured to display at least one device data out of the device data that has abnormally occurred within the period defined by the information indicating the abnormality occurrence time. Among the alarms generated within the period defined by the information indicating the abnormality occurrence time, it may also be configured such that, for example, the alarm of the most important abnormality, the alarm having the largest number of occurrences of abnormality, and the closest (for example, the latest) alarm to the occurrence time are displayed.

[0113] As a result, in FIG. 13, the device data acquired from the transfer controller 211 via the operation section 201 by the device-status-monitoring controller 215e and the device data acquired from the process system controller 212 via the operation section 201 by the device-status-monitoring controller 215e are configured to be displayed individually in the form of a graph, and the event data such as the alarm occurrence history is also configured to be displayed separately.

[0114] In FIG. 13, two graphs of the maximum value and the minimum value of the E axis torque and the maximum value, the minimum value, and the average value of the pipe temperature are displayed, but the graph is limited to two.

[0115] Although the conditions are defined in the abnormal-phenomenon-specific information, since the alarm information is important information for abnormality analysis, it may also be configured such that the event data such as the alarm occurrence history or the like is displayed even if it is not defined in the abnormal-phenomenon-specific information.

[0116] As described above, according to the present embodiment, if the data that cannot be represented by numerical values such as the event data is displayed in contrast to the graph, it is possible to confirm the factors (for example, opening of the maintenance door) other than the variation of the process data.

[0117] Furthermore, according to the present embodiment, an abnormality can be efficiently analyzed even by the maintenance personnel with low skill for trouble analysis which is time consuming due to a large volume of data, thereby reducing downtime when a trouble occurs.

[0118] According to the present embodiment, one or more effects as set forth below may be achieved.

[0119] (a) The data-analysis-support-controller according to the present embodiment is configured to extract the device data associated with the abnormal-phenomenon-specific information by referring to the abnormality analysis information, and to display it on the operation display section. This makes it possible for the maintenance personnel to know the information necessary for performing the abnormality analysis without omission. Thus, it is possible to accurately perform the abnormality analysis.

[0120] (b) The data-analysis-support controller according to the present embodiment is configured to create a time-series graph by superimposing the data associated with both the recipe-specific information and the abnormal-phenomenon-specific information in time series, while arranging the start time of the recipe based on the data time information related to the abnormality analysis information, and creating it in the form of a graph, and to display it on the operation display section. With this configuration, as a result, it is possible to reduce a burden on the maintenance personnel who perform an abnormality analysis.

[0121] (c) The data-analysis-support controller according to the present embodiment is configured to repeatedly read data of a predetermined number of times when creating the time-series graph. And then, it is configured to display the data thus read on the operation display section 227 by superimposing it in time series, while arranging the start time of the recipe based on the data time information associated with the data, and creating it in the form of a graph. This makes it possible to reduce a work burden on data acquisition by the maintenance personnel who perform an abnormality analysis.

[0122] (d) The data-analysis-support controller according to the present embodiment is configured to receive the basic information including the abnormal-phenomenon-specific

information as an input to acquire device data associated with the abnormality analysis information. Therefore, the maintenance personnel may arrange the event data and the statistical data associated with the abnormal-phenomenon-specific information in time series to create a graph, and display it on the operation display section 227. Since it is possible to know sufficient verification items necessary for abnormality analysis, it is possible to quickly and accurately perform the abnormality analysis, regardless of the skills of the maintenance personnel.

[0123] The substrate processing apparatus according to the embodiment of the present disclosure can also be applied not only to a semiconductor manufacturing apparatus but also to an apparatus that processes a glass substrate such as a liquid crystal display (LCD) device. The present disclosure is also applicable to various substrate processing apparatuses such as an exposure apparatus, a lithography apparatus, a coating apparatus, and a processing apparatus using plasma.

[0124] The present disclosure relates to a function of supporting analysis of data abnormality generated while monitoring the integrity of data generated in an apparatus, and can be applied to various substrate processing apparatuses.

EXPLANATION OF REFERENCE NUMERALS

[0125] 1: substrate processing apparatus

201: main controller

215: device management controller

215e: device-status-monitoring controller

215f: data-analysis-support controller

215h: storage section

227: operation display section

WHAT IS CLAIMED IS:

1. A substrate processing apparatus, comprising:

a device-status-monitoring controller that stores, in a storage section, device data generated by the apparatus;

an analysis-support controller that acquires the device data related to abnormality analysis information from the storage section based on basic information that includes:

information that defines an abnormal event, at least one of the device data corresponding to the abnormal event, and step information indicating a step where the at least one of the device data is generated; and

recipe-specific information that includes at least a recipe name; and

a display device that displays the device data related to the abnormality analysis information in a manner that goes back to a past time from a time when a latest recipe specified by the recipe name is executed.

2. The apparatus of Claim 1, wherein a master apparatus includes the device data as standard, and

wherein standard data used for comparison by the device-status-monitoring controller is configured by data obtained from the master apparatus.

3. The apparatus of Claim 2, wherein the standard data is an actual measurement value of the master apparatus including the device data as standard, and the device-status-monitoring controller is configured to determine an abnormality by comparison with the actual measurement value of the master apparatus.

4. The apparatus of Claim 1, wherein the basic information further includes information indicating a time when the abnormal event has occurred, and the analysis-support controller is

further configured to display the device data related to the abnormality analysis information on the display device in a manner that goes back to the past time from a specified abnormality occurrence time.

5. The apparatus of Claim 1, wherein the abnormality analysis information is configured to include event information that includes event data indicating information that an alarm has been generated.

6. The apparatus of Claim 5, wherein the analysis-support controller is further configured to display the information of the generated alarm on the display device in the manner that goes back to the past time from the time when the latest recipe specified by the recipe name is executed.

7. The apparatus of Claim 1, wherein abnormality analysis information is configured to include:

substrate-processing-specific information that specifies a substrate process executed by the substrate processing apparatus in which abnormal data is generated;

the recipe-specific information that specifies a recipe executed by the substrate processing apparatus at a time when the abnormal data is generated;

data time information that specifies a time when the abnormal data is generated; and

abnormal-phenomenon-specific information that specifies an abnormal phenomenon.

8. A substrate processing apparatus comprising a device management controller,

wherein the device management controller includes:

a device-status-monitoring controller that stores, in a storage section, device data generated by the apparatus; and

an analysis-support-controller that acquires the device data related to abnormality analysis information from the storage section based on basic information that includes:

information that defines an abnormal event, at least one of the device data corresponding to the abnormal event, and step information indicating a step where the at least one of the device data is generated; and

recipe-specific information that includes at least a recipe name, and

wherein the apparatus comprises a display device that displays the device data related to the abnormality analysis information in a manner that goes back to a past time from a time when a latest recipe specified by the recipe name is executed.

9. The apparatus of Claim 8, wherein the device management controller includes the storage section configured to store a device name and an IP address of a master apparatus, and the device management controller is configured to perform communication connection with the master apparatus with the IP address, and then to compare a device name of the master apparatus acquired by the communication connection with the device name of the master apparatus stored in the storage section.

10. The apparatus of Claim 9, wherein the device management controller is configured to acquire a recipe file from the master apparatus when the device names in comparison match each other and copy the recipe file acquired from the master apparatus to create a recipe file of the apparatus.

11. A substrate processing apparatus, comprising:

a device-status-monitoring controller that stores, in a storage section, device data generated by the apparatus;

an analysis-support-controller that acquires the device data related to abnormality analysis information from the storage section based on basic information that includes:

information that defines an abnormal event, at least one of the device data corresponding to the abnormal event, and step information indicating a step where the at least one of the device data is generated;

information that specifies a time (abnormality occurrence time) when the abnormal event has occurred; and

recipe-specific information that includes a recipe name; and

a display device that displays the device data related to the abnormality analysis information in a manner that goes back to a past time from a specified abnormality occurrence time.

12. A device management controller, comprising:

a device-status-monitoring controller that stores, in a storage section, device data generated by an apparatus ;

an analysis-support controller that acquires the device data related to abnormality analysis information from the storage section based on basic information that includes:

information that defines an abnormal event, at least one of the device data corresponding to the abnormal event, and step information indicating a step where the at least one of the device data is generated; and

recipe-specific information that includes at least a recipe name; and

a display device that displays the device data related to the abnormality analysis information in a manner that goes back to a past time from a time when a latest recipe specified by the recipe name is executed.

13. A computer-readable recording medium storing a program that causes to perform a process in a device management controller, the process comprising:

storing, in a storage section, device data generated by an apparatus;

acquiring the device data related to abnormality analysis information based on basic information that includes:

information that defines an abnormal event, at least one of the device data corresponding to the abnormal event, and step information indicating a step where the at least one of the device data is generated; and

recipe-specific information that includes at least a recipe name; and

displaying the device data related to the abnormality analysis information in a manner that goes back to a past time from a time when a latest recipe specified by the recipe name is executed.