

DESCRIPTION

TITLE OF INVENTION: FLANGE TIGHTENING TRAINING SYSTEM, DEVICE,
PROGRAM, METHOD, AND INFORMATION TERMINAL

5 Technical Field

[0001] The present invention relates to, for example, a technique for training of tightening flanges with a gasket interposed therebetween, skill evaluation of the flange tightening, and presentation thereof.

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Background Art

[0002] Flanges with a gasket interposed therebetween are provided at a tightening portion, for example, between conduits or between a pump and a conduit through which fluid
15 flows. The flanges are tightened with a plurality of bolts and a plurality of nuts to seal the tightening portion.

Regarding the flange tightening, there has been known that output signals of the strain gauges disposed on the plurality of bolts are received; a variation between output
20 signals during the tightening work, a variation between output signals at the completion of the tightening work, and the degree of tightening at the completion of the tightening work are calculated; and then the skill level is determined based on the results (e.g., refer to Patent Literature 1).

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Citation List

Patent Literature

[0003] Patent Literature 1: JP 2015-217497 A

30 Summary of Invention

Technical Problem

[0004] Meanwhile, such a person in charge of seal handling is required to have high skills, and thus training for enhancing the person's ability is essential. In addition, the

person in charge of seal handling is required to evaluate properly the ability and improve the quality of on-site handling. Ability evaluation is extremely important because it is a prerequisite for reliability in seal handling, and training that is the prerequisite is not negligible. Seal handling requires training for various items such as the procedure of bolt tightening at a plurality of locations, recognition of elastic interaction, avoidance of uneven tightening, torque feeling, confirmation of sealability, compressive fracture of a gasket, and handling at a narrow location. It is natural for beginners in seal handling to improve their skills through such training. In contrast, it is important for experts in seal handling to receive daily training for constantly acquiring high skills. In the ability evaluation of seal handling, only the experience and the evaluation result are emphasized. Neglecting the training, however, may have issues, for example, in that the substantial improvement of the technique and the reliability in the handling cannot be obtained.

It is extremely important to objectively present and confirm the experience of engineers and the evaluation results of their abilities for enhancing the reliability in the handling.

Patent literature 1 does not disclose or suggest regarding such demands or issues, nor does disclose or suggest an arrangement or the like to solve the demands or issues.

[0005] Therefore, in view of the above issues, an objective of the present invention is to achieve enriched training for reproducing a seal handling site, ability evaluation, and sharing of the training information and ability determination information.

Solution to Problem

[0006] In order to achieve the above objective, according

to one aspect of the present invention, provided is a flange tightening training system in which flanges with a gasket interposed between the flanges are tightened with bolts and nuts, the flange tightening training system including: a
5 flange tightening training unit configured to provide training of flange tightening, the flange tightening training unit being configured to generate flange tightening training information; a tightening feeling training unit configured to provide training of tightening feeling including a torque
10 feeling of flange tightening, the tightening feeling training unit being configured to generate tightening feeling training information; an ability determination unit configured to determine ability of flange tightening, with the flange tightening training information, the ability determination
15 unit being configured to generate ability determination information; and a management unit configured to perform training management, in link with any or at least two of the flange tightening training unit, the tightening feeling training unit, and the ability determination unit.

20 [0007] In the flange tightening training system, the management unit may further manage any or at least two pieces of information of the flange tightening training information, the tightening feeling training information, and the ability determination information in association with identification
25 information of a trainee.

The flange tightening training system may further include: a storage unit configured to accommodate any or at least two pieces of information of the flange tightening training information, the tightening feeling training, and the
30 ability determination information in association with identification information of a trainee; and an information presentation unit configured to present any or at least two pieces of information of the flange tightening training information, the tightening feeling training, and the ability

determination information in association with the identification information.

The flange tightening training system may further include: an information terminal to be connected to the management unit wiredly or wirelessly; and an identification tag accommodating identification information of a trainee, in which based on the identification information read from the identification tag, the information terminal may present the flange tightening training information, the tightening feeling training information, or the ability determination information in association with the identification information.

[0008] In order to achieve the above objective, according to one aspect of the present invention, provided is a flange tightening training device with which flanges with a gasket interposed between the flanges are tightened with bolts and nuts, the flange tightening training device including: a detection unit configured to detect tightening axial forces; and an evaluation unit configured to compare each of the detected axial forces or a mean value of the detected axial forces with a target axial force to calculate a variation of each of the detected axial forces or a variation of the mean value of the detected axial forces, the evaluation unit being configured to calculate a piece of evaluation information indicating whether or not the variation is within a reference value.

The flange tightening training device may further include: a storage unit configured to accommodate any or at least two of a set of the detected axial forces, the mean value, the variation, and the piece of evaluation information in association with identification information of a trainee; and an information presentation unit configured to present any or at least two of the set of the detected axial forces, the mean value, the variation, and the piece of evaluation information, together with the identification information.

[0009] In order to achieve the above objective, according to one aspect of the present invention, provided is a program for causing a computer to perform: a function of providing training of flange tightening and generating flange tightening training information; a function of providing training of tightening feeling of flange tightening and generating tightening feeling training information; a function of determining ability of flange tightening, based on the flange tightening training information and generating ability determination information; and a function of performing training management, in link with any or at least two of a flange tightening training unit, a tightening feeling training unit, and an ability determination unit.

The program may further cause the computer to perform: a function of managing any or at least two pieces of information of the flange tightening training information, the tightening feeling training information, and the ability determination information in association with identification information of a trainee.

In order to achieve the above objective, according to one aspect of the present invention, provided is a program for causing a computer to perform:

a function of capturing detected axial forces; and

a function of comparing each of the detected axial forces or a mean value of the detected axial forces with a target axial force to calculate a variation of each of the detected axial forces or a variation of the mean value of the detected axial forces and calculating a piece of evaluation information indicating whether or not the variation is within a reference value.

[0010] In order to achieve the above objective, according to one aspect of the present invention, provided is a flange tightening training method of tightening flanges with a gasket interposed between the flanges, with bolts and nuts, the

flange tightening training method including: providing training of flange tightening and acquiring flange tightening training information; providing training of tightening feeling of flange tightening and acquiring tightening feeling training information; determining ability of flange tightening, with the flange tightening training information and acquiring ability determination information; and performing training management, in link with any or at least two of a flange tightening training unit, a tightening feeling training unit, and an ability determination unit.

The flange tightening training method may further include: managing any or at least two pieces of information of the flange tightening training information, the tightening feeling training information, and the ability determination information in association with identification information of a trainee.

In order to achieve the above objective, according to one aspect of the present invention, provided is a flange tightening training method of tightening flanges with a gasket interposed between the flanges, with bolts and nuts, the flange tightening training method including:

detecting tightening axial forces;

and comparing each of the detected axial forces or a mean value of the detected axial forces with a target axial force to calculate a variation of each of the detected axial forces or a variation of the mean value of the detected axial forces and calculating a piece of evaluation information indicating whether or not the variation is within a reference value.

[0011] In order to achieve the above objective, according to one aspect of the present invention, provided is an information terminal to be wiredly or wirelessly connected to the management unit of the above flange tightening training system, or to be wiredly or wirelessly connected to any of the flange tightening training devices, in which the information

terminal presents, in connection with the management unit, any or at least two pieces of information of the flange tightening training information, the tightening feeling training information, and the ability determination information in association with the identification information, or presents, in connection with the flange tightening training device, any or at least two of a set of the detected axial forces, the mean value, the variation, and the piece of evaluation information in association with identification information of a trainee.

Advantageous Effects of Invention

[0012] According to the present invention, any of the following effects can be obtained.

<Flange Tightening Training Device>

(1) According to a flange tightening training device of the present invention, performance of skill evaluation based on whether or not a variation of the detected axial force of each bolt or a variation of the average value of the detected axial forces is within the range of a reference value enables speedy evaluation and enables each skilled person to recognize easily his or her own skill level.

(2) The skilled person can tighten the bolts and nuts while confirming the evaluation information, and can obtain the training effects in seal handling combined with the skill evaluation.

[0013] <System>

(3) A flange tightening training system according to the present invention, training can be provided with skill determination, which enables improvement of the comprehensive skill in seal handling. For example, the flange tightening training unit enables a trainee to acquire a handling feeling, such as the tightening procedure and the influence of elastic interaction. The tightening feeling training unit enables the

trainee to experience the seal handling, such as the tightening feeling including the torque feeling with a tightening tool. The skill determination unit can perform ability determination with the above flange tightening training device.

(4) The identification information explicit on the evaluation tag carried by the skilled person, the detection information and evaluation information in association with the identification information are presented on the information terminal, which enables sharing the skill of the skilled person who operates the seal handling and easy confirmation from the display information of the information terminal.

[0014] <Program>

(5) According to a program of the present invention, flange tightening training, feeling training, experiencing training, and skill evaluations thereof can be achieved speedily and accurately with a computer.

<Flange Tightening Training Method>

(6) According to a flange tightening training method of the present invention, the evaluation of flange tightening can be performed based on actual measured values and flange tightening skill can be improved.

[0015] <Information Terminal>

(7) According to an information terminal of the present invention, communication with the flange tightening training device or the management unit of the flange tightening training system provides the information terminal with the evaluation information generated by the flange tightening training device or the flange tightening training system, which enables the information terminal to present the evaluation information.

[0016] In addition, other objectives, features, and advantages of the present invention will become more apparent by referring to the accompanying drawings and each embodiment.

Brief Description of Drawings

[0017] Fig. 1 is a diagram of a flange tightening training system according to a first embodiment.

5 Fig. 2 is a diagram of the function of each unit of the flange tightening training system.

A of Fig. 3 illustrates a training-management information file, and B and C of Fig. 3 each illustrate an ability-determination information file.

10 Fig. 4 is a flowchart illustrating the processing procedure of the flange tightening training system.

Fig. 5 is a diagram of a flange tightening training system according to a second embodiment.

15 Fig. 6 is a flowchart illustrating the processing procedure of the flange tightening training system.

Fig. 7 illustrates a flange tightening training system according to Example 1.

Fig. 8 illustrates the hardware of a flange tightening training device.

20 A of Fig. 9 illustrates a torque feeling training device, and B of Fig. 9 is a diagram of the hardware of the torque feeling training device.

Fig. 10 is a diagram illustrating the hardware of a server device.

25 A of Fig. 11 illustrates reading of an identification tag by an information terminal; B of Fig. 11 illustrates the identification tag; and C of Fig. 11 illustrates the information terminal.

30 A of Fig. 12 is a diagram illustrating the hardware of the information terminal, and B of Fig. 12 illustrates a training-information display table.

Fig. 13 illustrates a flange tightening training system according to Example 2.

Fig. 14 illustrates a training-management information

file according to Example 2.

Fig. 15 is a flowchart illustrating the processing procedure of tightening feeling training.

5 Description of Embodiments

[0018] [First Embodiment]

<Flange Tightening Training System>

Fig. 1 illustrates a flange tightening training system according to a first embodiment. The configuration illustrated in Fig. 1 is an example, and thus the present invention is not limited to such a configuration.

The flange tightening training system (hereinafter, simply referred to as "training system") 2 has a flange tightening training unit 4, a tightening feeling training unit 6, an ability determination unit 8, and a management unit 10.

The flange tightening training unit 4 provides flange tightening training in which flanges with a gasket interposed therebetween are tightened with bolts and nuts. The flange tightening training unit 4 includes explanation for the tightening procedure, elastic interaction, uneven tightening, and the like, as a collective education for the trainees of the flange tightening.

The tightening feeling training unit 6 provides training to each trainee of the flange tightening for improvement in tightening feeling including torque feeling with a hand tightening tool.

The ability determination unit 8 allocates, for example, about 5 minutes as a fixed time to each trainee, and evaluates variations of detected axial forces at the completion of tightening and a variation of the mean value of the detected axial forces. Then, if each variation in tightening is, for example, within $\pm 15\%$ of the reference value, the ability determination unit 8 determines that the ability is passed.

The management unit 10 is linked to the flange tightening

training unit 4, the tightening feeling training unit 6, and the ability determination unit 8. The management unit 10 has a control unit 12, a storage unit 14, a communication unit 16, an information presentation unit 18, and an input operation unit 20.

The control unit 12 includes, for example, a computer, and the control unit 12 is wiredly or wirelessly linked to any or at least two of the flange tightening training unit 4, the tightening feeling training unit 6, and the ability determination unit 8 to exchange information. The storage unit 14 includes storage elements such as a read-only memory (ROM) and a random-access memory (RAM), and stores various programs such as an operating system (OS) and a training program, control information, and the like. The communication unit 16 communicates with an external information terminal or the like.

Under the control of the control unit 12, the information presentation unit 18 presents training information and ability determination information in association with identification information of a trainee. The trainee identification information, training information, and the like are input with the input operation unit 20.

[0019] <Function of Each Unit of Training System 2>

Fig. 2 illustrates the function of each unit in the training system 2. In Fig. 2, the same constituents as those in Fig. 1 are denoted with the same reference signs.

The flange tightening training unit 4 has a flange tightening training device 24 for allowing a trainee to receive training of flange tightening. The tightening feeling training unit 6 has a torque feeling training device 26 for allowing the trainee to receive training of torque feeling.

The ability determination unit 8 has a flange tightening training device 28 to be used for determining the flange-tightening ability of the trainee.

The control unit 12 of the management unit 10 performs information capturing control 30, information storage control 32, training management control 34, flange tightening training control 36, tightening feeling training control 38, ability determination control 40, and information presentation control 42. The storage unit 14 accommodates trainee information 44, flange tightening training information 46, tightening feeling training information 48, ability determination information 50, control information 52, and the like. The trainee information 44, the flange tightening training information 46, the tightening feeling training information 48, and the ability determination information 50 are included in training management information 54 to be provided as presentation information in association with identification information described below.

[0020] <Control of Control Unit 12>

a) Information Capturing Control 30

The information capturing control 30 includes capturing various types of information such as the trainee information 44, the flange tightening training information 46, and the tightening feeling training information 48. The trainee information 44 includes, for example, the identification information of the trainee.

b) Information Storage Control 32

The information storage control 32 includes writing various types of information such as the trainee information captured by the information capturing control 30 to the storage unit 14 or reading the various types of information from the storage unit 14.

c) Training Management Control 34

The training management control 34 includes performing time management for the flange tightening training and the tightening feeling training, personnel management, and the like.

[0021] d) Flange Tightening Training Control 36

The flange tightening training control 36 includes assisting control of explanation for the tightening procedure, the elastic interaction, the uneven tightening, and the like with the flange tightening training device 24.

e) Tightening Feeling Training Control 38

The tightening feeling training control 38 includes performing assisting control of tightening feeling training with a hand tightening tool.

f) Ability Determination Control 40

The ability determination control 40 includes performing assisting control of ability determination with the flange tightening training device 28 in the ability determination unit 8. The assisting control includes aggregation of the ability determination information.

g) Information Presentation Control 42

The information presentation control 42 includes providing presentation information to the information presentation unit 18 for the various types of information accommodated in the storage unit 14 and updating display content.

[0022] <Training-Management Information File 56>

A of Fig. 3 illustrates a training-management information file 56. The training-management information file 56 accommodates the above training management information 54 and is saved in the storage unit 14 (Fig. 2).

The training-management information file 56 has a trainee section 58, an item section 60, and an attribute section 62. The trainee section 58 has, for example, a trainee's name segment 64 and an identification information segment 66, and accommodates the trainee information 44. The trainee's name segment 64 accommodates the name of the trainee who has received training, and may accommodate attribute information such as affiliation. The identification information segment 66

accommodates ID (Identification) information for specifying the trainee.

The item section 60 accommodates the flange tightening training information 46, the tightening feeling training information 48, the ability determination information 50, and other information that are classified into training categories. For the training and the ability determination accommodated in the item section 60, the attribute section 62 accommodates, experience or non-experience of the training; the date and time, the place, and the evaluation for the experience of the training; and other history information, as attribute information for each trainee.

[0023] <Ability-Determination Information File 68-1>

B of Fig. 3 illustrates a first ability-determination information file 68-1. The ability-determination information file 68-1 accommodates ability determination information 50 and is in link with the ability determination information segment 50 in A of Fig. 3.

The ability-determination information file 68-1 accommodates the ability determination information in association with the trainee identification information. In the ability-determination information file 68-1, an identification information section 70, a trainee's name section 72, a date-and-time section 74, a location section 76, a used equipment section 78, an axial-force reference-value section 80, a detected axial-force section 82, a variation section 84, and an evaluation section 86 are set.

The identification information section 70 accommodates the above identification information, and the trainee's name section 72 accommodates the trainee's name specified by the identification information. The date-and-time section 74 accommodates the date and time of the flange tightening training that is the basis of the ability determination. The location section 76 accommodates the location where the flange

tightening training has been provided. The used equipment section 78 accommodates identification information indicating the equipment that has been used for the flange tightening training. The axial-force reference-value section 80

5 accommodates information of a recommended reference value. The detected axial-force section 82 accommodates respective detected axial force values of axial force sensors of the equipment used for the flange tightening training. The variation section 84 accommodates the variations of the
10 detected axial force values to the axial-force reference value. The evaluation section 86 accommodates the evaluation of the detected axial force, and pass-or-fail information.

[0024] <Calculation of Variations of Detected Axial forces or Variation of Mean Value of Detected Axial Forces>

15 When the detected axial force is defined as f and its reference value is defined as f_r , the variation $\pm \Delta f$ ($= \pm \Delta f_1, \pm \Delta f_2, \dots, \pm \Delta f_n$) of the detected axial force $f = f_1, f_2, \dots, f_n$ is obtained by the following mathematical expressions:

20 $\pm \Delta f_1 = f_1 - f_r \dots (1)$

$\pm \Delta f_2 = f_2 - f_r \dots (2)$

$\dots,$

$\pm \Delta f_n = f_n - f_r \dots (3).$

When the mean value of the detected axial force f ($= f_1, f_2, \dots, f_n$) is defined as f_a , and the added value of the
25 detected axial force is defined as

n

$\sum_{i=1}^n f_i = f_1 + f_2 + \dots + f_n \dots (4)$

$i=1$

30 for example, the mean value f_a of arithmetic mean of the detected axial force f is obtained by the following mathematical expression:

$f_a = (f_1 + f_2 + \dots + f_n)/n \dots (5).$ When the variation of the mean value f_a of the detected axial force f is defined

as $\pm \Delta f_a$, the variation $\pm \Delta f_a$ requires at least obtaining with the following mathematical expression:

$$\pm \Delta f_a = f_a - f_r \dots (6).$$

For example, the variation $\pm \Delta f$ of each detected axial force requires at least setting to $\pm \Delta f = 15\%$, and the variation $\pm \Delta f_a$ of the mean value of the detected axial forces requires at least setting to $\pm \Delta f_a = 15\%$.

Note that the reference value f_r may be a fixed value, a fixed range, or may be stepwise changed at tightening stages.

[0025] <Ability-Determination Information File 68-2>

C of Fig. 3 illustrates a second ability-determination information file 68-2. In the ability-determination information file 68-2, the same constituents as those in B of Fig. 3 are denoted with the same reference signs. The mean value of the plurality of detected axial forces and the variation thereof may be used for evaluation of the detected axial forces. The ability-determination information file 68-2 accommodates the mean value of the detected axial forces and the variation value thereof.

In the ability-determination information file 68-2, an identification information section 70, a trainee's name section 72, a date-and-time section 74, a location section 76, a used equipment section 78, an axial-force reference-value section 80, a detected axial-force section 82, a detected-axial-force mean-value section 88, a variation section 84, and an evaluation section 86 are set.

The identification information section 70, the trainee's name section 72, the date-and-time section 74, the location section 76, the used equipment section 78, the axial-force reference-value section 80, and the detected axial-force section 82 are the same as those of the ability-determination information file 68-1, and thus the description thereof will be omitted. The detected-axial-force mean-value section 88 accommodates the mean value of the plurality of detected axial

force values. The variation section 84 accommodates the variations of the axial force detected values to the mean value of the axial-force reference value. The evaluation section 86 accommodates the evaluation of the mean value of the detected axial forces, and pass-or-fail information.

[0026] <Processing Procedure>

Fig. 4 illustrates the processing procedure of the flange tightening training system. The processing procedure indicates exemplary functions of a program achieved by the computer and a training method using the computer together. In Fig. 4, "S" indicates a process or step, and the number attached to "S" indicates the order.

[0027] In the training system 2, after initialization (S101), information such as training information is captured (S102). The information that is the capturing target includes a trainee's name and identification information as trainee information 44, flange tightening training information 46, tightening feeling training information 48, and ability determination information 50.

After capturing of the trainee information 44, the trainee's history is confirmed (S103), and then training-management information file 56 for the trainee is generated (S104). For the training-management information file 56, if the flange tightening training information 46, the tightening feeling training information 48, and the ability determination information 50 are absent, the storage sections for these pieces information are unfilled.

After generation of the training-management information file 56, it is confirmed whether flange tightening training in the flange tightening training unit 4 has been completed (S105). If the flange tightening training has been completed (YES in S105), S106, S107 and S108 may be skipped and the procedure may shift to S109. If the flange tightening training has not been completed (NO in S105), the flange tightening

training is provided in accordance with the curriculum of the flange tightening training unit 4 (S106).

[0028] <Flange Tightening Training>

5 Training Form: Collective education for a plurality of gathered trainees

Training Time: Fixed time, for example, 5 minutes for all

Training Equipment: Use of flange tightening training device 24

10 Training Items: a) Procedure explanation for tightening bolts and nuts on a flange,

b) Explanation for elastic interaction that occurs in flange tightening, and

c) Explanation for uneven tightening and the like

15 [0029] During the flange tightening training, the training time is monitored and it is judged whether the flange tightening training has been completed (S107). If the flange tightening training has not been completed (NO in S107), the flange tightening training is continued (S106).

20 If the flange tightening training is complete (YES in S107), information obtained from the flange tightening training is captured in association with the trainee and accommodated in the training-management information file 56, as flange tightening training information 46 (S108), and then the training-management information file 56 is saved in the
25 storage unit 14. After storage of the information, presentation information is generated and information presentation is performed (S109). The information presentation is displayed as an image on the display screen of the information presentation unit 18 of the management unit 10 to
30 facilitate confirmation to the trainee. In the case where YES in S105 is selected and the procedure is skipped to S109, similarly, presentation of existing information is displayed as an image on the display screen of the information presentation unit 18 to facilitate confirmation by the trainee

and the administrator.

[0030] After completion of the flange tightening training, it is confirmed whether or not tightening feeling training in the tightening feeling training unit 6 has been completed (S110). If the tightening feeling training has been completed (YES in S110), S111, S112, and S113 may be skipped and the procedure may shift to S114. If the tightening feeling training has not been completed (NO in S110), the tightening feeling training is provided in accordance with the curriculum of the tightening feeling training unit 6 (S111).

[0031] <Tightening Feeling Training>

Training Form: Individual education for all trainees

Training Time: Fixed time, for example, 1 minute per person

Training Equipment: Use of torque feeling training device

Training items: a) Torque feeling training with a hand tightening tool, and
b) Others and torque feeling training

[0032] During the tightening feeling training, the training time is monitored and it is judged whether the tightening feeling training has been completed (S112). If the tightening feeling training has not been completed (NO in S112), the tightening feeling training is continued (S111).

If the tightening feeling training is complete (YES in S112), information obtained from the tightening feeling training is captured in association with the trainee and accommodated in the training-management information file 56, as tightening feeling training information 48 (S113), and then the training-management information file 56 is saved the storage unit 14. After storage of the information, presentation information is generated and information presentation is performed (S114). The information presentation is displayed as an image on the display screen of the

information presentation unit 18 of the management unit 10 to facilitate confirmation to the trainee. In the case where YES in S110 is selected and the procedure is skipped to S114, similarly, presentation of existing information is displayed as an image on the display screen of the information presentation unit 18 to facilitate confirmation by the trainee and the administrator.

[0033] After completion of the tightening feeling training, it is confirmed whether the ability determination in the

ability determination unit 8 has been completed (S115). If the ability determination has been completed (YES in S115), S116, S117, and S118 may be skipped and the procedure may shift to S119. If the ability determination has not been completed (NO in S115), the ability determination is performed in accordance with the curriculum of the ability determination unit 8 (S116).

[0034] <Ability Determination>

Ability Determination Form: Individual ability determination for all trainee

Ability Determination Time: Fixed time, for example, 5 minutes per person

Ability Determination Equipment: Use of flange tightening training device 28

The flange tightening training device 24 used for the training in the flange tightening training unit 4 may be used instead of the flange tightening training device 28.

Ability Determination and Pass-or-Fail Evaluation: a) Evaluation of variation of detected axial forces at completion of tightening, and

b) It is determined as pass if the detected axial forces are or the mean value of the detected axial forces is within $\pm 15\%$ of the reference value. The reference value can be changed freely.

[0035] During the ability determination, the ability

determination time is monitored and it is judged whether the ability determination has been completed (S117). If the ability determination has not been completed (NO in S117), the ability determination is continued (S116).

5 If the ability determination is complete (YES in S117), ability determination information obtained from the ability determination is captured in association with the trainee and accommodated in the training-management information file 56, as ability determination information 50 (S118), and then the
10 training-management information file 56 is saved in the storage unit 14. After storage of the information, presentation information is generated and information presentation is performed (S119). The information presentation is displayed as an image on the display screen of the
15 information presentation unit 18 of the management unit 10 to facilitate confirmation to the trainee. In the case where YES in S115 is selected and the procedure is skipped to S119, similarly, presentation of existing information is displayed as an image on the display screen of the information
20 presentation unit 18 to facilitate confirmation by the trainee and the administrator.

[0036] <Effects of First Embodiment>

According to the first embodiment, the following effects can be obtained.

25 (1) The flange tightening training, the tightening feeling training, and the ability determination can be continuously provided and performed as a series of processes. Thus, the trainings and the ability determination can be provided and performed efficiently and speedily.

30 (2) The continuous ability determination is performed for the skilled persons who have received the flange tightening training and the tightening feeling training. Thus, the products of the trainings appear in the result of the ability determination, and the skilled persons can gain feelings of

fulfillment and satisfaction for the trainings.

(3) The flange tightening training, the tightening feeling training, and the ability determination in series are provided and performed for the experienced trainees as well as the beginners. As a result, the seal handling skill can be enhanced in a short time.

(4) As exemplified in the first embodiment, with the settings of 5 minutes for the collective education, 1 minute per person for the tightening feeling training, and 5 minutes per person for the ability determination, for example, if 10 trainees are grouped into one group and the trainings and the ability determination are provided and performed for about 1 hour, the trainings and the ability determination for about 80 persons per day can be provided and performed. Thus, education can be provided for the seal handling trainees who have improved their abilities. These numerical values are examples, and thus the present invention is not limited such numerical values.

[0037] [Second Embodiment]

<Flange Tightening Training System>

A of Fig. 5 illustrates a flange tightening training system according to a second embodiment. In Fig. 5, the same constituents as those in Fig. 1 are denoted with the same reference signs.

The training system 2 according to the second embodiment includes an information terminal 90 connected to a management unit 10. The information terminal 90 is wiredly or wirelessly connected to, for example, the Internet 92 as a communication line.

The information terminal 90 has an information reading unit 94 and a display unit 96. The information reading unit 94 can read identification information 100 of a trainee displayed on an identification tag 98. The identification tag 98 may be an employee card or the like. The identification information

100 may be a bar code, a QR code (registered trademark), or the like. The information reading unit 94 may be a bar code reader, a camera, or the like that reads code information such as a bar code, a QR code, or the like. For example, a liquid
5 crystal display (LCD) is used for the display unit 96, and information is displayed as an image.

[0038] <Training Display Information>

B of Fig. 5 illustrates training display information 102 in association with the identification information 100 of the
10 trainee. The training display information 102 is expanded on the display unit 96 of the information terminal 90.

After reading the identification information 100 from the identification tag 98, the information terminal 90 is linked to the management unit 10. A training-management information
15 file 56 is provided from the management unit 10 to the information terminal 90. The training-management information file 56 (A in Fig. 3) is accommodated in a storage unit 14. As a result, the training display information 102 illustrated in B of Fig. 5 is displayed on the display unit 96.

20 A training-and-history section 104, a result section 106, and a date-and-time section 108 are set in the training display information 102. Ability determination, training, seal handling history, and the like are displayed in the training-and-history section 104. Result information of the training
25 displayed in the training-and-history section 104 is displayed in the result section 106. Date-and-time information of the training and the seal handling is displayed in the date-and-time section 108.

[0039] <Processing Procedure>

30 Fig. 6 illustrates the processing procedure of the flange tightening training system according to the second embodiment.

The second embodiment is based on the above first embodiment, and it is premised on information presentation that training management information 54 is accommodated in the

storage unit 14 of the management unit 10 of the training system 2. In addition, it is necessary that communication connection is established between the communication unit 16 of the management unit 10 and the information terminal 90 and the establishment enables the information terminal 90 to receive presentation information.

[0040] In the processing procedure, the information terminal 90 establishes communication with the management unit 10 (S201), and reads the identification information 100 of the trainee from the identification tag 98 (S202).

The information terminal 90 determines based on the read identification information 100 whether or not the trainee is a registered trainee (S203). If the trainee is the registered trainee (YES in S203), the information terminal 90 requests presentation information (S204). If the trainee is not the registered trainee (NO in S203), the process ends (S205).

The information terminal 90 judges whether the request is for presentation information (S206). If the request is for the presentation information (YES in S206), the information terminal 90 requests the presentation information to the management unit 10 (S207).

[0041] The management unit 10 receives the request for the presentation information (S208) and discriminates the identification information 100 provided from the information terminal 90 (S209). The management unit 10 judges whether the identification information 100 is proper (S210). If the identification information 100 is improper (NO in S210), the process ends (S211).

If the identification information 100 is proper (YES in S210), the management unit 10 generates training display information 102 from the training management information 54 (S212). The management unit 10 provides the generated training display information 102 to the information terminal 90 relating to the information presentation request (S213).

The information terminal 90 receives the training display information 102 (S214) and displays the training display information 102 on the display unit 96 (S215). This arrangement enables confirmation of training information and ability determination information about the trainee or a person engaged in work recognized from the identification tag 98.

[0042] <Effects of the Second Embodiment>

According to the second embodiment, the following effects can be obtained.

(1) The training display information 102 obtained from the training management information 54 in association with the identification information 100 of the trainee can be displayed after reading the identification information.

(2) The displayed presentation information is the training information and the ability determination information obtained in the implementation of the first embodiment. The training history and ability of a seal handling operator, namely, of the trainee can be confirmed with the displayed information, which enables the enhancement of reliability in seal handling.

(3) The trainee does not need to present his or her training history and ability in a document or the like. For example, the trainee can display the training history and ability with the carried identification tag 98.

(4) The administrator can immediately confirm the training history and ability of the trainee, which enables the enhancement of reliability with the trainee. Building such a relationship can improve the reliability in seal handling.

Example 1

[0043] <Flange Tightening Training System>

Fig. 7 illustrates a flange tightening training system according to Example 1. In Fig. 7, the same constituents as

those in Fig. 2 are denoted with the same reference signs.

This flange tightening training unit 4 has a flange tightening training device 24. The flange tightening training device 24 has a tightening handling part 110, a data logger 112, and a personal computer (PC) 114.

The tightening handling part 110 is disposed on a base 116 for the convenience of a trainee. The data logger 112 and the PC 114 are disposed on a base 118 that is set at a position and a height where seal handling can be performed while being confirmed by the trainee. The PC 114 has a display unit 122 together with an input operation unit 120.

[0044] With such a configuration, detected axial forces obtained from flange tightening of the tightening handling part 110 are collected by the data logger 112 and provided to the PC 114. The data logger 112 is an exemplary unit that collects information of the detected axial forces. The PC 114 is an exemplary information processing device that is used for information processing for explaining the tightening procedure of the bolts and nuts on the flange, the elastic interaction that occurs in the flange tightening, the uneven tightening, and the like described above.

[0045] A tightening feeling training unit 6 has a torque feeling training device 26 for acquiring a torque feeling as a tightening feeling. The torque feeling training device 26 has a device main body 126 for operating a tightening tool, on the top of a base 124.

An ability determination unit 8 has a flange tightening training device 28. The flange tightening training device 28 has a configuration similar to that of the flange tightening training device 24 described above. Thus, the constituents of the flange tightening training device 28 are denoted with the same reference signs and the description thereof will be omitted.

In addition, the ability determination unit 8 has a PC

114 and a server device 130 wiredly or wirelessly linked to the device main body 126. The server device 130 has a device main body 131, an input operation unit 134, and a display unit 136. The device main body 131 constitutes a server computer, and the input operation unit 134 includes a user interface such as a keyboard, a mouse, and a touch panel. The display unit 136 has, for example, an LCD as a unit that displays characters and images. The display screen of the display unit 136 may have the touch panel of the input operation unit 134.

[0046] <Flange Tightening Training Devices 24, 28>

Fig. 8 illustrates the hardware of the flange tightening training devices 24, 28.

The tightening handling part 110 has a flange joint 142 that couples piping portions 138 and 140. A gasket 144 is interposed between flanges 142-1 and 142-2, and a plurality of nuts 148 is attached to a plurality of bolts 146 each of which penetrates the flanges 142-1 and 142-2 at a regular interval on the circumferential edges of the flanges 142-1 and 142-2. The bolts 146 and nuts 148 each are tightened with a hand tool 152, and the gasket 144 is brought into pressure contact between the flanges 142-1 and 142-2 to seal the flange joint 142.

[0047] Each bolt 146 has a sensor 154 (= 154-1, 154-2, ..., or 154-8) that detects an axial force. The respective axial forces detected by the sensors 154-1, 154-2, ..., and 154-8 are captured into the server device 130 via the data logger 112, and the detected axial forces are evaluated. The server device 130 includes a processing unit 132, a storage unit 133, the input operation unit 134, a communication unit 135, and the display unit 136. The processing unit 132 is an example of the above control unit 12 (Fig. 1), and the storage unit 133 is an example of the above storage unit 14. The input operation unit 134 is an example of the above input operation unit 20 (Fig. 1), and the display unit 136 is an example of

the information presentation unit 18. The server device 130 has the communication unit 135 wiredly or wirelessly connected to, for example, the PC 114 of the flange tightening training unit 4, the PC 114 of the ability determination unit 8, and the torque feeling training device 26, to be used for communication for information exchange.

[0048] <Torque Feeling Training Device 26>

A of Fig. 9 illustrates the torque feeling training device 26. The torque feeling training device 26 has the function of allowing the trainee to acquire the tightening characteristics and the amount of force, and to receive repetitive training until there is no variation in the bolt tightening work. For example, as equipment for measuring a torque value applied from a tightening hand tool, a line checker may be used for the torque feeling training device 26. The device main body 126 has a socket port 156 and a display unit 158 on the front face of the device main body 126, and a reset switch 160 on the upper portion thereof. As a tightening hand tool, for example, a hand spanner or the like is inserted into or removed from the socket port 156.

The torque feeling training device 26 has a torque sensor 162, a control unit 164, a communication unit 166, and the display unit 158, as illustrated in B of Fig. 9. The torque sensor 162 detects torque applied from the hand tool to the socket port 156. The control unit 164 includes a computer. The control unit 164 is reset by pressing down the reset switch 160, captures the torque detected by the torque sensor 162, and controls the display unit 158. As a result, the torque value detected by the torque sensor 162 is displayed on the display unit 158. The display unit 158 has, for example, an LCD as a unit that displays characters and images. In the communication unit 166, detection information in association with identification information of the trainee is wiredly or wirelessly sent to the server device 130 as a management unit

10.

[0049] After pressing down the reset switch unit 160 to drive the torque feeling training device 26, when the trainee applies torque to the hand tool attached to the socket port 156, the torque value is displayed on the display unit 158. From the relationship between the displayed value and the torque applied from the hand tool, the trainee can acquire the torque feeling.

[0050] <Hardware of Server Device 130>

10 Fig. 10 illustrates the hardware of the server device 130. The server device 130 has a device main body 131 including a processor 168, a storage unit 170, an input-and-output unit 172, and a communication unit 174. The input operation unit 134 and the display unit 136 are connected to 15 the input-and-output unit 172.

The respective PCs 114 of the flange tightening training devices 24, 28 and the control unit 164 of the torque feeling training device 26 are wiredly or wirelessly connected to the server device 130.

20 [0051] <Information Terminal 90, Identification Tag 98, and Information Display>

A of Fig. 11 illustrates reading of the identification information 100 of the trainee from the identification tag 98 by the information terminal 90.

25 The identification tag 98 is, for example, an integrated circuit (IC) card carried by the trainee. The identification information 100 accommodated in the identification tag 98 can be read by, for example, a camera 176 built in the information terminal 90.

30 B of Fig. 11 is an example of the identification tag 98, and in this example, the identification information 100 is displayed together with a photograph 178 of the trainee. The identification information 100 is a bar code as an example. In this case, the photograph 178 may be used as the

identification information 100.

[0052] As illustrated in C of Fig. 11, the information terminal 90 has the camera 176, a display unit 96, and an input operation unit 180. The camera 176 is capable of shooting the identification information 100 of the identification tag 98 carried by the trainee. In addition to the camera 176, the information terminal 90 may have a code reader capable of reading bar codes and other codes. The display screen of the display unit 96 has a touch panel 182 to be used for input operations and the like.

[0053] The information terminal 90 includes, for example, a computer, as illustrated in A of Fig. 12, and has a processor 184, a storage unit 186, an input-and-output unit 188, a communication unit 190, the touch panel 182, the camera 176, and the like. The processor 184 executes the OS and the programs stored in the storage unit 186 to control reading of the identification information 100 by the camera 176, acquisition of the display information in association with the identification information 100, display of the display information, and the like.

Under the control of the processor 184, the communication unit 190 makes a wireless or wired communication connection with the management unit 10 and acquires the display information from training management information 54 in the storage unit 186.

[0054] B of Fig. 12 illustrates exemplary screen display displayed on the display unit 96 of the information terminal 90. For the screen display according to Example 1, a training-information display table 192 is generated. The training-information display table 192 has a content section 194, a result section 196, and a date-and-time section 198.

In the content section 194, "flange-tightening ability-determination result", "basic training", "practical training", and "work history" are displayed as display items. The

“flange-tightening ability-determination result” corresponds to the above ability determination result. The “basic training” corresponds to flange tightening training, and the “practical training” corresponds to tightening feeling training. The “work history” is history information indicating that the trainee has engaged in seal handling.

The result section 196 accommodates information such as determination result, provision or non-provision of training, and site where the seal handling has been performed. In this example, “PASS” indicating the pass is displayed for the “flange-tightening ability-determination result”. In the “basic training” and the “practical training”, “provided” indicating completion of the provision is displayed. In the “work history”, information such as business facility by which work has been performed and equipment is displayed. In addition, in the date-and-time section 198, the date and time corresponding to the content section 194 and the result section 196 are displayed.

[0055] <Processing Procedure>

The processing procedures of the tightening training and the ability determination in Example 1 is similar to those in the first embodiment (Fig. 4), and thus the description thereof will be omitted.

Furthermore, the processing procedure of information confirmation in association with the identification information of the trainee is similar to that in the second embodiment (Fig. 6), and thus the description thereof will be omitted.

[0056] <Effects of Example 1>

According to Example 1, the following effects can be obtained.

(1) For the flange tightening training, the ability determination can be performed subsequent to the basic training and the practical training required for the flange

tightening, and these trainings and ability determination can be efficiently managed by the server device 130 as the management unit 10.

(2) For the trainings and ability determination, the flange tightening training device 24 is disposed in the flange tightening training unit 4 and the flange tightening training device 28 is disposed in the ability determination unit 8 for the sake of description. These devices 24, 28, however, can be identical to each other. In other words, the ability determination can be performed by the device 24 used in the training. Thus, the commonality of the devices 24, 28 as described above is convenient for the trainee and such commonality results in simplification of the training facility and enhancement of the trainee's ability.

(3) In the management unit 10, scheduling of a series of trainings and each piece of information obtained in the flange tightening training unit 4, the tightening feeling training unit 6, and the ability determination unit 8 can be integrally managed in association with the identification information 100 of the trainee. Thus, the integrated management processing can be speeded up, and comprehensive evaluation can be performed by associating the respective pieces of information of the trainings and the ability determination with each other. In addition, the information can be fed back to the trainee, and the accomplishment of the training can be enhanced.

[0057] (4) In Example 1, the server device 130 as the management unit 10 has an independent configuration. The server device 130, however, may be integrated with the PC 114 of the tightening feeling training unit 6, and such a configuration enables downsizing of the system.

(5) For the trainee and a person in charge of handling, the flange tightening training and the ability determination can be confirmed with the information terminal 90. The administrator can easily and speedily confirm the training

history and ability at the handling site, which enables the enhancement of reliability in seal handling.

(6) As described above, according to the training system of Example 1, in addition to the performance of the ability determination, the trainings can be provided. Thus, the handling skill of a person engaged in seal handling can be improved.

(7) The information related to the engaged person, such as the ability and training history of seal handling, is recorded in association with the identification information 100 of the identification tag 98 carried by the engaged person. Thus, the information can be acquired and confirmed easily on the information terminal 90 by use of the identification information 100 of the identification tag 98, which enables sharing and visualization of the information. This arrangement contributes to reduction in educational cost between plants, optimal placement of the engaged person according to the training history and ability, and the like. Such contribution results in efficient and improved reliability in seal handling.

(8) The information terminal 90 may be a dedicated terminal, or a smartphone or the like may be used. Necessary security measures can be taken to prevent information leakage.

Example 2

[0058] <Tightening Feeling Training Unit 6>

Fig. 13 illustrates a tightening feeling training unit 6 according to Example 2. In Fig. 13, constituents common to those in Fig. 7 are denoted with common reference signs, and thus the descriptions thereof will be omitted. The torque feeling training device 26 is disposed in the tightening feeling training unit 6 in Example 1; the tightening feeling training, however, is not limited to the torque feeling training.

In Example 2, as a mechanism of enriching the training content of a tightening feeling training unit 6 for a trainee to acquire a tightening feeling, the tightening feeling training unit 6 has a sealability training device 200, a compressive fracture training device 202, and a narrow-site simulation handling training device 204.

[0059] The sealability training device 200 provides training for confirming defects in excessive tightening or insufficient tightening. The sealability training device 200 has a pressure gauge 206 and an air source 208 connected to a portion closed with a flange joint 142 of a tightening handling part 110. Flanges 142-1 and 142-2 are tightened to a surface pressure lower the surface pressure of a gasket required for sealing. The training is provided for confirming that air leakage occurs from the tightening handling part 110 with the pressure adjusted with the pressure gauge 206 and acquiring the necessity of setting the optimum tightening conditions to the tightening handling part 110.

Training information including the training conditions and training result of the sealability training device 200 is input to a PC 114 of the sealability training device 200 in association with identification information 100 of the trainee, and the associated training information is input to a server device 130 through the PC 114.

[0060] The compressive fracture training device 202 has a function of making the trainee experience a trouble caused by excessive tightening to understand the phenomenon.

In this case, the tightening handling part 110 is used to train on issues to be avoided, such as a creep phenomenon that is a temperature characteristic of gaskets, and reproduction of piping alignment.

Training information including the training conditions and training result of the compressive fracture training device 202 is input to a PC 114 of the compressive fracture

training device 202 in association with the identification information 100 of the trainee, and the associated information is input to the server device 130 through the PC 114.

[0061] The narrow-site simulation handling training device 204 provides training to make the trainee to acquire the skill necessary for tightening, on the assumption that a high-place or narrow-scaffold site environment, piping excluding a tightening target, or the like is present, and under the reproduction of a narrow handling-site environment. In this example, a frame 209 reproduces a narrow environment, and a workbench 210 reproduces a narrow and small scaffold.

Training information including the on-site situation, training conditions, training result, and the like of the narrow-site simulation handling training device 204 is input to a PC 114 of the narrow-site simulation handling training device 204 in association with the identification information 100 of the trainee, and the associated information is input to the server device 130 through the PC 114.

[0062] <Training Management Information>

Fig. 14 illustrates a training-management information file 56. The training-management information file 56 includes a trainee section 58, an item section 60, and an attribute section 62.

The trainee section 58 has, for example, a trainee's name segment 64 and an identification information segment 66, and accommodates trainee information 44. The trainee's name segment 64 accommodates the name of the trainee who has received training, and may accommodate attribute information such as affiliation. The identification information segment 66 accommodates ID information for specifying the trainee. The item section 60 accommodates training categories and the like. In this example, ability determination information 50 and the like are accommodated together with flange tightening training information 46; tightening feeling training information 48

including torque feeling training information 48-1, sealability training information 48-2, compressive fracture training information 48-3; and narrow-site simulation training information 48-4.

5 [0063] <Processing Procedure of Tightening Feeling Training>

Fig. 15 illustrates the processing procedure of the tightening feeling training according to Example 2. The processing procedure includes processes alternative to the
10 tightening feeling training (S110 to S113 in Fig. 4) in the first embodiment. This tightening feeling training has a training form in which individual education is provided to all trainees. Such tightening feeling training includes

- a) Torque feeling training,
- 15 b) Sealability training,
- c) Compressive fracture training, and
- d) Narrow-site simulation training. Therefore, the processing procedure includes the steps of selecting torque feeling, sealability, compressive fracture, or narrow-site
20 simulation. After shifting to the tightening feeling training, the torque feeling, sealability, compressive fracture, or narrow-site simulation is selected (S301).

[0064] <Torque Feeling Training>

In this example of the processing procedure, the torque
25 feeling training is preferentially preceded. Thus, it is judged whether the torque feeling training has been completed (S302). If the torque feeling training has not been completed (NO in S302), the torque feeling training is provided (S303).

During the torque feeling training, the training time is
30 monitored and it is judged whether the torque feeling training has been completed (S304). If the torque feeling training has not been completed (NO in S304), the torque feeling training is continued (S303).

If the torque feeling training is complete (YES in S304),

information obtained from the torque feeling training is captured in association with the trainee and accommodated in the training-management information file 56, as torque feeling training information (S305), and then the training-management information file 56 is saved in a storage unit 14. After storage of the information, presentation information is generated and information presentation is performed (S306). The information presentation is displayed as an image on the display screen of a display unit 136 of a management unit 10 to facilitate confirmation to the trainee.

In the case where the torque feeling training has already been completed (YES in S302), and even in a case where the procedure is skipped from YES in S302 to S306, similarly, presentation of existing information is displayed as an image on the display screen of the display unit 136 to facilitate confirmation by the trainee and the administrator.

[0065] <Sealability Training>

After completion of the torque feeling training, it is judged whether the sealability training has been completed (S307), and if the sealability training has not been completed (NO in S307), the sealability training is provided (S308).

During the sealability training, the training time is monitored and it is judged whether the sealability training has been completed (S309). If the sealability training has not been completed (NO in S309), the sealability training is continued (S308).

If the sealability training is complete (YES in S309), information obtained from the sealability training is captured in association with the trainee and accommodated in the training-management information file 56, as sealability training information (S310), and then the training-management information file 56 is saved in the storage unit 14. After storage of the information, presentation information is generated and information presentation is performed (S311).

The information presentation is displayed as an image on the display screen of the display unit 136 of the management unit 10 to facilitate confirmation to the trainee.

In the case where the sealability training has already been completed (YES in S307), and even in a case where the procedure is skipped from YES in S307 to S311, similarly, presentation of existing information is displayed as an image on the display screen of the display unit 136 to facilitate confirmation by the trainee and the administrator.

10 [0066] <Compressive Fracture Training>

After completion of the sealability training, it is judged whether the compressive fracture training has been completed (S312). If the compressive fracture training has not been completed (NO in S312), the compressive fracture training is provided (S313).

During the compressive fracture training, the training time is monitored and it is judged whether the compressive fracture training has been completed (S314). If the compressive fracture training has not been completed (NO in S314), the compressive fracture training is continued (S313).

If the compressive fracture training is complete (YES in S314), information obtained from the compressive fracture training is captured in association with the trainee and accommodated in the training-management information file 56, as compressive fracture training information (S315), and then the training-management information file 56 is saved in the storage unit 14. After storage of the information, presentation information is generated and information presentation is performed (S316). The information presentation is displayed as an image on the display screen of the display unit 136 of the management unit 10 to facilitate confirmation to the trainee.

In the case where the compressive fracture training has already been completed (YES in S312), and even in a case where

the procedure is skipped from YES in S312 to S316, similarly, presentation of existing information is displayed as an image on the display screen of the display unit 136 to facilitate confirmation by the trainee and the administrator.

5 [0067] <Narrow-Site Simulation Training>

After completion of the compressive fracture training, it is judged whether the narrow-site simulation training has been completed (S317). If the narrow-site simulation training has not been completed (NO in S317), the narrow-site simulation
10 training is provided (S318).

During the narrow-site simulation training, the training time is monitored and it is judged whether the narrow-site simulation training has been completed (S319). If the narrow-site simulation training has not been completed (NO in S319),
15 the narrow-site simulation training is continued (S318).

If the narrow-site simulation training is complete (YES in S319), information obtained from the narrow-site simulation training is captured in association with the trainee and accommodated in the training-management information file 56,
20 as narrow-site simulation training information (S320), and then the training-management information file 56 is saved in the storage unit 14. After storage of the information, presentation information is generated and information presentation is performed (S321). The information presentation
25 is displayed as an image on the display screen of the display unit 136 of the management unit 10 to facilitate confirmation to the trainee.

In the case where the narrow-site simulation training has already been completed (YES in S317), and even in a case where
30 the procedure is skipped from YES in S317 to S321, similarly, presentation of existing information is displayed as an image on the display screen of the display unit 136 to facilitate confirmation by the trainee and the administrator.

[0068] <Effects of Example 2>

According to Example 2, the following effects can be obtained.

(1) For the tightening feeling, the wide-ranging training of, for example, the torque feeling, sealability, compressive fracture, and narrow-site simulation can be provided.

(2) If only the torque feeling is sufficient depending on a trainee or a site, only the preferentially preceded torque feeling training is provided, and the tightening feeling training can be completed. In addition to the torque feeling, selectively trainings of any two or more of the sealability, compressive fracture, and narrow-site simulation can be provided.

(3) The training order can also be selected freely.

(4) During each training, the time is monitored and each training is completed at a predetermined time, so that the speedy and accurate training can be provided.

[0069] [Other Embodiments]

The embodiments of the present invention include the following variations.

(1) In the flange tightening training system 2, the flange tightening training unit 4, the tightening feeling training unit 6, the ability determination unit 8, and the management unit 10 can be centrally managed in one place, and such central management is effective. The flange tightening training unit 4, the tightening feeling training unit 6, and the ability determination unit 8, however, may be separately disposed one-to-one in a plurality of places, and training information obtained by each unit may be transmitted to the management unit 10 through a line such as the Internet and may be managed by the management unit 10.

(2) It is effective that the training information obtained by the flange tightening training unit 4, the tightening feeling training unit 6, or the ability determination unit 8 is automatically captured into the PC.

The data, however, may be managed through manual input by the administrator.

(3) The information terminal 90 may be a dedicated processing terminal, or may be a smartphone or a tablet terminal.

[0070] (4) The identification tag 98 is not limited to the IC card carried by the employee, and may be a smartphone, a notebook, a watch, or the like.

(5) The management unit 10 is in link with all of the flange tightening training unit 4, the tightening feeling training unit 6, and the ability determination unit 8. The management unit 10, however, may perform training management, in link with any or at least two of the flange tightening training unit 4, the tightening feeling training unit 6, and the ability determination unit 8.

(6) The ability determination unit 8 determines the ability, based on the training information obtained by the flange tightening training unit 4. The ability, however, may be determined in consideration of training information obtained from a different training.

As above, the most preferable embodiments of the present invention have been described. The present invention is not limited to the above description. Various modifications and alternations can be made by those skilled in the art on the basis of the gist of the invention described in the claims or disclosed in the description of embodiments. It is needless to say that such modifications and alterations are included in the scope of the present invention.

Industrial Applicability

[0071] According to the flange tightening training system, device, program, method, and information terminal of the present invention, various trainings required for seal handling can be provided, and training information obtained

from the trainings can be managed in association with identification information of a trainee. With this arrangement, effects such as improved ability of a seal handling operator and enhanced reliability in seal handling can be obtained.

Reference Signs List

	[0072]	2	flange tightening training system
	4		flange tightening training unit
10	6		tightening feeling training unit
	8		ability determination unit
	10		management unit
	12		control unit
	14		storage unit
15	16		communication unit
	18		information presentation unit
	20		input operation unit
	24 and 28		flange tightening training device
	26		torque feeling training device
20	30		information capturing control
	32		information storage control
	34		training management control
	36		flange tightening training control
	38		tightening feeling training control
25	40		ability determination control
	42		information presentation control
	44		trainee information
	46		flange tightening training information
	48		tightening feeling training information
30	50		ability determination information
	52		control information
	54		training management information
	56		training-management information file
	58		trainee section

60 item section
 62 attribute section
 64 trainee's name segment
 66 and 70 identification information segment, identification
 5 information section
 68-1 first ability-determination information file
 68-2 second ability-determination information file
 72 trainee's name segment
 74 and 198 date-and-time section
 10 76 location section
 78 used equipment section
 80 axial-force reference-value section
 82 detected axial-force section
 84 variation section
 15 86 evaluation section
 88 mean value section
 90 information terminal
 92 the Internet
 94 information reading unit
 20 96 display unit
 98 identification tag
 100 identification information
 102 training display information
 104 training-and-history section
 25 106 and 196 result section
 108 date-and-time section
 110 tightening handling part
 112 data logger
 114 personal computer (PC)
 30 116, 118, and 124 base
 120, 134, and 180 input operation unit
 122, 136, and 158 display unit
 126 and 131 device main body
 130 server device

- 132 processing unit
- 133 storage unit
- 135 communication unit
- 138 and 140 piping portion
- 5 142 flange joint
 - 142-1, and 142-2 flange
 - 144 gasket
 - 146 bolt
 - 148 nut
- 10 152 hand tool
 - 154, 154-1, 154-2, ..., and 154-8 sensor
 - 156 socket port
 - 158 display unit
 - 160 reset switch
- 15 162 torque sensor
 - 164 control unit
 - 166, 174, and 190 communication unit
 - 168 and 184 processor
 - 170 and 186 storage unit
- 20 172 input-and-output unit
 - 176 camera
 - 178 photograph
 - 182 touch panel
 - 188 input-and-output unit
- 25 192 training-information display table
 - 194 content section

CLAIMS

1. A flange tightening training system in which flanges with a gasket interposed between the flanges are tightened with bolts and nuts, the flange tightening training system

5 comprising:

a flange tightening training unit configured to provide training of flange tightening, the flange tightening training unit being configured to generate flange tightening training information;

10 a tightening feeling training unit configured to provide training of tightening feeling including a torque feeling of flange tightening, the tightening feeling training unit being configured to generate tightening feeling training information;

15 an ability determination unit configured to determine ability of flange tightening, with the flange tightening training information, the ability determination unit being configured to generate ability determination information; and

a management unit configured to perform training
20 management, in link with any or at least two of the flange tightening training unit, the tightening feeling training unit, and the ability determination unit.

2. The flange tightening training system according to claim
25 1,

wherein the management unit further manages any or at least two pieces of information of the flange tightening training information, the tightening feeling training information, and the ability determination information in
30 association with identification information of a trainee.

3. The flange tightening training system according to claim 1, further comprising:

a storage unit configured to accommodate any or at least

two pieces of information of the flange tightening training information, the tightening feeling training, and the ability determination information in association with identification information of a trainee; and

5 an information presentation unit configured to present any or at least two pieces of information of the flange tightening training information, the tightening feeling training, and the ability determination information in association with the identification information.

10

4. The flange tightening training system according to claim 1, further comprising:

 an information terminal to be connected to the management unit wiredly or wirelessly; and

15 an identification tag accommodating identification information of a trainee,

 wherein based on the identification information read from the identification tag, the information terminal presents the flange tightening training information, the tightening feeling training information, or the ability determination information in association with the identification information.

20

5. A flange tightening training device with which flanges with a gasket interposed between the flanges are tightened with bolts and nuts, the flange tightening training device comprising:

25

 a detection unit configured to detect tightening axial forces; and

 an evaluation unit configured to compare each of the detected axial forces or a mean value of the detected axial forces with a target axial force to calculate a variation of each of the detected axial forces or a variation of the mean value of the detected axial forces, the evaluation unit being configured to calculate a piece of evaluation information

30

indicating whether or not the variation is within a reference value.

6. The flange tightening training device according to claim 5, further comprising:

a storage unit configured to accommodate any or at least two of a set of the detected axial forces, the mean value, the variation, and the piece of evaluation information in association with identification information of a trainee; and

- 10 an information presentation unit configured to present any or at least two of the set of the detected axial forces, the mean value, the variation, and the piece of evaluation information, together with the identification information.

- 15 7. A program for causing a computer to perform:

a function of providing training of flange tightening and generating flange tightening training information;

- 20 a function of providing training of tightening feeling of flange tightening and generating tightening feeling training information;

a function of determining ability of flange tightening, based on the flange tightening training information and generating ability determination information; and

- 25 a function of performing training management, in link with any or at least two of a flange tightening training unit, a tightening feeling training unit, and an ability determination unit.

8. The program according to claim 7, further causing the 30 computer to perform:

a function of managing any or at least two pieces of information of the flange tightening training information, the tightening feeling training information, and the ability determination information in association with identification

information of a trainee.

9. A program for causing a computer to perform:

a function of capturing detected axial forces; and

5 a function of comparing each of the detected axial forces
or a mean value of the detected axial forces with a target
axial force to calculate a variation of each of the detected
axial forces or a variation of the mean value of the detected
axial forces and calculating a piece of evaluation information
10 indicating whether or not the variation is within a reference
value.

10. A flange tightening training method of tightening flanges
with a gasket interposed between the flanges, with bolts and
15 nuts, the flange tightening training method comprising:

providing training of flange tightening and acquiring
flange tightening training information;

providing training of tightening feeling of flange
tightening and acquiring tightening feeling training
20 information;

determining ability of flange tightening, with the flange
tightening training information and acquiring ability
determination information; and

performing training management, in link with any or at
25 least two of a flange tightening training unit, a tightening
feeling training unit, and an ability determination unit.

11. The flange tightening training method according to claim
10, further comprising:

30 managing any or at least two pieces of information of the
flange tightening training information, the tightening feeling
training information, and the ability determination
information in association with identification information of
a trainee.

12. A flange tightening training method of tightening flanges with a gasket interposed between the flanges, with bolts and nuts, the flange tightening training method comprising:

5 detecting tightening axial forces; and
 comparing each of the detected axial forces or a mean value of the detected axial forces with a target axial force to calculate a variation of each of the detected axial forces or a variation of the mean value of the detected axial forces
10 and calculating a piece of evaluation information indicating whether or not the variation is within a reference value.

13. An information terminal to be wiredly or wirelessly connected to the management unit of the flange tightening
15 training system according to any of claims 1 to 4, or to be wiredly or wirelessly connected to the flange tightening training device according to claim 5 or 6,

 wherein the information terminal
 presents, in connection with the management unit, any or
20 at least two pieces of information of the flange tightening training information, the tightening feeling training information, and the ability determination information in association with the identification information, or

 presents, in connection with the flange tightening
25 training device, any or at least two of a set of the detected axial forces, the mean value, the variation, and the piece of evaluation information in association with identification information of a trainee.