

DESCRIPTION

EQUIPMENT OPERATION SUPPORT SYSTEM

5 Technical Field

[0001] The present invention relates to an equipment operation support system used for operating equipment in a facility environment configured by connecting multiple pieces of equipment.

10 Background Art

[0002] One example of a connection relationship within a facility environment is an electrical system that supplies power from a power source to multiple pieces of equipment. In an electrical system, a single power source is connected to a plurality of devices via a power control apparatus
15 that switches the supply of electric power on and off (i.e., connects or disconnects the supply lines). For example, operations may be performed to turn off (i.e., disconnect) the power control apparatus installed in this type of electrical system. Since the power control apparatus supplies electric power to multiple pieces of equipment, switching on or off the power control
20 apparatus affects the pieces of equipment. Accordingly, if the power control apparatus is disconnected inadvertently, power supply to certain pieces of equipment that require electricity may be interrupted, potentially causing unintended stoppage of the operations of equipment that needs to remain active.

[0003] Therefore, when disconnecting the power control apparatus, electrical system diagrams and manuals among others are consulted to determine the scope of the impact of the power control apparatus before disconnecting it. Generally, electrical system diagrams are not necessarily designed to comprehensively reflect the full scope of the impact of the power control
30 apparatus, nor are they centrally managed.

[0004] Accordingly, as described in Patent Document 1, a search may be conducted, using an apparatus (equipment) as a keyword, for multiple P&IDs (piping and instrumentation diagrams, electrical system diagrams) that are not centrally managed, so that P&IDs are associated and displayed to operate
35 the apparatus while determining the scope of its impact using these diagrams.

Prior Art Documents

Patent Documents

[0005] Patent Document 1: JP H09-91327A

5 Disclosure of the Invention

Problem to be Solved by the Invention

[0006] However, in large-scale facility environments, the scope of the impact of each piece of equipment tends to be extensive, making it difficult to determine the scope of the impact of the equipment even when viewing a
10 connection screen displaying organized information, which may lead to operational errors such as human mistakes during the operation on the equipment.

[0007] It is an object of the present invention to solve the foregoing problem by providing operational support that enables appropriate operation.

15

Means for Solving Problem

[0008] In order to solve the above-described problem, an equipment operation support system of the present invention is an equipment operation support system for checking connection states of a plurality of pieces of
20 equipment in a facility environment, the equipment operation support system including: an operation support device; a display unit provided in the operation support device; an instruction reception unit provided in the operation support device and configured to receive attribute information identifying an operation target equipment for which operation support is to
25 be provided, and receive a simulated operation instruction; a display control unit provided in the operation support device and configured to control the display unit; a storage unit configured to store a plurality of connection operation diagrams each indicating a connection relationship among the pieces of equipment; a search unit configured to search for and extract a
30 connection operation diagram including the operation target equipment; and a simulated operation unit configured to output a simulated operation diagram created by reflecting, in the extracted connection operation diagram, a change in the connection relationship among the pieces of equipment that occurs when an operation is performed according to the simulated operation
35 instruction, in response to reception of the attribute information, the display control unit displaying the connection operation diagram including the

operation target equipment on the display unit, and in response to reception of the simulated operation instruction, the display control unit displaying the simulated operation diagram on the display unit.

[0009] With this configuration, it is possible to display a connection operation
5 diagram that includes the operation target equipment identified by attribute information and display a simulated operation diagram reflecting a change in the connection relationship that occurs in the connection operation diagram according to the simulated operation instruction, thereby allowing accurate determination of the scope of impact when operating the operation
10 target equipment and appropriate execution of operations.

[0010] Moreover, the attribute information may be represented by an identification code, and the instruction reception unit may read the identification code.

[0011] With this configuration, the attribute information can be easily
15 obtained to identify the operation target equipment.

[0012] Furthermore, the instruction reception unit may receive the attribute information by voice input or manual input.

[0013] With this configuration, there is no need to display identification information on the operation target equipment, and accordingly, it is possible
20 to easily obtain attribute information and identify the operation target equipment with a simple configuration.

[0014] In addition, the storage unit may store reference materials related to the pieces of equipment in association with the pieces of equipment, the instruction reception unit may receive a material display instruction
25 instructing display of a reference material, and the display control unit may cause the display unit to display the reference material associated with the operation target equipment, based on the material display instruction.

[0015] With this configuration, it is possible to determine the appropriateness of the operation by referring to reference materials, thereby
30 allowing for more appropriate operation.

[0016] Further, the operation support device may include the storage unit, the search unit, and the simulated operation unit.

[0017] With this simple configuration, it is possible to provide an operation support system capable of providing appropriate operation support.

35 [0018] Additionally, the system may comprise a server configured to perform data communication with the operation support device, and the server may

include the storage unit, the search unit, and the simulated operation unit.

[0019] With this configuration, the operation support device can have a simpler configuration, thereby providing an operation support system with improved operability.

5 [0020] Moreover, a single server can handle multiple operation support devices, so that when the multiple operation support devices are remotely located and when multiple pieces of related equipment are operated, it is possible to provide operation support reflecting the results of operations on the related pieces of equipment.

10 [0021] The facility environment may be an electrical system, and the multiple pieces of equipment may include a power control device.

[0022] In this way, it is possible to provide appropriate operation support for power supply equipment.

[0023] The system further may comprise a procedure manual creation unit
15 configured to create, based on an operation log recording the simulated operation instruction, a procedure manual including information indicating (i) the operation target equipment and (ii) an order of execution of tasks to be performed on the operation target equipment.

[0024] As a result, a procedure manual for tasks to be performed on the
20 operation target equipment can be created easily. Furthermore, since the operator creates the procedure manual based on the simulated operation instructions (more specifically, the operation log, i.e., a history of the simulated operation instructions) while checking (or simulating) the simulated operation diagrams for changes in the equipment, it is possible to
25 produce a procedure manual that allows the tasks to be carried out more safely, thereby providing for the establishment of a safer work environment.

[0025] In response to reception of an instruction indicating completion of a switching task of switching a state of the operation target equipment included as an operation target in the procedure manual, the display control unit may
30 change a state of the operation target equipment indicated in the connection operation diagram in real time to indicate a state after completion of the switching task.

[0026] As a result, the operator and a supervisor monitoring the task can easily track the progress of the task.

35 [0027] The storage unit may store a database storing data representing the plurality of connection operation diagrams indicating current and future

connection relationships among the pieces of equipment.

[0028] Therefore, even if multiple tasks (work operations) are being performed in parallel on a single piece of equipment, the current and future states of the equipment can be accurately checked, thereby preventing operational congestion.

[0029] The facility environment may be a piping facility, the pieces of equipment may include a fluid control device configured to control distribution of a fluid flowing through pipes in the piping facility, and a change in a state of the piping facility may be simulated in the simulated operation diagram according to a change in a state of the fluid control device.

[0030] As a result, it is possible to establish a safer work environment in a piping facility through which a fluid flows.

Brief Description of the Drawings

[0031] FIG. 1 is a circuit diagram illustrating an electrical system according to a first embodiment.

FIG. 2 is a view illustrating a power control panel according to the first embodiment.

FIG. 3 is a view showing a schematic configuration of a power source operation support system according to the first embodiment.

FIG. 4 is a diagram illustrating the functional blocks of the power source operation support system according to the first embodiment.

FIG. 5 is a diagram illustrating a simulated operation diagram according to the first embodiment.

FIG. 6 is a diagram illustrating a simulated operation diagram according to the first embodiment.

FIG. 7 is a diagram illustrating a process flow of maintenance of equipment according to the first embodiment.

FIG. 8 is a view showing a schematic configuration of a valve operation support system according to a second embodiment.

FIG. 9 is a diagram illustrating the functional blocks of the valve operation support system according to the second embodiment.

FIG. 10 is a diagram showing one example of a task procedure according to the second embodiment.

FIG. 11 is a diagram showing one example of a piping and instrumentation diagram of a piping facility according to the second

embodiment.

FIG. 12 is a diagram illustrating a pinboard database that stores piping and instrumentation diagrams according to the second embodiment.

FIG. 13A is a diagram showing one example of a simulated operation diagram according to the second embodiment.

FIG. 13B is a diagram showing one example of a simulated operation diagram according to the second embodiment.

FIG. 13C is a diagram showing one example of a simulated operation diagram according to the second embodiment.

FIG. 14 is a diagram showing one example of a task flow in the planning phase according to the second embodiment.

FIG. 15 is a diagram showing one example of the task flow in a task execution phase according to the second embodiment.

FIG. 16 is a diagram showing one example of a detailed information screen according to the second embodiment.

Best Mode for Carrying out the Invention

[0032] First Embodiment

In a facility environment where multiple pieces of equipment 3 (see FIG. 1) are interconnected, an equipment operation support system assists with the operation on the equipment 3 to enable easy determination of the scope of the impact of the equipment 3 during the operation thereof. Described below, as an example, is a power source operation support system (see FIG. 1) for supporting the operation on power control devices 5, i.e., the equipment 3 (examples of “operation target equipment,” see FIG. 1), in an electrical system 1 (an example of an “facility environment,” see FIG. 1) that includes the power control devices 5.

[0033] Electrical System

First, the electrical system 1 will be described hereinafter with reference to FIGS. 1 and 2.

[0034] As shown in FIG. 1, the electrical system 1 includes multiple pieces of equipment 3 to which electric power is supplied from a common power source 2, such as a power supply or transformer, and supply lines 4 that transmit electric power from the power source 2 to individual pieces of equipment 3. Power control devices 5, i.e., a type of the equipment 3, are installed on the supply lines 4. The power control devices 5 can be switched between a

connected state, in which the supply lines 4 are connected, and a disconnected state, in which the supply lines 4 are disconnected. In the connected state, the supply lines 4 supply electric power and, in the disconnected state, the supply lines 4 stop the supply of electric power.

5 [0035] The electrical system 1 is subdivided into branch electrical systems 1a by the power control devices 5. For example, in FIG. 1, the electrical system 1 is divided into a branch electrical system 1a by a power control device 5a, into a branch electrical system 1b by a power control device 5b, and into a branch electrical system 1c by a power control device 5c. For example,
10 a piece of equipment 3a provided in the branch electrical system 1a is supplied with electric power in response to the connection of the power control device 5a; a piece of equipment 3b provided in the branch electrical system 1b is supplied with electric power in response to the connection of the power control device 5b; and a piece of equipment 3c provided in the branch
15 electrical system 1c is supplied with electric power in response to the connection of the power control device 5a and the power control device 5c. In addition, each piece of equipment 3 may be connected to a supply line 4 via a changeover switch 6. The changeover switch 6, i.e., a type of equipment 3, can switch between connection and disconnection of the supply line 4 and
20 controls the supply of electric power to the piece of equipment 3. Although a changeover switch 6 is provided for each piece of equipment 3 in FIG. 1, it is not essential to provide a changeover switch 6 for some or all pieces of equipment 3.

[0036] As shown in FIG. 2, the plurality of power control devices 5 are
25 grouped together in one or more power control panels 10. Each power control device 5 includes a power switch 11, a meter 12 for displaying information on electric power, indicator lamps 13 for showing the connection state, and a QR code (registered trademark) 14 for identifying the power control device 5. The power switch 11 can switch the supply line 4 between
30 connection and disconnection, thereby controlling the supply of electric power to the corresponding electrical system 1. The QR code (registered trademark) 14 is an example of attribute information 35 (see FIG. 3). The attribute information 35 includes data for identifying the corresponding power control device 5, and may include various types of information, such as
35 the shape, name, and model type of the power control device 5. The power control device 5 controls the supply of electric power to the corresponding

electrical system 1 through the operation on the power switch 11. It should be noted that at least some of the changeover switches 6 may also be grouped together in one or more power control panels 10, similarly to the power control devices 5. Also in this case, similarly to the power control device 5, the
5 operation units of the changeover switch 6 include a power switch 11, a meter 12 for displaying electric power information, an indicator lamp 13 for showing the connection state, and a QR code (registered trademark) 14 for identifying the power control device 5.

[0037] Power Source Operation Support System

10 The following describes the power source operation support system 20 based on FIGS. 3 and 4 with reference to FIG. 1.

First, the configuration of the power source operation support system 20 will be schematically described hereinafter.

[0038] As shown in FIG. 3, the power source operation support system 20
15 includes a portable operation support device 21, such as a tablet, and a server 22 capable of communication with the operation support device 21 via data transmission. The power source operation support system 20 uses the operation support device 21 to identify a piece of operation target equipment subject to operational support, that is, a power control device 5 or a
20 changeover switch 6, and provides operational support for the operation target equipment (power control device 5 or changeover switch 6). Described below is a specific example of the operation on the power control device 5. The operation support device 21 reads a QR code (registered trademark) 14 corresponding to the attribute information 35 to identify the power control
25 device 5. The QR code (registered trademark) 14 is provided on the power control device 5, i.e., the operation target equipment. The operation support device 21 transmits to the server 22, either the attribute information 35 of the identified power control device 5 or other information that can identify the power control device 5. The attribute information 35 may include
30 various types of data, but at least, information for determining (identifying) the power control device 5 is transmitted.

[0039] The server 22 identifies an electrical system diagram 32 (an example of a connection operation diagram) associated with the power control device 5, or the operation target equipment, with the operation support device 21
35 subsequently displaying the electrical system diagram 32. Furthermore, as described below, the operation support device 21 receives a simulated

operation instruction 36 and displays a simulated operation diagram 33, which reflects changes in connection relationships resulting from operations involving the power control device 5 or the changeover switch 6 shown in the electrical system diagram 32. The operator refers to the displayed electrical system diagram 32 and the simulated operation diagram 33 to determine the appropriateness of the operation and operates the power control device 5 accordingly.

[0040] The following specifically describes the functional configuration of the operation support device 21 and the server 22.

As shown in FIG. 4, the operation support device 21 includes a display unit 25, a display control unit 26, an instruction reception unit 27, a communication unit 28, and a storage unit 29.

[0041] The display unit 25, under the control of the display control unit 26, displays various elements, such as operation menus, an electrical system diagram 32, and a simulated operation diagram 33, and also receives various types of operation inputs. The instruction reception unit 27 includes a camera 34 and receives information read from a QR code (registered trademark) 14 via the camera 34 as attribute information 35 as well as operation information related to operations received via the display unit 25.

The operation information includes information, such as simulated operation instructions 36, which correspond to operations performed on the power control device 5 or the changeover switch 6 in the electrical system diagram 32 displayed on the display unit 25. The instruction reception unit 27 stores information, such as the received attribute information 35 and simulated operation instructions 36, in the storage unit 29. The communication unit 28 transmits and receives various types of information to and from the server 22. The communication unit 28 transmits the received attribute information 35 and simulated operation instructions 36 among others to the server 22 and receives the electrical system diagram 32 and simulated operation diagram 33 from the server 22. The storage unit 29 also stores the electrical system diagram 32 and the simulated operation diagram 33 among others received from the server 22 via the communication unit 28.

[0042] The operation support device 21 also includes a function to determine whether or not the operation target equipment to be operated is appropriate. In this case, the display unit 25 receives not only operation information but also other information and instructions. For example, prior to operation

support, the display unit 25 may separately receive operation schedule information related to the operation target equipment to be operated (a power control device 5 or a changeover switch 6). The instruction reception unit 27 stores the received operation schedule information in the storage unit 29.

5 During operation support, upon receiving the attribute information 35, the instruction reception unit 27 or another unshown control unit compares the operation target equipment corresponding to the operation schedule information (the power control device 5 or the changeover switch 6) with the operation target equipment corresponding to the attribute information 35

10 (the power control device 5 or changeover switch 6), and causes the display unit 25, under the control of the display control unit 26, to indicate whether they match or do not match. Furthermore, the operation support device 21 may also include a warning unit 31, so that, if the operation target equipment (the power control device 5 or changeover switch 6) corresponding to the

15 operation schedule information does not match the operation target equipment (the power control device 5 or changeover switch 6) corresponding to the attribute information 35, the instruction reception unit 27 or another unshown control unit may determine that the wrong operation target equipment is to be operated, thus causing the warning unit 31 to issue an

20 alert. The warning unit 31 may be a warning lamp or a speaker that emits an alarm. Alternatively, the warning may also be displayed on the display unit 25.

[0043] The server 22 includes a communication unit 41, a control unit 42, an identification unit 43, a storage unit 44, a search unit 45, and a simulated

25 operation unit 46.

[0044] The communication unit 41 transmits and receives various types of information to and from the operation support device 21 under control of the control unit 42. For example, the communication unit 41 receives attribute information 35 and simulated operation instructions 36 from the operation

30 support device 21, and transmits the electrical system diagram 32 and the simulated operation diagram 33 to the operation support device 21. The control unit 42 causes the received attribute information 35 and simulated operation instructions 36 to be stored in the storage unit 44.

[0045] The identification unit 43 identifies the power control device 5 or the

35 changeover switch 6, i.e., the operation target equipment, which corresponds to the received attribute information 35, under control of the control unit 42.

The search unit 45 identifies, under control of the control unit 42, the electrical system 1 that includes the identified power control device 5 or changeover switch 6, and searches for the electrical system diagram 32 corresponding to the electrical system 1 in the storage unit 44. The found
5 electrical system diagram 32 is transmitted to the operation support device 21 via the communication unit 41 under control of the control unit 42.

[0046] The simulated operation unit 46 generates a simulated operation diagram 33, which reflects instructions to operate the power control device 5 or the changeover switch 6 in the electrical system diagram 32, based on
10 simulated operation instructions 36 received via the communication unit 41. The simulated operation diagram 33 indicates the status of power supply to the supply line 4 and the equipment 3 in response to the switching of the power control device 5 or the changeover switch 6 between connection and disconnection. As a result, the operator, by referring to the electrical system
15 diagram 32 displayed on the operation support device 21, performs the simulated operation on the power control device 5 or the changeover switch 6 on the electrical system diagram 32 on the operation support device 21, and determines the appropriateness of the operation by checking the simulated operation diagram 33 corresponding to the result of the operation.

20 [0047] Electrical System Diagram and Simulated Operation Diagram

The following describes specific examples of the electrical system diagram 32 and the simulated operation diagram 33 based on FIGS. 1, 5, and 6 with reference to FIG. 4.

[0048] As described above, the electrical system diagram 32 shown in FIG. 1
25 is displayed on the display unit 25 of the operation support device 21, and shows the equipment 3, the power control devices 5, the changeover switches 6 in the electrical system 1, and the supply lines 4 representing the connection relationships among these elements. Furthermore, the electrical system diagram 32 is capable of receiving, as simulated operation instructions 36,
30 operations to switch a power control device 5 and a changeover switch 6 between connection and disconnection on the electrical system diagram 32 in a simulated manner.

[0049] For example, if a touch panel serves as the display unit 25, each time the power control device 5 and the changeover switch 6, i.e., the operation
35 targets on the electrical system diagram 32, are touched, the power control device 5 and the changeover switch 6 are switched between connection and

disconnection. Alternatively, switches corresponding to the respective power control device 5 and changeover switch 6 (not shown) may be displayed on the touch panel, and each time the switch is touched, the corresponding power control device 5 or changeover switch 6 may be configured to switch
5 between connection and disconnection. In this case, the switches may be displayed on the corresponding power control device 5 and changeover switch 6, or may be collectively displayed in an operation area separately provided, such as an operation menu.

[0050] The simulated operation diagram 33 is a view illustrating how electric
10 power is supplied, corresponding to the states of the power control device 5 and the changeover switch 6 according to the simulated operation instructions 36. The electric power supply is represented by, for example, highlighting the supply lines 4 and the equipment 3 that form electric power supply paths 37 for by using different colors, or by applying hatching to the
15 supply paths 37, as shown in the example of FIG. 5.

[0051] For example, in response to the simulated disconnection of the power control devices 5a and 5b, electric power is not supplied from the power source 2 to any location. Therefore, as shown in FIG. 5, highlighting by hatching or color to indicate the power supply paths 37 is displayed only between the
20 power source 2 and the power control devices 5a and 5b. In addition, in response to the simulated connection of the power control device 5a and the changeover switch 6a, electric power is supplied to the supply line 4a and the equipment 3d. Accordingly, as shown in FIG. 6, highlighting by hatching or color to indicate the power supply paths 37 is displayed on the power source
25 2, the power control device 5a, the supply line 4a, and the equipment 3d.

[0052] Power Source Operation Support

The following describes a specific example of a process flow to support the operation on the power source based on FIG. 7 with reference to FIGS. 1 and 4.

[0053] As for the operation on the power control panel 10, there are cases
30 where a specific power control device 5 or changeover switch 6 is simply turned on or off, cases where multiple power control devices 5 or changeover switches 6 are turned on or off in an appropriate sequence, and even cases where one or more power control devices 5 or changeover switches 6 are
35 turned on or off before disconnecting the line for maintenance of equipment 3. Described below is a specific example of the process flow, based on a case

where maintenance of equipment 3 is performed that involves operations (power control operations) of a power control device 5 on the power control panel 10. The necessity of maintenance for equipment 3 is determined at a location remote from the power control panel 10, for example, in a factory or an office. Accordingly, the worker (operator) either personally determines that the equipment 3 needs maintenance at a factory, etc., or receives instructions to perform maintenance, and then initiates the maintenance.

[0054] Once it is determined that maintenance of equipment 3 is to be carried out, the equipment 3 that requires operation is identified from the drawings such as electrical schematics and manuals installed in the factory or similar location. Then, information associated with the power control device 5 determined to require switching on/off as part of the maintenance is entered to the operation support device 21 as information regarding the operation target equipment for operation (Step #1 in FIG. 7). The entered information about the operation target equipment is stored in the storage unit 29 under the control of the instruction reception unit 27. An input screen is displayed by operating the operation menu shown on the display unit 25, so that the information about the operation target equipment is entered via manual input or similar means on the input screen for receiving this information.

[0055] Next, the worker (operator) heads for the site where the power control panel 10 is installed, coming from the factory or another location. The worker (operator) then uses the camera 34 of the operation support device 21 to read the QR Code (registered trademark) 14 on the power control device 5 of the power control panel 10 (Step #2 in FIG. 7). The attribute information 35 obtained by reading the QR Code (registered trademark) 14 is stored in the storage unit 29.

[0056] Further, the display control unit 26 causes the display unit 25 to display the name or other identifier of the power control device 5 corresponding to the attribute information 35, as the operation target equipment to be operated (Step #3 in FIG. 7). The worker (operator) checks the displayed name or other identifier to determine whether the power control device 5 to be operated is appropriate before proceeding to the next step. If it is not determined to be appropriate, the power control device 5 to be operated is the wrong one, and the QR Code (registered trademark) 14 provided on the correct power control device 5 needs to be scanned again. At this time, the instruction reception unit 27 may compare the power control

device 5 corresponding to the entered operation schedule information with the power control device 5 corresponding to the attribute information 35, and if they do not match, the process may prompt the scanning of the QR Code (registered trademark) 14 on a different power control device 5, and may

5 further issue a warning via the warning unit 31.

[0057] Thus, by pre-entering operation schedule information pertaining to the operation target equipment into the operation support device 21, it becomes possible to compare and confirm, upon reading the attribute information 35 of the operation target equipment to be operated, whether the

10 equipment to be actually operated is the appropriate equipment 3, thereby preventing an unintended operation, such as disconnecting power to an unintended power control device 5.

[0058] Next, the instruction reception unit 27 controls the communication unit 28 to transmit the attribute information 35 stored in the storage unit 29

15 to the server 22 (Step #4 in FIG. 7). The control unit 42 of the server 22 stores, in the storage unit 44, the attribute information 35 received via the communication unit 41.

[0059] Subsequently, the identification unit 43, under the control of the control unit 42, identifies the power control device 5 as the operation target

20 equipment corresponding to the received attribute information 35 (Step #5 in FIG. 7). Then, the search unit 45 searches for and extracts the electrical system diagram 32 associated with the identified power control device 5 from among the electrical system diagrams 32 stored in the storage unit 44 (Step #6 in FIG. 7). Under the control of the control unit 42, the communication

25 unit 41 transmits the found electrical system diagram 32 to the operation support device 21.

[0060] Next, the operation support device 21 stores the electrical system diagram 32, received via the communication unit 28, in the storage unit 29. The display control unit 26 of the operation support device 21 then causes the

30 display unit 25 to display the electrical system diagram 32 stored in the storage unit 29 (Step #7 in FIG. 7). The electrical system diagram 32 displayed at this point includes the equipment 3 that receives electrical power from the power control device 5 corresponding to the scanned QR code (registered trademark) 14.

35 [0061] The worker (operator) checks the displayed electrical system diagram 32 to confirm the scope of the impact of the power control device 5 to be

operated. Furthermore, to accurately assess the scope of the impact, a simulated operation on the power control device 5 is carried out on the display unit 25. Subsequently, the worker (operator) taps the power control device 5 shown on the display unit 25 and enters a simulated operation instruction 36 to switch on/off the power control device 5 (Step #8 in FIG. 7). The target of the simulated operation is not limited to a power control device 5, and it may also be a changeover switch 6 shown in the electrical system diagram 32. The instruction reception unit 27 stores the simulated operation instruction 36, entered by touching the display unit 25, in the storage unit 29. Additionally, the instruction reception unit 27 transmits the stored simulated operation instruction 36 to the server 22 via the communication unit 28. The control unit 42 of the server 22 stores the simulated operation instruction 36, received via the communication unit 41, in the storage unit 44.

[0062] Next, the simulated operation unit 46 outputs a simulated operation diagram 33 corresponding to the simulated operation instruction 36 under the control of the control unit 42 (Step #9 in FIG. 7). As described above, the simulated operation diagram 33 is a view in which changes in connection relationships among supply lines 4, resulting from operations performed on specific equipment 3, such as power control devices 5 or changeover switches 6, in the electrical system 1 according to the simulated operation instruction 36, are reflected in the electrical system diagram 32. The output simulated operation diagram 33 is transmitted to the operation support device 21 via the communication unit 41 under the control of the control unit 42.

[0063] The simulated operation diagrams 33 in which changes in the supply paths 37 corresponding to changes in connection relationships among the supply lines 4, resulting from operations performed on specific equipment 3, such as power control devices 5 or changeover switches 6, are reflected in the electrical system diagram 32 are prepared in advance in the same number as the number of the patterns of change, and stored in the storage unit 44. A simulated operation diagram 33 corresponding to the received simulated operation instruction 36 is selected and output. Alternatively, supply paths 37 corresponding in number to the patterns of a change in the connection relationships among the supply lines 4 are prepared in advance, and a supply path 37 is selected according to the input simulated operation instruction 36, then integrated with the electrical system diagram 32 to generate and output the simulated operation diagram 33.

[0064] The transmitted simulated operation diagram 33 is stored in the storage unit 29 via the communication unit 28. Upon receiving the simulated operation diagram 33, the display control unit 26 causes the display unit 25 to display the simulated operation diagram 33 stored in the storage unit 29. The worker (operator) checks the displayed simulated operation diagram 33 and repeats input of the simulated operation instruction 36 as needed to verify that the simulated operations are performed on the appropriate operation target equipment (e.g., the power control device 5 or the changeover switch 6) in an appropriate order (Step #10 in FIG. 7). Next, the worker (operator) performs operations, such as disconnection of the power control devices 5 (operation target equipment), in the verified order (Step #11 in Figure 7).

[0065] Lastly, the worker (operator) performs required operations, such as disconnecting the line, and then performs operation on the equipment 3 that requires maintenance (Step #12 in Figure 7).

[0066] As described above, operational support can be provided by performing a simulated operation on operation target equipment prior to actual operation thereof and displaying the scope of the potential impact of the operation. As a result, the operator can determine whether the operation is appropriate before performing the operation, thus preventing potentially incorrect actions to ensure proper operation.

[0067] Second Embodiment

Next, with reference to FIGS. 8 to 16, an equipment operation support system according to a second embodiment will be described. FIG. 8 is a diagram showing a schematic configuration of the equipment operation support system according to the second embodiment.

[0068] As illustrated in FIG. 8, the second embodiment differs from the first embodiment in that the equipment operation support system (in this embodiment, a valve operation support system 120) generates a procedure manual (hereinafter referred to as a procedure manual D1) for performing a task (operation) on the operation target equipment (in this embodiment, a valve 105) installed within a facility environment (in this embodiment, a piping facility 101). The piping facility 101 according to this embodiment includes piping 104 through which a fluid such as flammable gas flows and a plurality of valves 105 (examples of fluid control devices) arranged in the piping 104. Note that the piping facility 101 also includes other equipment,

such as flanges and pumps, and the tasks included in the procedure manual D1 may include inspection of equipment other than the valves 105, such as the pumps. Similar to the first embodiment, the piping 104 branches and is divided.

5 [0069] In the piping facility 101, a plurality of tasks are performed on each of the plurality of valves 105. Hereinafter, the plurality of tasks will be collectively referred to as a “work operation.” A work operation may be carried out over multiple days within a single piping facility 101. Therefore, multiple work operations may be performed in parallel within the same
10 piping facility 101.

[0070] Overview of Valve Operation Support System

The valve operation support system 120 assists in operating (closing or opening) at least one of the plurality of valves 105 provided in the piping facility 101 (plant).

15 [0071] The valves 105 may be configured to be manually operable for opening and closing, or, as in the first embodiment, may be configured as electromagnetic valves that can be switched by operating a valve control panel 110 installed in the plant. The valve control panel 110 may include switches 113 for toggling the valves 105 between open and closed, and QR
20 codes (registered trademark) 114 for identifying the valves 105. It should be noted that the valve control panel 110 may also include display lamps (not shown) among others that indicate the state of the valves 105.

[0072] The flow of the fluid through the piping 104 is controlled by switching the states of the valves 105. Specifically, when the valves 105 are open, the
25 fluid flows through the piping 104, and when the valves 105 are closed, the flow of the fluid is stopped.

[0073] As shown in FIGS. 8 and 9, the valve operation support system 120 includes an operation support device 121 and a server 122 capable of data communication with the operation support device 121. FIG. 9 is a diagram
30 illustrating the functional blocks of the valve operation support system 120.

[0074] Operation Support Device

In the second embodiment, the operation support device 121 includes a first operation support device 121a and a second operation support device 121b. In this embodiment, the first operation support device 121a is an
35 operation support device 121 used by a supervisor in a control room to monitor tasks, and is a tablet terminal, for example. The second operation support

device 121b is an operation support device 121 that is brought to the site by a worker performing tasks related to the valve 105, for example, a smartphone. The respective configurations of the first operation support device 121a and the second operation support device 121b are identical with the configuration of the operation support device 21 described with reference to FIG. 4. However, the operation support device 121 may omit the camera 34.

[0075] Server

As shown in FIG. 9, the server 122 includes a procedure manual creation unit 47, in addition to the communication unit 41, the control unit 42, the identification unit 43, the storage unit 44, the search unit 45, and the simulated operation unit 46 described in the first embodiment. In the second embodiment, the storage unit 44 stores a task procedure database DB1, a pinboard database DB2 (an example of a database), and a task result database DB3. It should be noted that the storage unit 44 is configured by, for example, a semiconductor memory, a magnetic disk device, or the like.

[0076] The task procedure database DB1 stores data indicating the procedure manual D1 created by the procedure manual creation unit 47.

[0077] The pinboard database DB2 stores data representing a plurality of piping and instrumentation diagrams 132 and/or simulated operation diagrams 133, which illustrate the current and future states of the piping facility 101, that is, the connection relationships among the plurality of valves 105 (the piping 104). The pinboard database DB2 stores information for indicating the states of all valves 105 in the piping facility 101 in time sequence. For example, the pinboard database DB2 stores information for indicating the states of all the valves 105 in the piping facility 101 at predetermined time intervals (e.g., every hour). It should be noted that any time interval may be selected as appropriate by the system designer.

[0078] The task result database DB3 stores data indicating the history of the task results.

[0079] As shown in FIG. 9, the procedure manual creation unit 47 generates data representing the procedure manual D1, which is used to smoothly carry out a work operation (a plurality of tasks). The procedure manual creation unit 47 is capable of transmitting the data representing the generated procedure manual D1 to the operation support device 121 via the communication unit 41. Upon receiving the data representing the procedure

manual D1 via the communication unit 28, the operation support device 121 (the first operation support device 121a and/or second operation support device 121b) stores the data in the storage unit 29. Furthermore, the operation support device 121 (display control unit 26) displays the procedure manual D1 on the display unit 25 based on the data representing the procedure manual D1. Hereinafter, the screen displayed on the display unit 25 showing the procedure manual D1 will be referred to as the task procedure screen DG1.

[0080] FIG. 10 is a diagram illustrating an example of the procedure manual D1. As shown in FIG. 10, the procedure manual D1 includes at least information indicating the order in which to perform the tasks, the task procedure (task description), the person responsible for each task, and the progress of the tasks. Note that tasks that do not involve opening or closing a valve 105 (for example, a pre-task meeting as shown in No. 1 of FIG. 10) may be entered by the operator using fixed phrases stored in the operation support device 121 or the server 122. However, the operator may also freely enter any text other than the fixed phrases.

[0081] In this embodiment, the procedure manual creation unit 47 generates the data of the procedure manual D1 based on the operation log that records simulated operation instructions 136 (instructions for touch operation on the screen) performed by the operator on the screen displaying the piping and instrumentation diagrams 132 and/or the simulated operation instructions 136.

[0082] The identification unit 43, as shown in FIG. 9, identifies the valves 105 corresponding to the attribute information 135 received from the operation support device 121, and the search unit 45 extracts, from the storage unit 44, data indicating the piping and instrumentation diagram 132 (an example of a connection operation diagram) corresponding to the identified valves 105. The control unit 42 transmits the extracted data indicating the piping and instrumentation diagram 132 to the operation support device 121 via the communication unit 41. Upon receiving the data indicating the piping and instrumentation diagram 132 via the communication unit 28, the operation support device 121 (including the first operation support device 121a and/or the second operation support device 121b) stores the data in the storage unit 29. The operation support device 121 (the display control unit 26) then displays the piping and instrumentation

diagram 132 on the display unit 25 based on the data indicating the piping and instrumentation diagram 132. Hereinafter, the piping and instrumentation diagram 132 shown on the display unit 25 may also be referred to as the “piping and instrumentation diagram screen G1” (see FIG. 11).

[0083] Piping and Instrumentation Diagram

FIG. 11 is a diagram illustrating an example of the piping and instrumentation diagram 132 of the piping facility 101. The piping and instrumentation diagram 132 shows the connection relationships among the plurality of valves 105 (on the piping 104) within the piping facility 101. It should be noted that, in the following description, closed valves 105 are shown filled in black, and open valves 105 are shown outlined in white.

[0084] As shown in FIG. 12, in this embodiment, the piping and instrumentation diagrams 132 include multiple piping and instrumentation diagrams 132 representing different states of the piping facility 101 at different dates and times. Specifically, the piping and instrumentation diagrams 132 include a piping and instrumentation diagram 132 showing the state of the piping facility 101 (with the plurality of valves 105) at the current time (e.g., when the piping and instrumentation diagram 132 is displayed on the display unit 25) and a piping and instrumentation diagram 132 showing the state of the piping facility 101 (with the plurality of valves 105) at a future time relative to the current time. These piping and instrumentation diagrams 132 are stored in the storage unit 44 of the server 122 (in the pinboard database DB2), and the operator can refer to the piping and instrumentation diagram 132 corresponding to a specified date and time by designating the date and time.

[0085] The simulated operation unit 46, as shown in FIG. 9, generates data representing simulated operation diagrams 133 (see FIGS. 13A to 13C). More specifically, the simulated operation unit 46 generates data of the simulated operation diagram 133 that simulates changes in the state of the piping facility 101 resulting from simulated operation instructions 136 performed on the screen displaying the piping and instrumentation diagram 132 shown in FIG. 11, i.e., on the piping and instrumentation diagram screen G1, or on the screen displaying the simulated operation diagram 133. It should be noted that the state of the piping facility 101 changes in response to changes in the state of the valves 105 caused by the simulated operation

instructions 136 performed on the piping and instrumentation diagram screen G1 or on the screen displaying the simulated operation diagram 133. Upon generating the data of the simulated operation diagram 133, the simulated operation unit 46 transmits the data to the operation support device 121. The operation support device 121 (the display unit 25) displays the simulated operation diagram 133 based on the data received from the server 122 (the simulated operation unit 46). Hereinafter, the simulated operation diagram 133 displayed on the display unit 25 may be referred to as the simulated operation screen G2.

[0086] Namely, the simulated operation diagrams 133 shown in FIGS. 13B and 13C are diagrams that simulate changes in connection relationships resulting from simulated operation instructions 136 (touch operations in this embodiment) on the valves 105 displayed on the simulated operation screen G2 shown in FIG. 13A, and illustrate the simulated states of the piping facility 101 in which the valves 105 are switched over in a simulated manner.

[0087] As shown in FIGS. 13B and 13C, the simulated operation screen G2 visually displays and simulates changes in the state of the piping facility 101 according to the changes in the states of the valves 105 caused by the simulated operation instructions 136. Specifically, on the simulated operation screen G2, the flow directions of the fluid are displayed, and the portions of the piping 104 defining the start and end points of the isolated sections are rendered differently from other portions of the piping 104. By connecting the piping 104 of the isolated sections with the shortest paths, the operator can identify locations where fluid accumulation may occur during nitrogen injection (purging) for the removal of flammable gas.

[0088] For example, as shown in the simulated operation screen G2 of FIG. 13A, in response to switching a valve 105a (hereinafter referred to as the first operation target valve 105a) and a valve 105b (hereinafter referred to as the second operation target valve 105b) from open to closed, liquid-seal sections (liquid-sealed state), in which fluid remains in the piping 104 between the first operation target valve 105a and the second operation target valve 105b, are displayed as shown in FIG. 13B.

[0089] Further, as shown in FIGS. 13B and 13C, in response to switching, from closed to open, a valve 105c (hereinafter referred to as the third operation target valve 105c) and a valve 105d (hereinafter referred to as the fourth operation target valve 105d), which are located downstream of the first

operation target valve 105a and different from the second operation target valve 105b, and a valve 105e (hereinafter referred to as the fifth operation target valve 105e), located upstream of the third and fourth valves 105c and 105d, the liquid-sealed state is resolved; however, residual-liquid sections
5 (sections in a residual-liquid state) in the piping 104 are displayed. It should be noted that residual-liquid state may not occur as shown in FIG. 13C depending on the pressures of the valves 105 (at least one of the third, fourth, or fifth operation target valves 105c, 105d, or 105e) at their opening.

[0090] The sections of the piping 104 that may enter a liquid-sealed state,
10 residual-liquid state, or the like are displayed on the display unit 25 using color schemes, line types, line thicknesses, and/or hatching that differ from those for other sections of the piping 104.

[0091] In other words, on the simulated operation screen G2, changes in the state of the piping facility 101 are visually represented according to the
15 changes in the states of the valves 105 caused by simulated operation instructions 136, allowing the operator to more easily track the changes in the state of the piping facility 101.

[0092] It should be noted that the simulated operation unit 46 may utilize AI technology to generate data representing the simulated operation diagrams
20 133. Specifically, information indicating the pressure and flow rate of a fluid (in a static state) may be associated with the piping 104 as parameters. By inputting the parameters of the piping 104 and the parameters of the valves 105 (information indicating the states of the valves 105), along with training data indicating the state of the fluid, it is possible to generate data
25 representing the simulated operation diagrams 133 using a pretrained model trained through machine learning.

[0093] Next, the flow of steps in the planning phase of the work will be described with reference to FIGS. 8 to 14. FIG. 14 is a diagram illustrating an example of the task flow in the planning phase. It should be noted that,
30 the following describes the case in which the procedure manual D1 is created on the first operation support device 121a; however, the procedure manual D1 may also be created on the second operation support device 121b.

[0094] Planning Phase

As shown in FIG. 14, when a work operation is planned (Step #11),
35 the operator retrieves a piping and instrumentation diagram 132 (Step #12). Specifically, the operator operates the first operation support device 121a to

specify the scheduled date and time for the work and the valves 105, or the operation target equipment (enter the attribute information 135 of the valves 105, or the operation target equipment, in this embodiment). In response, the display control unit 26 of the first operation support device 121a transmits,
5 via the communication unit 28, the information indicating the specified date and time and the attribute information 135 of the valves 105, or the operation target equipment, to the server 122, and requests the transmission of data about the piping and instrumentation diagram 132.

[0095] When transmission of data about the piping and instrumentation
10 diagram 132 is requested, the control unit 42 of the server 122 extracts, from among the data of the piping and instrumentation diagrams 132 stored in the pinboard database DB2, the data representing the piping and instrumentation diagram 132 including the valves 105 identified by the attribute information 135 and corresponding to the specified date and time,
15 and transmits the extracted data to the operation support device 121 (to the first operation support device 121a in the example shown in FIG. 14). Based on the received data, the first operation support device 121a causes the piping and instrumentation diagram 132 (the piping and instrumentation diagram screen G1) to be displayed on the display unit 25 (a touch panel in this
20 embodiment).

[0096] The operator performs simulated operation instructions 136 on the piping and instrumentation diagram screen G1 (or the simulated operation screen G2) (Step #13). For example, the operator sequentially selects the valves 105, or the operation target equipment from among those on the piping
25 and instrumentation diagram screen G1 (or the simulated operation screen G2) in the order specified by the planned work schedule, and switches the valves 105 accordingly. It should be noted that the display control unit 26 maintains an operation log that indicates the simulated operation instructions 136 by the operator (i.e., the selected valves 105 and the order in
30 which they were selected).

[0097] Subsequently, in response to an operation by the operator for either the completion of the simulated operation instructions 136 or the creation of a procedure manual D1, the procedure manual creation unit 47 generates data representing a procedure manual D1 based on the operation log (Step
35 #14). Specifically, it generates data that represents the procedure manual D1 (see FIG. 10) specifying (e.g., listing) that the selected valves 105 are

handled in the order of their selection (Step #14). It should be noted that the data representing the generated procedure manual D1 is stored in the task procedure database DB1. For instance, the task procedure database DB1 establishes associations among, and stores, the data indicating the task name (e.g., "shut off XYZ meter inlet valve"), the task order (e.g., No. 2), the identification information of the valves 105, or the equipment to be operated (e.g., "XYZ meter inlet valve"), the task details (e.g., "shut off"), the time and date of the tasks (e.g., December 22, 2023, at 13:00), and person responsible, etc.

[0098] Before heading for the worksite where the operator performs the tasks, approval of the created procedure manual D1 needs to be obtained from an approver (e.g., a supervisor) via an official approval process using the operation support device 121 or another device (Step #15). Data indicating that approval has been granted through the official approval process is transmitted from the operation support device 121 or another device to the server 122.

[0099] Upon receiving the data indicating that approval has been granted, the control unit 42 of the server 122 updates the pinboard database DB2 so that the states of the valves 105 to be changed by the tasks specified in the approved procedure manual D1 may be appropriately reflected (Step #16). For example, the pinboard database DB2 establishes associations among, and stores, data that includes information identifying a valve 105 (e.g., "XYZ meter inlet valve"), the state of the valve 105 (e.g., closed), and the time period during which the valve 105 remains in this state (e.g., from 09:00 on December 21, 2023, to 13:05 on December 22, 2023).

[0100] As described above, in the piping facility 101, multiple work operations may be scheduled concurrently. Therefore, if tasks overlap with respect to the same valve 105, that is, operations are scheduled for the same date and time, the control unit 42 transmits an alert about the task overlap to the operation support device 121 (i.e., the first operation support device 121a and/or second operation support device 121b), and causes this alert to be alarmed via the warning unit 31 of the operation support device 121. In this way, the operator is prompted to review the procedure manual D1.

[0101] Note that it is possible that operations associated with the operation target equipment may be modified, deleted, and/or added after the procedure manual D1 has been created. In such cases, the operator may retrieve the

previously created procedure manual D1 from among the procedure manuals D1 (data) stored in the task procedure database DB1 and update it. At this time, it is also possible that the state of the operation target equipment, namely the valve 105, may differ between the point in time when the procedure manual D1 was stored in the task procedure database DB1 (hereinafter referred to as “previous creation time”) and the point in time when the procedure manual D1 is retrieved from the database DB1 (hereinafter referred to as “current creation time”). Accordingly, the control unit 42 causes an alert to be issued via the warning unit 31 of the operation support device 121, notifying that there exists a valve 105 whose state has changed between the previous and current creation times. In this way, the operator is prompted to review the procedure manual D1. Thus, even if multiple work operations are being performed concurrently on a single equipment, the state of the piping facility 101 (the valve 105) can be accurately checked, thereby preventing operational congestion.

[0102] Task Execution

Next, the flow of task execution will be described with reference to FIGS. 8 to 16. It is assumed that during task execution, a supervisor in the control room monitors the tasks using the first operation support device 121a, while the operator is heading for the worksite with the second operation support device 121b. FIG. 15 is a diagram illustrating an example of the task flow in the task execution phase. FIG. 16 is a diagram showing an example of the detailed information screen G3.

[0103] Upon arriving at the worksite, the operator pulls up the procedure manual D1 (i.e., the task procedure screen DG1) on the display unit 25 of the second operation support device 121b. Referring to the procedure manual D1, the operator performs one task according to the procedure manual D1 (Step #21). For example, the operator may carry out the task according to the procedure described in reference to FIG. 7 in the first embodiment. While checking the valve 105, or the operation target equipment, the operator switches the state of the valve 105, etc.

[0104] In this embodiment, as shown in FIG. 16, the display control unit 26 of the second operation support device 121b may display detailed task information 134 on the display unit 25, presenting the details of the selected task. Hereinafter, the detailed task information 134 shown on the display unit 25 will be referred to as the detailed information screen G3. The

detailed information screen G3 is displayed in response to the selection of a desired task from among the items (tasks) shown on the task procedure screen DG1, which displays the procedure manual D1. It should be noted that the data representing the detailed information screen G3 may be
5 generated in advance and stored in the storage unit 29 of the second operation support device 121b, or it may be generated by the display control unit 26 in response to an operation.

[0105] The detailed information screen G3 may include the scheduled work date, task sequence, detailed information about the valve 105, i.e., the
10 operation target equipment, and a confirmation button B1. The confirmation button B1 is used to confirm that the state of the valve 105, i.e., the operation target equipment, has been switched.

[0106] Upon completing one of the tasks included in the procedure manual D1 (Step #21), the operator can record the completion of the task (i.e., the
15 completion of switching of the state of the valve 105, or the operation target equipment) in the second operation support device 121b by operating (pressing) the confirmation button B1 (Step #22). In response, the display control unit 26 of the second operation support device 121b displays the completion of the task on the display unit 25 (Step #23). Specifically, as
20 shown in FIG. 10, the display control unit 26 of the second operation support device 121b displays a check mark CH in the progress field for the task in the procedure manual D1 (i.e., the task procedure screen DG1). In addition, information indicating the completion of this task is transmitted from the second operation support device 121b to the first operation support device
25 121a (e.g., transmitted from the second operation support device 121b to the first operation support device 121a via the server 122). When the first operation support device 121a receives the information indicating the completion of the task, the display control unit 26 of the first operation support device 121a updates the state of the valve 105 displayed in the piping and instrumentation diagram 132 (i.e., the piping and instrumentation
30 diagram screen G1) on the display unit 25 to reflect its post-operation (switched) state in real time. In other words, the completion of the task is displayed in real time in the piping and instrumentation diagram 132 (Step #23). As a result, the supervisor monitoring in the control room (and the
35 operator) can easily track the progress of the task.

[0107] Once the above-described processes in steps #21 to #23 are repeated

until all the tasks in the procedure manual D1 have been completed, information indicating the history of the executed tasks is stored in the task result database DB3 by the worker (or operator) operating the operation support device 121. For example, the task result database DB3 establishes
5 associations among, and stores, data indicating the tasks, such as the task description (e.g., "shut off XYZ meter inlet valve ") and the time and date of the task (e.g., at 13:00 on December 22, 2023).

[0108] As described above, according to the second embodiment, as the procedure manual D1 is created based on the operation log of the simulated
10 operation instructions 136, it is easy to perform the tasks in the procedure manual D1, which is for the tasks on the valves 105. Furthermore, since the operator creates the procedure manual D1 while checking the simulated operation diagrams 133 for changes in the piping facility 101 based on the simulated operation instructions 136 (the operation log of the simulated
15 operation instructions 136), it is possible to produce a procedure manual D1 that allows the tasks to be carried out more safely, thereby providing for the establishment of a safer work environment.

[0109] Alternative Embodiments

(1) The operation target equipment is not limited to power control
20 devices 5, and it may also include changeover switches 6 or other equipment 3 that can be operated. Similar to the above embodiments, the power source operation support system 20 identifies an electrical system 1 that contains operation target equipment based on the attribute information 35
corresponding to the operational target equipment, and then displays the
25 electrical system diagram 32 corresponding to that electrical system 1 and the simulated operation diagram 33 corresponding to entered simulated operation instructions 36 in order to provide operation support.

[0110] (2) In the above embodiments, the operation support device 21
(operation support device 121 in the second embodiment, which similarly
30 applies hereinafter) may display not only the simulated operation diagram 33 (simulated operation diagram 133 in the second embodiment, which similarly applies hereinafter) but also reference materials related to the operation target equipment or other equipment 3. For example, the reference materials may include operation procedures, various diagrams, instruction
35 manuals, specifications, and various technical documents. These materials are stored in the storage unit 44 of the server 22 in advance. In response to

receiving an instruction to display material, the instruction reception unit 27 of the operation support device 21 transmits the instruction to the server 22 via the communication unit 28. The server 22 reads out the reference materials related to the operation target equipment identified by the attribute information 35 (attribute information 135 in the second embodiment, which similarly applies hereinafter) from the storage unit 44 and transmits them to the operation support device 21 via the communication unit 41. The display control unit 26 of the operation support device 21 displays the received reference materials on the display unit 25. By displaying the reference materials, the worker (operator) can check them and more easily verify the appropriateness of the intended operation.

[0111] (3) In the above embodiments, the facility environment is not limited to the power system including the power control devices 5; rather, it may include various types of equipment 3, and even be a collective of pieces of equipment 3 (operation target equipment) whose interrelated relationships are subject to change depending on the operation on the equipment 3.

[0112] For example, as described with respect to the second embodiment, the facility environment may be constituted by supply equipment that supplies fluids, such as gas or tap water. This type of supply facility includes valves as the equipment to be operated. The equipment operation support system according to this embodiment identifies valves as operation target equipment based on attribute information 35, displays a connection operation diagram showing the scope of the supply facility affected by the valve operations, and accepts simulated operation instructions 36 (simulated operation instructions 136 in the second embodiment, which similarly applies hereinafter) to display simulated operation diagrams 33 corresponding to the valve operations. In addition to depicting changes in the connection state of the piping (supply lines 4) in response to the valve operations, the simulated operation diagrams 33 may also display the indicated values of indicators arranged at predetermined points along the piping (supply lines 4).

[0113] With this configuration, changes in the state of the facility environment resulting from valve operations can be confirmed, thereby enabling verification of the appropriateness of the operation. As a result, proper operation can be carried out.

[0114] (4) In the above embodiments, the operations performed on the operation target equipment are not limited to simply turning it on/off, and

they may also involve adjusting the supply quantity. For example, if the operation target equipment is a valve, the simulated operation instruction 36 may involve an adjustment of the degree of opening of the valve. Similarly, if the operation target equipment is a power control device 5, the amount of supplied power may be adjusted by the simulated operation instruction 36. In cases where the supply quantity is simulated, the simulated operation diagram 33 displays changes in state corresponding to the adjusted supply quantity.

[0115] (5) Although simulated operation diagrams 33 and supply paths 37 that correspond to changes in connection relationships are prepared in advance, such as those involving the supply lines 4 in the above embodiments, the present invention is not limited to this; rather, it will also suffice to embed a program within an electrical system diagram 32 and, by executing the program, display the supply paths 37 in the electrical system diagram 32 (connection operation diagram) according to simulated operation instructions 36. In this way, it is no longer necessary to prepare a large number of simulated operation instructions 36 in advance, allowing for more efficient operational support.

[0116] The simulated operation diagram 33 need not be a drawing; rather, it may be information that indicates changes in the facility environment. For example, a simulated operation diagram 33 may be presented as a table listing the equipment 3 to which power is supplied or into which fluids flow, or as a table incorporating supply quantities or inflow amounts.

[0117] (6) In the above embodiments, the server 22 (the server 122 in the second embodiment, which similarly applies hereinafter) may be capable of supporting multiple operation support devices 21 (the operation support devices 121 in the second embodiment, which similarly applies hereinafter), and the simulated operation diagram 33 may be capable of dynamically reflecting the state of operable equipment 3. According to this configuration, when coordinating the operations on multiple pieces of operation target equipment, it is possible to perform simulated operations on one piece of operation target equipment while reflecting the actual operation on another piece of operation target equipment. As a result, even operations involving multiple pieces of operation target equipment can be properly supported.

[0118] (7) In the above embodiments, the operation support device 21 (operation support device 121 in the second embodiment) includes a processor,

such as a CPU. The operation support device 21 may be configured with hardware, but at least part of its functionality may alternatively be implemented in software. In such cases, the software is stored in the storage unit 29 and executed by the processor. The configuration of the functional blocks is likewise not limited to the above, and the functional blocks may be consolidated or subdivided as appropriate. Similarly, the server 22 includes a processor, such as a CPU. The server 22 may also be configured with hardware, or alternatively, at least part of its functionality may be implemented in software. In such cases, the software is stored in the storage unit 44 and executed by the processor. The configuration of the functional blocks is likewise not limited to the above, and the functional blocks may be consolidated or subdivided as appropriate.

[0119] (8) In the above embodiments, at least one of the identification unit 43, the search unit 45, and the simulated operation unit 46 may be provided in the operation support device 21 (the operation support device 121 in the second embodiment) rather than in the server 22 (the server 122 in the second embodiment). If all of these are provided in the operation support device 21, the operation support system (the power operation support system 20 in the first embodiment, the valve operation support system 120 in the second embodiment) may omit the server 22. In this case, an electrical system diagram 32 (a connection operation diagram) is selected, and a simulated operation diagram 33 is either selected or generated in the operation support device 21. Additionally, at least one of the identification unit 43, the search unit 45, and the simulated operation unit 46 may be implemented independently of both the operation support device 21 and the server 22.

[0120] (9) In the above embodiments, attribute information 35 is identified via a QR Code (registered trademark) 14, but it may be identified not only via a QR Code (registered trademark) 14, but also using various other identification codes.

[0121] For example, identification codes, such as barcodes, may be used, and the name of the operation target equipment itself may serve as an identifier. Additionally, the attribute information 35 may be location information of the operation target equipment, which consists of, for example, latitude, longitude, and height from a reference point (e.g., elevation above sea level). The attribute information 35 may be input by reading by the camera 34, manual entry via a keyboard or other input devices (human input), or voice

input through a microphone. Moreover, instead of using a QR Code (registered trademark) 14, an RFID (Radio Frequency Identifier) tag may be attached to the power control devices 5 (valves), and the attribute information 35 stored in the RFID tag may be read by a reader provided in the operation support device 21.

[0122] The configurations disclosed in the above embodiment (including alternative embodiments, which similarly applies hereinafter) may be applied in combination with configurations disclosed in other embodiments, provided there is no contradiction. Furthermore, the embodiments disclosed herein are illustrative, that is, the invention is not limited to these embodiments, and modifications may be made as appropriate without departing from the spirit of the invention.

Industrial Applicability

[0123] The present invention can be applied to assistance in equipment operation within various facility environments that include operable equipment.

Description of Reference Signs

20	[0124]	1:	electrical system (facility environment)
		3:	equipment
		5:	power control device (operation target equipment)
		6:	changeover switch (operation target equipment)
		14:	QR code (registered trademark) (identification code)
25		20:	power source operation support system (equipment operation support system)
		21:	operation support device
		22:	server
		25:	display unit
30		26:	display control unit
		27:	instruction reception unit
		28:	communication unit
		29:	storage unit
		32:	electrical system diagram (connection operation diagram)
35		33:	simulated operation diagram
		35:	attribute information

	36:	simulated operation instruction
	41:	communication unit
	42:	control unit
	43:	identification unit
5	44:	storage unit
	45:	search unit
	46:	simulated operation unit
	47:	procedure manual creation unit
	101:	pipng facility (facility environment)
10	105:	valve (operation target equipment: fluid control device)
	120:	valve operation support system (target equipment support system)
	121:	operation support device
	122:	server
15	132:	pipng and instrumentation diagram (connection operation diagram)
	133:	simulated operation diagram
	135:	attribute information
	136:	simulated operation instruction
20	D1:	procedure manual
	DB2:	pinboard database (database)

CLAIMS

1. An equipment operation support system for checking connection states of a plurality of pieces of equipment in a facility environment, the
5 equipment operation support system comprising:
 - an operation support device;
 - a display unit provided in the operation support device;
 - an instruction reception unit provided in the operation support device
and configured to receive attribute information identifying an operation
10 target equipment for which operation support is to be provided, and receive a simulated operation instruction;
 - a display control unit provided in the operation support device and configured to control the display unit;
 - a storage unit configured to store a plurality of connection operation
15 diagrams each indicating a connection relationship among the pieces of equipment;
 - a search unit configured to search for and extract a connection operation diagram including the operation target equipment; and
 - a simulated operation unit configured to output a simulated operation
20 diagram created by reflecting, in the extracted connection operation diagram, a change in the connection relationship among the pieces of equipment that occurs when an operation is performed according to the simulated operation instruction,
 - in response to reception of the attribute information, the display
25 control unit displaying the connection operation diagram including the operation target equipment on the display unit, and
 - in response to reception of the simulated operation instruction, the display control unit displaying the simulated operation diagram on the display unit.
- 30
2. The equipment operation support system according to claim 1,
wherein the attribute information is represented by an identification code, and
the instruction reception unit reads the identification code.
- 35
3. The equipment operation support system according to claim 1,

wherein the instruction reception unit receives the attribute information by voice input or manual input.

4. The equipment operation support system according to claim 1,
5 wherein the storage unit stores reference materials related to the pieces of equipment in association with the pieces of equipment, the instruction reception unit receives a material display instruction instructing display of a reference material, and the display control unit causes the display unit to display the
10 reference material associated with the operation target equipment, based on the material display instruction.

5. The equipment operation support system according to claim 1, wherein the operation support device includes the storage unit, the search
15 unit, and the simulated operation unit.

6. The equipment operation support system according to claim 1, further comprising:
a server configured to perform data communication with the
20 operation support device, wherein the server includes the storage unit, the search unit, and the simulated operation unit.

7. The equipment operation support system according to any one of
25 claims 1 to 6, wherein the facility environment is an electrical system, and the pieces of equipment include a power control device.

8. The equipment operation support system according to claim 1, further
30 comprising:
a procedure manual creation unit configured to create, based on an operation log recording the simulated operation instruction, a procedure manual including information indicating (i) the operation target equipment and (ii) an order of execution of tasks to be performed on the operation target
35 equipment.

9. The equipment operation support system according to claim 8,
wherein in response to reception of an instruction indicating completion of a
switching task of switching a state of the operation target equipment included
as an operation target in the procedure manual, the display control unit
5 changes a state of the operation target equipment indicated in the connection
operation diagram in real time to indicate a state after completion of the
switching task.
10. The equipment operation support system according to claim 1,
10 wherein the storage unit stores a database storing data representing the
plurality of connection operation diagrams indicating current and future
connection relationships among the pieces of equipment.
11. The equipment operation support system according to claim 1,
15 wherein the facility environment is a piping facility,
the pieces of equipment include a fluid control device configured to
control distribution of a fluid flowing through pipes in the piping facility, and
a change in a state of the piping facility is simulated in the simulated
operation diagram according to a change in a state of the fluid control device.
20