



## The Speedflow guide to high-performance auto plumbing

The fluid systems of any high performance vehicle are as essential as any other component and careful attention to detail and good preparation are both necessary to ensure consistent performance. The plumbing of performance vehicles needs to be carefully planned and is best done when most of the major components (motor, transmission, steering, manifolds etc.) have been located in the chassis. Although hose lines can be routed almost anywhere, plumbing fittings, due to the specialised engineering involved in their manufacture, are not cheap and careful planning can reduce the amount of wasted hose and incorrectly purchased fittings and adaptors. It will also result in a tidier, more easily maintained system which will not let you down. The possible dire consequences of a fluid leak during any kind of race emphasises the need to plumb your car to a high standard. We also carry a range of products whose specification are less than that required for competition but are designed specifically for the vehicle enthusiast. These have a similar appearance to competition standard equipment and are excellent for general purpose use but are less expensive.

### **JIC/AN. (Joint Industry Council / Army-Navy)**

JIC/AN plumbing is the industry standard for automotive and aerospace use – all over the world. When properly assembled it will not leak, become loose, burst, collapse, wear through, corrode or wear out. It is heat and flame resistant, it will not chafe - it is specifically designed for the job. It is versatile and if treated with care, can be re-used. As most fittings are manufactured to a common standard, plumbing components rarely become obsolete. In summary: Steel, aluminium and stainless plumbing constitutes the best, safest and most economical way of doing the job properly. All JIC/AN fittings have a mating flare seat at 37° but are not interchangeable with some similar SAE fittings which have a flare seat at 45°. Most performance fittings employ the 37° flare seat but it is always advisable to check prior to assembly as these fittings will thread together but will not seat correctly, tightening the joint will damage the seat of both fittings and the joint will leak. Speedflow uses the "JIC" name to refer to the standard equipment but the term "AN" is interchangeable. The single most common cause of a leaking hose is the insufficient or over tightening of the hose end, if in doubt, call us and we'll guide you. Check the general recommendations for sealing any particular fitting and always fit a sealing washer or apply compound where specified. If unsure, you can usually order pre-assembled hoses to your specifications at little or no extra cost. JIC fittings do not require additional sealing compound or washers.

### **Threads, grips and seals**

Many ancillary and engine components employ female "National" Pipe Threads (NPT) - this is cheap and easy for the manufacturers but it means an appropriate adaptor is required to join them to the JIC system. NPT threads are generally tapered and rely only on the interference fitting of the thread to seal, they require PTFE tape to ensure a proper seal. This will also act as a lubricant to prevent galling of the tapered thread when tightening. Some adaptors employ a sealing washer to ensure seal integrity, these are usually on fittings with parallel threads not featuring a flare seat. Sealing washers come in different forms such as Dowty, Stat-O-Seal, and

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aluminium or copper crush washers. Check the general recommendations or ask the people at Speedflow about your applications. O-Rings are also used on fittings which are threaded together but the thread does not provide a leak-free seal, these incorporate a groove to accept the O-ring seal. "Hose Ends" are the parts used for sealing the cut ends of hose, they provide a threaded joint (JIC) but are also required to seal the end of the hose against leaks whilst gripping it so tightly that it will not blow off – your life may depend upon it. Speedflow manufacture only hose ends which feature the 'nut and cutter' style sealing joint. This creates multiple sealing points within the hose end to give the best possible seal and hose retention characteristics. See the assembly instructions in the Speedflow catalogue for details - it's free! When re-using the cutter-style of hose end, always remember to clean out the cutter area and to re-cut the hose to provide a clean section of hose to allow the fitting to seal correctly.

### **Swept and forged fittings**

The flow characteristics and pressure drop through a fitting or hose end can be critical. The relatively sharp bends incorporated in regular angled hose ends will likely cause cavitation (make bubbles) and impair the flow through it. This will prevent proper fluid flow and cause expensive lean conditions in fuel systems. The bent-tube type of hose end offers better flow than a forged type due to the smooth "swept" internal profile of the fitting. A forged fitting is heavier and has a much higher flow resistance because it is drilled internally forming an angular notched internal "corner".

### **High pressure hydraulics**

Conventional flexible hydraulic lines swell under pressure thus, in the case of a braking system, this uses up precious pedal travel and impairs braking efficiency. Fitting Teflon® hose with a braided reinforcing cover will mostly eliminate this swelling and improve braking performance. It will also improve the 'feel' of the brakes through the pedal and bolster driver confidence. Ensure that flexible hoses are not allowed to come under tension through the movement of any component (check suspension and steering movements) or through fouling other components. This may be avoided by planning hose runs carefully and employing the correct angle of hose end and/or adaptor. Angled hose ends or banjo fittings are more expensive but are usually preferable over running long looping hose runs. A banjo fitting offers roughly the same flow rate as a 90 degree forged hose end. Always allow sufficient clearance around a hose end as any braided hose will quickly chafe anything it rubs or vibrates against. This will not only damage the hose outer but also the panel or component with which it is in contact. Teflon® systems are suitable for brakes, power steering, turbo, clutch and general hydraulic lines.

### **Safety considerations**

When assembling a plumbing system always allow sufficient bend radius in the hose to avoid kinking, particularly when used on moving parts (steering etc). Check Speedflow's free catalogue for hose bend radius details. Never allow a component (brake caliper) to hang by its hose during maintenance as once a 'kink' appears in a hose it will be unsafe to use - it will subsequently fail. You may also damage the hose end, the adaptor or strip the thread in the caliper itself. Any damaged fitting should be replaced and a new olive should always be fitted when re-using those fittings designed for use with Teflon hose. When re-using or re-fitting any hose line, always ensure that it is kept perfectly clean whilst removed, both to avoid dirt and grit fouling the fitting seat and thread, also to avoid contaminating the fluid. Various types of plugs and bungs are available for this purpose.

### **Which hose? Which fittings?**

Get your planning right! Operating problems and unnecessary expense can best be avoided by choosing the most direct yet practicable routing of each particular run. See the chart below for

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typical hose type applications. The choice of fittings and adaptors should allow for bends and for the flexibility required in the runs themselves including passing through bulkheads and firewalls. Ease of future maintenance should always figure high in your designs and bear in mind the necessity to remove filters, covers, carburettors, gear ratios, brake pads, draining fuel and even changing gearboxes and engines. Good planning takes the pain out of tear-downs. For large diameter water hoses, braided hose is not recommended as it is not flexible enough in the large sizes generally required for top and bottom hoses. It is heavy, expensive and unnecessary. To give the impression of a braided hose it is usual to fit stainless steel over-braid to a manufacturers hose but be sure to use a new section of hose before covering it. Used in the appropriate application (owner/enthusiasts and show vehicles) over-braid is visually attractive and can be secured with coloured anodised aluminium cover clamps or hose finishers using hidden stainless steel worm drive clamps.

"Fittings" are generally divided into 3 main groups, Hose Ends, Adaptors and Special Purpose Fittings. Hose Ends are available in swivel format (so you can adjust the angle even after the joint has been tightened) - straight or angled configuration, also in a variety of JIC thread size options. This aids the chances of directly mating hoses to more components. Adaptors are mostly used to join (1) Hose ends to your equipment or vehicle. (2) Step up or down on hose size or type. (3) To enable hose runs to pass through obstructions (bulkheads etc.). Special Purpose Fittings mate fluid systems to in-line filters, fuel blocks, regulators, valves, remote filter heads, take-off and sandwich plates, making TEE joints and many other applications. Any hose line run should incorporate as few joints as possible to reduce the risk of leaks. An angled hose end provides a neater and more compact bend than a run of hose and is particularly useful where space is at a premium.

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### More tips

Swivel hose ends will relieve the problem of hose twisting, either as a result of the vehicle operation or merely during tightening of the hose ends or fittings. It is best to run lines together if possible but consider the relative temperature of fluids being carried, they should be of similar temperature. Cooling fluids should not be routed close to heat sources (exhausts, turbos, intercoolers etc.) For hoses run in areas of the car vulnerable to high temperature or to a risk of fire, fire retardant covering can be provided by fitting it to the hose. Care should also be taken not to run lines in vulnerable areas (under the chassis etc), it may look safe on a stationary car in the workshop but under racing conditions, loading or unloading from a trailer or on a chassis stand, line runs may prove to have suffered extensive (and expensive) damage. For long runs in chassis, or in applications where flexibility is not a requirement, hard lines in aluminium or copper tubing are a cheaper and lower maintenance option. Care should be taken to adequately support and protect hard line runs, they should be fitted early in the construction of a race car, either in or along chassis rails but they cannot subsequently be easily removed or replaced if damaged. Fittings are available to enable hard lines to be connected to flexible hoses either through direct connection or via a bulkhead fitting. Speedflow hard lines require a 37 degree flare to be made at each end of the tube which is supported and used as the mating surface by the sleeves and nuts used to support and make a leak-free connection. Care must be taken to flare the tube end correctly to accept the appropriate fitting. This service is available free from Speedflow for 37 degree systems at most sizes. Hard lines are available in aluminium, copper or stainless steel. Aluminium is generally the preferred option. Hard lines allow a tighter bend radius than flexible hose and are lighter, they can be prone to leaking at the joints if fitted in locations where body or chassis flexing is excessive. Speedflow carry a hard-line option which does not require to be flared. Both hard and flexible lines should be adequately supported and/or secured by line clamps. Ideally hose runs should, where practicable, be supported at about 450 mm intervals.

Although performance plumbing appears to be a complex and often confusing aspect of racecar engineering, if approached logically and with our help and advice, it is possible for you to produce your own fluid transfer systems to a very high standard without breaking the bank.

### **Selecting the right hose, sizes and fittings**

Below is a chart showing recommended applications for 100 and 400 series hoses and for the high-pressure 200 series. The flow rate required will determine the minimum size for your application.

#### **100 & 400 series hoses**

- 04 Small oil and fuel lines, pressure gauges and vacuum lines.
- 05 Small oil and fuel lines and vacuum lines.
- 06 Carburettor, fuel, oil feed and drain lines. Water overflow line.
- 08 Oil cooler, water, fuel and oil lines.
- 10 Oil cooler, water, fuel and heater hose lines.
- 12 Large oil cooler, dry sump, fuel and heater hose lines.
- 16 Water, dry sump, fuel, heater hose lines.
- 20 Fuel, oil, water and radiator lines.
- 24 Water and Radiator lines.
- 32 Water and Radiator lines.

#### **200 series hose**

- 03 Brake, clutch, power steering, fuel injection, Nitrous, hydraulic systems and gauges.
- 04 Brake, clutch, power steering, fuel injection, Nitrous and hydraulic systems.
- 06 Nitrous oxide injection, power steering.

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### **How to mate the SPEEDFLOW system to your block, equipment, etc.**

One of the most difficult problems to overcome is how to mate your new plumbing system to whatever it is you need to connect it to. Whatever hose and fitting sizes you choose to employ, you are inevitably going to need to hook it up to your vehicle. In an attempt to guide you for about 95% of all the different types used by various manufacturers in different countries, the list below gives you a guide as to the most common threads you will encounter..

#### **NATIONAL PIPE THREAD (NPT)**

Is found on nearly all American vehicles and after-market equipment. It is a taper thread and is therefore difficult to measure. NPT threads must be sealed using PTFE tape. Speedflow's 816 range of adaptors will connect NPT to the JIC system.

JIC or AN (they are the same).

Found on all the major after-market plumbing systems, recognised by the 37° "flare" seat. All JIC/AN fittings use a UNF thread although are measured in "dash" sizes.

#### **METRIC**

Metric threads are the preserve of European and Japanese vehicles and equipment.

#### **UNF**

Is universal although tends not to be found on European or Japanese vehicles.

## BSP

British Standard Pipe threads are used throughout UK manufactured plumbing equipment and associated accessories.

### **Measuring Metric or UNF threads.**

Its a simple case of measuring across the threads. Use millimetres for Metric threads, inches (fractions) for UNF threads. The measurements for UNF, BSP and NPT are quoted in inches but are not the same physical size, do not attempt to measure an NPT thread with a rule or vernier, call us for help.

### **Measuring BSP threads.**

This is also a case of measuring across the threads but the BSP quoted sizes are not the same as this measurement. An 1/8-BSP thread measures 0.39" across, a 1/4-BSP is 0.53" across, 3/8-BSP is 0.66", 1/2-BSP is 0.83", 5/8-BSP is 0.90" and 3/4-BSP is 1.04".

Measuring the internal dimensions of female threads cannot be undertaken with any accuracy.

### **How can you tell which thread you have?**

We don't expect you to know but it is very difficult for us to determine which thread you have without seeing it. We will advise all we can and, in so doing, we'll need to find answers to these questions.

- (1) Determine if "your" thread is male or female.
- (2) Decide the likely country of manufacture and thread type.
- (3) Determine the size of the thread.
- (4) Measure the threads-per-inch (for UNF) or thread pitch in millimetres (for metric).

The above is to help you narrow down the options but we don't expect our customers to know exactly what threads they have, this can always be found by investigation but it may require a little patience. Many of our customers send or bring in their parts or even the old plumbing system to us, this way we can design and build your new system - in the way you want it done - there and then.

If you wish to visit, no problem – but please phone first to arrange a date and time, most of our business is by phone or internet. Ring us on +44 (0)870 225 0097.