

HYDROCAM Bolt Tensioners Industrial Tightening Systems



The SKF Group

The SKF Group is an international industrial corporation owned by SKF Sweden AB. Founded in 1907, it operates in 130 countries and has some 40000 employees.

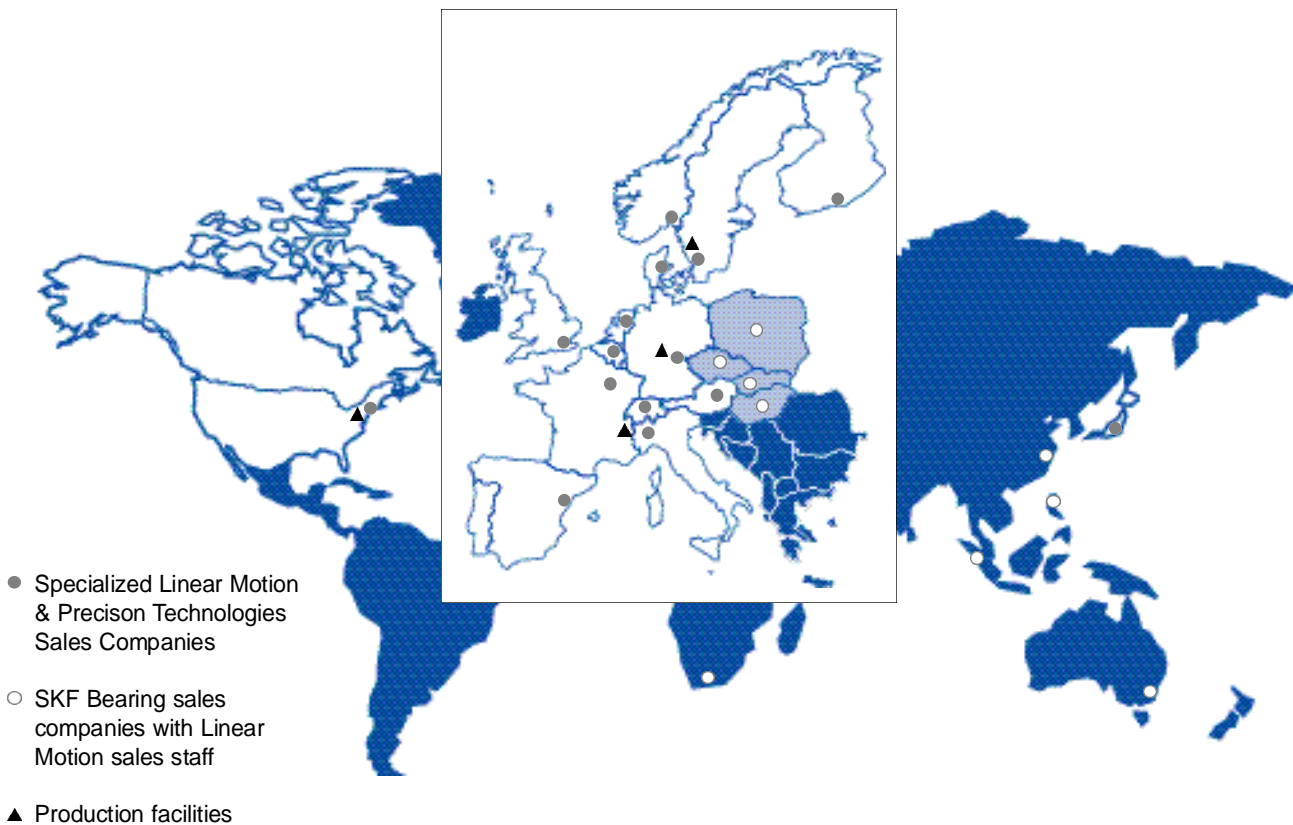
The company has over 80 manufacturing units throughout the world and a network of nearly 20000 distributors and retailers. SKF is the world leader in the rolling bearing business.

SKF Linear Motion & Precision Technologies

SKF Linear Motion & Precision Technologies is an organization within SKF which, as the name suggests, is dedicated to the manufacture, sales and service of linear motion products, high precision bearings and spindles.

It serves the market through its organization of 15 specialized sales companies located in Europe, North America and Japan.

In addition to the services provided by these sales companies, product and application support is available worldwide through the SKF international network.



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Earlier catalogues with data which is different than that contained herein are no longer valid.

We reserve the right to make changes required by technological developments.

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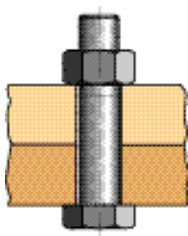
Introduction

SKF® has worked in the field of bolt-tightening by pre-load tension since the 1940's. At that time, design studies concentrated on the tightening of slewing rings, where the SKF group's subsidiary, RKS, is a leading specialist.

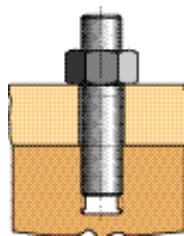
Since the 1940's, SKF Equipements has continuously furthered its bolt-tightening experience in every industrial sector and in many different types of applications.

Today, SKF Equipements offers two descriptive documents on the subject of bolt-tightening: the "Bolt-tightening Handbook", which discusses the technical aspects of bolt-tightening, and this product catalogue: the "HYDROCAM® Bolt-Tensioner - Industrial Tightening Systems" catalogue.

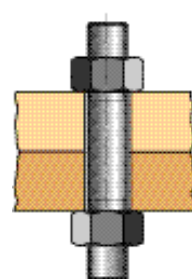
Well aware that good tightening control is extremely important economically, SKF Equipement offers both expertise and service to solve any problems involving the tightening of bolted assemblies.



Screw and nut



Stud with nut on one end



Stud with nuts on both ends

Just what is a bolted assembly ?

A bolted assembly quite simply means the putting together of at least two parts using one or several bolts. As is shown in the figure above, these bolts can be made up of screws and nuts, studs with nuts on one or both ends, and possibly washers.

In the following document, the word "bolt" includes these three types of screwing components.

Bolted assemblies are the most commonly used connecting systems in mechanics. And although they appear to be quite simple, bolted assemblies do pose several challenges at many levels: design department, assembly workshop, on-site, and maintenance.

Rough dimensioning methods are too often applied at the design stage, which leads to unnecessary oversizing. Such oversizing does not enhance product safety, quite the contrary...

The design and implementation of a bolted assembly requires a very strict methodological approach, for errors can lead to costly and often disastrous failures.

Several studies have shown that incidents encountered on bolted assemblies are most often due to improper design of the assembly (analysis, design, calculation, component choice) or poor implementation (tightening method, tooling, inspection).

Today it is known that of all the various causes of failure (overloading, design flaws, manufacturing defects, and others), the most frequent is improper assembly. Tightening problems, whether insufficient tightening, excessive tightening or heterogenous tightening, alone account for over 30% of all bolted assembly failures.

More specifically, 45% of all fatigue failures are estimated to be due to improper assembly.

Therefore, the importance of the design of the bolted assembly and the means used to tighten it are of utmost importance.

The "Bolt-tightening Handbook" clearly explains that "optimum tightening means a bolt which is not too tight and not too loose" and shows how to achieve the best tightening.

It reviews all the tightening methods and proves that the best tightening control is provided by the Hydrocam hydraulic tensioner.

This "Product Catalogue" describes all the products and services that SKF offers in order to enable you to better manage your bolted assemblies.

Both of these documents provide indispensable information on optimizing the bolted assemblies that you are designing and on choosing the best tightening method for your application. They describe the key aspects, which are:

- Quality
- Accuracy
- Homogeneity
- Ease of use

These provide additional advantages such as:

- Reliability and safety
- Optimized dimensions
- Time savings
- Cost reduction in use, control and maintenance.

In addition, this catalogue provides other useful information such as standard bolting dimensions, units conversion, and the conversion of torque into tension load...

As an example - did you know that the SKF hydraulic tensioner can tighten bolts from 5 to 500 mm ?

Please do not hesitate to contact SKF for your needs. You may be surprised by all the services SKF can provide in the field of bolted assembly tightening.



What makes up the Hydrocam bolt tensioner ?

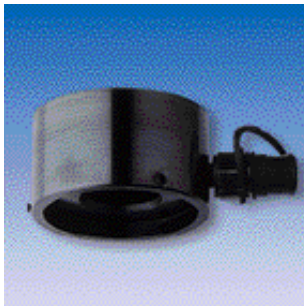
A standard Hydrocam tensioner has a hydraulic body which, using a hydraulic fluid, exerts a strong tension load on the bolt through the brace screwed on that bolt. In some tensioner types (HTC R), the body is screwed directly on the bolt to be tightened. The body also rests on the skirt in order to apply the reaction force on the assembly to be tightened.

Prior to screwing the body-brace-skirt unit on the protruding end of the bolt, a socket has to be placed on the nut of the bolt. This nut can then be "turned down" (screwed until the lower surface of the nut comes into contact with the assembly bearing surface), by a tommy bar, while the tensioner applies the tension load.



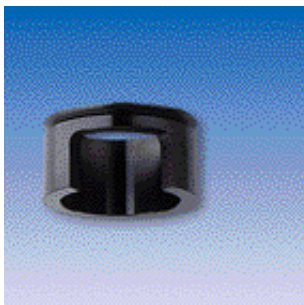
Brace

The brace is screwed on the protruding end of the bolt, above the nut. It supplies the tension load exerted by the hydraulic body on the bolt.



Hydraulic body

Using the fluid under pressure, the hydraulic body creates the tension load on the brace by pushing on the skirt.



Skirt

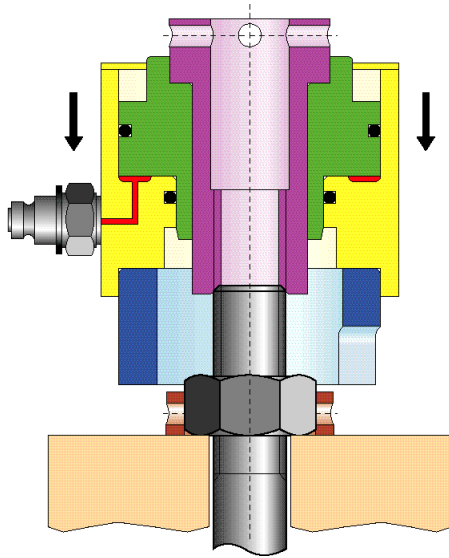
The skirt is placed around the nut on the assembly to be tightened. It transmits the compression force to the assembly by reaction to the tension load applied on the bolt by the hydraulic body.



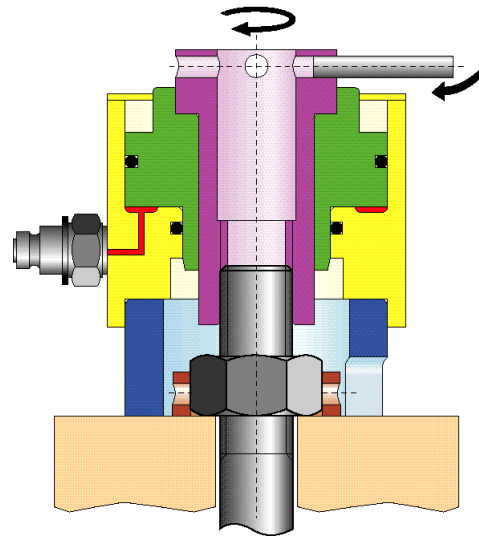
Socket for standard nut (optional)

In the case of assemblies with standard nuts, a socket is placed around the nut to effortlessly bring the nut into contact with the assembly. For this purpose, the outer surface of the socket is drilled with radial axis holes to hold the push rods. Turning down occurs while the tension load is applied by the hydraulic body.

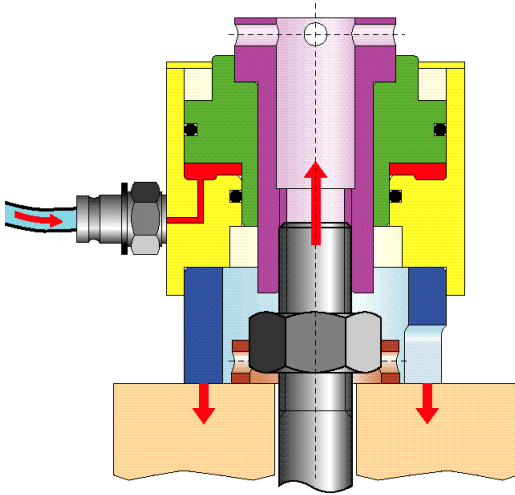
How a Hydrocam tensioner works



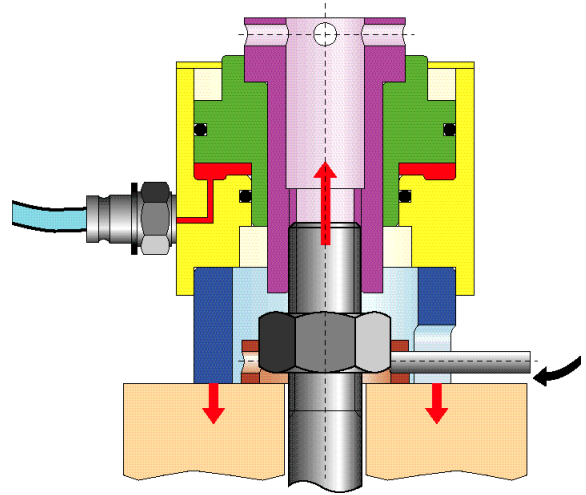
1 - The turn-down socket is placed over the nut and the hydraulic tensioner grasps the bolt.



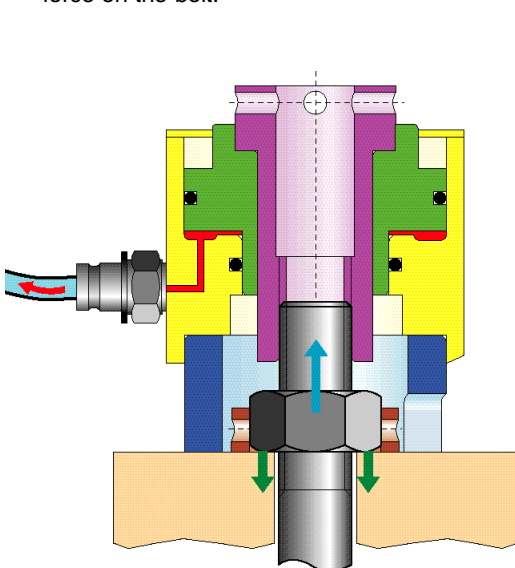
2 - The brace/retraction unit is screwed onto the protruding end of the bolt.



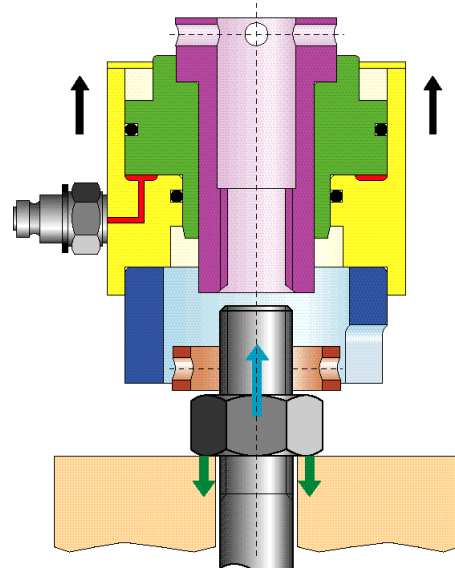
3 - After the hydraulic connections, the tensioner is pressurized and applies the required tractive force on the bolt.



4 - While the pressure is maintained, the nut is turned down without loading, using the socket and the tommy bar.



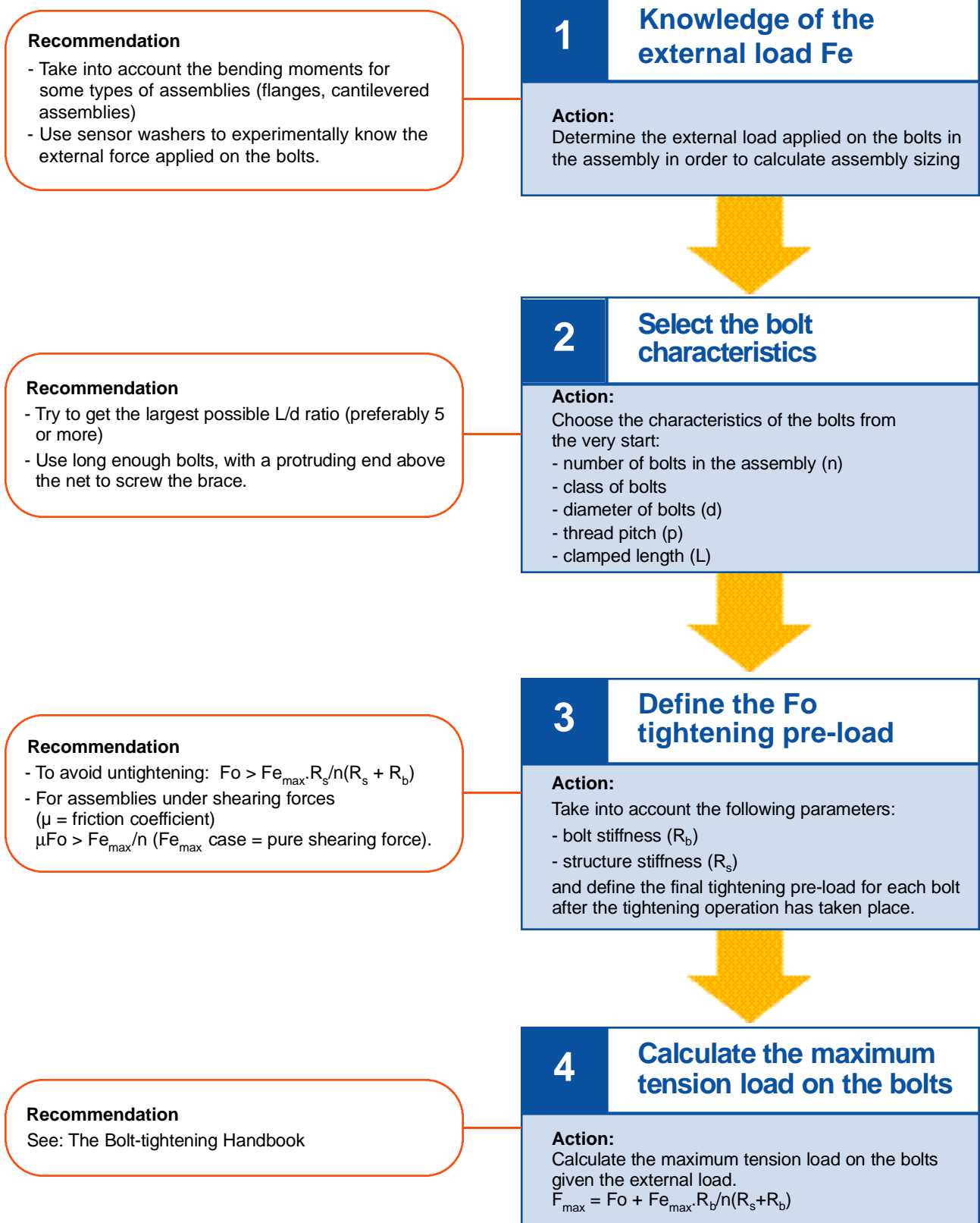
5 - Their pressure is released and the piston is pushed back. The tightening load is now exerted through bolt tension.



6 - The tensioner and the socket can be removed.

Optimize your bolted assembly

SKF Equipments provides recommendations and services for each one of these steps



5

Monitor the stress in the bolts

Action:

Calculate the maximum stress borne by the bolts in stressed section S

$$\sigma_{max} = F_{max}/S$$

Recommendation

- For the threaded part of the bolt, use the equivalent section (As) as the bolt section
- For the cylindrical parts, use the entire section
- In the event of a central link, take the section variation into account
- See the Bolt-tightening Handbook

6

Optimize bolt size

Action:

Try to increase the length to diameter ratio (L/d). If the maximum stress on the bolt is well within its yield point, the diameter can be reduced.

Recommendation

- The higher the L/d ratio and the higher the tightening stress, the better the fatigue behavior of a bolted assembly is. Tightening stress should be close to the yield point (preferably 80% Re). See pages 26 and 27 "Tightening Stress Chart"
- Likewise, in decreasing bolt stiffness, the share of the external load applied to the bolt is also decreased
- Choose the class of bolt material to appropriately resist the maximum load Fmax applied on the bolt
- See the "Bolt-tightening Handbook".

Use the following criteria to evaluate the optimization of your assembly

- Tightening stress is as close to 80% of Re as possible
- Highest possible L/d diameter
- Lowest assembly weight and size as possible
- Appropriate safety margin ?
- Tightening techniques have been taken into consideration since the design stages of the project

Recommendation

See: "Recommendations for the Use of Hydrocam Tensioners" p 10-11

Continue to optimize

no

The assembly is not optimised

yes

Optimized Assembly

Please send us your technical data using the fax form on page 71

or

Once the assembly is designed, choose the best Hydrocam Tensioner for your application, using the logic diagram on the following pages

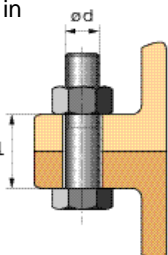
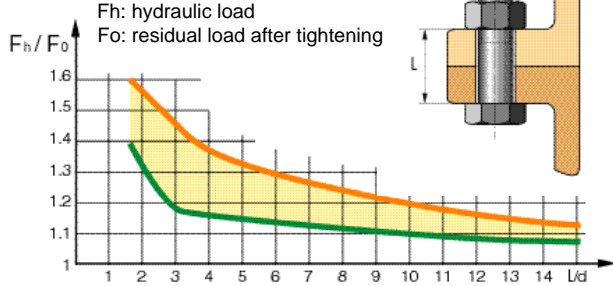
Choose the best tightening solution: The HYDROCAM Hydraulic Bolt Tensioners

Designing the Assembly

See "Optimize your Bolted Assembly" pages 6-7

Note:

- Use a sensor washer for a direct reading of the residual load (page 62).
- Accuracy is also increased by measuring bolt elongation. Contact SKF Equipements for further information
- Ratio F_h/F_o can also be obtained in some cases by calculation

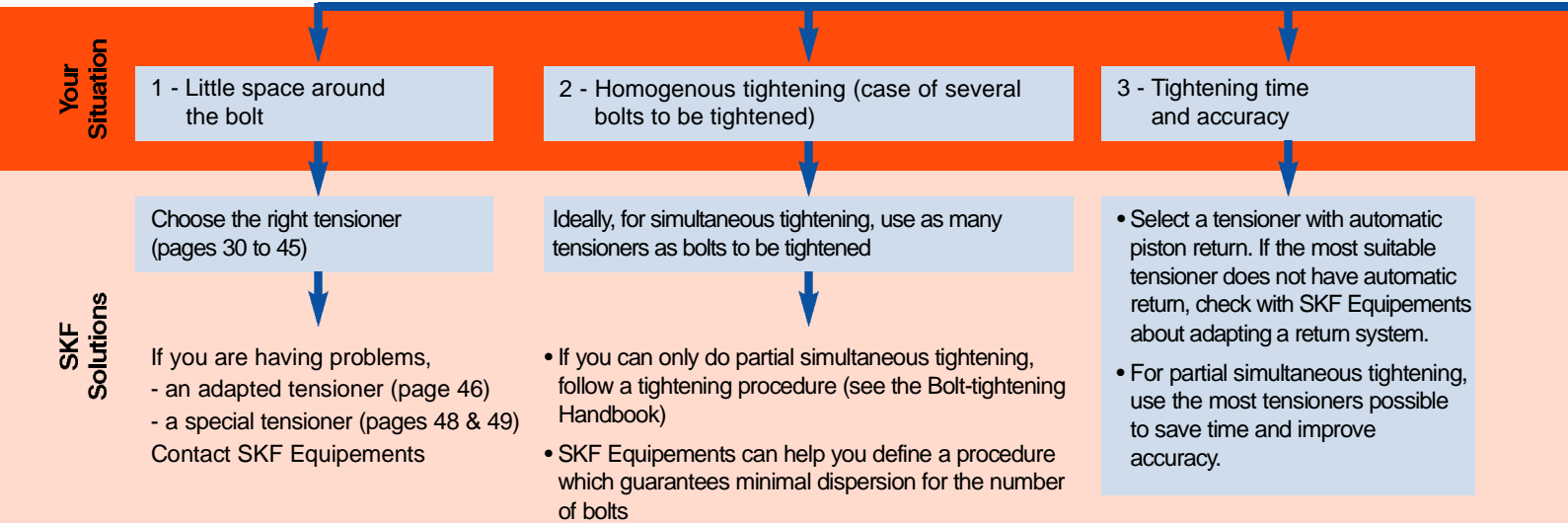



F_h : hydraulic load
 F_o : residual load after tightening

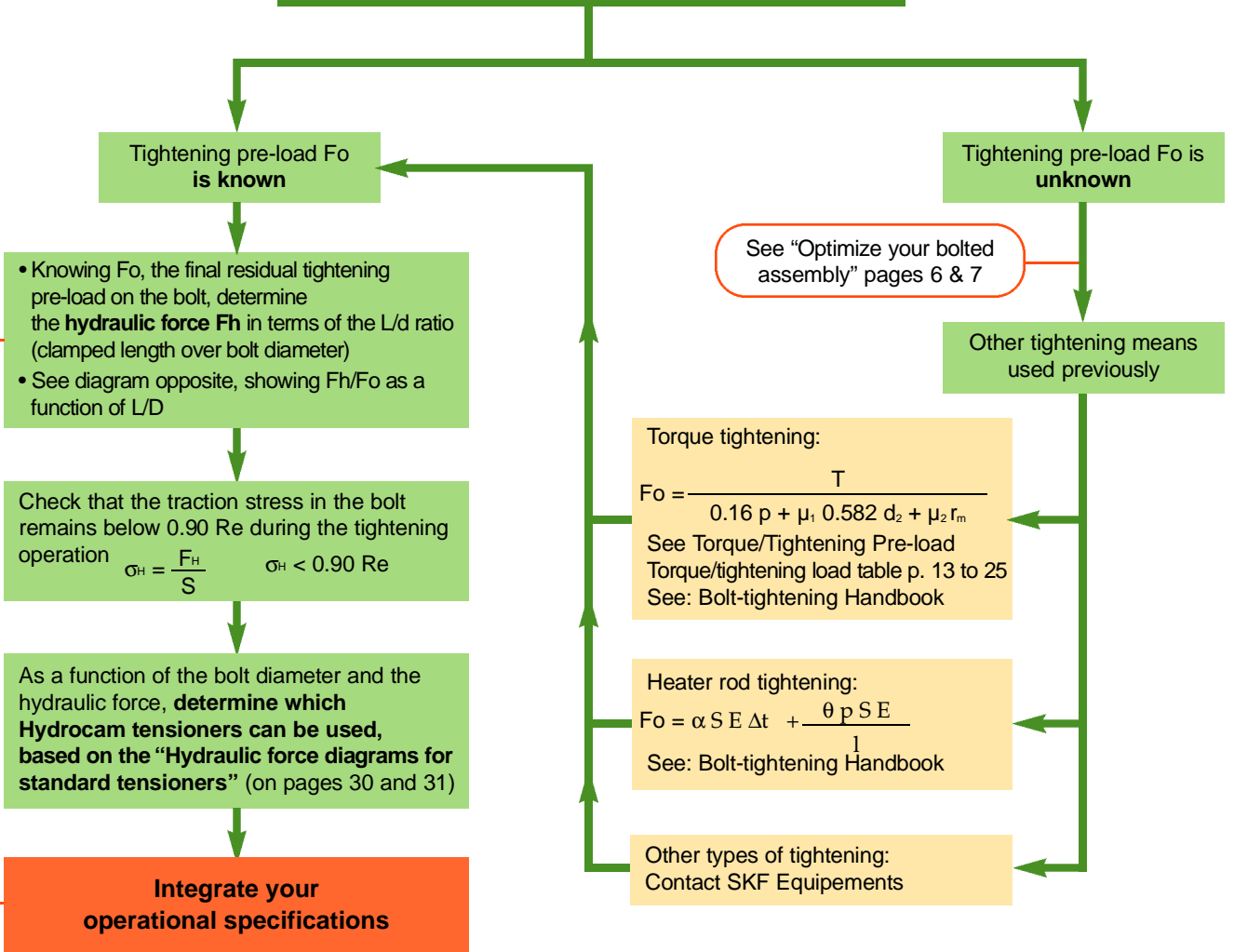
— Upper limit: wide pitch thread
— Lower limit: narrow pitch thread

The F_h/F_o ratio as a function of bolt aspect ratio L/d for commonly used bolting steels

No extra charge for special thread



Tightening the Designed Assembly



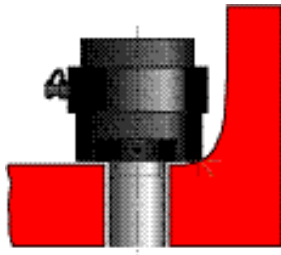
To check the price of your Hydrocam tensioner, use the fax form on page 70

Recommendations for the Use of HYDROCAM Tensioners

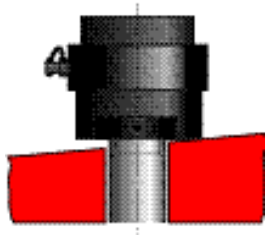
Design in the use of tensioners from the very start of the design phase of your assembly.

For the very best Hydrocam Tensioner efficiency and usage, please follow the following recommendations from the very start of the design stage of the bolted assembly. Failure to observe these basic recommendations can result in problems for which SKF cannot be held liable. To operate the Hydrocam Tensioners, please see the user manual enclosed with the product.

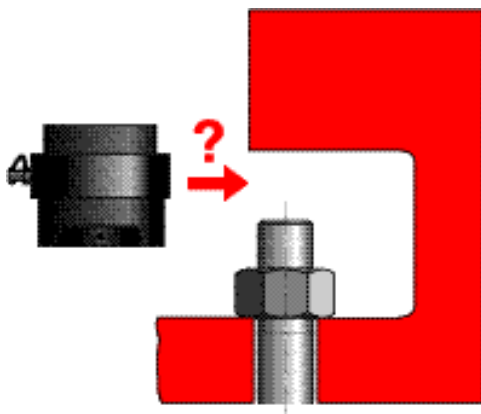
Avoid



Insufficient flat area around the bolt

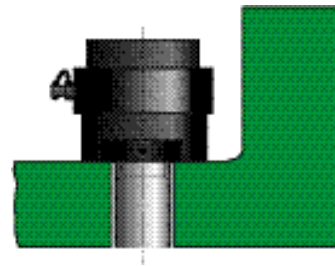


Bearing area is slanted with respect to the bolt axis

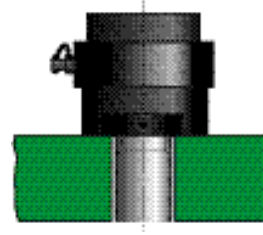


Not enough room to fit the tensioner

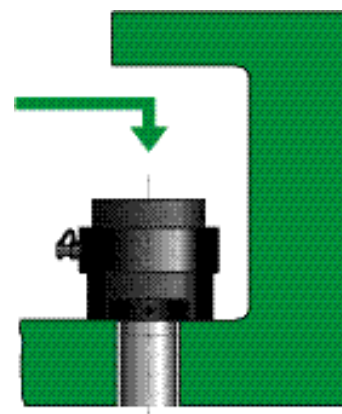
Recommended



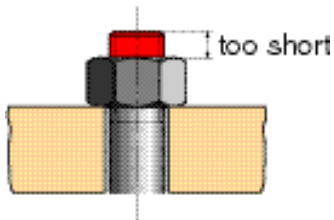
The lower part of the skirt must be in full contact with the assembly



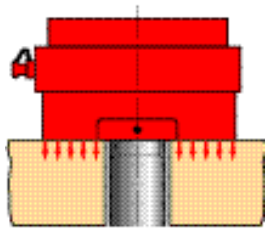
The skirt/assembly contact surface must be perpendicular to the bolt axis



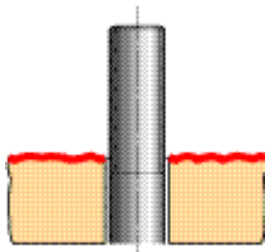
Design enough clearance to install the tensioner



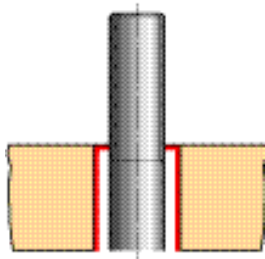
The protruding end of the bolt is too short



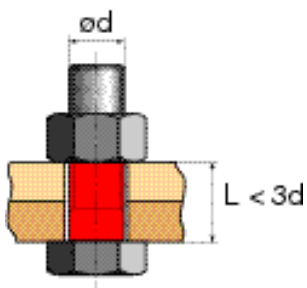
The tensioner is too big for the bolt – not enough pressure



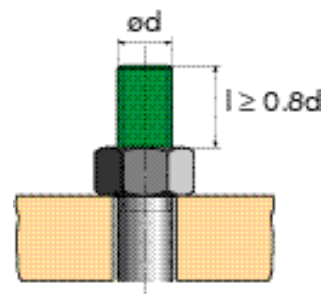
Surface is too rough



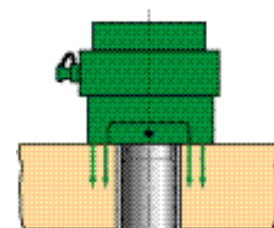
Diameter of the bolt hole is too big



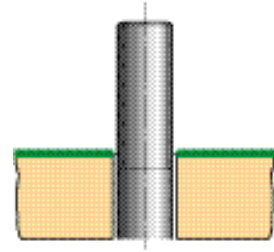
L/d ratio is too small



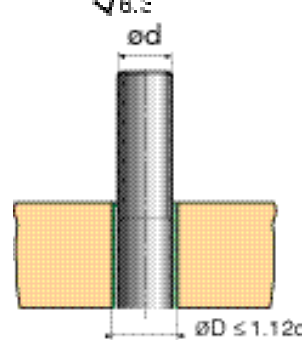
The length of the protruding end must provide for screwing the tensioner brace on a length of at least $l > 0.80$



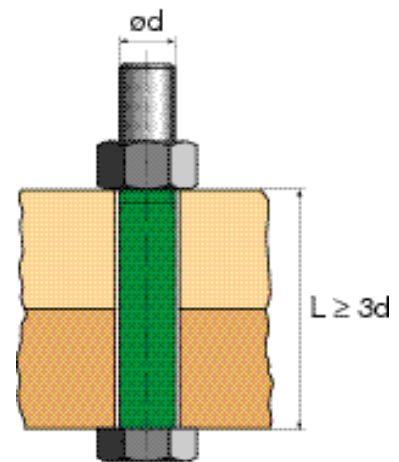
Tensioner diameter must be adapted to the bolt, and must operate under high pressure for the best tensioner and tightening performance



Surface condition under the Hydrocam tensioner must be at least $Ra \le 0.3$



The bolt hole diameter must be as small as possible



The L/d ratio must be as high as possible

Units Conversion

Metric system – Imperial system

Length:

Metric units	→	Imperial units
1 millimeter (mm)	=	0.039370 in
1 centimeter (cm)	=	0.03281 ft
1 meter (m)	=	39.370 in
1 meter (m)	=	3.2808 ft

Imperial units	→	Metric units
1 inch (in)	=	25,4 mm
1 foot (ft)	=	30,48 cm
1 inch (in)	=	0,0254 m
1 foot (ft)	=	0,3048 m

Force:

Metric units	→	Imperial units
1 newton (N)	=	0.22481 lbf
1 kilo-newton (kN)	=	224.81 lbf
1 kilogramme force (*) (kgf)	=	2.20462 lbf

Imperial units	→	Metric units
1 pound force (lbf)	=	4,4482 N
1 pound force (lbf)	=	0,004448 kN
1 pound force (lbf)	=	0,453593 kgf

(*) the "kilo" is not a unit of force as such. In practice, 1 kilo force (1 kgf) = 9.81 N

Torque:

Metric units	→	Imperial units
1 newton meter (N.m)	=	0.73756 lbf.ft
1 meter kilo (m.kgf)	=	7.233 lbf.ft
1 newton meter (N.m)	=	8.8507 lbf.in
1 meter kilo (m.kgf)	=	86.796 lbf.in

Imperial units	→	Metric units
1 pound force foot (lbf.ft)	=	1,3558 N.m
1 pound force foot (lbf.ft)	=	0,13826 m.kgf
1 pound force inch (lbf.in)	=	0,113 N.m
1 pound force inch (lbf.in)	=	0,0115 m.kgf

Stress - Pressure:

Metric units	→	Imperial units
1 bar	=	14.504 psi
1 Mega pascal (MPa)	=	145.04 psi

Imperial units	→	Metric units
1 pound square inch (psi)	=	0,06895 bar
1 pound square inch (psi)	=	0,006895 MPa

Reminder:
 1 bar = 1 daN/cm²
 1 MPa = 1 N/mm²
 1 MPa = 10 bar

Remarque: In practice, "1 kg" = 10 MPa
 Example: "90 kilo" steel means that the yield point is 900 MPa.

Torque/Tightening load Tables

The tables on the following pages show the tightening load applied to a bolt when this bolt has been tightened with a torque wrench. This tightening load is strongly influenced by the friction coefficients from the threads and the nut face in contact with the assembly. Such friction is due to the tightening method using the torque wrench.

Torque / Tightening load - Metric system

Bolt diameter from 5 to 30 mm	pages 14 to 15
Bolt diameter from 33 to 72 mm	pages 16 to 17
Bolt diameter from 76 to 150 mm	pages 18 to 19

Torque / Tightening load - Imperial system

Bolt diameter from 1/4" to 1 1/4"	pages 20 to 21
Bolt diameter from 1 3/8" to 3 1/2"	pages 22 to 23
Bolt diameter from 3 3/4" to 6"	pages 24 to 25

Torque tightening therefore introduces great uncertainty in the actual value of the bolt's residual tightening pre-load. However, the tables on the following pages do establish an order of magnitude.

If the plan is to tighten an existing assembly with hydraulic tensioners instead of with the torque wrench, tensioners able to supply a tension force similar to torque tightening must be chosen. However, for the sake of precaution, we recommend further calculation of the required tension force based on the optimization of a bolted assembly on pages 6-7.

Reading the tables:

For a bolt diameter M39, tightened with a torque value of 3500 N.m. (approximately 350 m.kg), the tightening pre-load is 484 kN for a friction coefficient of 0.15.

If this tightening pre-load were applied to a bolt from class 8-8 (yield point: 640 MPa), the tightening stress in this bolt would be 75% of the yield point (Re). However, if the friction coefficient is 0.10, the same torque of 3500 N.m will generate in this bolt a tightening traction load of 695 kN leading to exceed the elastic limit.

Friction Coefficient:

0.10 (0.08 / 0.12): phosphate treated or galvanized bolt, good quality lubrication

0.15 (0.13 / 0.17): black or galvanized bolt, low quality lubrication

0.20 (0.18 / 0.25): regular bolts, no lubrication.

Tightening load (kN) - metric system

As a function of the torque (N.m)
of the diameter of the standard bolt from 5 to 30 mm
of the bolt friction coefficient

Ø Bolt (mm)	5			8			10			12			14			16			
Pitch (mm)	1			1.25			1.5			1.75			2			2			
Width across flats (mm)	10			13			17			19			22			24			
Friction coefficient	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	
Torque (N.m)																			
10	12	8	7	9	6	5	7	5	4	6	4	5	4						
20	24	17	13	18	13	10	14	10	8	12	9	7	11	8	6	10			
30	35	25	20	27	19	15	21	15	11	19	13	10	16	11	9	15	10		
40	47	34	26	35	25	19	28	20	15	25	17	13	22	15	12	19	14	10	
50	42		33	44	31	24	35	25	19	31	22	17	27	19	14	24	17	13	
60	39			53	38	29	42	30	23	37	26	20	33	23	17	29	20	16	
70	46			44		34	49	34	26	43	30	23	38	26	20	34	24	18	
80				50		39	56	39	30	49	35	27	43	30	23	39	27	21	
90				44			63	44	34	56	39	30	49	34	26	44	31	24	
100				49			49		38	62	43	33	54	38	29	48	34	26	
120							59		45	74	52	40	65	45	35	58	41	31	
140							53			87	61	47	76	53	41	68	48	37	
160							61			69		53	87	60	46	77	54	42	
180										78		60	98	68	52	87	61	47	
200										87		67	108	76	58	97	68	52	
250										83			94		72	121	85	65	
300													113		87	145	102	79	
350																101		119	92
400																116		136	105
450																		153	118
500																			131
550																			144
600																			
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1200																			
1400																			
1600																			
1800																			
2000																			
2500																			
3000																			
3500																			
4000																			

Ø Bolt (mm)	18			20			22			24			27			30				
Pitch (mm)	2.5			2.5			2.5			3			3			3.5				
Width across flats (mm)	27			30			32			36			41			46				
Friction coefficient	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20		
Torque (N.m)																				
10																				
20																				
30																				
40	17																			
50	22			19																
60	26		18	23																
70	30		21	16	27		19													
80	35		24	19	31		22	29												
90	39		27	21	35		24	19	33											
100	44		30	23	39		27	21	36		26	32								
120	52		37	28	46		33	25	44		31	39								
140	61		43	33	54		38	29	51		36	27	45		32	40				
160	70		49	37	62		43	34	58		41	31	52		36	46				
180	78		55	42	70		49	38	66		46	35	58		41	31	52			
200	87		61	47	77		54	42	73		51	39	64		45	35	58		40	
250	109		76	58	97		68	52	91		64	49	81		57	44	72		50	
300	131		91	70	116		82	63	109		77	59	97		68	52	86		60	
350	152		107	82	135		95	73	127		89	69	113		79	61	101		70	
400	174		122	94	155		109	84	146		102	79	129		91	70	115		80	
450			137	105	174		122	94	164		115	88	145		102	79	129		90	
500			152	117	193		136	105	182		128	98	161		113	87	144		100	
550			167	129	213		149	115	200		140	108	177		125	96	158		110	
600			183	140			163	126	219		153	118	193		136	105	173		121	
650					152			177	136	237		166	128	210		147	113	187		131
700					164			190		147	255		179	137	226		159	122	201	
750					175			204		157			191	147	242		170	131	216	
800							217	168			204	157	258		181	140	230		161	
850									178			217	167	274		193	148	244		171
900									189			230	177	290		204	157	259		181
950									199			242	187	306		215	166	273		191
1000									210			255	196			226	175	288		201
1200													236			272	210	345		241
1400															317	244	403		281	
1600																	279			321
1800																	314			362
2000																			402	
2500																			386	
3000																				
3500																				
4000																				

Tightening load (kN) - metric system

As a function of the torque (N.m)
of the diameter of the standard bolt from 33 to 72 mm
of the bolt friction coefficient

Ø Bolt (mm)	33			36			39			42			45			48			
Pitch (mm)	3.5			4			4			4.5			4.5			5			
Width across flats (mm)	50			55			60			65			70			75			
Friction coefficient	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	
Torque (N.m)																			
300	71																		
350	83			75															
400	95			86															
450	107	74		97			89												
500	118	83		107	75		99												
550	130	91	70	118	82		109			101									
600	142	99	76	129	90		119			110									
650	154	107	82	139	97	75	129	90		119									
700	166	116	89	150	105	81	139	97		128			120						
750	178	124	95	161	112	86	149	104		137			128						
800	189	132	101	172	120	92	159	111		146	102		137						
850	201	140	108	182	127	98	169	117	90	155	108		145						
900	213	149	114	193	135	104	179	124	95	165	115		154				143		
950	225	157	120	204	142	109	189	131	101	174	121		163				151		
1000	237	165	127	215	150	115	199	138	106	183	127	98	171	119			159		
1200	284	198	152	258	180	138	238	166	127	219	153	117	205	143			191		
1400	331	231	177	300	210	161	278	194	148	256	178	137	239	166	128		223	155	
1600	379	264	203	343	240	184	318	221	170	292	204	156	274	190	146		255	177	
1800	426	297	228	386	270	207	357	249	191	329	229	176	308	214	164		287	199	153
2000	474	330	253	429	300	230	397	276	212	366	255	196	342	238	182		318	222	170
2500	592	413	317	537	375	288	497	346	265	457	319	244	428	297	228		398	277	212
3000		495	380	644	450	346	596	415	318	548	382	293	513	357	273		478	332	255
3500		578	444		525	403	695	484	371	640	446	342	599	416	319		557	388	297
4000			507		600	461	794	553	424	731	510	391	684	476	364		637	443	340
4500			570		675	518		622	477	823	573	440	770	535	410		716	499	382
5000						576		691	530	914	637	489	855	594	456		796	554	425
5500						633		760	583	1005	701	538	941	654	501		876	609	467
6000						691		829	636		764	587	1026	713	547		955	665	510
6500									689		828	636	1112	773	592		1035	720	552
7000									742		892	685		832	638		1114	776	595
7500									795		956	733		892	683		1194	831	637
8000									848			782		951	729		1274	886	680
8500												831		1011	774			942	722
9000												880		1070	820			997	765
9500												929		1129	866			1053	807
10000												978			911			1108	850
12000															1093			1330	1020
14000																			1190
16000																			1360
18000																			
20000																			
25000																			
30000																			
35000																			
40000																			

Ø Bolt (mm)	52			56			60			64			68			72		
Pitch (mm)	5			5.5			5.5			6			6			6		
Width across flats (mm)	80			85			90			95			100			105		
Friction coefficient	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20
Torque (N.m)																		
300																		
350																		
400																		
450																		
500																		
550																		
600																		
650																		
700																		
750																		
800																		
850																		
900																		
950																		
1000	150																	
1200	180																	
1400	210	146		197														
1600	240	166		225														
1800	270	187	143	253			240											
2000	300	208	159	281	195		266		251									
2500	375	260	199	351	244	187	333	231	314			299						
3000	450	312	239	421	293	224	399	277	377	262		359				343		
3500	525	364	279	491	342	262	466	323	247	440	305	419	290			400		
4000	599	416	319	561	390	299	532	369	283	502	349	267	479	332		458		
4500	674	468	359	632	439	337	599	415	318	565	392	301	539	373	286	515	356	
5000	749	520	398	702	488	374	665	462	353	628	436	334	599	415	317	572	396	
5500	824	572	438	772	537	411	732	508	389	691	480	367	659	456	349	629	435	333
6000	899	624	478	842	585	449	799	554	424	753	523	401	718	498	381	687	475	363
6500	974	676	518	912	634	486	865	600	459	816	567	434	778	539	413	744	515	393
7000	1049	728	558	983	683	523	932	646	495	879	610	468	838	581	444	801	554	424
7500	1124	780	598	1053	732	561	998	692	530	942	654	501	898	622	476	858	594	454
8000	1199	832	637	1123	781	598	1065	739	565	1005	698	534	958	664	508	915	633	484
8500	1274	884	677	1193	829	636	1131	785	601	1067	741	568	1018	705	540	973	673	514
9000	1349	936	717	1263	878	673	1198	831	636	1130	785	601	1078	747	571	1030	712	545
9500	1424	988	757	1334	927	710	1264	877	671	1193	828	635	1137	788	603	1087	752	575
10000	1499	1040	797	1404	976	748	1331	923	707	1256	872	668	1197	830	635	1144	792	605
12000		1249	956		1171	897	1597	1108	848	1507	1046	802	1437	996	762	1373	950	726
14000		1457	1116		1366	1047	1863	1292	989	1758	1221	935	1676	1162	889	1602	1108	847
16000			1275		1561	1196		1477	1131	2009	1395	1069	1916	1328	1016	1831	1267	968
18000			1434		1756	1346		1662	1272	2260	1570	1202	2155	1494	1143	2060	1425	1089
20000						1496		1846	1413		1744	1336		1660	1270	2288	1583	1210
25000									1767		2180	1670		2075	1587		1979	1513
30000												2004			1905		2375	1815
35000												2338			2222			2118
40000																		2421

Tightening load (kN) - metric system

As a function of the torque (N.m)

of the diameter of the standard bolt from 76 to 150 mm
of the bolt friction coefficient

Ø Bolt (mm)	76			80			85			90			95			100		
Pitch (mm)	6			6			6			6			6			6		
Width across flats (mm)	110			115			120			130			135			145		
Friction coefficient	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20
Torque (N.m)																		
3500	383																	
4000	438			420														
4500	493			473			454											
5000	548	378		525			505											
5500	603	416		578			555			516								
6000	657	454		631	435		605			563								
6500	712	492	376	683	471		656	452		610			588					
7000	767	530	405	736	507		706	487		657			633					
7500	822	568	434	788	544	415	757	521		704			679					
8000	876	605	462	841	580	443	807	556		751	516		724			678		
8500	931	643	491	893	616	470	858	591	451	798	548		769			720		
9000	986	681	520	946	652	498	908	626	477	845	580		814			763		
9500	1041	719	549	998	689	526	959	660	504	891	613		859	590		805		
10000	1096	757	578	1051	725	553	1009	695	530	938	645	491	905	621		848		
12000	1315	908	694	1261	870	664	1211	834	636	1126	774	589	1086	745	567	1017	697	
14000	1534	1059	809	1471	1015	775	1413	973	742	1314	903	688	1267	869	662	1187	813	
16000	1753	1211	925	1682	1160	885	1614	1112	848	1501	1032	786	1448	994	756	1356	929	707
18000	1972	1362	1040	1892	1305	996	1816	1251	954	1689	1161	884	1629	1118	851	1526	1045	795
20000	2191	1514	1156	2102	1450	1107	2018	1390	1060	1877	1290	982	1809	1242	946	1695	1161	883
25000	2739	1892	1445	2627	1812	1383	2523	1738	1325	2346	1612	1228	2262	1553	1182	2119	1452	1104
30000	3287	2270	1734	3153	2175	1660	3027	2085	1590	2815	1935	1474	2714	1863	1418	2543	1742	1325
35000		2649	2023	3678	2537	1936	3532	2433	1855	3284	2257	1719	3167	2174	1655	2967	2033	1546
40000		3027	2312		2900	2213	4036	2780	2120	3754	2579	1965	3619	2484	1891	3390	2323	1767
45000		3406	2601		3262	2490		3128	2385	4223	2902	2210	4071	2795	2128	3814	2613	1988
50000			2890		3625	2766		3475	2650	4692	3224	2456	4524	3105	2364	4238	2904	2208
55000			3179			3043		3823	2915		3547	2702	4976	3416	2600	4662	3194	2429
60000			3468			3320		4170	3180		3869	2947	5428	3726	2837	5086	3484	2650
65000						3596			3445		4192	3193		4037	3073	5509	3775	2871
70000									3710		4514	3438		4347	3310	5933	4065	3092
75000									3975		4836	3684		4658	3546		4355	3313
80000									4240			3930		4968	3782		4646	3533
85000												4175		5279	4019		4936	3754
90000												4421			4255		5227	3975
95000												4666			4492		5517	4196
100000															4728		5807	4417

Ø Bolt (mm)	110			120			125			130			140			150										
Pitch (mm)	6			6			6			6			6			6										
Width across flats (mm)	155			170			180			185			200			210										
Friction coefficient	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20								
Torque (N.m)																										
3500																										
4000																										
4500																										
5000																										
5500																										
6000																										
6500																										
7000																										
7500																										
8000																										
8500																										
9000																										
9500																										
10000	794																									
12000	953																									
14000	1112	761			1019																					
16000	1271	869			1165			1105																		
18000	1430	978	743			1311			1243				1210													
20000	1589	1086	826			1456	994			1381			1345				1249									
25000	1986	1358	1032			1820	1242	943			1727	1177			1681	1145			1561							
30000	2383	1630	1238			2185	1491	1132			2072	1412	1071			2017	1374			1873	1274	1785				
35000	2780	1901	1445			2549	1739	1320			2417	1648	1250			2353	1603	1215			2185	1486	2083			
40000	3177	2173	1651			2913	1988	1509			2763	1883	1428			2689	1832	1389			2497	1699	1287	2380		
45000	3574	2445	1858			3277	2236	1697			3108	2119	1607			3025	2061	1563			2809	1911	1448	2678	1819	
50000	3971	2716	2064			3641	2485	1886			3453	2354	1786			3361	2290	1736			3122	2123	1609	2975	2022	
55000	4368	2988	2270			4005	2733	2075			3799	2589	1964			3697	2519	1910			3434	2336	1770	3273	2224	1684
60000	4766	3259	2477			4369	2982	2263			4144	2825	2143			4034	2748	2084			3746	2548	1930	3570	2426	1837
65000	5163	3531	2683			4733	3230	2452			4489	3060	2321			4370	2977	2257			4058	2760	2091	3868	2628	1990
70000	5560	3803	2890			5097	3479	2640			4835	3295	2500			4706	3206	2431			4370	2973	2252	4165	2830	2143
75000	5957	4074	3096			5461	3727	2829			5180	3531	2678			5042	3435	2605			4682	3185	2413	4463	3032	2297
80000	6354	4346	3302			5825	3976	3018			5525	3766	2857			5378	3664	2778			4995	3397	2574	4760	3235	2450
85000	6751	4618	3509			6190	4224	3206			5871	4002	3035			5714	3893	2952			5307	3610	2735	5058	3437	2603
90000	7148	4889	3715			6554	4473	3395			6216	4237	3214			6050	4122	3125			5619	3822	2896	5355	3639	2756
95000		5161	3921			6918	4721	3583			6561	4472	3392			6386	4351	3299			5931	4034	3057	5653	3841	2909
100000		5432	4128			7282	4970	3772			6907	4708	3571			6723	4580	3473			6243	4246	3217	5950	4043	3062

Tightening load (lbs) - imperial system

As a function of the torque (ft.lb)
of the diameter of the standard bolt from 1/4" to 1 1/4"
of the bolt friction coefficient

Ø Bolt (in)	1/4"			5/16"			3/8"			7/16"			1/2"			9/16"		
Nber of threads/inch	20			18			16			14			13			12		
Width across flats (in)	7/16"			1/2"			9/16"			5/8"			3/4"			27/32"		
Friction coefficient	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20
Torque (ft.lb)																		
5	1556	1114	867	1350	964	750												
10	3111	2227	1735	2700	1928	1499	2382	1700	1322	2126	1519		1808	1284				
20	6223	4455	3469	5400	3856	2998	4764	3400	2643	4252	3038	2364	3615	2568	1991	3230		
30		6682	5204	8100	5783	4497	7147	5100	3965	6378	4558	3546	5423	3852	2987	4846	3435	
40			6938		7711	5996	9529	6800	5286	8503	6077	4728	7230	5136	3982	6461	4580	3547
50					9639	7495	11911	8500	6608	10629	7596	5910	9038	6420	4978	8076	5725	4434
60						8995		10200	7930	12755	9115	7092	10846	7704	5974	9691	6870	5320
70								11900	9251	14881	10635	8274	12653	8988	6969	11306	8014	6207
80									10573	17007	12154	9456	14461	10272	7965	12921	9159	7094
90									11894		13673	10638	16269	11556	8961	14537	10304	7981
100											15192	11820	18076	12840	9956	16152	11449	8867
120												14183	21691	15408	11947	19382	13739	10641
140												16547		17976	13939	22613	16029	12414
160														20544	15930	25843	18319	14188
180															17921		20609	15961
200															19912		22898	17735
250																	28623	22168
300																		26602
350																		
400																		
450																		
500																		
550																		
600																		
650																		
700																		
750																		
800																		
850																		
900																		
950																		
1000																		
1200																		
1400																		
1600																		
1800																		
2000																		
2500																		
3000																		
3500																		
4000																		

Ø Bolt (in)	5/8"			3/4"			7/8"			1"			1 1/8"			1 1/4"														
Nber of threads/inch	11			10			9			8			7			7														
Width across flats (in)	15/16"			1/18"			1 5/16"			1 1/2"			1 11/16"			1 7/8"														
Friction coefficient	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20												
Torque (ft.lb)																														
5																														
10																														
20																														
30																														
40	5829																													
50	7286			6141																										
60	8744		6192	7369																										
70	10201		7224	5592		8597		6060																						
80	11658		8256	6391		9825		6926	8471																					
90	13115		9288	7189		11053		7792	6016		9530																			
100	14573		10320	7988		12281		8657	6685		10589		7447	9283																
120	17487		12383	9586		14737		10389	8022		12707		8936	11139																
140	20402		14447	11183		17193		12120	9359		14825		10426	8040		12996		9132	11530											
160	23316		16511	12781		19650		13852	10696		16943		11915	9188		14853		10437	13178											
180	26231		18575	14379		22106		15583	12033		19061		13404	10337		16709		11742	9051		14825									
200	29145		20639	15976		24562		17315	13370		21178		14894	11485		18566		13046	10057		16472		11584							
250			25799	19970		30703		21643	16712		26473		18617	14357		23207		16308	12571		20590		14480	11166		18754				
300			30959	23964		36843		25972	20055		31768		22341	17228		27848		19570	15085		24708		17376	13400		22505				
350				27958		42984		30301	23397		37062		26064	20099		32490		22831	17599		28826		20272	15633		26256		18375		
400				31953		49124		34630	26740		42357		29787	22971		37131		26093	20113		32944		23168	17866		30007		20999		
450								38958	30082		47652		33511	25842		41773		29354	22628		37062		26064	20099		33758		23624		
500								43287	33425		52946		37234	28713		46414		32616	25142		41180		28960	22333		37509		26249	20189	
550								47616	36767		58241		40958	31585		51056		35878	27656		45298		31856	24566		41259		28874	22208	
600									40110				44681	34456		55697		39139	30170		49416		34752	26799		45010		31499	24227	
650									43452				48404	37327		60338		42401	32684		53534		37648	29032		48761		34124	26246	
700									46795				52128	40199		64980		45662	35198		57652		40544	31266		52512		36749	28265	
750													55851	43070		69621		48924	37713		61770		43440	33499		56263		39374	30284	
800													59575	45941		74263		52185	40227		65888		46336	35732		60014		41999	32303	
850														48813		78904		55447	42741		70007		49232	37965		63765		44624	34321	
900														51684		83545		58709	45255		74125		52128	40199		67515		47249	36340	
950														54555		88187		61970	47769		78243		55024	42432		71266		49874	38359	
1000														57427				65232	50283		82361		57920	44665		75017		52499	40378	
1200														68912				78278	60340		98833		69504	53598		90021		62998	48454	
1400																		91325	70397		11530		81088	62531		105024		73498	56529	
1600																			80453		5		92672	71464		120027		83998	64605	
1800																			90510				10425	80398		135031		94498	72681	
2000																					6		89331	150034		104997	80756			
2500																					11584		11166				131247	100945		
3000																					0		3				157496	121134		
3500																												141324		
4000																												161513		

Tightening load (lbs) - imperial system as a function of the torque

Ø Bolt (in)	1 3/8"			1 1/2"			1 3/4"			2"			2 1/4"		
Nber of threads/inch	6			6			5			4 1/2			4 1/2		
Width across flats (in)	2 1/16"			2 1/4"			2 5/8"			3"			3 3/8"		
Friction coefficient	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20
Torque (ft.lb)															
300	20326														
350	23713			21946											
400	27101			25081											
450	30489 21394			28216											
500	33876 23771 20140			31352 21913											
550	37264 26148 21971			34487 24105			29471								
600	40651 28525 23802			37622 26296			32150								
650	44039 30902 25633			40757 28487 21896			34829								
700	47427 33279 27464			43892 30679 23580			37509			32919					
750	50814 35656 29295			47027 32870 25265			40188 28124			35270					
800	54202 38033 31126			50162 35062 26949			42867 29999			37622					
850	57590 40410 32956			53298 37253 28633			45546 31874			39973					
900	60977 42787 34787			56433 39444 30317			48225 33749			42325					
950	64365 45165 36618			59568 41636 32002			50904 35624 27399			44676					
1000	67752 47542 43942			62703 43827 33686			53584 37499 28842			47027 32870			42299		
1200	81303 57050 51266			75244 52592 40423			64300 44999 34610			56433 39444			50758		
1400	94853 66558 58589			87784 61358 47160			75017 52499 40378			65838 46018			59218 41191		
1600	108404 76067 65913			100325 70123 53898			85734 59999 46146			75244 52592 40423			67678 47075		
1800	121954 85575 73237			112866 78888 60635			96451 67498 51915			84649 59166 45476			76138 52959		
2000	135505 95083 91546			125406 87654 67372			107167 74998 57683			94055 65740 50529			84597 58844 45111		
2500	169381 118854 109855			156758 109567 84215			133959 93748 72104			117568 82175 63161			105747 73555 56388		
3000	142625 128164			188109 131481 101058			160751 112497 86525			141082 98611 75794			126896 88265 67666		
3500	166396 146473			153394 117901			187543 131247 100945			164596 115046 88426			148046 102976 78944		
4000	164782			175308 134744			214335 149996 115366			188109 131481 101058			169195 117687 90221		
4500				197221 151587			241127 168746 129787			211623 147916 113690			190344 132398 101499		
5000				168430			267918 187496 144208			235136 164351 126323			211494 147109 112777		
5500				185273			206245 158628			258650 180786 138955			232643 161820 124054		
6000				202116			224995 173049			282164 197221 151587			253792 176531 135332		
6500							243744 187470			305677 213656 164219			274942 191242 146610		
7000							262494 201891			329191 230091 176852			296091 205953 157887		
7500							216312			246526 189484			317241 220664 169165		
8000							230732			262961 202116			338390 235374 180443		
8500							245153			279397 214749			359539 250085 191720		
9000							259574			295832 227381			380689 264796 202998		
9500										312267 240013			401838 279507 214276		
10000										328702 252645			422987 294218 225553		
12000										303174			353062 270664		
14000										353703			411905 315775		
16000													360885		
18000													405996		
20000													451107		
25000															
30000															
35000															
40000															
45000															
50000															
55000															
60000															
65000															
70000															
75000															

(ft.lb.) and of the diameter of the standard bolt from 1 3/8" to 3 1/2" and of the bolt friction coefficient

Ø Bolt (in)	2 1/2"			2 3/4"			3"			3 1/4"			3 1/2"		
Nber of threads/inch	4			4			4			4			4		
Width across flats (in)	3 3/4"			4 1/8"			4 1/2"			4 7/8"			5 1/4"		
Friction coefficient	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20
Torque (ft.lb)															
300															
350															
400															
450															
500															
550															
600															
650															
700															
750															
800															
850															
900															
950															
1000															
1200															
1400	53233														
1600	60838														
1800	68443			62769											
2000	76047	52922		69743											
2500	95059	66153		87179			80506								
3000	114071	79383	60873	104615	72539		96607								
3500	133083	92614	71018	122051	84629	64770	112708	77912		104694					
4000	152095	105845	81164	139487	96719	74023	128809	89042		119650					
4500	171107	119075	91309	156923	108809	83276	144911	100172	76542	134607	92806		125671		
5000	190118	132306	101455	174359	120899	92529	161012	111303	85046	149563	103118		139634		
5500	209130	145536	111600	191795	132989	101782	177113	122433	93551	164519	113430		153598		
6000	228142	158767	121746	209230	145079	111034	193214	133563	102055	179475	123741	94420	167561	115265	
6500	247154	171998	131891	226666	157168	120287	209315	144693	110560	194432	134053	102288	181524	124870	
7000	266166	185228	142037	244102	169258	129540	225416	155824	119065	209388	144365	110157	195488	134476	
7500	285178	198459	152182	261538	181348	138793	241518	166954	127569	224344	154677	118025	209451	144081	109810
8000	304189	211689	162328	278974	193438	148046	257619	178084	136074	239301	164988	125893	223415	153687	117130
8500	323201	224920	172473	296410	205528	157299	273720	189214	144579	254257	175300	133762	237378	163292	124451
9000	342213	238150	182619	313846	217618	166552	289821	200345	153083	269213	185612	141630	251341	172898	131772
9500	361225	251381	192764	331282	229708	175804	305922	211475	161588	284169	195924	149499	265305	182503	139092
10000	380237	264612	202909	348717	241798	185057	322024	222605	170092	299126	206235	157367	279268	192108	146413
12000	456284	317534	243491	418461	290157	222069	386428	267126	204111	358951	247483	188840	335122	230530	175695
14000	532332	370456	284073	488204	338517	259080	450833	311647	238129	418776	288730	220314	390975	268952	204978
16000		423379	324655	557948	386876	296092	515238	356168	272148	478601	329977	251787	446829	307373	234261
18000		476301	365237	627691	435236	333103	579642	400689	306166	538426	371224	283260	502683	345795	263543
20000		529223	405819		483595	370115	644047	445210	340185	598252	412471	314734	558536	384217	292826
25000			507274		604494	462643	805059	556513	425231	747814	515589	393417	698171	480271	366032
30000			608728		725393	555172		667816	510277	897377	618706	472101	837805	576325	439239
35000						647701		779118	595324		721824	550784	977439	672379	512445
40000									680370		824942	629467	1117073	768434	585651
45000									765416		928060	708151		864488	658858
50000												786834		960542	732064
55000												865518		1056596	805271
60000												944201		1152650	878477
65000															951684
70000															1024890
75000															1098096

Tightening load (lbs) - imperial system

As a function of the torque (ft.lb.)
of the diameter of the standard bolt from 3 3/4" to 6"
of the bolt friction coefficient

Ø Bolt (in)	3 3/4"			4"			4 1/4"			4 1/2"			4 3/4"		
Nber of threads/inch	4			4			4			4			4		
Width across flats (in)	5 5/8"			6"			6 3/8"			6 3/4"			7 1/8"		
Friction coefficient	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20
Torque (ft.lb)															
5500	144036														
6000	157130														
6500	170224			160248											
7000	183318	125855		172575											
7500	196412	134844		184902			174665								
8000	209506	143834		197228	135169		186310								
8500	222601	152824		209555	143617		197954			187570					
9000	235695	161813	123196	221882	152065		209599			198604					
9500	248789	170803	130040	234209	160513		221243	151392		209637					
10000	261883	179793	136885	246536	168961	128521	232887	159360		220671				209672	
12000	314260	215751	164261	295843	202753	154225	279465	191232		264805	180950			251607	
14000	366636	251710	191638	345150	236545	179929	326042	223104	169568	308939	211108	160335		293541	
16000	419013	287668	219015	394457	270337	205633	372620	254976	193792	353073	241267	183240		335476	228956
18000	471389	323627	246392	443764	304130	231337	419197	286848	218016	397208	271425	206146		377410	257576 195501
20000	523766	359585	273769	493071	337922	257041	465775	318720	242240	441342	301583	229051		419345	286195 217223
25000	654708	449482	342211	616339	422402	321302	582218	398400	302800	551677	376979	286313		524181	357744 271529
30000	785649	539378	410654	739607	506883	385562	698662	478080	363360	662013	452375	343576		629017	429293 325835
35000	916591	629274	479096	862874	591363	449822	815105	557760	423920	772348	527771	400838		733853	500842 380141
40000	1047532	719171	547538	986142	675843	514083	931549	637440	484480	882684	603167	458101		838689	572391 434446
45000	1178474	809067	615981	1109410	760324	578343	1047993	717120	545040	993019	678563	515364		943525	643940 488752
50000	1309415	898963	684423	1232678	844804	642603	1164436	796800	605600	1103355	753958	572626		1048362	715488 543058
55000		988860	752865	1355945	929285	706864	1280880	876480	666160	1213690	829354	629889		1153198	787037 597364
60000		1078756	821307	1479213	1013765	771124	1397324	956160	726720	1324026	904750	687152		1258034	858586 651670
65000		1168652	889750		1098246	835384	1513767	1035840	787280	1434361	980146	744414		1362870	930135 705975
70000		1258549	958192		1182726	899645	1630211	1115520	847840	1544696	1055542	801677		1467706	1001684 760281
75000			1026634		1267207	963905		1195201	908400	1655032	1130938	858940		1572542	1073233 814587
80000			1095077		1351687	1028165		1274881	968960	1765367	1206333	916202		1677379	1144781 868893
85000			1163519		1436167	1092426		1354561	1029520	1875703	1281729	973465		1782215	1216330 923199
90000			1231961			1156686		1434241	1090080		1357125	1030728		1887051	1287879 977504
95000						1220946		1513921	1150640		1432521	1087990		1991887	1359428 1031810
100000						1285207		1593601	1211200		1507917	1145253		2096723	1430977 1086116

Ø Bolt (in)	5"			5 1/4"			5 1/2"			5 3/4"			6"							
Nber of threads/inch	4			4			4			4			4							
Width across flats (in)	7 1/2"			7 7/8"			8 1/4"			8 5/8"			9"							
Friction coefficient	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20					
Torque (ft.lb)																				
5500																				
6000																				
6500																				
7000																				
7500																				
8000																				
8500																				
9000																				
9500																				
10000																				
12000	239662																			
14000	279605			266933																
16000	319549			305066			291839			279711										
18000	359493		245071	343199																
20000	399436		272301	381332		259694	364798		248202	349638		302120								
25000	499295		340377	258197	476665		324618	455998		310253	437048		297106	419611		285028				
30000	599154		408452	309836	571998		389541	295335	547197		372304	282130	524458		356527	503533		342033		
35000	699013		476528	361475	667331		454465	344557	638397		434354	329152	611867		415948	315065	587455		399039	302135
40000	798872		544603	413115	762664		519388	393780	729597		496405	376173	699277		475370	360074	671377		456045	345297
45000	898731		612678	464754	857998		584312	443002	820796		558456	423195	786687		534791	405084	755299		513050	388459
50000	998590		680754	516393	953331		649235	492224	911996		620506	470217	874096		594212	450093	839221		570056	431621
55000	1098449		748829	568033	1048664		714159	541447	1003195		682557	517239	961506		653633	495102	923143		627061	474783
60000	1198308		816904	619672	1143997		779082	590669	1094395		744607	564260	1048915		713054	540112	1007065		684067	517945
65000	1298167		884980	671311	1239330		844006	639892	1185594		806658	611282	1136325		772476	585121	1090987		741072	561107
70000	1398026		953055	722950	1334663		908929	689114	1276794		868709	658304	1223735		831897	630130	1174909		798078	604269
75000	1497885		1021130	774590	1429996		973853	738337	1367994		930759	705325	1311144		891318	675140	1258832		855084	647431
80000	1597744		1089206	826229	1525329		1038776	787559	1459193		992810	752347	1398554		950739	720149	1342754		912089	690593
85000	1697604		1157281	877868	1620662		1103700	836782	1550393		1054861	799369	1485964		1010160	765158	1426676		969095	733756
90000	1797463		1225357	929508	1715995		1168623	886004	1641592		1116911	846390	1573373		1069582	810167	1510598		1026100	776918
95000	1897322		1293432	981147	1811328		1233547	935226	1732792		1178962	893412	1660783		1129003	855177	1594520		1083106	820080
100000	1997181		1361507	1032786	1906661		1298470	984449	1823991		1241012	940434	1748192		1188424	900186	1678442		1140111	863242

Table: Metric System Tension Load (kN)

This table shows the tightening loads to apply to a bolt as a function of bolt diameter and class (mechanical properties) in order to obtain tightening at 80% of its yield point (Re).

Bolt Diameter (mm)	Pitch (mm)	kN load for tightening to 80% of the yield point		
		Class		
		8-8 Yield point = 640 MPa	10-9 Yield point = 900 MPa	12-9 Yield point = 1080 MPa
8	1.25	19	26	32
10	1.5	31	44	53
12	1.75	45	63	76
14	2	64	90	108
16	2	80	113	135
18	2.5	105	147	176
20	2.5	125	176	212
22	2.5	155	218	262
24	3	180	254	305
27	3	235	331	397
30	3.5	297	418	502
33	3.5	355	499	599
36	4	418	588	706
39	4	500	703	843
42	4.5	574	807	968
45	4.5	669	940	1128
48	5	754	1061	1273
52	5	900	1266	1519
56	5.5	1039	1462	1754
60	5.5	1209	1701	2041
64	6	1370	1927	2312
68	6	1564	2200	2640
72	6	1771	2491	2989
76	6	1991	2800	3360
80	6	2224	3128	3753
85	6	2533	3562	4275
90	6	2862	4025	4830
95	6	3212	4517	5420
100	6	3581	5036	6043
110	6	4380	6160	7392
120	6	5260	7397	8876
125	6	5730	8058	9669
130	6	6220	8747	10496
140	6	7261	10210	12252
150	6	8381	11786	14144

Example: One M39 class 10-9 bolt can be tightened with a residual tightening load of 703 kN to provide an initial tightening load corresponding to 80% of the bolt's yield point.

Table: Imperial System Tension Load (lbs)

Bolt Diameter		Number of threads* per inch	Pound load for tightening to 80% of the yield point		
(in)	(mm)		Class		
			8-8 Yield point = 95000 psi	10-9 Yield point = 130000 psi	12-9 Yield point = 155000 psi
5/16"	7.94	18	4047	5538	6603
3/8"	9.53	16	5974	8176	9748
7/16"	11.11	14	8194	11212	13368
1/2"	12.70	13	10926	14952	17827
9/16"	14.29	12	14002	19160	22845
5/8"	15.88	11	17388	23794	28370
3/4"	19.05	10	25702	35171	41935
7/8"	22.23	9	35462	48526	57858
1"	25.40	8	46513	63650	75890
1 1/8"	28.58	7	58620	80217	95643
1 1/4"	31.75	7	74341	101730	121294
1 3/8"	34.93	6	88648	121308	144637
1 1/2"	38.10	6	107767	147470	175830
1 3/4"	44.45	5	145709	199391	237736
2"	50.80	4 1/2	191586	262170	312587
2 1/4"	57.15	4 1/2	248786	340444	405915
2 1/2"	63.50	4	306360	419230	499851
2 3/4"	69.85	4	377706	516861	616257
3"	76.20	4	456514	624703	744838
3 1/4"	82.55	4	542783	742756	885593
3 1/2"	88.90	4	636514	871019	1038522
3 3/4"	95.25	4	737706	1009492	1203625
4"	101.60	4	846360	1158176	1380903
4 1/4"	107.95	4	962475	1317071	1570354
4 1/2"	114.30	4	1086052	1486176	1771979
4 3/4"	120.65	4	1217090	1665492	1985779
5"	127.00	4	1355590	1855018	2211753
5 1/4"	133.35	4	1501552	2054755	2449900
5 1/2"	139.70	4	1654975	2264702	2700222
5 3/4"	146.05	4	1815859	2484860	2962718
6"	152.40	4	1984205	2715229	3237388

Example: One 1 1/2" class 10-9 bolt can be tightened with a residual tightening load of 147470 lbs to provide an initial tightening load corresponding to 80% of the bolt's yield point.

* Coarse thread series UNC/UNRC



Standard product range

In its standard range of hydraulic tensioners, SKF Equipements offers no less than 6 different types of tensioners with characteristics which are both different and complementary.

The product range includes multi-purpose, powerful, thin, compact and other types of tensioners, covering a wide range of bolt dimensions from M8 to M160 (5/16" to 6"), and able to apply pre-tightening loads ranging from 50 kN to 8500 kN.

Tensioner dimension has been carefully designed to allow use in the widest range of situations.

The product range has improved and extended over the years, benefiting from SKF Equipements' extensive experience in the hydraulic tightening field. Experience gained from responding to customer demand has also contributed to enriching the product range.

This range should therefore meet your tensioner and accessory needs. If however this were not the case, SKF Equipements also makes customized tensioners (adapting standard tensioner parts to your application) and special tensioners (new design of dedicated tensioners).

Specially designed tensioners have enabled us to increase the range of sizes of bolts tightened, covering M5 to M500 (3/16" to 20").

Generally speaking, it is more economical to plan the use of the tensioner from the assembly design stage, and to try to use standard equipment.

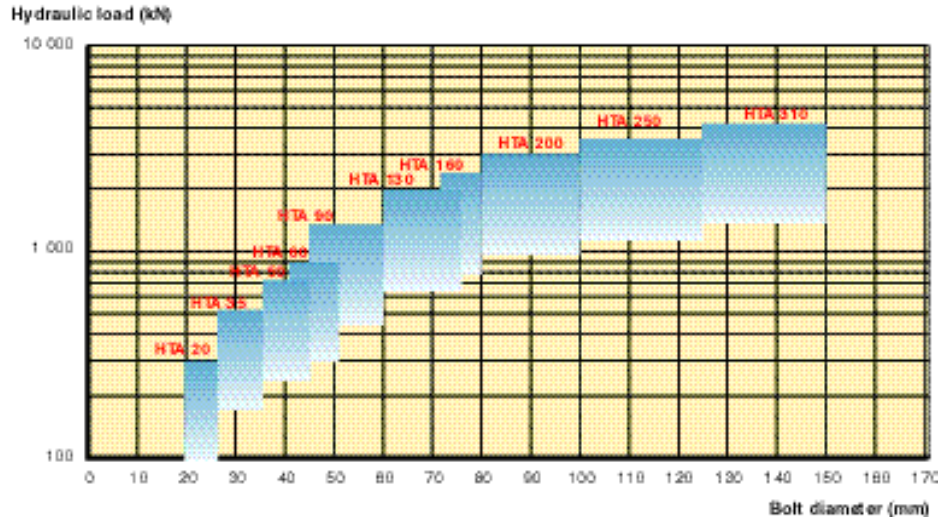
This provides significant savings in the cost of tightening bolted assemblies.



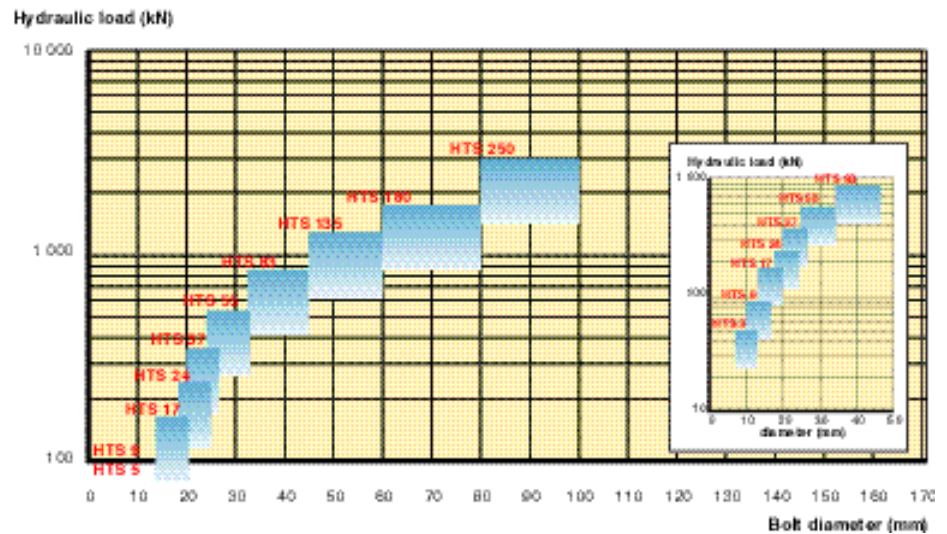
Hydraulic force diagrams for standard tensioners

These hydraulic force diagrams help define the type(s) of tensioners which best suit your application, depending on the size of the bolt and the traction load to apply. In addition, you must verify the other characteristics with respect to your operational constraints (space, weight, time...).

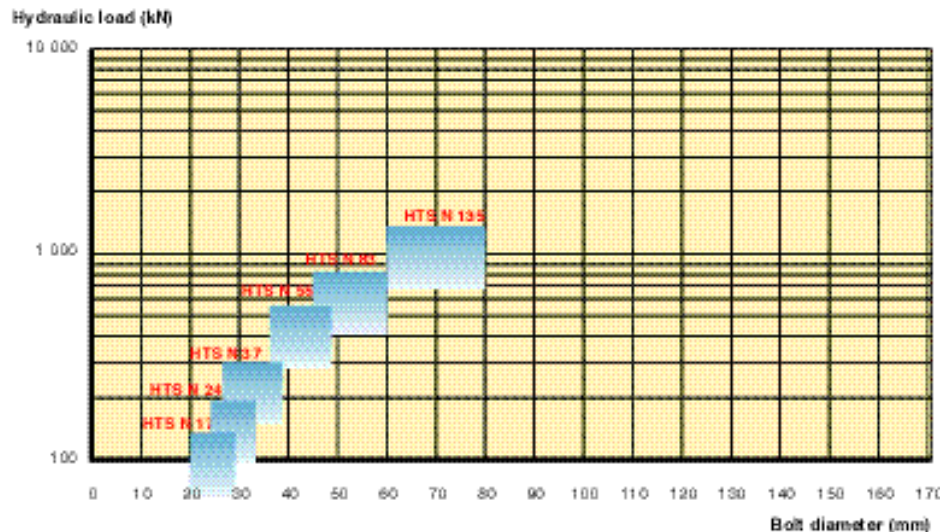
HTA



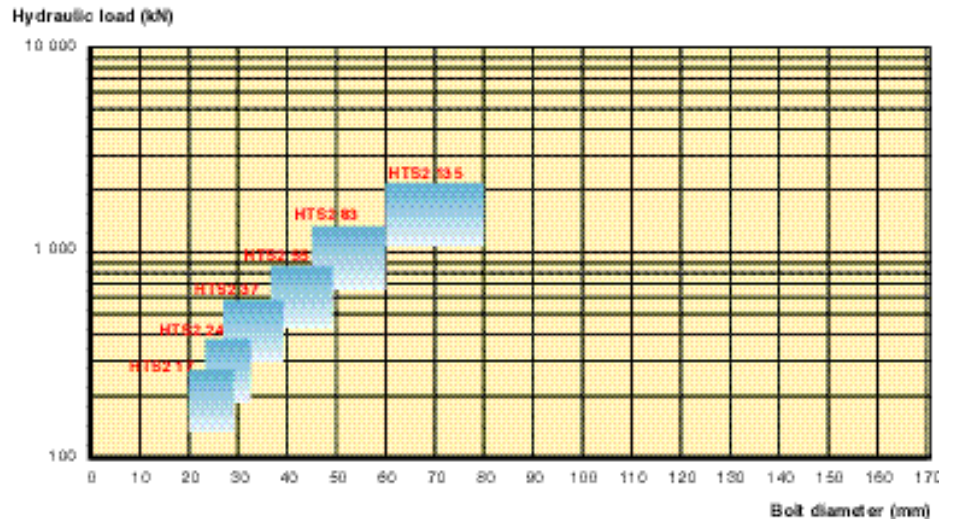
HTS



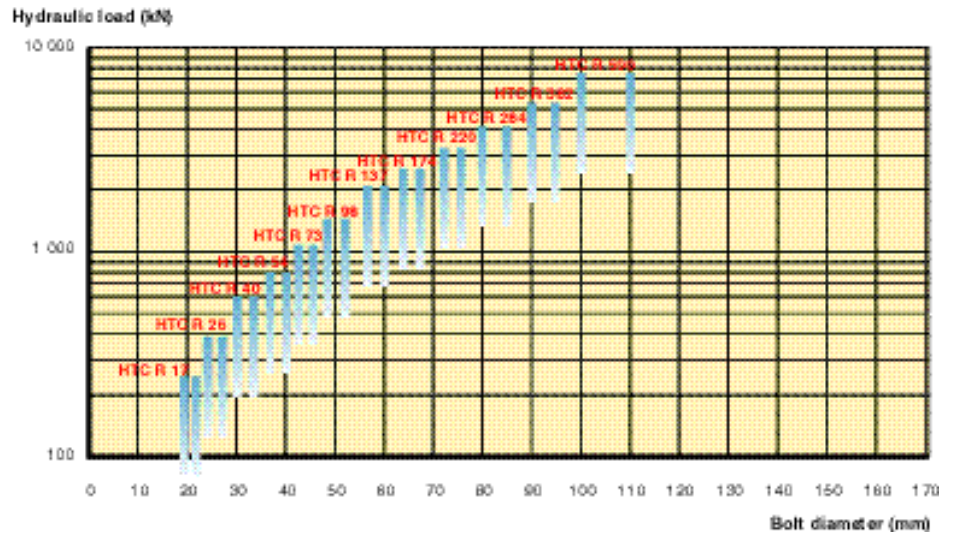
HTS N



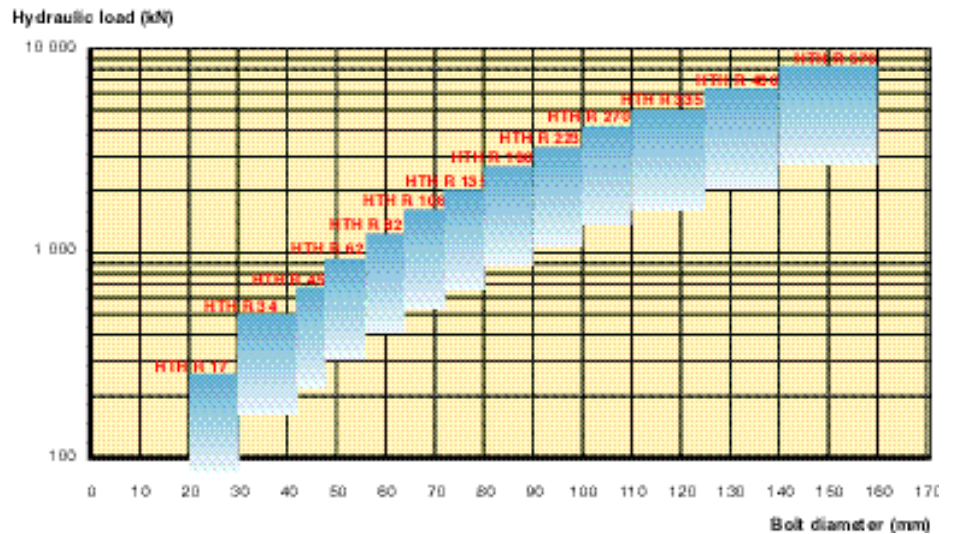
HTS2



HTC R



HTH R



Summary Table: Standard Tensioner

This table summarizes the main features of each tensioner, in order to help you select the standard tensioner for your operational requirements.



HTA



HTS



HTS N

Tightens several diameters ⁽¹⁾	Yes	Yes	Yes
Diameters of the bolts tightened	Small and large	Small and very small	Small
Space occupied by the tensioner	Normal	Small	Little
Tightening load	High	High	Average
Stroke arresting device	Optional	Optional	Optional
Automatic return	No	Optional	Optional
Cost index ⁽²⁾	100 (base)	140	160
Special Feature	Adaptable	Very small bolt diameters	The same tensioner can tighten several diameters
Catalogue page	34 - 35	36 - 37	38 - 39

⁽¹⁾ by changing the brace

⁽²⁾ indicative, also takes into account the loads applied

Characteristics



HTS 2



HTC R

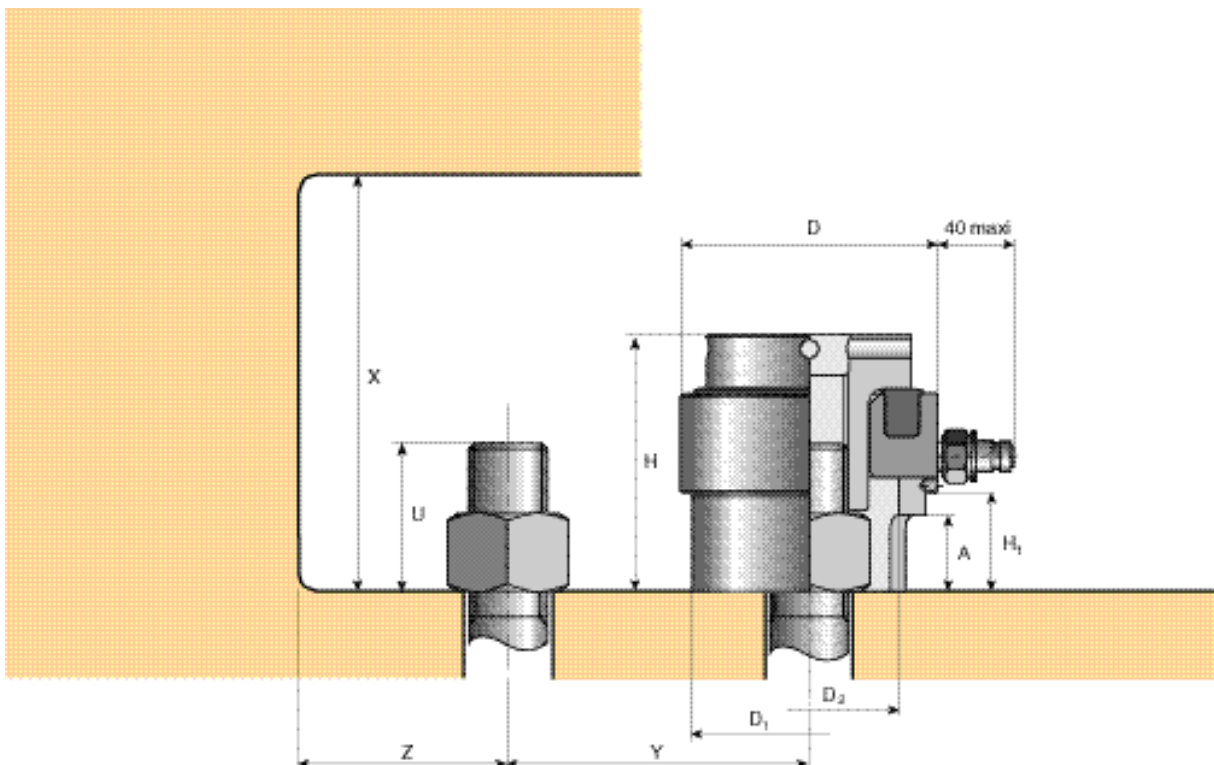
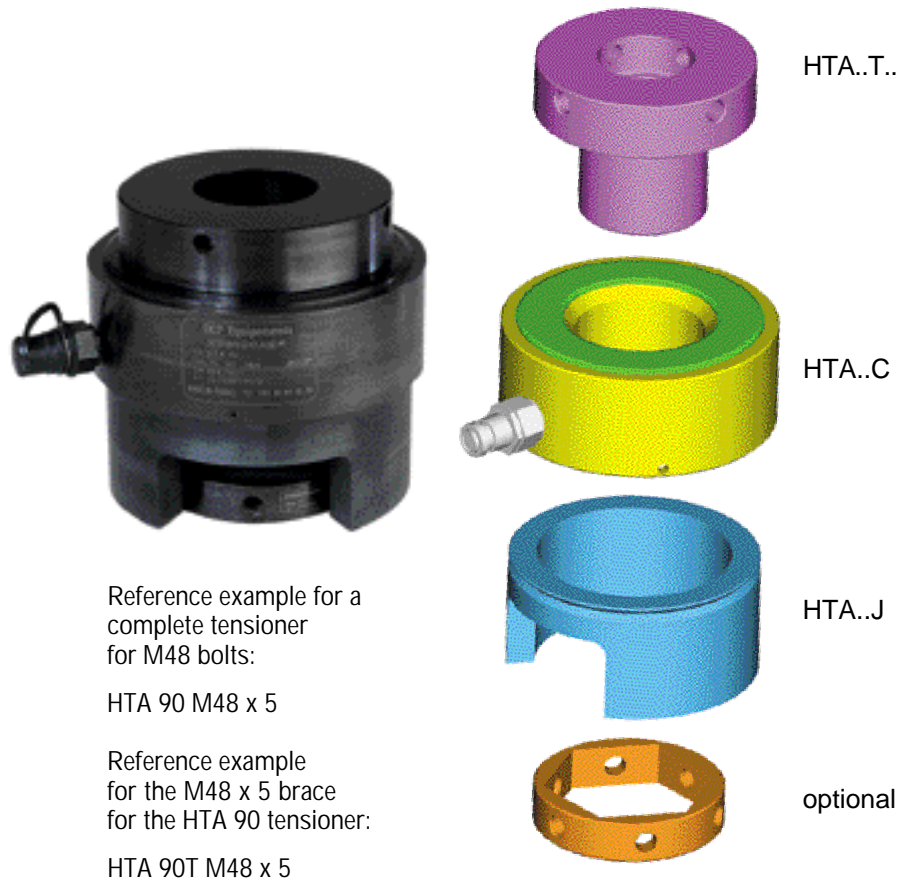


HTH R

Yes	No	Yes
Small and average	Small and large	Large and very large
Very little	Compact	Very little
High	Very high	Very high
Optional	Yes	Yes
Optional	Yes	Yes
200	180	250
Fits in very narrow spaces	Compact and powerful	Takes up very little space and very powerful
40 - 41	42 - 43	44 - 45

Multi-purpose

The dimensions and the traction load suit this tensioner to many different applications.

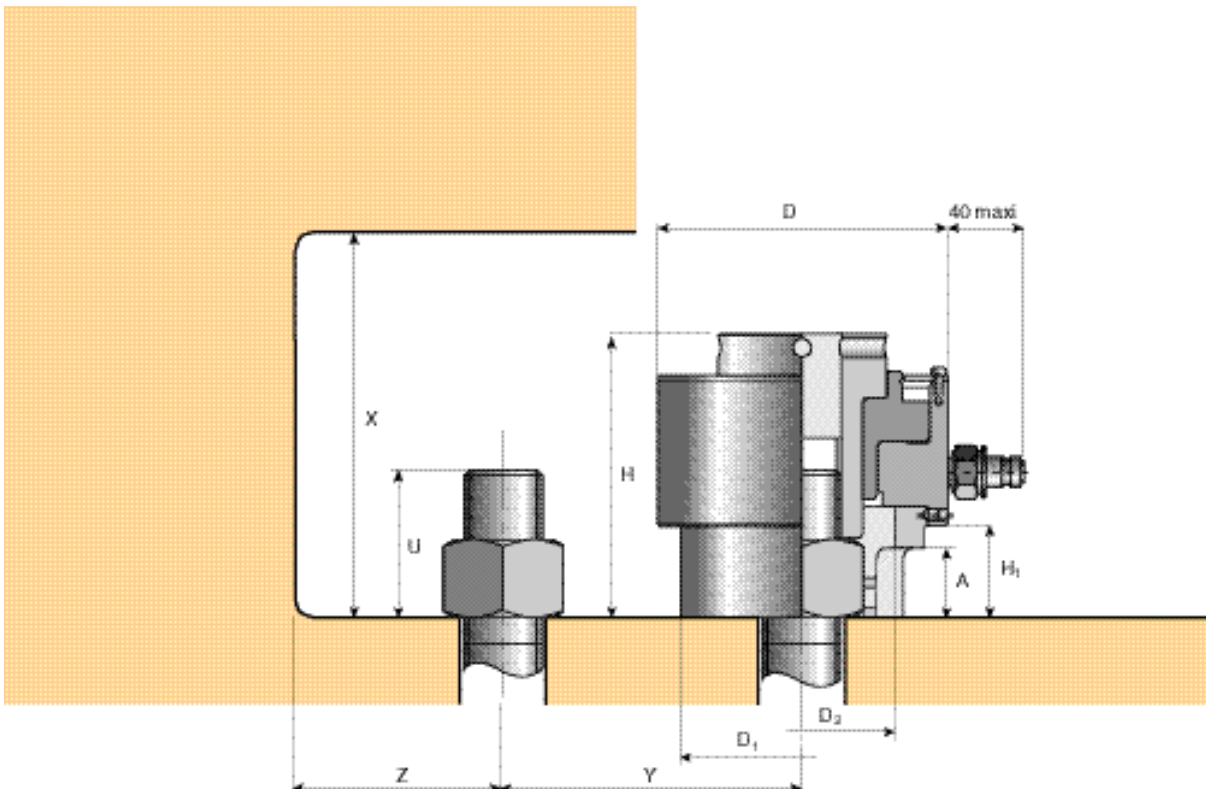


Tensioner reference		HTA 20	HTA 35	HTA 50	HTA 60	HTA 90	HTA 130	HTA 160	HTA 200	HTA 250	HTA 310
Bolt dimension (M Ø x pitch)	Metric system	M 20 x 2.5	M 27 x 3	M 36 x 4	M 42 x 4.5	M 45 x 4.5	M 60 x 5.5	M 72 x 6	M 80 x 6	M 100 x 6	M 125 x 6
		M 22 x 2.5	M 30 x 3.5	M 39 x 4	M 45 x 4.5	M 48 x 5	M 64 x 6	M 76 x 6	M 85 x 6	M 110 x 6	M 130 x 6
		M 24 x 3	M 33 x 3.5	M 42 x 4.5	M 48 x 5	M 52 x 5	M 68 x 6	M 80 x 6	M 90 x 6	M 120 x 6	M 140 x 6
		M 27 x 3	M 36 x 4	M 45 x 4.5	M 52 x 5	M 56 x 5.5	M 72 x 6	M 76 x 6	M 95 x 6	M 125 x 6	M 150 x 6
Ø in - Threads/in	Imperial system	3/4" - 10	1" - 8	1 3/8" - 6	1 1/2" - 6	1 3/4" - 5	2 1/2" - 4	2 3/4" - 4	3 1/4" - 4	3 3/4" - 4	5" - 4
		7/8" - 9	1 1/8" - 7	1 1/2" - 6	1 3/4" - 5	2" - 4 1/2	2 3/4" - 4	3" - 4	3 1/2" - 4	4" - 4	5 1/4" - 4
		1" - 8	1 1/4" - 7	1 3/4" - 5	2" - 4 1/2	2 1/4" - 4 1/2	3" - 4	3 1/4" - 4	3 3/4" - 4	4 1/4" - 4	5 1/2" - 4
			1 3/4" - 6							4 1/2" - 4	5 3/4" - 4
Max. Pressure	(MPa)	150	150	150	150	150	150	150	150	150	150
	(psi)	21756	21756	21756	21756	21756	21756	21756	21756	21756	21756
Hydraulic area	(cm ²)	20	35	50	60	90	130	160	200	250	310
	(in ²)	3.10	5.43	7.75	9.30	13.95	20.15	24.80	31.00	38.75	48.05
Max. hydraulic load	(kN)	300	525	750	900	1 350	1 950	2 400	3 000	3 750	4 650
	(lbf)	67443	118025	168606	202328	303492	438377	539541	674426	843032	1045360
Piston stroke (mm)		8	8	8	8	8	8	10	10	10	10
D (mm)		86	109	128	137	166	198	215	244	284	325
H (mm)		100	116	128	140	154	179	190	217	245	273
H1 (mm)		30	40	49	54	65	82	86	106	131	156
D1 (mm)		74	97	116	133	154	187	203	232	272	313
D2 (mm)		56	73	90	102	114	137	145	180	223	260
A (mm)		26	31	38	40	42	50	50	60	73	86
U (mm)		38	52	69	80	86	114	137	152	190	238
		42	57	74	86	92	122	145	162	209	247
		46	63	80	92	99	130	152	171	228	266
		52	69	86	99	107	137	152	181	238	285
						114	145		190		
X (mm)		138	168	197	220	240	293	327	355	425	506
		142	173	202	226	246	301	335	365	444	515
		146	179	208	232	253	309	342	374	463	534
		152	185	214	239	261	316	342	384	473	553
						268	324		393		
Y (mm)		56	73.5	91	91	119	147	163.5	184.5	222	262.5
		57	76.5	94	92	122	150	166.5	187.5	227.5	265
		59	79	97	94	124.5	153	169.5	193	236	274
		62	81	100	96	127.5	155.5		196	242	280
					130.5	158.5		202			
Z (mm)		44.5	56	65.5	69.5	84.5	101	109	124	144	164.5
Total tensioner weight (kg)		3	4.8	7.5	9	15.3	25	31	39	54	75

Small

The HTS tensioner is specially designed to tighten small bolts (starting with M8).

However, it can also tighten large bolts. Its design also tolerates possible geometric faults in the assembly parts.



Tensioner reference		HTS 5	HTS 9	HTS 17	HTS 24	HTS 37	HTS 55	HTS 83	HTS 135	HTS 180	HTS 250
Bolt dimension (M Ø x pitch)	Metric system	M 8 x 1.25	M 10 x 1.5	M 14 x 2	M 18 x 2.5	M 20 x 2.5	M 24 x 3	M 33 x 3.5	M 45 x 4.5	M 56 x 5.5	M 80 x 6
		M 10 x 1.5	M 12 x 1.75	M 16 x 2	M 20 x 2.5	M 22 x 2.5	M 27 x 3	M 36 x 4	M 48 x 5	M 60 x 5.5	M 85 x 6
		M 12 x 1.75	M 14 x 2	M 18 x 2.5	M 22 x 2.5	M 24 x 3	M 30 x 3.5	M 39 x 4	M 52 x 5	M 64 x 6	M 90 x 6
		M 16 x 2	M 20 x 2.5	M 24 x 3	M 27 x 3	M 33 x 3.5	M 42 x 4.5	M 56 x 5.5	M 68 x 6	M 95 x 6	
								M 45 x 4.5	M 72 x 6	M 100 x 6	
									M 76 x 6	M 80 x 6	
Ø in - Threads/in	Imperial system	5/16" - 18	3/8" - 16	9/16" - 12	3/4" - 10	7/8" - 9	1" - 8	1 1/4" - 7	1 3/4" - 5	2 1/4"-4 1/2	3" - 4
		3/8" - 16	7/6" - 14	5/8" - 11	7/8" - 9	1" - 8	1 1/8" - 7	1 3/8" - 6	2" - 4 1/2	2 1/2" - 4	3 1/4" - 4
		7/16" - 14	1/2" - 13	3/4" - 10	1" - 8	1 1/8" - 7	1 1/4" - 7	1 1/2" - 6	2 1/4"-4 1/2	2 3/4" - 4	3 1/2" - 4
		9/16" - 12	5/8" - 11					1 3/4" - 5	3" - 4	3 3/4" - 4	
Max. Pressure	(MPa) (psi)	100 14504	100 14504	100 14504	100 14504	100 14504	100 14504	100 14504	100 14504	100 14504	120 17405
Hydraulic area	(cm ²) (in ²)	5 0.78	9 1.40	17 2.64	24 3.72	37 5.74	55 8.53	83 12.87	135 20.93	180 27.90	250 38.75
Max. hydraulic load	(kN) (lbf)	50 11240	90 20233	170 38217	240 53954	370 83179	550 123645	830 186591	1 350 303492	1 800 404655	3 000 674426
Piston stroke (mm)		5	6	6	6	6	7	8	8	15	15
D (mm)		51	60	65	80	97	114	145	180	250	285
H (mm)		58	68	85	95	95	111	142	200	265	310
H1 (mm)		14.5	17.5	16	20	20	26	46	75	95	140
D1 (mm)		40	48	60	64	84	98	122	155	220	250
D2 (mm)		28.5	35	42	52	60	72	92	117	156	194
A (mm)		14.5	17	16	14	18	24	35	40	55	47
U (mm)		16	20	27	35	38	46	63	86	107	152
		20	23	31	38	42	52	69	92	114	162
		23	27	35	42	46	57	74	99	122	171
			31	38	46	52	63	80	107	130	181
								86		137	190
										145	
										152	
X (mm)		74	88	112	130	133	157	205	286	372	462
		78	91	116	133	137	163	211	292	379	472
		81	95	120	137	141	168	216	299	387	481
			99	123	141	149	174	222	307	395	491
								228		402	500
										410	
										417	
Y (mm)		33	39.5	46.5	56.5	67.5	79	91.5	119.5	160.5	193
				48	58.5	68.5	81.5	94.5	122.5	163.5	196
				49.5	59.5	71	84.5	97	125	166.5	201.5
				51.5	62	73.5	87	100	128	169	204.5
								103		172	210
										175	
										178	
Z (mm)		23.5	28.5	34	41	50	58	74	92	127	144
Total tensioner weight (kg)		0.5	1	1.7	2.4	3.7	5.3	10.4	27	62	91

HTS N

Thin

This tensioner is designed to fit into narrow spaces. It is also used when bolts are spaced close together.

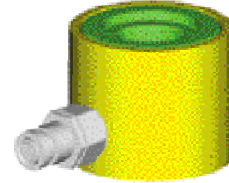
It particularly suits tightening big bolts with low traction load.



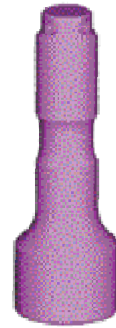
Tensioner component reference



HTS 2..ES



HTS..C



HTS N..T..



HTS 2..J



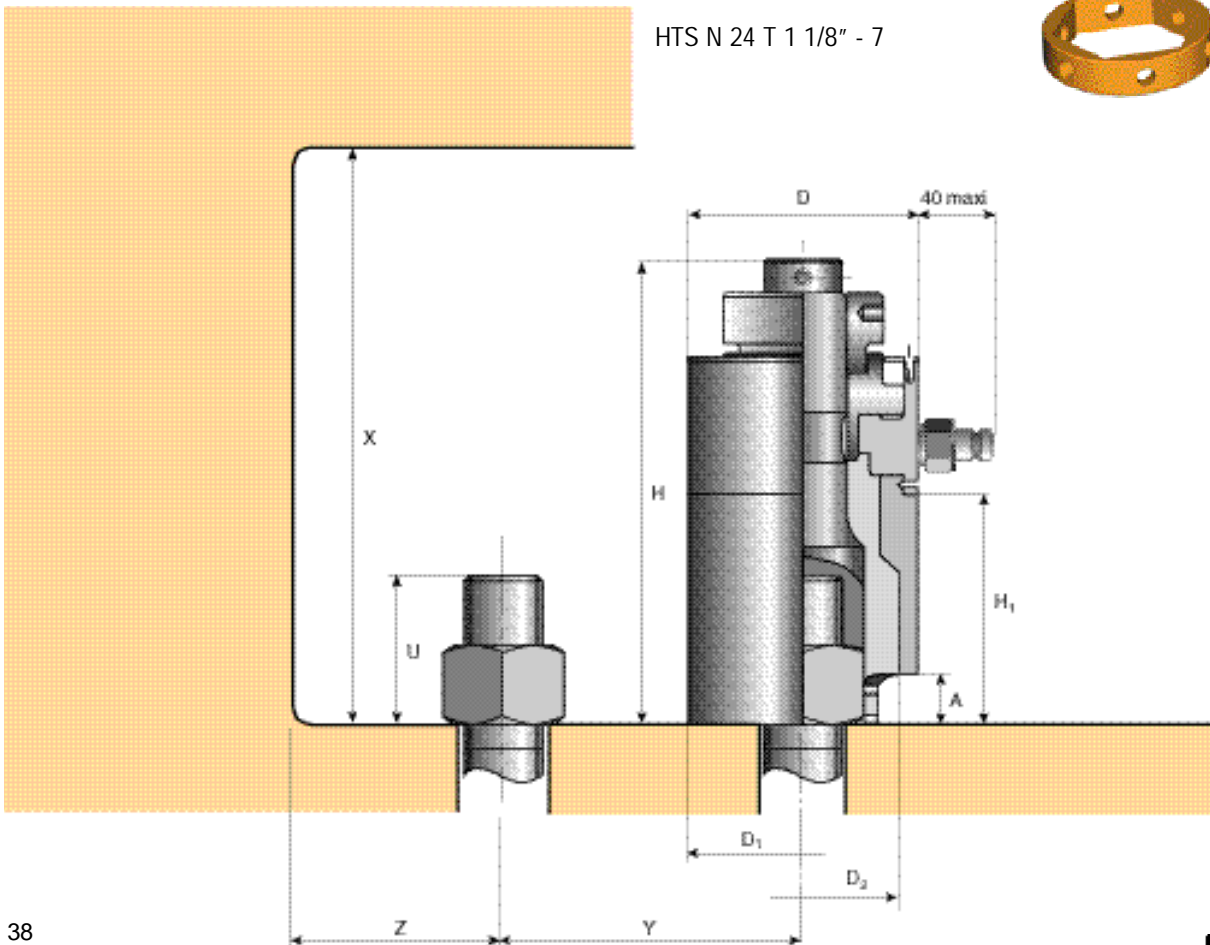
optional

Reference example for a complete tensioner for 1 1/8" - 7 bolts:

HTS N 24 1 1/8" - 7

Reference example for the 1 1/8" - 7 brace of the HTS N 24 tensioner:

HTS N 24 T 1 1/8" - 7



HTS N

Thin

Tensioner reference		HTS N 17	HTS N 24	HTS N 37	HTS N 55	HTS N 83	HTSN 135
Bolt dimension (M Ø x pitch)	Metric system	M 20 x 2.5	M 24 x 3	M 27 x 3	M 36 x 4	M 45 x 4.5	M 60 x 5.5
		M 22 x 2.5	M 27 x 3	M 30 x 3.5	M 39 x 4	M 48 x 5	M 64 x 6
		M 24 x 3	M 30 x 3.5	M 33 x 3.5	M 42 x 4.5	M 52 x 5	M 68 x 6
		M 27 x 3	M 33 x 3.5	M 36 x 4	M 45 x 4.5	M 56 x 5.5	M 72 x 6
				M 39 x 4	M 48 x 5	M 60 x 5.5	M 76 x 6 M 80 x 6
Ø in - Threads/in	Imperial system	3/4" - 10	7/8" - 9	1 1/8" - 7	1 3/8" - 6	1 3/4" - 5	2 1/4" - 4 1/2
		7/9" - 9	1" - 8	1 1/4" - 7	1 1/2" - 6	2" - 4 1/2	2 1/2" - 4
		1" - 8	1 1/8" - 7	1 3/8" - 6	1 3/4" - 5	2 1/4" - 4 1/2	2 3/4" - 4
			1 1/4" - 7	1 1/2" - 6			3" - 4
Max. Pressure	(MPa) (psi)	80 11603	80 11603	80 11603	100 14504	100 14504	100 14504
Hydraulic area	(cm ²) (in ²)	17 2.64	24 3.72	37 5.74	55 8.53	83 12.87	135 20.93
Max. hydraulic load	(kN) (lbf)	136 30574	192 43163	296 66543	550 123645	830 186591	1 350 303492
Piston stroke (mm)		6	6	6	7	8	8
D (mm)		65	80	97	114	145	180
H (mm)		161	177	206	233	286	390
H1 (mm)		75	78	95	115	145	200
D1 (mm)		65	80	97	114	145	180
D2 (mm)		53	66	76	95	120	152
A (mm)		20	20	25	25	30	50
U (mm)		38 42 46 52	46 52 57 63	52 57 63 69 74	69 74 78 86 92	86 92 99 107 114	114 122 133 137 145 152
X (mm)		199 203 207 213	223 229 234 240	258 263 269 275 280	302 307 311 319 325	372 378 385 393 400	504 512 520 527 535 542
Y (mm)		51.5 52 55 57.5	62 65 68 70.5	73.5 76.5 79 81.5 84.5	90 93 96 99 102	114.5 117.5 120 123 126	143.5 146.5 149 152 155 158
Z (mm)		34	41	50	58	74	92
Total tensioner weight (kg)		3	4.6	7.6	11.6	20	50

HTS 2

Thin and powerful

Like the HTS N Tensioner, HTS 2 takes up very little space.

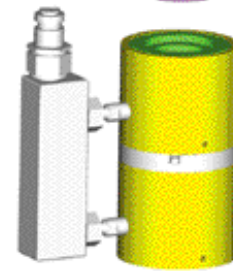
Due to its two-story design, there is greater tightening load for a given diameter as compared with HTS or HTS N.



Tensioner component reference



HTS 2..ES



HTS 2..C



HTS 2..T



HTS 2..J



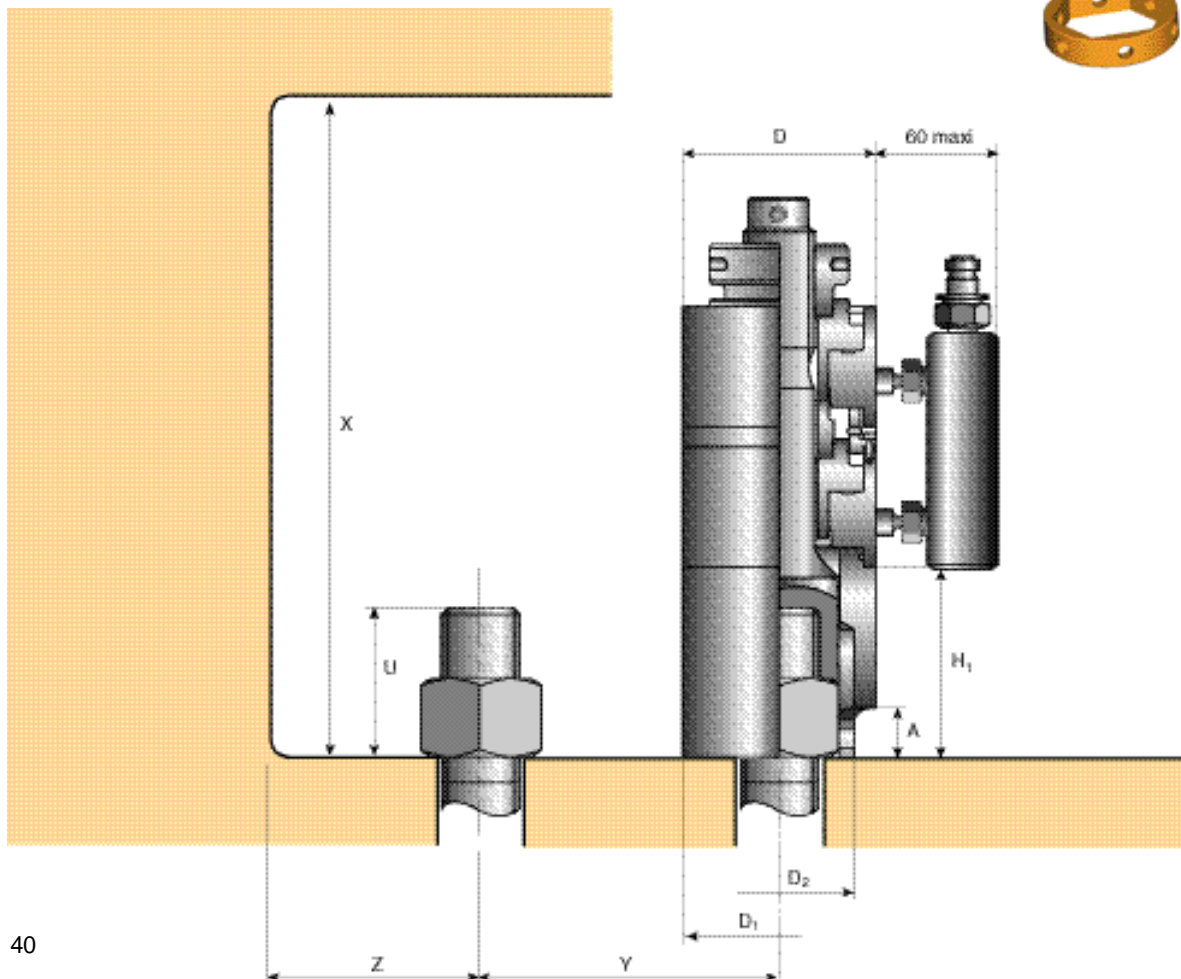
optional

Reference example for a complete tensioner for M36 bolts:

HTS 2 37 M36 x 4

Reference example for the HTS 2 37 tensioner upper screw:

HTS 2 37 ES



HTS 2

Thin and powerful

Tensioner reference		HTS2 17	HTS2 24	HTS2 37	HTS2 55	HTS2 83	HTS2 135
Bolt dimension (M Ø x pitch)	Metric system	M 20 x 2.5	M 24 x 3	M 27 x 3	M 36 x 4	M 45 x 4.5	M 60 x 5.5
		M 22 x 2.5	M 27 x 3	M 30 x 3.5	M 39 x 4	M 48 x 5	M 64 x 6
		M 24 x 3	M 30 x 3.5	M 33 x 3.5	M 42 x 4.5	M 52 x 5	M 68 x 6
		M 27 x 3	M 33 x 3.5	M 36 x 4	M 45 x 4.5	M 56 x 5.5	M 72 x 6
Ø in - Threads/in	Imperial system	3/4" - 10	7/8" - 9	1 1/8" - 7	1 3/8" - 6	1 3/4" - 5	2 1/4" - 4 1/2
		7/8" - 9	1" - 8	1 1/4" - 7	1 1/2" - 6	2" - 4 1/2	2 1/2" - 4
		1" - 8	1 1/8" - 7	1 3/8" - 6	1 3/4" - 5	2 1/4" - 4 1/2	2 3/4" - 4
			1 1/4" - 7	1 1/2" - 6			3" - 4
Max. Pressure	(MPa)	80	80	80	80	80	80
	(psi)	11603	11603	11603	11603	11603	11603
Hydraulic area	(cm ²)	34	48	74	110	166	270
	(in ²)	2.64	3.72	5.74	8.53	12.87	20.93
Max. hydraulic load	(kN)	272	384	592	880	1 328	2 160
	(lbf)	30574	43163	66543	98916	149273	242793
Piston stroke (mm)		6	6	6	7	8	8
D (mm)		65	80	97	114	145	180
H (mm)		228	245	277	312	363	500
H1 (mm)		75	78	95	115	145	200
D1 (mm)		65	80	97	114	145	180
D2 (mm)		53	66	76	95	120	152
A (mm)		20	20	25	25	30	50
U (mm)		38	46	52	69	86	114
		42	52	57	74	92	122
		46	57	63	80	99	130
		52	63	69	86	107	137
				74	92	114	145
X (mm)		266	291	329	381	449	614
		270	297	334	386	455	622
		274	302	340	392	442	630
		280	308	346	398	470	637
				351	404	477	645
							652
Y (mm)		51.5	62	73.5	90	114.5	143.5
		52.5	65	76.5	93	117.5	146.5
		55	68	79	96	120	149
		57.5	70.5	81.5	99	123	152
				84.5	102	126	155
Z (mm)		34	41	50	58	74	92
Total tensioner weight (kg)		4.8	7.6	11.4	16.9	30	66

HTC R

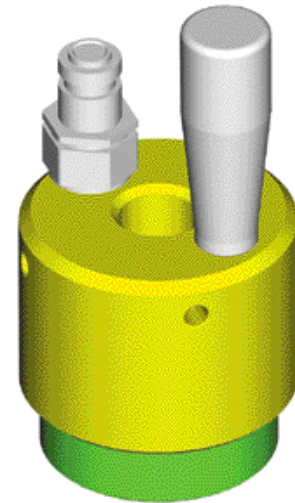
Tensioner component reference

Compact and powerful

HTC R, the most powerful tensioner in the Hydrocam standard range, can apply very high traction loads.

The brace and the body are monolithic. The HTC R tensioner, with its automatic piston return and few parts, is very easy to use and well-suited to simultaneous tightening.

Each unit is dedicated to a single bolt diameter



HTC R..C..

Reference example for a complete tensioner for 2 1/2" - 4 bolt:

HTC R 137 2 1/2" - 4



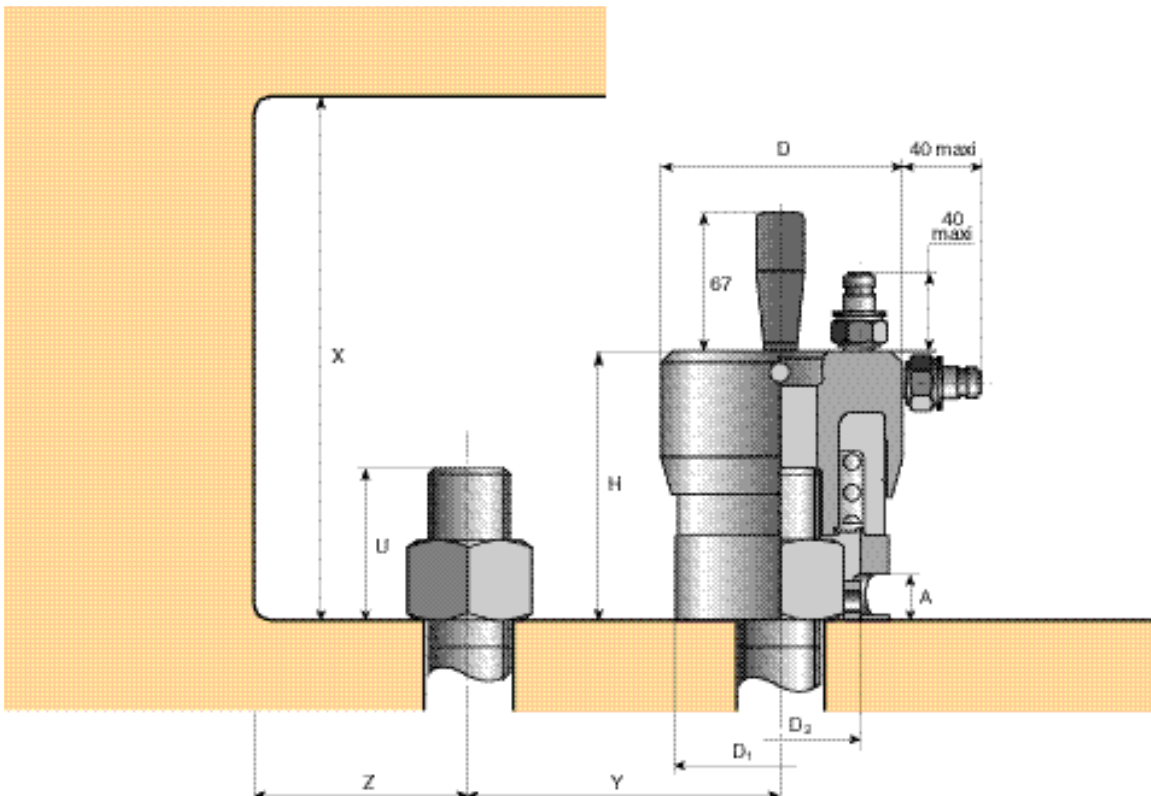
HTCR..J

Reference example for the HTC R 137 tensioner body for a 2 1/2" - 4 bolt:

HTC R 137 C 2 1/2" - 4



optional



HTC R

Compact and powerful

Tensioner reference		HTC R 17	HTC R 26	HTC R 40	HTC R 54	HTC R 73	HTC R 98	HTC R 137	HTC R 174	HTC R 220	HTC R 284	HTC R 362	HTC R 500
Bolt dimension (M Ø x pitch) Ø in - Threads/in	Metric system	M 20 x 2.5 M 22 x 2.5	M 24 x 3 M 27 x 3	M 30 x 3.5 M 33 x 3.5	M 36 x 4 M 39 x 4	M 42 x 4.5 M 45 x 4.5	M 48 x 5 M 52 x 5	M 56 x 5.5 M 60 x 5.5	M 64 x 6 M 68 x 6	M 72 x 6 M 76 x 6	M 80 x 6 M 85 x 6	M 90 x 6 M 95 x 6	M 100 x 6 M 110 x 6
	Imperial system	3/4" - 10 7/8" - 9	1" - 8 1 1/8" - 7	1 1/8" - 7 1 1/4" - 7	1 3/8" - 6 1 1/2" - 6	1 3/8" - 6 1 1/2" - 6	1 3/4" - 5 2" - 4 1/2	2 1/4"-4 1/2 2 1/2" - 4	2 1/2" - 4 2 3/4" - 4	2 3/4" - 4 3" - 4	3 1/4" - 4 3 1/2" - 4	3 1/2" - 4 3 3/4" - 4	4" - 4 4 1/4" - 4
Max. Pressure	(MPa) (psi)	150 21756	150 21756	150 21756	150 21756	150 21756	150 21756	150 21756	150 21756	150 21756	150 21756	150 21756	150 21756
Hydraulic area	(cm ²) (in ²)	17 2.64	26 4.03	40 6.20	54 8.37	73 11.32	98 15.19	137 21.24	174 26.97	220 34.10	284 44.02	362 56.11	500 77.50
Max. hydraulic load	(kN) (lbf)	255 57326	390 87675	600 134885	810 182095	1 095 146165	1 470 330469	2 055 461982	2 610 586750	3 300 741868	4 260 957685	5 430 1220711	7 500 1686064
Piston stroke (mm)		8	8	8	8	8	8	8	10	10	10	10	10
D (mm)		71	83	103	117	134	154	183	204	227	255	287	335
H (mm)		93	103	116.5	130	144	159.5	195	225	241	225	240	260
H1 (mm)		41	47	52.5	60.5	68.5	72.5	90	108	114	87	98	113
D1 (mm)		60.5	73	90	103	120	138	160	178	194	217	244	283
D2 (mm)		45.5	54	67	76.5	89.5	102	116	127	136	151	168	192
A (mm)		14	17	20	23	26	29	32	37	42	47	51	56
U (mm)		38 42	46 52	57 63	69 74	80 86	92 99	107 114	122 130	137 145	152 162	171 181	190 209
X (mm)		111.5	126	145	163.5	183	204	247	285	308	300	323	356
Y (mm)		50	61.5	75.5	87.6	102	116.5	133.5	148	162	179.5	202	233
Z (mm)		37	43	53	60	68.5	78.5	93	103.5	115	129	145.5	169.5
Total tensioner weight (kg)		2	3	4.5	6.2	9.5	15	24.2	34	45.5	49	65	99

HTH R

Thin and super-powerful

This full-option tensioner provides maximum power for a minimum of space.

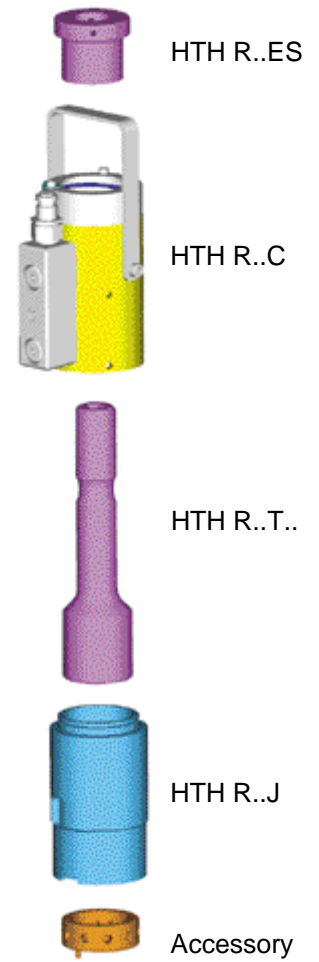
Built on two or three stories (depending on the diameters to be tightened), this is the thinnest tensioner in the Hydrocam standard product range.

In most cases, it requires the use of cylindrical nuts.

The HTH R also has an automatic piston return mechanism and is very well-suited to simultaneous tightening.



Tensioner component reference

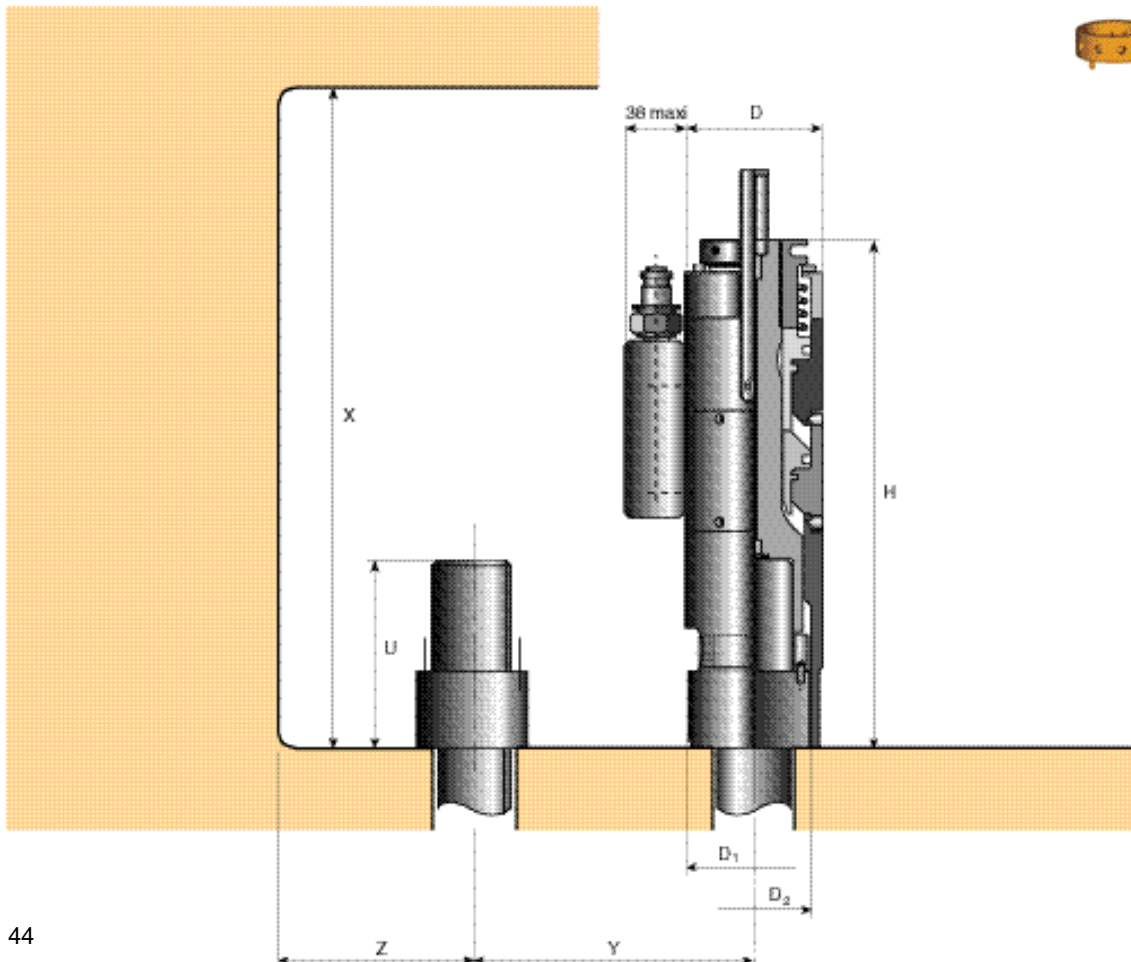


Reference example for a complete tensioner for M72 bolts:

HTH R 108 M72 x 6

Reference example for the HTH R 108 tensioner skirt:

HTH R 108 J



Tensioner reference		HTH R 17	HTH R 34	HTH R 45	HTHR 62	HTH R 82	HTH R 108	HTH R 135	HTH R 180	HTH R 223	HTH R 270	HTH R 335	HTH R 427	HTH R 567
Bolt dimension (M Ø x pitch)	Metric system	M 20 x 2.5	M 30 x 3.5	M 42 x 4.5	M 48 x 5	M 56 x 5.5	M 64 x 6	M 72 x 6	M 80 x 6	M 90 x 6	M 100 x 6	M 110 x 6	M 125 x 6	M 140 x 6
		M 22 x 2.5	M 33 x 3.5	M 45 x 4.5	M 52 x 5	M 60 x 5.5	M 68 x 6	M 76 x 6	M 85 x 6	M 95 x 6	M 110 x 6	M 120 x 6	M 130 x 6	M 150 x 6
		M 24 x 3	M 36 x 4	M 48 x 5	M 56 x 5.5	M 64 x 6	M 72 x 6	M 80 x 6	M 90 x 6	M 100 x 6		M 125 x 6	M 140 x 6	M 160 x 6
		M 27 x 3	M 39 x 4											
	M 30 x 3.5	M 42 x 4.5												
Ø in - Threads/in	Imperial system	3/4" - 10	1 1/4" - 7	1 1/2" - 6	1 3/4" - 5	2 1/4"-4 1/2	2 1/2" - 4	2 3/4" - 4	3 1/4" - 4	3 1/2" - 4	3 3/4" - 4	4 1/2" - 4	5"	5 1/2" - 4
		7/8" - 9	1 3/8" - 6	1 3/4" - 5	2" - 4 1/2	2 1/2" - 4	2 3/4" - 4	3" - 4	3 1/2" - 4	3 3/4" - 4	4" - 4	4 3/4" - 4	5 1/4" - 4	5 3/4" - 4
		1" - 8	1 1/2" - 6								4 1/4" - 4		5 1/2" - 4	6"
		1 1/8" - 7												
Max. Pressure	(MPa)	150	150	150	150	150	150	150	150	150	150	150	150	150
	(psi)	21756	21756	21756	21756	21756	21756	21756	21756	21756	21756	21756	21756	21756
Hydraulic area	(cm ²)	17	34	45	62	82	108	135	180	223	270	335	427	567
	(in ²)	2.64	5.27	6.98	9.61	12.71	16.74	20.93	27.90	34.57	41.85	51.93	66.19	87.89
Max. hydraulic load	(kN)	255	510	675	930	1 230	1 620	2 025	2 700	3 345	4 050	5 025	6 405	8 505
	(lbf)	57326	114652	151746	209072	276515	364190	455237	606983	751985	910475	1129663	1439899	1911997
Piston stroke (mm)		8	10	10	10	10	10	10	10	10	10	10	10	10
D (mm)		63	73	84	100	110	122	136	147	160	180	200	223	255
H (mm)		180	270	290	315	334	420	460	510	560	585	635	695	770
H1 (mm)		60	41	45	50	61	144	155	171	185				
D1 (mm)		62	70	81	96	108	118	134	144	157	175	200	223	255
D2 (mm)		45	61	68	81	90	101	112	124	138	152	171	190	217
U (mm)		50	73	98	107	117	132	144	160	176	190	208	245	270
		55	77	101	109	122	137	152	166	181	208	236	251	290
		60	84	107	117	132	145	160	176	190		245	270	310
		68	91											
		73	98											
X mini (mm)		230	343	388	422	451	552	604	670	736	775	843	940	1 040
		235	347	391	424	456	557	612	676	741	793	871	946	1 060
		240	354	397	432	466	565	620	686	750		880	965	1 080
		248	361											
		253	368											
Y mini (mm)		55	68	77	91	101	112	125	137	151	168	187.5	208.5	238
Z mini (mm)		33	38	43.5	51.5	56.5	62.5	68.5	75	82	92	102	113.5	129.5
Total tensioner weight (kg)		3.5	7	10	14	16	25	36	47	59	79	90	150	220

Customized standard tensioners

Do you have a specific assembly ? SKF Equipements adapts the tensioner to your application.

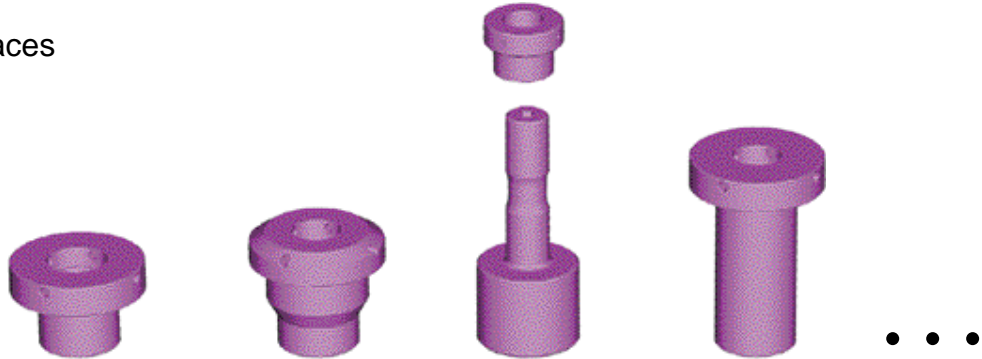
A Hydrocam standard tensioner has been selected for your application... but there may be one feature of your bolted assembly which prevents the tensioner from being used.

SKF Equipements can easily adapt the following components of the tensioner to fit your size and accessibility constraints:

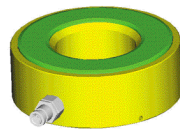
- the brace
- the skirt
- the socket
- the reaction nut

The examples of customized parts shown below portray only a small portion of what can be done – the possibilities are endless.

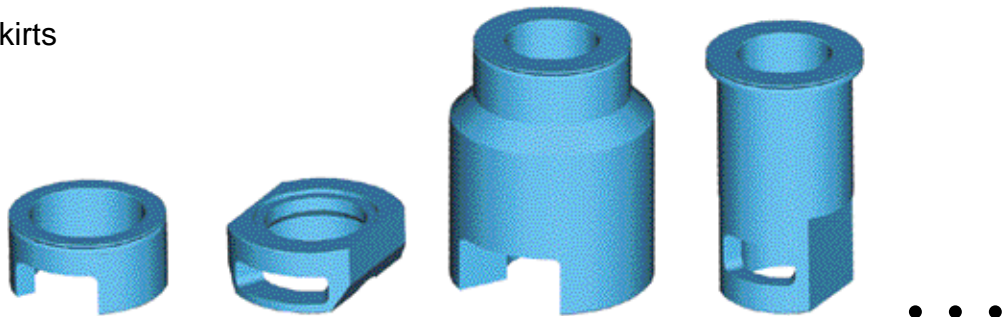
Customized braces



Standard body



Customized skirts

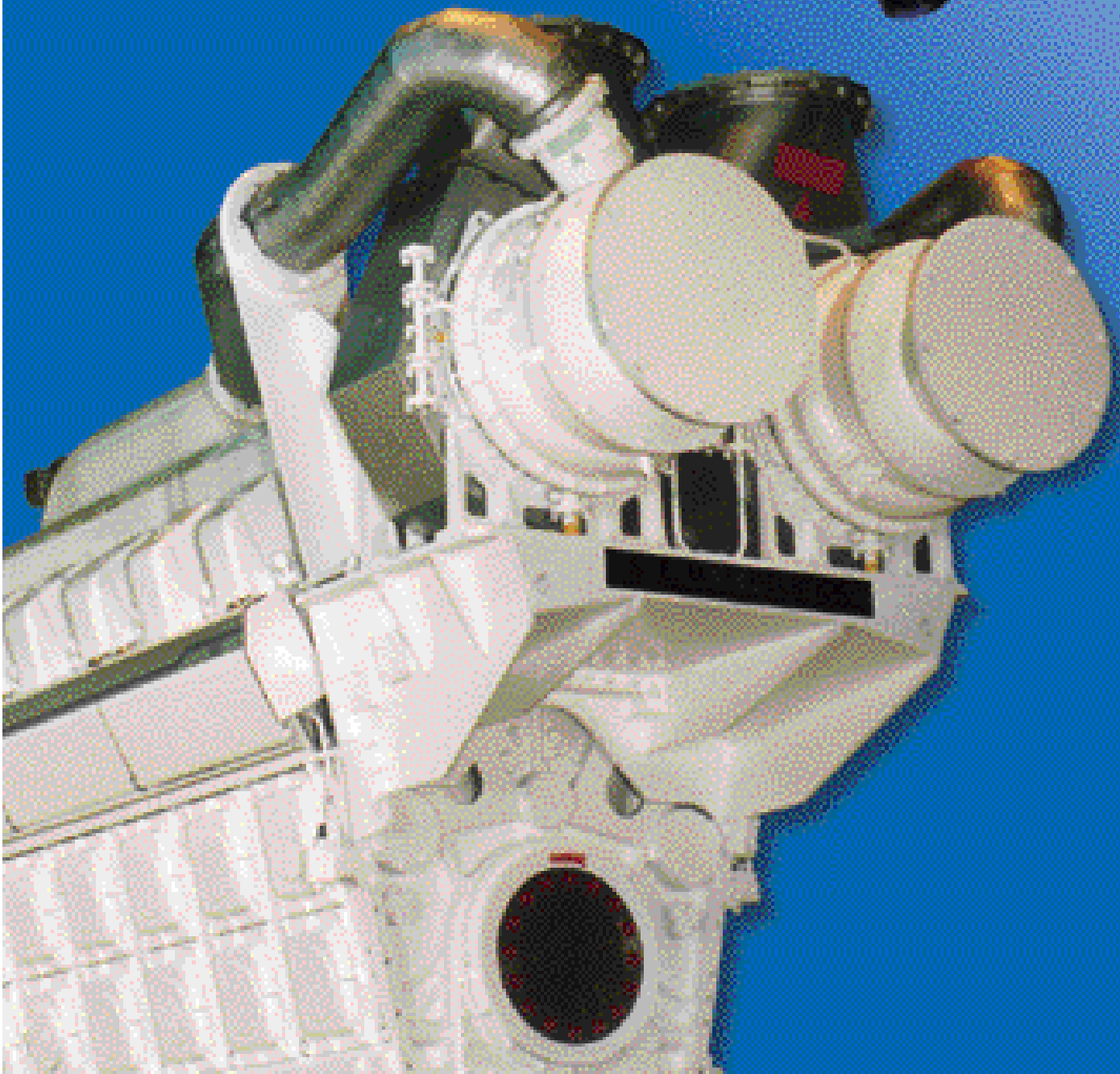


Customized sockets



If your application presents special characteristics which preclude using a standard body, please turn to the page “Special Tensioners”, on pages 48 and 49.

Simultaneous
tightening
equipment for
the cylinder
head on large
diesel engines



Special Tensioners

You have a specific application which requires a design study. SKF Equipements designs, computes, optimizes and manufactures the hydraulic tensioner to meet your needs.

SKF Equipements offers tailor-made design of the various tensioner components, in compliance with your application requirements. The operating principle remains the same, however new functions can be added. A brief overview of SKF expertise follows:

- The general shape, size and number of components can vary as needed, to fit the accessibility, size restrictions and handling constraints.
- The choice of the materials and heat treatments is adapted to meet the mechanical and weight specifications of an application. SKF tensioners can also be manufactured in lighter materials such as titanium.

- The tensioner environment can require the use of specific hydraulic fluids. Hydrocam tensioners can be designed to work with all types of hydraulic connectors.
- Turning down operations can be motorized and fully automated.
- In cases requiring high accuracy, SKF can supply sensor washers or devices to measure bolt elongation.
- For improved tightening uniformity over several bolts, we recommend either total (preferably) or partial simultaneous tightening.

...

Let us know your needs – we will meet them !



Stainless steel tensioner

- works with water
- compact
- no pollution of the assembly
- environmentally friendly



Titanium tensioner

- works with water
- ultra-light
- easy handling
- designed to be handled by a diver in an underwater environment

Compact tensioner

- tightens hard-to-reach bolts
- controls turning-down operations



Monolithic 8-tensioner ring

- simultaneous, homogenous tightening
- quick, simple use



Micro tensioner

- compact
- tightens very small bolts (M5)
- highly accurate (a few microns of screw elongation)



Tensioner for automatic multiple stud tensioner machines, nuclear reactor vessel opening and closing operations

- remote-controlled
- highly efficient application of high tightening pre-loads
- Excellent efficiency



Tensioner for
500 mm diameter bolts

Tensioners for very large diameter bolts

- Tighten very large diameter bolts
- Automatic piston return
- Retaining sleeve or clamping jaws

Special machines and control systems

Your application requires remote control tightening which is simultaneous, controlled, accurate and totally safe. SKF Equipements researches your application and adds hydraulic tensioners to instrumentation and control systems.

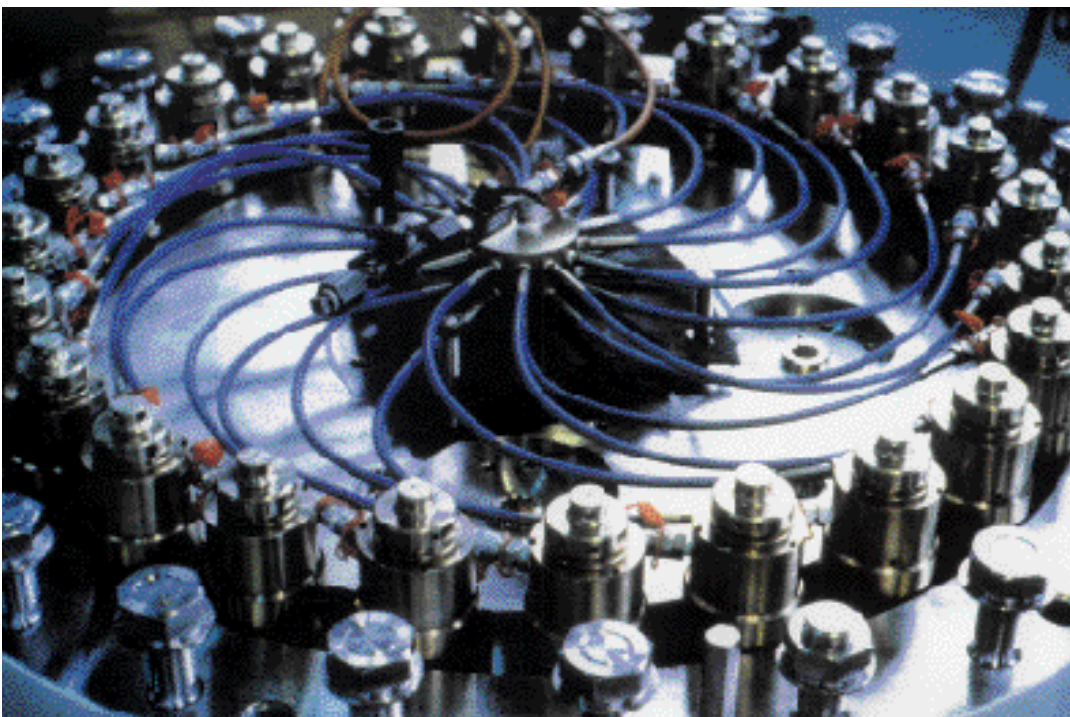
In adding Hydrocam hydraulic tensioners to an instrument, regulation and control system, you automate and protect your tightening. You can also ensure homogenous tightening by using a simultaneous tightening procedure, and improve accuracy by using measurement and control devices. The handling phases can be automated and included in the machine operating process, resulting in reliable, accurate and rapid tightening operations.

The following lists a brief sampling of some of the automated functions commonly found in special tightening machines:

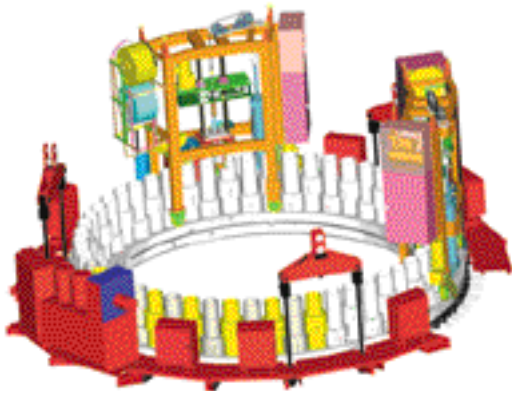
- pressure increase for controlled tensioners
- turning down operations for the nuts to be tightened
- automatic piston return
- stud screwing and unscrewing
- piston stroke control
- measurement of bolt elongation
- continuous measurement of the tightening load



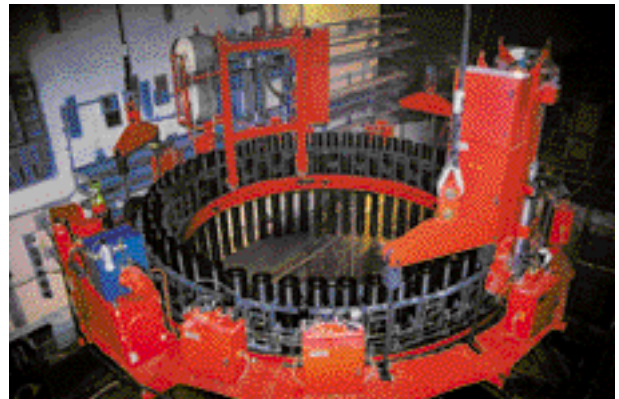
Remote control of a tightening machine working in a risk area



Central feed individual tensioner simultaneous tightening



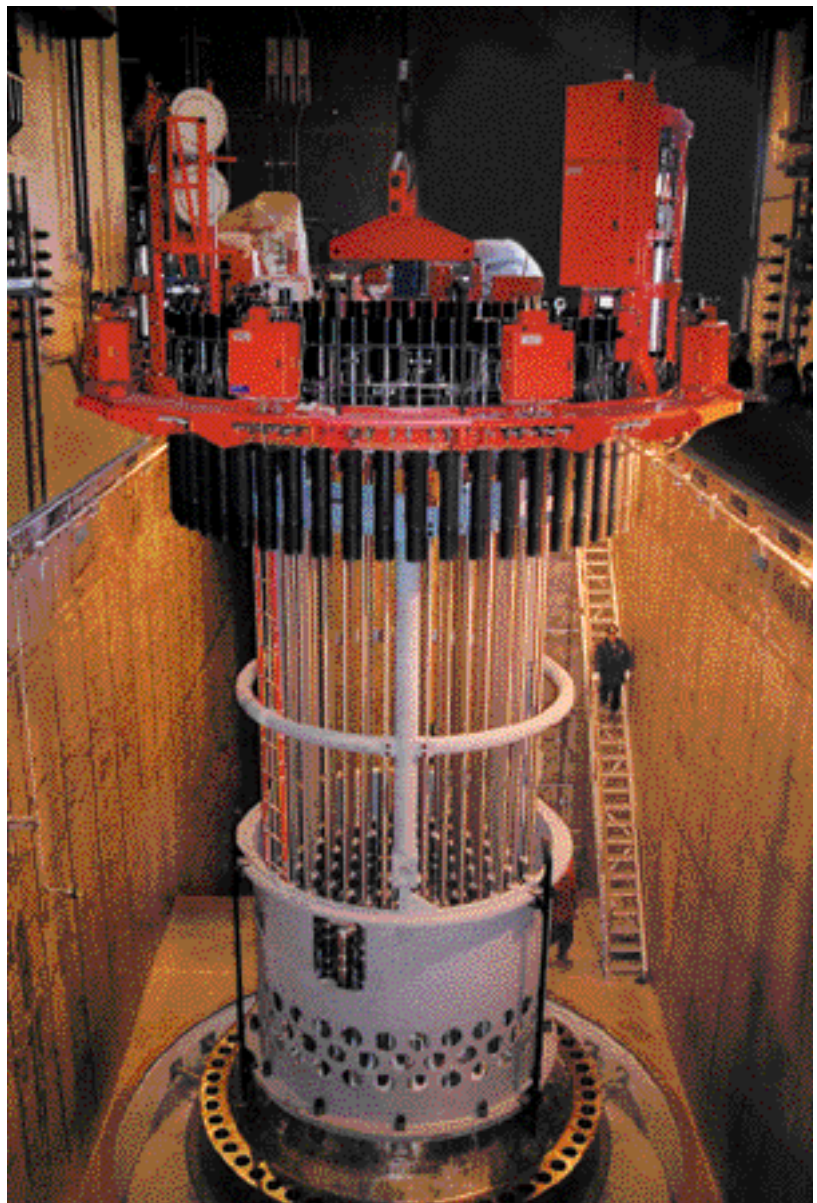
CAD of the MST (Multiple Stud Tensioner) or MSDG (Stud Tightening and Untightening Machine).



On-site assembly of the MST



MST remote control panel



Automatic MST machine with 54 studs, preparing the closure of a nuclear reactor vessel.

Applications

The Hydrocam range provides you with the tensioner which meets your economic criteria

1. Civil Engineering

Safety – Performance

The tightening operations for the clamp bolts on the primary load-bearing cables of suspended bridges are performed with Hydrocam HTA tensioners, known for their flexibility and ease-of-use.

For these and other crucial tasks, where access is difficult and conditions are severe, the tightening tool must guarantee good performance, resistance, efficiency and easy handling.



2. Public works machinery

Critical tightening level and homogeneity

The safety of the bolted assemblies - on crane slewing rings for example – largely depends on the high tightening level and on the uniformity of the applied tightening load.

Hydrocam tensioners such as HTH R, HTC R, HTS 2 or N require little space and apply extremely high, uniform tightening loads in each bolt. The low drag friction coefficients of the seals which equip the hydraulic body ensure high quality assembly and excellent homogeneity.



3. Wind turbines

Rapid service

The use of double-acting HTC R Hydrocam tensions with automatic piston return means fast performance of all the tightening operations on wind turbines, without interrupting production. This guarantees the performance and reliability of these heavy-wear machines, ensuring ongoing electricity production.





4. Nuclear industry

Safety – Lower dosimetry

Bolted assemblies in the nuclear industry are subject to extremely strict quality rules to ensure safety. Hydrocam HTA and HTS standard tensioners, operating with oil or water, alone or simultaneously, meet the demanding nuclear industry requirements for tightening operations.

In addition to standard tensioners, specialized Hydrocam tensioners using automatic feed and control equipment, can be used for remote, rapid tightening of specific assemblies. This reduces contamination and dosimetry risks for the operators.



5. Aeronautics

Precision - Weight reduction

In the aeronautics industry, customized HTS Hydrocam tensioners, used alone or simultaneously, tighten very small bolts with high accuracy, reducing the time required for assembly operations. Hydrocam tensioners take full advantage of the mechanical properties of the main assembly materials used in aeronautics, reducing weight. If necessary, water-based tensioners can be supplied.



6. Diesel Engines

Reduced flywheel mass

Bolted assemblies in engines have to withstand heavy mechanical stresses, particularly dynamic. With the use of customized HTA or HTC R Hydrocam tensioners, you can take full advantage of the mechanical characteristics of the materials in the primary assemblies, leading to reduced volumes and masses, in particular flywheel masses. Engine performance and operating costs are clearly improved.

Company resources and organization at the client's service

The ITE Department at SKF Equipment is totally client-oriented. It disposes of the resources and the organization it needs to meet its customers' needs...

Located in spacious, well-designed premises in France, Paris area



Customer-focused approach combining quality, performance and friendliness.



A team of engineers which combines understanding, expertise, experience and a forward-thinking attitude to analyze clients' needs and provide the best solutions

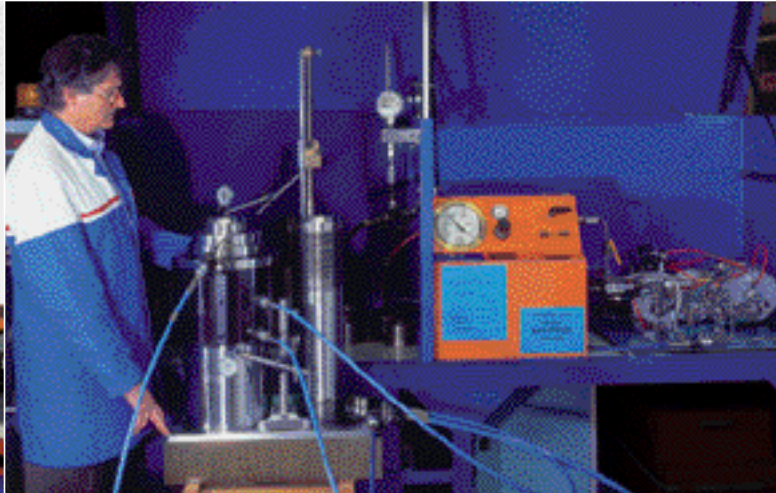
The Design Department works on the cutting edge (CAD, analytical software and finite element structural analysis)



Control and verification instrumentation to measure hardness, dimensions, surface condition, geometrical defects...



Mechanical test beds to measure loads, stresses and strains, to determine equipment performance and lifetime



Hydraulic test beds (using oil and water), for low-pressure tests (0-300b), and high pressure tests (300-3000b)



Well-equipped production and assembly workshops.

... and in addition

SKF's quality organization has been acknowledged by ISO 9001 certification ;

A powerful network of partners, subcontractors and suppliers, carefully selected and regularly audited ;

And the entire SKF network, capable of meeting customer demand anywhere in the world.

SKF Equipements' Services

Work alone no longer ! SKF Equipements offers its partnership for all your tightening applications.

Assistance in designing bolted assemblies

You have to design new bolted assemblies or revise the design of existing assemblies.

SKF's vast experience on a wide range of applications has led to the creation of a complete set of theoretical and practical tooling and hardware which can solve nearly any problem encountered in the field of bolted assembly tightening.

SKF can therefore offer its assistance from the very start of the design stage.

This saves you precious time and frees you to concentrate on the design aspects which are at the core of your business.

In addition, you reap all the advantages which result from optimized bolted assembly design: saved space, less weight, increased safety, easier assembly and maintenance.

Assistance in selecting the best tightening method

You are dealing with tightening or loosening problems on an existing bolted assembly.

SKF has faced such problems daily, and has a wide range of solutions.

Turn to SKF for assistance in selecting the most effective tightening method for your needs, given your space constraints, loads, time, environment, cost and other issues.

Expertise and experiments

You would sometimes like to have an expert opinion, or conduct an experiment on bolted assemblies.

Thanks to the wide variety of problems solved with their clients, SKF has gained in-depth expertise in the field. SKF has long been conducting on-going experiments, and has developed specifications, procedures, protocols and instructions...

SKF can help you define, calculate, measure and analyze the static and dynamic loads applied on the bolts in your assemblies, both on stand-by and in service.

SKF offers its services in every area where error or the wrong direction can have serious consequences on costs and schedules.

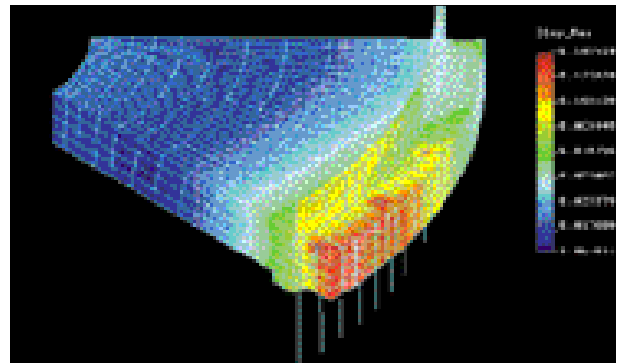
Checks and tests

You most certainly conduct many checks and tests on your application, however the skilled operators and the proper tooling can be very demanding. This can lead to very complex situations which cannot always be solved in-house.

SKF offers the full range of tooling it has developed over the years, and can provide you with – or design – the specific, effective and practical solution for your problem.

SKF teams are expert users of this equipment, and can modify, adapt or redesign existing tooling to meet your needs.

In a word – rapid, effective service in the testing field.



Optimizing the number of rounds required for the partial simultaneous tightening of a 96-bolt flange, using 8 tensioners.



On-site intervention, tightening the man hole hatch on the primary cooling system of a steam generator.

Training

Although the field of bolted assemblies is highly complex and vast, it is relatively rarely included in the curricula followed by engineers and technicians.

Based on its long-standing experience, SKF has developed training programs which can be very useful for your teams dealing with bolted assemblies. SKF can also offer tailor-made programs to meet the specific requirements you have identified.



Training on hydraulic tensioner tightening techniques

Technical support / On-site assistance

There is no lack of jobs to be done in your workshops and on your sites. However, you may not always have skilled employees on hand to do the job where and when it needs to be done.

SKF can send skilled technicians to your workshops and site, to provide you with the help you need.

On-site, in addition to working with the tightening tools, SKF can perform many other tasks, such as:

- repairing and reconditioning the parts to be tightened (cleaning, grinding, adjustment, control ...)
- repair and preparation of sealing surfaces
- replacement of assembly parts
- cutting bolts to be replaced
- checking the tightening loads using the most appropriate means, and others.

SKF also provides rental equipment for temporary, short-term use.

Installation and commissioning

You have purchased new bolt tightening equipment. Perhaps your staff is not yet familiar with the equipment, or you prefer or are not able to assign a task force to implementing it.

SKF offers installation and commissioning services, and can also operate the equipment for you each time you need to use it.

Maintenance and repair / in the workshop and on-site

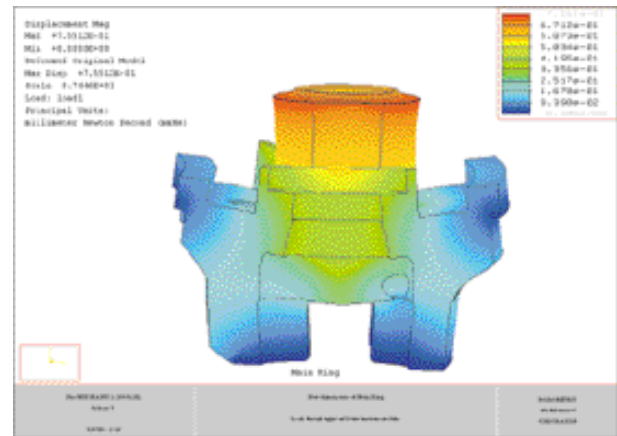
You may not have a repair shop able to maintain and repair the tightening equipment.

SKF can do this work for you, preferably in their own workshops if the material can be sent back, or on-site, if working conditions are conducive to performing maintenance, overhaul and repair on the site.

Industrial partnerships

You are looking for an industrial partner capable of supplying you with regular or periodic service in one or several of the previously described areas.

SKF offers you a partnership arrangement in which SKF commits to supplying the required services in a time frame and way which are to be defined. SKF offers total flexibility to come up with the formula which best meets the client's needs.



Display of assembly strain during bolt tightening using Hydrocam tensioners.



Kit demonstrating the use of Hydrocam tensioners with the BoltSafe sensor washer.

Tensioner Accessories

High pressure hoses

High pressure hoses are supplied with high pressure self-sealing quick-coupling connectors, in unit lengths up to 300 m. Two types of hose depending on the pressure used:

HFC: operating pressure: 150 MPa:
Bursting pressure: 450 MPa

TFC: operating pressure: 300 MPa:
Bursting pressure: 550 MPa

Designation example:

HFC 1: 1-m long hose,
operating pressure 150 MPa

MFC 2: 2-m long hose,
operating pressure 80 MPa



Ref: MFC, HFC or TFC
(specify length)

High pressure quick-coupling connectors

The self-sealing quick-coupling connectors on the Hydrocam tightening and pressure supply equipment are heavy-duty and easy to use. There are three types of quick-coupling connectors depending on the pressure used: HBC 10; HBC 15; HBC 30.

Designation example:

HBC 15 N/M: quick-coupling male connector,
operating pressure: 150 MPa

HBC 30 N/F: quick-coupling female connector,
operating pressure: 300 MPa



ref: HBC..
(specify pressure)

Distribution blocks

The distribution blocks can simultaneously connect several hydraulic tensioners. They are equipped with high pressure self-sealing quick-coupling connectors. You select the number of outlets.

Designation example:

HDB 1-2: distribution block one inlet – two outlets

HDB 1-3: distribution block one inlet – three outlets



ref: HDB1..
(specify number of outlets)

Oil can

Hydraulic oil is supplied in 5-liter cans. All Hydrocam tools are delivered fully oiled and ready to use.



ref: HCO 5L

Air-driven hydraulic generating set

This air-driven hydraulic generating set, equipped with an air/oil pressure intensifier, supplies adjustable pressure of 300 MPa, calibrated by the air inlet. For air supply of 0.6 MPa (6 bar), the hydraulic flowrate at 100 MPa is 0.2 l/min. This unit has a class 1 manometer, a 5-liter tank and 2 hydraulic outlets with quick-coupling, self-sealing connectors. Dimensions: W 340 x D 320 x H 540 mm
Weight: 34 kg.



ref: GHP 20300

Air-driven hydraulic generating set GHP 10200

This air-driven hydraulic generating set, equipped with an air/oil pressure intensifier, supplies adjustable pressure of 160 MPa (200 MPa on request), calibrated by an air inlet. For air supply of 0.6 MPa (6 bar), the hydraulic flowrate at 100 MPa is 0.2 l/min. This hydraulic set has a class 1 manometer, a 5-liter tank, and 2 hydraulic outlets with quick-coupling self-sealing connectors. Dimensions: W 340 x D 320 x H 440 mm
Weight: 26 kg.



ref: GHP 10200

Electro hydraulic generating set GHE 10200

This electro hydraulic generating set, equipped with a 0.55 kW electric motor, 415/240/110 voltage and a pressure intensifier, supplies pressure of 160 MPa (200 MPa on request). The hydraulic flowrate at 100 MPa is 0.8 l/min. This hydraulic set has a class 1 manometer, a 5-liter tank, and 2 hydraulic outlets. Dimensions: W 250 x D 170 x H 435 mm
Weight: 27 kg.



ref: GHE 10200

Pressure intensifier

This device enables setting a constant pressure ratio between the inlet and the outlet of the pressure intensifier. The pressure ratio must be defined when ordering. Two types of pressure intensifiers are available:
ILP: pressure ratio from 1.1 to 5
IHP: pressure ratio from 5 to 10



ref: ILP ou IHP.
(specify pressure ratio)

Self-locking caps for hexagonal nuts

Made of polyethylene
Black
High-performance: the circular hold ring clips on under the nut.
Total protection from pollution, impact, corrosion, chemicals, gouges.



ref: CAP.
(specify bolt dimension)

Sealing kit for Hydrocam bolt tightener hydraulic bodies

The composite sealing kit for the Hydrocam bolt tightener hydraulic bodies good high pressure performance, great wear resistance and a low drag friction coefficient, providing efficiency on the order of 98%. These high performance characteristics contribute to high quality bolted assemblies. Sealing kits for standard tensioners are in stock. The reference refers to the hydraulic body.

Designation examples:

HAK 20: sealing kit for HTA 20 C standard hydraulic body

HSK 50: sealing kit for HTS 50 C standard hydraulic body.



ref: HAK, HSK, HCK or HHK...
(the hydraulic section of the tensioner)

Tommy bar

Tommy bars are used to screw the braces and turn down the nut by rotating the hydraulic tensioner socket. Tommy bar diameters depend on the tensioner model they are used with.

Ref: BR 6-8. BR 10-12. BR 12-14. BR 14-16.



ref: BR..
(specify dimensions, see table page 61).

Double stage manual pump

The double stage manual pump is equipped with a manometer and a 3-m high pressure hose with a self-sealing quick-coupling connector. It has a 2300 cm³ tank and applies pressure up to 150 MPa (1500 bar). At low pressure, the volume for each piston stroke is 17.5 cm³. At high pressure, it is 1.25 cm³. Weight: 14 kg. Comes in a steel carrying case.



ref: PH 1500

Single stage small manual pump

This small single stage manual pump is equipped with a manometer and a 1.5 m high pressure hose with a self-sealing quick-coupling connection. It has a 250 cm³ tank and applies pressure of 100 MPa (1000 bar).

Volume per piston stroke is 1 cm³. Weight: 3.5 kg. Comes in a steel carrying case.



ref: PH 1000 S

Single stage manual pump

This single stage manual pump is equipped with a manometer and a 1.5 m high pressure hose with a self-sealing quick-coupling connection. It has a 700 cm³ tank and applies pressure of 100 MPa (1000 bar).

Volume per piston stroke is 1 cm³. Weight: 6 kg. Comes in a steel carrying case.

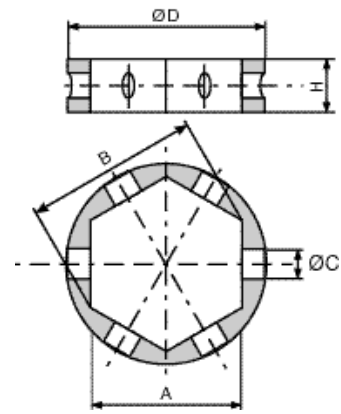


ref: PH 1001

Sockets



Réf: ACC..
(specify bolt diameter)



The sockets enable easy turning down (or up) of the hexagonal nuts during hydraulic tensioner tightening (or untightening). The standard socket is a hexagonal bore which fits the application nuts.

Designation example: ACC M 39: socket for M39 bolt diameter
ACC 1 1/4": socket for 1 1/4" bolt

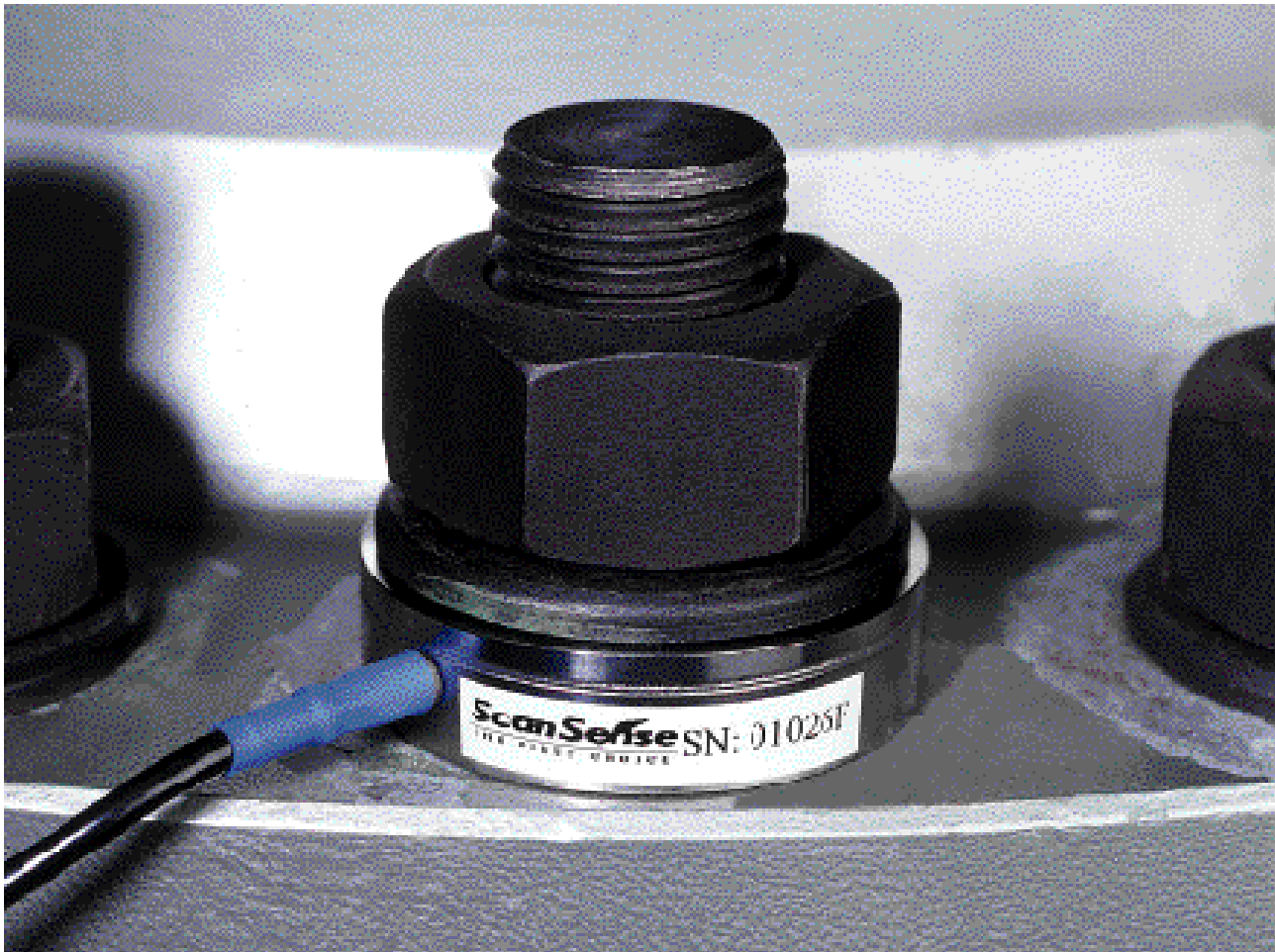
The range of standard sockets covers bolt dimensions from M8 to M150 (5/16" to 6"). See table below.

Stud	outside diameter Ø D	width across flats A	width across points B	Height H	tommy bar Ø C
M 8	27	13	15.0	8	4
M 10	30	17	19.6	10	6
M 12	34	19	21.9	10	6
M 14	41	22	25.4	12	6
M 16	41	24	27.7	12	6
M 18	41	27	31.2	12	6
M 20	41	30	34.6	12	6
M 22	44	32	36.9	12	6
M 24	48	36	41.6	12	6
M 27	52	41	47.3	16	8
M 30	60	46	53.1	16	8
M 33	65	50	57.7	16	8
M 36	68	55	63.5	16	8
M 39	75	60	69.3	20	10
M 42	82	65	75.1	20	10
M 45	88	70	80.8	20	10
M 48	94	75	86.6	20	10
M 52	100	80	92.4	20	10
M 56	105	85	98.2	20	10
M 60	111	90	103.9	20	10
M 64	117	95	109.7	24	12
M 68	123	100	115.5	24	12
M 72	129	105	121.3	24	12
M 76	134	110	127.1	24	12
M 80	142	115	132.8	28	14
M 85	148	120	138.6	28	14
M 90	159	130	150.1	28	14
M 95	165	135	155.9	28	14
M 100	177	145	167.5	28	14
M 110	189	155	179.0	28	14
M 120	208	170	196.3	28	14
M 125	220	180	207.9	28	14
M 130	226	185	213.6	28	14
M 140	243	200	231.0	28	14
M 150	254	210	242.5	28	14

In some applications, the nuts may be cylindrical or have special shapes. For cylindrical nuts, sockets are not required. For special shape nuts, SKF manufactures custom-made sockets.

The BoltSafe sensor washer

By Scan-Sense



What is the tightening pre-load in my bolt ?

Your bolted assembly is a critical part of your application, and reliability is crucial. The BoltSafe sensor washer, designed by the ScanSense company, provides you with the information you need on the reliable operation of your application.

BoltSafe washers are integrated into your application, where they are as easy to use as any normal washer. Using a handheld reader or a PC connected to your application's BoltSafe networks, you can accurately monitor the tightening pre-load of each BoltSafe washer equipped bolt in your application. This way, you can easily check if the prescribed tightening load remains throughout operations. You ensure operational safety and the reliability at low cost.

What is the accuracy ?

BoltSafe washers are an excellent means of monitoring, for they are capable of detecting any load variation in the bolt.

The accuracy of the measurement of the absolute load in the bolt depends on several factors. First of all, Hydrocam tensioners must be used to guarantee measurement accuracy, particularly in the case where the washer is placed directly under the nut. Indeed, after turning down the nut and releasing the pressure of the tensioner, solely the axial tightening pre-load is applied on the washer, whereas, with torque tightening, torsion stresses are induced in the BoltSafe washer. In addition, torque tightening misaligns the washer with respect to the bolt, which significantly impairs measurement accuracy.

Accurate load measurement also depends on assembly quality, such as the perpendicularity of the bearing faces with respect to bolt axis, surface flatness, absence of holes, gouges and roughness on the assembled parts in contact with the BoltSafe washer faces.

How does it work ?

The BoltSafe washer operating concept is based on the fact that material's ability (depending on its structural quality) to conduct a magnetic field is an almost linear function of the stress inside the material. Each washer contains an electronic chip which processes the measurement and transforms it into a digital signal. The chip provides unique identification of the BoltSafe washer and integrates it in the BoltSafe washer network.

Optimum tightening with BoltSafe washers and Hydrocam tensioners.

In the case of tightening of a flange or a bolted assembly, the use of Hydrocam tensioners on each bolt is sufficiently efficient to avoid the need for a BoltSafe sensor washer on each bolt. A few BoltSafe washers are sufficient. The Hydrocam tensioner ensures the homogeneity and the repeatability of the tightening, and the washer provides knowledge of the bolts' pre-load with increased accuracy.

If the number of tensioners used is lower than the number of bolts in the assembly, the number of BoltSafe washers on the bolts should be increased. This way, the BoltSafe washer network will more easily detect variations in the pre-load on the bolts when the specific procedure is applied to a partial simultaneous tightening (see simultaneous tightening in the Bolt-tightening Handbook).

Lastly, efficient monitoring of load in operation will depend on the positioning of the BoltSafe washers, which must be carefully chosen.



Hydrocam tensioner tightening with the BoltSafe CMS tightening measurement washer.

Where is the BoltSafe washer used ?

BoltSafe washers are already used in every kind of bolted assembly which is subjected to load variations due to vibrations, changes in temperature, pressure, external loads or any other mechanical influence. In these and other situations, BoltSafe washers can monitor the tightening level.

Add your application to the growing list using BoltSafe washers for accurate measurement.



Monitoring

The tightening level of your application can be monitored in several different ways depending on the number of BoltSafe washers and on the security and monitoring program in place for your application.

Monitoring individual BoltSafe washers

If a number of BoltSafe washers are individually installed throughout your application, each washer can be read with a simple SM-100 handheld reader, which can read two types of BoltSafe washers:

- the Bolt Safe CMS washer (Continuous Monitoring System) connected to the SM-100 by a cable
- the BoltSafe PMS washer (Periodic Monitoring System) which is read through a probe in contact with an electronic interface in the washer.

There is also a SM-200 reader similar to the SM-100 reader, yet with an additional storage function to store the information from 255 BoltSafe washers. This information can be downloaded to a PC using BS-2000 software.

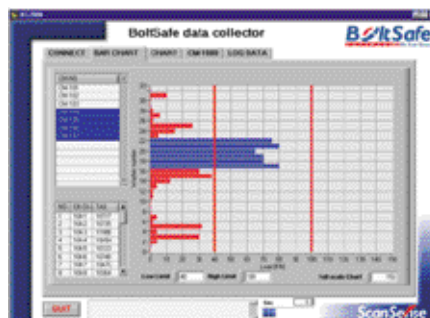
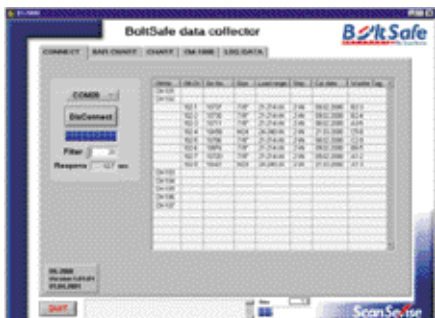
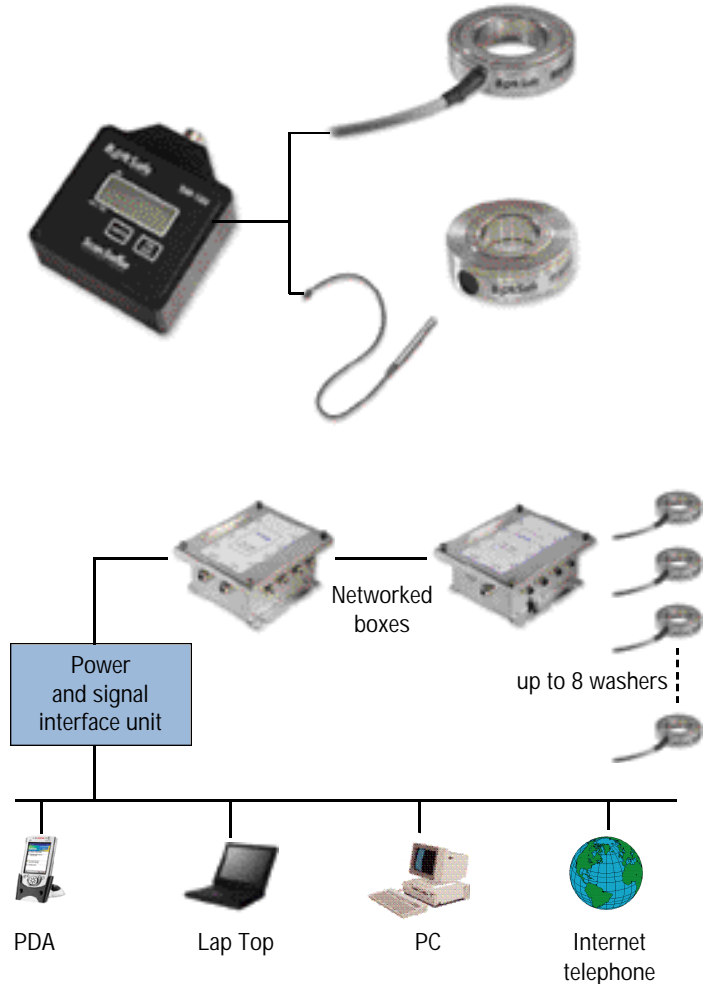
With this monitoring system, the operator must come close to each BoltSafe washer to read the measurement.

Monitoring a network of BoltSafe washers

The BoltSafe washers in your application can also be connected to a central station, the CM-1000, which displays the tightening load level on each washer. In this case, a pocket computer (Palm Top) or a portable computer (laptop) is used to interrogate, identify and store the measurement from each one of the BoltSafe washers in the network. This reader can then be directly connected to a PC to download the data using BS-2000 software.

With this monitoring system, the operator reads the BoltSafe washer information from a single spot, close to the application.

Equipment description	Reference
Handheld reader with no memory	SM-100
Handled reader with memory	SM-200
BoltSafe network adapter	CM-1000
BoltSafe analysis and display software	BS-2000



The BS-2000 software processes the data from the BoltSafe washers.

Remote monitoring of the BoltSafe network

The BoltSafe washer network in a strategic application can be an integral part of a company's security and monitoring system. The objective is to detect and warn of any abnormal situation reflected by variations in the tightening pre-load in the bolts in the application.

In this monitoring arrangement, the BoltSafe washers are connected to interconnected CM-1000 stations. A single network station is then connected to a PC (RS-232 connection) and to the BS-2000 program, where warning levels can be programmed to warn the overall surveillance system. Or, the PC can be remotely polled and can provide information from afar

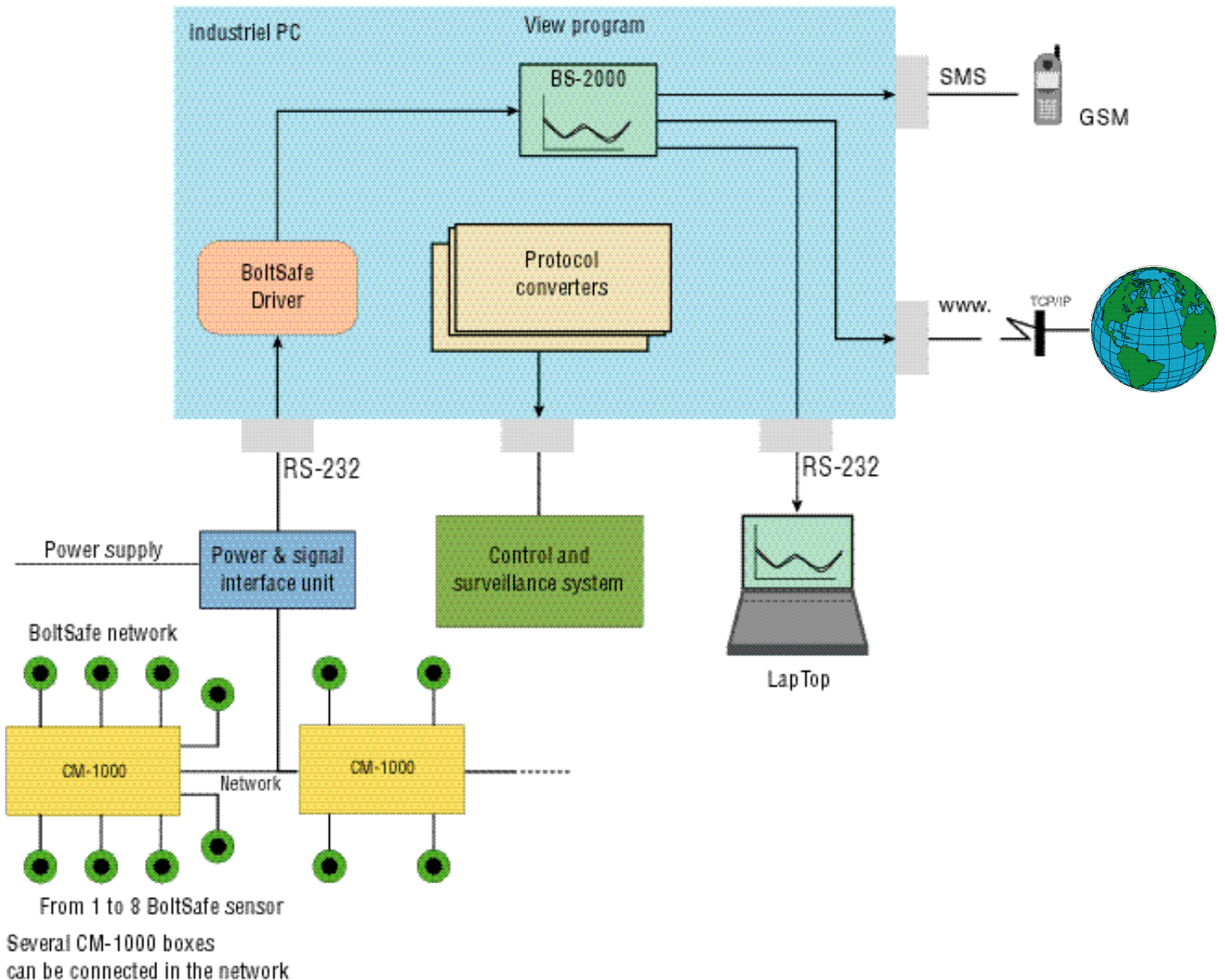
The BS-2000 program

The BS-2000 program was specially designed to provide the user with user-friendly interface enabling him to instantaneously review residual pre-tension directly on the screen. The program is easy to use and to understand. It uses the structures, icons and drag-and-drop functionality from the standard Windows environment.

Residual pre-tension data can be analyzed in three different ways (list, bar chart and histogram) and can be saved to files or printed.

BS-2000 software can also be concurrently used to upload data recorded in the SM-200 reader or from a hand-held reader.

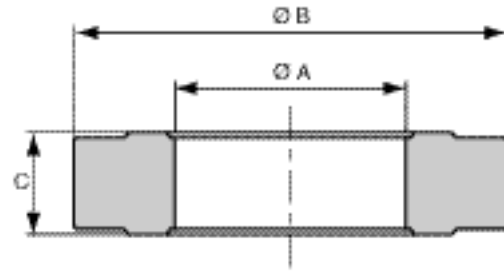
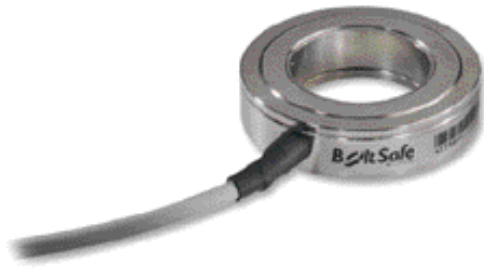
In the case of remote surveillance, software functions can be added to provide access to the monitored BoltSafe network by all control systems.



The BoltSafe CMS washer

By Scan-Sense

Standard range



The BoltSafe CMS (Continuous Monitoring System) washer is connected to a SM-100 or CM-1000 station via cable.

Metric system

Bolt description	Bolt diameter (mm)	Inside diameter A (mm)	Outside diameter B (mm)	Thickness C (mm)	Weight (gr)	Maximum tightening load (kN) Class 10.9
M20	20	20.4	37	14	73	116
M22	22	22.4	40	14	85	208
M24	24	24.4	44	14	104	239
M27	27	27.4	50	14	137	315
M30	30	30.6	56	17	214	385
M33	33	33.6	58	17	218	480
M36	36	36.6	66	17	295	560
M39	39	39.6	68	17	300	670
M42	42	42.6	75	20	445	772
M45	45	45.6	80	20	506	905
M48	48	48.6	86	20	591	1018
M52	52	52.6	92	20	669	1221
M56	56	56.6	100	20	798	1408
M60	60	60.8	108	23	1083	1647
M64	64	64.8	114	23	1196	1794

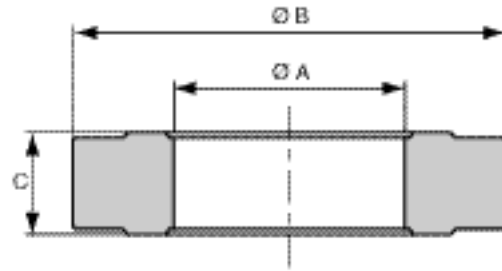
Imperial system

Bolt description	Bolt diameter (mm)	Inside diameter A (mm)	Outside diameter B (mm)	Thickness C (mm)	Weight (gr)	Maximum tightening load (kN) Class 10.9
7/8"	22.2	22.6	47	14	133	214
1"	25.4	25.8	52	14	160	280
1 1/8"	28.6	29	57.1	14	191	354
1 1/4"	31.8	32.3	63	17	286	437
1 3/8"	34.9	35.5	69	17	343	529
1 1/2"	38.1	38.7	74	17	391	629
1 5/8"	41.3	41.9	80	20	543	739
1 3/4"	44.5	45.1	85	20	608	857
1 7/8"	47.6	48.2	91	20	698	983
2"	50.8	51.4	98	20	816	1119
2 1/4"	57.2	57.8	108.8	23	1156	1416
2 1/2"	63.5	64.3	116.6	23	1289	1748

The BoltSafe PMS washer

By Scan-Sense

Standard range



The BoltSafe PMS (Periodic Monitoring System) washer. Measurement is read through a probe in contact with an electronic interface in the washer.

Metric system

Bolt description	Bolt diameter (mm)	Inside diameter A (mm)	Outside diameter B (mm)	Thickness C (mm)	Weight (gr)	Maximum tightening load (kN) Class 10.9
M30	30	30,6	64.3	20	372	385
M33	33	33,6	68.4	20	413	480
M36	36	36,6	72.8	20	462	560
M39	39	39,6	78	20	528	670
M42	42	42,6	83	20	593	772
M45	45	45,6	87.6	20	655	905
M48	48	48,6	92	20	716	1018
M52	52	52,6	97.2	20	784	1221
M56	56	56,6	102	20	845	1408
M60	60	60,8	108	23	1083	1647
M64	64	64,8	114	23	1196	1794

Imperial system

Bolt description	Bolt diameter (mm)	Inside diameter A (mm)	Outside diameter B (mm)	Thickness C (mm)	Weight (gr)	Maximum tightening load (kN) Class 10.9
1 1/4"	31,8	32,3	67	20	401	437
1 3/8"	34,9	35,5	73	20	474	529
1 1/2"	38,1	38,7	78	20	535	629
1 5/8"	41,3	41,9	84	20	619	739
1 3/4"	44,5	45,1	86	20	628	857
1 7/8"	47,6	48,2	91	20	698	983
2"	50,8	51,4	98	20	816	1119
2 1/4"	57,2	57,8	108,8	23	1156	1416
2 1/2"	63,5	64,3	116,6	23	1289	1748

Glossary of terms

Bolt Class	<p>Category of bolts defined by the mechanical characteristics of failure limit and yield point.</p> <p>Example: Class 12-9 bolt</p> <p>The first figure indicates one hundredth of the failure limit in MPa</p> <p>The second figure indicates the coefficient in 10ths that would have to be applied to this failure limit in order to find the yield point.</p> <ul style="list-style-type: none">• Failure limit: 1200 MPa• Yield point: 1080 MPa
Tensile stress	<p>The relation between the tensile strength exerted on the bolt and its unit area.</p>
Hydraulic load	<p>Force transmitted during tightening operation, by the hydraulic tensioner to the bolt, produced by the hydraulic pressure from the hydraulic area of the tensioner.</p>
Residual load	<p>Force or pre-tension applied on the bolt when the nut has been turned down and the hydraulic pressure has been released.</p>
External load	<p>Force applied on the bolted assembly from operation of the application.</p>
Elongation	<p>The stretching of the bolt by tensile stress.</p>
Stud	<p>A bolt which is threaded on both ends over a certain length. Most often, the central part remains smooth and is generally smaller than the threaded sections.</p>
Yield point	<p>The maximum stress point possible in a bolt in order to undergo no elongation when the tensile stress stops. Beyond this stress limit, the bolt sustains permanent strain.</p>
Failure limit	<p>Maximum possible stress causing the failure of the bolt.</p>
Tightened length	<p>Distance between the bearing face under the nut and the bearing face under the bolt head or under the other nut head if it is a stud.</p>
Pre-stressing	<p>Stress applied to the bolt when it is tightened, and the result of the relation between the residual load and the equivalent bolt area. Prestress does not take into account the stress from the external load.</p>
Bolt stiffness	<p>The theoretically constant ratio between the tensile strength applied on a bolt and the elongation due to this strength. Bolt stiffness depends on the area, the modulus of elasticity and the tightened length.</p>
Automatic return	<p>A mechanical device on certain tensioners which returns the piston to its original position when tensioner pressure stops.</p>
Equivalent bar area	<p>Cylinder section modeling the threaded part of a bolt, subjected to uniform tension. The calculation of cylinder diameter is based on thread diameter and pitch.</p>
Hydraulic area	<p>Piston area subjected to hydraulic pressure.</p>

Conclusion

This catalogue illustrates SKF Equipements expertise in the industrial tightening field. This catalogue is aimed at helping bolted assembly designers from the very start of the design stage for bolt-tightening applications.

The information, the recommendations and the description of the total product range, with its diverse and varied product characteristics, provide the reader with everything he needs to define the equipment which best meets the needs of his application.

The crucial message is that tightening is one of the most critical steps in a bolted assembly, and must be thoroughly studied.

Every bolted assembly must be tightened just right. There is no such thing as “too little or too much tightening”.

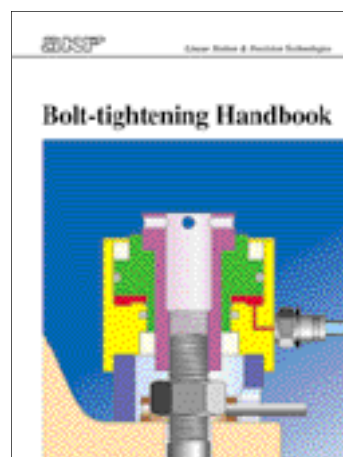
And SKF Equipements can help you define and implement what is just right for you.

SKF Equipements can:

- help you optimize your assemblies
- help you choose the tensioner(s) adapted to your application
- design custom tensioners for your needs
- manufacture special tightening machines.

Industrial tightening is our profession.

We can help you concentrate on yours.



Fax / / date

From:

Company _____

Address _____

Name _____

Tel N° _____

Fax N° _____

I would like price information on the following models:

Send to

SKF Equipements

Département Techniques de Serrage Industriel
30-32, avenue des Trois-Peuples
F-78180 Montigny-le-Bretonneux

Fax: 33 1 30 12 69 79

Tel.: 33 1 30 12 69 76

Price request

Note: for descriptions and references, see the following sections:

- standard tensioners pages 34 to 45
- accessories pages 58 à 61

RESERVED FOR SKF

SKF Equipements offer

N°54 -

N°	Equipment description	reference	quantity

unit price	delivery*

*delivery date upon ordering

Comments:

For all specific requests, please call us at + 33 1 30 12 69 79

Fax / / date

From:

Company _____

Address _____

Name _____

Tel N° _____

Fax N° _____

I would like information on Hydrocam Tensioners:

Send to

SKF Equipements

Département Techniques de Serrage Industriel
30-32, avenue des Trois-Peuples
F-78180 Montigny-le-Bretonneux

Fax: 33 1 30 12 69 79

Tel.: 33 1 30 12 69 76

Information on the Hydrocam Tensioner(s)

Application: existing being validated

Equipment: _____

Parts to be tightened: _____

Bolt characteristics

(specify numbers)

Thread diameter (d): _____

Pitch: _____

Bolt diameter (D): _____

Extending length (l): _____

Nut(s): _____

- width across flats (f): _____

- height (h): _____

Washer(s): _____

- ϕ outside (A): _____

- Thickness (e): _____

Bolt material: _____

Yield point: _____

Class: _____

Bolt distribution

(supply diagram if possible)

Distribution diameter: _____

Number of screws: _____

Distance between 2 bolts: _____

Optimizing the bolted assembly

(dimensions and number of bolts)

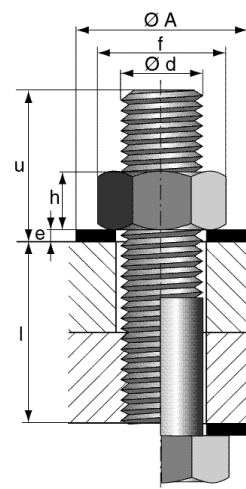
yes no

External load: _____

static dynamic

Application point: _____

(diagram if possible)



Current tightening method (specify units)

Torque (wrench) _____

- torque applied: _____

- elongation : _____

Heating rod _____

- temperature: _____

- screwing angle: _____

Other methods _____

Hydraulic tensioner tightening

Residual pre-load (per bolt) _____

Hydraulic load (per bolt) _____

Simultaneous tension: yes no

How much: _____

Existing:

Feed to provide for:

manual pump

air-driven generating set

Electro hydraulic generating set

Space available for the tensioner

Height (X): _____

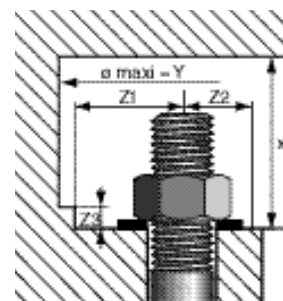
Diameter (Y): _____

Local obstruction (Z1): _____

(Z2): _____

(Z3): _____

Drawings enclosed: _____



SKF Equipements

- sells the SKF Linear Motion product range: driving systems (ball & roller screws, linear motors), actuation systems, positioning systems, precision bearings and spindles for machine tools.
- offers top-quality components and industrial equipment parts such as:
 - modular solutions for automation
 - gas springs
 - shock absorbers
 - bushings
 - precision chains
 - seals
 - wheel and ball transfer units
- designs and manufactures the HYDROCAM range of bolt tensioners
- backs up the quality of its services and products in the form of ISO 9001 certification



Bolt-tightening products and services provided by SKF Equipements



HYDROCAM bolt tensioners:

- complete standard range including six different types covering a large range of bolt sizes: M8 to M160 and loads of 50 kN to 8500 kN
- standard tensioners adaptable according to application interface
- special tensioners designed for dedicated applications, extending the range of bolt sizes from M5 to M500



Sensor washers for measuring tightening loads



Accessories:

- manual pumps delivering various pressure ranges: 700, 1000 or 1500 bar
- air-driven hydraulic power units delivering various pressure ranges: 700, 1000, 1500, 2000 or 3000 bar
- electrically driven hydraulic power units delivering various pressure ranges: 700, 1000, 1500 or 2000 bar
- high-pressure hoses of all lengths; distribution blocks
- pressure intensifiers.



Simultaneous tightening machines and systems (with optional automation)



Standard and customised automatic remote-control systems



Services:

- assistance in design of bolted joints,
- assistance in selecting most appropriate tightening method,
- expertise and experimentation,
- industrial partnerships
- checks and tests,
- training,
- technical assistance / on-site intervention,
- installation and commissioning,
- maintenance and repairs in our workshop or on site,
- distance monitoring.

Throughout the world, SKF local companies or offices represent SKF's ITE department for all queries regarding bolt-tightening equipment.

Europe

Austria

Linear Motion

SKF Österreich AG

Phone : +43 22 36 6709-0

Fax : +43 22 36 6709-270

e-mail : multitec.austria@skf.com

Benelux

SKF Multitec Benelux B.V.

Phone : +31 030 6029029

Fax : +31 030 6029028

Sales Office Belgium /Luxembourg

Phone : +32 2 5024270

Fax : +32 2 5027336

e-mail : multitec_benelux@skf.com

France

SKF Equipements

Phone : +33 1 30 12 73 00

Fax : +33 1 30 12 69 09

e-mail : equipements.france@skf.com

Germany

SKF Linearsysteme GmbH

Phone : +49 9721 657-0

Fax : +49 9721 657-111

e-mail : lin.sales@skf.com

Italy

SKF Multitec S.p.A.

Phone : +39 011 57 17 61

Fax : +39 011 57 17 633

e-mail : multitec.italy@skf.com

Nordic area

SKF Multitec Sweden

Phone : +46 42 25 35 00

Fax : +46 42 25 35 45/46

Sales Office Norway

Phone : +47 22 30 71 70

Fax : +47 22 30 28 14

Sales Office Denmark

Phone : +45 65 92 77 77

Fax : +45 65 92 74 77

Sales Office Finland

Phone : +358 94 52 97 52

Fax : +358 94 12 77 65

e-mail : multitec.nordic@skf.com

Spain

SKF Productos Industriales S.A.

Phone : +34 93 377 99 77

+34 93 377 99 07

Fax : +34 93 474 2039 / 3156 / 2156

e-mail : prod.ind@skf.com

Switzerland

Linear Motion

& Precision Technologies

Phone : +41 1 825 81 81

Fax : +41 1 825 82 82

e-mail : skf.schweiz@skf.com

United Kingdom

SKF Engineering Products Ltd.

Phone : +44 01582 490049

Fax : +44 01582 496574

e-mail : skf.ep1@skf.com

Americas

USA

SKF Motion Technologies

Phone : +1 610 861-4800

Toll free : +1 800 541-3624

Fax : +1 610 861-4811

e-mail : motiontech.usa@skf.com

Asia

Japan

SKF Japan Ltd.

Phone : +81 3 3436 4129

Fax : +81 3 3578 1014

e-mail : skf.japan@skf.com

<http://www.linearmotion.skf.com>

For all other Countries contact:

Linear Motion & Precision Technologies

Phone: +39 011 9852553

Fax: +39 011 9852202

e-mail: motion.technologies@skf.com