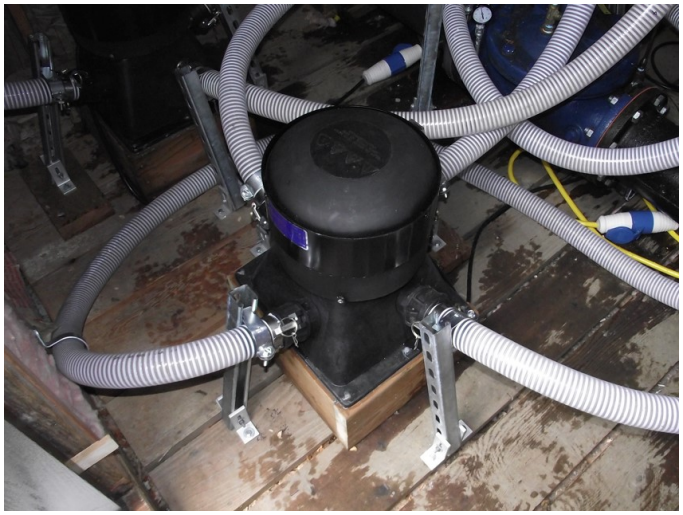
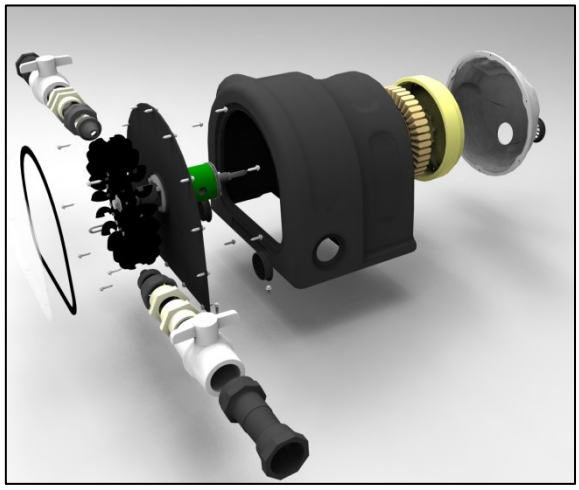
PowerSpout

WATER GOES IN | POWER COMES OUT

# Turbine manifold guide





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**Revisions history**

1.0 Edited by H.P. April 2018
1.1 Updated with more examples and thread sealing advice Sep 2019 by ML

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## Introduction

PowerSpout Turgo turbines (TRG) and Pelton turbines (PLT) require manifolds. The manifold is the system of pipes that connects your penstock to your turbine jets. (The **penstock** is what we call the main pipeline from the intake)

1-10+ hydro turbines are commonly connected to a single penstock. It is helpful if at the end of the penstock there is a large valve or blanking plate so the pipe can be flushed to purge sand/silt. Turbine manifold pipes can be branched off the main run before this end fitting.

Do not forget to fit your **pressure gauge** to the manifold. It is supplied with the turbine and it has a male 1/4" BSP thread.

Well installed TRG turbines (steel and flexible pipes)

Twin TRG turbines in the process of being installed (steel and flexible pipes)
(**note jet supports not yet fitted**)

5 x TRG turbines in the process of being installed (steel and flexible pipes)

3 x PLT turbines with a combination of PVC and 75mm flexible hoses

6 x PLT turbines with a combination of PE pipe and PCV manifolds

Some pictures (that are a work in progress) show a **common installation error**: **no pipe supports installed**. If support are not fitted the turbine casing will distort under the weight of the pipework. Please take care to read the instructions and support the flexible pipework so as to achieve the correct jet alignment, and maximise your power output.

This document covers different ways that turbines can be connected via manifolds in a cost effective manner. Parts for many of these options can be ordered at the same time as you order your PowerSpout turbine.

When selecting materials for the manifold you need to consider the operating pressure and flow rate per jet.

You can build the manifold from various types of pipework: Rigid PVC with solvent weld fittings, PE pipe with compression fittings and flexible hoses.

A common comment from dealers and clients is that flexible pipe manifolds need supports and are rather unsightly.

We tend to agree, but note they are:

- Cost effective
- Easy to align - with flexible hoses you can make fine adjustments to the nozzle by manipulating the hose itself during optimisation at set-up and then securing it in this position.
- Easy to remove
- Use fewer elbows, so have lower losses for a given ID.

## Recommended manifold pipe sizes (internal diameter or bore)

For flows up to 3l/s per jet, the pipe internal diameter should be 50mm or larger
For flows up to 5l/s per jet, the pipe internal diameter should be 65mm or larger

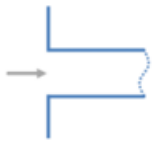
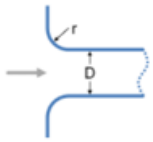
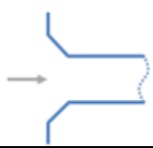
The table below shows the power loss in Watts per metre of pipe.
(Also consider that an elbow or Tee fitting equals roughly 2 more metres of pipe. Such losses tend to be negligible on a long, large bore penstock, but important on small-bore manifolds.)

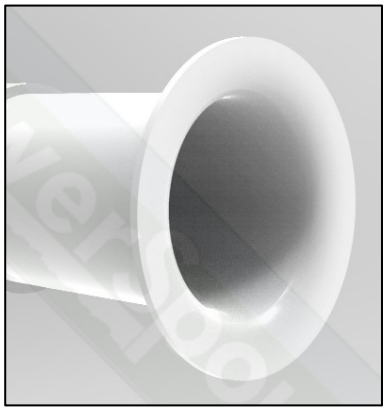
| Flow l/s | Pipe bore in mm 40 | 50 | 65 | 90 |
|---|---|---|---|---|
| 1 | 1.8 | 0.6 | 0.2 | 0.04 |
| 2 | 3.6 | 1.2 | 0.4 | 0.07 |
| 3 | 5.4 | 1.8 | 0.5 | 0.10 |
| 4 | 7.2 | 2.5 | 0.7 | 0.15 |
| 5 | 9.0 | 3.0 | 0.9 | 0.20 |

***Losses in Watts per metre of pipe***

Try to avoid small internal diameter fittings and sharp elbows.

When water enters a smaller bore pipe there is some loss that depends critically on the shape of the entrance. It helps to put a radius on the edge of the mouth as illustrated in the loss coefficients (K-value table) below. A higher K-value means more lost power.

| Type | Shape | r/D | K-value |
|---|---|---|---|
| Flush/Square-Edged |  | 0 | K = 0.5 |
| Rounded |   | 0.02 | K = 0.28 |
| | | 0.04 | K = 0.24 |
| | | 0.06 | K = 0.15 |
| | | 0.10 | K = 0.09 |
| | | 0.15+ | K = 0.04 |
| Inward Projecting/Re-entrant |  | - | K = 0.78 |
| Chamfered |  | - | K = 0.25 |



It is for this reason that our Coanda intakes have a large bell mouthed intake to significantly reduce friction intake loss (picture opposite).

## Connecting your pipe to the PowerSpout

The PLT and the TRG both have 2" male BSP threads on their jet-holders. Connect the manifold pipes to these.

In the case of the PLT you will be supplied with valves that have "parallel" threads cut, (one end) so as to tighten against an O-ring on the turbine casing.

In the case of the TRG you will have female BSP threaded camlock fittings supplied with the turbine, to screw onto the jet holder.

Where camlocks and hoses are used (whether on the TRG or on the PLT) we recommend mounting the valves at the penstock end of the hose.

The ball valves supplied have either

- 2" female BSP taper threads on both ends (one of which may have been cut parallel for the PLT)
- or (for the USA and other countries that use NPT threads) a 2" BSP thread on the jet side and 2" NPT thread on the other side. Customers in the USA can buy NPT threaded fittings locally.

For more details of pipe threads in relation to the PowerSpout please see **PS all PLT and TRG thread sizes** in the document index.

## Quick connections

The ability to quickly remove the turbine from the pipework is important so that turbines can be easily serviced.
There are 2 common ways that a quick connection can be made:

- Plastic Camlocks 50mm (2")
  Camlocks with flexible pipes (hoses) are more suited to lower head sites of 60m and less.

- PVC mac-unions (for rigid pipes)
  PVC mac-unions are rated for heads up to 160m.

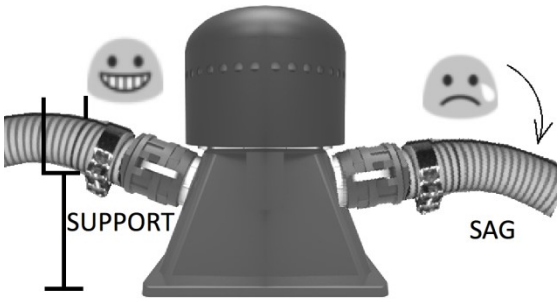
## Camlock fittings (supplied with the TRG turbine) and hoses

With each TRG turbine (apart from twin pack deals) comes with four valves and four sets of camlock fittings and pipe clamps. You can use these fittings with some 50mm flexible hose to easily connect the turbine in the sequence shown below.


The 2" hose is ideal for flow up to 3 l/s per jet. For higher flows you may still wish to use them (as they are so convenient) but bear in mind that the output watts may be a little less than predicted by the online calculator, due to losses in the hoses and fittings.

**Note - not all 2" hose is the same. You need <u>suction hose</u>, that has a steel (or hard plastic) spiral braid within the hose material to prevent kinks**

Flexible pipework needs to be **supported** to take the weight off the turbine casing. We supply suitable brackets with the turbine. These may need to be adjusted during commissioning tests, to optimise the jet alignment (maximise rpm).




If you stress camlocks by having very tight bends in your flexible pipes, then you can get a leak on the camlock rubber seal, so please do a good job, support the pipe well and ensure that there is no stress in the pipe where the camlock fittings lock together.

These camlock sets can also be ordered as extras with the PLT turbine. They are rated for up to 6 bar and include 1 male and 1 female thread and the hose clamps but you will need to buy the hose locally.

## Incorrect flexible hose used

The hose used in this picture failed as it was rated for 0.7bar (7m). It needed to be at least 3 bar (30m) rated. The supplier told the client it was rated for 7 bar but the decimal point was missing and the real rating was 0.7 bar. This error is easy to spot as soft PVC used for TRG turbines needs to have a wall thickness no less than 3mm. The wall on this pipe was only 1mm thick.

## The connections made to the penstock

You will need up to 2 penstock connections for every PLT turbine, and up to 4 for every TRG turbine.
Connection to the penstock can be made in the following ways:

- Bolt over saddles and flexible hoses (for lower head sites)
- Pipe fittings - T's and Y's
- Our PVC 4 jet manifold – for PVC pipes and the TRG turbine
- Our PVC 2 jet manifold – for PVC pipes and the PLT turbine

## Bolt over saddles

These are available to order with your turbine for pipes with outside diameters of:

- 160 mm
- 110 mm
- 90 mm

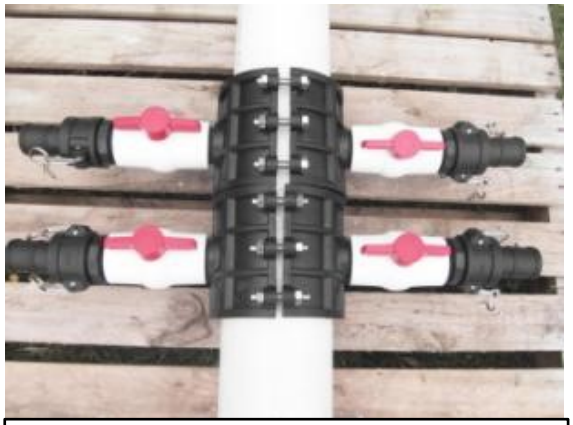
You can install as many as are needed. They are double sided so provide 2 x 50mm BSP male threads per saddle set. Pictures below show how you install them on your pipes.

These saddles can also be used for attaching the pressure gauge (with reducing bushes between) or for making a large pipe vent just after the intake.

Once the saddles are fitted, use the valves and camlocks (often supplied with your TRG turbine) as shown. **Note that the valves are fitted to the saddle and not to the turbines**. This ensures that the turbines can be easily removed for servicing, leaving the off valves in place.

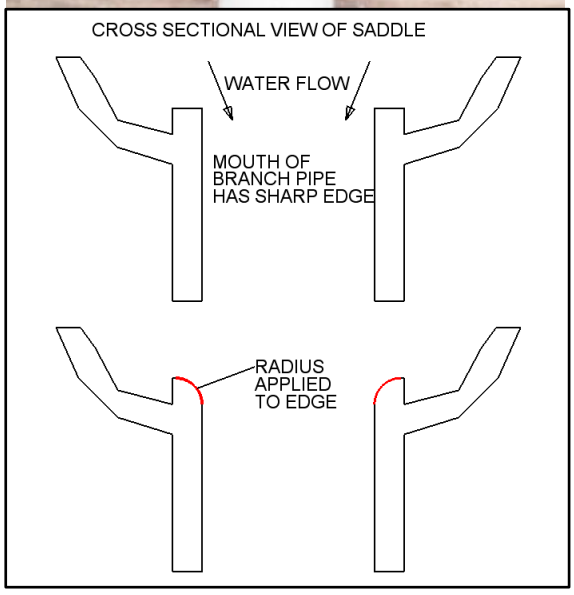
Saddles have the following advantages:

- Low cost
- Less freight bulk and light in weight
- Easy to fit, no special tools needed



Saddles have the following disadvantage:

- Sharp take-off so higher fitting losses, meaning they are not suited to low head, high flow sites




We recommend you minimise the entry loss on these saddles by rounding off the edges of the mouth where the flow enters the branch so as to reduce turbulence.

Saddles connected to turbines via camlocks and flexible pipes suit heads between 3m and 60m, and flows up to 3 l/s per turbine jet with 50mm ID pipework.

Most PLT turbines can be connected in this manner. For TRG applications the next option should also be considered.

## Pipe fittings - Y's

PVC "Y" fittings suit higher flow TRG sites that commonly use 160 or 200mm OD PVC pipes.
PowerSpout can supply this optional PVC manifold kit as shown below. The end user has to glue it together. It suits sites in the head range 5-20m and flows up to 4 l/s per jet with 50mm ID pipework. For sites in the 2-5m range, 3" camlocks and flexible pipe connections should be considered. Manifold losses are more critical as there is little head to start with, and such losses can result in reduced performance.

The TRG PVC manifold kit comprises:

- 1 x 200-160mm PVC reducer
- 2 x 160mm joiner pipes (120mm long)
- 2 x 160mm to 110mm double "Y" fittings
- 1 x 160mm screw end plug
- 4 x 110x75mm reducers
- 4 x 75x65mm reducers
- 4 x 65mm joiner pipes (100mm long)
- 4 x 65mm to 2" BSP male fittings
- 4 x 2" BSP ball valves – often supplied with your turbine
- 4 x 2" BSP male camlocks and hose-tail fittings

When all glued together it looks like the picture on the right.

Your TRG turbine can be positioned as shown and then hooked up with flexible pipes. Unless you buy the discounted TRG twin pack, camlocks fittings and valves are supplied with the turbines. All you need to buy is 10m of 50mm ID (2") flexible hose.

It is also feasible to weld a manifold based on a steel chamber or gas bottle. See this case study for example.

## Water leaks on large pipe threads

Most clients installing their own turbines may have never had to seal large pipe threads before. Large injection molded PVC and PE fittings may have a sloppy fit that can be near impossible to 100% seal with the common techniques used for smaller threaded pipes.

The reason for these poor fits is often shrinkage tolerances, different makes and a mismatch of tapered and parallel sided threads. These can be a difficult to seal on larger threads (typically > 2.5" or 65mm).

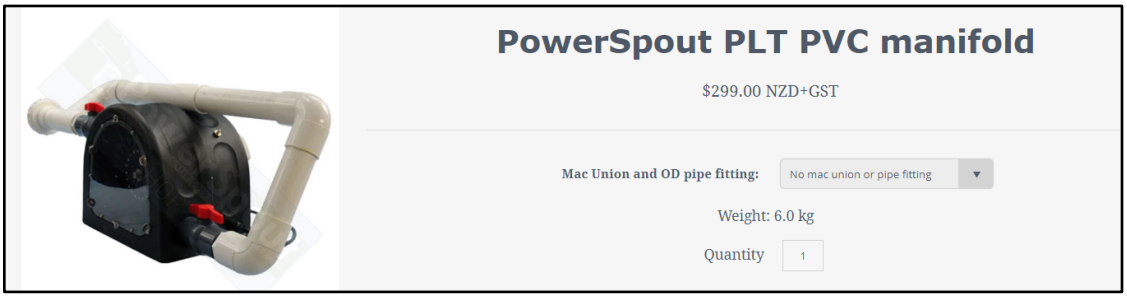
If a large threaded fitting continues to leak (after up to 10-20 turns of PFTE tape has been tried) and the join never needs to be taken apart then we advise the following solution:

- Loctite 55 thread glue (metal on plastic)
- Foaming gorilla grip expanding polyurethane glue (plastic/metal on plastic)
- Thick PVC pressure pipe cement (PVC on PVC)

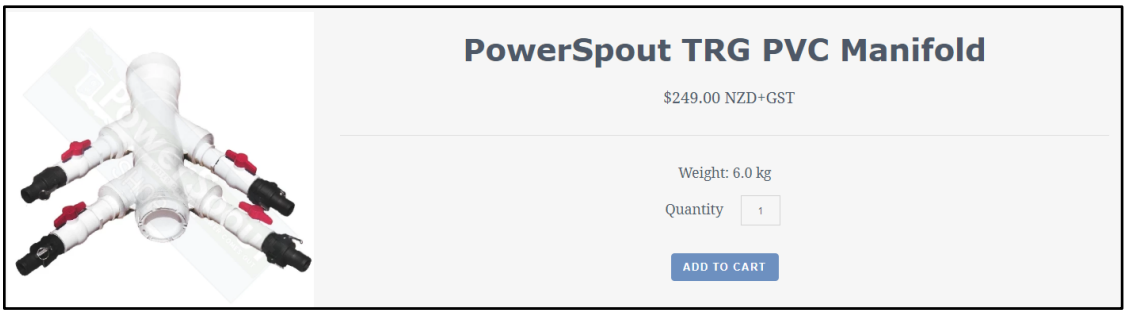
Small drips, will often seal themselves if left alone for 1-2 weeks and are not a big concern.

## PVC manifolds for our PLT turbines

PowerSpout can supply PVC manifolds for our PLT turbines. Options include a range of fittings to suit different penstock diameters.






The installer will need to make a few glued connections, as it is a semi-assembled kit. These manifolds can be ordered with a PLT/TRG turbine as they can share the same carton. Please note this weighs 6kg, which will have an impact on the overall carton weight. Weight must never exceed 29kg.

Ensure that the fittings are clean, glue both surfaces with a liberal amount of PVC cement, work very quickly, use the correct glue and push fully home with a high force. DIY'ers are advised to practice first on off-cuts and spare fittings.

The picture below shows two turbines connected via PVC manifolds to a mac-union and then to the black plastic MDPE pipe.

The penstock was separated into 2 lines prior to feeding each manifold by using a T and 90-degree elbows.


PVC manifolds with MAC unions


HDPE pipe fittings

## Pipe fittings - T's and 90 degree elbows

For many sites, MDPE or HDPE pipe fittings can be used to build a manifold.
You are likely to need

- T's
- 90 degree elbows
- Joiners
- Thread adaptors (male for valves, female for gauge)
- Reducing bushes (for the pressure gauge)

PE pipe and fitting manifolds

It's also worth considering hoses (as used with the TRG) as an option for the PLT on sites with low pressure and low flow. We offer camlock kits and pipe saddles that can be purchased along with your PLT turbine so as to make it easy to construct a manifold with flexible hoses. In such cases we recommend moving the valves from the turbine to the pipe saddles.

If you are installing just 1-2 PLT turbines then it is likely you are using 63-110 mm OD MDPE pipe. Offcuts of this pipe with some fittings can be used to make a low cost splitter manifold combined with a factory made PVC manifold as shown.

All the tight bends in the manifold above do not result in significant losses since the penstock pipe is 80mm ID; this splits into 2 x 80mm ID pipes, then this is split again into 2 x 65mm ID PVC pipes. This means that the water velocity in the PVC pipes is 1/3 of that in the penstock, so losses will be very low.

## Mock up your manifold off-site first

You will save a lot of time if you mock up your manifold and exhaust water collection off site where it is easier to work. This picture shows multiple PLT turbines trial fitted off site prior to moving all the parts into difficult terrain. Note the mac unions so that the turbines can be easily removed.

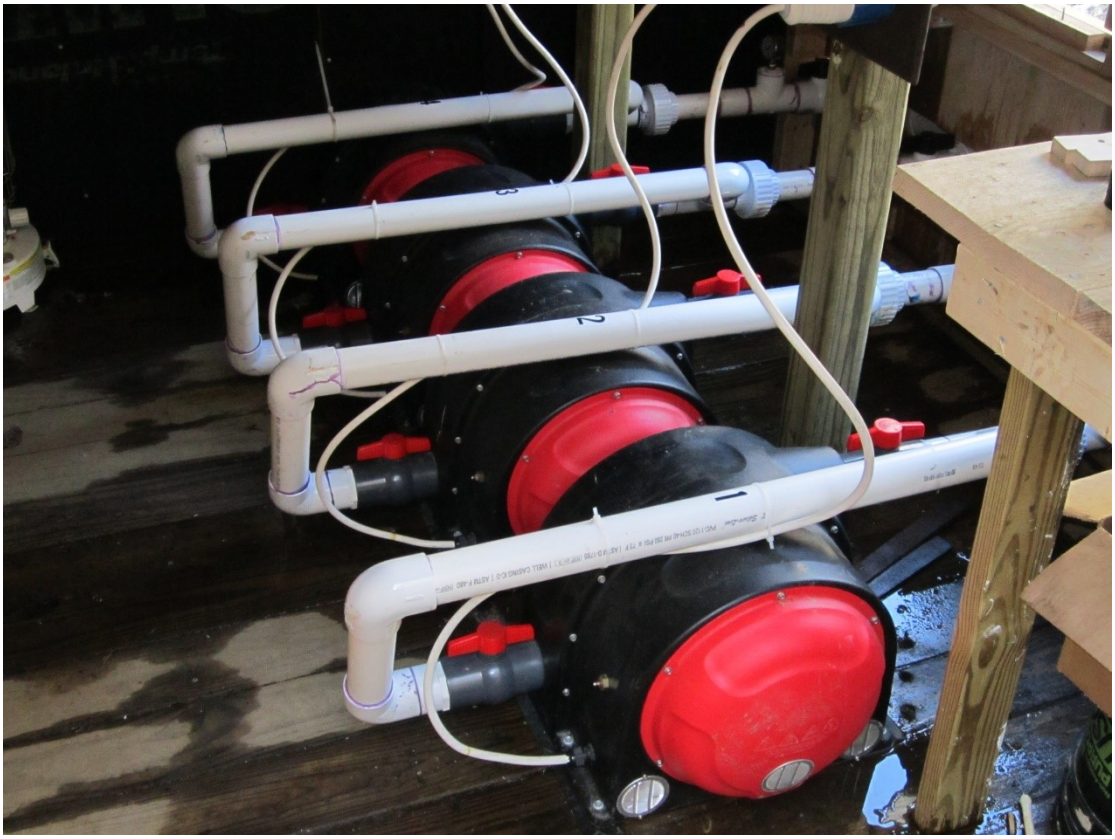
## Examples of PLT manifold options

There are many possible manifold solutions; there are some good pictures below to give you ideas for your situation.






Some manifolds are constructed using larger radius bends or "swept bends" that have lower losses than the tighter "elbows". The difference is not noticeable for low flow sites but in high flow cases there may be a useful gain in output Watts.



## Measuring pressure in your pipe and manifold

Pressure losses in your penstock and manifold are typically in the range 5-33%, with a 10% loss typical (used as the default in the online calculator). It is very helpful if you can measure both the static and dynamic pressure at the end on the penstock and just prior to the turbine jets. From these readings you are then able to determine the losses in the penstock and the losses in the manifold. All PowerSpout turbines (other than discounted twin packs) include a pressure gauge.

The pressure tapping kit (optional extra) allows you to insert a quick release pressure fitting at points of interest. You will need to drill and tap the pipes to use these fittings. When a reading is not being taken they can be plugged with a length 6mm plug supplied.

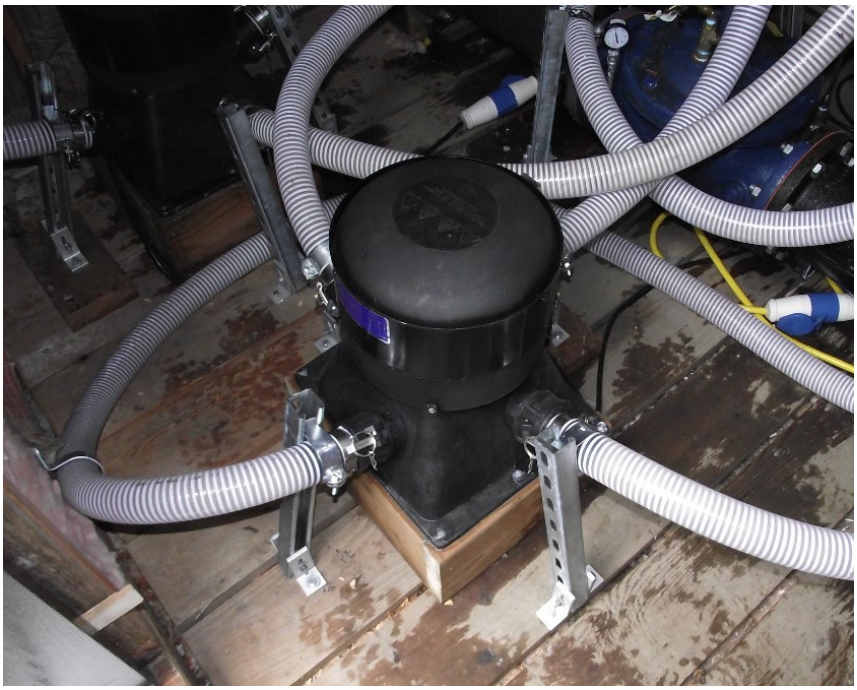
If turbine performance is less than estimated in the Advanced Calculation tool, check that you have not installed an undersized manifold by measuring the pressure loss across the manifold.

Sharp elbows create as much head loss as a 1-2m of pipe length. If your penstock is 1000m long a few fittings are of little consequence, but if you are on a short small diameter penstock at a low head then this can result in significant power loss, multiple elbows are to be avoided in small bore manifolds.

## Pipe supports

Make sure the pipe is secured firmly just prior to the turbine (note metal supports in pictures). A large pipe full of water can be very heavy and needs support. You can support the pipe by installing a wooden/steel post either side of the pipe with a horizontal member above and below the pipe to secure it. Bear in mind when securing moveable pipes that you may wish to manipulate the pipe itself during optimisation at set-up so as to find the best jet position/angle.

This photo shows below well supported pipes on a TRG. These TRG turbines are supplied with pipe supports.



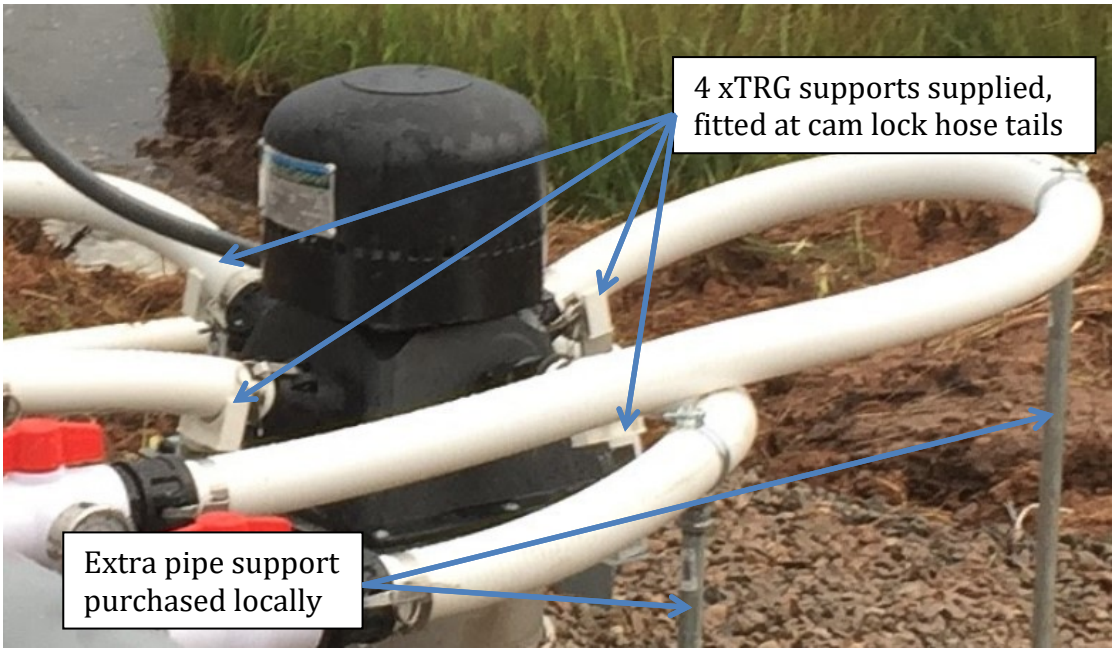
It is important to support the pipes when first installing them, but clients often forget in their eagerness to turn it on. The correct jet alignment is not easy to find once the casing has been distorted.

Staff in our factory use a jig to obtain perfect jet alignment. This is done by heat setting the case material around each jet holder. The jig is a 1mm wire that is held centrally in the jet holder but can be moved in and out. Jet positions are heat set until all jets align perfectly. This is how our turbines are supplied.

Problems frequently arise when the pipework is not supported prior to filling with water, as the extra weight can distort the set that we put in the casing. Small distortions may spring back. Armed with a heat gun larger distortions can also be fixed. Otherwise some force may be needed to achieve the optimum jet angle and maximum performance.

## Example of excellent pipe supported TRG turbine




## Examples of poorly installed TRG turbines

Despite all TRG turbines (other than TRG twin packs) being supplied with adjustable pipe supports (as shown in the picture above), we often see these supports missing or incorrectly placed. The installations that follow illustrate poor TRG installations as they illustrate:

- no pipe supports
- some have kinked pipes
- some have incorrect pipe material

Incorrect pipe material and no pipe supports

No pipe supports

No pipe supports


No pipe supports and kinked pipe


No pipe supports and kinked pipe

The image (above left) was emailed to us from a client who had had their turbine professionally installed some years ago. Power had dropped from 300W to 100W over a period of several years and nobody could figure out why. The left hand picture is telling, the jets have sagged due to the weight of the flexible pipes. The jets supports supplied had not been fitted and had become lost.

After us pointing out the error, the client then attached straps as shown on the right and full output was quickly restored. When faced with this problem, neither the installer nor the client took the time to read the installation manual. If they had (at the start of the project) this whole issue could have been avoided.

We have in recent years edited our PLT/Cube/TRG installation manuals to alert readers sooner and more often to the need to put in pipe supports. But this will not help you if you fail to read the documentation relevant to your product prior to installation. When we are emailed pictures like this our replies tend not to be rather blunt.