In this article we will continue to look at aquatic helicopter operations and how local public safety agencies without a dedicated helicopter asset can interface with local public service aircraft to increase safety and effectiveness in inland water rescues. In Part I we explored the command and control aspects as well as NCHART’s inter-agency SAR helicopter program. In Part II we will explore the techniques, tactics and reasoning behind common aquatic helicopter SAR operations. Many of the techniques and tactics described in this article are straightforward but are only safe when conducted with active aircraft under supervision of a qualified instructor. As always the best tactic in any given situation is a product of sound judgment which can only be developed through proper training, practice and experience.

Aerial Reconnaissance & Search
Helicopters are effective as aerial reconnaissance tools to help locate victims during search/location phase of a rescue. In Part I we discussed the capabilities limitations regarding weather and flight rules of public service aircraft. Aerial reconnaissance is a low risk mission for most aircraft given absence of inclement weather during the day and can speed up a waterborne search. In these types of missions it is imperative that ground crews have communication capabilities with the aircraft. In rivers and canyons, radio signals are often diminished due to line-of-sight obstructions. Some teams have started to carry portable repeaters either on utility vehicles or apparatus which can improve communication.

If the search involves a complicated section of river or flood zone with interconnecting sections and dense vegetation, visual references become confusing and in some cases obsolete. Visual references which lack unique landmarks can cause confusion in relaying positional information between ground crews and aircraft. One particular tool which has become quite effective in this application is small portable waterproof GPS receivers. Each swim team or boat crew should have at least one GPS with them. This is both for effectiveness and safety. Should the victim be located or if the rescue crew has an emergency and require evacuation, relaying positional coordinates to incident commander and aircraft will eliminate confusion and foster a rapid response.

Aerial reconnaissance combined with pre-planning will determine whether or not a safe landing zone exists. In the absence of a proper landing zone, the aircrew may elect to use one skid of the aircraft braced
against rocks or the bank. A toe-in hot landing may also be performed which braces the toes of the skids against an object for stability. In toe-in and one-skid hot landings the danger level is at its highest due to stability of the aircraft and proximity to rotor blades. If, during the reconnaissance of the incident, it is determined that a suitable landing zone or hot-landing is not possible it will be necessary to insert rescuers and equipment from the helicopter while in hover. There are several options available and each has its advantages and limitations. In any case when hover insertions are undertaken it is important to note that the risk to the rescuer, pilot and aircrew are elevated compared to normal flight.

**The Physics of Hover Insertions**

Over-water hover insertions are a risky operation with regards to flight physics. Tremendous power is required of the helicopter due to the effects of ground effect. Ground effect is a phenomenon which occurs when the helicopter is approximately 1 – 1 ½ rotor diameter distance above the ground. As airflow from the rotor blades strikes the ground, airflow restriction allows the helicopter to use less power to maintain lift. However as the helicopter lifts beyond the rotor diameter ground effect is lost. When ground effect is lost, airflow is no longer restricted which the helicopter must then overcome with more power to maintain lift.

Another important concept for rescue crews to be aware of is auto-rotation. Auto-rotation is an emergency procedure which allows the helicopter to land safely in the event of engine failure. Auto-rotation takes advantage of flight physics by turning the rotor blades only through upwards air draft; for this to occur the helicopter must be at an altitude high enough to allow enough upwards air-draft to spin the rotor blades.

The phenomenon of ground effect and auto-rotation is of particular interest to rescue swimmers who may be suspended below the aircraft in a hoist or short-haul extrication. The operating altitudes for both these operations occur in a rough altitude range of 25-100 feet. This operational altitude is considered “no man’s land” in a single engine aircraft where if an engine failure were to occur there are no physics to take advantage of and a catastrophic crash could occur.

Because of the crash hazards associated with winching and short-hauls in an over-water environment it is crucial that pilots, crew members and rescue swimmers participate and refresh their skills in water crash survival training a.k.a. “the dunker”. In California the U.S. Navy has trained civilian rescue team members alongside military members in water crash survival. For areas which lack military resources portable home-made mock-ups of helicopter cockpits have been fabricated and adapted to pool use.

**Hoist Operations**

Hoists are a simple quick effective tool for water SAR. The advantages of winch rescues are that the aircraft can go into rescue operation immediately on scene, insert a rescue swimmer and recover both the rescue swimmer and victim directly into the cabin. This evolution can be repeated on site as many times as necessary without
should be mindful of the concept of moving water. Rescue teams present fewer complications when stabilized before contact is made and refreshed annually.

As discussed in the previous article, hoist rescues in static water present fewer complications when compared to winch rescues in swift or moving water. Rescue teams should be mindful of the concept of reconfiguration as required in rope work. One particular safety concern is conscious immersion victims who are exhibiting sign of panic. Rescue swimmers should always approach these victims with caution and after a careful assessment. Combative victims should be stabilized before contact is made and these methods should be practiced and refreshed annually.

As discussed in the previous article, hoist rescues in static water present fewer complications when compared to winch rescues in swift or moving water. Rescue teams should be mindful of the concept of fleet angle. Fleet Angle is the angle of the cable as it is paid out in relation to the hoist. Some hoists may have a fleet angle of less than 30 degrees. This relates to the practical application of hoist rescues in moving or swift water. Hoists retain maximum strength by resisting direct vertical loads. Lateral or vector forces can decrease maximum strength of the hoist and cable. Therefore, the operational challenge is to match the rescue swimmer on the hoist with the speed of the water so that when the rescue swimmer contacts the victim, the angle of the cable is minimal.

Improvements in hoist design have improved the durability of winches when operated at angles lateral to the center of the aircraft. Goodrich’s Translating Drum Cable Management technology with its series of swivels and guide plates built into the hoist decreases angular stress on the cable allows for wider operational angles.

This technology has played an important part in maritime rescue where winds, sea-state and ship size prohibit the aircraft from a direct overhead hover. Rescue swimmers and equipment are deployed and recovered in a manner which places the cable at a wide angle. When applied to a swift water rescue, the aircraft must fly the course of the victim and timing is essential. If a rescue swimmer is deployed and an obstacle such as a tree or power pole presents itself, then the aircraft must recover the rescue swimmer and abort the current rescue attempt. Pre-planning common locations will allow pilots and crew to avoid these situations.

Helicasting
Helicasting is a method to transport and deploy rescue swimmers while the aircraft is flying no faster than 10 knots and no higher than 10 feet. Helicasting is also a very rapid and effective way to deploy rescue divers. In military or tactical helicasting most standard operating procedures prohibit helicasting in uncharted waters or water with a depth less than 10 feet. Inland water rescues, especially in flooding often involve unknown water depths and submerged hazards. Pre-planning and experience in your local bodies of water can help mitigate this risk.

When a victim is located and the rescue swimmer is helicasted into a body of water it is critical that the rescue swimmer keep eyes on the victim at all times. There have been incidents where visual contact is lost during the cast and the victim becomes submerged and is lost. An effective jump position is a modification of the “giant stride” entry taught to SCUBA diver which is legs spread apart and arms wide so that the entry into water is slowed down.

If the victim is current in swift water, the crew chief or spotter or first responders and rescue swimmer should continuously assess downstream hazards. The hazard in swift water is hitting rocks or obstructions during the jump. Every attempt should be made to cast in green, deep water of at least 10 feet. If the victim is located and casting near the victim is not possible a marker device should be deployed upwind of the victim. This helps positively mark the victim’s location and also provides wind cues to the pilot. In dry-brush areas, common in California, care should be taken so that a smoke flare would not compound the problems by starting a wildfire. However smoke flares are very helpful in immersion rescues.

U.S. Aviation Regulations require that crewmembers and rescue swimmers involved in over-water operations are trained in water crash survival. A study conducted by the U.S. Navy revealed that 55% of water crash fatalities were drownings with no related trauma, while 90% of all personnel that survived a water crash were trained in water crash survival. The obvious challenge is to locate the egress point while immersed and disoriented. This training can be conducted at low-cost in local pools with fabricated prop and rescue divers. In the event of a water crash landing the following procedures apply:

All personnel should be wearing an INFLATABLE personal flotation device:
• Eye protection on/face shield down.
• Ensure side doors are open and secure loose items if time permits.
• Take a crash position, brace for impact and hold to maintain a reference point.
• Once submerged disconnect helmet cord if connected and utilize emergency escape breathing device (HEED) if available.
• Release seat, gunner’s belt, or tether and egress to surface.
• Activate inflatable PFD and conduct personnel
Short-haul rigging requires set up time on the ground but is inexpensive, lightweight and allows for extraction of personnel and victims.

Law enforcement helicopters can be used to transport fire department resources such as rigid hull inflatable boats.

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imperative that the rescue swimmer plan for this event and carry a knife to contend with loose rigging in water! Another disadvantage of short-haul rescue is time and control. In order to set up for short-haul the aircraft must land away from the incident and construct rigging. The ropes are typically laid out in front of the aircraft for pilot observation and the rescue swimmer with a victim extraction device is attached to the end of these ropes. The helicopter then flies to the incident to extract the victim. Because the short-haul system is constructed as a fixed system underneath the aircraft, the pilot has no visual reference and must rely on the crew chief or tactical flight officer. Once the rescue swimmer and victim are attached to the short-haul they cannot be brought into the aircraft and must be flown in space to the safe zone and as described early in this article, the majority of the short-haul rescue is performed out-of-ground effect. The risk management assessment provided in Part 1 will help ground crews make informed decisions whether deploying a short-haul rescue is too high of a risk for the incident. If you are developing inter-agency helicopter rescue capabilities the hardware required for short-haul is minimal. Standard rope rescue equipment is used in the majority of the system. Aircraft equipped with cargo hooks can be used in conjunction with a quick-release mechanism as a back-up. Anchoring procedures are slightly varied in each agency however the typical procedure is to place webbing or slings are placed around the belly of the aircraft and interior floor which act as the anchor. A quick disconnect is then connected between the anchor and the fixed rope. In the event of an emergency the tether attached to the quick release will disconnect the entire load from the aircraft.

Rescue Rappelling
A trend that continues with some agencies is moving away from rappel insertions, primarily due to the training commitments required to maintain proficiency. Most agencies that perform helicopter rappelling usually commit to continuous proficiency and refresher training with entire days dedicated on the calendar in frequencies as high as every two weeks. With the current global economy and diminishing budgets, administrators are often forced to make cut decisions. High risk, low-frequency sub-sets of skills within a discipline such as helicopter rappelling is a likely choice to be cut. In the range of skills for rescue swimmers, rappelling still has its place and is a great tool especially in aircraft that do not have a hoist. When compared to hoisting, rappelling has a greater time sequence where the helicopter must hover on station, deploy ropes, descend the rescue swimmer, retrieve ropes and move to a command observation position. However if crews practice this technique the time sequence can be refined and minimized. In aircraft that do not have a winch this may be the only option for insertion of a rescue swimmer or let down of cargo and equipment when geography is hazardous or time is crucial. It is a quick way to get a rescuer on rappel and command post are rendered non-operational in the helicopter environment requiring proficiency and understanding in hand/body signals. The same issues exist during short-haul operations and now are applying them in a new environment. Hard-points for attachment of rope are identified by the aircrew and depend on the aircraft however they are commonly located on the interior floor or exterior above the door. High-point anchor attachments are advantageous for the rescue swimmer because it makes the transition to rappel easier.

Friction devices also vary but the most common in the US are the Sky Genie, Brake-Bar Rack, and Rescue-8. The Sky Genie is the most popular helicopter rappel device and allows for variance of friction; however they are not commonly used in ground/water SAR and are somewhat costly. Sport climbing friction devices such as the ATC are insufficient and dangerous to use in this environment. Adapting the skill set ground SAR teams already have, being proficient in the friction device, particularly lock-off procedures are critical. If an emergency were to occur during rappel, the rescue swimmer must be able to lock off and signal this to the aircrew so forward flight can occur. In certain circumstances it might be more advantageous for the rescue to make a rapid decent to the ground, disconnect and immediately leave the crash hazard area. [ED: Consider European and Australian style autohock descendens for h-rallips] The mechanics of helicopter rappelling are no different than standard rescue rappelling. The rescue swimmer must maintain a smooth controlled rappel and overcome the skids of the helicopter using edge transition techniques. This requires the rescue swimmer to maintain contact with the skids by extending the feet and controlling the decent until the rescuer is inverted. If two rescue swimmers are inserted by rappel than it is important to maintain the same position throughout the rappel to avoid unexpected lateral loading which the pilot must then overcome.

The main difference between ground SAR rappelling and helicopter rappelling is the operational environment. The noise and wind are tremendous and can be intimidating to first-timers. Standard verbal and radio commands between rescuer on rappel and command post are rendered non-operational in the helicopter environment requiring proficiency and understandings in hand/body signals. The same issues exist during short-haul operations and an example of hand signal communications are listed here;

Conclusion
Risk in aquatic helicopter rescue is relative to the hazards of the incident and training of crews, both ground and aircraft. Like all other water rescue tactics, use of helicopters is a tool available even in first responder public safety agencies without a helicopter. Law enforcement, National Guard and military all utilize helicopters as part of their mission. In fire departments, rescues are a high-risk, low-frequency occurrence, but when they do occur the chances of saving a life are great. A new model for rescue should be resource sharing and cooperation between agencies with specialized assets. Fire departments are the agencies that typically have a technical rescue team while law enforcement typically has a helicopter. When you combine the assets of both and cross-train, you add an extremely valuable asset to the community at little to no cost.