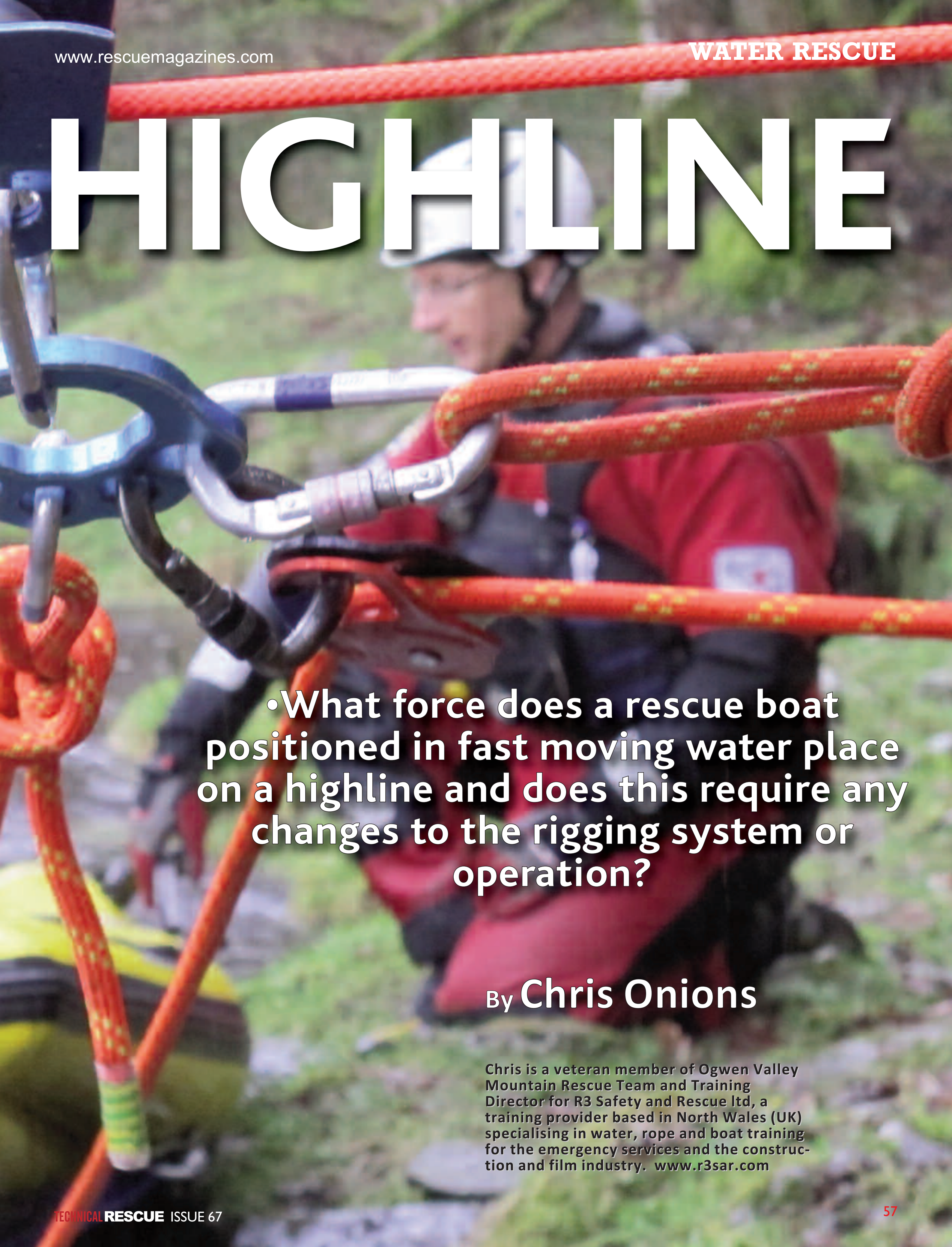
BOAT on a

Many readers will have attended a swiftwater rescue class and will recall that rescue tactics are often presented as a hierarchy of risk - talk, reach, throw, row, go/tow, helo(copter). The boat on a highline tactic fits somewhere between a go/tow and a helo option as it requires a boat to be located in fast water by a rope system and the diagrams overleaf illustrate just one way that this can be achieved. It is a very useful tactic when fine positioning in fast water is required, for example near to the boil line of a hydraulic or on the upstream or to access the occupants a car stranded in flood waters. However, many rescuers consider this to be a high risk option, or just too difficult to rig. In a later article in this series, Paul O'Sullivan will challenge this hierarchal view and explore a tactical decision making process based upon operational risks being determined by the rescue environment and



HIGHLINE

•What force does a rescue boat positioned in fast moving water place on a highline and does this require any changes to the rigging system or operation?

By Chris Onions

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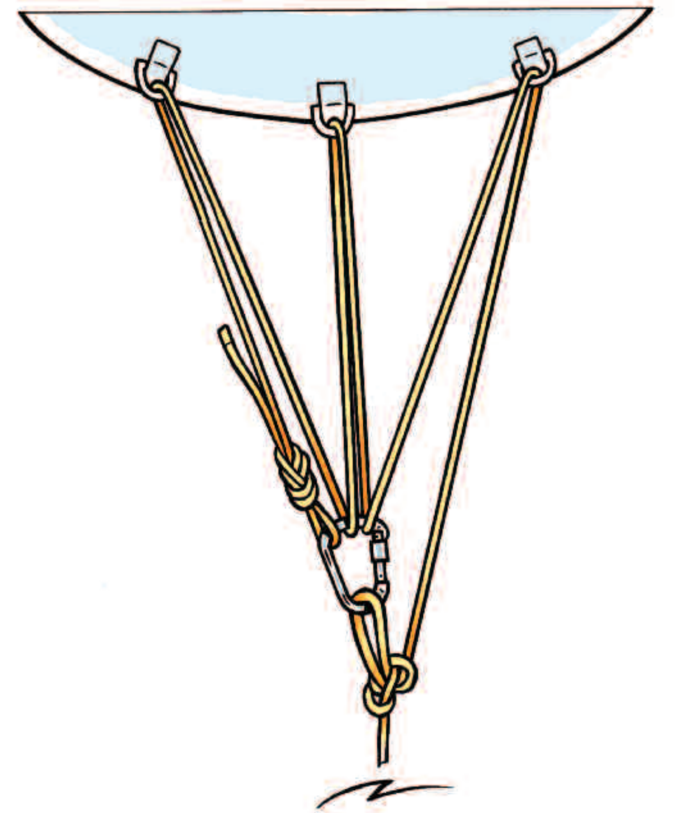
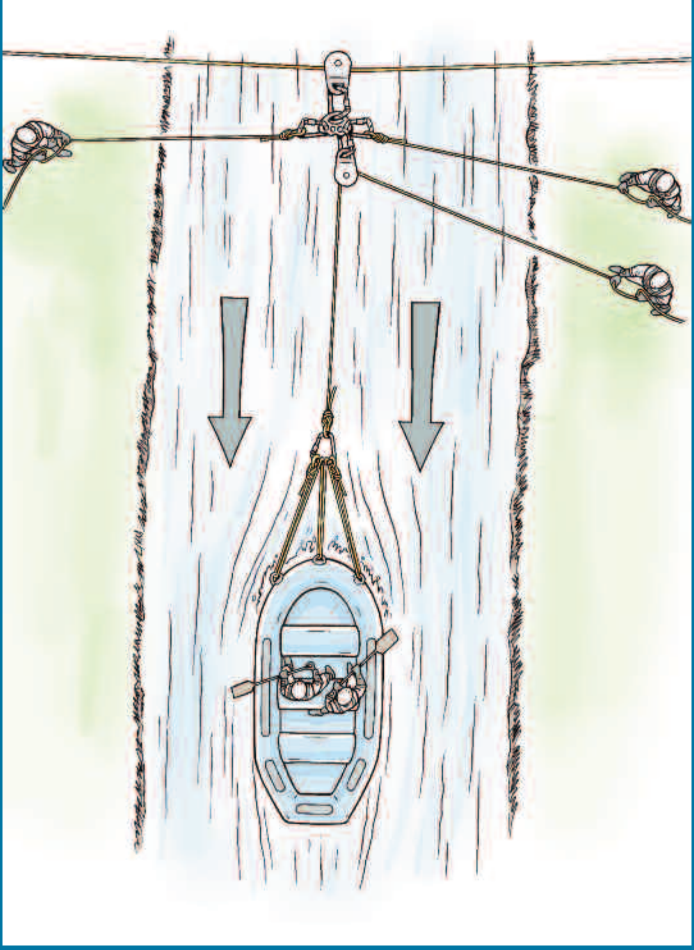


Traditional load-distributing anchor system



the capability of the rescuer and needs of the victim.

We are all aware of the concept of the rescue chain in which the strength rating of linked components are known, and that the integrity of the system is a determined by the weakest link. So while we are aware of the individual ratings of karabiners, ropes and pulleys – do we actually have a knowledge of the load a rescue boat places on the rescue chain when it is positioned in moving water? Increasing our knowledge in this area will certainly help us identify how strong the rescue chain needs to be so we can work towards establishing a safe working practice.

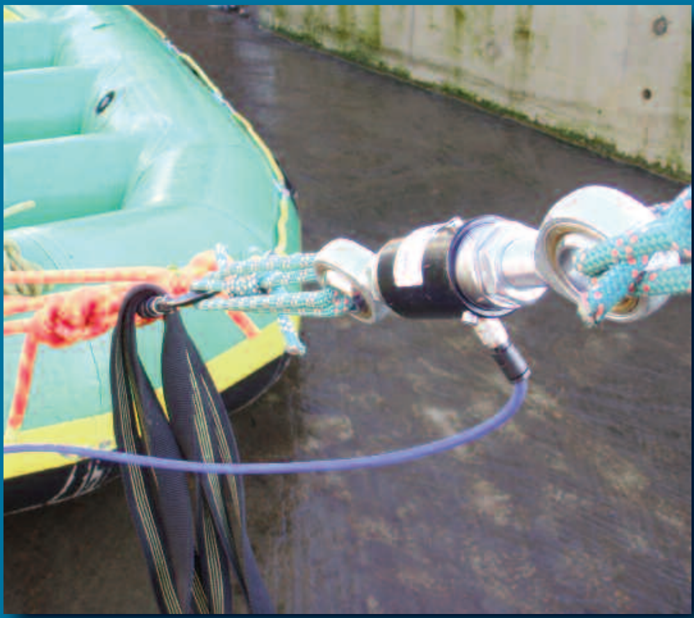
In an attempt to answer these questions we turned our attention to establishing the speed of water that water rescuers are likely to encounter. The NFPA state that threshold velocity for swiftwater starts at 1 knot (which is about 0.5 meter per second), and in the UK, the DEFRA Flood National Enhancement Project, Concept of Operations Document states 10 mph (about 5 meters per second) as the required water velocity that a rescue power boat should be capable of operating in. We chose a venue, the Tees Barrage International White Water Centre (UK) where we could calibrate and control the speed of water at a portion of the course with a steep gradient within this range of water speed.

We constructed a Norwegian Reeve (floating, Type B EN1891 low stretch kernmantle with a carriage positioned on a single track line). A load cell was positioned at the focal point of a load distributing anchor on the upstream side of the raft to record the force placed upon the whole system when water was introduced into the channel. Now of course we know that the force at the highline anchors will increase as the angle of the highline increases but we also know that we can work out this force multiplication by applying the rules of trigonometry. So by placing the load cell at the boat end of the system, we could determine the load on the boat and work out the consequences of force multiplication for the track line retrospectively. We have called this load with respect to water speed the running load.

During the testing we used a 12 foot Eurocraft self-bailing raft as our rescue vessel, with three people on board representing the Helm, Rescuer and Patient. They were positioned in the middle of the boat so keeping the weight distribution, and therefore trim, about neutral. We then turned the water on…

What did we find out?

Interestingly, the load was more or less constant regardless of the speed of the water in the channel. If anything the load was very slightly higher at lower water speeds, suggesting that the raft demonstrated a displacement mode at lower speeds, and was able



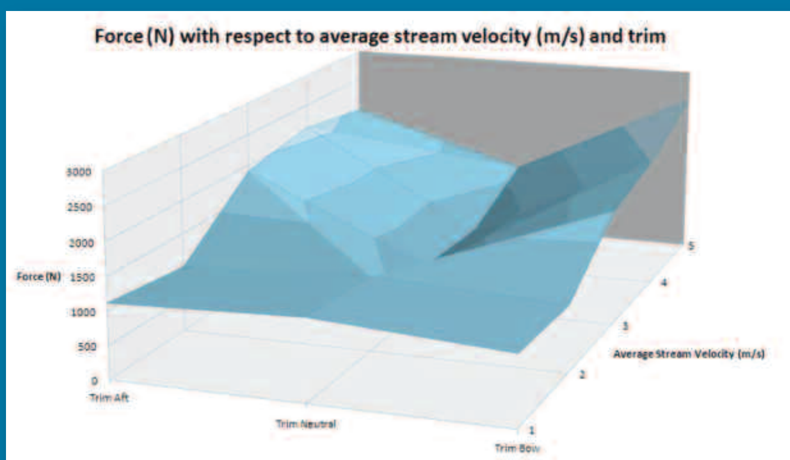
to plane at higher speeds. The value was about 1.3kN but the force became significantly elevated when the crew redistributed themselves at the rear or front of the boat. This redistribution of load influences how the raft is trimmed, and the graph overleaf shows how force changes with respect to trim and water speed. Importantly, the force was relatively constant, or even decreased slightly as the water speed was increased unless the trim was adjusted by moving the crew rear or afwards.

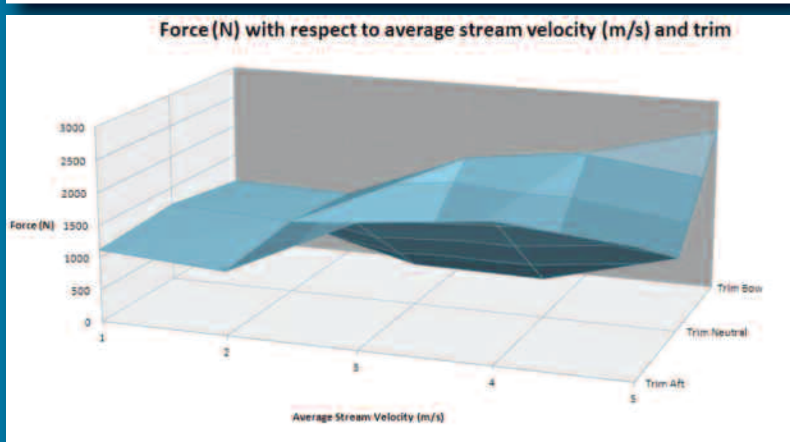
We wanted to investigate the effects of trim further, as we

suspected that a poorly trimmed raft may result in a significantly greater load. We were reminded about the work of the British Columbia Council for Technical Rescue (BCCTR) which identified the factors surrounding a worse case event within rope rescue. They suggested that when during a rope rescue operation, a rescue sized load is moved from the horizontal over an edge, should a system or Operator error occur, then the load may fall about 1m with only minimal rope in service to absorb the energy of the fall. They realised that this was a challenging set of circumstances for a belay system to cope with, and early testing yielded peak force results of about 15kN for those belay devices that were successfully able to arrest the falling load.

So what about the factors surrounding a worse case event for a boat on a highline? We considered what human factors may influence this during a rescue, perhaps the crew would move close to the bow when pulling a patient on board, so adversely trimming the raft. Then conceivably in high enough flow, the bow would be flooded when dipped below the established pillow wave. If one of the D-ring anchor patches were to fail, how would this load the others when the load distributing anchor became tight again?

Well, there was only one way to find out, so under maximum flow conditions (about 11 mph water speed) with everyone crammed nervously into the bow to represent the crew hauling the patient into the raft, we measured the force and then cut a sacrificial anchor leg. We repeated this a number of times and were happy that the peak force under these circumstances was about 3.5kN.





Now a load of 3.5kN doesn't sound excessive, until the reader considers the force multiplication effect of system on the track line anchor points. A tight track line of 160 degrees will result in a force multiplication of x3, or about 10kN of force should the worst case event occur. This value is approaching that of the maximum arrest force as proposed by the BCCTR and is certainly a considerable load. Unlike a fall situation, which would result in a brief 'jolt' the load associated with a flooded boat on a high line would be maintained for a significant duration until the crew had sorted themselves out into a neutral state of trim again. It therefore makes sense to rig the highline with more sag, so the anchor points should be selected further upstream to maintain a smaller mid-point angle. It also makes sense to use progress capture devices that slip at a known threshold. Suitable mechanical devices with smooth internal profiles such as the Petzl I'D and CMC MPD have known and reliable gripping thresholds that when exceeded induce a slipping clutch effect reducing the likelihood of system failure.

So returning to our thoughts around rescue tactics, feasibly an enhanced understanding of the associated load of a boat on a highline will shift the perception that the technique is a 'high risk' option. With a sound understanding of the factors associated with a worst case event (and how to avoid them) it may be considered as just another tool in the tool-box appropriate for when a precisely positioned, true-rescue in high energy water conditions is required.