About fittings in general, and compression fittings in particular used in the PC industry

Introducing the Lok-Seal™ line of compression fittings

By Gabriel Rouchon, CEO Swiftech – April 13th, 2012

Introduction

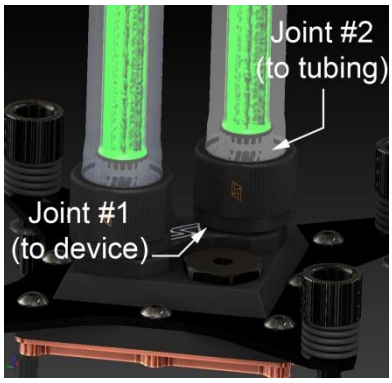
In the past few years, our company had the opportunity to build a respectable number of liquid cooled computers, either for trade-shows, in-store demos, and events of various nature. The rise in popularity of compression type of fittings in the past 2 years has compelled us to follow what seemed to have become a norm for any showcase type of system.

Besides a confessed appreciation for the solution's cosmetic elegance, this experience also left us with many frustrations, a few flooded systems, worn-out fingers, sometimes bruises (!) and an impressive pile of damaged, expensive high-end fittings.

More importantly, it triggered a serious reflection on the subject matter, including an in-depth analysis of what was being done, and how it could be done better.

Part I of this article presents our observations and reflections on the subject matter, and Part II introduces Swiftech's Lok-Seal™ line of compression fittings which are the fruit of such reflections.

Axioms:



1. We do not want leaks in our computers.
2. There are at least twice as many fittings in any given liquid cooling loop as the sum of the cooling devices that they connect together.
3. There are at least two joints in each fitting:
    a. Joint #1, between the fitting and the cooling device
    b. Joint #2, between the fitting and the tubing
4. Any joint potentially represents a disaster waiting to happen.

Conclusions:

1. By virtue of the number of joints alone, *fittings represent the largest source of possible leaks in any given liquid cooling loop*.
2. It logically follows that ***if we do not want leaks in our computers, then the fittings we use should be the safest possible*.**

What constitutes a safe fitting?

1. Proper joint design
2. Secure retention of the fitting to the cooling device
3. Secure grip of the tubing by the fitting
4. Proper installation

Part I

Observations and reflections about commonly available compression fittings

1. The most popular compression fittings used for liquid cooling and sold in the computer industry follow the "tool less "convenience trend, and the user is often expected/encouraged to tighten them by hand. Remark: with regards to joint #1 (fitting to cooling device), to the exception of plastic-made fittings, there is no precedent to the best of our knowledge of a similar design concept in any other industry: all fittings, whether used for liquid or gas, classic barb, compression, or quick-connect, feature some sort of a shape: typically a hex. This allows the installation of the fittings with a tool so that they can be tightened in conformance with the type of joint that is being used. By contrast, the most popular compression fittings in our industry only feature a surface knurling treatment which is intended to either facilitate a finger grip or to prevent ripping when pliers are being used. While this might be a positive in terms of cosmetic considerations, it represents real dangers from a safety point of view. Please read on to find out why…

2. During our inspection of the most popular compression fittings found in our industry, we observed that the compression ratio of the o-ring was far higher than generally accepted standards (up to 65% observed versus 25 to 30% nominal for this type of application). As a consequence -and when fastened by hand, the fittings never completely compressed the o-ring and wouldn't reach a hard mate with the cooling device surface. This peculiarity was easily observable by the fact that the o-ring remained visible once the fitting had been installed finger tight. Surprisingly to us, what is normally considered as improper installation by fittings professionals in any other industry, has in fact been turned into a marketing feature in our own industry: it is no wonder why vendors are now selling o-rings in various bright colors to enhance the looks of your system...but accordingly to generally accepted standards, these o-rings should never be visible in the first place! It has thus become apparent to us that an excessive o-ring thickness – or too shallow of an o-ring groove, are being intentionally used to compensate for the known deficiencies inherent to how these fittings are generally being utilized in our application.

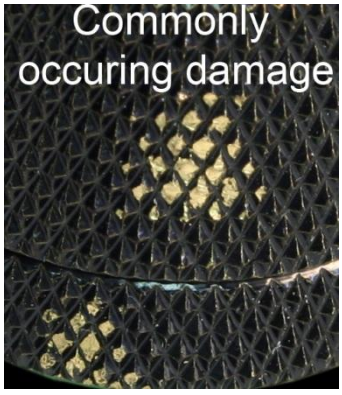
So let us now examine why this is considered as a big "no-no" by fittings professionals.

All fittings can be subject to a counter-clockwise force which tends to loosen them; in our liquid computer application, this force is usually transmitted by the tubing which when bent in a particular direction may result in a counter-clockwise force against the fitting. Who among experienced liquid cooling system builders never had a fitting getting loose over time, please stand up and raise your hand! This author, for one will remain quietly seated. With compression fittings, the situation gets even worse: this counter-clockwise force is almost always present and is induced by the friction

exerted by the collar against the tube when it is being tightened: in effect, as it is being rotated clockwise the collar may grab the tube and create a torsion in the tubing walls; the resulting spring effect in turn exerts the dreaded counter-clockwise force against the fitting, thus tending to loosen it. Let us clarify in all fairness that swivel types of fittings are either less or not subject to this issue, because the swivel relaxes any counter-clockwise force exerted on the fitting base.

We should also mention that another serious handicap we face in our application is the fact that it is space constrained. As a result, the length of male thread in most computer fittings generally does not exceed 5mm. Considering the 12mm OD for the G ¼ thread (which is our de facto standard) we are below the generally accepted minimum thread engagement length which should be about 1:1. Compounding this difficulty is the fact that half of our cooling devices are made of ductile POM, so thread stripping becomes a real problem under such conditions.

Based on experience, and looking at other industry standards, there is no question in our mind that for safety reasons all fittings must establish a hard contact with their mating surface so that they can be locked with sufficient torque to counteract any opposite forces that could loosen them over time. What we observe instead is that in lieu of this hard contact, and when tightened by hand, most current compression fittings solely rely on the friction created by the compressive force exerted onto the o-ring to prevent them from loosening. We therefore submit that this <u>much too often</u> ends up resulting in catastrophic leaks as evidenced by the numerous forum testimonials found all over the world.



Experienced/careful users know better of course. But in the vast majority of cases, the only tool available to them to tighten their compression fittings properly are a pair of pliers. Unfortunately, using steel pliers on soft brass irrevocably damages the nice knurled surface finish of the fitting, and when each fitting may cost up to $10 each, frustration understandably runs high! It in turn compels our experienced users to wrap the plier's jaws with some sort of protection such as tape or fabric. After fastening (or loosening) a few fittings though, the tape or fabric often wears out, leaving bare metal against bare metal, and damage occurs again. With black fittings in particular, the black Sharpie pen for touch-ups has now become another essential tool among experienced liquid cooled computer builders!

So how do we resolve this conundrum as manufacturers? If a/we cannot extend the thread length of our fittings due to practical space constraints, and b/we are unwilling or unable for cost and/or cosmetic reasons to forego the use of Acetal in our applications, and c/ if we also want to provide leak-free results in one of the most critical applications there is, *<u>then the only choices we have left are 1/ to optimize safety by design, and 2/ to provide users with the necessary education for proper installation.</u>*

2. In the course of our investigation on compression fittings, we encountered another serious type of issue: when the collar does not securely grip the tubing, the later will pop out of the former easily, resulting in a nice mess. This occurred on a catastrophic scale with a system that had been sent to our labs featuring fittings that require a custom tool for installation. The tool was nowhere to be found when we received the system, and we can only speculate that the installer had tightened the collars by hand. As we applied a firm pull on the tubes, they all disconnected at will. While this could certainly be attributed to user installation error, we believe that one should be able to use the type of tool that is most commonly available in our homes, as opposed to custom tools that so easily get lost over time.

3. We also observed more mundane design issues where some fittings had a very thin tube wall in an effort to improve flow rate, but used a slot at the barb extremity for assembly/disassembly. When attempting to fasten or loosen the fitting with a screw driver, the tip of the barb would get severely damaged. We do believe in this respect that mechanical integrity should not be sacrificed in favor of performance in an application that calls for repeated use.

4. Finally, we came across the real cheap designs, where flow rate was not even an after-thought, and low manufacturing cost prevailed in all aspects of the design. These fittings stayed on a shelf, as a reminder to what we at Swiftech would never want to do.

So we eventually sat down at the design table, and started listing our priorities, noting as a pre-requisite that our fittings would comply with the G ¼ thread specification, the de facto standard in our industry:

1. **Safety:** we wanted our fittings to be started by hand, and safely tightened with a tool.
2. **Convenience:** we didn't want custom tools, they are too easily lost! Users would be able to use the most commonly available tool in their toolbox: typically, an adjustable wrench.
3. **Performance:** no design would sacrifice flow rate, in fact we wanted less flow restriction than any other fittings we'd looked at on the market, whenever possible of course and within strict safety standards.
4. **Durability:** because they could be used with a tool, our fittings would better resist damage during repeated assembly and disassembly.
5. **Elegance:** they had to look good, and be available in at least two of the most popular finishes: Chrome, and Black
6. **Price:** it had to be in line with the market, and preferably more competitive.

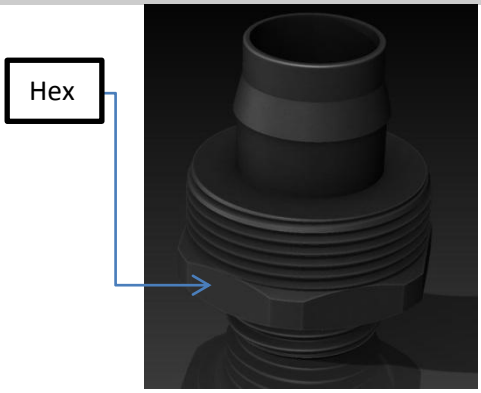
…and after months of R&D the Lok-Seal™ line of compression fittings and adapters was born..

Part II

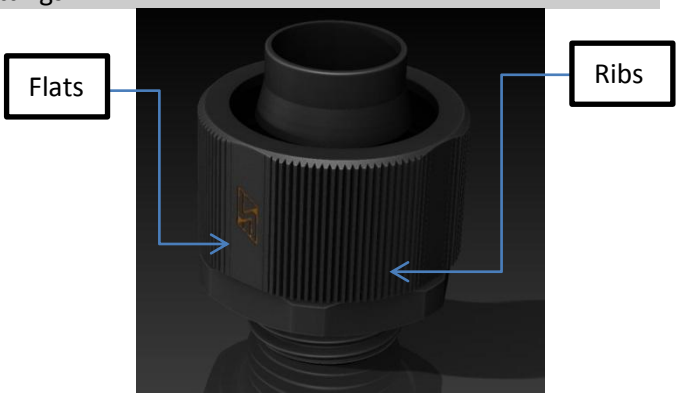
Introducing the Lok-Seal™ line of compressions fittings

1. **A safer approach**

Fittings



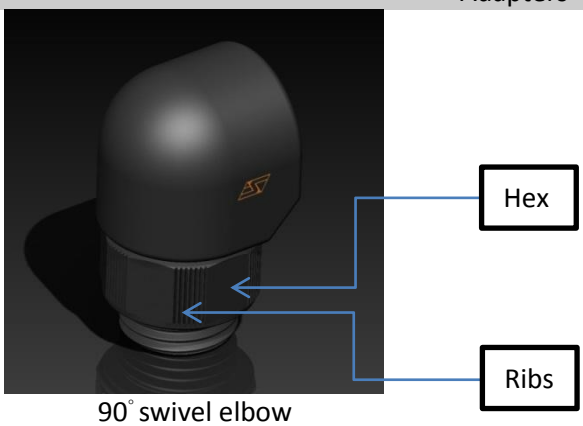
All Lok-Seal™ compression fittings feature An Hex shape at the base of the fitting so they can be properly secured to your cooling devices



All Lok-Seal™ compression fitting collars feature ribbing for a good finger grip, as well as 4 flats so that tubing can be properly secured to the fitting

Recommended Universal tool		
A small adjustable wrench with jaw opening up to 1" (25.4mm) may be used instead of the specific tools listed below.		
Specific tool sizes		
Fitting Inch Tube ID x OD Metric Tube OD xID	Fitting base hex: Flat wrench or socket	Collar: Flat wrench
⅜"x ½" – 13/10	Metric: 17mm - Inch: 11/16"	Metric: 18mm - Inch: adjustable wrench
⅜" x ⅝" – 16/10	Metric: 20mm - Inch: 13/16"	Metric: 21mm - Inch: adjustable wrench
½" x ¾" – 19/13	Metric: 24mm - Inch: 15/16"	Metric: 25mm - Inch: 1"

Adapters



90° swivel elbow

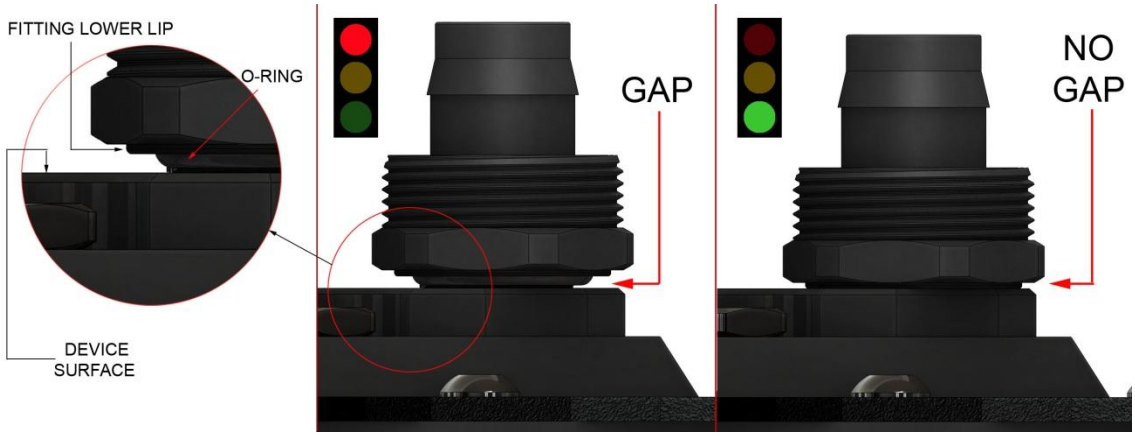
45° swivel elbow

All Lok-Seal™ adapters (swivel or non-swivel) feature a combination of finger grip ribs, as well as a hex shape so they can be easily and properly secured to your cooling devices. A choice of 2 common tools can be used: adjustable wrench or 17mm Metric flat wrench.

2. **Recommended use**

a. Attach the fittings to the cooling devices first!
While not mandatory, and whenever possible, it is always preferable to fasten your fittings to the cooling devices prior to installing such devices inside the case. This will eliminate interference issues that may be encountered when working with tools inside of space constrained enclosures.

b. Torque specifications
Unlike other compression fittings commonly found in our industry, *but in conformance with accepted standards in all other industries,* when tightened by hand the Lok-Seal™ fittings will normally easily (*) reach a finger tight locked position, as they are designed to mate with the surface of the cooling device that they are being attached to.



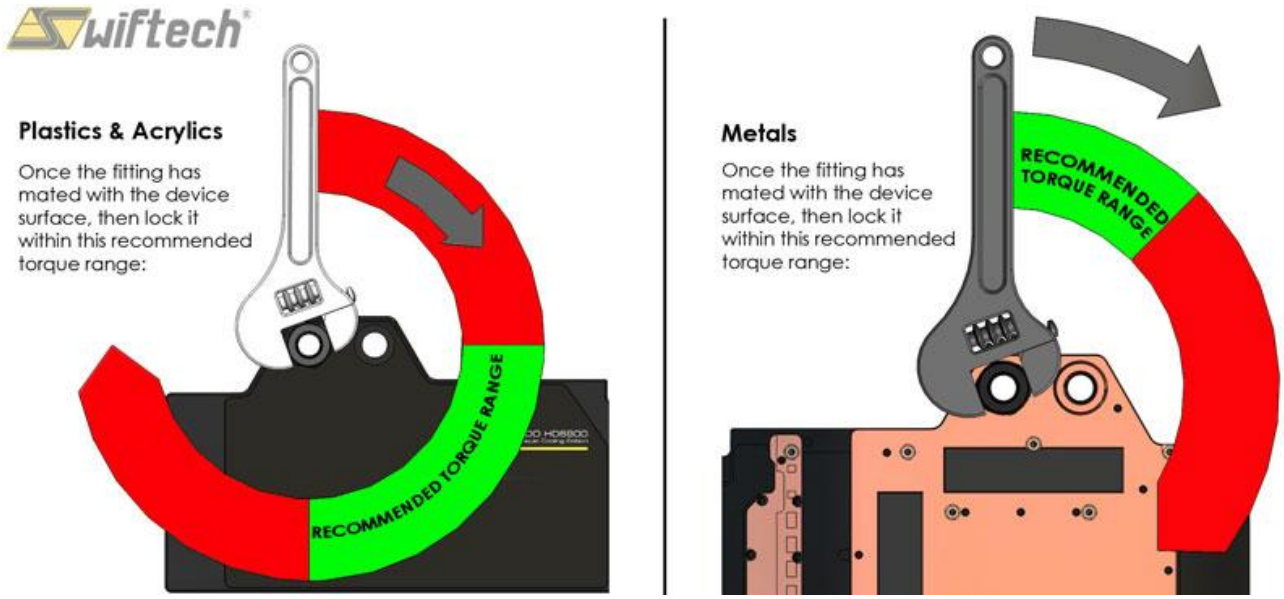
(*) The amount of force necessary to screw the fittings down in "finger tight" mating position may substantially vary from one device to another depending on various factors. Users are advised to always visually check on the actual position of the fitting relative to the device surface rather than solely relying on feel. There should be little -not to exceed the thickness of a sheet of paper, or no visible gap between the fitting lower lip and the device surface.

For complete long-term safety and leak-free operations, Swiftech® recommends that the fittings be locked in place using the recommended tools and that the torque levels specified below be applied:

Soft materials	Minimum recommended	Maximum recommended (**)
Acetal (POM) and acrylics	¼ of a turn after initial contact between mating surfaces	½ of a turn after initial contact between mating surfaces
Hard Materials	**Recommended**	
Copper, brass, aluminum	⅛ of a turn after initial contact between mating surfaces	

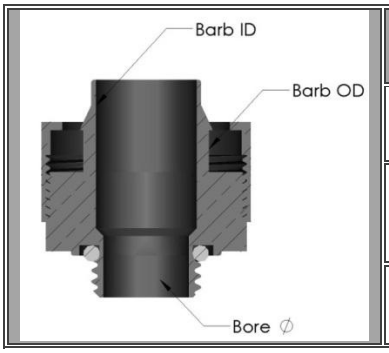
(**) For full 5mm thread depth – please inspect the device threads prior to applying the maximum recommended torque – when partial threads exist due to application necessity, only apply the minimum torque.

See the illustration next:



3. Performance – Perhaps the least restrictive fittings on the market

To the best of our knowledge, the Lok-Seal™ fittings currently feature the largest bore diameter (10.2mm) in our industry, resulting in reduced pressure drop and improved flow rate:



Inch Tube IDxOD Metric Tube ODxID	Male Thread inch	Bore Ø mm	Barb ID mm	Barb OD mm
⅜"x ½" – 13/10	G 1/4	10.2	9.5	11.1
⅜" x ⅝" – 16/10	G 1/4	10.2	10.2	12
½" x ¾" – 19/13	G 1/4	10.2	12	15

To further improve flow, the barb OD of the compression fittings is larger than the nominal tubing ID size, thus stretching the tube upon insertion. An extra lip is featured at the tip of the barbs to facilitate insertion of thick-wall tubing which is harder to stretch.

Elbow adapters also feature to the best of our knowledge the largest bore diameter on the market; they are designed and machined to reduce pressure drop as much as possible.

Adapters	Male Thread	Bore Ø	Female thread
90° Swivel Elbow	G1/4	10.2	G1/4
90° Dual Swivel Elbow	G1/4	10.2	G1/4
45° Swivel Elbow	G1/4	10.2	G1/4

15mm MF extension	G1/4	10.2	G1/4

Extensions used for SLI, Crossfire and various other applications equally feature a larger bore diameter than usually found in similar fittings:

Extensions	Males Threads inch	Male Bore Ø mm	Female Bore Ø mm
G1/4 MMEXT Short (11-18mm)	G 1/4	8.3	9.9
G1/4 MMEXT Medium (20-33mm)	G 1/4	8.3	9.9
G1/4 MMEXT Long (41-65mm)	G 1/4	9.3	10.9

4. Durability and quality of finish

Using a tool to fasten your Lok-Seal™ fitting will contribute in greatly reducing wear & scratches on the black painted versions and almost completely eliminate damage to the chrome versions.

Black fittings use an electrophoresis process, resulting in a thin, even and durable coat of paint with a glossy finish. Chrome plated fittings are processed in the same plant as our water-block bases, which are already reputed for their durability and they bright mirror finish: for reference, chrome plating is an additional metal deposit on top of an existing coat of nickel plating. Many of our competitors stop at the nickel plating stage, which is cheaper, and results in a yellowish tint as opposed to the bright white finish provided by chrome.

5. Pricing

Lok-Seal™ compression fittings are priced competitively compared to other brands (1):

Inch tube ID x OD Metric tube OD x ID Description	Lok-Seal™ MSRP	BitsPower	Koolance MSRP	Alphacool	Phobya	Enzotech	MFC
	Black & Chrome	Black/ Chrome	Black & Chrome	Black & Chrome	Black & Chrome	Black/ Chrome	Black & Chrome
½"x¾" - 19/13 fitting	$7.95	$9.49/$7.99	$6.74	-	-	$8.49/$7.99	$7.50
⅜"x⅝" - 16/10 fitting	$6.49	$9.99/$8.99	$6.49	$7.49	$6.99	$7.99/$6.99	$6.99
⅜"x½" - 13/10 fitting	$5.49	$8.95/$6.99	$4.49	$6.99	$5.99	$7.99/$6.99	-
90° Swivel elbow adapter	$8.49	$11.99	$9.99	$5.99	-	-	-
45° Swivel elbow adapter	$7.49	$12.99/$10.49	$9.99	$7.49	-	-	-
90° Dual swivel elbow adapter	$14.49	$14.95/$14.99	-	-	-	-	-
15mm Male/female extender	$3.49	$5.99/$5.49	-	-	-	-	-
Short extension (11-18mm)	$4.49	-	-	-	-	-	-
Medium Extension (20-33mm)	$7.95	-	$12.99	-	$7.49	-	-
Long Extension (41-65mm)	$9.95	-	$14.99	-	$8.49/$799	-	

4-Way manifod	$13.95	$13.99	-	-	-	-	-

(1) Based on items sold individually, and published MSRP when available (Koolance), or US reseller price (all others).