Helicopters

In Search and Rescue

Intermediate Level

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COVER PHOTO: Angel City Air and Welk Aviation from HeliOps magazine. Photo courtesy Ned Dawson

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Objective

The Mountain Rescue Association (MRA) is a volunteer organization dedicated to saving lives through rescue and mountain safety education and has developed this program to assist search and rescue (SAR) organizations in their helicopter operations.

This material is designed for search and rescue professionals that work frequently with helicopters and helicopter management in their search and/or rescue operations.

At the conclusion of this program, the reader should be able to:

- Understand essential elements of helicopter operations within the Incident Command System (ICS)
- Identify several key elements of helicopter landing and takeoff areas; and,
- Understand helicopter and heliport management.

About the Authors

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A 30-year veteran of Colorado's *Alpine Rescue Team,* Charley has participated as a field member and Incident Commander for hundreds of rescues among Colorado's highest peaks, and has consulted rescue mountaineers, mountain guides, and climbers throughout the world, from Israel to China, from Mt. Kilimanjaro to Aconcagua.

Dr. Charlie Mize

Charles Haviland Mize, BA MD, is a specialist in emergency medicine and resuscitation and is a leading expert on the retrieval of critically-ill and injured patients from austere environments at high-altitude. He has led numerous helicopter rescue operations throughout the Himalaya. He is a co-founding member of BearBadger, a physician-led team that undertakes high-risk patient retrieval, and is the founder of Bhutan Emergency Aeromedical Retrieval, the Kingdom of Bhutan's pre-hospital helicopter critical care and mountain rescue team..

Introduction

As a search and reconnaissance platform capable of rescue and extrication, the helicopter brings unparalleled versatility in its ability to support emergency and disaster response. The helicopter is a powerful machine, but not one without risk. Helicopter crashes are devastating and often lethal events that threaten even the most prepared and careful rescue operations. Even on the ground, helicopters pose significant danger: rotor blades spinning faster than 150 M.P.H. can inflict deadly wounds to the careless or inattentive. The safety of helicopters in search and rescue is in direct proportion to the knowledge and skill of those who manage their use.

Mission management must assure safety training of ground personnel. Photo: Bob Wagner

Keen attention to safety can coexist with efficient and rapid helicopter operations, and often, it must. Rescue teams must be prepared for "mass disaster accidents" which demand quick mobilization and efficient deployment of large-scale rotary wing operations if human lives are to be saved. Imagine if numerous passengers were to survive a 747 crash in a remote mountain highland: many are certain to be injured, and all will be with limited food and little means of keeping warm. Their survival would depend upon the rescue team's safe, efficient and rapid deployment of a large helicopter operation. Although it is often assumed the chance of survival in such a setting is remote, over 100 passengers survived a similar crash in Japan in the early 1980s when a DC-10 struck a mountain.

In the response to a mass casualty incident, the rescue team's ability to quickly manage large-scale air operations may be critical to the success of the mission. While other aircraft are often able to assist search and rescue operations (fixed-wing, drones), the helicopter's versatile abilities and its rapid response time ensures that it will remain a vital part of SAR and demands that the rescue team members have a working knowledge of helicopters and the various factors which influence their effective use. For this reason, large-scale air operations, and the management thereof, are described within this training material.

Large scale rescues with numerous aircraft present many new challenges to rescue operations. Photo: Canadian Special Forces

This *Intermediate Level Helicopter Safety* program is designed to familiarize the student with helicopter operations in search and rescue (SAR) beyond basic helicopter safety.

In particular, this program incorporates elements of the Incident Command System (ICS), and users of this program should be familiar with ICS.

Part 1 – Helicopter Essentials

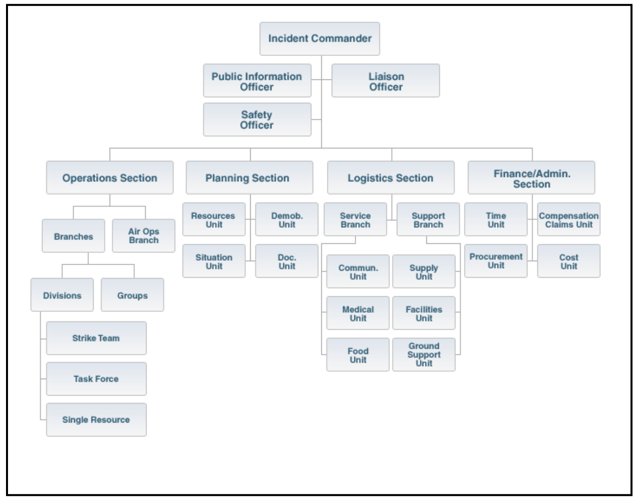
The safety of a helicopter rescue program depends on the training, qualifications and experience of the search and rescue personnel. Rescuers must have a working knowledge of helicopter safety and operations, augmented with experience in the use of helicopters in rescue settings. Knowledge of and experience in the Incident Command System (ICS) and its hierarchy is also necessary.

Helicopter Operations within ICS

One of the attributes of the Incident Command System is that can it be scaled up or down to accommodate the size of a search or rescue operation. This scaling of size is equally important in search and rescue operations that include the use of helicopters.

For large-scale air operations with multiple aircraft, the Heliport Manager manages the Heliport within the Incident Command System. The Heliport Manager reports to the Air Operations Branch Director, who is also responsible for any fixed wing operations. The Air Operations Branch Director reports to the Operations Section Chief who, in turn, reports to the Incident Commander.

For smaller search and rescue operations in which a very informal, scaled-down Incident Command System is used, the Incident Commander may be responsible for most aspects of the decision-making process with regard to air operations. In so doing, the Incident Commander must take responsibility for air and aviation safety. He or she must ensure that all safety issues are addressed.



SOURCE: https://emilms.fema.gov/IS200b/ICS0102280text.htm

Helicopter Size Classification

The aviation industry generally classifies helicopters by size, dividing helicopters into one of three groups depending on the number of passengers the helicopter is able to carry.

The three classes are as follows (in increasing order of size):

- Light: 0 to 6,000 pounds (typically seats 1 to 7)
- Medium: 6,001 to 12,500 pounds (typically seats 8 to 16)
- Heavy: 12,501 pounds and higher (typically seats 17 or more)

ICS Classification of Helicopters

The Incident Command System, on the other hand, has defined four classes of helicopters, again defined by size. They are (note the *decreasing* order of size):

- Type I: seats at least 16 people and has a minimum capacity of 5,000 lbs. Both a CH-47 (Chinook) and UH-60 (Blackhawk) are Type I helicopters.
- Type II: seats at least 10 people and has a minimum capacity of 2,500 lbs. Both an UH1-H and a Bell 212 are Type II helicopters.
- Type III: seats at least 5 people and has a minimum capacity of 1,200 lbs. Both a 206 and a Hughes 500 are Type III helicopters.
- Type IV: seats at least 3 people and has a minimum capacity of 600 lbs.

Calling for Helicopters

Since the use of helicopters is not without risk, SAR teams must consider several important factors when determining whether or not to request helicopter support.

First, the SAR team must consider the urgency of the mission. Does the victim have a time-critical injury or environmental exposure for which the speed of helicopter evacuation might make a vital difference? Are ground teams able to transport the victim without worsening any injury, and if so, do the benefits of helicopter use outweigh the attendant risks? Search and rescue teams often overlook this primary consideration.

Second, the team must consider how the physical environment of the rescue mission will affect helicopter aviation. Changes in weather, altitude, terrain and daylight conditions can dramatically alter and sometimes impair helicopter performance. Moreover, different models of helicopter can have different 'ideal flying conditions.' It is therefore essential that team leadership keep these factors in mind when requesting helicopter support, and be familiar with the machines at their disposal.

Third, the team should consider the skills of the pilot. Many search and rescue teams have the good fortune to work time and again with the same pilots, such as local television station pilots or Helicopter EMS (HEMS) pilots. These repeat operations with the same pilots afford SAR teams the opportunity to develop a clearer sense of a pilot's abilities in SAR activities and to consider these abilities when calling for helicopter assistance. Rescue teams that do not know a pilot or pilot's competence should consider carefully whether particular skills are required to achieve the mission and how likely the pilot is to have them.

Finally, SAR teams must consider whether the helicopters at their disposal are able to safely accomplish the tasks the SAR team would require of them. For example, requesting a helicopter to perform spotting during a search operation in fair weather entails little risk to aircraft and crew. By contrast, the risks involved in hoist operations substantial and high. If a helicopter encounters engine trouble in-flight, the pilot will often drop the external load – even if that load is a live rescuer suspended on a line – to improve the helicopter's performance in an attempt to save the lives of the others on board.

Just as search and rescue team members must have the physical skills to perform their field duties, the team's leadership must have the wisdom to know when the risks of helicopter use outweigh the benefits. When conditions are not appropriate for flying, only the best Incident Commander will have the courage to choose **not** to call for the helicopter.

Risk Calculation and Assessment Using a GAR Model

The elements mentioned above should all be incorporated into a team's risk assessment program when determining when to request (and NOT request) aviation assets A careful risk assessment is a key element of incident command, and rescue teams should consider utilizing a standard risk assessment model. There are numerous variations of a common model, the "Green-Amber-Red" model (or "GAR Model"). While we do not wish to prescribe any one particular model, we do strongly recommend that rescue teams utilize an objective risk assessment model when considering requesting aviation resources.

Air Force Rescue Coordination Center (AFRCC)

Civilian SAR teams are fortunate to have at their disposal a multitude of helicopter resources through the United States armed forces. The Air Force Rescue Coordination Center (AFRCC) is the main "command center" for US military aircraft, and requests for such aircraft in support of a local SAR mission must go through the AFRCC.

> *In 1956, the National Search and Rescue Plan was published, establishing a crucial link between military resources and their unique recovery capabilities, and the civilian sector chartered to respond to those in need. This plan established the United States Air Force as the executive agent for inland search and rescue, covering the continental United States, less the major navigable waterways. To provide coordination to meet the growing demand for search and rescue, in 1947 the Air Force established three Rescue Coordination Centers, at Hamilton Air Force Base, California, Lowry Air Force Base, Colorado, and MacDill Air Force Base, Florida.*
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> *In 1974, as a result of improved technology and communications capabilities, these three Rescue Coordination Centers were consolidated into the Air Force Rescue Coordination Center at Scott Air Force Base, Illinois. While at Scott, the Air Force Rescue Coordination Center came under the control of several different commands: Military Airlift Command, Twenty-Third Air Force, Aerospace Rescue and Recovery Service, and Air Rescue Service. As budget cuts and agency reorganizations continued in the military, the Air Force Rescue Coordination Center was eventually relocated to Langley Air Force Base, Virginia in 1993, and was aligned under the newly organized Air Combat Command.*
>
> *Despite military restructuring, the peacetime mission has remained unchanged and vital from 1974 to current day. As of August 2001, over 56,450 search and rescue missions have been performed, resulting in over 12,830 lives saved. (AFRCC web site)*

The AFRCC mission is "Continuously building a coordinated search and rescue network ensuring timely, effective lifesaving operations whenever and wherever needed."

Helicopters by Types

Of the many types of helicopters, four are useful for rescue operations. For the purpose of this program, we refer to these four types of helicopters as:

- Rescue Helicopters
- Transport Helicopters
- Observation Helicopters
- Helicopter Emergency Medical Services (HEMS) aircraft

Each of these is further described below.

Rescue Helicopters

A "rescue helicopter" is defined as a rotary wing aircraft capable of forward flight and out-of-ground effect (OGE) hovers in high altitudes and warm weather. The aircraft must be also be able to land in rugged terrain on small, unimproved helispots. SAR teams use rescue helicopters to perform rescue operations, often at high altitude.

Transport Helicopters

The ability to transport up to 6 search and rescue personnel and their gear is what defines a "transport helicopter." Transports helicopters must also be capable of high altitude, warm weather flying, and able to land in moderate terrain using medium- to large-sized improved helispots. As the name suggests, transport helicopters transport search and rescue teams to the field when ground transport would be impractical or require too much time.

Not surprisingly, these types of helicopters are the most commonly dispatched by the Army when it assists in civilian search and rescue operations.

Observation Helicopters

An "observation helicopter" is one with limited seating and limited tactical capabilities at altitudes on hot days. SAR teams would employ an observation helicopter to support search operations (spotting) from the air.

Helicopter Emergency Medical Services (HEMS) Helicopters

A Helicopter Emergency Medical Services (HEMS) aircraft is one that transports critically injured patients from accident scenes or local hospitals to major trauma centers for immediate care. Medical crewmembers provide comprehensive prehospital, emergency and critical care to these patients on scene and en route.

The term Helicopter Emergency Medical Services (HEMS) is often used to describe Air Medical Helicopter programs, and will be used throughout this guidebook. This is essentially a flying ambulance with a flight nurse or doctor on board and a variety of specialized equipment to enable critical care medicine.

The high safety requirements of HEMS helicopters often leads to an ability to fly in high altitude and warm weather as well as a capability to land in moderate terrain using small- to medium-sized improved helispots.

Some HEMS helicopters will also transport rescuers as part of their program. Photo: Charley Shimanski

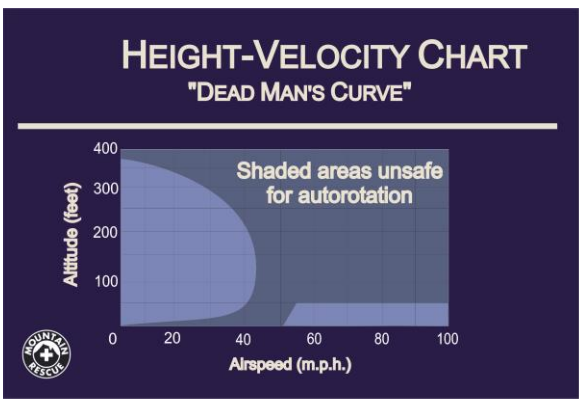
Limitations of Helicopter Deployment in SAR: advanced considerations

The Mountain Rescue Association's basic level helicopter training program defines several helicopter limitations, such as visibility, weather, fuel capacity, etc. For this intermediate level program, we explore more nuanced limitations of helicopter use in SAR, limitations that require a more thorough understanding of helicopter aviation.

Height-Velocity Chart

Most helicopters can be piloted safely to the ground in the event of an engine failure via autorotation (see Helicopters in SAR – Basic Level). Safe landing through autorotation is only possible, however, if the helicopter is operating within certain speeds and altitudes.

Each helicopter flight manual contains a "Height-Velocity" chart, which indicates the speeds and altitudes required to enable safe autorotation in the event of a mechanical or electrical failure. At speed/altitude combinations below the curve in the "caution" areas of the chart, safe autorotation of the helicopter will be difficult, if not impossible . For this reason, the Height-Velocity Chart has been given the nickname "Dead-Man's Curve."



Density Altitude

Search and rescue operations often require helicopter flight in high temperatures, high humidity, and at high elevations (low atmospheric pressures), each of which can impair helicopter performance.

Density altitude is a concept pilots use to account for the effects of temperature, humidity and atmospheric pressure on the performance of aircraft. It is a concept equally important for a SAR team's leadership to understand when considering if, how and when to request aircraft assistance. A helicopter cannot work as effectively at higher altitudes as it can at sea level. Heat similarly reduces helicopter performance: increasing temperature during flight effectively increases the elevation in which the helicopter must now fly. On a hot day, the density altitude at a particular location may be 2,000 or even 3,000 feet higher than the elevation of that location on a cool day. Increased humidity has an effect, albeit a minor one, on density altitude as well.

Technically defined, "density altitude" is pressure altitude corrected for temperature and humidity. All three factors (atmospheric pressure, temperature and humidity) affect the density altitude in varying degrees. The higher the density altitude, the weaker the helicopter performance. High elevation (e.g. reduced atmospheric pressure), high temperature and high humidity all contribute to higher density altitudes. Air is thinner at higher density altitudes, and this thin air reduces rotor blade efficiency and in turn helicopter performance. As a consequence, a helicopter will require additional rotor blade pitch and engine power to maintain the same lift capacity it would have a lower density altitude. Greater rotor blade pitch angles increase drag – resistance of air against the moving blades – which demands more power from the engine. However, in the thin air of high density altitudes, non-supercharged piston engines operate with less efficiency, further limiting aircraft performance.

A high-density altitude can result in loss of engine power, reduced lift and reduced payloads. A helicopter flying in a high-density altitude will require longer takeoff and landing rolls and will experience a decreased rate of climb. Of the three variables listed above, humidity plays a very minor role in determining density altitude.

Density altitude is one reason why helicopter pilots may prefer to fly in the early morning hours. It also explains why a pilot, whose chopper is full of fuel, may wish to fly with only one passenger at a time.

Most importantly, density altitude is the reason why search and rescue missions should consider the need for helicopters the night before (or early in the day of) rescue operations, since flying conditions can deteriorate during the afternoon hours.

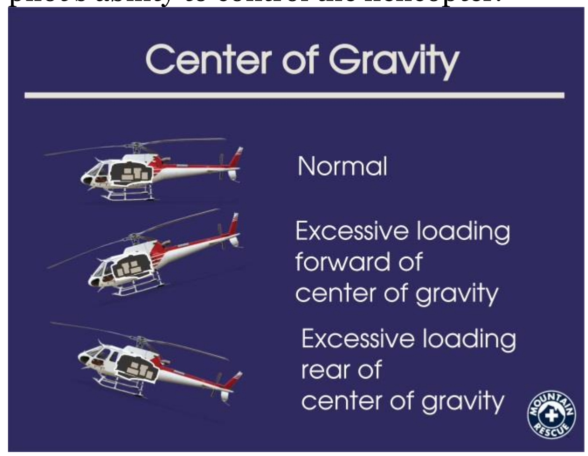
Loss of Tail Rotor Effectiveness

The helicopter's tail rotor generates thrust to counter the torque created by the main rotor, and is controlled by the pilot with pedals at his/her feet (see Helicopters in Search and Rescue, Basic Level, part 2 – what makes helicopters fly). When the anti-torque provided by the tail rotor is insufficient to counteract the torque of the main rotor, the ship experiences the condition called "loss of tail rotor effectiveness." The helicopter will begin to spin, although not necessarily fast. This uncontrolled spin is a dangerous condition, however, no matter its speed. Loss of tail rotor effectiveness is more common during flight in high altitude, high temperature and/or with heavy loads – flight conditions all common in mountain search and rescue operations.

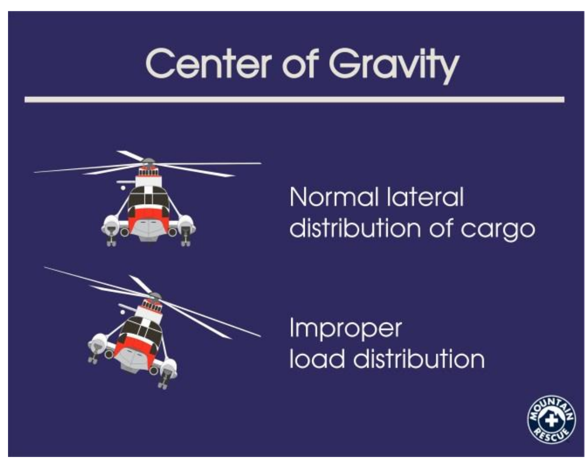
Helicopter Loading

Center-of-Gravity Effects

When loading aircraft, it is important to understand how changes in an aircraft's center-of-gravity (CG) can affect flight. While careful consideration of how load placement can alter an aircraft's weight and balance is important in the loading of all aircraft, it is crucial in the loading of helicopters. In fixed-wing aircraft, load is balanced over a horizontal wing area and can thus rest in a comparatively wide area before dangerously altering the plane's center of gravity. A helicopter, however, carries load under a single point, like a pendulum. Therefore, even a small amount of "out of CG" loading can greatly affect a pilot's ability to control the helicopter.



Unloading a helicopter in hover changes the aircraft's center-of-gravity while the pilot is attempting to keep the ship level and stationary. It is thus technically challenging for both pilot and for crew. This center-of-gravity effect is a significant contribution to the danger of one-skid offloads and is one of the reasons why such offloads should be performed with precision, by rescuers familiar with this procedure, and only when absolutely necessary.



Helicopter Performance Capabilities and Specifications

Search and Rescue missions can make broad demands on helicopter performance: high altitude, large search areas, long distances from refueling points and a need carry the weight of crew and supplies are all challenges that aircraft must meet in order to complete the mission safely and successfully. For this reason, it is vital that SAR team leadership understand the varied performance of different helicopters and give due consideration to an aircraft's lifting capacity, hover ceiling, airspeed and fuel requirements when selecting aircraft for SAR operations.

Capabilities and Specifications - Definitions

An understanding of the definitions listed below is essential to appreciate how the technical specifications of one helicopter can vary from another. Remember that these specifications are generally for a "standard day" (altitude = sea level; temperature = 59 degrees Fahrenheit).

Hover Out of Ground Effect (HOGE)

Hover Out-of-Ground Effect (HOGE) is the absolute altitude limit of the helicopter's ability to hover when out-of-ground effect. Briefly, Ground Effect is the additional lift caused by the return of a helicopter's rotor wash from suitably hard terrain below the helicopter, and is typically limited to flight elevations one-half the main rotor diameter from the ground. (For a more comprehensive discussion of Ground Effect, see Helicopters in Search and Rescue, Basic Level, Part 3 Principles of Flight.)

Hover In Ground Effect (HIGE)

Hover In-Ground Effect (HIGE) is the altitude limit of the helicopter's ability to hover when in in-ground effect (as noted above, normally effective up to a height above ground equal to the radius of the main rotor). This is measured from the plane of the main rotor blades to the ground.

Gross Weight

"Gross Weight" is the maximum certified weight in pounds of the aircraft, its pilot, crew, fuel, equipment and cargo. Some models have higher or lower weights for jettisonable external loads, cargo that is carried outside of the cabin, often below the helicopter's skids, and that can be released while the helicopter is in flight or hover. If no number appears in the external weight block, the weight is the same as internal.

Payload

Payload is established by subtracting the equipped weight of the helicopter from the computed gross weight for a calm day at 5,000 feet pressure altitude, 80 degrees Fahrenheit, 7,400 feet density altitude, 2 hours of fuel and a pilot. Pilots and crew use charts or "tabulated data" which provides payload data for a variety of temperatures and pressure altitudes.

Ceilings

These are in- and out-of-ground effect hovering ceilings, computed at maximum gross weight in a standard atmosphere and calm air. This value is "density altitude." Published performance figures for a given helicopter are often written in this format: Hover Ceiling at Max Weight = 4500ft OGE and 6500ft IGE. In this example, the helicopter listed would be able to hover at max weight at a density altitude 4500 feet above the ocean, but could hover at density altitudes as high as 6500 feet provided it was within one-half its rotor diameter above hard ground.

Fuel Consumption and Fuel Capacity

Fuel consumption, given in pounds per hours, is computed for 5,000 feet pressure altitude at 80 degrees Fahrenheit. Fuel capacity is computed using a measured amount of fuel burned in a known amount of time.

Part 2 – Helicopter Landing and Takeoff Areas

One of the most important aspects in One of the most important aspects in planning for helicopter operations is the selection of heliports and helispots for the helicopters. The Air Operations Director and/or Heliport Manager (within the ICS system) may have at their disposal the finest helicopter, the finest crew, and the finest helicopter accessories available. Without a network of heliports and helispots, however, it would remain impossible for them to deploy the machine and its crew to their full effect.

For large, extended search and rescue operations, the types of activity and the volume of helicopter traffic will determine selection and development of helispots. The ideal site should be inexpensive to develop and should be sufficiently large to accommodate the type of helicopters used and the volume of traffic expected.

Landing and Takeoff Areas - Definitions

Permanent Heliport

A permanent heliport is a permanent facility for helicopter operations, often at or near the incident command post. It is usually the "home base" of assigned helicopters and personnel and thus has a greater depth of resources to support helicopter operations compared to temporary or intermittently used take-off and landing areas or those areas of smaller size.

For large scale operation, a heliport should be large enough to accommodate at least two medium-class helicopters, and should have fueling facilities, a reliable wind indicator, signs, fire extinguishers, paved pads, vehicle parking areas, and reliable telephone and/or radio communications.

A heliport of this size should be located far enough from the command post that the sounds of aircraft ingress and egress does not disturb operations at the command post. Still, it should be close enough that distance or other logistical challenges do not compromise reliable two-way radio communication.

The types of activity will affect the selection and development of heliports and helispots. Photo: Charley Shimanski

Helibase

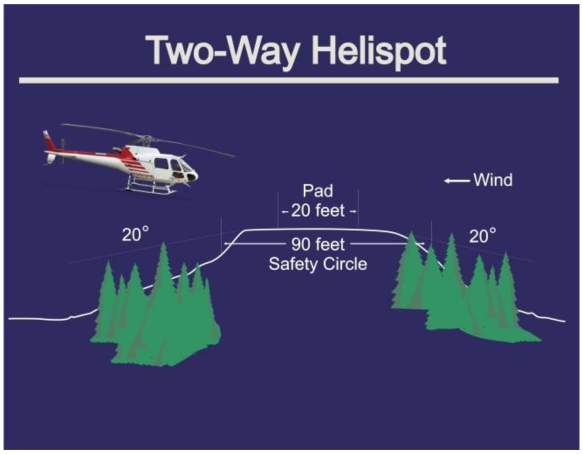
A helibase is a secondary base to be activated intermittently as the need arises. A helibase should contain most of the facilities required for a permanent heliport.

In an extremely large operation, there may be two or more helibases. Facilities should include parking areas for refueling and maintenance trucks, and adequate communications with the command post.

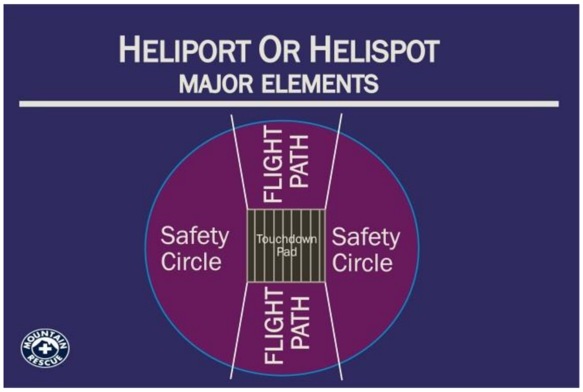
Helispot

A helispot is a natural or improved takeoff and landing area intended for temporary or occasional helicopter use in the field. It may or may not have road access. In many cases, helispots do **not** meet the basic requirements of a heliport and, therefore, should not be declared formally or referred to as heliports.

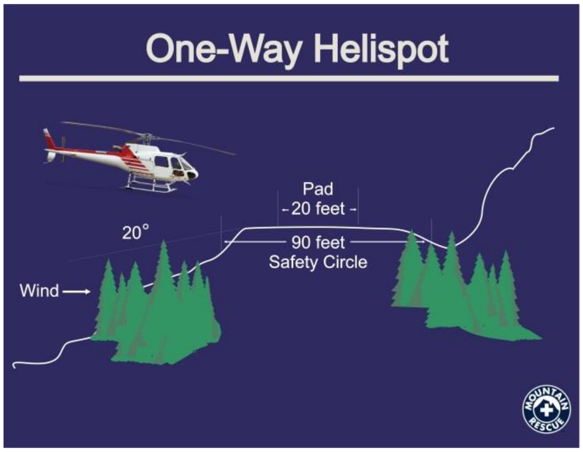
A two-way helispot (pictured below) is ideal because it gives the pilot the ability to choose an approach that allows flight into the wind during landings and takeoffs. Remember that a helicopter pilot will prefer to land and takeoff into the wind to increase lift (see Helicopters in Search and Rescue, Basic Level, Part 3, principles of flight).



It is important to maintain safety precautions around all helispots. A safety circle (described in the diagram) of 90 feet or greater is important, as is a 20-foot landing area (or "touchdown pad"). In addition, trees and other natural or man-made obstructions should be low enough to allow for a 20° angle of approach or departure.



The ideal helispot is hard and level, is naturally free of dust and debris and offers an unobstructed flight path. A helispot should be reasonably near incident or work sites. In some cases, one-way helispots may be the only option. In this case, the same safety circle, touchdown pad and approach/departure angle should be maintained.



Off-Site Landing Area/Landing Zones

An off-site landing area is an unimproved area to be used once, and only once, at the discretion of the pilot. These sites are common in rescue operations where only one victim is to be rescued, and the evacuation is made by helicopter.

Rescuers often call these off-site landing areas "landing zones" or "LZ's."

Major Elements of a Heliport/Helispot

Detailed below are several important aspects that must be considered when developing heliports or helispots.

Landing and Takeoff Area

As its name suggests, the landing and takeoff area is the specific area in which the helicopter actually lands and takes off. This area includes both the touchdown pad and safety circle. A "landing and takeoff area" exists in virtually every landing zone, whether it is at a heliport, helibase or helispot.

Safety Circle

The safety circle is a zone created to ensure an obstruction-free area on all sides of the landing and takeoff area.

Touchdown Pad

A touchdown pad is that part of the landing and takeoff area where it is preferred that the helicopter land. As with the safety circle, it is essential that there be no large obstacles or debris in this area. When possible, the touchdown pad should be clearly marked.

Approach/Departure Path (Flight Path)

The approach/departure path is a clear path selected for flight extending upward and outward, in both directions, from the touchdown pad and safety circle. At higher density altitudes, this path must be extended to allow for takeoff when altitude and heat reduce the aircraft's lift.

Other Helispots/Heliport Safety Considerations

Whenever possible, landing zones should be located such that landings and takeoffs may be made into the prevailing winds. Rescuers should avoid, if at all possible, one-way helispots (those which only allow for approach from one direction, see above), especially at higher altitudes. Furthermore, slopes should be avoided at all costs: hard, level terrain is essential for safe landing.

Landing Zones Over or Near Water

Water provides a poor ground effect base for hovering. River currents move the ground cushion and can disorient pilots. Furthermore, if a helicopter must take off over water from a helispot on shore, the ship may need at least 300 feet of water over which to gain air speed.

Canyons

Rescuers should be know that canyon bottoms lack the downdrafts from neighboring ridges and often contain areas of 'dead air' – also known as dead air holes – that provide reduced lift to aircraft. Moreover, in deep canyons, a helicopter will need a long forward run or an area sufficiently wide to circle in order to gain elevation.

Grassy Meadows

Like water, meadows with high grass will tend to dissipate helicopter ground cushion and thus provides little or no in ground effect hover. High grass may also hide obstacles to safe landing: rocks, logs and swampy ground. Furthermore, dry grass can be a serious fire hazard.

Landing Zones on Snow or Ice

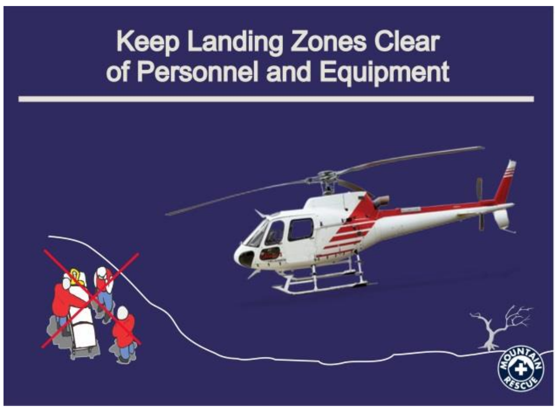
The presence of snow or ice on a landing zone dramatically increases the danger to aircraft and rescuers. For this reason, SAR teams should avoid placement of landing zones on ice or snow whenever possible. If an icy landing zone must be used, it is vital that those with greater than 10% slope be avoided. When attempting landing on an icy landing zone, a pilot may not be able to judge the landing site's slope angle and iciness.

If rescue conditions demand use of an icy LZ, rescuers must stay well clear of the helicopter during landings and takeoffs, since the ice or snow under the helicopter skids can allow the torque generated by the main rotor to cause the tail rotor to swing or spin.

Landing zones with snow and ice complicate more than take-off and landings. If an aircraft is parked on a snowy/icy surface for an extended period, the skids may freeze to the surface of the snow/ice. This attachment is dangerous because it can cause the helicopter to roll and crash during takeoff.

Keeping LZ's Clear

Rescuers must keep landing zones clear of personnel and equipment at all times. In addition, rescuers should keep at least 100 feet away from helicopters except when loading.



Heliport Safety Operations

The following guidelines must be enforced at the heliport:

First, there should be NO SMOKING within 200 feet of all helicopters. Mission management should strongly consider having fire-fighting equipment (e.g. fully equipped pumpers) at the scene of the heliport during all hours of operation.

The following procedures should be observed when refueling helicopters at landing areas:

- Helicopter engines will be shut off and rotor blades fully stopped (aircraft equipped with closed-circuit fueling systems need not shut down).
- There will be no passengers aboard the choppers while refueling.
- Both helicopters and fuel containers must be grounded.
- Fire extinguishers will be on hand.

Wind direction should be indicated by use of a windsock, flagging or streamers. Heliport landing zones, particularly refueling areas, should be dust-proofed by wetting down or by other means to prevent damage by dust and other foreign objects. LZ's should be kept clear of lightweight, loose objects and unauthorized personnel. Ground vehicles near helicopters should not be moved until the chopper rotors have come to full stop. Helicopters with wheels must be chocked after landing, and parking brakes must be set.

One-wheel or one-skid landings should not be performed in the heliport. When helicopter accessories such as sling loads are being used, unauthorized personnel should never be standing directly beneath any portion of the helicopter or equipment. Finally, takeoff and landing areas must be clear of other aircraft, personnel and vehicles.

Heliport Equipment

The following equipment should be available at the heliport:

- Fire extinguisher (200 pounds at each permanent base heliport - 20 pounds per helicopter.)
- Protective clothing
- Crash rescue equipment for entry and extrication.
- Crash evacuation kit including stokes litter and appropriate first aid equipment.
- Water for refuelers doused in jet fuel - possibly a spare set of overalls

Furthermore, the Incident Commander, Operations Chief and/or Heliport Manager must know how to mobilize specialized crash/fire rescue units---their locations, phone numbers and call-out procedures. The above team leadership should be familiar with the nearest medical facilities, their locations and phone numbers, and should know which facilities specialize in the treatment of burns and head injury. Team leadership must also ensure that medical transport/ a means to transport patients exists, to possibly include trauma center helicopters with their specialized teams.

Heliports should have several pieces of essential safety equipment. Photo: Charley Shimanski

Helicopter Evacuations

In addition to transporting search and rescue workers, helicopters are often used to transport injured subjects. In these cases, helicopters can make pickups in three ways

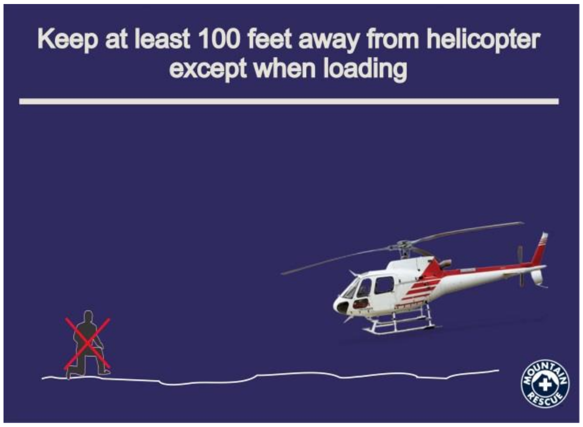
1. by landing at a LZ
2. by making a hovering or one-skid recovery, or
3. by using an external load operation (hoists, short-hauls)

The last two are hazardous, even under optimal conditions. In conditions of mountainous terrain, evacuations should be by landing if at all possible, even if this means a trail carry of the victim by ground crews to a nearby LZ. In many mountain rescue situations, there is ample time to locate or construct a safe landing zone and no benefit (and significant increased risk) to attempt hovering or one-skid recoveries.

Landing Recoveries

A landing recovery is the safest of the three means of subject/patient evacuation listed above, and requires that the helicopter be on the ground, with its full weight supported on its skids or landing gear. In most landing recoveries, the helicopter's rotors will come to a full stop. Despite its relative safety, however, hazards exist even in a landing recovery. While rescuers will have likely trained with the helicopter and its crew and have worked with them in the past, the victim is likely experiencing helicopter evacuation for the first time and may be anxious, afraid or uncertain. Rescuers should therefore give victims brief direction regarding helicopter safety, to include what the victim should expect, and a warning to stay away from the rear of the helicopter (if the patient is ambulatory). Even if the helicopter is fully without power, rescuers should escort any walking victims to the helicopter and assure that they are secured in their seats with their full restraint safely locked in, including seat belt and chest harness.

Rescuers should note that a patient on his or her back in either a litter or on the helicopter pram will likely become nauseated during helicopter flight and may vomit during transport. Safe patient evacuation requires that rescuers understand and prepare for this event so as to make the patient as comfortable as possible and to minimize danger to crew in-flight.



Hovering and One-Skid Recoveries

Although landing recoveries are the safest means of evacuation, there are times when geography and the severity of a patient's medical condition conspire to necessitate a hovering or one-skid recovery. These recoveries are dangerous, and pilots and rescuers should choose to carry them out only after careful deliberation of other options. Often it is a victim's time-critical medical condition that leads rescuers to purse a hovering or one-skid recovery.

Although a victim's deteriorating medical condition can prompt rescuers to undertake a hovering or one-skid recovery, these same medical problems can be made worse or their treatment compromised by the technical challenges of the recovery itself. In addition to the fear, uncertainty and anxiety the victim may experience during the recovery, the rotor downwash and movement limitations imposed by hover and one-skid recoveries can make patient transfer painful, and can render adequate monitoring or treatment of life-threatening conditions difficult or impossible. Prior to commencing recovery in hover or on one-skid, rescuers should advise the victim of the recovery procedure and should be certain that the victim is capable of withstanding the physiologic and emotional strain of the recovery procedure, which will include very loud noise, high rotor wash and often rough movement in dangerous conditions.

If rescuers are unable to communicate with the pilot and a rescuer will not accompany the victims on board the chopper, the rescue team should attach a tag to the victims stating their medical conditions, the treatments they have received as well as where they should be taken.

When selecting a site for a hovering recovery, rescuers and pilots use factors that are nearly the same as when selecting a helispot: the site should be hard, dust-free and with clear flight path. When compared to helispots, however, hovering recoveries enable use of a smaller ground area, rougher terrain and steeper slope. On the other hand, it is extremely important that the site afford ample room for movement of both the main rotor and the tail rotor boom, since the pilot may have to turn the helicopter suddenly if the wind changes. If at all possible, hovering recoveries should employ an experienced hand signaler, ideally one that the pilot knows is competent. Ground personnel should keep within the pilot's view as the landing site's geography allows. One-skid recoveries undertaken on rock outcrops often render these safety additions impractical.

External Loads (Suspended/Retractable Recoveries)

A detailed explanation of external load operations is found in the "Helicopters in Search and Rescue Operations – Advanced Level" program of the Mountain Rescue Association.

In-flight Emergencies

Even with careful attention to safe preparation and flight planning, in-flight emergencies can occur. These emergencies may arise from mechanical issues within the aircraft, or from compromised visibility and/or deteriorating weather outside of it.

In the event of an in-flight emergency, the following procedures must be observed:

- Notify base of emergency and location, regardless of how minor the emergency may appear. This is normally accomplished by the pilot
- Assure that seat belts and, whenever possible, chest harnesses are snug.
- Secure protective equipment, including helmet and clothing.
- Keep hands and feet clear of controls.
- Secure any loose gear.
- Check emergency exits and operation.
- Observe the following crash landing seating positions
    - For passengers facing forward or sideways with seat belt only: lean forward, tuck head between knees and place arms around knees.
    - For passengers facing forward with seat belt and shoulder harness: lean back all the way and tighten all straps.
    - For passengers facing to rear with seat belt and/or shoulder harness: lean back all the way and tighten all straps.
- Exiting: Wait until all motion stops unless there is a fire or unless instructed to do otherwise by the pilot.

Part 3 – Helicopter and Heliport Management

Introduction

The addition of helicopter aviation to any search and rescue mission complicates operation management. Safe and efficient deployment of helicopters in SAR requires experienced and qualified leadership with a working knowledge of helicopter aviation and its required logistics. For larger operations, this depth of experience will span key leadership in incident command and those in charge of heliport management.

The speed of helicopter flight creates the primary logistical challenge: helicopter missions have short turn-around times which in-turn demand efficient support (fuel, personnel, mission direction, etc.) in order to enable the helicopter to augment SAR operations to the fullest extent possible. The experienced Heliport Manager will anticipate these rapid turn-arounds and prepare for them.

Recommended Procedures

A Heliport or Helispot Manager should be assigned to each heliport or helispot employed by the SAR mission. The Heliport/Helispot Manager should be trained in basic helicopter use and thoroughly familiar with the safety principles that underpin safe loading and unloading of aircraft. The Heliport Manager of each given heliport or helispot will oversee loading and unloading and will enforce safety procedures. SAR leadership should provide an adequate ground crew to support the manager and aircraft.

It is the responsibility of the Incident Commander or Air Operations Director to place trained and qualified people in helicopter management.

Considerations When Utilizing Media Helicopters

Media helicopters will often partner with search and rescue operations: a successful rescue for an SAR team can make for a great news story. When search and rescue teams request the assistance of media helicopters, however, the media staff may in-turn request for information or interviews. It is important that the Heliport Manager recognize that the Incident Commander, Operations Chief, head of local law enforcement or the assigned Public Information Officer are responsible for media interviews are press releases. The Heliport Manager should discourage media interviews with SAR team members, rescued subjects or family until operational leadership has been notified.

Special consideration must be given when working with media helicopters. Photo: Charley Shimanski

Considerations When Utilizing HEMS Helicopters

If HEMS medical helicopters arrive at a heliport or at the command post en route to a rescue scene, the Heliport Manager or Incident Commander must ensure that the flight medical team is able to quickly contact field medical personnel for a briefing on the rescue and/or patient's status to enable the field team to marshal support quickly and efficiently. Those familiar with the designated field LZ should brief the pilot on the site and the challenges it might pose to safe landing.

Locating the Base Heliport

Search and rescue teams should observe standard guidelines when deciding where to locate helicopter landing and takeoff sites. The best heliports are positioned on exposed ridges or knobs adjacent to a precipice or sharp geographic fall. Helicopters can make use of these steep drop-offs to gain airspeed and lift during takeoff and to undertake takeoffs with less power, larger payloads and greater safety margins. These sharp drop-offs become increasingly important at higher elevations because they enable a helicopter to gain airspeed safely in altitudes where the air is thinner and lift is reduced.

Location of the heliport is of fundamental importance, and in particular, it's the location relative to that of the command post. If possible, the heliport should be within walking distance of the command post, but not so close that dust, dirt and noise impair base operations.

The heliport should be large enough to accommodate all helicopters engaged in the mission. In extended search operations, the Air Operations Chief should also plan for potential expansion of the search and rescue helicopter fleet when sizing the heliport.

The heliport must be accessible by road, and preferably a road distinct from the main road to the to the command post. The heliport should have access to water, if possible.

Activating the Base of Operations

Search and rescue team leadership must consider several important issues when activating the Heliport. First, personnel should restrict travel on the heliport using barriers, cones, flagging, etc. The team should then ensure controlled access for official vehicles and personnel and provide warning and directional signals as necessary. Signage should include "NO SMOKING" signs at fuel storage areas around heliport as well as directional signs pointing the way to the heliport and the command post.

Installation of a windsock or flagging (if windsock is not available) is essential. These wind indicators must be outside any and all takeoff or landing paths and should be posted where pilots can clearly see them. Wherever possible, wind indicators should employ a smooth surface pole to prevent the flag or sock from "hanging-up" in heavy wind or rotor wash.

Heliport management requires logistical consideration of Fuel and Oil. The Heliport Manager must maintain adequate supplies of jet fuel and oil and ensure proper storage of the same. All drums should be stored at least 100 feet from the landing area and provided with shade and air circulation. Finally, fuel trucks should enter the landing and takeoff area only for refueling of aircraft, and be removed promptly upon completion of their work.

A functional Heliport requires robust and effective communications. Telephone contact with the command post may be useful. Radio communications between aircraft, managers and the command post are essential for efficient use of aircraft. Pilots should be briefed on the appropriate frequencies for all communications. Finally, all helicopters must be equipped with radios/frequencies essential to the mission.

In addition to the above, experienced heliport management will consider other important issues. Trash cans for paper, oily rags, and oil cans etc. may be useful. If the SAR team leadership anticipates the mission be a long one, they should ensure the presence of a portable generator or other source of electricity to provide lighting. Water or dust abatement liquids should be employed to maintain a dust-proof environment for the heliport. Finally, leadership should consider keeping a vehicle ready to transport rescuers, pilots and key overhead to and from the command post.

Managing the Heliport

Duties of the Heliport Manager

The following duties are the responsibility of the Heliport Manager:

First, s/he requests ground operations crew through the Operations Chief. S/he also supervises construction of the heliport and helispots. The Heliport Manager must also order necessary facilities and equipment from the Operations Chief for safe efficient heliport operation and supervise the installation and placement of these facilities.

The Heliport Manager must obtain data on each aircraft operating on the heliport, including:

- Type
- Owner and pilot(s)
- Estimated time of travel
- Limitations on normal use
- Hours flown

The Heliport/Helispot Manager must also secure a priority list of air missions and schedule flights as directed by the Operations Chief and/or Incident Commander. In addition, the Heliport Manager supervises and clears all missions approved by the project manager (Assignments should be made the previous night, during the evening planning session). Maps showing mission area, hazard areas, heliports, etc. must be furnished to helicopter support crews and pilots.

The Heliport Manager must brief pilots, helicopter support crews and other personnel on the following:

- Type of mission to be flown
- Landing and takeoff areas (helispots) to be used to include their numbers and locations
- Weather conditions
- Hazards, such as power lines
- Safety and emergency procedures
- Other aircraft activities
- Established flight patterns at all landing areas
- Communications protocol and frequencies

Aided by the ground crew, the Heliport Manager must instruct all personnel in helicopter safety. Emphasis is placed on safety training in approaching, entering, riding and exiting the helicopter. The Heliport Manager must also assure that personnel and freight are loaded at the heliport and unloaded at the field helispot safely

The Heliport Manager must also ensure that flight operations cease during periods of high wind and poor visibility and arrange to protect helicopters at night.

The Heliport/Helispot Manager must also address several other operational concerns. S/he must receive overhead, crews and supplies as they arrive at the heliport and then verify arrangements for transportation to assigned destinations. S/he must also record estimated time of arrival (ETA) on all assigned helicopters. To do so successfully, the Heliport Manager must work closely with the helicopter dispatcher and timekeeper. By recording ETAs, leadership ensures better helicopter management and can initiate search immediately for overdue or lost helicopters. (A missed radio check-in during a 1988 Alpine Rescue Team search was the primary reason that the team quickly located the downed aircraft with one survivor on board).

Duties of the Heliport Crew

The Heliport Crew must construct and equip the heliport as directed by the Heliport Manager. They must maintain the heliport including dust abatement. They must also assist in supervising the loading and unloading of personnel. It is best to escort personnel to and from helicopters. Ground crewmen also carry tools and equipment for passengers and check belts before takeoff.

Conclusion

The key to effective resource management in search and rescue operations lies in the following:

- Early identification of the mission's requirements
- Effective mobilization of these required resources
- Efficient management of the resources at the scene
- Accountability for resource utilization

Effective helicopter resource management brings additional concerns that must be met to ensure the success of a search and rescue operation. These are:

- Clear safety standards that are met – if not exceeded – by the entire team
- A means to track compliance with these safety standards
- A risk-benefit analysis undertaken prior to the launch of any aircraft.

With proper management of airborne resources, search and rescue teams can accomplish more than when their efforts are held to the ground.

Once again, "helicopter management" is "the direction, scheduling, coordination and control of helicopter use in accordance with agency policies to ensure maximum efficiency as well as safety in all aspects of the search or rescue operation."

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Dedication

This program is dedicated to Peter Peelgrane, Chief Helicopter Pilot, KUSA-TV, Denver. As a pilot, Peter demonstrated unparalleled concern for mankind, clear focus on safety and uncanny eyes of an eagle. As a friend, he displayed ardent determination to overcome hardship and a questionable sense of humor. For all these things, Peter, we miss you