

Lockings/Seals

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Why bolted joints fail

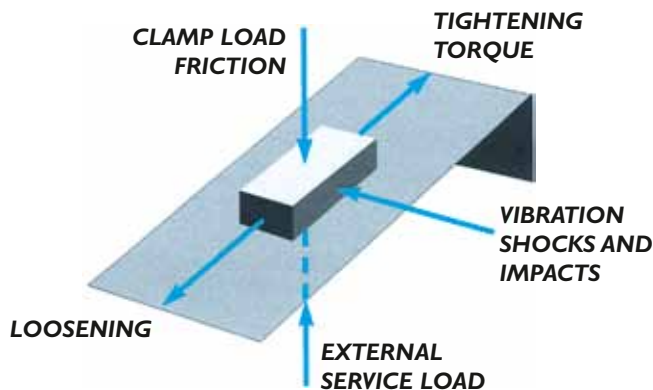
The problem of bolted joint loosening has been a concern since the first screws were used in the 15th century. The mechanism of loosening is best illustrated by imagining the bolt thread unwound from the shank. It is, in effect, a ramp. The mating thread is a small block placed on this ramp. The forces that hold the joint together are friction and the compression of the material between the nut and bolt members (clamp load). If the outside forces acting on the joint exceed the clamp load, the parts move sideways (dilation).

As the block is pushed sideways across the ramp, it will also move downhill. This is loosening. The higher the preload (clamping force) the faster the block moves downhill if the clamp load is exceeded. Repeated sideways movement (vibration) comes in several frequencies; very small, rapid repeated impacts cause frequent slow unwinding (fretting loosening) while sharp, hard jolts cause faster step-like loosening.

Adequate preload (clamp load which exceeds anticipated service loads), will prevent loosening if it is possible to predict the forces acting on the joint.

Many times the loading on real world joints is not calculable. Service loads that are greater than the clamping load have been known to completely loosen a joint in under a dozen sharp shocks.

The sideways movement does not always come from external shaking of the joint. Significant sliding can be caused by thermal expansion and contraction of the bolted joint (i.e., engine attachments). Bending of joined components also causes transverse sliding and loosening. Once the joint is loosened and the clamp load is, for all practical purposes, lost another attachment failure mode can occur. This is fatigue failure. Fatigue is the constant bending and unbending of the bolted member like a paper clip that is bent until it breaks. Just like the paper clip which could not be pulled apart in our bare hands, it breaks at very very low strength levels in fatigue. Proper clamp load prevents this bending, loose fasteners do not.



Locking is the answer

The locking feature was developed to maintain the joint at its tightened position to prevent loosening and attendant fatigue. A secondary function was to prevent complete disassembly of the joint, thereby allowing the operator some notice of the deteriorating attachments through shaking, noise, etc.

There are two basic types of locking features, based upon functioning. The first are features which maintain the joint at its tightened position. They are "free spinning" during the installation and, via the action of its feature, "lock" the joint at the point of installation. Typical of this type of locking element are the deflection slotted nuts, various coned washers, ridged bearing faces, numerous patented thread form modifications which interfere with the tightening by jamming thread flanks together, and dozens of special multi-piece assemblies which rotate, etc., to lock the elements into rigidity. While all of these features have a use somewhere or sometime they all fail to resist vibration loosening.



Mechanical locking nuts

This means they all become free spinning and can walk off easily once the preload has been lost. Preload, if properly designed, is capable of maintaining the joint integrity; however, its loss is also the loss of the locking fastener. No value is added when using this type of locking element beyond a few special cases where the service load is near the preload limit and repeatedly cycled.

The second type of locking features adds resistance to the free turning installation of the fasteners while also holding their final assembled position. Resistance Element Prevailing Torque (REPT) fasteners all possess an interference feature that retards free spinning of the fastener into its mating thread.

Deflected threads on bolts and crimped threads on nuts have been used since their official invention during the 1940's. The idea goes back into the misty past when nicks and other damage to threads offered resistance to assembly. The torque values were completely arbitrary and generally not reproducible. All metal types of locking features, usually the mainstay for modern industry's locking needs, are beginning to fade from use today. Modern technology and customer driven product improvements now require easier to drive, more trouble free and serviceable attaching methods.

Increased demand for corrosion resistance on parts has led to the use of thicker platings and coatings which cause jamming, galling and premature tool turnoffs as the installation torque is used in overcoming the interference of the coating rather than in tightening the attachment. Metal to metal contact causes galling and tearing of the metal when the deflected threads contact each other and spin on, especially with today's very fast tooling (hydraulic pulse tools spin at 3000+ RPM's).

Service is almost impossible when the metal to metal features have "welded" themselves together in long run down, high speed joints. Reusability, sensitivity to hole and other dimensional variations, as well as mass and length thickness considerations have all led to the decline in acceptability of this type of locking feature. The deflected thread, after one or two uses, begins to open up and reform its original thread shape, losing its interfering/locking ability. Some types of metal crimped nuts cause interference between the socket and the nut due to the out-of-roundness of the squeezed nut, a situation which causes lost assembly time as the drive socket stays stuck on the nut rather than on the drive gun.



Resistance element prevailing torque nuts

Non-metallic prevailing torque elements

The earliest non-metallic locking elements were small pellets and strips which were embedded in the threads. They have excellent vibrational resistance but require machining and additional labor to insert the plastic pieces. There is still use of these types in areas of complex configurations and small thread sizes and in the aerospace and aircraft industries.

The nylon collar nut is a popular locking fastener type also. The collar is retained at the top surface by swaging over the top edge of the nut. It shows consistency in torque, vibrational resistance, and the 360° collar acts like a bushing while reducing installation tool chatter. The multipart construction is an unacceptable economic negative in some applications. The increased height and mass also limited the areas in which this type is successfully used. The fact that this nut is generally only available in soft steel means that no high strength attachments may be joined as the harder material can not be swaged after heat treatment and the plastic would melt if swaged before. This same problem limits the corrosion coatings, which may be used. Swaged after and the platings may crack, swage before and the chemicals may leach out and stain and/or the collar may melt during baking.

The next generation of non-metallic element fasteners were manufactured with the element fused permanently to the threads. This produced parts with all the advantages of the implanted elements but without the cost. The NYLOK® patch is available in either partial or full circumferential varieties, depending upon the amount of torque required and other considerations such as the need for a sealing function as well.

The NYLOK® patch acts as a wedge by forcing the threads of the fastener against the mating threads at the side opposite of the patch area. The nylon patch, because of its elastic "memory" properties, tries to regain its original shape, further increasing the frictional resistance to loosening. Nylok Fastener Corporation's special control of the bonding process prevents the patch from loosening and being removed during the installation operation. Internally threaded fasteners may be manufactured with a full circumferential patch. This part type acts exactly like the collar insert parts but without the cost penalty.



Nytemp® patch

Non-metallic element parts are much less sensitive to metal thread variations which leads, in turn, to much better torque control. Reusability is outstanding (some MIL and industry specifications require 15+ reuses). Non-metallic locking elements are limited to applications not exceeding 250°F (121°C). Applications that involve temperatures of up to 450°F (232°C) should be specified with orange NYTEMP® patch, Nylok's unique high temperature resistant material.

Adhesive locking elements

Prehistoric evidence of the usage of glue like compounds for fastening illustrates that this is not a new idea. However; it was not until the 1940's that the development of techniques and chemicals made the use of fastener adhesive locking a practical and economical reality. The adhesives currently in use consist of two part compounds which harden in the absence of air. The two parts of these adhesives are kept from interacting by encapsulating one or both parts in very small capsules, microns in diameter. The other part of the compound is the medium in which the spheres are mixed or suspended. The action of installation of the fastener into its mating part crushes and mixes the capsules and the curing process begins. Dependent upon the compound and formulation strength, the hardening begins within a couple of minutes. The adhesive is about 60% hardened within the hour and is completely hardened within 24 hours. While there is some use of liquid adhesives which are applied to fasteners on line, the mess and environmental concerns have made the pre-applied adhesive coatings method the undisputed leader.

PRECOTE® adhesive compounds, applied at NYLOK®, meet all industry and governmental standards. Several different formulations are available to tailor the part to the customers specifications and special conditions such as high heat applications or extremes in moisture or sealing.

Adhesive patched nuts display low installation torque as the compound is soft and mixing occurs during installation. Breakaway torques can be as strong as the breaking point of some soft steels and can be modified to meet customers requirements.

Prevailing off torque of adhesive parts, once the bond is broken, is less than plastic patch parts. Some second time hardening may occur as not all of the encapsulated capsules crush and mix the first time but what torque values are obtainable are happenstance numbers. Breakaway values, could be quite high and in the case of larger sizes (5/8" M16) make the parts almost unremoveable. The quick hardening of the adhesive also limits adjustment of the installed fastener to within five minutes of installation. Heat and humidity can cause premature hardening of the adhesive, thereby limiting the shelf life and storage conditions of pre-applied adhesive fasteners to inside areas away from furnaces and heaters.

Because the adhesive is soft and fills the thread interspaces completely when smeared and mixed by the fasteners, long rundowns are not recommended.



P-80=Pink P-30=Yellow P-5=White P-85=Turquoise

The ideal condition is for the bolt end to be tightened to a flush condition with the nut face so the adhesive coatings are in full contact within the threads. No more than 1-2 threads protrusion are suggested for normal designs and at 4 threads of protrusion the joint strength may be reduced as much as 90%. This reduction is due to the wipeout of the adhesive by the fastener during installation.

Another design consideration when using adhesive locking features is the number of threads available for coating. Standard nuts have few internal threads available for adhesive. Since many specifications require one thread to be free of adhesive on each side for assist in starting, and there are only 4 threads total in the 1/4, M6, 5/16 and M8 nuts, only 2 threads are available for adhesive and high breakaway torques.



Product overview, Locking elements/Seals

Table 106 Tuflok® Screw = Blue patch/Tuflok® Nut = Torq-patch lock-nut

Tuflok®	Colour	Screw-off torque 1st disassembly		Main function	Time to full function	Temp. °C limit
		Screw	Nut			
1 (soft)	Blue	1,8 Nm	—	Locking	Immediately	-50 - +120
2 (std) (More inert than Tuflok® 1)	Blue	1,8 Nm	5,0 Nm	Locking	Immediately	-50 - +120
3 (hard)	Blue	1,8 Nm	4,0 Nm	Locking + sealing	Immediately	-50 - +120

All data is based on screw M10 class 8.8 untreated.
A number of excellent features for locking, damping, adjustment etc. See our handbook "Locking elements".

The above is marketed by Mattssons and manufactured by a joint venture company: Nylok Scandinavia AB.

Table 106.1 Nytemp®

Nytemp®	Colour	Screw-off torque 1st disassembly	Main function	Time to full function	Temp. °C limit
	Orange	1,8 Nm	Locking + sealing	Immediately	-50 - +232

All data is based on screw M10 class 8.8 untreated.
A number of excellent features for locking, damping, adjustment etc. See our handbook "Locking elements".

The above is marketed by Mattssons and manufactured by a joint venture company: Nylok Scandinavia AB.

Table 106.2 Nyseal®

Nyseal®	Colour	Main function	Time to full function	Temp. °C limit
	Green	Sealing	Immediately	-50 - +120

Nyseal® is a patented pre-applied permanent sealing that prevents leakage of fluids up to the pressure of 100 psi, and can be used immediately.
Replaces o-rings, gaskets and sealing compounds.

It is also good for preventing chemical reactions between aluminium and stainless steel (galvanic element).
Nyseal® is re-useable and the green sealing compound does not shrink or dry out.

Table 106.3 Precote®

Precote®	Colour	Min. unripping without pre-tension after 24 h at room temp.	Main function	Time to full function	Temp. °C limit	Friction (μ)
5	White	2-6 Nm	Sealing	Immediately	-50 - +180	0,11 - 0,13
30	Yellow	15-20 Nm	Sealing + locking	6 hours	-50 - +150	0,12 - 0,14
80	Pink	24-30 Nm	Sealing + locking	6 hours	-50 - +170	0,28 - 0,30
85	Turquoise	22-26 Nm	Sealing + locking	6 hours	-50 - +170	0,12 - 0,14

All data is based on screw M10 class 8.8 untreated.

- Precote is a chemical thread locking and thread sealing.
- Threads are pre-applied with Precote.
- At assembly micro-capsuled chemical substances are released and a hardening process begins.

The above product is marketed by Mattssons.

- Precote can be applied on all metallic materials and different surface treatments.
- Precote can be applied on threads from M3.
- Precote can be stored for 4 years if the storage has an atmospheric humidity of max. 65% and a temperature between 12 and 28°C.

Product overview, Locking elements/Seals

Table 106.4 Dri-Loc®

Dri-Loc®	Colour	Min. unriveting without pre-tension	Main function	Time to full function	Temp. °C limit
2010	Yellow	12* Nm	Locking	6-12 hours	180
2040	Pink	15 - 25 Nm	Locking	6-12 hours	150

Dri-Loc® 2040 is especially suitable for surface treated articles.

*It is valid for M10 zinc phosphatised screws and nuts 24 hours in 22°C.

Source: Loctite catalogue.

Table 106.5 Dri-Loc®

Dri-Loc®	Colour	Screw-off torque 1st disassembly	Main function	Time to full function	Temp. °C limit
Plastic	Red	1,5 Nm	Locking	Immediately	-55 - +120

Dri-Loc® Plastic.

All data is based on screw M10 class 8.8 untreated.

Non-hardening thread locking that increases the friction in the thread.

Can be assembled/disassembled up to 3 times.

Source: Loctite catalogue.

Table 106.6 Dri-Seal®

Dri-Seal®	Colour	Main function	Time to full function	Temp. °C limit
5061	Light blue	Sealing	6-12 hours	-10 - +130

Dri-Seal® 5061.

Source: Loctite catalogue.

Non-hardened, water-based thread sealing that immediately seals against high pressures. Seals against most fluids and gases.

Table 106.7 3M®

3M®	Colour	Min. unriveting without pre-tension	Main function	Temp. °C limit
2353	Blue	9 Nm	Locking	-80 - + 90
4291	White		Sealing	-25 - +150

3M® 4291.

Source: 3M.

Non-hardened, water-based thread sealing that immediately seals against high pressures. Seals against most fluids and gases.

NYPLAS is a plastisol (PVC) material, pre-applied coating under the heads of a variety of fasteners to provide sealing against water, moisture, dust, air and noise dampening.



The advantages are clear:

- Seals/dampens immediately upon assembly.
- No secondary material required.
- Eliminates the need for O-rings, gasket seals and sealant compounds.
- Eliminates leak path.
- Re-useable.
- Non-toxic, assembler friendly.
- Excellent shelf life; will not shrink or dry out with age.
- Meets major automotive manufacturers' specifications.
- Saves money and time.
- Working temperature: -40°F to 300°F (-40°C to 150°C).

Source: Nylok 050518.

INNYVATION & NYLOK NYPLAS.

Innyvation is Nylok's word for our way of developing new products that solve challenges our customers are facing.

NYPLAS is a Nylok development that solved manufacturers' needs for a fastener that would seal and dampen without the need for additional parts at assembly.

NYPLAS meets and exceeds these key automotive industry specifications:

COMPANY NAME	SPECIFICATIONS	DATE
GM	GM6086M - TYPE 3	050518
GM	GMI131M - TYPE D	050518
Ford	ESB-M4G70-A or B	050518
Ford	WSK-MAG70C	050518
DaimlerChrysler	MSDC-43	050518

Nylok's patented temporary retention coating holds fasteners in place during transport or assembly.

The advantages are clear:

- Can be applied to both threaded and unthreaded fasteners.
- Temporarily holds fastener in place during fabrication, assembly, and transportation.
- Positioning application only.
- Soft enough to allow hand assembly.
- Non-toxic, assembler friendly.
- Environmentally friendly.
- Provides a solution for robotics riveting type production.
- Can be located at any point on fastener length.
- Speeds assembly time.
- Requires no additional features.
- Cost effective.
- Not affected by gasoline.



INNYVATION & NYLOK NYSTAY.

Innyvation is Nylok's word for our way of developing new products that solve challenges our customers are facing. It's backed by a host of worldwide patents.

A Nylok customer had a problem: the assembly point of his manufacturing process was a bottleneck. Workers were using plastic retaining washers to hold parts in place, a time-consuming operation. Nylok engineers responded with not only a new product, NYSTAY, but also with an entirely new process of assembly. The new process, made possible by NYSTAY, cut down on products and steps, and sped up assembly in dramatic fashion.



Source: Nylok 050518.

Nylok-products - Problem and Solution

In the following summary you will find some of the most common FAQs regarding our Nylok-products.

Problem:	Solution:	Problem:	Solution:
Loosening screws due to vibration:	Precote 19-2, Precote 30, 80 or 85, Tuflok	Protection from weld splatter:	Nycote
Leaking under the head:	Nyplas or Nyseal	Stop capping weld studs & capping nuts:	Nycote
Thread galling:	Nytorq	Electrodeposited coatings:	Nycote
Thread masking:	Nycote	Locking - all types:	Tuflok, Precote
Transportation loosening:	Nytorq, Precote, Nystay, Precote 19-2	Locking - high temp:	Nytemp
Noise dampening:	Nystay or Nyseal	Reusability in locking or adjustment:	Tuflok, Precote 19-2
Bump stop:	Nystay, Nyseal or Nyplas	High breakaway low assembly torque:	Precote
Insulation:	Nyplas, Nystay or Nyseal	Miniature screw locking:	Tuflok, Precote, Precote 19-2
Seal out water and dust:	Nyplas or Nyseal		
Seal out chemicals (gas, oil, fuel, etc):	Nyseal		

Source: Nylok.

Table 106.8 Selection Loxeal® Thread locking

Loxeal® product	Description	Max. Bogus	Fixing time in minutes	Unriveting force (ISO 10964)*	Temp. °C range
24-18	Weak, easy to dismantle with ordinary tools	M24 0,20 mm	15-30	4-8 Nm	-55 - +150
55-03	Medium strong, allround, oil tolerant, drinking water approved	M36 0,25 mm	10-20	17-22 Nm	-55 - +150
83-55	Strong, oil tolerant	M20 0,15 mm	10-20	28-35 Nm	-55 - +150
86-72	Strong, for coarse threads and high temperatures, DVGW approved for gas	2" 0,30 mm	20-40	20-35 Nm	-55 - +230
70-14	Capillary effecting, weld and pore sealing, can be applicated after assembly	M5 0,07 mm	10-20	15-25 Nm	-55 - +150

*ISO 10964: Bolt M10 x 20, quality 8.8, nut h=0,8d.

Source: Loxeal.

A majority of the products are fluorescent under blue light.

Table 106.9 Selection Loxeal® Thread sealing

Loxeal® product	Description	Max. Bogus	Fixing time in minutes	Unriveting force (ISO 10964)*	Temp. °C range
18-10	Thread sealing with PTFE white, weak locking adjustable, AGA/DVGW approved for gas and water	M80 3" 0,30 mm	20-40	7-10 Nm	-55 - +150
53-14	Pneumatic-hydraulic sealing DVGW approved for gas	M20 3/4" 0,15 mm	10-20	12-16 Nm	-55 - +150
55-37	Thread sealing reinforced, flexible, DVGW approved for gas	1 1/2" 0,20 mm	15-30	18-22 Nm	-55 - +150
58-11	Gas and oil sealing approved for gas, water; oil, oxygen according to DVGW, LPG (AGA), BAM, WRC	M80 3" 0,50 mm	15-30	18-22 Nm	-55 - +150

*ISO 10964: Bolt M10 x 20, quality 8.8, nut h=0,8d.

Source: Loxeal.

The majority of the products are fluorescent under blue light.

Nord-Lock® Securing washer/Wedge Lock Nut

The Nord-Lock principle

The Nord-Lock washer has radial teeth on one side, and tilted cams on the other side, whose incline rising gradient is greater than the thread's pitch. The washers are assembled in pairs with the cams toward each other and create the unique Nord-Lock locking device.



Cu/C paste = Copper/graphite paste (Molykote® 1000)

GF = ratio of yield point

μ_{th} = thread friction

μ_b = washer friction

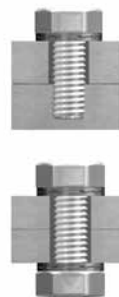
1 N = 0,225 lb

1 Nm = 0,738 ft-lb

The washers are in standard performance delivered in pairs glued, zinc-flake. The surface hardness is approximately 46,1 HRC.

Other alternatives that are available for delivery is stainless steel A4.

When the screw is tightened, the teeth are worked into the material and screw head respectively and a connection takes place. When the screw tends to come off it pulls the connected washer, which is forced onto the cams of the opposite washer. The pre-stress increases instead of decreases by the wedge effect that arises.



Recommended torque value (Nm)

Table 218 Nord-Lock® Securing washer zinc-flake with zincplated screw 8.8

Dim.	Thread	Pitch (mm)	Oil on surface, GF = 75% $\mu_{th} = 0,10, \mu_b = 0,16$		Cu/C paste, GF = 75% $\mu_{th} = 0,11, \mu_b = 0,16$		Dry surface, GF = 62% $\mu_{th} = 0,15, \mu_b = 0,18$	
			Torque (Nm)	Clamping force (kN)	Torque (Nm)	Clamping force (kN)	Torque (Nm)	Clamping force (kN)
NL3	M3	0,5	1,3	2,4	2,1	2,4	1,3	2
NL4	M4	0,7	3,1	4,2	4,4	4,2	3,1	3,5
NL5	M5	0,8	6	6,8	8	6,8	6	5,6
NL6	M6	1	10,5	9,7	13,2	9,7	10,5	8
NL8	M8	1,25	25	18	30	18	25	15
NL10	M10	1,5	49	28	49	28	50	23
NL12	M12	1,75	85	40	83	40	85	33
NL14	M14	2	135	55	131	55	136	46
NL16	M16	2	205	75	197	75	208	62
NL18	M18	2,5	288	92	275	92	291	76
NL20	M20	2,5	402	118	382	118	408	97
NL22	M22	2,5	548	146	517	146	557	120
NL24	M24	3	693	169	652	169	703	140
NL27	M27	3	1010	221	945	221	1028	182
NL30	M30	3,5	1379	269	1286	269	1401	222
NL33	M33	3,5	1855	333	1722	333	1889	275
NL36	M36	4	2394	392	2219	392	2436	324
NL39	M39	4	3087	468	2852	468	3145	387
NL42	M42	4,5	3820	538	3525	538	3890	445

Table 219 Nord-Lock® Securing washer zinc-flake with untreated screw 10.9

Dim.	Thread	Pitch (mm)	Oil on surface, GF = 71% $\mu_{th} = 0,13, \mu_b = 0,14$		Cu/C paste, GF = 75% $\mu_{th} = 0,11, \mu_b = 0,15$	
			Torque (Nm)	Clamping force (kN)	Torque (Nm)	Clamping force (kN)
NL3	M3	0,5	1,8	3,2	3,5	3,4
NL4	M4	0,7	4,1	5,6	7	5,9
NL5	M5	0,8	8,1	9,1	12,5	9,6
NL6	M6	1	14,1	12,9	20,1	13,6
NL8	M8	1,25	34	23	44	25
NL10	M10	1,5	67	37	73	39
NL12	M12	1,75	115	54	121	57
NL14	M14	2	183	74	188	78
NL16	M16	2	279	100	281	106
NL18	M18	2,5	391	123	388	130
NL20	M20	2,5	547	156	534	165
NL22	M22	2,5	745	194	719	205
NL24	M24	3	942	225	902	238
NL27	M27	3	1375	294	1297	310
NL30	M30	3,5	1875	358	1755	378
NL33	M33	3,5	2526	443	2340	468
NL36	M36	4	3259	522	3003	551
NL39	M39	4	4203	624	3845	659
NL42	M42	4,5	5202	716	4740	757

Cu/C paste = Copper/graphite paste (Molykote® 1000)

GF = ratio of yield point

μ_{th} = thread friction

μ_b = washer friction

1 N = 0,225 lb

1 Nm = 0,738 ft-lb

Table 220 Nord-Lock® Securing washer zinc-flake with untreated screw 12.9

Dim.	Thread	Pitch (mm)	Oil on surface, GF = 71% $\mu_{th} = 0,13, \mu_b = 0,12$		Cu/C paste, GF = 75% $\mu_{th} = 0,11, \mu_b = 0,15$	
			Torque (Nm)	Clamping force (kN)	Torque (Nm)	Clamping force (kN)
NL3	M3	0,5	2	3,9	3,8	4,1
NL4	M4	0,7	4,6	6,7	7,6	7,1
NL5	M5	0,8	9,1	10,9	13,6	11,5
NL6	M6	1	15,8	15,4	21,8	16,3
NL8	M8	1,25	38	28	47	30
NL10	M10	1,5	75	44	93	47
NL12	M12	1,75	128	65	151	68
NL14	M14	2	204	89	232	94
NL16	M16	2	311	120	342	127
NL18	M18	2,5	437	148	467	156
NL20	M20	2,5	610	188	638	198
NL22	M22	2,5	831	233	852	246
NL24	M24	3	1052	270	1064	286
NL27	M27	3	1533	352	1519	372
NL30	M30	3,5	2091	430	2042	454
NL33	M33	3,5	2815	532	2710	562
NL36	M36	4	3633	626	3463	662
NL39	M39	4	4683	748	4415	790
NL42	M42	4,5	5799	860	5429	908

Table 221 Nord-Lock® Securing washer stainless steel with screw stainless steel A2/A4

Dim.	Thread	Pitch (mm)	A2-70, A4-70 Cu/C paste, GF = 65% $\mu_{th} = 0,12, \mu_b = 0,14$		A2-80, A4-80 Cu/C paste, GF = 65% $\mu_{th} = 0,12, \mu_b = 0,14$	
			Torque (Nm)	Clamping force (kN)	Torque (Nm)	Clamping force (kN)
NL3ss	M3	0,5	1,5	1,5	1,7	2
NL4ss	M4	0,7	3	2,6	3,6	3,4
NL5ss	M5	0,8	5,5	4,1	6,7	5,5
NL6ss	M6	1	8,1	5,9	11,2	7,8
NL8ss	M8	1,25	18	11	21	14
NL10ss	M10	1,5	26	17	34	23
NL12ss	M12	1,75	41	25	62	33
NL14ss	M14	2	68	34	101	45
NL16ss	M16	2	108	46	157	61
NL18ss	M18	2,5	157	56	224	75
NL20ss	M20	2,5	223	72	318	95
NL22ss	M22	2,5	310	89	438	118
NL24ss	M24	3	397	103	558	137
NL27ss	M27	3	589	134	823	179
NL30ss	M30	3,5	815	164	1132	219
NL36ss	M36	4	1445	239	1993	319

Table 222 Nord-Lock® Securing washer 254 SMO® with screw 254 SMO®

Dim.	Thread	Pitch (mm)	A2-70, A4-70 Cu/C paste, GF = 65% $\mu_{th} = 0,12, \mu_b = 0,14$		A2-80, A4-80 Cu/C paste, GF = 65% $\mu_{th} = 0,12, \mu_b = 0,14$	
			Torque (Nm)	Clamping force (kN)	Torque (Nm)	Clamping force (kN)
NL3ss-254	M3	0,5	1,5	1,5	1,7	2
NL4ss-254	M4	0,7	3	2,6	3,6	3,4
NL5ss-254	M5	0,8	5,5	4,1	6,7	5,5
NL6ss-254	M6	1	8,1	5,9	11,2	7,8
NL8ss-254	M8	1,25	18	11	21	14
NL10ss-254	M10	1,5	26	17	34	23
NL12ss-254	M12	1,75	41	25	62	33
NL14ss-254	M14	2	68	34	101	45
NL16ss-254	M16	2	108	46	157	61
NL18ss-254	M18	2,5	157	56	224	75
NL20ss-254	M20	2,5	223	72	318	95
NL22ss-254	M22	2,5	310	89	438	118
NL24ss-254	M24	3	397	103	558	137
NL27ss-254	M27	3	589	134	823	179
NL30ss-254	M30	3,5	815	164	1132	219
NL36ss-254	M36	4	1445	239	1993	319

Source: Nord-Lock.

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