GRADIOR POWER

Assembly manual for pipe supports

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Maintenance and operational reliability:

Pipe supports assemblies are designed and supplied for normal operational conditions, or in specific defined contract conditions as a maintenance-free.

Between calculated and installation / work load can occur difference even 15% which is primarily caused by pipe wall thickness tolerations and other influences not involved in piping computational model. Considering that, we recommend especially for category III pipes to perform installation supervision and eventual adjustment, and moreover periodical revisions of pipe support condition.

For installation supervisions and periodical revisions we have elaborated system of implementation and assessment, which complies with international laws and recommendations. This revisions and inspections can be ordered in addition to equipment delivery. The range of inspection duration is in range of 2-3 workdays at the operation site.

Periodical revisions plan is described in special company standard.

Design:

Elements and pipe supports assemblies are designed from view of functionality, load capacity and permissible load in accordance with EN 13480-3 chapter 13 and furthermore German guidelines VGB R 510-L-Teil 1. Upon request we also supply pipe supports designed and manufactured according to ASME B31.1 and MSS-SP58 standards.

Maximum allowable loads for individual elements are stated in pipe support catalogue. Tabulated values are declared for normal operational conditions, i.e. static load and temperature 80°C and standard carbon steel as a default material.

Selecting assemblies of pipe hangers, supports and guides from catalogue

For pipe supports it is favorable to use type support assemblies, assembled from catalogue elements:

- standard assemblies are reliable and well-proven
- standard support elements are described in catalogue
- assemblies comply with all requirements of standards EN 13 480-3, VGB R 510-L-Teil 1 and ASME B31.1 a MSS-SP58.

You can choose pipe support assembly only by its design and function which you demand for your construction. We will select right components and materials for you.

Type support assemblies are stated in type illustrations in section B of the catalogue.

All necessary data for parameter specification you can find in our data list. That is also available in MS Excel format for download form our web pages.

We recommend use of our data lists as they are structured for explicit description and also supplemented with annotations for users. Unified form of specifications is always most comprehensible for submitter, just like for supplier.

Connection of the hanger rods to the structure

To connect the hanger rods to the steel structure, there are more possible options consisting of type elements. The type of connection is necessary to be specified in the order datasheet. All the types fulfill the condition of a possible angle deviation of the rod up to 4° from the vertical axis. Connections of the specific load group are dimensioned for the highest load stated in the chart on page B-1.

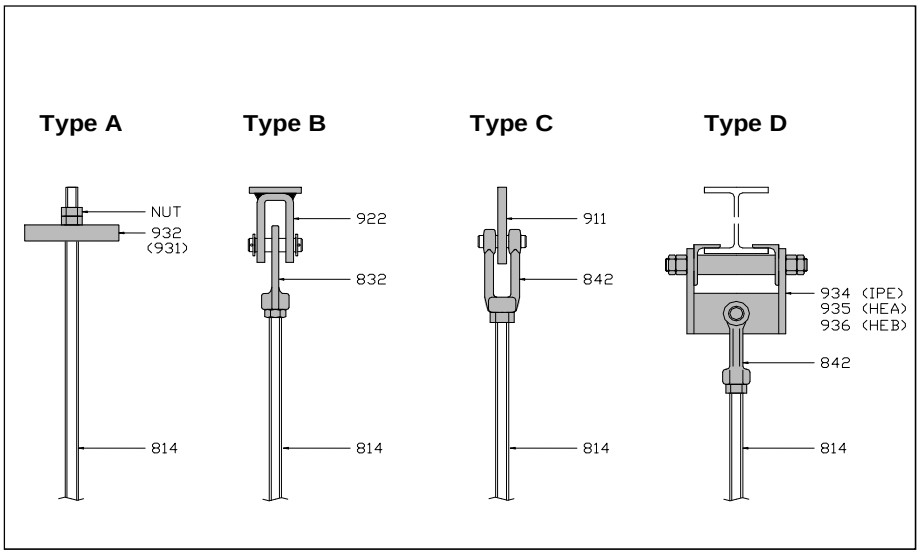
The connection art depends on the type of the auxiliary steel structure. In terms of the load transmission, all the types are equivalent.
For higher rod angle deviations - more than 4° and for hanger assemblies of the RH2 and RH4 types, it shall be used a connection type B only.

Type A - spherical plate for setting onto U-channel beams.

Type B - weld on clevis for higher horizontal movements of piping.

Type C - weld on eye for standard use.

Type D - connection clamp to the profile flange. Easy assembly without necessity to weld, e.g. for zinc-coated constructions.



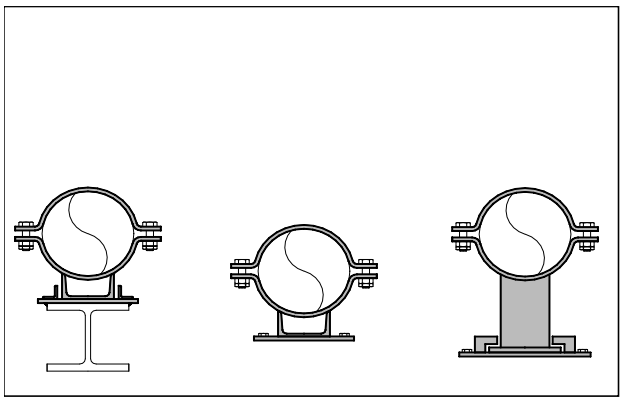
Setting of supports onto construction / floor

To prevent the steel or supportive structures or floors from abrasion, we suggest to set the sliding supports at steel plates. The plates can be equipped with parts for guiding the supports in all directions at random clearance, or with the PTFE sliding plate to decrease friction between support and the base plate.
The supports of 611, 614, 661, 664 types can be delivered together with a polyamide plate to prevent coat abrasion.

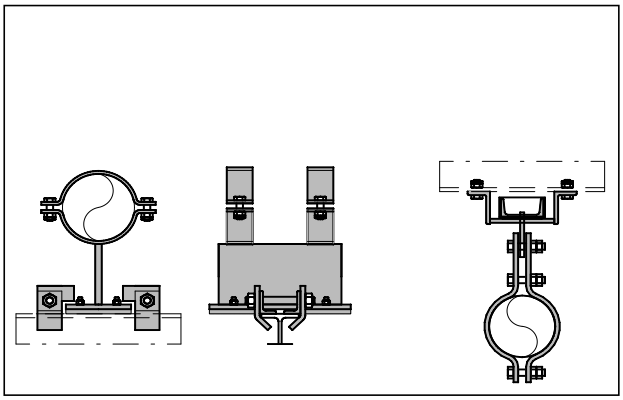
The plates of the GP and SP types are delivered as options which can be welded or bolted to the structure, optionally connected to the floor via concrete anchors.
The plates for the supports of the SS type correspond in dimensions to the base dimensions of the standard types of supports (type group 61x).

For GS assemblies, it is necessary to use auxiliary bespoke structures.

Examples of support plate options:



Connection of supports to structure :



Installation of spring hangers and supports shall be performed according to support manufacturer assembly drawing for each hanger. Spring hangers/supports are supplied blocked and preset to the required load. Before installation, the rods shall be cut to the required length, measured for each support at site. Positive length allowace for rods set in turnbuckle shall be at least 0,5*nominal spring travel. After subsequent load adjustment the mimimum rod overlap must be at least 0,5*M (see fig.). In case of spring hangers 1x2 the top rod must be screwed into top plate to depth M and fastened down by safety nut.

Deblocking and load adjustment

Deblocking of spring support shall be executed after pipe cleaning, pressure test and insulating. Remove safety tape fastening the clusters inserted into spring hanger. At right load setting, when spring and pipe loads are equal, the blocking clusters may be put slightly out of hanger.

The bottom edge of the inner plate will remain in position at the level of the blue arrow.

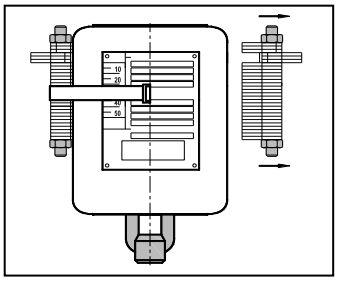
If not, the bottom edge of the inner plate is not on the blue arrow when unblocking (difference between calculated and actual load), the spring load readjusted turning span nuts or turnbuckle, to achieve the level of the bottom edge of the inner plate at the blue arrow.

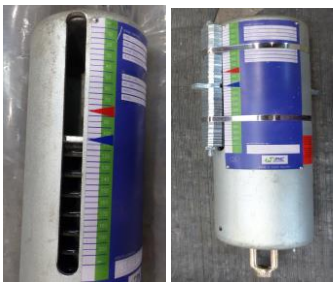
The setting of the spring type SH7 to the blue arrow is reversed. When setting in cold condition, the blue arrow must be to the TOP edge of the inner plate.

After deblocking, a cluster shall be fasten to hanger rod or support casing, using a steel wire. It may be used for repetitionary pressure test.

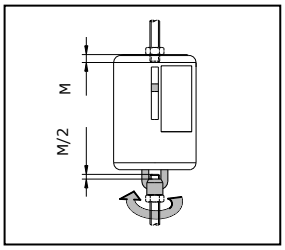
The operating load is indicated by the red arrow.

The position of the inner spring plate between the blue and red arrows shows the calculated values of the spring displacement between the cold and operating conditions.

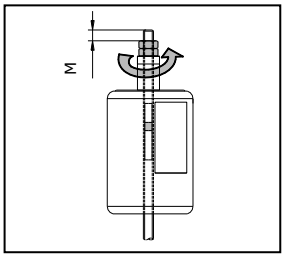




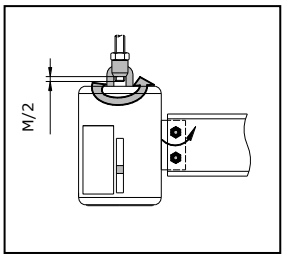
Hangers Type 1x2 are connected to rods screwed in upper spring plate and turnbuckle on the lower connection side. For load adjustment turnbuckle to be used.



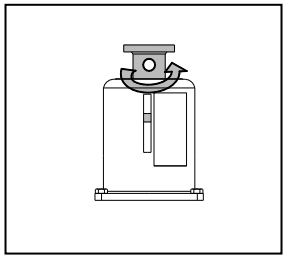
Hangers Type 1x3 to be set on double beams and connected to rod inserted through the hanger. For load adjustment use rod nuts set on upper spring body. Hanger shall be attached to structure from horizontal movements.



Hangers Type 1x4 to be connected to pipe support trapeze beams type **341** via bolt connection. Bolt tightening torques acc. to standards for steel structures. Hanger rod connected to the turnbuckle. For load adjustment use turnbuckle.



Spring support Types 1x7 are set bellow the pipe support. A proper position adjustment shall be checked. For load adjustment turn the threaded support tube. Support shall be attached to structure from horizontal movements.



Beams and Trapezes

They are used as a rod connecting elements for double rod hanger assemblies.

Beams are connected on rod hangers by clevis with pin (for type 334) or directly by threaded rod (type 311 and 321).

For hanger assemblies RH4-6, SH11-19 and similar it is possible to use modified beam type 334.

Beams type 334 are welded, other types are designed for bolt connection.

Overview

Type	Application
311	For direct hanging of pipes DN10 - DN32 through U bolts (tmax=80°C)
321	For hanging of pipes up to DN80 and temperatures up to 150°C (without horiz. travels)
334	For hanger assemblies RH and SH according to assemblies overview
341	For conecting of spring hangers 1x4 and assembly SH acc. to assemblies overview

Application:
Beams of types 300 are designated for pipe support through sliding or weld-on support. Placing of shortened supports of types 612A, 615 on beams is also possible. All supports must be welded to beams due to position securing. In case of expansion or other pipe travel, the hanger rod deviation must occur, not pipe-on-beam drift. The weldment of shoe to beam shall be made at site.

Piping shall be placed as close to beam center as possible to prevent uneven rod loading. We recommend to keep the support position in area of +/-0,2 * E from beam center, where E is hanger rods spacing. For hanger assemblies RH4-6 and SH11-19 beam shall be modified by welding a spherical plate type 932. Plate must be placed accurately in the beam centre. The weldment of shoe to beam shall be made at site.

Installation:
Firstly, the beams shall be connected to hanging rods, assembly plan according to connection elements 800. Beam must be always in horizontal position regarding its longitudinal axis. Allowed deviation is 1%. Beams type 334 can be used for sloped piping up to 45° pipe slope. Support shoes must be welded during installation according to assembly drawing of hanger. After welding the repair coat must be applied. For humid conditions, the shoe and beam weld must be enclosed. Piping must be placed so that rod hangers do not go through insulation.

Surface treatment:
As default, the beams are delivered with top coating.
Beams for small pipe dimensions are galvanized.

Rigid struts
are designed to restrain pipe movements and retain tensile / compressive forces in strut axis.

Use for retain dynamic and static forces. Their installation also prevents emergence of dynamic forces and piping vibrations.

Can be installed in horizontal or vertical direction.

Rigid struts type 411 can be also installed in pairs, in assemblies similar to double rod hangers type RH2 and RH3. We design such configurations upon request.

Overview

Type	Application
411	Rigid strut with ball rod-ends for transfer of tensile / compressive forces
440	Weld-on clevis for weld attachement of strut to steel structure
420	Dynamic clamp for strut attachement to horizontal piping DN>150
423	Light clamp for strut attachement to horizontal piping DN<150

Design

Rigid struts type 411 are length adjustable by right-left bolts. Ball rod-end allows for ±6° of angular motion. Struts are designed for static and cyclic stress, values stated in table are for 10000 cycles.

Clamps for pipe connection are designed for sustained static and occasional forces, in area of higher temperatures and for material groups 3 and 4 it is necessary to multiply standard tabeled load for material group 1 by corrective factor given in table.

Rigid struts assemblies RS are guaranteed to keep clearance of pipe movement restraining direction under 0,5mm for pins dÒ33mm or 0,015*d for pins d>33mm.

Installation

Installation of pipe clamps **type 420** must ensure that upper clamp nut does not "strangle" pipe and that suspension of clamp nuts washers is allowed. **Nuts** shall be tightened only to seating and clearance adjustment, and **must not be preloaded!**

Installation of clamps type 423 is the same as of clamps type 733. Nuts are manually tigtened to seating on clamps and position determining. Afterwards they are tightened by spanner by 90°.

Struts of type 411 must be installed in position according to assembly drawing that allows 6° misalignment. Adjustment bolts should be positioned approximately in middle distance of thread length. Strut shortening / lengthening is performed by turning of strut pipe. After adjustment it is necessary to examine the screw depth through holes in pipe and secure bolts by safety nut.

Clevis with pin type 440 is jointed to steel structure with fillet welds. Weld size is stated on assembly drawing of type RS. Pin must be secured by cotter pin after installation.

Load

Allowable clamp load **Fmax** given in table relates to mat. group 1 and temperature 80°C. For different temperatures and materials it is necessary to multiply standard tabeled load by correct. factor given in table.

Correction loading factor at operational temperature - k (-)														
Temp. (°C) / Material	20-80	100	200	250	300	350	400	450	480	500	520	540	560	580
S235	1	0,89	0,81	0,73	0,60	0,51								
16Mo3					0,87	0,79	0,71	0,66	0,60	0,46				
10CrMo910								0,87	0,83	0,66	0,50	0,37	0,27	0,2

Weld-on shoes are designed for use as an individual sliding supports or guidance for small horizontal load.

Application of weld-on shoes is convenient especially for operations in corrosive enviroments, for outdoor or subterranean piping. Use of clamp supports of type range 600 in such cases leads to moisture condensation and water retention in interstice between clamp and pipe, with consequential corrosive damage of pipe wall. Pipe shoes of type range 500 are welded to pipe wall by enclosed weld and after surface treatment the joint remains protected from corrosive damage.

Overview

Type	Application
511	**SS** - sliding support, equal height design
512	**SS** - sliding support, equal height design
564	Telescopic stanchion - sliding / fixed
566	Telescopic dummy legs - sliding / fixed

Limitations

Use of weld-on shoes and stanchions is limited by danger of crack initiation in shoe/pipe weld joint, which may occur on piping with high operational temperatures. Different temperatures of pipe wall surface and shoe causes high load gradients in weld area. Thereby use of weld-on shoes is limited for temperatures up to 150°C and, considering another hazard effects, for low-pressure piping up to PN40. Weld joint can not be heat treated.

Installation

Position of weld-on shoe can not be adjusted after installation, therefore it is necessary to scale carefully the shoe position before welding, especially with regard to assumed pipe movements in operational condition. Shoes are welded by fillet welds according to assembly drawing. Welding method and plan is selected by installing organisation according to relevant rules for piping installation - parts integrally connected to pipe wall. Welds must be performed in such way that the residual tension in weld area is minimalized.

Surface treatment

Weld-on shoes are available in two surface treatment options:

System 1 - top coat + weldable prime coat in weld area

System 2 - galvanized + weldable prime coat in weld area

After welding it is necessary to perform surface treatment finishing - corrective prime coat and top coat in weld area.

Installation

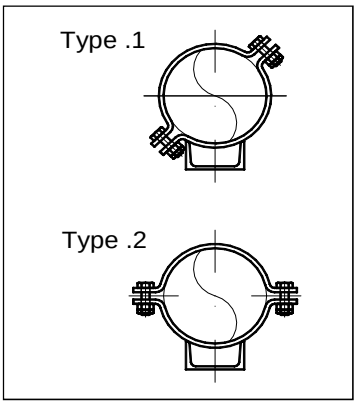
The sliding supports of type **.1** is possible to set directly under the piping fixed in a required asembly height.

Type **.2** supports (horizontal clamp), set support shoe first before piping location. The same procedure for the fix points of the 652 type.

The sliding supports are located to the steel or other sliding surfaces, which must be properly cleaned and surface-treated before assembly.

The supports are welded only to the trapese beams of the double-rod hangers only. The fix points can be welded or bolted down to structure.

For anchoring / guide plates see list 9-9 or notes at support drawing.



Height adjustment of supports

Steel structures under the supports must be levelled in such way, that the support will be visibly loaded and in contact with baseplate. A desired level adjustment is possible using inserting plates, which must be firmly connected to the structure and fixed to avoid any movements.

Height-adjustable supports of the 664 type shall be welded before release the temporary lifting devices of the piping. The welds are indicated in support assembly drawing. Coat on welded surfaces shall be applied .

Height-adjustable supports of the 661 type, the bolted connections are tightened on the support shoe. The plates between each other must be clean and grease-free. The nuts are tightened according to the size at the same torque as the nuts of the type 652 clamps according to the following chart. A safety fixing shall be done by a counter-nut.

Tightening of bolt connections of sliding support pipe clamps

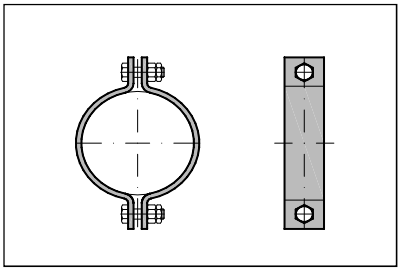
The bolts of pipe clamps are tightened according to the following charts. For piping of DN>40, the nuts are secured by a counter-nut. A proper tightening of the bolts is important to avoid slipping between the clamp and the pipe and load transfer from pipe surface to structure, especially for fix points and restraints.

<u>Nuts of pipe clamps type 712 (all support types)</u>

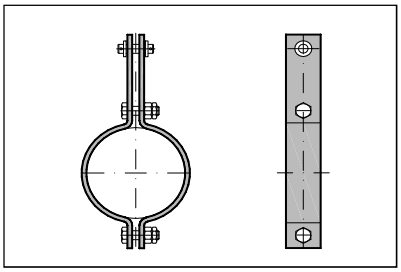
a/ Tight the nut by hand
b/ Tight up with a spanner at the angle:
+ 90° for bolts size M10 - M16
+180° for bolts greater than M16

<u>Nuts of U-clamp - support type 652</u>

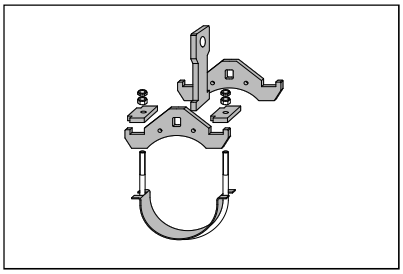
a/ Clean the nut surface and lubricate with a agent based on MoS
b/ Tight with a torque spanner up to the values:
15 Nm for size M12
30 Nm for sizes M16 - M20
50 Nm for sizes M24
100 Nm for sizes M30



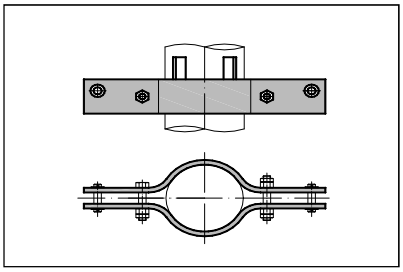
Pipe clamp Type 712 - double bolt clamps used for supports of the 600 type group or pipe hangers for uninstaled piping.
Half-sleeves bolted together with hexagonal bolts for lower temperatures and stud bolts for temp. over 350°C.
For nut tightening of support clamps see assembly manual to supports, page 6-11.
Nut tightening of hanger clamps equal to 713 type.



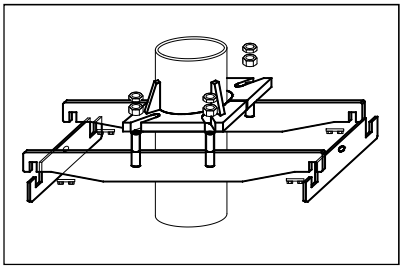
Pipe clamp Type 713, 723, 733 - triple bolt clamps used for pipe hangers. Connection to hanger rod via eyenut type 832.
Type 713 - all bolts hexagonal, types 723, 733 bolting acc. to temperature range, rod connection stud type 850.
Tight clamp nuts slight by hand and turn up to following angles:
M10-M20 - up to 90-120°
M24-M36 - up to 90°
All nuts shall be secured with counter-nut.



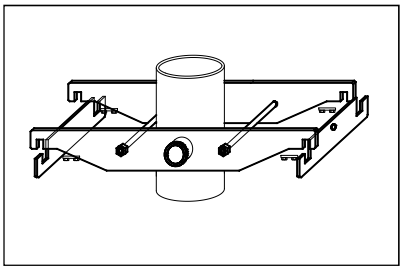
Pipe clamp Type 731 - heavy clamp for pipe hangers.
Non-welding assembly acc. to figure. U-clamp shall be provided by load distribution strap. Side girders to be bolted together and secured with studbolts.
Tight clamp nuts slight by hand and turn up to following torques:
M10-M16 - up to 2 Nm
M20-M24 - up to 5 Nm
All nuts shall be secured with counter-nut.



Pipe clamp Type 744, 754 - riser clamps for hangers of vertical piping. Inner bolting of hexagonal / stud bolts, connection to hanger rod via eyenut type 832. Bolting types same with triple bolt clamps, rod connection stud type 850.
Tight clamp nuts slight by hand and turn up to following angles:
M10-M20 - up to 90-120°
M24-M36 - up to 90°
Lugs welding provided by piping manufacturer.



Pipe clamp Type 764 - heavy riser clamp for pipe hangers.
Assembly acc. to figure. Lugs welding provided by piping manufacturer. Side girders to be bolted together to mainplate.
All nuts shall be secured with counter-nut.
Short girders to be set in the notch of main girder and locked by thrust plate from bellow.



Pipe clamp Type 765 - heavy riser clamp for pipe hangers.
Assembly acc. to figure. Pipe lugs welding provided by piping manufacturer. Side girders to be bolted together and secured with studbolts. All nuts shall be secured with counter-nut.
Short girders to be set in the notch of main girder and locked by thrust plate from bellow.

Installation instructions

Hanger rods shall be installed in vertical direction - except of the hangers with high horizontal movements where the rod may be preset in a cold condition under an angle given by the value designated by hanger drawing.

The threaded rods are supplied in lengths with an assembly allowances rounded to +0,5m. To reach required length, the rods shall be cut at site.

By installation, attention shall be paid to the screwed depth of all elements. The threaded length of the rod must be visible in all check holes.

After assembling of all hanger items, the rod must be tightened up to take over the weight of the piping. Tightening is done using turnbuckle in rod assembly or in a spring hanger. For the A type of structure connection (square plate type 932), use the nuts above square plate.

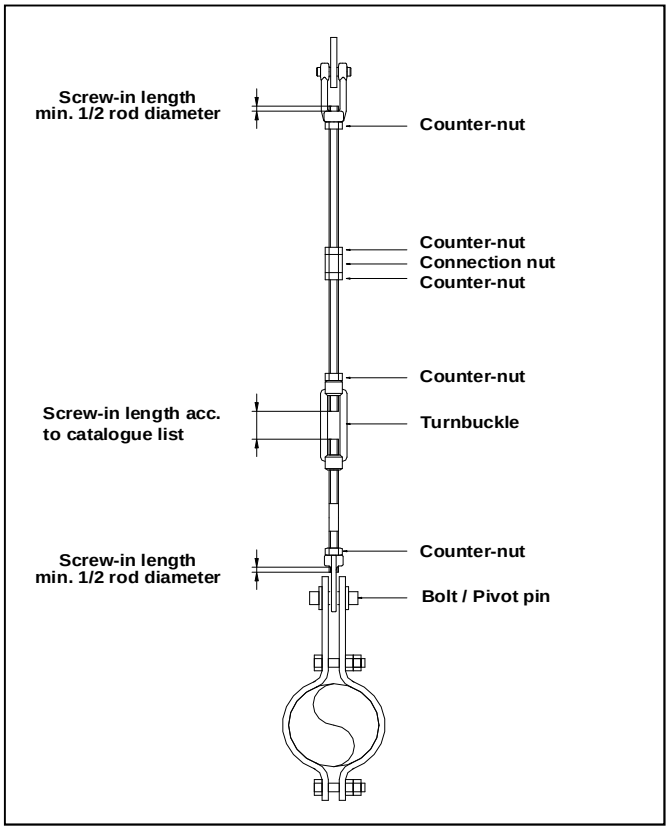
Before tightening all the counter-nuts of the rod, the screw-in depth of the threads shall be checked again. The counter-nuts to be tightened slightly with a flat spanner.

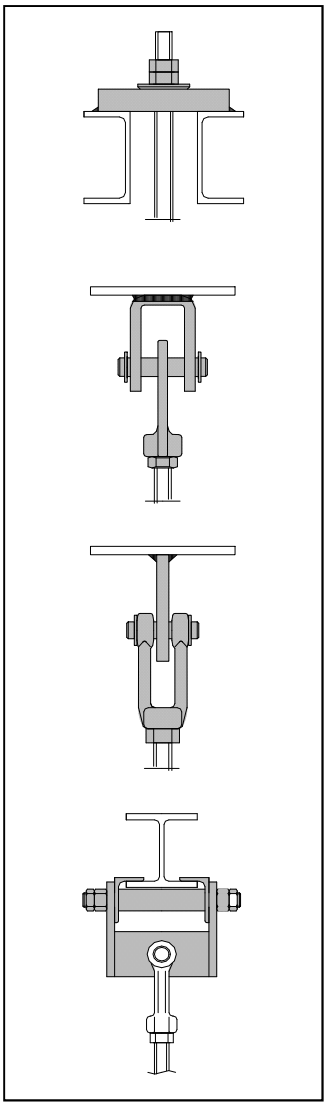
The splits of the stud pins shall be properly splayed out after the assembly.

A different connecting way of the rods than using a coupling nuts type 824 is strictly forbidden.

By an additional readjusment of the hanger rod length, the counter-nut of the turnbuckle shall be set loose. Other rod counter-nuts shall remain fixed. The thread of the turnbuckle shall be lubricated with an agent on basis of MoS. The reaction moment resulting from the rod turning is caught with a spanner at the upper and lower counter-nut of the particular rod element. After adjusting, the counter-nuts to be tightened again.

The hanger rods are maintenance-free with a correct assembly.



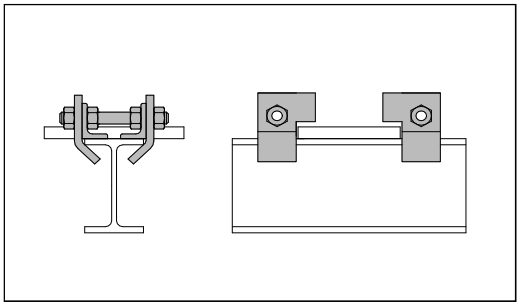


Spherical washer plate Type 932 - set on U-channels.
Minimum distance between channels shall be kept to allow hanger rod angulation. For maximum distance see table of Type datasheet. Washer to be tack welded to beam flange to avoid any movement.
Spherical surface shall be cleaned before assembly.

Weld on clevis Type 922 - at first, clevis to be welded from both sides parallel to pivot axis. These welds are main load carrying. Complete tight welds on bent sides. Weld sizes are given in table of Type datasheet. Insert stud through the eyenut and secure by washers and split pins.

Weld on eye Type 911 - plate to be continuosly fillet-welded to required position, weld thickness acc. to table datasheet. Up to plate size 20 use fillet weld, for greater sizes use partial penetrated fillet weld (K-weld).
The welds shall meet the requirements for visual check acc. to ISO 5817, grade C or AWS D1.1.

Beam clamp Type 935-937 - set L-splice plates on beam flange. Splices are tight to beam through stud bolt and spacer tube. Tight the bolt to close gap between spacer and clamp sidewall. Bolt to be secured by counter nuts.



Beam clamp for supports Type 932-937
at assembly set first pipe support or base plate. Set L-profiles to required support gap-space. Splice plates to be tighted through stud bolts, inserted in spacer tubes. Clamp shall be fixed by outer nuts, tight torque 15Nm for all sizes.

Anchoring / sliding plates Type 950 and 960 - fixing of plates to structure/floor via welding or bolting. Weld shall be performed on tack method to prevent heat damage of PTFE plate. Guide plates shall be laid as set together on pipe shoe.

1. Objective

Piping suspension represents a Important feature from the point view of the operational reliability of pipe systems directly affecting function of the assembly and its life time. In case of incorrect function of the pipe hangers an unacceptable loading of e.g. flanges can occur, causing leakage of the connected rotating equipment resulting in increased vibrations as well as leakage in parts of piping resulting in possible cracks, especially with pipes in the area of material creep point. Another important feature of the pipe supports is providing of protection against dynamic impacts in the piping.
To assess the pipe support function we recommend introduction of a system of periodic inspections with subsequent evaluations. The periodic inspections are planned for those pipe systems where the operating conditions and the danger of failure are assessed as critical for the operation reliability of the power assembly - HP pipe work, steam piping in the area of material creep point.

2. Description and range of inspections

The inspections are made in the selected branches, for the following characteristics:

a/ Position in the cold pipe condition
b/ Position in the operating (hot) pipe condition
c/ Setting of the pre-stressing force of springs
d/ Purity of sliding parts
e/ Damage to the piping supports components, compactness
f/ Visible deformation of piping support components
g/ Possibility of movement
h/ Reserves in the lift of spring components
i/ Vertical movement in hot condition

These characteristics are tested, if possible, for all branches of the piping systems.

The piping position in the cold condition is checked after cooling of piping under 50°C. The position in hot condition is checked at the operating nominal mode. An integral part of the inspection report should be the record on the temperature course during inspection.

Selection of pipe works for the position inspection Is made by the planner or the engineer responsible for the piping static, with regard to the visibility, accessibility and reading reliability, in particular for the junctions that are important and provide a representative image of the piping behaviour as a whole.

Under deformation of suspension components, visible plastic deformations of rigid components are understood, e.g. clamps, clips, eyes, parts of supporting steel structures and brackets etc.

The possibility of movements - inspection whether the movement of piping is prevented neither in horizontal nor in vertical direction.

Purity of sliding parts - visual inspection in line with criteria given in chapter 4.

3. Inspection periods

The following inspection periods are determined for the main systems:

1. Regular inspection after five year operation
2. Another regular inspections in the five year period
3. Extended inspection after twenty years operation

Visual inspection of compactness (intactness) and deformations of the piping support components is made on random basis at each planned shutdown.

4. Inspection ranges:

a/ Regular inspection

Inspection, measurement and evaluation are made for all items given in para. 2. The high-pressure systems are inspected to 100% range for all piping support components. For other piping systems the inspection is made on random basis.

b/ Extended inspection

Inspection, measurement and evaluation are made for all items under para. 2, in addition inspection of clamps and clips of piping is made after removal of insulation.
On the high-pressure systems it is made to 100% range, for all piping support components. For other piping systems the inspection is made on random basis.

5. Evaluation description

The evaluation is performed by a specialist planner or engineer responsible for piping static. For individual checked characteristics the evaluation is made in line with the following criteria:

a/ Position in the cold piping condition
Comparison of the actual position with the assembly position / calculation position or position measured during preceding inspection. Change in the piping position between individual inspection periods is evaluated. The causes of the position change can be in the relaxing of springs, plastic deformations of piping and parts of piping supports, deformations of supporting structures etc.

b/ Position in the operating piping condition
Comparison of actual position with calculation position or position measured at the preceding inspection. Change in the piping position between individual inspection periods is evaluated as well as possibility of the shifts of piping supports. The causes of deviations between individual inspection periods can be in increased friction in spring cages, spring relaxing etc.

c/ Setting of the spring initial stress
Should a change be required, during the shutdown the change in the initial stress of springs setting of supports of a constant strength will be made.

d/ Purity of the sliding support parts
For the spring hangers / supports the pureness and wear of the sliding parts of spring cages are evaluated. With sliding supports especially corrosion of sliding parts is evaluated. Evaluation of the condition is made according to the following scale:

1. Surfaces without material wear, without contamination, corrosion
2. Surfaces without material wear, slight contamination, flat corrosion when oxidized parts cannot be slipped off.
3. Surface with slight wear without marks of seizing, contaminated, flat corrosion.
4. Unacceptable – visible wear - scratches, pitting corrosion

e/ Damage to the piping supports components, compactness (intactness)
All piping support components should be intact and undamaged without breaks and cracks (neither local).

f/ Visible deformations of the piping support components
All rigid piping suspension components, esp. sleeves, bend parts, should be without visible plastic deformations.

g/ Possibility of shifting
Spring cages of hangers should not be to the stop in the lower or upper position. Draw rods of hangers should be capable of a necessary deflection. Supports should not be locked in the move by a foreign body or corrosion.

h/ Reserves in spring components lift
For the spring suspensions and supports the lift reserve should be 10% of the calculation shift from both end position, however at least 5 mm.
For suspensions and supports of a constant force the lift reserve should be 10% of the calculation shifts from the both end positions, however at least 10 mm.

i/ Horizontal shift in hot condition
Measured horizontal shifts in hot condition are compared with calculation shifts for the purpose of piping behaviour evaluation.

6. Maintenance

All parts of piping supports are in regular operation maintenance free. In case of occasional damage or Irregular function, please contact the manufacturer.