



## TORQUE TALK: Can Thread-lockers snap your Bolts in half?

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**During the 6 Month final assembly of our brand new \$500,000 Off Road Race Truck, I noticed a few of my very expensive, 12 point, Military Spec Bolts were broken (snapped in half), after being torque up using our new “Digital” Torque Wrench –**

*The search for the cause of our broken bolts was immediately underway!*

Based in Western Australia, Proformance Motorsport design, manufacture and build Off Road Race Trucks and components. We CAD design and CNC machine our own Differentials, Gearboxes, Wheel Hubs, Axles and even manufacture the entire chassis and fibreglass bodies - all in house.

Running a business that charges money to take customers for rides in our race trucks, we lose money every time a component fails or we have a truck that is disabled. We pride ourselves on only using the best materials and components available to ensure our vehicles are the most reliable they possibly can be. We all try to use the best bolts we can and 12 point bolts when we can get hold of them. As many of us know, a bolt is held in place by the preload caused when torque is applied to the head.

The best bolt manufacturers in the world will provide race car engineers with the recommended amount of “stretch” recommended for their bolts to achieve the correct amount of preload. Professional engine builders will always use a micrometer to measure the physical stretch of a con rod bolt when it is tightened.

In 99% of circumstances, it is simply not possible to use a micrometer to measure the length of the bolt when it is being tightened and therefore bolt manufacturers will supply us with Bolt Torque Charts to guide us how much to tighten the bolt. Any one that has ever rebuilt an engine will be familiar with the need to use a torque wrench to tighten the Head Bolts.



Most of us are aware that amount of resulted bolt stretch (preload) for a particular applied torque varies greatly due to the following:

- Dirty/Rusty Threads – The Torque Wrench clicks (Beeps, or similar) at the preset torque setting, but the bolt is not stretched to the desired preload and the parts are not clamped sufficiently and the bolt can easily come loose.
- Oily Threads – The oil lubricates the threads and the bolt can be over-tightened when the recommended torque is applied and the bolt may fail prematurely.

Most High End bolt manufacturers will provide torque settings, showing the required torque for a Dry Bolt, and a lubricated bolt. See the example below.

**TECH**

## GENERAL TORQUE RECOMMENDATIONS

Listed here are the general torque recommendations for most ARP fasteners. Recommended torque is equal 75% of the fastener's yield strength. Simply read down to the correct fastener size, then across to find the torque value for your application. **ALWAYS LUBRICATE THE FASTENERS PRIOR TO APPLYING TORQUE TO ENSURE ACCURATE READINGS.**

**Note 1.** The torque values represented here are intended to be for general information only, not for specific installations.

**Note 2.** On specific installations, where the supplied instructions deviate from the torque values listed here, always follow the specific instructions packaged with each kit.

### Recommended Torque to Achieve Optimum Preload (Clamping Force) Using ARP Lubricants - Torque (ft./lbs.) - Preload (lbs.)

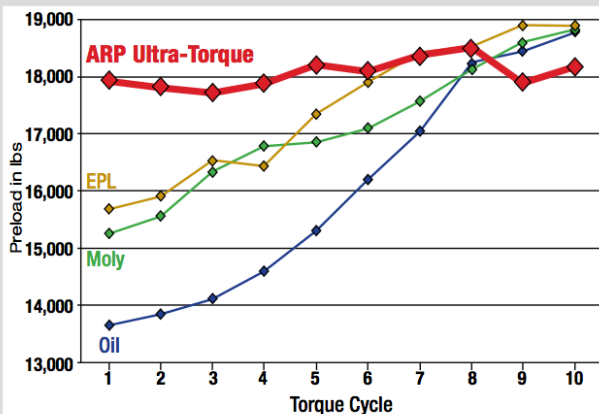
Note: For those using Newton/meters as a torquing reference, you must multiply the appropriate ft./lbs. factor by 1.356.

Fastener Diameter	Fastener Tensile Strength (PSI)					
	170,000/180,000 (1,171 Nmm <sup>2</sup> )		190,000/200,000 (1,309 Nmm <sup>2</sup> )		220,000 (1,515 N/mm <sup>2</sup> )	
	Torque w/ARP lube	Preload	Torque w/ARP lube	Preload	Torque w/ARP lube	Preload
1/4"	12	3,492	14	3,967	16	4,442
5/16"	24	5,805	28	6,588	32	7,371
3/8"	45	8,622	50	9,782	55	10,942

The type of lubricant used can significantly alter the resulting preload created by the torque applied when tightening the bolt. See the data below, again from ARP:

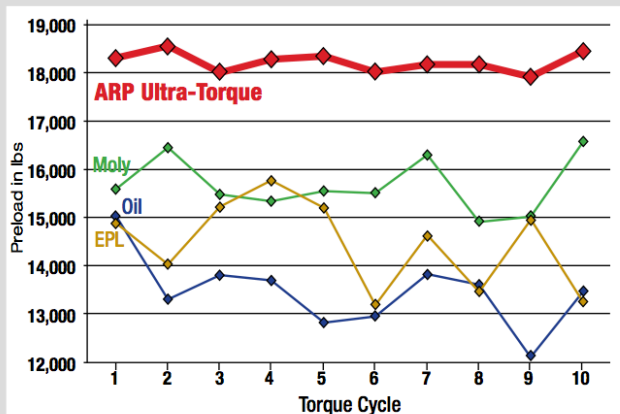
## Lubricant Comparison Data

**Installation Preload Scatter Comparison**  
(Target Preload 18,000 LBS @ 120 FT-LBS)



13,655	13,854	14,111	14,603	15,304	16,203	17,035	18,237	18,452	18,806
15,262	15,559	16,338	16,788	16,859	17,093	17,565	18,121	18,603	18,838
15,688	15,906	16,533	16,450	17,340	17,906	18,430	18,517	18,902	18,893
17,928	17,819	17,736	17,883	18,202	18,099	18,356	18,494	17,906	18,163

**Fastener to Fastener Preload Comparison**  
(Target Preload 18,000 LBS @ 120 FT-LBS)



15,027	13,305	13,793	13,687	12,810	12,945	13,813	13,591	12,110	13,462
15,593	16,451	15,477	15,336	15,554	15,506	16,290	14,908	15,014	16,576
14,876	14,031	15,207	15,766	15,197	13,173	14,619	13,462	14,944	13,247
18,321	18,549	18,025	18,282	18,353	18,028	18,176	18,182	17,929	18,443

Plated Bolts vs. Black Bolts:

Something many of us are not aware of is that plated bolts (Silver or Gold appearance) require different tightening torques than plain, Black Bolts. If this is news to you, then take a look at the fine print in the Unbrako table below (*look for the asterisk*).

MECHANICAL PROPERTIES															
	nom. size	ALLOY STEEL							STAINLESS STEEL						
		tensile strength pounds		minimum tensile strength psi min.	minimum yield strength psi min.	single shear strength of body lbs. min.	recommended seating torque* in-lbs		tensile strength pounds		minimum tensile strength	minimum yield strength	single shear strength	recommended seating torque* in-lbs	
		UNRC	UNRF				UNRC	UNRF	UNRC	UNRF				UNRC	UNRF
		plain	plain	plain	plain	plain	plain								
#0	-	342	190,000	170,000	320	-	3	-	171	95,000	30,000	130	-	1.3	
#1	499	528	190,000	170,000	475	5	5	250	264	95,000	30,000	190	2.0	2.3	
#2	702	749	190,000	170,000	660	7	8	352	374	95,000	30,000	260	3.8	4	
#3	925	994	190,000	170,000	875	12	13	463	497	95,000	30,000	350	5.7	6	
#4	1,150	1,260	190,000	170,000	1,120	18	19	574	628	95,000	30,000	440	8.0	9	
#5	1,510	1,580	190,000	170,000	1,400	24	25	756	789	95,000	30,000	550	12	14	
#6	1,730	1,930	190,000	170,000	1,700	34	36	864	964	95,000	30,000	670	15	17	
#8	2,660	2,800	190,000	170,000	2,400	59	60	1,330	1,400	95,000	30,000	850	28	29	
#10	3,330	3,800	190,000	170,000	3,225	77	91	1,660	1,900	95,000	30,000	1,280	40	45	
1/4	6,050	6,910	190,000	170,000	5,600	200	240	3,020	3,460	95,000	30,000	2,200	95	110	
5/16	9,960	11,000	190,000	170,000	8,750	425	475	4,980	5,510	95,000	30,000	3,450	170	190	
3/8	14,700	16,700	190,000	170,000	12,600	750	850	7,360	8,350	95,000	30,000	4,470	300	345	
7/16	20,200	22,600	190,000	170,000	17,100	1,200	1,350	10,100	11,300	95,000	30,000	6,760	485	545	
1/2	27,000	30,400	190,000	170,000	22,350	1,850	2,150	13,500	15,200	95,000	30,000	8,840	750	850	
9/16	32,800	36,500	180,000	155,000	28,300	2,500	2,700	17,300	19,300	95,000	30,000	11,200	920	1,050	
5/8	40,700	46,100	180,000	155,000	34,950	3,400	3,820	21,500	24,300	95,000	30,000	13,800	1,270	1,450	
3/4	60,200	67,100	180,000	155,000	47,700	6,000	6,800	31,700	35,400	95,000	30,000	19,850	2,260	2,520	
7/8	83,100	91,700	180,000	155,000	64,000	8,400	9,120	44,000	48,400	95,000	30,000	27,100	3,790	4,180	
1	109,000	119,000	180,000	155,000	84,800	12,500	13,200	57,600	63,000	95,000	30,000	35,300	5,690	6,230	
1	-	122,000	180,000	155,000	107,000	-	13,900								
1-1/8	137,000	154,000	180,000	155,000	107,000	14,900	16,600								
1-1/4	175,000	193,000	180,000	155,000	132,500	25,000	27,000								
1-3/8	208,000	237,000	180,000	155,000	160,000	33,000	35,000								
1-1/2	253,000	285,000	180,000	155,000	190,500	43,500	47,000								
1-3/4	342,000	394,000	180,000	155,000	259,500	71,500	82,500								
2	450,000	521,000	180,000	155,000	339,000	108,000	125,000								
2-1/4	585,000	664,000	180,000	155,000	429,000	155,000	186,000								
2-1/2	720,000	828,000	180,000	155,000	530,000	215,000	248,000								
2-3/4	888,000	1,006,000	180,000	155,000	641,000	290,000	330,000								
3	1,074,000	1,204,000	180,000	155,000	763,000	375,000	430,000								

\*Seating torques for alloy steel calculated in accordance with VDI 2230, "Systematic Calculation of High Duty Bolted Joints," to induce approximately 120,000 PSI in the screw threads through 0.500-inch diameter, and 115,000 PSI over 0.500-inch diameter. Seating torques for stainless steel are calculated to induce approximately 40,000 PSI stress. Values are for plain screws. For cadmium plated screws, multiply recommended seating torque by .75; for zinc plated screws multiply by 1.40. See note, page 1.  
See Technical Guidelines section for additional information on torques, installation, and hole preparation.

Looking the fine print above (after the asterisk) you will clearly see:

- Zinc plated bolts require 40% more torque than Black (Unplated) bolts
- Cad Plated bolts require 25% less torque than a Black (Unplated) bolt.

The Silver or Gold “Zinc Plating” causes the threads to bind just like a dirty or rusty bolt and the bolt stretch (preload) is often not achieved after the required torque is applied and the Cad Plating acts a thread lubricant, increasing bolt stretch per applied torque. Now you know why High End ARP bolts for race engines are always BLACK!!

Proformance Motorsport only use Unbrako Cap Screws (Allen Bolts) or Military Spec 12 Point Bolts when (we can get hold of them) and due to the mud and dirt associated with off road racing, Proformance Motorsport always use Pacified Zinc Plated bolts to prevent corrosion. Our crew uses high end “digital” torque wrenches on every bolt we tighten and we always use thread locker!!

*The question was “Why are we starting to see broken bolts even before we have driven the new race truck?”*

We had some of the bolts removed and tested for hardness and tensile strength and found no problems. We checked and double-checked the manufacturers recommended torque settings and found nothing that would cause the breakages that were occurring.

Like many race shops, we had lots of different brands of and many different grades thread-lockers and all different colours and viscosities. They all seemed to hold the bolts in place ok and we never really problems with bolts that came

loose, but we found that not all brands provided the same preload to the bolt. We found that some brands of thread-lockers were lubricating the bolt so well that the bolt would simply snap in half if the manufacturer's recommended torque was applied.

After many hours of testing, and chewing through few sets of batteries in my very cool digital torque wrench I put together the results of my testing in a nice spreadsheet of my findings PROVING that various thread-lockers acted as lubricants and the lubricating properties were very unpredictable. After my bench and vice were completely covered in patches of red, green, purple and blue thread locker, I contacted Loctite Australia for some advice to make some sense of all my testing and results.

Chris Manger of Loctite Western Australia visited our premises and after a few minutes explaining our problems to him, Chris presented a test case where Loctite had previously performed similar tests in a controlled laboratory. The results of the Loctite testing clearly confirmed my findings that different brands and types of thread-lockers provide very very different amounts of preload/stretch when the bolt is tightened to the recommended torque. Some (Many) thread-lockers simply act as an unreliable and non-predictable lubricant and most provide unpredictable, non-constant preloads.

It seems that some thread-locker manufacturers have simply "forgotten" to advise the user of their products on the product label that the lubricating action completely can and will result in excessive preload resulting in broken bolts if you actually tighten them to the required torque using your bright and shiny torque wrench.

After more discussions with Chris from Loctite, we were advised that the Loctite range of Thread-Lockers are designed to simulate as close as possible to a dry bolt condition. After seeing the data we are now able to torque our bolts to the recommended torque settings without fear of snapping the bolt in half or having the bolt snap in half when we drive our vehicles.

In summary:

- Check with the manufacturer of your bolts to obtain the required torque setting
- Apply the torque "correction factor" if your bolt is Cad or Zinc plated
- If using a thread-locking compound, use a product from a manufacturer that can provide you with data sheet showing how the thread locking product will affect your bolt tightening torque and the resulting bolt preload.
- If in doubt – Only Use Loctite Products like all the major race teams (*designed to replicate dry assembly torques/preloads*)

I hope someone out there in race car land learns from our findings.

Happy engineering

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