

# DIR Stage Rigging in Detail

**Warning: this site is still partially under construction.**

## Introduction

I wanted to call this page "DIR Stage Rigging for Dummies," because it is very detailed. But I was afraid IDG books would chase me down for some kind of trademark or copyright infringement, even though I'm not going to make any money off this. Anyway, since I received my cave training from [GUE](#), a number of people have asked me to show them how to rig their stage bottles correctly. Although there are many great pictures to be found on the 'net showing what the finished product looks like, I have been unable to find any detailed instructions on how to rig your stage bottle. Thus came the impetus to create this instructional page.

First, a few notes. The improperly marked white Heiser bottles shown in most of these pictures *do not belong to me*. They belong to Larry Cohen, to whom I have given links to [DIR bottle marking instructions](#) as well as [The Baker's Dozen](#). Nonetheless, I owe Larry a debt of gratitude for helping -- and allowing -- me take the pictures. (It's his hands you'll see in most of the pictures with the white bottle.) The much-abused yellow aluminum 40 is one of my oxygen bottles. It was the first stage bottle I ever got, and it was rigged all kinds of wrong ways until Ted set me straight.

In case you're curious, I took the pictures with an Olympus D450 Zoom camera, and then used Microsoft Image Composer (which comes with FrontPage) to crop and rescale the images. As you can see, I am no great artist, but these pictures should clarify a lot for you.

I am not discussing bottle marking, as there are already plenty of good references on that.

You may notice that the end result looks a little different than [Todd Leonard's](#), [Jeff Bentley's](#) and even [GUE's](#). The method I'm showing here is as shown to me by Ted Cole in October '99 (who, in March '99, co-taught my Cave 1 class with JJ). (Note that some of the details are slightly different than what Ted showed me.) I am sure that the above stages work about the same as what I'm showing here, but it's just not how I do mine. Nor am I sure of the details of how the bottom knot is constructed on those.

## Preparation

Here are the materials you will need to have on hand to rig your stages.

- A stage bottle (duh!)
- A minimum of 50" of 1/4" NYLON rope
- At least 2 feet of cave line (the end of your safety spool will do -- you don't have to cut the line off)
- A wire hanger
- 8-10" of 5/8" heating hose (as would be used in an engine -- usually available in a marine supply store). If you are unable to get this, 3/8" fuel hose will do, but step 3 will be hard to complete if you don't get thinner rope. Clear tubing is good too (and has the added benefit of letting you monitor the condition of the rope underneath).
- A hose clamp of appropriate size for the stage bottle to be rigged
- Electrical tape **or** webbing to slide the hose clamp through or motorcycle or truck tire inner tube
- Two stainless steel bolt snaps of appropriate size. These should be smallish, if you're diving

without gloves; if you're diving with gloves, select the smallest size that you can operate with ease while wearing your gloves.

- (Optional) lipstick or eyebrow pencil (you knew you needed that non-diving girlfriend for something!)
- Screwdriver of appropriate size for use on the hose clamp
- Lighter
- Scissors
- Motorcycle or truck tire inner tube (depending on the circumference of the bottle), or heavy-duty surgical tubing for securing the stage regulator hose

Before you start, you may need to stretch the rope. Ideally, the rope you get will not be stretchy, so you won't need to do this step, but sometimes it's hard to tell beforehand. The easiest thing to do is to wet the rope, loop it over your shower rod, tie a 5-10 lb. weight to the bottom and let it hang there for a week or so. If you fail to do this (or if the rope stretches after you've used the bottle), you'll need to adjust everything. It's by no means the end of the world, but pre-stretching the rope will save you a small headache. It's kind of like buying pre-shrunk jeans...

## Rigging the Bottle

### Step 1 - Mark the bottle

First you should look up bottle marking instructions and mark the bottle appropriately. This is especially important if you will be using Oxygen in the bottle, as the hose clamp will get in the way of writing the word "oxygen."

### Step 2 - Cut rope



Measure rope a little more than twice the length of the bottle, including the valve. Having extra rope makes it easier to tie the final knot, so be liberal.

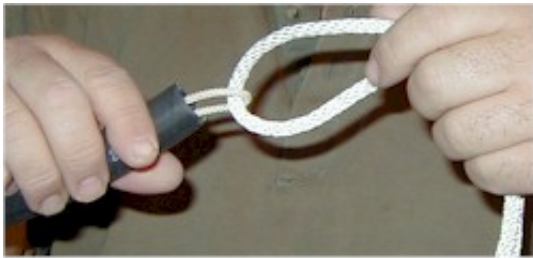
### Step 3 - Thread the rope through the hose



In case you didn't know, the purpose of the heating or fuel hose is to make a handle you can use to easily pick the bottle up under water. This is **not** a handle for carrying the bottle on land -- doing so will stretch and loosen the line and you will then need to fix it. You will find that those who are not "in the know" will be inexorably drawn to this handle and will pick up your stage bottle by it at every possible opportunity. This is especially true of people who would not normally handle your equipment for any reason (like the girlfriend

whose lipstick pencil you're going to borrow later).

First, double up the cave line and stick the end through the heating or fuel hose, and push it all the way through, so a loop is sticking out. If you have difficulty pushing the cave line through the hose (this is often the case, as the hose is usually not straight), tape it to a wire hanger and use the hanger to push it through. Now, stick the rope through the loop in the end of the hose. Pull on the other end of the cave line to thread the rope through the hose.



Note that if you had difficulty pulling the rope through the hose (this would be the case if you were trying to thread 1/4" rope through a 3/8" fuel hose -- ask me how I know!), you should try to leave the correct amount sticking out the end (i.e., no more and no less) than you need for installing the top clip, so you might want to read step 4 before pulling too much through.

**Voila!**



#### Step 4 - Install the top clip



Where the top clip will be positioned depends partially on what size clips you're using. If you're using giant clips (as in these pictures), the clip will need to be higher up on the neck of the bottle than if you're using small clips. What you need to keep in mind is:

1. You should be able to install and remove the strap without untying the knot, as shown in the illustration to the left. In general, if you pull the loop across the handle **first**, you won't need to leave as much extra room.
2. The bottle should ride very closely to your body at the top.
3. But, there needs to be enough

play that you can clip and unclip the bottle easily while swimming. Even if you're wreck diving (and therefore carrying your stages with you at all times), there will probably be occasions when you'll want to remove the bottle in the water.

**Make a loop knot around the top clip.** Here's how you do it.

First, thread the looped end of the rope through the clip.

Cross the free end over the end by the hose.

Tuck it under, and through, on the hose side of the clip

Pull it snug, but do not tighten all the way.



Put the loop over the top of the bottle. With a large clip like this, the knot should usually be as tight as you can make it while you can still get it on and off over the valve handle. With a smaller clip, the bottom of the knot should usually line up with the bottom of the top row of numbers stamped on the bottle.



Tighten the knot while moving it up or down as required, then double-check that it is in the correct place.

If you're not sure if you got it right, put on your harness and, while holding the bottle under your arm, clip it to you and see how it feels.

### Step 5 - Install the Hose Clamp

**The hose clamp should be isolated from the bottle.** There are a number of good ways to do this:

- Put a piece of truck or motorcycle inner tube around the bottle where the hose clamp will go. This is the quickest, easiest, and most frequently seen method, but the rubber degrades after a while and must be replaced. I'm not showing this method here, as you can see it on most stage bottle pictures on the 'net.
- Slide the hose clamp through a piece of webbing. This is a very neat, quick and easy method. And as an added benefit, a bit of colored webbing will make your gear look really slick and distinctive :) The problem is that it's difficult to get the nut through the webbing, so you might end up with a bit of the hose clamp in contact with the bottle. Obviously this is not a tragedy of earth-shattering proportions.
- Put electrical tape around the bottle where the hose clamp will go. I think I invented this one (patting self on back), as I've never seen anyone else do it. I was installing a hose clamp on a stage late at night on the boat, and realized that I didn't have any inner tube with me. And there was no way I was going to find any at that hour. Since then, electrical tape has become my preferred method, because it's very tidy. It sticks well yet, is easily removed from the bottle, and doesn't leave any sticky residue.



Here is what the hose clamp looks like, from the front of the bottle, in a tube of webbing. Pretty slick, eh?

If you want to use electrical tape, the first step is to put the hose clamp loosely on the bottle in the correct



place. This will generally be immediately below where the fuel hose ends (make sure the fuel hose is pushed all the way up to the top knot). Next, use your (or your wife's / girlfriend's) lipstick pencil to draw a line where the top or bottom of the hose clamp is. If you look closely at the picture, you can see the red line just below the label on the bottle. This is kind of important, since electrical tape is sort of wiggly by nature, so it's hard to make a straight line without a guide. (If you don't make the line straight, you might end up having to install a double width of electrical tape in order to isolate the hose clamp from the bottle all the way around.) Lipstick pencil is nice to use because it rubs off easily. If you use a sharpie, everyone will see your mistakes.

Another advantage of this method is that if you take the hose clamp off, you know exactly where to put it when you re-install it.



**Before tightening the hose clamp, make sure the rope is properly positioned.** The rope should run down the front of the bottle, directly below the valve opening.

After you have positioned the rope correctly, pull it taut before tightening the hose clamp all the way. There should be no slack at all between the top of the rope and the hose clamp. This is crucial for the bottle to ride correctly in the water.

Regardless of the material you choose to isolate the hose clamp from the bottle, **the nut should face the back of the bottle**, where it won't cut your suit. It's a good idea to cover it with something -- such as electrical tape :) -- to help protect your suit, and prevent it from catching on things.



Tire inner tube will also cover the nut, but you'll find that the nut puts a hole in the inner tube after only a few dives.

Some people prefer to have the nut face to one side or the other. In my opinion, it's best to have the nut face to the left (if you're looking at the valve face) -- if you face it to the right, it will rub against your suit. (This is of course assuming that you wear all your bottles on the left at all times. If you're not wearing the bottles on the left, the position of the nut is the least of your concerns at this point, and you should go immediately to techdiver to have the problem explained to you.)

In this picture, you can see that we didn't cut the webbing long enough. To measure the webbing, you should wrap it around the bottle.



After you have affixed the electrical tape, install the hose clamp over it. Look at it from all sides to insure that it's not in direct contact with the bottle. Then put electrical tape over the hose clamp. As you can see, you'll need to run it over the nut twice to cover it completely.

You might want to wait until you've completed step 6 (installation of the bottom clip) before putting electrical tape over the hose clamp, as you may find that you need to move the hose clamp up or down a bit.

I could have done a neater job. It looks a little better from the front.



## Step 6 - Install the bottom clip

This is by far the hardest step. In short, what you have to do is tie the clip on using a fisherman's knot. It is a little bit difficult to describe how to do this (and one of the reasons why I felt there was a need for this guide), so I took a lot of pictures.

Before I discuss how to make the knot, I'd like to talk about how far below the hose clamp the clip should hang when you're done. Current DIR thinking says that the bottom of the bottle(s) should ride fairly close to your body. In the past, it was thought that the bottom of the bottle could hang as far away from you as you wanted, however this is not as streamlined as if it is close. Bottles that are (even slightly) positively buoyant when empty will climb up into your armpit as you breathe them down, and an aluminum 80 will hit your tanks, making a bonging noise that your dive buddy will find quite annoying after an hour's deco.

If you are using giant clips, the top of the clip should be right up against the hose clamp.

If you are using smaller clips, you should allow a bit of slack (an inch or so) between the hose clamp and the top of the clip, or it may be difficult to take off and replace the bottle in the water.

If you generally dive with multiple stages, you should allow a couple of inches of slack between the bottom of the hose clamp and the top of the clip. Otherwise, all the bottles after the first one are a bit difficult to put on. This is the most flexible arrangement, because you can take up the slack by pushing the clip through behind the fuel hose, just above the hose clamp, so I prefer to rig all my stages this way.

You may want to rig just one bottle to start out with and dive it a couple of times to see what works best.



Take one of the pieces of line below the hose clamp and thread it through the bolt snap. For the sake of brevity, we'll refer to this as "piece 1" and the piece that you didn't thread through the bolt snap as "piece 2" from now on.

Leave somewhere between two and five inches between the bolt snap and the hose clamp so you have plenty of room to work with. Once you're done making the knot, you'll see that you can adjust this loop pretty easily before tightening the knot.

Take piece 1 and fold it up, between itself and piece 2.





(Now, aren't you glad there's a picture of that?)



Cross piece 2 over the top of both parts of piece 1.



Cross piece 2 under both parts of piece 1 and itself.



Fold piece 2 across itself and then DOWN through itself.

If you look closely at the picture on the left, you can see the end poking out on the side of piece 1.

Carefully pull piece 2 until the knot is snug. If you did it right, it should look like this. Piece 2 is sticking out the bottom, and piece 1 is sticking out the top.



The second half of the knot is exactly like the first, but reversed.

Cross piece 1 over the top of the two parts.

(Not that it matters, but one of them is part of piece 1 and the other is part of piece 2.)

Cross piece 1 under the parts and itself.

Push it UP and through itself and pull it snug.

This is how it should look now.  
Notice that the knot is very sloppy



and the top part and bottom part don't seem to fit together too well. That's normal. What you need to do now is gently push the two parts side to side until they match up.

If you did it right, the resulting knot should almost look as though one piece of rope (composed of the ends of piece 1 and piece 2) is threaded diagonally through the knot.

If necessary, loosen both pieces a bit and adjust the size of the loop until it's the way you want it.

Then push the knot up as close to the hose clamp as you can get it. Adjust it again, so it looks like the picture at the left, push it up some more, readjust it again, etc. until it's as snug to the hose clamp as possible and neat.

To tighten the knot, pull down on the bolt snap. One of the nice things about this type of knot is that pulling on it should make it tighter, yet it is not too hard to untie, so you can adjust it later if need be.

Now, cut the ends off and burn them. If this is your first time rigging a stage in this manner, I suggest that you leave a couple of inches extra until you've had a chance to try it out. That gives you room to adjust it if need be.

You will find that you'll want the section between the top clip and the hose clamp to be about the same length regardless of the size of the stage (at least I've found that to be true for 30's, 40's and 80's), so once you've got one bottle set up correctly, you can model all your others after it.

### Step 7 - Regulator hose storage

Finally, slide one or two wide sections of inner tube over the bottle and over the hose clamp. This is used to secure the regulator hose while you're not breathing from it. To deploy the regulator, simply grab the hose by the second stage and pull. If your inner tube is the right size, the regulator should come free without the inner tube falling off.

I find it a bit difficult to store the hose in the inner tube again when diving with heavy gloves. What I've done is to use slightly thinner slices of inner tube (about 1" wide) that are too big for the bottle. I take up the extra slack by making a knot in the inner tube. This gives me something to pull on to make room to shove the hose through. Other people seem to feel that thick bungee or thick surgical tubing works well and gives you a good knot to grab on to.

## Step 8 - Regulator configuration

Your regulator should be on the end of a 40" hose. This gives you plenty of room to cross it behind your neck and breathe it from the right side. The gauge, which should be marked in 100 PSI increments, should be on a 6" hose. Bend the hose and use cave line or bicycle innertube pieces to secure it to the 1st stage, so it's always in position for immediate hands-free reading. TUSA makes a really nice tiny gauge. I recommend you refer to [Todd Leonard's](#) and [GUE's](#) pictures of how to rig the regulator. Note that the GUE picture is a little old, as the rope is running down the back of the bottle, but the regulator works the same way. If you would like more detailed instructions on rigging the regulator, please let me know and I'll add them to these pages.

## Conclusion, about me and Links

I hope you found this guide helpful. If you have any comments (positive or negative), suggestions, or questions, please write to me at *mmowens at panix dot com*.

*Although I am an avid (if relatively new) cave diver, my main diving activity is wreck diving in the great stroke pit :) known as "the Northeast" or "Wreck Valley." I am a crew member on the [Wahoo](#). I live in New York City, and do Windows database programming in [Borland's Delphi](#) for a living.*

*Here are some links you may find interesting:*

*My [compendium of links](#) - links on subjects including diving, Delphi programming, Web development (focused on Unix, Apache, Perl and FrontPage), Hoaxes and Urban legends, Windows tips, and miscellaneous interesting and / or entertaining stuff. (Don't worry, it's all neatly categorized.)*

*[Wahoo](#) web page - so I know what tables to cut for the weekend. And I always bring along San Diego tables, just in case.*

*[NDBC Station 44025](#) (weather buoy) - so I know how much bonnie I'll need to take for the weekend.*

*[Village Divers](#) - the place where Tony Thomas, my boyfriend and frequent dive buddy works. I am now maintaining their web pages, but the overall design was done by someone else a couple of years ago.*

*[Panix](#) - New York City's oldest commercial internet service provider. Panix is the DIR ISP and host. My site, the village divers site, and several other sites I maintain are hosted by Panix.*

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