A Comparison of Different Air Filters

The Falco shares the same filter element as the Mille. It's no surprise then that there are a few aftermarket air filters available. Reports on these have been mixed. It seems the majority of people are convinced that there are no performance benefits to using an alternative filter. In most cases, though, the aftermarket filters are renewable, so it's more likely that they will be free-flowing and they will be cheaper in the long run. Click on any image to enlarge it.
Getting access to the filter is quite simple. See my airbox page for a quick look at how to get to the filter.
The **stock filter** is a pleated paper element. There is plenty of surface area. In fact, I'll venture a guess that this filter is larger than those used on most automobiles. Construction is certainly identical. I do not know the cost of this element.

The stock disposable element. Paper pleats with a wide wire mesh on the exit side of the element.

The most sought-after aftermarket element seems to be the **K&N filter**. Made by K&N Engineering, this reuseable filter is a proven design. The filter is made of cotton, sandwiched between two layers of thin profile mesh which reportedly "orient" the airflow to prevent turbulence. The trapping ability of the filter comes largely from the fact that the element is conditioned with a tacky oil. K&N filters are typically expensive in the US, and not all elements are imported. If you want a K&N filter for your Falco, you'll need to find part number AL-0003 overseas (this part number does not exist in the US). Both Red Racing in Italy and PDQ in England will export filters at reasonable cost ($45), but the lead time has been known to be long at times. K&N filters come pre-oiled, but eventually you will want to buy their renewing kit containing a mild detergent and a spray can of oil. Never use engine oil, as it breaks down in the presence of water.
Filter air KN ref: RST1000 FUTURA 01-04 AL-1098 £42.70 STAGE 1 FILTER TO GO INSIDE AIRBOX
Filter huile KN ref : KN-152

K&N renewable filter. Cotton pleats with fine wire mesh on the intake and exit sides. K&N filter oil is red so you can see how even your coverage is.

Tired of not being able to get filters for resale from K&N, Ken Zeller contracted to have his own made using the same materials. You can find these filters at his site, Evoluzione Cyclesports. Their part number is 75000. The filter prices are currently sale priced at $31 delivered in the US, $41 overseas. Their site claims 2 BHP increase with this filter. The filter is pre-oiled.

Evoluzione Cyclesports filter.

Factory Pro Tuning is selling a filter made by BMC that they claim is the only filter they've tested for the Mille that made a horsepower difference (although it was something like 1 HP). Their website mentions Evolutione filter, but its not clear to me if this is the same filter sold by Ken Zeller at Evolutione or not. Contact Factory Pro for more information about the filter, number FI-BMC-20306. BMC makes street and race filters, and it seems from the website that this is a street flow. The filter prices are $60.

I've been told that the Mille SP comes with a performance filter made of oiled foam in a wire cage, similar to Uni filters. In general, these foam filters flow extremely high, even higher than the cotton filters. Although it uses a different airbox, the filter is supposed to be a bolt on item for the Mille and should also fit the Falco. The possible downside is that an Aprilia representative has said that the filtering ability of the SP airbox is not great. Its a race only item.
For those of you looking for the ultimate in performance and value, I've found an inexpensive element with more surface area than all the other filters. This will require a bit of airbox modification but I think the results would be worth it.

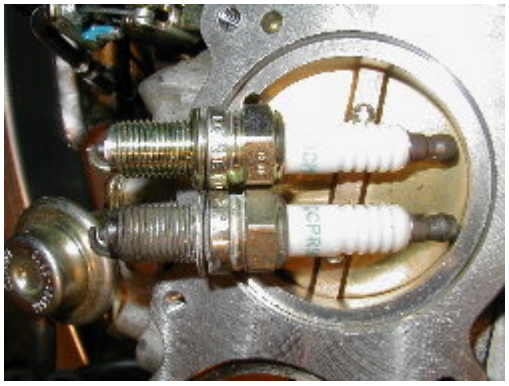
Sears Shop-Vac filter. Paper pleats. This filter has stood up for 12 years in my 8 gallon shop-vac.

Summary of Air Filter Features						
Filter	*Material*	*Height*	*ID*	*Pleat size*	*Pleats*	*Surface area*
Stock	Paper (disposable	4-1/2 in	3-7/8 in	1/2 in	92	414 sq in
K&N	Oiled Cotton (cleanable	4-1/2 in	4 in	1/2 in	47	212 sq in
Evoluzione	Oiled Cotton (cleanable	n/a	n/a	n/a	n/a	n/a
BMC	Cleanable -- no details	n/a	n/a	n/a	n/a	n/a
Mille SP	Oiled Foam (cleanable	n/a	n/a	n/a	n/a	n/a
Sears	Indestructable paper	7 in	4-1/2 in	1-1/4 in	111	1,942 sq in

A Comparison of Different Spark Plugs

The Falco owners' manual calls out two acceptable spark plugs. Both are NGK resistors plugs, standard gap with maybe a slightly extended nose. This is an inexpensive plug, at about $3 apiece. My bike was shipped with the colder heat range DCPR9E. You can go safely go up one

heat range to a DCPR8E according to the sticker on the bike. There are probably plugs made by other manufacturers (Denso, perhaps) that have the same reach and heat range, but there is no universal conversion of heat ranges between manufacturers that works for all engines.
The R in the plug identification means the plug contains a high resistor in order to surpress radio noise. Most likely, the high tension leads feeding the plug are highly resistive too (8kohm a foot typical).



Two types of NGK plugs are specified by Aprilia for the Falco. On top is the DCPR8E. Below is the stock DCPR9E.

A colder plug means that the electrode does not extend as far into the cylinder. The electrode will be more shielded from combustion heat, but more importantly will have less thermal impedance, or will sink more heat back into the cylinder head than a "hotter" plug. The objective is to select a heat range that burns off contaminants at the same rate they are deposited. Too cold a plug will become coated with deposits and will foul. Too hot and the insulator may crack, the electrode edges will round, pre-ignition can occur, or if the plug reaches too far, the plug could actually contact the piston at speed.
Street plugs typically have extended noses like this one, because they must be operated in conditions of low speed or idling without fouling. Service intervals are not as often as a race bike either, so it's helpful that deposits can become greater without fouling the extended nose plug.

The Falco uses two plugs per cylinder, each fed by its own coil. These plugs were regapped once at 4,500 miles, then removed at 7,500 miles. The insulators are tan colored and dry. The electrodes are still fairly sharp, and the deposits on the grounds are typical of pump gas.

Much has been said about "reading" plugs. I guess what you have to remember is that the plug is a history of a lot of running hours, under many different operating conditions and with fuel from different pumps. If the plug is burning hot, it may be dominated by a snapshot of the last operating condition, but if you were running lean for 10,000 miles then pulled the plug after operating the choke for 1 minute, you'd probably never see the lean condition. If you really want

to read plugs, you have to start with a fresh plug and operate the bike at the one condition you are interested in. Then kill the motor and coast it to a stop without changing the conditions. An exhaust gas analyzer is much easier to read.

The ignition system in the Falco is mostly likely "inductive", as opposed to CDI, or capacitive discharge. I say this because the plug gap is fairly low, not because I could read the wiring diagram. Some day I will put a scope on it. Each plug is fed by its own coil (four in total). Ken Zeller at Evoluzione Cyclesports makes a device for the Falco which boosts the coil primary voltage to strengthen the spark. It is supposedly a well-tried and failsafe device. I'm not sure if it makes more power, or just makes a more reliable spark.

The Falco manual says to clean and regap the plugs at the 4,650 mile service, then to replace at 9,350 miles. It is a good idea to file the electrode sharp at the first service. A sharp edge will arc over at lower voltages, or will maintain a spark longer. You probably don't want to clean plugs with a wire wheel as I've done in the past. I've read that this can embed conductive particles in the insulator and your plug can short. I also used to work at a shop that had a portable sandblasting tool for cleaning plugs. Even blowing with compressed air afterwards, you were never quite sure if there was a piece of sand still stuck up in the insulator. I usually just replace them if I have new plugs on hand, or file and regap and skip the cleaning step.

Before removing the spark plugs on the Falco, you'll definitely want to blast the head cavities with compressed air. Mine were full of sand. For a description of how to get to the plugs, see the airbox page. When replacing the plugs, you can use the torque figures given below, but this is one of the only places I don't trust a torque wrench. The feel of the gasket crushing has an eerie feeling similar to that of threads stripping. It has to be experienced by hand to be appreciated.

Summary of Spark Plug Features

NGK plug	*Heat range*	*Operating conditions*	*Reach*	*Thread dia*	*Gap*	*Socket size*	*Torque*
DCPR9E	Colder	Higher speed/higher temperature	18 mm	12 mm	0.024-0.028 in (0.6-0.7 mm	5/8 in	14 ft/lbs (20 Nm
DCPR8E	Hotter	Lower speed/lower temperature					

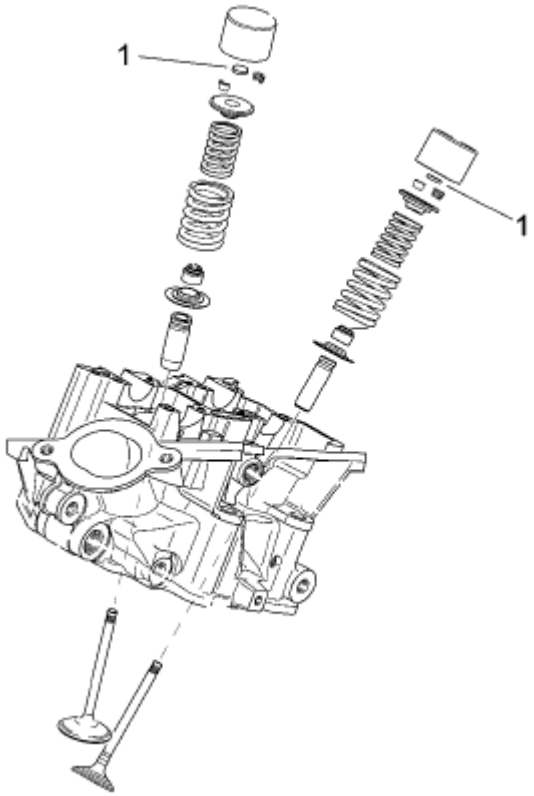
Servicing Your Aprilia Falco Valves

Background

The Falco utilizes four valves per cylinder head (two exhaust, two intake), driven by two overhead cams per cylinder head (one intake and one exhaust), and of course there are two cylinder heads. The cams are gear and chain driven off the crankshaft, with a system of guides and a self-adjusting tensioner to keep the chain from jumping. Over each valve stem is a small cylindrical shim, 10 mm in diameter and about 2mm thick. The entire keeper and spring is covered by an inverted bucket, providing a smooth and hardened surface for the cam lobes to push against. In this system, the valve shim sees little wear, and service intervals are high. There are also no rocker arms (or followers) so reliable operation at 10,500 rpm is possible. The downside is that servicing the shim requires removal of the camshafts.

In order to allow for thermal expansion of the valve stem, and wear of the valve seat, there must be some cold clearance between the valve stem/bucket and camshaft base radius. With zero clearance, the valve will not fully close and seal the combustion chamber. Also, the valve cooling comes from the time that the valve is sitting closed in the valve seat. A valve that isn't in the seat long enough will overheat, particularly on the exhaust side. Too much clearance is not as bad, but will create excessive noise. This is why US spec machines often have tighter clearances than European spec. Also, the more the clearance, the later on the lobe the valve opens, so duration is reduced and performance at higher RPM will suffer.

As the valve and seat wears in, the clearance will become smaller. A valve clearance that increases would generally indicate cam lobe wear. According to Aprilia, you should examine your valve clearances at the initial break-in service, and again every 9,350 miles. If you find a valve near a clearance limit, you may want to decrease the service interval unless you routinely reset the clearances of all your valves (easy on screw type adjusters, time consuming and possibly expensive on shim type).



Drawing of one cylinder head. Two of four valves shown. Shims are labeled "1" in the diagram. Unlike shim-on-bucket designs, there is no way to extract the shims without removing the camshaft

Servicing Your Aprilia Falco Valves (continued)

Go to the beginning of this article.

Checking the Clearances

Remove the airbox. In order to access the valves, you need to lift the tank and remove the airbox. See the airbox page for some tips on this. In my case, I had removed the tank anyways, and I really appreciated not having it in my way while I worked. To remove the tank, it's helpful to have a second quick disconnect (dry break) to use to drain the tank, because there is no petcock on the high pressure fuel outlet. You can unplug the sender at the harness under the seat. At any rate, it's probably not *necessary* to remove the tank to service your valves.
Remove the valve covers. It goes without saying that you want to be clean at this point, so wipe down any dirt from around the frame rails and underside of the tank. Anything that can fall in the motor while you work needs to be moved. There is nothing really in the way of removing the rear valve cover. The five screws come off and it's free. The front valve cover takes a bit of blind work to get at the screws, and you'll probably have to loosen the throttle body boot clamps and pop the throttle body off to get removal clearance. You don't need to totally remove the throttle

body--just unseat it a bit to raise the throttle cables. On the rear cover, remove the reuseable rubber gasket with the cover. On the front, my gasket was tacked in place near the throttle body with a blob of silastic. This turned out to be very helpful, so I recommend you leave the gasket on the cylinder head if the factory has tacked yours down too.

Remove five perimeter bolts to remove the valve covers. Rear cover shown here. Front will probably require that the throttle body boots be loosened too.

Find Top Dead Center. At this point, the cams are now exposed (enough). When you are measuring the clearance on a valve, you want the cam lobe to be rotated completely off the bucket. In principle, you can measure clearances anytime the cam lobe you are working on is not in the 90 degree rotation that faces the valve. At TDC, you can measure all four valves at once. On most bikes, it's easiest to just remove the access plug and rotate the crankshaft with a socket until the cylinder you are working on is at top dead center. On the Falco, this requires a 14 mm allen key which I didn't have. I chose to just bump the bike over with the starter. Be careful with this route--you don't want to start the bike and the Falco won't bump over with the kill switch active. Any way you choose to turn the bike over, it's nearly impossible to stop the motor at TDC with the spark plugs installed. You need to release the compression. I removed a plug and reinstalled it into the plug cap with a ground lead attached between the battery ground and the plug ground. The Falco ignition is probably not CDI, so this step may not be necessary, but I wanted to be sure there was a spark gap to load the coil just in case. On the Falco, the two cam lobes are facing away from each other at TDC. If you look at the cam drive gears, each is marked twice: once with an intake mark (IN) and once with an exhaust mark (EX). This is because the cam gears are one common part and are used on both cams. When viewing the exhaust cam (the cam closest to the header pipe), only pay attention to the EX mark. When viewing the intake cam (the cam closest to the throttle bodies), only pay attention to the IN mark. At top dead center, the EX on the exhaust cam faces and aligns with the IN mark on the intake cam. You can measure the clearances without these being perfectly aligned. The other hitch is that on the rear head, there is a balance shaft drive gear blocking the exhaust timing marks. Just bring the intake mark horizontal and facing the exhaust cam and you'll have TDC.

A view of the cam timing marks on the rear head. This head is NOT at TDC. Notice that the balance shaft drive gear blocks the marks on the exhaust cam. To find TDC, this motor would need to be bumped around until the /N mark comes around to horizontal (facing the other cam).

Measure the clearances. Slip a feeler gauge between the cam and the bucket. The range of acceptable clearances is small, so you'll probably just be able to do a go-no-go type of test. The there is a little drag on the feeler, you've got the right size. If it slides in easily, you probably have a clearance a half size looser. Of course, if the gauge doesn't fit at all, you've got less clearance than the gauge. Try to determine and record the valve clearance for each valve to the nearest half feeler size.

Measuring the clearance on a rear exhaust valve. This engine is not at TDC, so in order to measure the intake side it will have to be bumped over. There are another set of valves to measure that are not visible here. Use the access slots in the cam hold-down to feel those clearances. Both lobes on a cam are in the same position.

2000-1/2 Aprilia Falco Valve Clearance Specs and Measurements				
Valve Type	*Valve Location*	*Acceptable Clearance*	*Front Cylinder Measurement (my bike)*	*Rear Cylinder Measurement (my bike)*
Intake	Gear side	0.005-0.007 in	**0.0045**	0.0060
	Opposite Gear		0.0050	0.0055
Exhaust	Gear side	0.009-0.011 in	0.0090	0.0100
	Opposite Gear		0.0100	0.0095

You can see from the table that I had an intake valve on the front cylinder was too tight. While it wasn't an exhaust valve, it could still be subjected to overheating. Also, I have no history so I don't know if it will continue to move before my next service interval. That shim will need to be swapped. If your valve clearances are in tolerance, congratulations. Button the bike up and check them again in 9,300 miles.

Servicing Your Aprilia Falco Valves (continued)

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Removing The Shims

If you were unlucky enough to find a valve or two out of adjustment, you'll have to swap shims. Sometimes you can swap shims within your bike to bring all the valves back into spec. For instance, if you have a tight intake valve, you may be able to swap shims with a looser valve to make them both acceptable. If you can't do this, or don't want to be taking out more cams than necessary, you'll need to measure up your shims and head to the dealer. At any rate, you'll need to know what your current valve clearance is, so don't start tearing out the cams until you've recorded it. Once you've recorded the clearances, you can begin taking out the cams. Make sure you are at TDC. While its possible to measure clearances without bringing a cylinder to TDC, you can't remove the cams if either of the cams are pressing down on the valves. Also, in case you lose your cam alignment marks, you have a prayer of realignment if the crankshaft is in the TDC position. If you can't see the timing marks on the front cylinder, you can unbolt the upper nylon chain guide and bump the engine with it off. Just stuff a rag into the cases when you are unbolting it in case you drop a bolt. Once the cylinder you are working on it at TDC, remove the key, throw the kill switch and don't think about bumping the motor over until the cams are back in place. Aprilia calls out a tool to lock the crankshaft in place. This is really not necessary.
Mark the cam to chain alignment. If you haven't already removed it, start by unbolting the nylon chain guide on the top of the gears. Once the top guide is off, use contact cleaner to clean the chain and gears, and make an indelible mark on the top of each gear (12 o'clock) extending onto the chain. This will help you get the chain back on the sprockets in the right position. Now, count the number of chain pins between the marks. If you rub one mark off, you can use this count to replace it. Every orientation mark you can make will help. If you are working on the rear cylinder, you have the balance shaft drive to work around. Mark the backside of the gears if it is easier.

Remove the upper nylon chain guide, but don't drop the bolts in the case. Front cylinder has two vertical bolts. Rear has two horizontal bolts.

Remove the chain tensioner. The next step in cam removal is usually to release the chain tensioner. The Falco tensioner is a hydraulic plunger that pushes on a nylon guide on one side of the chain run from the cam to the crankshaft (the side facing the "V" between cylinders). After removing the tensioner, the chain should be slack enough to be removed from the gears (you must hang it from a coat hanger because dropping it into the cases would be bad!). If there isn't enough slack from just releasing the tensioner, sliding a guide out should do the trick. I believe only the guide opposite the tensioner should slide out. I say "should" and "believe" a lot in this paragraph because I found it very difficult to get onto the tensioner plug for the front cylinder. After rounding out a spot in the plug with a ball-end allen key, it looked like I was going to have to drain the cooling system and start removing the coolant manifold. Looking for a lazy way out, I sought another way to release the cams. So, not having even seen a manual, I can't offer any tensioner removal advice yet.

The chain tensioner access plugs are on the sides of the cylinders. The front is well hidden beneath a coolant manifold. The rear is more easily found.

Alternatively, unbolt the cam gear. There really isn't any tension on the chains at all. So it appeared to me that I could unbolt the cam that I needed to remove from the gear. This turned out to be just the trick. Before starting, I zip-tied the chain very tightly to each gear. This way, I didn't have to worry about re-alignment of the chain and gear. The only possible misalignment now is the cams to the gears, and since the cams can only go on one of three ways this is very easy. In fact, if you remember the cams face away from each other at TDC you're all set. On the rear cylinder (which I didn't touch), there's the extra gear on the exhaust cam to drive the

balance shaft. Make sure you mark this gears alignment to the cam gear and to the balance shaft gear. You must put the balance shaft back in phase with the rest of the motor! Now you can unbolt the gear on the cam you need to remove. Again, keep a rag stuffed in the case so you can't drop a bolt into the engine.

Three socket cap bolts (removed in this picture) hold on the cam gear. The boss on the cam will retain the gear while the bolts are removed. These bolts are installed with thread lock. Note the zip-tie maintaining chain to gear alignment, and the rag stuffed in the case.

Remove the cam holder. It's time to free the cams! On the front cylinder, there is a cam position sensor covered in silastic. You do not need to remove this. The cam holder isn't going far and there's plenty of slack in this sensor. On the rear head (which I didn't do), there's a balance shaft. It *appears* to me that the shaft is retained by two additional bolts behind the cam gears (which you can leave alone) and remains in the cam holder. It shouldn't cause any extra grief, except that it must be properly realigned when reinstalled. There are eight socket cap screws retaining the cam holder. Remove them in a crossways pattern. Make sure you get the washers with the screws, and don't drop them!

Remove these eight bolts and the cam holder can be lifted out of place and set aside. There isn't enough chain tension to rock the cams, so don't worry about that.

Remove the cam. Now you can slide the gear off the cam and lift the cam out of its seat. The buckets over the valve you need to adjust can be lifted out with a magnet, or a suction cup valve lapping tool. Sometimes the shims stick to the underside of the bucket, so be prepared for that and don't drop the shim in the motor! If the shim is still on the valve stem, you can lift it off with the magnet. If you remove more than one bucket, remember to mark them so you can reinstall buckets on the same cam lobe they came off of.

Once the cam is out, you can pick up the bucket with a magnet. The shim can be seen here still on the valve, but I've had them stick to the bucket if the magnet is powerful enough. Don't pull the bucket off the magnet over the motor or the shim could drop out into the cases.

Servicing Your Aprilia Falco Valves (continued)

Go to the beginning of this article.

Selecting A Replacement Shim

There are a few ways you can go about selecting the new shim. The quick way is to add or subtract half the adjustment range to the shim you've removed. This assumes the valve was marginally out of spec. A more accurate but time consuming way is to measure the shim you've removed, and use this along with the present clearance and new clearance target to calculate the new shim size. I would not recommend that you sand down a shim to change it's size. This would probably only work if you can guarantee that the shim was not just surface-hardened. Replacement shims are available from Aprilia in 0.025 mm increments, ranging from 2.300 mm to 3.000 mm. This is a 10 mm diameter button shim, and is probably available for other manufacturers too. Shims are almost always marked with the size in mm on their surface (sometimes the decimal is dropped). The shim that I removed from my bike had no markings, so I had to measure it with micrometers. A dial caliper doesn't really have enough resolution, but you can use it in a pinch.

Measure the shim with a micrometer if it isn't marked.

An Intake Valve example. My smallest micrometers measure in inches, as do my finest clearance feelers, so I'll do the math in inches here. If you are using measurements or shim markings in mm, divide the measurement in mm by 25.4 to get to inches, or multiply inches by 25.4 to get mm.

[1] Clearance measured:	0.0045	in
[2] Add size of shim you removed:	+ 0.1026	in
[3] Result: Clearance with no shim	= 0.1071	in
[4] Subtract desired final clearance (center of range = 0.0060)	- 0.0055	in*
[5] Result: New shim size required	= 0.1016	in

Multiply by 25.4 to get mm:	x 25.40	mm/in
Result: New shim size in mm:	= 2.5806	mm
Round to nearest 0.0025 mm:	= 2.5800	mm

Note! When I did this, I thought the intake clearance spec was 0.005 - 0.006 in, but I've since been told that its 0.005 - 0.007 in. So the target I should have used to center the clearance would have been 0.0060 in, not 0.0055 in. What I did is OK, but its more likely my valves will be out of spec again at the next interval because I set them closer to the limit than I had to.

For an exhaust valve, the desired clearance (line 3) is 0.0100 in.

Be prepared to settle for a different shim size if your dealer doesn't have a large selection in stock. There's a ten shim size range that will probably set up your clearances correctly. You may want to redo the shim selection example plugging in the extremes of the range for line 3 to see which shims are acceptable. When you get your new shim, you may want to measure it just to be sure it's marked correctly. The new shim I installed in this example measured 2.578 mm.

Some dealerships are cool and if you go to the service department they'll just swap you shim for shim, no charge. My Aprilia dealer and Yamaha dealer were like that. Other dealers will insist you buy the shim, which I've done. After a few services, you have enough shims to swap around yourself. The worst are the dealerships that won't sell out of service stock, and want you to order the shims and wait 5 days for them. There is a chain of dealerships like this in Boston,

and I take great pleasure in bring all the bikes I've bought at other dealers to them for inspection every year so I can show them the business they are losing.

Installing The Replacement Shim

After you've verified the shim size, drop it in place on the valve stem. Placing number markings up may be better so the numbers don't wear off you can see the shim size without removing it. It's a good idea to clean the inside of the buckets before reinstalling. Squirt a little motor oil on the valve and replace the buckets on the same valves they were removed from. Most manufacturers say to put a smear of moly assembly paste on the buckets before reinstalling the cams. I never have this stuff, but I am pretty liberal in pouring engine oil all over the cams and buckets. Squirt some motor oil in the cam bearing surfaces, then install the cam(s). Remember to reinstall the cams so that the lobes are away from each other. The gears should line up on the TDC marks when you index the bolt holes.

These cams are at TDC. The gear that I removed is bolted lightly to the cam already.

Reinstall the cam holder. On the front cylinder, don't forget the cam sensor wire was held down by a clip under one of the cam holder bolts. I didn't do the rear head, but it appears that the balance shaft gear should be aligned with its drive gear at this point too. You'll want to tighten the 8 bolts gradually in a crossways pattern, working inside to outside. Final torque on these and all the other M6 bolts you've removed is 11 N/m. Before reinstalling the cam gear bolts, clean the threads on the bolt and cam with contact cleaner and apply some thread lock (Loctite 243). The cams should now be bolted to the gears, the timing marks are now aligned, and the cam lobes are facing away from one another. Verify all the registration marks you made align too.

Reinstall the chain tensioner. Again, I didn't remove my tensioner, so I don't know the procedure here. I do know they have a copper crush washer and need to be tight or they will leak. If you zip-tied the gears to the chains, you can cut these now. Reinstall the upper chain guide. I used Loctite on the chain guide bolts too. M6 bolts should be torqued to 11 N-m.

Verify the valve clearance. Remove your rag from the cases and bump over the motor a few times to seat everything. Try not to start the bike! Naturally, the motor should spin freely with no bad noises if you've timed the cams correctly. Bring the timing marks back to TDC and verify that you've corrected the valve clearances. You may want to verify all the clearances in case you swapped a bucket or something else. My intake valve clearance was right about 0.0055 inch after installing the new shim.

Install the valve covers. Push any wire looms or cables aside so you have free access to the head. No sealant is necessary on these gaskets. They're cut into the covers and sit flat on the head. On the front head, I left the gasket tacked to the head, so I just aligned it to the bolt holes, then very carefully dropped the cover on top of it. After starting the bolts, I used an inspection mirror to verify that the gasket was seated around the front of the head where it isn't visible. On the rear head, you can hold the gasket on the cover as you drop it in place. Torque all M6 bolts to 11 N/m (tight).

Button it up. Pop your throttle bodies back into place and snug down the boots with no intake leaks. Reinstall the spark plugs if you haven't already. At this point, if your tank is installed you could run the bike to make sure it started. Install the airbox--don't forget the breather line and to clip the sensor to the airbox lower.

Synchronizing the Cylinder Vacuum

Motorcycle cylinders work quite independently compared to automobiles. Separate carburation, intake manifolds, exhaust pipes and sometimes even independent air filters allow the cylinders to be tuned so that one may be making more power than another. This can be due to differences in air flow, temperature, injection, or valve adjustment betwen the cylinders. Periodically, the cylinders should be synchronized. This is usually done by comparing intake manifold vacuum beneath each throttle and trimming the mixture until balanced.

Some old-timers will tell you it can be done by ear, listening to the air flow in each carb throat through a tube stuck in your ear. Most modern tuners have switched to mercury sticks. Rigid tubes stuck in a bath of mercury are attached to the vacuum source. The vacuum draws the mercury up the sticks in proportion to pressure difference between the manifold and the atmosphere. In order to smooth out the individual vacuum pulses, a damping device is needed. This is nothing more than a small orifice (pin hole) restriction in the lines, placed close to the manifold with an air reservoir (length of tube) behind it. Because there is no real air flow in the

gauges, there is no pressure drop across the orifice. But when the manifold vacuum drops there is a delay before the gauge pressure can bleed off and it appears steady and readable. Other types of vacuum gauges include mercury-less versions (that draw metal rods), or traditional needle, or "clock" gauges. The clock gauges are very fast acting (they are designed that way so you can see engine problems such as sticking valves). You will definitely need a damper if you choose a clock gauge. I would recommend using two side by side gauges for checking cylinder synch. The reason is, the cylinders are not perfectly independent. As one cylinder drops strength, the idle drops, and this will change the vacuum in the second cylinder's manifold. It takes a bit of fooling around to get a cause-and-effect feel when you are turning the screws. Swapping gauges would make this difficult.

A cheap set of carb sticks. Marked in centimeters of mercury, these are very sensitive. Most manufacturers request balance less than 2 cm Hg. Up to four cylinders can be viewed side-by-side.

The Falco control unit uses manifold pressure as one of its primary map variables (especially at idle). You would like to synch the cylinders with this control "open loop" so you will need to unplug the electrical connector from the manifold pressure sensor. This sensor is clipped to the lower left side of the airbox. Attached to this are two very small vacuum lines, connected between a "tee" connector and each of the manifolds below the throttle body. These should be unplugged from the tee. You can use them as a vacuum source, or you can plug them. You will need very small adapters to attach these hoses to most vacuum gauges. I found suitable conical shaped adapters in my Mitivac vacuum test kit.

On the left side of the airbox, unplug the electrical connector to the manifold pressure sensor. Also, remove the two vacuum hoses from the "tee". Test vacuum may be taken off of these. Or plug them.

On the right side of the intake manifolds, there are larger vacuum ports. The front port is plugged. The rear is attached to the clutch diaphragm. You can use these for test vacuum and

they will fit most gauges easily. The clutch line uses Aprilia's favored clic-clamp. You may not be able to reuse this clamp if you remove it. Plan on having a 1/4-in worm clamp on hand.

Larger vacuum ports are on the right side of the intake manifolds. The rear line feeds the slipper clutch. Depending on how you remove the clamp, you may not be able to reuse it.

Attaching the gauges to the left-side vacuum lines. Note the adapters and damper orifices in the lines.

You'll want to adjust the cylinders while warmed up, but if you plan on idling for an extended time, you may want to put a fan in front of the bike. You can start the bike up and idle it with the gauges in place, but remember never to rev the throttle on or off quickly with the sticks attached. It is possible to suck mercury out of the gauges and into your engine. Before starting your bike, though, locate the brass air bleed screws on the left side of the throttle body. Mark the slot location, then turn the screws lightly all the way in, counting the turns. Turn them back out to their original location. Record the number of turns so if you get messed up you can get back to where you were.

The mixture is trimmed with air bleed screws. Clockwise closes off the orifice, making the mixture richer. Count the number of turns to seat the screws before you start working. From the factory, these screws are usually set an equal number of turns out (approximately 1-1/4).

If you are working for the EPA, you'll want to see how lean you can possibly set these screws and still have the bike idle without overheating or stalling. For the rest of us, the tuning theory is to richen these screws (turn clockwise) until doing so no longer results in a better idle. Better idle, loosely defined, is a faster idle speed and a steadier vacuum. Your secondary objective is to balance the vacuum in the manifolds for each cylinder. While you do this, you will want to keep the idle speed around 1,300 - 1,500 rpm. Balancing at too high an rpm accentuates

differences in port flow. Adjust the idle speed with the thumbscrew on the right side frame. Note that the thumbscrew and idle screws do the same thing: control the amount of air in the mixture. So, many different "solutions" of air screw settings and idle screw settings are possible (not to mention the CO adjust screws in the ECU box). Driveability will dictate the best settings. Normally, that is around 1 to 1-1/4 turns out on the air screws and the idle adjust thumbscrew near its lowest possible setting (it will stop reducing the idle when the throttle plates hit the second idle stop). If you are running a Factory Pro or other aftermarket chip, you may find that lower air screw settings and more throttle plate opening are necessary for good off-idle throttle response. See the idle adjustment page for hints in this case.

I can only suggest a tuning procedure here, as I haven't read the manual on this. I ended up with the front screw out 1-3/4 turns and the rear screw out 1-1/4 turns. So a good starting place would probably be with both screws 2 turns out. Richen up a quarter turn at a time until the idle drops. Eventually, it will drop noticeably. When it does, back the screws out 1/4 turn. Balance the cylinders from there, by turning the strong cylinder's screw out. Watch the vacuum gauges. If the vacuum is erratic, as if searching for an idle speed, try leaning out another 1/4 turn. My bike never did have a really steady vacuum when balanced, but seemed to run better with the front cylinder slightly stronger. I've been told this is not abnormal.

When you are done, reset the idle speed and reconnect the vacuum lines and electrical connector.

Update: August 2001. A Mille owner from Australia was good enough to send me a copy of the Mille service manual for the cylinder synchronization procedure. In summary:

- They did not synchronize vacuum, they synchronized %CO emissions, setting them to between 0.8% and 1.3% CO at 1250 rpm (plus or minus 100 rpm). This is quite lean, of course. Coolant temperature during this test is 80-100 C (176-212 F), and air temp is 20-30 C (68-86 F).
- Vacuum was checked, and targeted at 300 mbar plus or minus 30 mbar (22.5 cm Hg plus or minus 2.25 cm). The manual warned that small differences in vacuum were acceptable only if the CO% was in range. They did not disconnect the pressure sensor (but my dealer told me they did this at Aprilia training).

Aprilia Falco Oil Change

The oil change procedure isn't documented in the US owner's manual. In fact, it's recommended that the dealer change your oil. It's really not that difficult.

Location of various parts (click to enlarge)

Note: Instructions and torque values below are from the Australian RSV-1000 owner's manual. The first drain plug is easy to find at the bottom of the oil tank on the right side. It is a hex-cap bolt with a 10 mm head. Remove the bolt and let the oil drain. The owner's manual says to retorque the bolt to 15 N-m (11 ft-lbs, 133 in-lbs). Due to the poor machining I've seen on the oil tank (mine has overcut threads), I would absolutely tighten this plug by hand. If there is any doubt, use a new M8 aluminum crush washer, and tighten it jut snug enough to feel the crush washer yield. Two people have emailed me to tell me they have stripped this plug, so be very careful!

The second drain plug is located on the kickstand side of the engine. It is a socket cap plug and mine was installed by a gorilia. The first time you remove it, use a tight fitting allen key. If it gives you any grief, use a hammer-driven impact on it instead of rounding it out. The plug is magnetic, and should be cleaned before reinstalling it. Tighten the plug to 12 N-m (9 ft-lbs, or 106 in-lbs).

Location of oil filter (click to enlarge)

Behind the oil filter cover is a paper filter element (made by Champion, sold by Aprilia for about $14). Remove the two socket cap screws shown in the picture. The filter fill be pressed into the cover. Pry it loose (noting the orientation) and press on another another filter. The o-ring on the cover can be reused. I primed my filter by filling it with oil before installing it. Tighten the two cover screws just firmly.

There is a filter screen in the bottom of the oil tank that is supposed to be cleaned every other oil change. (I have not cleaned this yet, so I'm not speaking with experience here.) A good time to clean it is when you have the recalled hose replaced, because to service the filter you are supposed to remove the lower hose clamp on the oil tank. Make sure you have an extra hose clamp on hand before removing one of the "clic" clamps. After removing the hose, unscrew the tank filter and clean it with compressed air. Replace the filter and tighten it to 30 N-m (22 ft-lbs). I've found that if you fill the cold oil level to the horizontal fin on the engine cover (see picture) when on the sidestand, the level will rise to nearly the MAX line when hot. Start with 3-1/2 quarts, idle the engine for a minute, then you will need to top it off. The owner's manual recommends checking the oil level with the engine hot (15-20 minutes riding), turned off, and held level. Internet wisdom has said otherwise, but I think there's more important things to worry about than 50 cc's of oil.

Misc stuff: I know oil is a controversial subject for some, so take these notes with a grain of salt.

- The owner's manual says oil change interval is first 600 miles, then every 4500 miles (2300 miles if you race the bike).
- The owner's manual says to use 15W-50 weight oil.
- I've been changing my oil every 3000 miles, and using 15W-50 Mobil 1 (synthetic) since the 3,000 mile mark. *In my opinion*, the engine was not broken in fully by 600 miles by far, so I used regular non-synthetic oil at the first service. Lately (7,500 miles), I've been experiencing some clutch slippage in 2nd gear, so I'm going to try a different oil.
- Update July 2001: I replaced my clutch at 7,500 mi and have been using semi-synthetic ever since. Motul 3100 last year and Torco semi-synth this year. 11,500 miles and no clutch slippage yet, although it is harder than ever to get it into neutral now with the Torco oil.
- Update October 2002: After using nothing but semi-synthetic oil for the last 7,500 miles, I'm at 15,000 miles and need yet another clutch. I conclude the predominant cause of clutch failure on this bike is not related to oil.

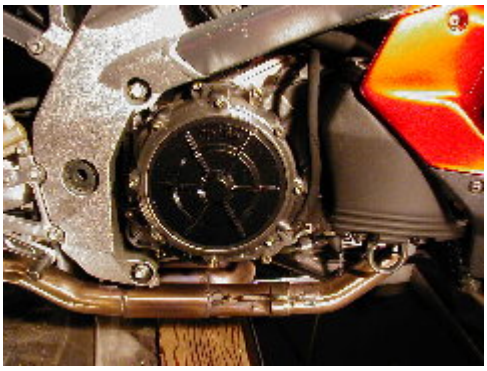
Aprilia Falco Clutch Replacement

At approximately 6,000 miles, I began noticing clutch slip at high 2nd gear loads. Over the next 1,500 miles, it got worse, until the clutch would break free in second and third under any hard acceleration.

At this time, Aprilia considers this a consumable item and doesn't cover the clutch under warranty. Fortunately, at $160 list (I paid $144) for the entire clutch kit, it is reasonably priced. Even better, it is very easy to replace. Still, please ask your dealer to bring early clutch failure to the attention of Aprilia. If enough of us complain, maybe they'll redesign it.

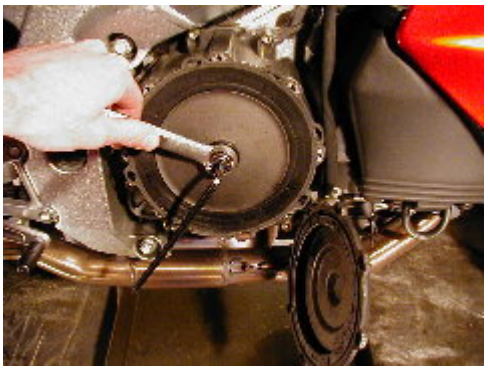
Update (17-Jan-2002) Barnett now makes a clutch kit for the Falco. John Abatte has installed one. Priced similar to the Aprilia clutch, it has different construction and may provide better life.

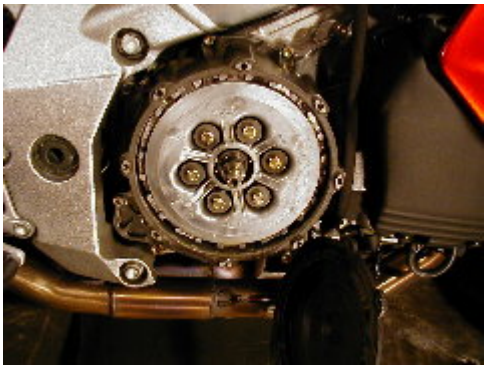
Disassembly procedure: Click on images to enlarge



Start by setting the bike on the sidestand, clean the clutch cover and oil tank bottom, then drain the oil tank. You do not need to remove the magnetic oil plug or oil filter. The clutch is behind the right hand (brake lever side) engine cover. Only the eight M5 screws on the inner cover need to be removed. You can leave the vacuum hose in place.

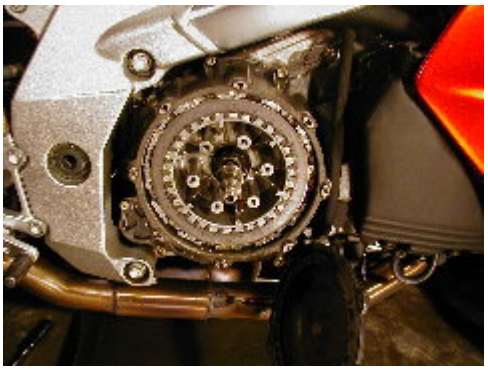
Carefully set the cover aside. Lift the eight tabs on the vacuum diaphram and rotate the diaphram off the tabs. Use a 19mm wrench on the M12 locknut while holding the clutch disengagement shaft with an allen key.





Remove the outer washer, vacuum "pressure plate", diaphragm, support disc, and inner washer and set them aside in order. The "spring holder" hub will now be exposed. Shift the bike into gear, hold the rear brake down and remove the six M6 bolts, washers and springs.

Remove the hub, exposing the clutch stack. Fish out the steels and frictions from the basket. You do not need to remove the shaft, but don't bend it. Inspect the basket and hub, especially along the fingers. Smooth wear spots are normal, but there should be no edges that would prevent the stack from sliding easily.



You should inspect any new or old components before you reinstall them. Frictions should always be replaced. Inspect them for glazing, wear (thickness), and cracking. Steels should be checked for bluing (a sign of overheating), and warpage. I check for warping by holding two steels together and looking for light between them (spec is less than 0.006 in warpage for one plate). Springs should be checked to make sure they have adequate free length (short springs are an indicator of fatigue and the reduced spring rate will not provide enough holding pressure).

Measurements for the Stock Aprilia clutch:

Item	Avg, New	Avg, Used	Aprilia Spec
Spring	1.72 in	1.73 in	> 1.69 in
Steel plate	0.059 in	0.058 in	
Friction plate (new measured dry)	0.137 in	0.135 in	
Stack height (steels+frictions)	1.82 in	1.80 in	> 1.77 in

Assembly procedure:

- The clutch should be installed wet--soak the new frictions in oil while you are taking apart the clutch.
- Replace the clutch stack, alternating steels and frictions. The stack starts and ends with a steel. My steels were placed in the clutch from the factory with the chamfered side facing out, but Barnett advises just to make sure they are all pointing the same way. Note that the new Aprilia kits have a special chamfered steel that goes on the hub first. Slide the frictions into the deep fingers in the basket. You'll notice one friction plate may have a red dot painted on it. As far as I could measure, it was identical to the other frictions, but I saved it for last. The last friction is rotated 15 degrees from the others and fits in the shallow fingers of the basket. End the stack with a steel. Note that the *Barnett* stack is not made up of uniform sized plates. You should follow the instructions on stack assembly provided with their kit.
- Replace the hub. Snug down the bolts, washers and new springs in a cross-ways pattern. Step on the rear brake and torque them gently to 11 N-m. This isn't much--don't crack the basket!
- Replace the washer, support plate, rubber diaphragm, pressure plate, washer and nut on the end of the clutch actuating rod. Before torquing the nut down, rotate the rubber diaphragm so it isn't hooked on the tabs. It will lie flatter if it is free to rotate when you torque down the nut. The nut should be tightened down to 20 N-m, but you'll need a crowsfoot adapter (with appropriate torque conversion) if you want to use a torque wrench while you hold the rod with an allen key. Alternatively, you could hold the nut with a wrench and use a torque wrench in the counterclockwise direction on the actuating rod. If the diagragm has a ripple and isn't lying flat, loosen the nut and try again. Hook the tabs on the rubber diagragm.
- Replace the cover and snug the bolts down in a cross-ways order. The torque spec is 5 Nm, which is just snug. If the cover weeps oil, you can always tighten it up a bit more later. I didn't

disconnect the cover vacuum line, so I tested for a vacuum seal by starting the engine and feeling the feedback in the clutch lever. But don't forget to replace the oil before starting the bike.

- You may want to bleed your slave cylinder. I had no problems, but at least one person has reported getting a bubble in the line somehow during the clutch replacement procedure.
- Remember to break in your clutch. You don't want to burn your new steels while you're taking down the high spots. I think with the slipper clutch it doesn't take long at all.

Update (July 2003) I've finally faced the inevitable and replaced my clutch a second time (at 16,000 miles). I again chose the stock clutch, which has reportedly been updated since my last installation. You can read more about the differences and a few minor installation notes.

Aprilia Falco Clutch Replacement (Again)

Despite using nothing but semi-synthetic oils, my clutch started slipping again around the 15,000 mile mark. By 16,000 miles it was not at all enjoyable to ride, so I once again replaced it. This time, I had a choice. There was the updated stock clutch, which might provide better life (Aprilia has never said there was an issue with clutch life so it's hard to tell). And for the aftermarket, Barnett has stepped up and offered a replacement. Barnett clutches usually come with stiffer springs, but people often use them with the stock springs, or a mix of half stock, half Barnett springs. Also, the kevlar construction of a Barnett clutch seems to make it hang on a little longer, but I've been told it's degradation is greater when it starts to slip. In the end, I chose to give the updated stock clutch a try.

Measurements for the New Aprilia clutch (comparing my third clutch I'm about to install to measurements taken from my second clutch before I installed it):

Item	Avg, New design	Avg, Original design when new	Aprilia Spec
Spring	1.73 in	1.72 in	> 1.69 in
Steel plate	0.058 in	0.059 in	
Friction plate (new measured dry)	0.137 in	0.137 in	
Stack height (steels+frictions)	1.82 in	1.82 in	> 1.77 in

As you can see, Aprilia has not made any dimensional changes to the clutch pack.

It might be interesting to compare the measurements of the clutch I removed (my second clutch) to its measurements before installation. I didn't keep individual component identities, so we can only compare averages.

Item	Avg, Original design	Avg, Original design	Aprilia Spec

	before installation	after 9,000 miles	
Spring	1.72 in	1.73 in	> 1.69 in
Steel plate	0.059 in	0.058 in	
Friction plate (before use was measured dry)	0.137 in	0.137 in	
Stack height (steels+frictions)	1.82 in	1.82 in	> 1.77 in

As you can see, again there was no wearing of the clutch materials. Suggesting again that another mechanism is at fault for the clutch failiure.

The steels did not look blued this time, probably because I was quicker to recognize the slipping clutch and babied the bike a little. There were three steels with very minor warpage, perhaps 0.010 inches deflection when held against a flat surface. The steels were definitely polished smooth.

Aprilia Falco Clutch Replacement (Again), continued...

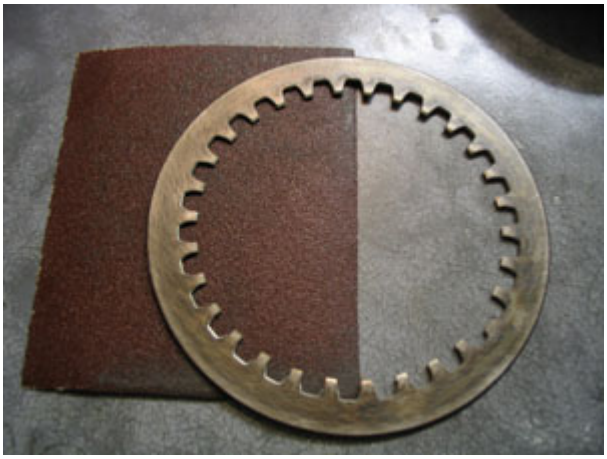
Go to start of this article...

The only difference I noticed about the new clutch design is that there is now a special 10th plate. This plate has chamfered cuts in the teeth, and one of the teeth is cut short. On consulting with my dealer (*thanks Seacoast Sport Cycle*), he informed me that this plate goes deepest in the motor (goes in first). I placed the chamfered side facing out of the motor (for no real good reason--I can argue for either way).

The first steel into the motor is chamfered. It also has one shortened tooth. The RSV manual did not cover its placement, so I placed the chamfered side facing out of the motor, and put the shortened tooth adjacent to the lubrication hole drilled deepest in the hub. The corroded look of this steel is because it was not packaged with oil like the other steels. There was no serious pitting, so I cleaned it up and used it.

Before assembling the clutch, I did try one more trick. In discussions with Marc Salvisberg of Factory Pro tuning, he mentioned that an old racer's trick was to scuff up your steels with coarse

sandpaper. When I first heard this, I cringed, but Marc knows a lot of tricks that work. And I started thinking, when I get an automobile flywheel resurfaced, it comes back with a ground finish, not polished smooth. Perhaps a bit of bite would keep the frictions from glazing.



I put a sheet of 100 grit sandpaper on a flat surface, and one by one, lightly scuffed up the frictions. I used a small circular motion to make sure there were plenty of scratches going across the friction radially. In the end, the result was very mild because I didn't want to take off any material. After I was done, I cleaned the steels in a mixture of laundry soap and water to remove any abrasive grit.

Remember to pre-soak your frictions in oil. Then locate the friction with the blue dot painted on the tab (my previous clutch had a red-dot). I didn't see what was different about this plate, but it is supposed to go on the stack last.

The final friction to go in the stack has a blue dot painted on it. This friction is normally offset from the others and placed in special slots in the basket.

The only other thing I did differently with this clutch was to wash the rubber vacuum diaphragm in soapy water, as it had started to build up some oily deposits. I used contact cleaner to wash the metal parts of the diaphragm assembly.

Here are the part numbers off the packaging for this clutch. I'm unsure of the total prices, but with an oil filter and four quarts of Silkolene semi-synth it was $214.

Spring (6)	239480
Steel plate (9)	0259260
Steel plate (1)	0259264
Friction plate (9)	8106634

Aprilia SL-1000 Fork Spring Replacement

Fork Spring Selection

The Falco is shipped stock with Showa USD (upside-down) cartridge forks. The spring rate is quite stiff for a street bike, at 1.0 kg/mm (straight rate). Most people will have to turn the preload adjusters all the way out to get even close to 35 mm rider sag (a good starting point for modern sportbikes). Under those conditions, the Falco will only have about 15 mm static sag, and gurus say a value close to 60% of rider sag, or 20 mm indicates you're in the ballpark for the right spring rate. For a race bike, less than 20 mm static sag would suggest a marginally stiff spring rate. For road use, traction (and comfort) will benefit from reducing the spring rate further.

- View Traxxion Dynamics' suggested spring rate chart (Traxxion specializes in *racing* applications, so consider this a recommendation for smooth surfaces). *[From Traxxion's website as of August 2001]*
- View Race Tech's suggested spring rate chart. Race Tech markets their parts for street and competition, and give different curves for each application. Many aggressive riders find Race Tech's recommendations a bit on the soft side. *[Chart from Race Tech's installation guide as of July 2000]*

From magazine test articles, I estimate the weight of the Falco with aftermarket cans at 475 lbs. Don't forget to add your rider weight with gear before using the graphs above.
I went conservative and chose .95 kg/mm springs, only a 5 percent reduction in stock spring rate. Just to try a different vendor, I went with Traxxion Dynamics springs. I've used Race Tech's in the past, and both appear to be similar products (shot-peened, heat-treated, pre-set, chrome silicon, guaranteed rate, etc, etc). Although there is one notable difference: the Race Tech springs for the Falco are reportedly tapered and small enough in inside diameter that you will have to remove a plastic locating spacer from the damping rod to install them (this requires removing the cartridge). The Traxxion springs are very similar to the stock springs and do not require this additional step. I should also note that both Traxxion and Race Tech market straight rate springs (like the OEM springs in this bike). If progressive rate springs are preferable, try Hyperpro.

Spring Replacement Procedure

Before starting, you'll need a few parts on hand. First is fork fluid. I strongly recommend you don't go any higher than 5 Wt. fork oil with the stock valving. Honda markets Showa oil in 475 ml bottles. You'll need one bottle per fork leg. If your fork seals are leaking, or you suspect

your bushings are worn, this is a perfect time to replace them. But pulling the seals is *not* required to replace fork springs, so I chose not to replace my seals at this time. Also, you'll most likely want to alter the length of your preload spacers unless you happen to get new springs of the exact same free length as the old springs. Race-tech usually supplies spacer material. Traxxion did not, and their springs are shorter than stock so you couldn't cut down the original spacers. Spacers can be made from thin-walled aluminum tubing, or even 1-inch PVC water pipe.

IMPORTANT: You may also want to rig up a few tools to make this job easier. Read this procedure fully to see what is required before deciding if you want to attempt this job without the special tools

Fork Removal Procedure

Remove the fork leg

- You do not have to remove the forks to replace the fork springs. But I really believe it would be more messy and time consuming to work with them in place. So, I recommend placing the bike on a suitable front stand. Both Pit Bull and CFM Motorsports (Woodcraft) make front stands to fit the Falco steering head (27 mm pin is required, as well as unbolting of the air dam and top of the horn cover). However you choose to suspend the front of the bike, do not weight the wheel or forks, as these are being removed! Remove the front wheel (unbolting the calipers helps--see the owner's manual), and remove the front fender (four bolts, very easy). Slip the axle back through the forks.

CFM front stand in use. Forks are ready to be removed. You probably shouldn't hang your calipers by the hoses. I propped them up after I got the fork removed. Slip the axle through the forks and you can unbolt one without it dropping.

-
- Working on only one fork for now, loosen the pinch bolts on the upper triple clamp and clip-ons.
- Before removing the fork leg, break loose the preload caps (the red anodized caps). These are very soft aluminum. I've deformed mine a bit using a 12-pt socket on them, so now I use an open ended wrench that's been taped to protect the anodizing. Try not to scratch the tank or smash the instrument panel. If you have a soft-jawed pipe vice, you can skip this step and break the cap loose later.

- Loosen the pinch bolts on the lower triple clamp, keeping the axle through the fork to keep it from dropping to the ground. Remove the axle and carefully pull the fork out of the clamps from the bottom.

- Take the fork leg somewhere clean, and clean the fork leg of any dirt before you open it up. During disassembly, it's helpful to have a way of clamping the fork in an upright position while you work. A soft jawed vice will work. I stacked up about four used tires on a square of carpet and placed the fork in there. Even if the fork tipped, it couldn't tip enough to spill oil.

This procedure is based on my RS250 manual, which also has USD Showa forks.

Disassembly Procedure

Remove the springs

- The RS250 manual leaves draining the fork oil until a later stage, but I prefer to get it over with now. The method I've been using is to back out the compression screw at the bottom of the fork leg, then removing the compression valve and draining the oil out the bottom (see the page on replacing fork oil). You need to be very careful not to damage the valve needle. Record the number of turns to fully seat the compression valve before backing it out. After removing the valve, pump the forks a few times to spray out the oil, then replace and tighten the compression valve.

- Turn the rebound adjust screw on top of the preload cap all the way in (gently), recording the number of turns. Then turn it all the way out (again, gently) to free the needle from the orifice. Next turn the preload adjuster in to reveal the spring clip on the top of the adjuster rod (anodized blue). Remove this clip, keeping your hand over it so as not to spring it across the room. After removing the clip, you can back out the preload adjuster all the way and remove it from the fork.

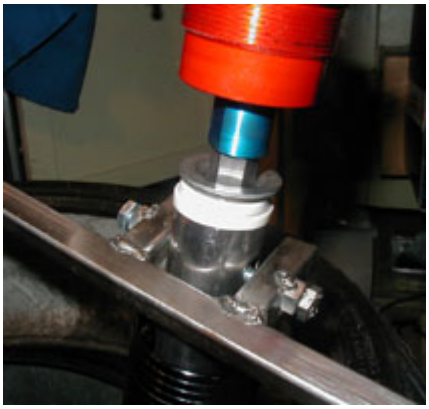
- Remove the nylon ring underneath the preload adjuster that retains three pins that push down on the spring. Unscrew the red preload cap completely now. There should be no spring pressure behind it. When it is unscrewed, the fork can be collapsed, revealing a steel preload tube bolted to the cap. This tube is pressing down on the spring and is under pressure.

- To remove the preload tube, it must first be pushed down against the spring while the blue damping rod is held up. When the tube has compressed the spring about an inch, it will reveal a wrench flat on the damping rod that must be held while the preload cap is removed. I strongly recommend you make or buy both of the special tools to depress and hold this tube.

    - The first tool grips the preload tube using the holes in its sides and has handles to allow you to push down on the tube with both hands. At 1 kg/mm, you need to be able to apply about 50 lbs to depress the tube enough to get at the wrench flat. I thought about using a couple long bolts, or perhaps modifying a c-clamp to fit in the hole. In the end I just welded up a tool shown in the picture below.

    - The second tool is a like a slotted clip, something to just slip over the damping rod under its lock nut to hold the preload tube down so you can release the push-down tool and remove the cap. The clip or plate could be a fender washer, maybe 1-1/2 inches in diameter to hold the tube, with a half inch hole slotted out to the edge to slip over the rod. I was quite lucky, as I had a piece just like this already: the Honda CBR600F3 cartridge forks have a slotted and dished washer in their parts list that serves a similar function (holding down the spring beneath a lock nut). If you order this part, or find it at a junk dealer, it works perfectly. I had a few bent F3 forks lying around.

The preload tube has already been compressed and clipped down, revealing the wrench flats on the blue damping rod that you need to expose. Note the use of two tools to compress and retain the preload tube. (Click on image to enlarge and show notations.)



- I would recommend you depress the tube carefully and evenly, and only enough to get the clip in place. There is something that the tube bushing can get hung up on deeper in the forks (perhaps it can leave the bottom of the tube), and I managed to damage a bushing because I was not careful about this. (At least I think that's how it was damaged). This bushing does not have a separate part number, and an entire preload tube must be ordered if you damage it ($45 a side). To avoid depressing the tube excessively, have an assistant hold the preload cap up and slip in the clip while you depress the tube. Once the tube is clipped down, you can hold the rod with a wrench and unscrew the red preload cap from it.

- After the preload cap has been removed, you can once again depress the preload tube with the tool and remove the clip. Release the tube slowly, maneuvering it so it doesn't hang up on the blue damping rod.

- Remove the preload tube from the fork (with plastic spacer and washer above), then fish out the spring beneath it, and finally the washer and preload spacer beneath that. Remember that if you tip the fork over at this point to retreive the spacer, its going to have residual oil in it!

- Note that USD forks, unlike standard damping rod forks, will fall apart if the preload cap is off and you lift them by the upper (outer) tube. Don't do this!

Assembly Procedure

Cut the new preload spacer

- If your replacement springs are a different free length than the OEM springs, you'll need to adjust the length of the preload spacer that you pulled from the bottom of the tube. The object is to preload the spring about 15 mm with the preload adjuster screwed all the way out and the damping rod fully extended. You can insert the spring, plastic spacers, washers and preload tube (but *not* the preload spacer), then screw the preload cap onto the damping rod and pull it up. With the preload adjuster installed and at its highest adjustment level, measure the distance between the preload adjuster pins and the top of the washer on the preload tube. Add 15 mm and that should be right.

- Alternatively, compare the lengths of the old spring and new spring, then adjust the length of the preload spacer so that the sum of the old spring and old spacer is the same as the new spring and spacer.

- Or even easier, you can use blind faith and ask the spring manufacturer how long the spacer should be. Traxxion keeps records of installations they've done in the past, and instructed me to use 128 mm. This was what I did.

- You can shorten up the existing preload tube if you need to reduce the spacer size. Or 1-inch PVC water pipe is easy to cut in a chop saw and doesn't weigh too much. I had some lightweight aluminum tube (from previously purchased Race Tech springs) that was light and doesn't displace much fluid. No matter what you choose, deburr and clean it with soapy water after cutting.

On the left is the OEM spring and spacer. On the right is a Traxxion Dyanmics 0.95 kg/mm spring and a 128 mm aluminum tube cut for a spacer. On the far right, you can see the preload tube assembly (bushing on bottom). In the foreground is the slotted washer (tool #2) used to clip down the spring. (Click on image to enlarge.)

Replace the oil

- Oil level should be measured from the top of the *collapsed* fork tube, with the cartridge in place but without any spacers or springs installed. Its helpful to make a dipstick with two marks on it if you don't have the professional level tube to set the oil level.

- I'm not sure what the factory oil level is, but Traxxion recommended 150 mm. Racetech's website recommended 80 mm! Using Traxxion's recommendations, I was left with a couple ounces of oil in each 475 ml bottle (maybe using 425 ml). Myself and other Falco owners have measured how much OEM oil was drained from the forks, and the value seems to be 455 ml. So I'd guess that Traxxion's recommendations are lower than stock.

- Before verifying the final oil level, pump the damping rod up and down a dozen or so times. Pump it slowly as oil will start flowing from the rebound hole in the tube. Its a good idea to check this hole, because on one of my forks it had a large peel of steel stuck in it from the drilling operation. Let the fork drain internally for a few minutes then verify the oil level.

If you do a lot of fork oil changes, they sell rigid tubes with adjustable height stoppers that reach down the fork tube. A syringe then pulls out excess oil until the level is correct. Here I used my standard stick of scrap dipstick (not too big--you don't want to displace much oil). Oil level is almost always specified with the springs and spacers removed and the fork collapsed. The damping assembly remains bolted in the fork (otherwise, the oil would leak out the bottom!)

Assemble the fork

- Drop the preload spacer into the oil, followed by the washer, then the spring. Before placing the preload tube in the oil, you'll want to tie a piece of safety wire to the damping rod so you can pull it up. Then place the preload tube, plastic spacer and final washer over the damping rod.

- Using the safety wire, pull the damping rod up (fully extended). I even tied the wire to the ceiling to hold it. Using the spring compression tool, compress the preload tube and put the clip under the lock nut. Again, you only want to compress this tube enough to expose the lock nut. Hold the damping tube up while you do this or you'll have to compress the tube further and risk damaging the bushing.

- Remove the safety wire and screw on the red preload cap. Tighten the cap, then use the spring compression tool once more to remove the clip from under the lock nut. Slowly release the spring tension. Remove the spring compressor, and screw the preload cap into the fork tube snugly.

- Replace the preload pins (make sure the pins are aligned in the holes), then thread in the preload adjuster. Replace the wire clip on the top of the rebound adjuster.

Stroke the forks several times. They should compress and rebound smoothly. The bushings will make some sliding noise but shouldn't click.

Fork Replacement Procedure

- From below, slide the fork back into the triple clamps. You'll want to align one of the marks on top of the fork to the upper triple clamp, or use a caliper to measure the height if you weren't using a mark. Stock, the bike is aligned to the third line from the top (not including the very top most line at the edge). I'm running mine with four lines showing.

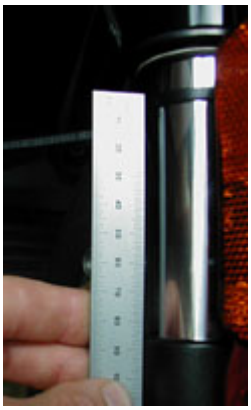
- Tighten the lower triple clamp first, then the preload cap. Finally the upper clamp and clip-ons. The torque specs for the M8 bolts are 25 N-m.

- When the forks are tightened, you'll want to test their alignment by slipping the axle through them. You may have to rotate the fork tubes slightly, but you shouldn't have to compress either tube to get the axle so slip through easily.

- Replace the fender, then the front wheel and calipers. After lowering the bike to the ground, replace the plastic air dam and upper screws on the plastic horn cover.

- Reset the compression and rebound damping screw positions. You'll want to check the sag again. A good target for rider sag is 32 - 35 mm.

With four or five lines showing, I got about 34 mm rider sag, 22 mm static sag (quick measurements). Usually with lighter springs you need less rebound, more compression. I reset both rebound and compression to 1.5 turns out from full in and with this setting I seem to get a comfortable ride, nearly full fork travel but no bottomming yet. More testing and tuning to come I'm sure...



Aprilia SL-1000 Fork Oil Replacement

It's hard to tell from the US owner's manual (I think they printed part of the maintenance table in Italian), but I believe the fork oil is scheduled for replacement at 4,600 miles. I put this service off mostly because there are no oil drain screws, and partly because I've never had a bike with USD forks, but at 7,700 miles I had the front end suspended to work on the suspension, so I changed the fork oil then. The following is the procedure I used. I didn't have a manual to guide me on this, so I can't guarantee it's accuracy. It worked for me.

Raise the front of the bike securely so that the front wheel is unweighted. I suspended my bike from an engine hoist. Loosen the top pinch bolts on the triple clamp, as well as the pinch bolts on the clip-ons. Unscrew the fork caps--if you back off the preload completely, they will not be under any pressure. You may want to tape the anodized caps so you don't scratch them up like I did.

After removing the caps, raise the front wheel so that the forks compress all the way and the fork caps stick out the top, then measure the oil level from the top of the forks. (I think I made this measurement without the forks completely compressed, so my measured values were in error).

The trick to avoid removing the forks is to drain the oil through the compression valves. For reference, count the number of turns in to seat the adjusters. Then back the adjustment screw out all the way so the needle isn't contacting the orifice. With an pan or beaker underneath, remove the entire compression valve with a 14 mm wrench and allow the oil to drain.

Replace the compression valves snugly and reset the adjustment screw. Refill the oil from the top. After adding about 8 ounces, I pumped the fork up and down a few times to bleed the cartridge (I'm not sure this works for USD forks), then I compressed the forks completely and set the final oil level. Replace the fork caps, then torque the pinch bolts on the triple clamps and handlebars to 25 N-m. Reset your preload adjustment if you changed it.
I don't have the oil level spec for the Falco or RSV, nor do I know if the level would be specified with the cartridge and spring still in the fork. I ended up setting my oil level to 6 cm, using approximately 925 ml of fork oil (460 per leg). Later, I measured the volume I drained out to be almost 900 ml (450 ml per leg). I used Showa 10wt fork oil, sold in 475 ml bottles under the Pro-Honda label. The oil that I drained from my forks was very clean (the cleanest I've even drained), so it's probably OK to postpone this service.
Updates

- It's spring in New England and I've had the bike out to some fun roads. I have to guess, 10W is not the oil viscosity you want. Too much rebound and compression damping. I turned down the compression last fall, but the rebound is incredibly high. The wheels leave the ground a lot. I'm guessing 5W is the way to go.
- John Abate recently changed his fork oil, and was careful with his measurements. Here's what he provided:

  Fork oil volume drained (per leg): 455-457 ml

- Racetech's page for the RSV with Showa forks lists this information:

  Recommended oil viscosity: 5W

  Oil level: 8 cm

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Replacing the Front Brake Pads

Sintered pads don't seem to wear out, they just seem to get harder and harder. After nearly 11,000 miles, mine still had a lot of friction material on them, but not a lot of bite. It would stop, but not without a lot of effort. I was way overdue for new pads.

I haven't tried a lot of different pad brands, but I'm always impressed with EBC HH's on the track. They seem to work very well with stainless rotors, and when warm they are great with iron rotors too. I decided to try the EBC HH pads on the Falco, part number FA 244 HH. The Falco, Mille, and RS250 Challenge share the same pads, so there's sure to be a lot of different brands to try.

After removing the two M10 bolts, the calipers can be removed without removing the wheel. Sometimes, its necessary to push back the pads a bit to make clearance to tip the caliper. Only remove one caliper at a time so you don't overflow your master cylinder! Plus, it never hurts to leave a caliper intact in case you forget how to put it together.

To remove the pads, you need to remove the two retaining clips, then the two slide pins. The pads will then slide out of the caliper.

It is possible to remove the pins and pads without removing the caliper. But if you have time, you'll probably want to remove the caliper in order to clean the dust from around the pistons.

Make sure you have a little airspace at the top of your master cylinder, then carefully pry back the pistons to make sure they are free. This also allows the new (usually thicker) pads to fit over the caliper. If you flip the pads and place them in the calipers, you can pry back the pistons squarely without damaging the pads.

Sintered pads are hard. Very hard. Like modern clutch plates, they can be work hardened to the point of losing friction properties long before they wear out of spec (< 2mm). On the left is the new EBC pad, with less friction material than the 11,000-mile old stock pad on the right.

Before reassembly, there's a few things to do.

- Using small files, knock down the edges around the locating holes and sides of the brake pad backing plates. We want to make sure there's no burrs or edges that can dig in and prevent the pads from sliding during use.
- An anti-squeal trick I was taught for cars was to use a file to knock down the sharp leading and trailing edge of the friction material too. I do this on bikes too, although I don't know if it makes a difference.
- Use steel wool to clean the slide pins. There may be a couple divots in them from hard braking. Sand these out but try not to remove so much material that the pads will rattle excessively.
- Before reinstalling the slide pins, wipe a very thin coat of anti-seize lubricant on them. The pins slide into the caliper, through the pads, picking up the "hooks" on the anti-rattle plate at each pin. There is an arrow on the anti-rattle plate which points "up" when properly installed.
- Reinstall the retaining clips, and tuck the upper clip under the anti-rattle plate for added safety.
- Install the caliper with the mounting bolts just snug. Pump the brake lever to seat the pads, then torque the M10 mounting bolts to 50 N-m (about 35 ft-lbs).
- Do the other side!

When EBC HH pads first came out, the trackside vendors had posted a notice from EBC on proper break-in procedure. I think the posters have long since disappeared, but from memory, this is how EBC recommends breaking in their pads for track use. I imagine for street use, you can adapt this technique, or simply follow the back of the packaging which says that 250 miles of frequent, light use is needed to bed in the pads.

EBC HH Pad Break-in Procedure for the Track

- Take two slower laps of the track, using the brakes lightly to warm them up and bed them in.
- Take one hot lap of the track, using full braking power.
- Pull into the pits and allow the pads to *completely* cool.
- The pads are now ready to race.

Servicing the Clutch Slave Cylinder

The Falco has a hydraulic-actuated clutch, as opposed to the cable-actuated clutches found on many sportbikes. There are advantages and disadvantages. Some would say the cable clutches have better feel, or one-to-one connection between ones hand and the clutch action. But the hydraulic clutch, while somewhat vague at times, suffers none of the cable friction. This, coupled with the vacuum feedback circuit, means less clutch effort for a heavy-springed big-bike clutch. Also, in theory, a hydraulic clutch should be very reliable with no routing difficulties, lubrication issues, or cable breakage. I've found this to not be the case, as bleeding and the seal failure of the Brembo cylinder are more of a problem than they should be.
The Falco clutch fluid has always turned black a couple of weeks after changing it. This has not been a problem, as I flush it every oil change. But recently on a trip, I lost a large portion of my clutch travel. The seal seamed intermittent, and the last little bit of lever travel that did work was very hard to actuate. Needless to say, my hand was cramped up in no time and I did not look forward to shifting. No fluid had been lost, but I suspected the slave cylinder ("control cylinder") based on the experience of many a Falco and Mille owner. I removed the cylinder for inspection.

The clutch slave cylinder lies behind the countershaft sprocket cover. Three bolts hold it in place. There is a weep hole in the housing ("flange") behind the cylinder, and on my bike there was a few drops of hydraulic fluid around this hole. If you are replacing the cylinder, you should probably remove the clutch hydraulic line first, but for inspection it is not necessary.

You can remove the piston from the cylinder by pumping the clutch lever a few times. Unlike a brake cylinder, there is no square seal in the bore. Instead, the piston is more like an accelerator pump or fork seal, with a one-way wiper on the piston itself. The bore should not be scratched, and the seal should be flexible and intact. Any nicks or cracks, and a rebuild is in order. The rubber seal on the flat end of the piston is simply a grease seal for the end of the actuator rod. It should be cleaned but is not critical. On my bike there was some grooving of the actuator rod where it touched the seal. If this grooving is sharp, you would want to lightly sand it.

The slave cylinder bolts to a spacer, or flange. This is easily removed and should be cleaned to keep sand and chain grit away from the cylinder. Clean the actuator rod, particularly where it touches the seals.

After cleaning the piston and bore with brake cleaner, I lubricated the seal and bore with fresh brake fluid and reassembled them. A dab of fresh grease in the hole at the end of the piston will reduce friction on the actuator rod. The torque spec on the three bolts is 8.7 ft-lb (12 Nm). The torque spec on the bleeder nipple is 10.8 ft-lb (15 Nm). After refilling and bleeding the system, my clutch lever was restored to its original feel.

Had a rebuild been necessary, there are a few options. I've been told Brembo does *not* sell a service kit, but I believe some manufacturer in the UK does (please email me if you have purchased one). Outside of buying another stock cylinder, Evoluzione Cyclesports sells a replacement. This replacement has reduced clutch effort, but at the price of a different feel that you may or may not like (generally, more leverage means more travel is required). I would speak to them before ordering to make sure the countershaft cover can fit over it, as the original Mille cylinder they offered required some cutting.

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