ES-10-100, ES-10-200
ES-11-100, ES-11-200
EXPANSION JOINT

PRODUCT MANUAL

Thank you very much for choosing the Yoshitake's product. To ensure the correct and safe use of the product, please read this manual before use. This manual shall be kept with care for future references. The symbols used in this manual have the following meanings.

⚠ **Warning**	This symbol indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.
⚠ **Caution**	This symbol indicates a hazardous situation that, if not avoided, may result in minor or moderate injury or may result in only property damage.

Table of Contents

YOSHITAKE

■EPDT-344a■

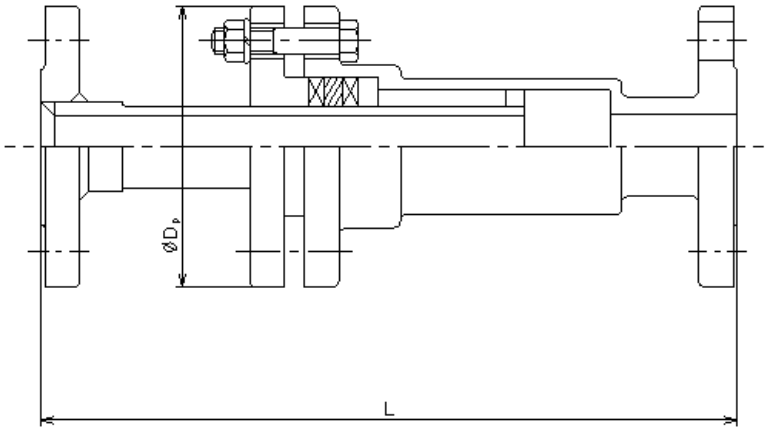
1. Specifications

Model	ES-10-100	ES-10-200	ES-11-100	ES-11-200
Application	Steam, Air, Cold and hot water, oil, Other non-dangerous fluids			
Nominal size	20A – 200A			
Max. pressure	1.0 MPa		2.0 MPa	
Max. temperature	220℃			
Max. axial extension	20mm	40mm	20mm	40mm
Max. axial compression	80mm	160mm	80mm	160mm
Connection	JIS 10K RF flanged		JIS 20K RF flanged	

Caution

Please confirm that the indications on the product correspond with the specifications of the ordered product model before use.
* If they are different, please contact us without using the product.

2. Dimensions



ES-10-100, ES-11-100 (mm)

Nominal size	Face to face dimension L			Max. axial extension δ	Do
	Set length	Max. operating length	Min. operating length		
25A	380	400	300	100	114
32A	380	400	300	100	124
40A	380	400	300	100	130
50A	380	400	300	100	142
65A	430	450	350	100	175
80A	430	450	350	100	188
100A	430	450	350	100	216
125A	500	520	420	100	242(270)
150A	500	520	420	100	290(305)
200A	500	520	420	100	340(350)

The value in ( ) is dimension of ES-11-100.

ES-10-200, ES-11-200 (mm)

Nominal size	Face to face dimension L			Max. axial extension δ	Do
	Set length	Max. operating length	Min. operating length		
25A	560	600	400	200	114(125)
32A	560	600	400	200	124(135)
40A	560	600	400	200	130(140)
50A	560	600	400	200	142(155)
65A	600	640	440	200	175(175)
80A	600	640	440	200	188(200)
100A	640	680	480	200	216(225)
125A	640	680	480	200	242(270)
150A	690	730	530	200	290(305)
200A	690	730	530	200	340(350)

The value in ( ) is dimension of ES-11-200.

3. Precautions before installation

⚠Caution

1. Provide anchors, guides, and pipe supporting device when installing the product.
   *The function of the product will not be fulfilled due to equipment breakage, piping bending, abnormal product growth, etc.
2. Please use the product within the range from the minimum length to the maximum length.
   *If the product is not within the specified range, the product will not function due to abnormal expansion and contraction of the product.
3. Install the product correctly so that the inlet and outlet are correct. There is a display on the body showing the direction of fluid flow.
   *Installation in the wrong direction may not only affect the original performance, but may also lead to an accident.
4. Install so that there is no misalignment in both horizontal and vertical piping.
   *Misalignment may lead to noise or damage from the inner cylinder, which may not only affect the original performance, but may also lead to an accident. In particular, vertical piping is prone to misalignment, so provide anchors, guides, and pipe supporting device to prevent misalignment.

(1) The expansion/contraction of piping depends significantly on temperature. To ensure satisfactory results, use the expansion joints within the maximum expansion/contraction length.
(2) Secure anchors and guides are required to make full use of the function of the joint connected to piping.
(3) The piping system shall be equipped with main anchors at the following positions. (Refer to the reference piping example on page 5.)

[1] End part of straight piping with shut-off plate.
[2] Portion of bent pipe where the flow direction changes.
[3] The portion between two expansion joints where the piping systems are changed by reducer.
[4] The portion of piping between two expansion joints where a valve is installed.
[5] The entrance of a side branch containing an unrestrained expansion joint into the main piping.

(4) Using a sufficient number of anchors and guides is important not only for guiding the piping to absorb its expansion or contraction with the joints, but also for preventing pipe bending or buckling or joint damage. Check where anchors and guides should be installed, and mount them according to the correct procedure.

4. Installing anchors, guides and pipe supporting device

4.1 Load acting on the main anchor of straight pipe

Mount a main anchor at both ends of the piping, each branch point, and the location where a reducer or valve is installed. These main anchors need to be strong enough to withstand the force required to stretch or contract the sleeve plus the internal pressure thrust resulting from the effect of the internal fluid pressure.

$$F_{MA} = F_S + F_M + F_G$$

$$= a \times P \times 100 + F_M + F_G \quad \cdots\cdots\cdots\cdots (A)$$

F_{MA}	:	Load acting on the main anchor of straight pipe	{N}
F_S	:	Pressure thrust of expansion joint	{N}
F_M	:	Frictional force of expansion joint	{N}
F_G	:	Frictional force of guide elements	{N}
a	:	Effective area of expansion joint	{cm^2}
P	:	Pressure	{MPa}

Table 1 Load acting on the main anchor of straight pipe

Nominal size			25A	32A	40A	50A	65A	80A	100A	125A	150A	200A
Effective area of expansion joint a {cm^2}			9.1	13.9	18.1	28.3	45.6	62.2	102.0	151.7	213.7	366.0
pressure thrust of expansion joint Fs {N}	Internal pressure	0.2MPa	182	278	362	566	906	1244	2040	3034	4174	7320
		0.4MPa	364	556	724	1132	1812	2488	4080	6068	8548	14640
		0.6MPa	546	834	1086	1698	2718	3732	6120	9102	12822	21960
		0.8MPa	728	1112	1448	2264	3624	4976	8160	12136	17096	29280
		1.0MPa	910	1390	1810	2830	4530	6220	10200	15170	21370	36600
Frictional force of expansion joint F_M {N}			2300	2500	3300	4000	5100	6200	7520	9400	11300	14800

4.2 Load acting on the main anchor at intermediate straight pipe of expansion joints with different diameters

$$F_{MA}=(F_{S1}+F_{M1}+F_{G1}) \text{ [large-diameter side]} - (F_{S2}+F_{M2}+F_{G2}) \text{ [small-diameter side]}$$

$$= (a_1-a_2)P \times 100 + (F_{M1}-F_{M2}) + (F_{G1}-F_{G2}) \quad \cdots\cdots\cdots (B)$$

4.3 Load acting on the main anchor of curved pipe

Mount a main anchor at each point where the piping changes its direction.
The thrust works in two different directions and becomes a resultant vector of two thrusts.

$$F_{MB} = (F_{MA1} + F_{MA2}) \sin\frac{\alpha}{2} \cdots\cdots\cdots (C)$$

F_{MB}	:	Load acting on the main anchor of curved pipe	{N}
α	:	Angle between the centerlines of the curved pipe and straight pipe	{°}
F_{MA1}	:	Load acting on the upstream main anchor of curved pipe	{N}
F_{MA2}	:	Load acting on the downstream main anchor of curved pipe	{N}

4.4 Load acting on intermediate anchors

An intermediate anchor is required when two or more joints are mounted between main anchors. Intermediate anchors should be strong enough to withstand the force required to expand or contract the sleeve, the frictional force of pipe guides, and other loads.

$$F_{IA} = (F_{M1}+F_{G1}) \text{ [upstream side]} - (F_{M2}+F_{G2}) \text{ [downstream side]} \cdots\cdots\cdots\cdots (D)$$

On the up and downstream sides of an intermediate anchor, when the pipes connected are equal in diameter and numbers of guide elements on both sides are the same F_{M2} and F_{G2} are equal to F_{M1} and F_{G1} respectively, but opposite in sign, and the load acting on the intermediate anchor is zero, i.e. $F_{IA} = 0$. However, in some case, the pipe line is heated gradually from one side, and as a result, one side of the pipe expands more than the other side.
Therefore, when $F_{IA} = 0$, it is necessary to add the load acting from either the upstream side or the downstream side to the load considered in general piping design.

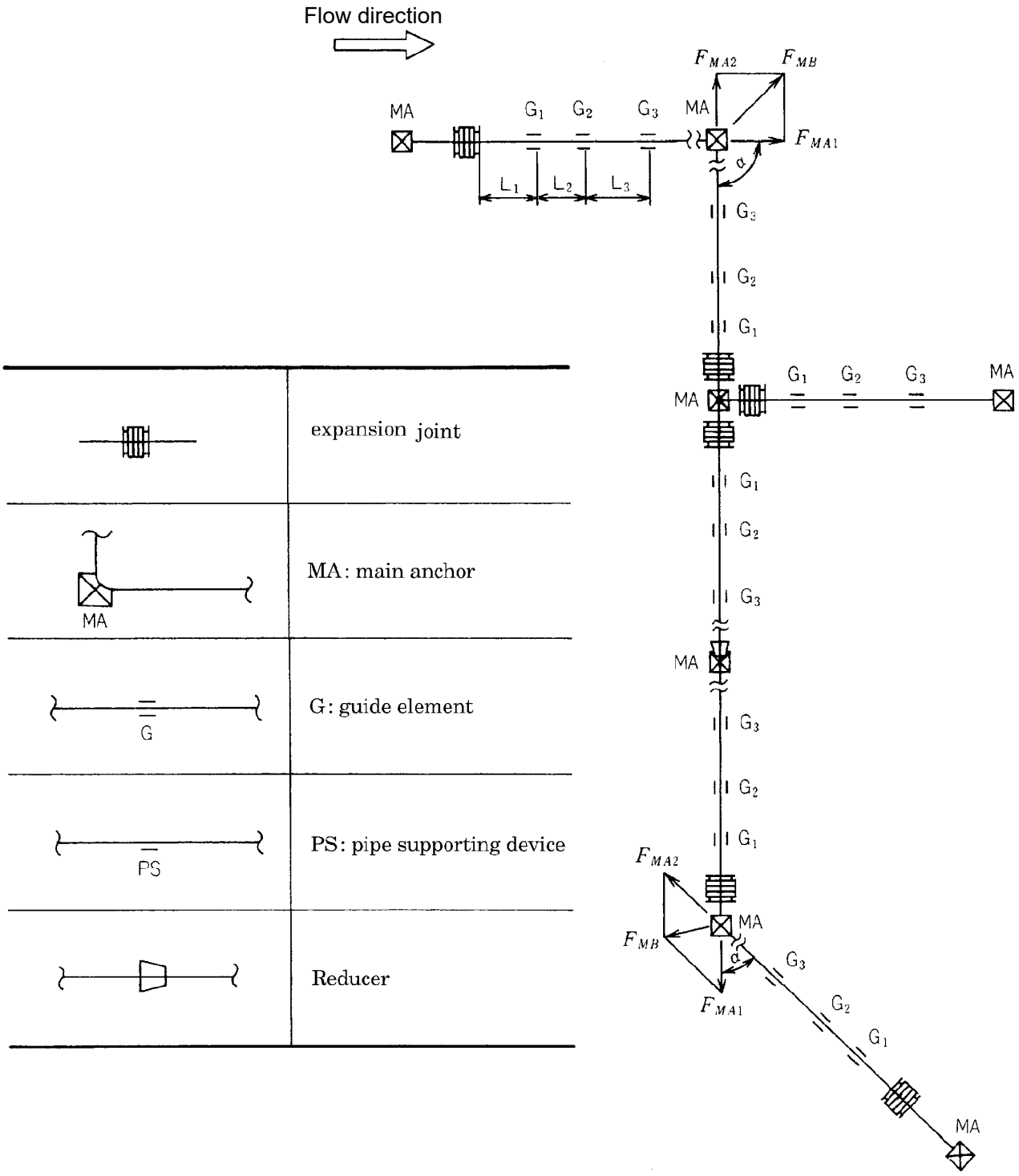
$$F_{IA} = F_{M1} + F_{G1} \cdots\cdots\cdots\cdots (E)$$

F_{IA}	:	Load acting on intermediate anchors	{N}

4.5 Caution on vertical piping

In case of vertical piping, the piping mass and fluid mass are further loaded, so when calculating the anchor strength, add them together. Make sure to install the product with no misalignment of the piping. Misalignment may lead to noise or damage from the sleeve.

4.6 Piping example



5. Installation interval of guide elements for axial movements

In a piping using expansion joints for absorbing axial movements, guide elements (G) shall be installed to align the pipe joint and pipe and transmit the force necessary for axial movement smoothly to the anchor.

As given in figure 1, the installation intervals of respective guide elements such as the interval (L_1) from the expansion joints to No.1 guide element, the interval (L_2) to No.2 guide element and the interval (L_3) to the intermediate guide elements shall not exceed the interval values obtained from formula (F) to (H) shown in the following [1] to [3].

Keep the misalignment of 125A and smaller piping within ± 2 mm and that of 150A and larger piping within ±3 mm. Adjust the parallelism of piping to ±0.5˚ or less.

As to the pipings using carbon steel pipes for pressure pipings, when the expansion joints only for axial movement are used, the intervals of intermediate guide elements may be obtained from figure 2 instead of the calculation by formula (H).

[1] $L_1 \leqq 4D$ ·····(F)

[2] $L_2 \leqq 14D$ ·····(G)

[3] $$L_3 \leq 0.00157 \left(\frac{E_p I_p}{F_S + F_M} \right)^{0.5}$$ ····(H)

D	:	Outside diameter of pipe	{mm}
L_1	:	Interval between No.1 guide element and expansion joint	{mm}
L_2	:	Interval between No.1 and No2 guide element	{mm}
L_3	:	Interval between the intermediate guide elements	{mm}
E_p	:	Young's modulus of pipe material at design temperature	{N/mm^2}
I_p	:	Geometrical moment of inertia of pipe cross section	{mm^4}

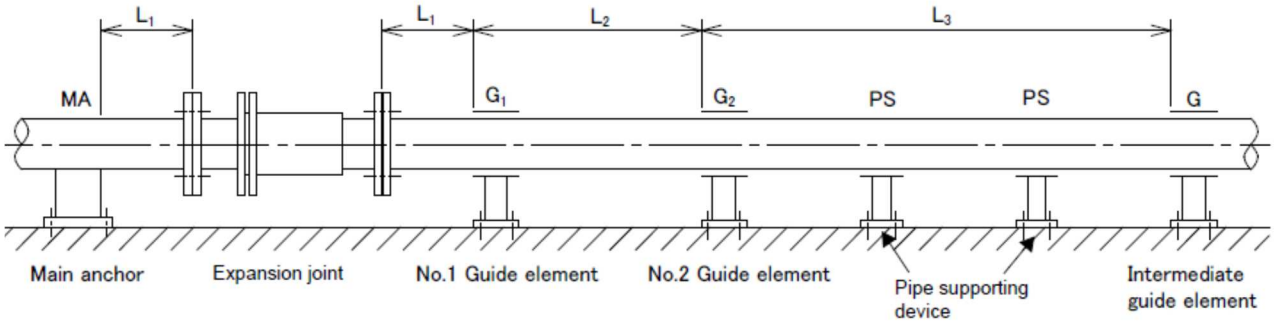


Fig.1 Mounting intervals of guide element

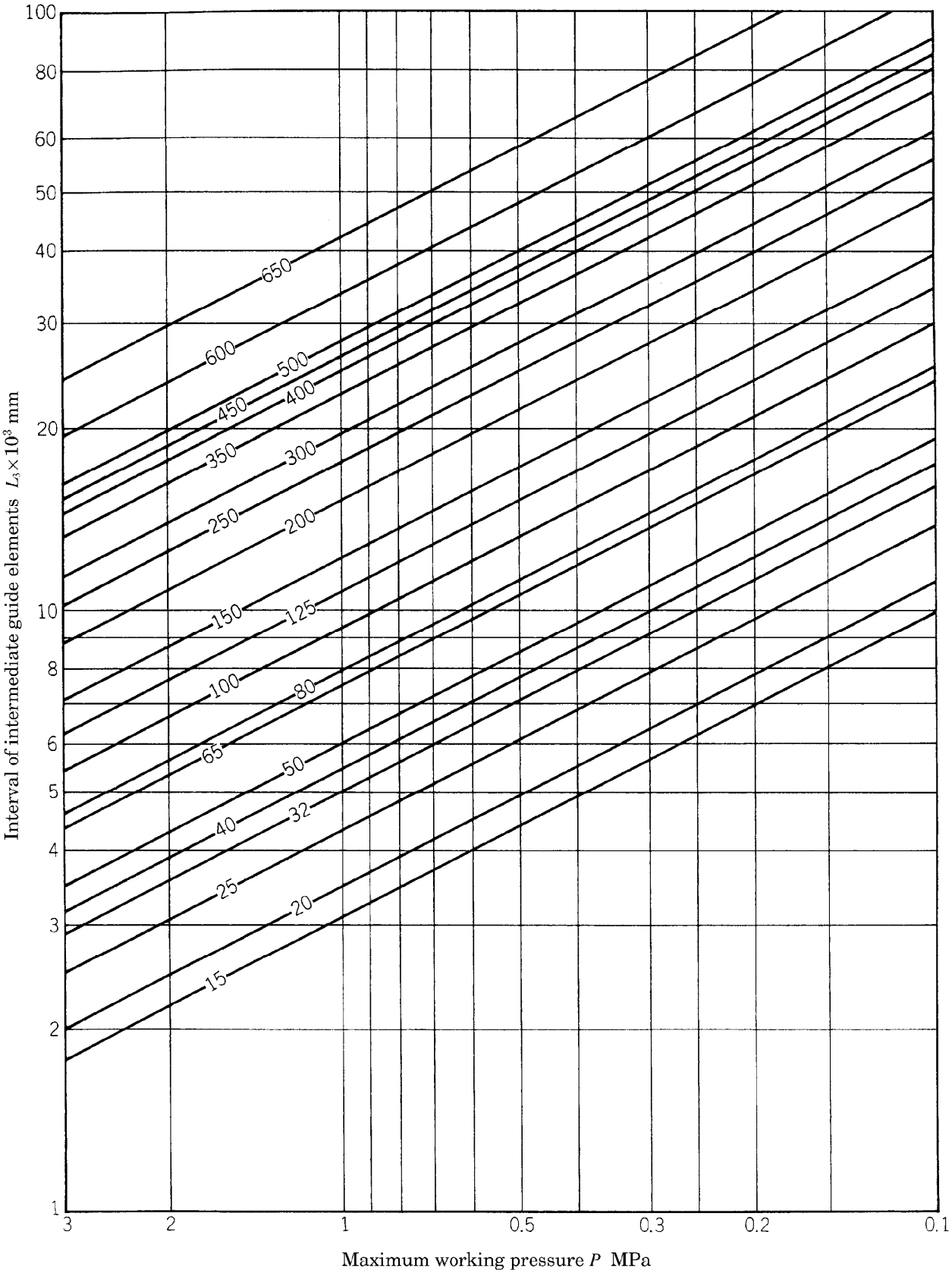


Fig.2 Maximum interval of intermediate guide elements according to the nominal pipe diameters

6.Pipe supporting device

Piping shall be provided with anchors, guide elements, and pipe supporting devices (U-bolts, roller supports, spring hangers, etc.) to support the own mass of the piping and the fluid included therein.

7.Installation of expansion joints

7.1 Number of expansion joints installed

The thermal expansion or contraction length of piping shall be calculated from the following [1], according to the temperature conditions of fluid, air temperature of the place where the piping is to be installed, piping material and piping length, and then the number of expansion joints to be installed shall be calculated from [2].

[1] Thermal expansion or contraction length of piping ($\Delta\ell$).

The thermal expansion or contraction length of piping shall be obtained according to formula (I).

Refer to Table 2 below for the linear expansion coefficient (β) of piping.

$$\Delta\ell = \beta\,(T - t_1)\,\ell \quad \cdots\cdots\cdots\cdots (I)$$

$\Delta\ell$	:	Thermal expansion or contraction in pipe length	{mm}
β	:	Liner expansion coefficient of piping	{℃$^{-1}$}
T	:	Maximum working temperature (design temperature) of pipe	{℃}
t_1	:	Minimum working temperature (design temperature) of pipe	{℃}
ℓ	:	Length of piping	{mm}

Table 2 Liner expansion coefficient of piping ($\times 10^{-6}$/℃) (Reference temperature 20℃)

Temperature (℃)	Carbon steel, Carbon molybdenum steel Low chrome steel (3CrMo)	Austenitic stainless steel (18Cr8Ni)
-40	10.48	16.05
-20	10.61	16.15
0	10.75	16.27
20	10.92	16.39
40	11.05	16.50
60	11.21	16.61
80	11.36	16.73
100	11.53	16.84
120	11.67	16.93
140	11.81	17.01
160	11.98	17.09
180	12.10	17.17
200	12.24	17.25
220	12.38	17.32

[2] The numbers of expansion joints installed (n_e)

The number of expansion joints (n_e) shall be obtained according to formula (J).
Maximum axial movement of expansion joint (δ) for ES-10-100 and ES-11-100: δ = 100.
Maximum axial movement of expansion joint (δ) for ES-10-200 and ES-11-200: δ = 200.
Unless, the maximum axial compression of ES-10-100 and ES-11-100 is 80mm, and the maximum axial compression of ES-10-200 and ES-11-200 is 160mm.

$$n_e = \Delta\ell / \delta \cdots\cdots\cdots\cdots (J)$$

n_e	:	The number of expansion joints	
$\Delta\ell$	:	Thermal expansion or contraction in pipe length	{mm}
δ	:	maximum axial movement of expansion joint	{mm}

7.2 Adjustment of attaching face-to-face dimension

Since the thermal expansion of piping is absorbed by the contraction of the expansion joint, and the thermal contraction is absorbed by the extension of the expansion joint, prior to attaching the expansion joint, the attaching face-to-face length shall be obtained by formula (K), considering the preset amount from the site air temperature, working temperature range and the maximum axial movement.

$$L_S = L_e - \delta \frac{t_2 - t_1}{T - t_1} \cdots\cdots\cdots (K)$$

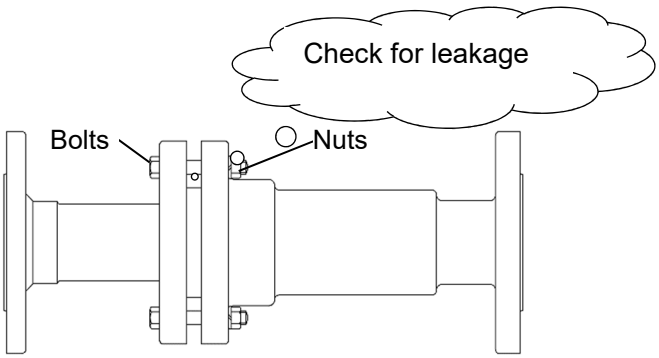
L_S	:	Attaching face-to-face length of expansion joint	{mm}
L_e	:	Maximum face-to-face length of expansion joint	{mm}
δ	:	maximum axial movement of expansion joint	{mm}
t_1	:	Minimum working temperature (design temperature) of pipe	{℃}
t_2	:	Air temperature at installation of the expansion joint	{℃}

*If require to change the face-to-face dimension, please let us know upon order. The product will be ship after adjusting at factory.

8. Operating Procedure

⚠ Warning

1. Be sure to confirm that there is no leakage after ventilation.
   * If there is a leak, retighten the bolts and nuts. (See the figure below)
   (Tightening pressure may drop due to the packing properties during product transportation and installation.)



2. Do not cause the occurrence of water hammer.
   * Otherwise, the expansion joint may be damaged, causing external leakage.
3. When using high temperature fluid, do not touch the product with bare hands.
   * Failure to follow this notice may result in burns.

Warranty Information

1. Limited warranty

   This product has been manufactured using highly-advanced techniques and subjected to strict quality control. Please be sure to use the product in accordance with instructions on the manual and the label attached to it.

   Yoshitake warrants the product to be free from any defects in material and workmanship under normal usage for a period of one year from the date of receipt by the original user, but no longer than 24 months from the date of shipment from Yoshitake's factory.

2. Parts supply after product discontinuation

   This product may be subject to discontinuation or change for improvement without any prior notice. After the discontinuation of the product, Yoshitake supplies the repair parts for 5 years otherwise individually agreed.

3. This warranty does not cover the damage due to any of below:
   (1) Valve seat leakage or malfunction caused by foreign substances inside piping.
   (2) Improper handling or misuse.
   (3) Improper supply conditions such as abnormal water pressure/quality.
   (4) Water scale or freezing.
   (5) Trouble with power/air supply.
   (6) Any alteration made by other than Yoshitake.
   (7) Use under severe conditions deviating from the design specifications
   (e.g. in case of corrosion due to outdoor use).
   (8) Fire, flood, earthquake, thunder and other natural disasters.
   (9) Consumable parts such as O-ring, gasket, diaphragm and etc.

   Yoshitake is not liable for any damage or loss caused by malfunction or defect of the product.

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