

INSTRUCTION MANUAL

MODEL LP-30H
OXYGEN ANALYZER
(Probe Transmitter)



Read the operation Manual



ENERGY SUPPORT CORPORATION

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Handling Precautions

Warning

- (1) When installing wiring around the terminal section of the analyzer or performing Maintenance inside the analyzer, take care to avoid electric shock.
Turn the power off without fail when performing maintenance of electrical parts.
- (2) Be sure to connect the grounding cable to the grounding terminal to reduce the possibility of electric shock.



The electric shock caution mark on the left is attached to the terminal area that may cause electric shock.

When wiring or checking, be careful not to get an electric shock.

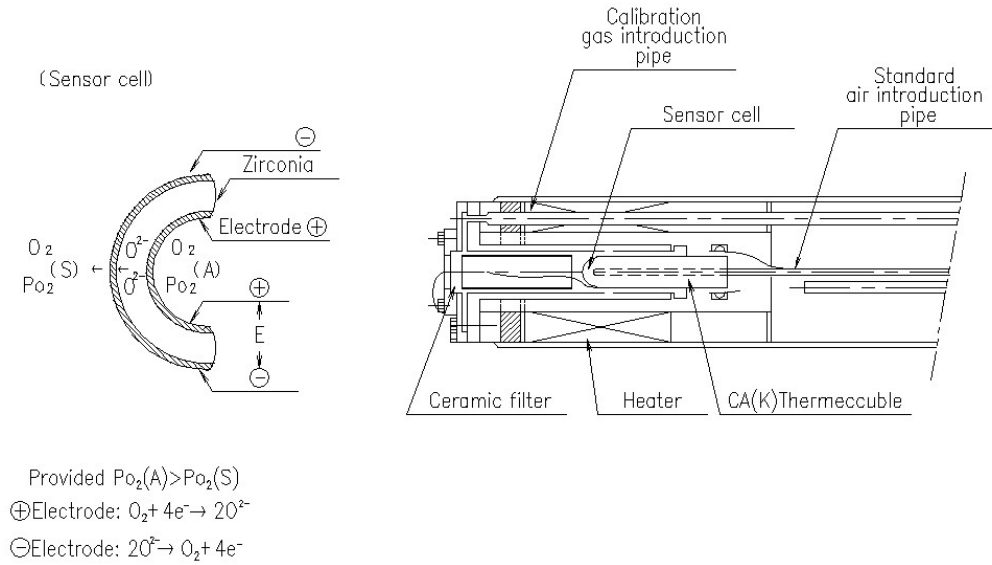
[Caution]

- (1) Stop the plant when removing or installing the probe transmitter. If it is unavoidable to remove or install the probe transmitter during plant operation, use sufficient care for the following points.
 - ① Wear heat resistant gloves because the installation section and its periphery are very hot.
 - ② Hot sample gas will blow out from a furnace at a positive pressure; never reach or approach openings.
 - ③ Dust in the sample gas will also blow out; wear protective glasses to protect your eyes from dust.
 - ④ The gas inside the furnace may blow out from piping parts of reference and calibration gases; plug the piping ports when removing or installing the probe transmitter. After the probe transmitter has been inserted, return the piping in its original state promptly.
- (2) Install the probe transmitter during stoppage of the plant. Turn the heater on one hour before plant operation. If the probe is not sufficiently heated, the detector cell or probe itself may be worn due to corrosive gases or the like.

1. General

The Oxygen Analyzer LP-30H is a device with a sensor (sensor cell), fitted at the tip of a probe, heated to a high temperature by a heater, and inserted in the of a boiler or various types of furnace, to measure automatically the oxygen partial pressure in combustion exhaust gas. This analyzer has no gas sampling part common in old types, needs minimal maintenance, has quick response, and is able to make stable measurement for a long time. Therefore, we are quite confident that the LP-30H Oxygen analyzer is the most suitable instrument for automatic control of low oxygen combustion aiming at energy conservation and NOx reduction.

2. Principle of Measurement



Cubic system solid solution composed of zirconia (ZrO_2) combined with calcium oxide (CaO) and yttrium oxide (Y_2O_3) becomes solid electrolyte which conducts oxygen ion (O^{2-}) at a high temperature. When a couple of electrodes (Porous) are faced to this solid electrolyte, and gases which have different oxygen partial pressure are supplied to each electrode, oxygen ion conduction will occur and the following electromotive force between the electrodes will be generated.

$$E = -\frac{RT}{4F} \ln \frac{P_{O_2}(S)}{P_{O_2}(A)}$$

Where E : Electromotive force generated between the electrodes (V)

R : Gas constant ($8.314 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$)

T : Absolute temperature of the (Normal $923 \cdot \text{K}$)

F : Faraday constant ($9.649 \times 10^4 \text{ C} \cdot \text{mol}^{-1}$)

$P_{O_2}(A)$: Oxygen partial pressure in the standard gas (air)
 (concentration 20.6 vol %)

$P_{O_2}(S)$: Oxygen partial pressure in the sample gas
 (concentration is indicated by vol %)

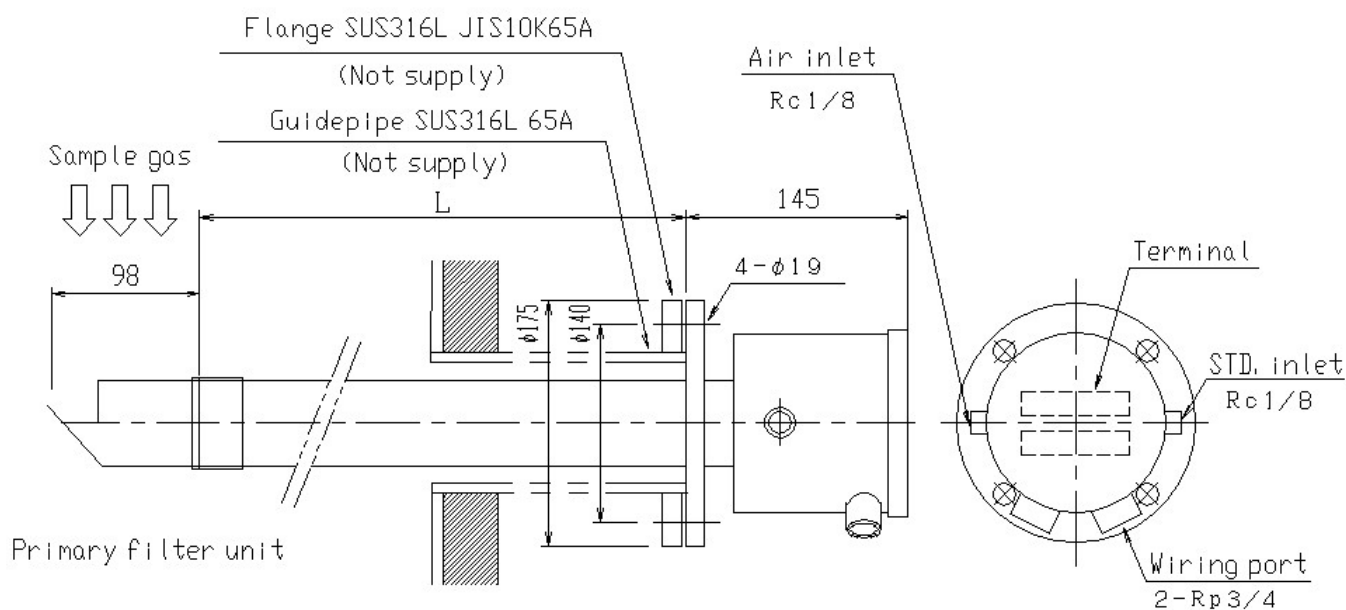
Substituting the numerical values of constants in the above equation, we obtain.

$$P_{O_2}(S) = 20.6 \cdot \text{Antilog}_{(10)}\left(-\frac{E}{45.78}\right)$$

P_{O_2} in the sample gas can be obtained through the above equation by substituting the measured electromotive force. This solid electrolyte (sensor cell) is fitted at the tip of the probe transmitter of the LP-30H Oxygen Analyzer and heated to 650°C . Sample gas flows through a special filter, diffuses and contacts with the cell, and electromotive force, corresponding to the O_2 partial pressure in the sample gas, is generated. This electromotive force E will be calculated through an Antilog conversion circuit in the control unit, and indicated as a direct readable O_2 pressure (VOL%)

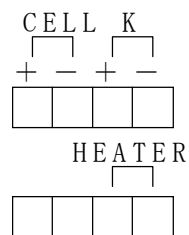
3. Components and their Functions

3-1 Probe Transmitter



Specifications

MODEL	LP-30H
Measurement principle	Zirconia
Response	Less than 10sec. (90%F.S)
	Changing the Calibration gas
Warm-up time	Approx. 20min.
Reference air flow rate	Approx. 2ℓ/min.
Calibration gas flow rate	Approx 1~3ℓ/min.
Accessories	Bolt, Nut, Washer M16, L70 (S38) 4
	Sets Gasket (JIS10K65A T1995 t3) 1



Number	LSize mm
Probe transmitter	500
AKS-16301□-LD	1000
	1500
Filter Unit	
KS-18549□	

Accessories

Name	Remarks	Q, ty
Bolt, Nut, W, SW	M16, L70 (S38)	4
Non asbestos packing	JIS10K65A	1

Name : LP-30H Oxygen Analyzer

Number : KS-16301□-LD

4. Mounting

Mounting, plumbing and wiring of LP-30H type Oxygen Analyzer will be shown.

Wrong selection of mounting place, and inappropriate mounting work will cause unexpected trouble, deterioration in performance of the analyzer, and also damage in the equipment later, therefore sufficient understanding of the contents of the following articles before undertaking the work is necessary.

In a special case in which the work is difficult to do according to the following articles, please discuss with us beforehand.

Before delivering the analyzer, the following items shall be determined or prepared.

- 1) Determination of the gas sampling position (mounting position of probes)
- 2) Determination of the mounting place of panel (control unit)
- 3) Determination of the plumbing and wiring routes
- 4) Purchase and mounting work of the guide pipes
- 5) Purchase of the plumbing and wiring material

4-1 Selection of the gas sampling position

Selection of the sampling point of sample gas, that is, the mounting position of the probe transmitter should be made normally to the position where the following conditions are satisfied.

- 1) Where the gas values of the sampled gas are representative values.
- 2) Where there is less change in oxygen concentration.
- 3) Where there is less change in gas pressure and temperature
- 4) Where the gas temperature is less than 600°C.
- 5) Where a uniform laminar flow of sample gas exists.
- 6) Where little mechanical vibration and shock exists. (Use by 0.1G or less)
- 7) Where maintenance work can be done easily.
- 8) Where outside air temperature is less than 80°C

4-2 Selection of the mounting position of the panel (control unit)

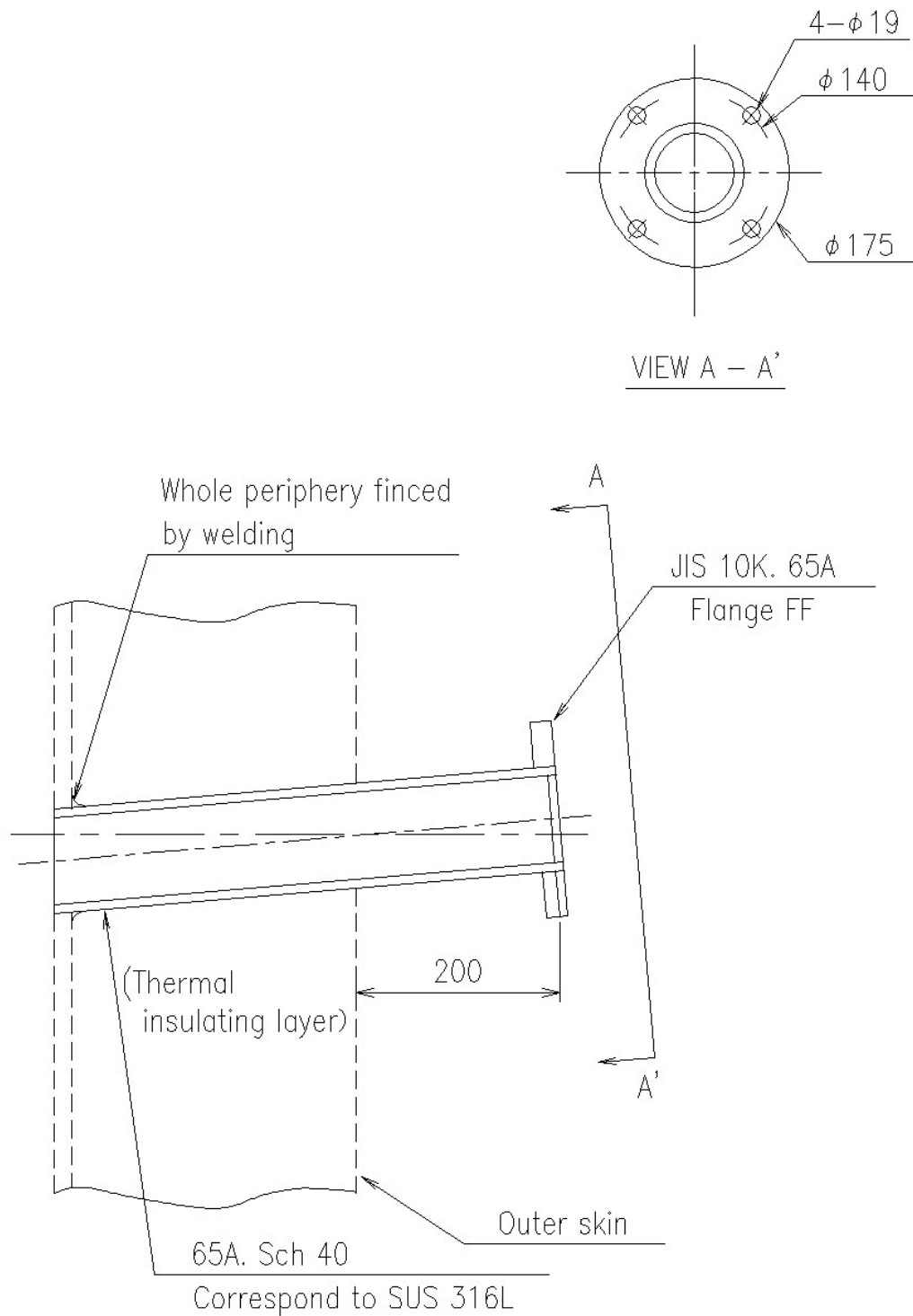
The selection of the mounting position of the panel in which the control unit

- 1) Where the outside air temperature is within the range of -5°C to less than 55°C and the temperature change during 24 hours is less than 15°C, which preferably as little change as possible.
- 2) Where little corrosive gas exists.
- 3) Where little mechanical vibration or shock exists.
- 4) Where there is not a direct stream of steam or hot air
- 5) Where there is, no exposure to the direct rays of the sun.
- 6) Where little electromagnetic induction exists.

- 7) Where the storing temperature of the standard gas cylinder is specifically less than 35°C, and there is no exposure to the direct rays of the sun and it is well ventilated.
- 8) Where the distance from the transmitter is shorter than 100m.
(A shorter distance is preferable to save the cost of plumbing and wiring work and to reduce the plumbing resistance)
- 9) Where the door of the panel can be opened and still allow enough space for maintenance.

4-3 Mounting of guide pipe

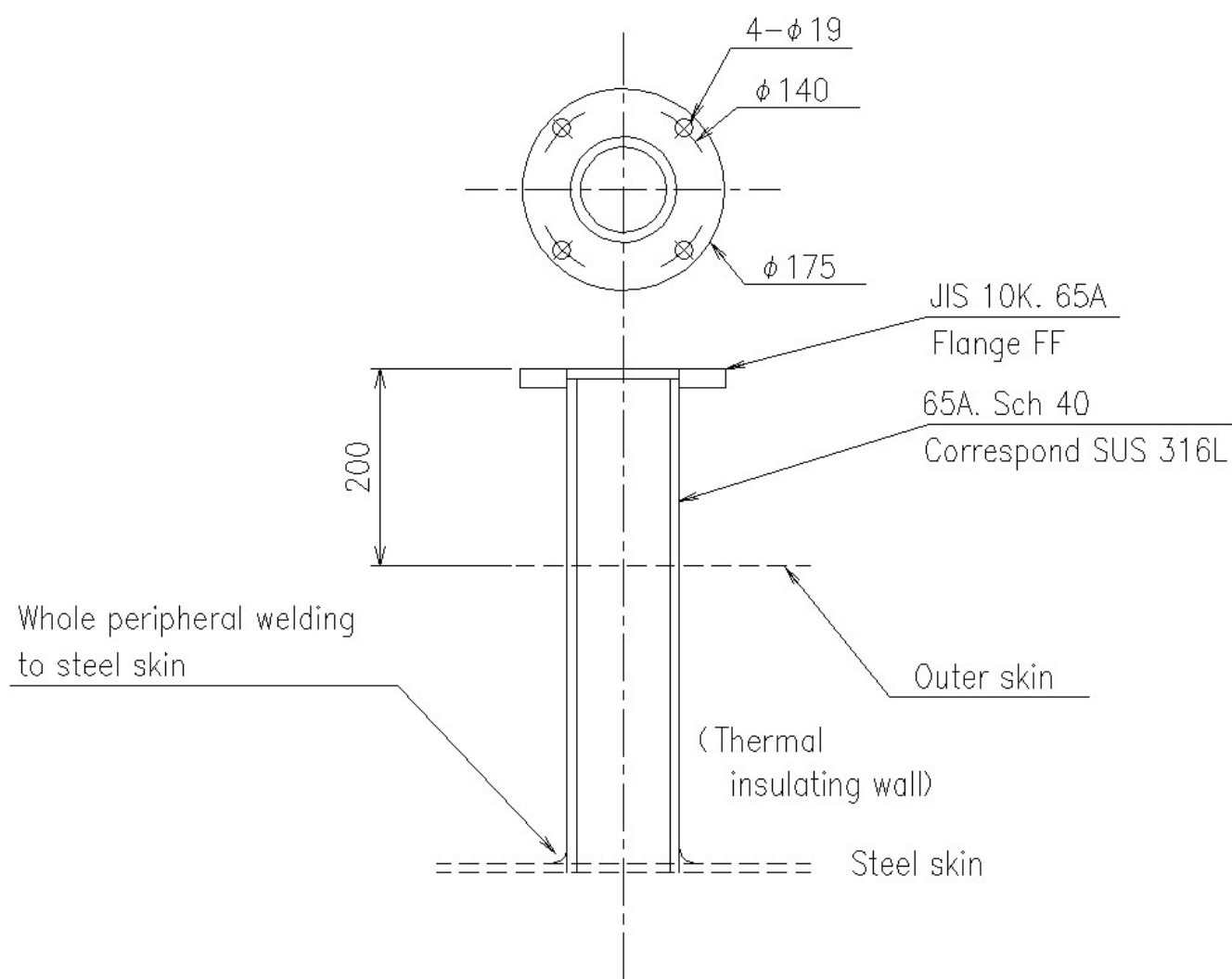
Horizontal mounting (on boiler wall, etc.)



Note) • Guide pipe and steel skin of the furnace wall shall be fixed by welding the whole periphery.

• Mounting angle of the guide pipe shall be 5~10 degrees downward to the horizontal axis.

Vertical mounting (on ceiling of boiler, etc.)



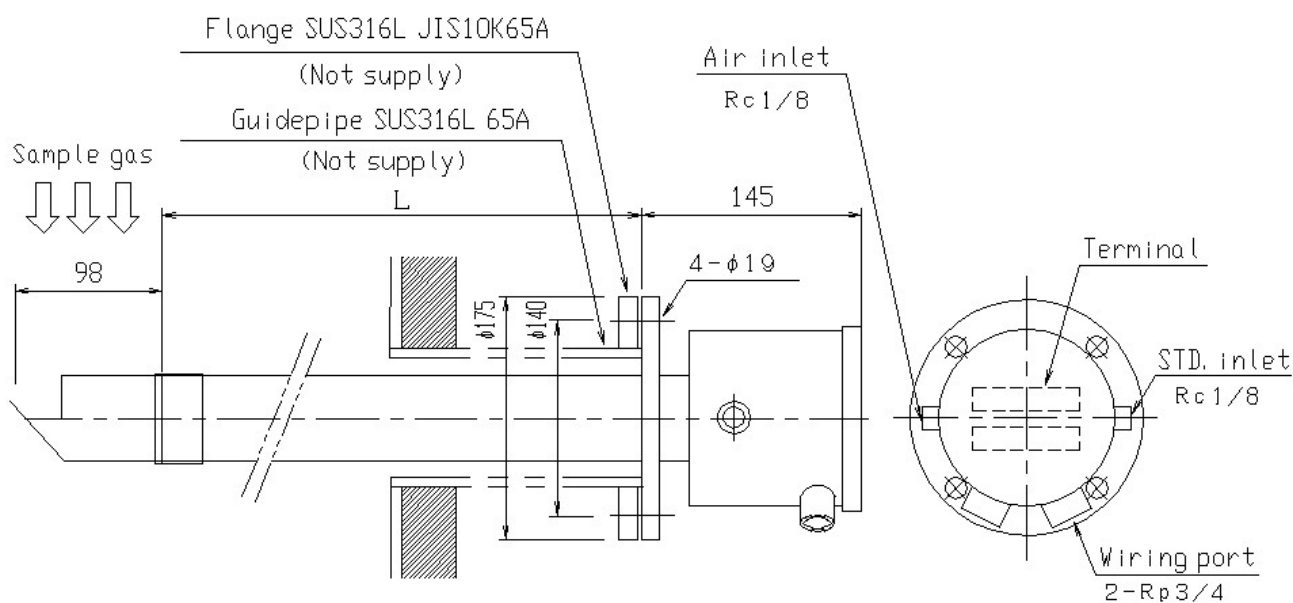
4-4 Mounting of Probe Transmitter

The probe transmitter is mounted according to the mounting drawing but the following conditions should be observed.

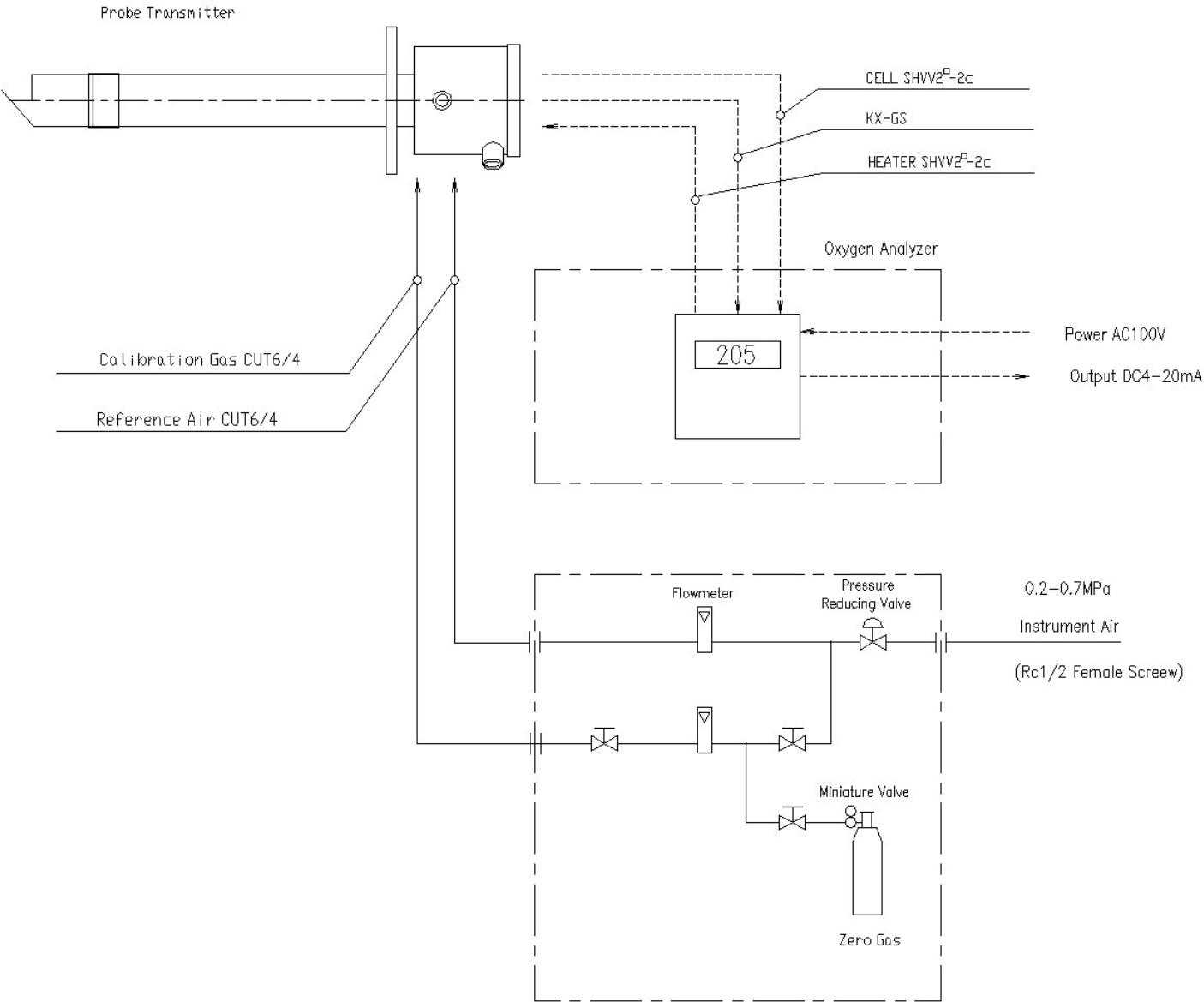
⚠ 「Caution」

- (1) Asbestos packing (accessories) should be mounted so as not to slip out.
- (2) Bolts and nuts (accessories) should be tightened uniformly so as to prevent uneven tightening.
- (3) The insertion of the probe transmitter to the guide pipe should be made slowly to avoid shock to the probe transmitter (especially to the tip of transmitter).
- (4) When the pressure in the furnace is positive in the case of inserting the probe transmitter, care should be paid concerning gas explosion.
And as gas explosion may occur from the plumbing holes of standard air and calibrating gas, blinding cocks should be inserted to the holes of plumbing.
- (5) Plumbing should be connected immediately after the completion of insertion of the probe control unit.
(or the blind stopper should be installed)

Mounting method of Probe transmitter



5. Piping and wiring



6. Inspection and Maintenance

6-1 Precautions for inspection and maintenance

「Caution」

(1) Remove / install the probe transmitter while the plant is shut down.

If you do remove / install the probe transmitter during plant operation, please pay attention to the following points.

- ① Use gloves for heat resistance, etc. because the temperature near the mounting seat is high.
 - ② If the furnace has a positive pressure, high temperature sample gas will be emitted, so be sure to keep your body away from the opening.
 - ③ Also, because dust and dirt in the sample gas spout out, wear dust-proof glasses etc. so that dust and dirt do not get into eyes.
 - ④ Also, there is a blowout of furnace gas from the reference air and calibration gas piping port. Attach a closing plug to the piping port and perform removal / installation of the probe transmitter.
- (2) When removing the filter unit and sensor unit, apply anti-seizure material (Molycoat 1000, Dow Corning) to the hexagonal socket bolt.
- (3) Apply a anti-seizure material (Molycoat 1000, Dow Corning) to the hexagonal bolt when removing / mounting the probe transmitter.
- (4) The sensor unit will be damaged if it falls. Pay careful attention to the handing when replacing the sensor unit.
- (5) At the time of removal / installation of the probe transmitter, please do the removal / installation work slowly so that shock is not applied to the probe transmitter body (especially the tip part).

6-2 Dairy inspection

- Check the indicated value or recorder chart.
- Check if the reference air flow rate is about 20/min.

6-3 Calibration of indication (about once a month)

- Carry out calibration of indication in accordance with DGO (Control Unit) Instruction Manual, and keep a record of (K) thermo-electromotive force and cell electromotive force and response time for ZERO gas and AIR. By this record, the frequency of sensor cell change can be determined.
- Measurement method of cell electromotive force and (K) thermo-electromotive force. This measurement is made at the time of inspection and calibration of DGO (Control Unit) Instruction Manual.

For measurement of the cell electromotive force and (K) thermo-electromotive force, a high input impedance instrument should be employed (e.g. digital volt meter). Either electromotive force is DC several tens mV.

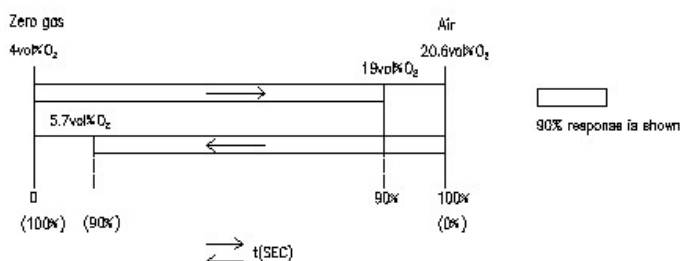
Measurement method of cell electromotive force

- ① Flow ZERO gas (SPAN gas) about 30/min in the calibration gas circuit.
- ② Measure the cell electromotive force at ZERO gas (SPAN gas) at this time between No.3(+) and No.4(-) of the receiver terminal block CELL terminal.
 - * The calculated output value of cell electromotive force is attached at the end of the instruction manual, so please refer to it.
 - * Since the cell EMF can be lowered somewhat at the beginning of calibration gas flow, wait for it to stabilize and measure it.
- Thermo-electromotive (K) EMF is measured between the thermo-electromotive (K) terminals of the receiver terminal block.
- How to measure response time

Measures the response time when switching between zero gas and air

- ① Flow zero gas into the calibration gas path approximately 3/min.
- ② Operate the value when the indication is stable and switch from zero gas to air.
(The air flow rate at this time is also about 3/min)
- ③ Measure the 90% response time to the air reading from the point when the zero gas reading starts changing at this time.
- ④ Next, measure the 90% response time from air to zero gas in the same way as in Section 3.
- ⑤ 90% response time when switching the calibration gas is about 10 seconds as a standard value regardless of the temperature difference of the calibration gas.

e. g.) 0~25vol%O₂ Range



- Standard of exchanging time of the sensor cell

The time to exchange the sensor cell is as follows.

- ① When the indication and calibration with the calibration gases
- ② When the response time becomes too much to handle in practical purpose.

For example

- Cell electromotive force When it becomes less than -30% against the calculated output Value. (For the calculated output value, refer to the table of cell electromotive force at the end of the instruction Manual)
- Response time When the calculation gas 90% response time becomes more than 30 sec at the time of the calibration gas change over (ZERO⇔SPAN gas)

6-4 Treatment at the stop of boiler and furnace

- In case of a short period (within 1 week)

Same as the normal operation , except that about 3ℓ/min. or air is flown continuously in the calibration gas circuit.

(Caution) • Do not turn off the electric power source of the O₂ analyzer.

- Please make the standard air flow about 2 / min continuously.
- Turn MEAS switch OFF.

- In case of long period (more than 1 week and less than a month)

Follow the same procedure as above (in the case of a short time) until the atmosphere in the flue becomes air atmosphere, but after that turn off the O₂ meter power supply. However, air venting to the calibration gas line and reference air should flow continuously.

Before starting the boiler / furnace operation, turn on the O₂ meter power supply a few hours ago.

- In case of stopping more than 1 month due to periodic inspection and other reasons. Same treatment as the above (in case of an extended period) but to check the probe transmitter, draw it out after waiting until the temperature in the flue goes down to normal temperature.
(In drawing the probe, sufficient care shall be paid in that treatment)

6-5 Periodic inspection (once a year, or according to circumstances)

- Inspection and cleaning of filter unit (according to circumstances)

When the movement of O₂ indication in the recorder chart becomes dull compared with the previous movement, it is probable that the filter unit will get clogged, so check the filter unit.

{ If the amount of dust in exhaust gas is about 500mg/Nm³, it will be used continuously for about one year Yes, but if the amount of dust is 500mg/Nm³ or more, the frequency of inspection (replacement) is May be short }

- Cleaning of filter

The filter can be re-used through purge of compressed air or pressurized water, depending on the adhering condition of the filter.

The following illustrate the method.

- 1) The purge pressure should be about 0.5kg/cm² in either method.
- 2) The time required to purge is about 10min.
- 3) When the purge is made through pressurized water, dry it sufficiently before re-installation.
- 4) Where dust is accumulated, remove it with a wire brush etc.

(Note) When dust has penetrated inside the filter, and a remarkable quantity of dust is found in the filter, the filter unit should be replaced .

Before mounting to the probe transmitter, sintering preventing agent (DOW CORNING C.MOLYKOTE 1000)

- Visual check of probe transmitter (once a year)

Pull out probe transmitter from the guide pipe and perform a visual inspection.

At this time, check the stage of corrosion and deformation of the probe transmitter main body SUS part.

In particular, areas located near the furnace wall proceed with corrosion, and it is often seen that soot etc. solidify.

Please remove those that are solidified such as soot. If the SUS part is cracked and there is an abnormal deformation, the probe transmitter body will be replaced.

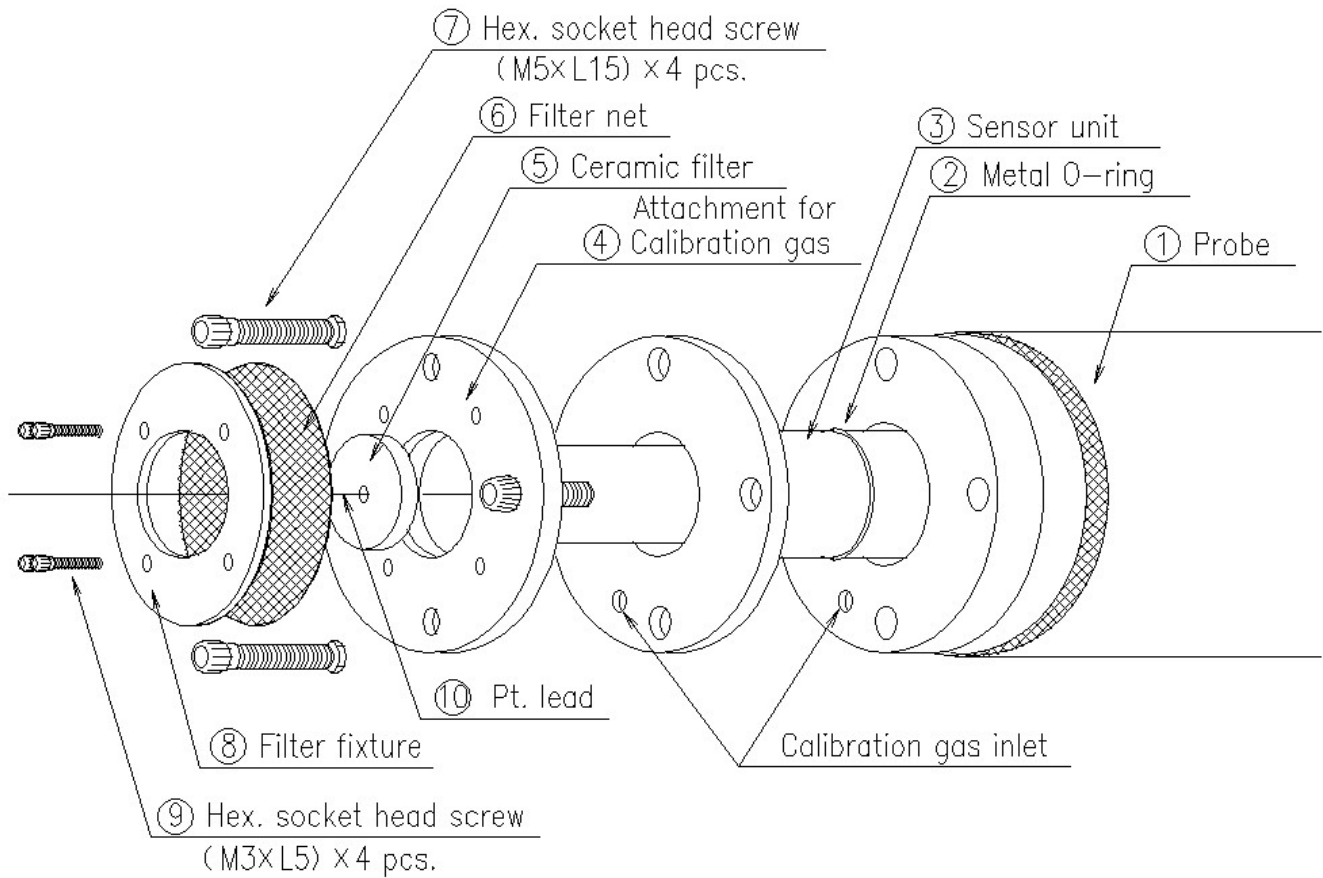
- Insulating resistance check of the wire cable (once a year)

Check whether there is any ground or insulation loss in the wire cable.

6-6 About heater unit

Please download the Safety Data Sheet (SDS) for IsoWool Blanket (artificial mineral fiber) used in the transmitter unit of this product from our homepage.

7. Exchange (removal) of filter unit



Filter unit & sensor unit external view

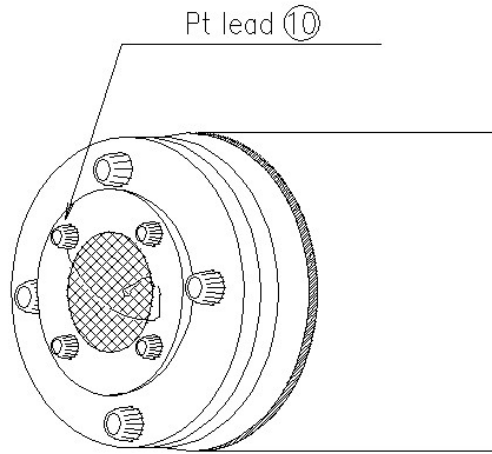
- Probe transmitter main body and filter unit are connected with screw joint.
- Since the screw joint is tightened with a hex socket head bolt, use a hex wrench to remove it.

7-1 Replacing Filter Unit

The filter unit consists of ④, ⑤, ⑥, ⑦, ⑧, ⑨ in the figure

- 1) Remove hexagon socket head bolt ⑨ with hexagon wrench (for M3)
- 2) Remove filter fixing bracket ⑧ and filter fixing net ⑥ ceramic filter ⑤ from Pt lead ⑩
- 3) Remove hexagon socket head bolt ⑦ with hexagon wrench (for M5) and remove calibration gas attachment ④
- 4) Install the replacement filter unit in the reverse order of 2) and 3)

- 5) Fix the unit with hexagon socket head bolt ⑨. At this time, wrap and fix the tip of PT lead ⑩ on one of the bolts.



Probe tip external view

7-2 Sensor Unit Replacement

- 1) Remove the filter unit according to paragraph 1.
- 2) Remove sensor unit ③ and metal O-Ring ②.
- 3) Insert the sensor unit for replacement and metal O-Ring.
- 4) Fix the filter unit in the reverse order of 1).

(Note) Anti-seizure agent (Molycoat1000, Dow Corning) on the screw part.

Please apply

Measures when the boiler is stopped

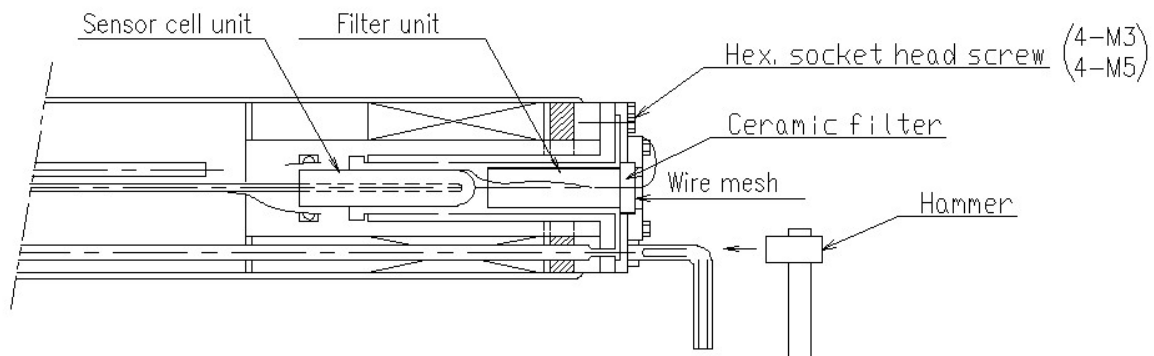
When the boiler is stopped, if you clean the inside of the boiler, or if there is a risk that a large amount of dust may fall during cleaning and inspection, product the probe transmitter according to the following procedure.

- (1) Turn off the O₂ meter power supply.
- (2) Remove the probe transmitter and terminate the wiring and piping.
- (3) Bring the probe transmitter into the instrument room etc. and perform the following maintenance.

- Clean the outer cylinder
- Remove the filter unit, wash the fittings with water and dry.
(The ceramic filter is replaced with a new one.)
- Remove the detection cell unit and perform air purge to remove dirt on the surface.
(If there is a drop in cell output or a delay in response time and it is considered that the cell is degraded, replace the detection cell unit.)
- Replace the metal O-ring with a new one and assemble it.

- (4) Attach a probe transmitter before boiler operation, and use it after instructed calibration.

Dismantling method of hex. socket head bolt



- (1) Remove dust around hex. socket head bolt with wire brush.
- (2) Spray a small amount of CRC (oil) on the bolt hole enclosure.
- (3) Insert a hexagonal rod spanner into the bolt and hit with a hammer as shown in the figure. (lightly)
- (4) Loosen the bolt.
- (5) Disassemble the bolt, so that SO₂ minutes and so on, after washing with hot water, dry, then put a small amount of anti-seizure (Molycoat1000 Dow corning) and assemble it.

C A (K) Thermocouple reference thermoelectric table (mV)

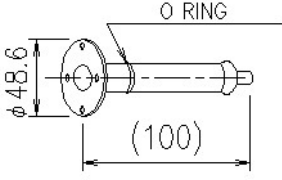
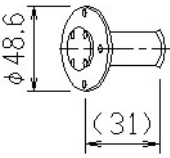
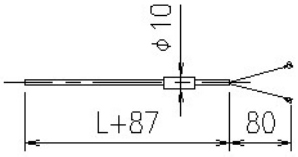
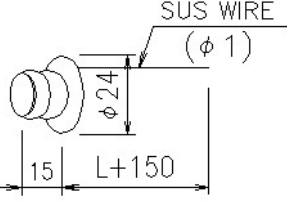
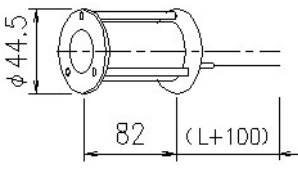
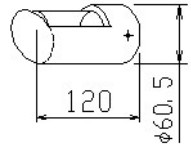
℃	0	1	2	3	4	5	6	7	8	9
600	24.91	24.95	25.00	25.04	25.08	25.12	25.17	25.21	25.25	25.30
610	25.34	25.38	25.42	25.47	25.51	25.55	25.59	25.63	25.68	25.72
620	25.76	25.80	25.85	25.89	25.93	25.97	26.02	26.06	26.10	26.15
630	26.19	26.23	26.27	26.32	26.36	26.40	26.44	26.48	26.53	26.57
640	26.61	26.65	26.70	26.74	26.78	26.82	26.87	26.91	26.95	27.00
650	27.04	27.08	27.12	27.17	27.21	27.25	27.29	27.34	27.38	27.42
660	27.46	27.50	27.54	27.58	27.62	27.66	27.71	27.75	27.79	27.83
670	27.87	27.91	27.95	27.99	28.04	28.08	28.12	28.16	28.21	28.25
680	28.29	28.33	28.38	28.42	28.46	28.50	28.55	28.59	28.63	28.68
690	28.72	28.76	28.80	28.85	28.89	28.93	28.97	29.01	29.06	29.10
700	29.14	29.18	29.22	29.27	29.31	29.35	29.39	29.43	29.48	29.52

Detection cell electromotive force table (mV)

(℃)	640	650	660	670	680
C A (K) (C J : 25℃) mV	25.61	26.04	26.46	26.87	27.29
定数K P O ₂ ^(s) (% O ₂)	45.28	45.78	46.28	46.77	47.42
0.1	104.8	105.9	107.1	108.2	109.7
0.25	86.8	87.7	88.7	89.6	90.9
0.5	73.1	73.9	74.7	75.5	76.6
1.0	59.5	60.2	60.8	61.5	62.3
1.5	51.5	52.1	52.7	53.2	54.0
2.0	45.9	46.4	46.9	47.4	48.0
2.5	41.5	41.9	42.4	42.8	43.4
3.0	37.9	38.3	38.7	39.1	39.7
3.5	34.9	35.3	35.6	36.0	36.5
4.0	32.2	32.6	33.0	33.3	33.8
4.5	29.9	30.3	30.6	30.9	31.3
5.0	27.8	28.2	28.5	28.8	29.2
6.0	24.3	24.5	24.8	25.1	25.4
7.0	21.2	21.5	21.7	21.9	22.2
8.0	18.6	18.8	19.0	19.2	19.5
9.0	16.3	16.5	16.7	16.8	17.1
10.0	14.2	14.4	14.5	14.7	14.9

$$\text{Electromotive force } E = -K \lg \frac{P O_2^{(s)}}{20.6} \quad K = 0.0496 \cdot T \text{ (°K)}$$

1. Recommended spare parts list

NO.	NAME	SKETCH	Q'ty	REMARK
1	Sensor Unit		1	KS-185443-C
2	Filter Unit		1	KS-185473
3	CA(K) Thermocouple		1	KS-185483-L
4	Cell Lead Contact		1	KS-185447-L
5	Heater Unit		1	KS-185452-LS
6	Primary Filter Unit		1	KS-185496 ※KS-163011-LD only KS-185498 ※KS-163016-LD only KS-185499 ※KS-163018-LD only

The contents of this manual are subject to change without notice for improvement.



For inquiries regarding product handling, please contact us or our distributors.
Inquiry form URL : <https://www.energys.co.jp/english/inq/all.php>
ENERGY SUPPORT CORPORATION
1, Aza Kamikobarii, Inuyama, Aichi 484-8505 Japan

