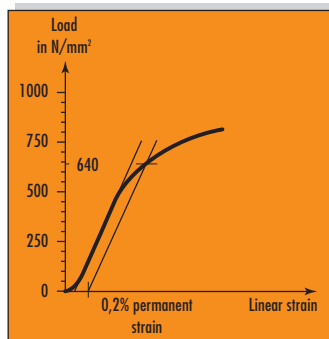


### FASTENERS FOR MAXIMUM PERFORMANCE

In modern constructions there is a demand for fasteners having ever increasing properties in order to reduce the weight, decrease the cost and at the same time increase the safety of the construction. Here the low alloyed hardenable steels have had a leading position in industry including many high strength variants such as 8.8, 10.9 and 12.9. A big disadvantage for fasteners in these types of steels is their very poor corrosion resistance in aggressive environments, their low strength at elevated temperatures and that they become very brittle at cryogenic temperatures. Bulten Stainless have for a long time been at the leading edge of development in high strength fasteners of corrosion resistant steels and was one of the main driving factors in pursuit of the international standard ISO 3506, where among other things, the property class 80

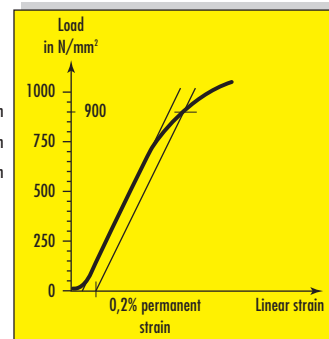
was specified. We have now further developed our products and in this brochure we present two new product lines the BUMAX 88 and BUMAX 109, having unique properties. For these products we have set the goal to reach the same Tensile and Yield strength as those valid for steel screws 8.8 and 10.9. At the same time these products should have better corrosion properties and other features than that of normal acid proof A4 products normally sold in the market. In this brochure, we present the most important characteristics for our unique products and where they clearly differ from the normal 'Trade Standard'. In table 1 the mechanical properties for A4 'Trade Standard' are shown compared to those of BUMAX 88 and BUMAX 109.

**BUMAX 88: 800/640 N/mm<sup>2</sup>**



Rm 800 N/mm<sup>2</sup> min  
Rp 0,2 640 N/mm<sup>2</sup> min  
80 % of the tensile strength

**BUMAX 109: 1000/900 N/mm<sup>2</sup>**



Rm 1000 N/mm<sup>2</sup> min  
Rp 0,2 900 N/mm<sup>2</sup> min  
90% of the tensile strength

### MECHANICAL PROPERTIES FOR FASTENERS IN AUSTENITIC STEELS

GROUP/TYPE	STRENGTH-CLASS	DIAMETER RANGE	ULTIMATE TENSILE STRENGTH Rm N/mm <sup>2</sup>	STRESS AT 0,2% PERMANENT STRAIN Rp 0,2 N/mm <sup>2</sup>	ELONGATION AT FAILURE
A4-70	70	≤ M24	700	450	0,4 x d
A4-80	80	≤ M24	800	600	0,3 x d
BUMAX 88	80	≤ M36	800	640	0,3 x d *
BUMAX 109	100	≤ M12	1000	900	0,2 x d
BUMAX 109	100	M14 - M20	1000	800	0,2 x d

TABLE 1

\* For dimensions >M30 the elongation at failure is 0,2 x d min.

### PRINCIPAL ANALYSIS FOR SOME ACID PROOF STEELS

BUMAX 88 and BUMAX 109 are produced in a version of the Swedish steel grade SS2343 having the carbon content (C) maximised to 0,030%, we call this grade 316 L Hi Mo.

In Table 2, the chemical composition for (316,316 L) A4 and BUMAX 88 and BUMAX 109 are shown.

STEELGRADE	C max	Cr	Ni	Mo
A4 (316)	0,080	16,0-18,0	10,0-14,0	2,0-3,0
A4 (316L)	0,030	16,0-18,0	10,0-14,0	2,0-3,0
BUMAX 88	0,030	16,5-18,5	11,0-14,5	2,5-3,0
BUMAX 109	0,030	16,5-18,5	11,0-14,5	2,5-3,0

TABLE 2

### CORROSION PROPERTIES

The three most common and most severe types of corrosion in falling severeness are Pitting, Crevice and General Corrosion. The chemical composition of the steel have an important influence on how well it can combat the different types of corrosion. The most important elements for this ability are Chromium (Cr), Molybdeunum (Mo) and Nitrogen (N).

Also the Carbon content (C) have influence, especially at elevated temperatures. The seemingly small differences of these alloying elements has a great influence on the properties of the steel. A number of laboratory tests have proved that the 316 L Hi Mo (SS2343) the grade used in BUMAX 88 and BUMAX 109, is superior to normal trade standard A4 for all different media and all types of corrosion.

#### MECHANICAL PROPERTIES AT HIGH AND LOW TEMPERATURES

The properties of a steel is effected by the temperature at which it will be working. When the temperature increases, the mechanical strength will decrease. In Table 3, the remaining yield strength at elevated temperatures is shown as a percentage of the value at room temperature. The values in the table are only to be regarded as guidelines. In the

table, values for class 70 and 80 in A4 together with the BUMAX 88 and BUMAX 109 products, are shown. For Class 50, which is the same as the steel in annealed condition, we refer to the valid steel standard data sheets. In the table, we also show the highest recommendable working temperature in air for fasteners in each grade and property class.

STEEL AND STRENGTH CLASS	REMAINING YELD STRENGTH IN % OF THAT AT ROOM TEMPERATURE (RT)						WORKING TEMP. IN AIR
	100°C	200°C	300°C	400°C	500°C	600°C	
A4-70/80	85	80	75	70	–	–	450–500
BUMAX 88	90	90	85	80	75	70	600
BUMAX 109	95	95	95	90	90	85	600

TABLE 3

#### IMPACT TEST AT DIFFERENT TEMPERATURES

At low temperatures the normal low alloyed steels becomes very brittle whereas the austenitic steels keep their toughness and can be used at very low temperatures. The steel ability to function at low temperatures is defined by its impact strength. In the table 4 the results from impact

test of screws in different property classes are shown. The impact strength decreases with increased strength. In spite of the high strength of BUMAX 88 and BUMAX 109 the impact strength is relatively good and considerably better than that of steel screw 8.8 and 10.9.

STRENGTH CLASS	IMPACT STRENGTH IN JOULE (J) AT °C				
	20	-50	-100	-140	-196
A4-70	96,9	91,9	84,5	80,5	73,4
BUMAX 88	79,5	74,5	69,0	60,0	47,4
BUMAX 109	36,0	34,0	32,9	31,0	29,5

TABLE 4

#### RELATIVE PERMEABILITY FOR SOME STEEL GRADES AND PROPERTY CLASSES

Permeability is a measurement on a materials ability to let a magnetic field go through and is described as the permeability value  $k_m$ . This is the value for the permeability of a material in relation to vacuum, where the  $k_m$  is 1,0 i.e. totally non-magnetic. In high-tech market segments such as electronics, computer industry and some parts of the marine industry it

is of greatest importance to use fasteners having low magnetic permeability ( $k_m$ ). In table 5 the  $k_m$  for some stainless and acid proof steels are presented. There is a noticeable difference between BUMAX 88, BUMAX 109 and the other grades. The values for the BUMAX products are so low that they could be regarded as non magnetic.

STEEL GRADE AND CLASS	Rp 0,2 I N/mm <sup>2</sup>	MAXIMUM RELATIVE PERMEABILITY
		$k_m$
A2-70	450	1,400
A2-80	600	1,800
A4-80	600	1,012
BUMAX 88	640	1,006
BUMAX 109	900	1,007

TABLE 5

#### FRICTION IN BOLTED JOINTS

Friction in bolted joints is characterised by  $\mu$  and is a value on how smooth the surfaces are gliding against each other. In order to be able to make use of the high strength fasteners in a proper way, it is essential that the joint gets the correct preload and is tightened by using a dynamometric wrench. The condition to obtain a correct tightening torque resulting in a correct preload is to have as low friction as possible

in the joint. Bulten Stainless BUMAX 88 and BUMAX 109 are treated with a special anti friction media and there is normally no demand for additional lubrication when they are assembled with a nut. When assembling in a threaded hole, additional treatment is often needed. In figure 1, a friction test of A4 trade standard (untreated) compared with BUMAX 88 and BUMAX 109 are shown.

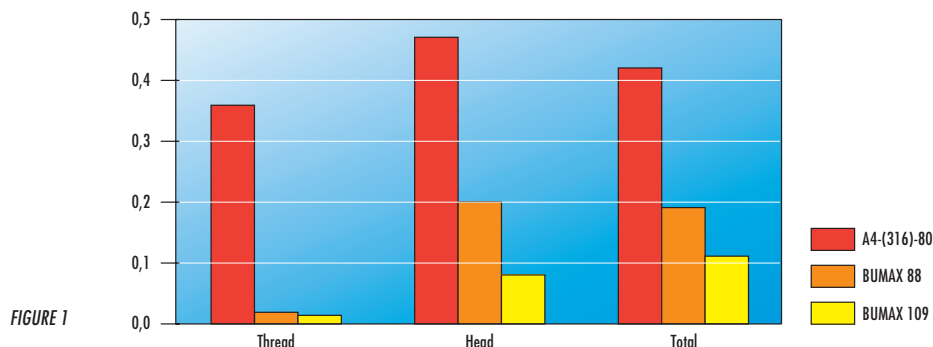


FIGURE 1

### TIGHTENING TORQUE AND FORCES

In order to keep a joint tight, it is of greatest importance that the correct preload is reached when assembling. The values in Table 6 are calculated to give a preload of about 65% of the Rp 0,2 (0,2% permanent strain). Correct preload can only be reached in a joint having low friction. If no anti friction media is used the preload can vary heavily and can reach as low levels as 20% of the given value.

This is due to the fact that the tightening force is used to overcome friction instead of tensioning the joint. BUMAX 88 and BUMAX 109 are treated with a high performance lubricant in order to obtain low friction.

For these products, the variation of the preloading values are not more than +/-15% when assembling in nuts using a calibrated dynamometric wrench.

DESCRIPTION	CLASS	DIMENSION														
		M3	M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M24	M27	M30	M36
TIGHTENING TORQUE Mv I Nm	A4-70	0,9	2,0	4,1	7,0	17	33	57	91	140	195	273	472	682	930	1620
	A4-80	1,2	2,7	5,4	9,3	22	44	76	121	187	261	364	629	909	1240	2160
	BUMAX 88	1,3	2,9	5,7	9,8	25	47	82	129	198	275	385	665	961	1310	2280
	BUMAX 109	1,7	4,1	8,1	14	34	66	115	161	248	344	481				

DESCRIPTION	CLASS	DIMENSION														
		M3	M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M24	M27	M30	M36
PRELOAD APPLIED kN	A4-70	1,5	2,6	4,2	5,9	11	17	25	34	47	56	72	103	134	164	239
	A4-80	2,0	3,4	5,5	7,8	14	23	33	45	61	75	96	138	179	219	319
	BUMAX 88	2,1	3,6	5,9	8,4	15	24	35	48	65	80	102	181	235	287	418
	BUMAX 109	2,9	5,2	8,6	12	21	34	49	60	81	100	128				

DESCRIPTION	CLASS	DIMENSION														
		M3	M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M24	M27	M30	M36
FAILURE LOAD kN	A4-70	3,5	6,1	9,9	14	26	41	59	81	110	134	172	247	321	393	572
	A4-80	4,0	7,0	11	16	29	46	67	92	126	154	196	282	367	449	654
	BUMAX 88	4,0	7,0	11	16	29	46	67	92	126	154	196	282	367	449	654
	BUMAX 109	5,0	8,8	14	20	37	58	84	115	157	192	245				

DESCRIPTION	CLASS	DIMENSION														
		M3	M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M24	M27	M30	M36
YIELD LOAD kN	A4-70	2,2	3,9	6,4	9,0	16	26	38	52	71	86	110	159	207	253	368
	A4-80	3,0	5,3	8,5	12	22	35	51	69	94	115	147	212	275	337	490
	BUMAX 88	3,2	5,6	9,1	13	23	37	54	74	101	123	157	226	294	359	523
	BUMAX 109	4,5	8,0	13	18	33	52	76	93	125	154	196				

DESCRIPTION		DIMENSION														
		M3	M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M24	M27	M30	M36
STRESS AREA	mm²	5,03	8,78	14,2	20,1	36,6	58	84,3	115	157	192	245	353	459	561	817
THREAD PITCH	mm	0,5	0,7	0,8	1,0	1,25	1,5	1,75	2,0	2,0	2,5	2,5	3,0	3,0	3,5	4,0

TABLE 6

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### STOCK PROGRAMME

BUMAX 88 products are stocked in a wide range from M3 to M36 and the most common types of screws, nuts and washers. We also stock a range of UNC-threaded products. Our stock of BUMAX 109 is unique in the world and we have increased this stock range successively. Today we stock BUMAX 109 hexagon screws and bolts from M6 x 20 mm to M12 x 120 mm and in addition nuts and washers in corresponding sizes.

### QUALITY ISO 9001-QS 9000

Within Bulten Stainless AB we are working according to the QA-Systems ISO 9001 and QS 9000 and are third party certified by TÜV.

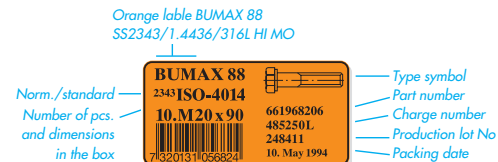


### SERVICE

The BUMAX 88 and BUMAX 109 products are manufactured in our own factories and therefore we can keep a very high service level on these products. Thanks to our own manufacturing, we can offer sizes other than those presented in our stock range enabling us to produce "special" products according to each customer's needs. We can produce products having even higher strength than the ones presented in this brochure. In these cases, it is the limitations on the steel itself deciding how far we can reach in terms of strength and other properties. We are continuously working on improving the properties of our products.

### DURABLE PACKING WITH CLEAR MARKING

Our products are packed in high quality sturdy boxes and are marked according to a colour coded system. This system is described in our product catalogues. We guarantee full traceability for all our products in unbroken boxes. On our labels all data for full traceability is given. The picture below explains the data given on the label.



### APPLICATIONS

Bulten Stainless products are already used today in applications where there are demands for high strength, good corrosion properties and high finish for safe assemblies, e.g. pumps and flange connections for high vacuum. Another interesting area is the marine sector for power transmission joints where our BUMAX 109 have replaced 10.9 steel screws which corroded in the actual environment.

Within the off-shore industry, weight saving is of great importance and here the high strength technology correctly applied, resulted in extremely good weight savings at the same time keeping, or even increasing, the safety. The VCF Compact Flange System is a good example on this technology. The new products are also of interest for the automotive industry where weight saving and increased safety are now becoming more important than ever before.



VCF-Compact flange from VERAX.



Aquadrive-coupling from Svenska Uni-Cardan AB