

Safety Regulation Group



CAP 426

Helicopter External Load Operations

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April 2006

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Appendix C Air Navigation Order 2005 (ANO) References

Glossary

AGL	Above Ground Level
AOC	Air Operators' Certificate
ANO	Air Navigation Order 2005
AUM	All Up Mass
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication (CAA Document)
COSHH	Control of Substances Harmful to Health
CofG	Centre of Gravity
DA	Density Altitude
DAC	Dangerous Air Cargo
EEDS	Electrically Initiated Explosive Devices
FM	Flight Manual
HF	High Frequency
HMSO	Her Majesty's Stationery Office
HSE	Health and Safety Executive
LOLER	Lifting Operations and Lifting Equipment Regulations 1998
MAUM	Maximum All Up Mass
PA	Pressure Altitude
PPE	Personal Protective Equipment
PUWER	Provision and Use of Work Equipment Regulations 1998
RADHAZ	Radio Hazards
RoA	Rules of the Air Regulations 1996
SWL	Safe Working Load
SWR	Steel Wire Rope
USL	Underslung Load(s)

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Chapter 1 Helicopter External Load Operations

1 Introduction

Helicopter flying with underslung loads (USL) requires special precautions to be taken if both the helicopter crew and third parties are to be protected from undue risk. This publication contains advice on various aspects of external load operations for the benefit of operators, pilots and persons supervising the securing and detaching of loads. A full and comprehensive briefing and a formal Risk Assessment should be carried out with all staff involved in the operation.

Reference may also be made to:

- CAP 428 – Safety Standards at Unlicensed Aerodromes (including Helicopter Landing Sites);
- Health and Safety Executive (HSE) legislation and guidance contained within the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER); and
- HSE Provision and Use of Work Equipment Regulations 1998 (PUWER).

HSE information can be accessed from www.hse.gov.uk.

In simple terms the CAA holds the duty of regulation above the point at which the load is released from the helicopter and the HSE legislation applies to the maintenance and inspection of all equipment below the point of release.

2 Carriage of Dangerous Air Cargo (DAC)

The rules applying to internal DAC loads do not necessarily apply to those carried externally. USLs pose less of a hazard to the helicopter and crew because the loads are further removed from them. Furthermore, USLs can be jettisoned immediately if required. In any event, the helicopter captain must be advised of any DAC aspects relating to the load that he is tasked to undersling. The most common hazards are those associated with static electricity when carrying items of a flammable or explosive nature, or radio hazards (RADHAZ) where aircraft High Frequency (HF) radio transmissions may affect electrically initiated explosive devices (EEDS) or fuse mechanisms of weapon systems. Finally, there is always the remote possibility of an unintended load release and any likely additional hazard posed by any DAC aspects must be considered prior to load pick-up.

3 Carriage of External Cargo

The normal method of carrying external cargo by helicopter is to suspend it from the helicopter by means of an external cargo hook or hooks. Depending upon the helicopter type, the cargo hook is either suspended by cables and/or a frame from the belly of the helicopter, or is attached to mountings on or a connection panel within the belly of the helicopter. The loads may be transferred to the main rotor gearbox by means of a load pole.

4 Carriage of Loads from Single Cargo Hooks

The system of employing a single cargo hook for suspending a load is known as "single hook suspension", whereas the system of lifting a load from a single point on the load is known as "single point lift". Helicopters operating with a single cargo hook allow for a relatively simple load hook-up process, but once in flight the load is free to twist and orientate into positions of high drag, or commence spinning about its vertical axis or take on a swinging motion. The overall effects of the foregoing generally become more pronounced with an increase in the helicopter speed. For this reason single cargo hook helicopters are frequently unable to exploit their true speed capabilities when carrying external loads.

5 Certificate of Airworthiness Limitations

Special advice concerning load-lifting equipment is contained in Flight Manual (FM) supplements applying to those helicopters equipped with hooks or hoists. The limitations, flight handling techniques and details of the representative loads demonstrated at the time of certification constitute basic information concerning the use of the aircraft in the load-lifting role. In the absence of specific details of loads, it should be assumed that only dense loads with predictable aerodynamic characteristics have been carried. In cases where it is intended to carry loads of irregular shape or low density the advice contained in paragraphs 6.18, 6.19 and 6.20 should be followed to determine the safe flight characteristics.

6 Operational Control and General Safety

6.1 Nature of Cargo Hooks

Helicopter cargo hooks are designed to function as "cargo release units", allowing for the release of a load by remote control, exercised by the pilot (sometimes the crewman) from within the helicopter. Most helicopter cargo hooks are of the electromagnetic type, often referred to as electromechanical release units. Although there are differences in appearance, size and design of the various hooks they all follow the same basic principle of operation. They employ a solenoid unit, housed on the hook casing, which converts electrical energy into mechanical movement, activating the internal mechanism of the release unit so as to open an internal latch. This allows the carrying beam of the hook, known as the load beam, to pivot downwards and release any attached sling, net-lifting ring or similar device.

6.2 Use of Term "Primary Hook"

The helicopter cargo hook is generally referred to as the "primary hook", which provides a simple way of distinguishing it from the terminal hook fitting at the end of any extension strop. The extension strop hook is, in turn, known as the "secondary hook".

6.3 Connector/Coupling Facility (Extension Strops)

The secondary hook on an extension strop provides a means of connection for slings or cargo lifting nets, which for any reason may not be directly attached to the primary hook. Secondary hooks also afford the means of coupling equipment lifting rings and multiple loads.

The extended distance from the helicopter to the load can be advantageous for the following reasons:

- It provides a safe suspension distance for loads, which, because of their size or flying characteristics, pose the risk of striking the helicopter in flight;
- It affords a means of attaching or landing a load when the helicopter is unable to descend because of surface obstacles such as trees, buildings or ships rigging;
- It allows the attachment of loads where the primary hook is incompatible with the rigged load;
- It allows the helicopter to hover higher thus minimising the effects of rotor downwash, with associated blowing of dust, snow or loose items, and damage to surrounding structures; and
- It makes the process of load hook-up safer and simpler for the helicopter crew and for ground handlers when operating with awkward shaped loads and increases the space available between the load and the helicopter. It also minimises the chance of the helicopter striking the load and removes the need for precise positioning over the load until the moment of lifting the load off the ground.

6.3.1 Extension strops are classified by a safe working load (SWL). Equipments vary in length, with the legs being constructed from textile or steel wire rope (SWR). The top of the leg is either formed with a lifting loop or eye, or has a shackle or similar device for attachment to the helicopter primary hook. The bottom of the leg is fitted with a secondary hook for reception of the sling lifting ring, net stirrup or similar device. Equipment attached to the secondary hook must be manually removed by depressing a spring-loaded keeper to enable the item(s) to pass free of the hook bill. The employment of a swivelling secondary hook is mandatory.

6.4 **Swivel Facility**

Certain loads have a tendency to rotate in flight, either intermittently or in the form of a sustained spin. Without a swivel device in the suspension system this would lead to winding up of the sling legs or strops, causing damage to these items and placing torsional strain on the primary hook and/or its point of attachment to the helicopter. The end result could be the inadvertent release of the load. It follows that for the carriage of new loads, or new load configurations, where the flying characteristics are unproven, or for loads that are known to rotate in flight, a swivel device must be included in the suspension system. The extension strop allows for the introduction of such a swivel device.

6.5 **Route Planning**

6.5.1 The selection of a route for a flight with an external load must be such that the risk to persons or property from a falling load is minimal. The Air Navigation Order 2005 (ANO) prohibits flight by helicopters with suspended loads over congested areas of cities, towns or settlements. The definition of congested area is contained in the ANO.

6.5.2 Operators are also reminded of the requirements of Rule 5 of the Rules of the Air Regulations 1996 (RoA). Flights contrary to the ANO and/or Rule 5 of the RoA may only be undertaken if the CAA has granted a written Permission, which may contain special conditions. Applications for these should be made in writing to the Flight Operations Inspectorate (Helicopters) (in the case of Air Operators' Certificate (AOC) holders) or the Flight Operations Inspectorate (General Aviation) (in the case of non-AOC holders), Safety Regulation Group, Civil Aviation Authority, Aviation House, Gatwick Airport South, West Sussex, RH6 0YR, at least two weeks before the date of the proposed operation. The application form for non-AOC holders may be obtained from www.caa.co.uk/docs/33/SRG1304ISS2.PDF. The fee payable may be found in the Official Record Series 5 CAA Scheme of Charges - General Aviation.

6.5.3 Routes selected should avoid the vicinity of roads carrying a heavy volume of traffic. Only in exceptional circumstances will Permission be granted for single-engine helicopters to cross motorways and busy public roads below 500 ft above ground level (agl). Where loads must be carried across busy public roads, police co-operation will normally be required to control traffic.

6.5.4 Any Permission granted by the CAA for USL operations over congested areas will be subject to specific conditions that may be unique to each operation.

6.6 **Lifting and Dropping Sites**

When there is a choice of sites, one that has an approach and departure path available in at least two roughly opposing directions is to be preferred. Platforms of temporary construction used for loads being lifted or dropped should be structurally sound and well secured. Obstructions or unfavourable terrain may require the use of a long strop but it should be remembered that helicopter performance will be reduced if the helicopter has to hover out of ground effect.

6.7 **Safety of Site Personnel**

6.7.1 Access to, and movements within, a lifting or dropping site should be strictly controlled. Personnel should not be allowed to work in, or cross, the operating area when aircraft movements are taking place.

6.7.2 The minimum scale of Personal Protective Equipment (PPE) for all site personnel should be a safety helmet with strap or retaining cord, ear protection, a high visibility jacket, a close fitting eye shield and foot protection such as Totectors. If the site is extremely dusty and/or the load has a Safety Data Sheet under the Control of Substances Harmful to Health (COSHH) then respiratory protection may also be required.

6.7.3 During loading, personnel beneath the helicopter should be kept to a minimum. Personnel must be clear of the load before any signal to lift is given unless they have been carefully briefed to assist by holding the lifting strops and/or the upper portion of the net tight and clear of the load as the helicopter takes up the weight. If practicable, the signal to lift should be given by the person effecting load attachment, once he has emerged from beneath the helicopter. With multiple loads a separate hooking team may be required with dedicated marshallers. The signal to lift the load clear of the ground should not be given until the helicopter has taken the strain, and the load is not entangled with the lifting tackle and is clear of any obstructions. It is most important that, in the event of engine failure with the load attached, the person(s) beneath the helicopter and the pilot should act to a pre-arranged plan that has been fully briefed before the lift takes place.

6.7.4 When a helicopter is approaching to release a load at the dropping site, personnel working in the immediate vicinity should keep their attention fixed on the helicopter and its load whilst it is close to them. The static electrical charge, which may build up on helicopter loads, should be discharged through a grounding cable before a suspended load is touched – see paragraphs 6.25, 6.26, 6.27 and Appendix B. Personnel should be aware that some helicopter cargo hooks may have an automatic release function when the pilot lowers the load onto the ground. Flight in turbulent air can activate this, thus jettisoning the load, whilst the helicopter/load combination is airborne. FMs state the minimum load which when attached to the lifting equipment should prevent this occurring.

6.7.5 Particular attention should be given to the effects of rotor downwash because of the danger of lifting loose boards or other debris, often present at operational sites, and the dust cloud that may be created. Plastic bags that can cause catastrophic damage to tail rotors pose a particularly common hazard.

- 6.7.6 Where a series of flights to a restricted dropping site is taking place the helicopter should not approach with another load until the previous load has been cleared from the site. Where a site is suitable, additional loads can be delivered as long as the unhooking personnel are briefed and remain clear until the additional load/s are on the ground. This will prevent any chance of the unhooking crew being trapped between an arriving load and one already in place.
- 6.7.7 Special areas should be set aside for the refuelling of aircraft and for fuel storage. The requirements of CAP 748 – Aircraft Fuelling and Fuel Installation Management – are to be met in full where they are applicable.

6.8 **Safety of Third Parties at Lifting and Dropping Sites**

When loads are being lifted onto, into or over multi-storey buildings, all personnel not working directly with the helicopter, as appropriate, beneath the flight path should vacate areas of one or more of the top floors, or even all the floors of such buildings. In deciding the areas and numbers of floors to be vacated, consideration should be given to the strength of the building and the weight of the helicopter and load. Similarly, with single level structures, all personnel not working directly with the helicopter should be vacated from the areas beneath the flight path. Police, fire, rescue and first-aid services should be notified of the activity.

6.9 **Hand Signals**

When working near to hovering helicopters and wearing ear protection it is impossible to hear speech. Instructions and verbal warnings are thus impossible. Only one person is normally required at the dropping site to marshal the helicopter to the correct position for placing the load, although others may be at hand, for example to return nets and slings. Pre-flight briefing of all personnel must include a warning to this effect and emphasise the need for constant alertness and unambiguous visual signals. Marshalls should ensure that they remain clearly in sight of the pilot at all times during the lifting operation. Signals for the marshalling of aircraft are given in the ANO. Those particularly relevant to helicopters are reproduced at Appendix A to this CAP. Within the construction industry there also exists a code of crane signals. Marshalls drawn from on-site personnel should be warned never to use this industrial code when signalling to a helicopter pilot.

6.10 **Preparation and Handling of Loads**

- 6.10.1 All slings, strops, nets, carriers and equipment used for lifting loads should be inspected before flight to ensure that they are in good condition, attached securely and strong enough for the task. Documentation should be shown to the helicopter captain before starting the lifting task. It is recommended that the tackle should have a breaking strain of not less than three times the weight of the load to be carried. Care should be taken to ensure that the tackle is compatible with the helicopter equipment. (For example, an open hook on the load could cause snagging when the helicopter attachment is formed by a cable loop). Both primary and secondary hook release mechanisms should be tested prior to use. Helicopters should carry a placard in the vicinity of the cargo hook showing the maximum permissible load for which the hook installation is approved. Each piece of lifting equipment should be marked with, or have documentary evidence of, its SWL. Any equipment with a limited life, e.g. number of lifts, calendar life etc., should be identifiable and a working record maintained.
- 6.10.2 It is normally the responsibility of the user to provide slinging and load securing equipment together with the final means of hooking up to either the primary or secondary hook. In accordance with the ANO, the helicopter operator must detail one person to supervise the distribution and securing of the load and must furnish that

person with written instructions. If the duties allocated to this supervisor necessitate the use of marshalling signals, illustrations of these signals should be included in those instructions.

- 6.10.3 At the pick-up point the load should be supported on level ground, or be so disposed that its attitude in relation to the slings or strops is the same as in flight. This will ensure that the load will not tilt or drag at the initial stages of the lift, ensure that it remains in balance, and minimise the onset of oscillations in flight. All personnel involved in the above duties should have access to all necessary publications and guidance literature to enable them to remain fully conversant with their role. Where this is not possible, e.g. carrying telegraph poles to be placed vertically into pre-prepared holes, detailed briefings should be given and only the most experienced pilots used for the task.
- 6.10.4 Control of the weight and distribution of loads is essential. For example, the weight of strops, slings, hooks, swivels etc. must be included in the total weight to be lifted; sand and aggregate should be kept dry and if possible weighed immediately before loading; small pieces of steel and timber should be bundled, the total weight being clearly labelled. Hand lines fastened to a load to assist ground personnel in its positioning should be of sufficient length and weighted to avoid entanglement with the helicopter structure or rotors. Large loads should ideally bear an indication of the position of the centre of gravity. A system of communication between the person responsible for loading and the pilot should be used to inform the pilot of unexpected changes in load.
- 6.11 **Netted Loads**
- 6.11.1 Advantages:
- Most loads are simple to prepare;
 - A wide variety of loads can be carried including mixed items that can be lifted as a single load; and
 - Both high and low-density loads can generally be lifted without affecting the handling characteristics of the helicopter.
- 6.11.2 The safety of the net depends upon the load weight being reasonably distributed in terms of mesh loading across the net. Uneven loading could, if significant, be dangerous at higher laden weights, particularly if the net is lifting a load that has snagged on the mesh of the net. Mesh severance could occur with the risk that this failure could propagate and cause total net failure leading to inadvertent release of the load.
- 6.11.3 Carriage of sharp edged loads without suitable net protection can result in severe damage to the net, particularly at potential load snagging points. The resulting damage could lead to an in-flight hazard.
- 6.11.4 Unless adequately secured there is always the danger that the airflow may propel low-density load items out of the net. Under certain conditions such unsecured items could lead to an in-flight hazard.
- 6.11.5 The ground marshallers and load preparation team should ensure that the netted load(s) are not dragged along the ground during lift-off or landing. Wear or serious damage can result, particularly with heavy loads. It is important if dragging has occurred that the net(s) receive an early and thorough after-flight inspection.

6.12 **Basic Rules for Slings and Nets**

- 6.12.1 Sling legs are to be arranged about the load in a symmetrical manner; e.g. with a four-legged sling the two outer legs are led to one end of the load and the two inner legs led to the other end.
- 6.12.2 It is very important to ensure that the sling legs are not crossed at the stage of attaching them to the load. The same principle applies to the lifting strops on nets at the stage of engaging lifting hooks to the net stirrups. It is also important to ensure that individual net lifting members are not twisted along their own length.
- 6.12.3 When the sling legs are in the fully deployed state, with the load suspended, the SWR and textile elements of the sling legs are to be clear of the load.
- 6.12.4 With four-legged slings, if less than four legs are being used to lift the load; the legs not in use must be securely taped to the legs in use. This will prevent snagging of the unused legs during the initial load lift and any possibility of flailing in flight.
- 6.12.5 Loose chain must be taped back securely onto the standing part of the chain, or secured in some other suitable manner. The mouths of all chain hooks should be taped after their engagement onto a chain, to prevent inadvertent detachment prior to load lift or at any time when the chain is slack. Similarly, to prevent snagging, shortening clutch claws must be taped.

6.13 **Aerial Advertising and Banner Towing**

Aerial advertising by banner towing from a helicopter is prohibited under Article 82 – Prohibition of Aerial Advertising and Propaganda - of the Civil Aviation Act 1982. The only form of aerial advertising allowed is prescribed in paragraph 4.g of the Civil Aviation Aerial Advertising Regulations 1995 (Statutory Instrument No. 2943) that allows “the use of any helicopter for communicating information by means of an illuminated or non-illuminated sign attached to but not towed behind the helicopter”.

6.14 **Maximum Weight of Load that can be carried on Helicopter Cargo Hooks**

The maximum weight of load that can be suspended from the load beam of a cargo hook is governed by the following:

- The SWL of the cargo hook;
- The maximum allowable weight of external load cleared for carriage by a given helicopter type. This is given in the FM, or supplement to the FM, and may be less than the rated lifting capacity of the cargo hook with which the helicopter is fitted;
- The SWL of the slinging equipment being used; and
- The Maximum All Up Mass (MAUM), payload available and allowable Centre of Gravity (C of G) envelope of the given helicopter type.

6.15 **Payload Available**

- 6.15.1 The actual payload that can be lifted (i.e. the payload available) for any particular sortie, will depend upon the following factors:
- Density Altitude (DA) at both the pick up and drop points. DA is a function of Pressure Altitude (PA), temperature and humidity;
 - Number of crew;
 - Basic weight of the particular helicopter and role equipment installed; and
 - The required radius of action, which will determine the fuel load plus reserve fuel as required for the sortie.

6.15.2 A common error made by inexperienced pilots is to think that the SWL of the primary hook is the same as the weight that can be carried by the helicopter. This disregards the MAUM limits of the helicopter itself and is potentially dangerous.

6.16 **Checks Prior to Hooking Up**

6.16.1 Immediately before hook-up the following checks must be made:

- Any net to be used must be fully serviceable;
- Net lifting strops are to be taped together, or held by a breakaway retainer, so that they cannot catch on any projecting portions of the load during the initial stages of the lifting operation;
- The All Up Mass (AUM) of the load is to be calculated. This is the weight of the load itself and all slings, nets, strops, swivels and shackles;
- There must be no exposed sharp edges that could damage the net or slinging equipment;
- All items which have a large volume but low mass, (i.e. low density loads) such as empty drums or jerry cans, must be positively secured in the net; and
- The net is to be as evenly loaded as possible.

6.16.2 It is permissible to lift clusters of two or more nets at once but the load in each net is to be of approximately the same bulk, i.e. of approximately the same density and mass. The use of an extension strop with a swivel hook is mandatory.

6.17 **Acceptance of a Load for Flight**

The final responsibility for the acceptance of any load for flight rests with the captain of the helicopter concerned. The masses of slung loads are to be made available to the captain before flight to enable accurate flight planning. The total mass of a slung load is always to be determined accurately.

6.18 **Precautions During Initial Lift**

6.18.1 Care must be taken that the lifting strops of the net do not catch or snag on any projection of the load. Taping the lifting strops will assist in keeping them clear but it may be necessary for personnel to assist by holding the lifting strops and/or the upper portion of the net tight and clear of the load as the helicopter takes up the weight.

6.18.2 With some loads it may be difficult to prevent individual parts of the net from being overloaded but every effort must be made to prevent this. Ideally each cord length within the net should be of equal tension but this is impossible to achieve in practice. If one or two cords in any one area of the net are taut, whilst adjacent cords are comparatively slack, then the load must be adjusted to equalise the tension as far as is possible.

6.18.3 Marshalls, crewmen and pilots must ensure that the helicopter cargo hook is central over the loaded net before the helicopter starts to lift. If it is not, the load will be dragged along the ground with consequent wear and possible breakage of the net.

6.19 **Flying Limitations and Load Stability**

6.19.1 Nets, slings and strops should not to be flown underslung when unladen. An empty net deploys rapidly towards the horizontal at speeds as low as 30 kts, with the subsequent danger that they may be drawn into the main or tail rotors. Although not recommended, if specially constructed weighted strops are flown unladen then careful briefings should be given, speeds restricted, and the "flight" of the strop monitored in flight by the use of mirrors. A comprehensive Risk Assessment should be conducted for all such operations.

- 6.19.2 The weight of cargo should not be less than 227 kg (500 lb) in total and this in turn should be related to the drag profile of the load. Certain low drag high-density loads with a total cargo weight of less than 227 kg may prove acceptable. The safe carriage of any ultra-low density or ultra-lightweight load will depend upon the speed at which the maximum allowable trail angle is attained and at which any deterioration in load handling characteristics takes place.
- 6.19.3 The maximum permitted speed at which a load may be flown will depend on one or more of the following factors:
- Load motion that can cause unacceptable stresses on the helicopter or interfere with control;
 - Helicopter flight or power limits;
 - The drag of the load which results in the maximum safe trail angle being reached;
 - The natural resonance of tensioned sling or strop lengths combined with aerodynamic forces and helicopter vibrations that generate unacceptable flutter in the slings and strops;
 - With two nets in a cluster-load net separation can occur at higher speed ranges. The onset of this phenomenon may limit the maximum speed at which the load may be carried; and
 - Any other FM limitations that prevent the carriage of the load at a higher speed.

6.20 **Load Oscillation**

- 6.20.1 Helicopter accidents have been caused by violent oscillation of underslung loads. The problem is complex and not fully understood so it is only possible to give general advice on corrective actions.
- 6.20.2 During the initial pick-up of the load, care must be taken to ensure that the helicopter is positioned vertically above the load, and that the load is lifted off smoothly and slowly. Load oscillations may develop while the helicopter is in the hover. These are usually due to incorrect positioning of the helicopter over the load at lift-off, are usually of a short period, and may normally be expected to damp out in a short time if the helicopter is held steadily in the hover.
- 6.20.3 In general the use of cyclic to control oscillations is not advised as more often than not over-controlling will result which will exacerbate the problem. If cyclic is used, it should be used with caution and in the direction of, and in phase with, the movement of the load. Should pilots encounter difficulty in stabilising a load, they should either lower it to the ground or jettison it promptly.
- 6.20.4 Load oscillations in forward flight result from a combination of the stability characteristics of the load and the forward speed of the helicopter. Loads of low volume and high density do not normally pose a problem, but large volume loads of low density and irregular shape are liable to start oscillating at a certain critical airspeed. The initial acceleration with an underslung load of this nature must, therefore, be made slowly, using extreme caution, in order that a safe approach towards this unknown critical speed is achieved. If the load starts to oscillate, airspeed must be reduced by at least 10% of the speed at which the oscillations began. If oscillation persists, a further reduction in airspeed, with power adjustment as necessary, may damp out the movement. Pilots are, however, warned that a large reduction in airspeed below translation lift speed, with the consequent increase in power required, may not be practical in all circumstances. Alternatively, a sustained balanced turn is sometimes effective in stabilising the load; while in others an increase in power, cautious use of the cyclic (but see paragraph 6.20.3 above) or a gentle climb with a reduction in airspeed have all proved effective.

6.21 **Strop Release**

- 6.21.1 Marshallers, crewmen and pilots must ensure that the helicopter is stationary in relation to the ground before load release and that the net is lowered gently to the ground. Failure to do this will cause the net to be damaged by dragging it over the ground or edges or corners of the load itself may cut the net. The load may also suffer damage and it could even topple thus hazarding the helicopter and ground personnel.
- 6.21.2 Following the load landing, the helicopter crew will endeavour to release the strop to one side of the load to avoid the risk of damage to the load from the slinging equipment. During this process ground handling personnel must keep well clear of the release area to avoid the danger of being struck by the heavy and potentially lethal metal elements of the strop assembly.
- 6.21.3 Following strop release the helicopter may need to land nearby to retrieve the strop.

6.22 **Non-Strop Release Operations**

For certain operations the helicopter crew may require the load to be released without releasing the strop from the primary hook. A common practice is to use a strop recovery line, also known as a light line, which enables the crewman to haul the free end of the strop up to the helicopter cabin following release of the load from the secondary hook. This enables strop retrieval in situations where the helicopter is unable to land, or where speedy strop retrieval and fast transits are required with the empty strop attached to the primary hook. Best practice is not to conduct transits with an empty strop hanging free from the primary hook because of the serious danger of entanglement of the strop in the helicopter main and/or tail rotors (but see paragraph 6.19.1).

6.23 **Accidental Release and Snagged Loads**

- 6.23.1 The arming switch for the hook release system should be positioned within easy reach of the pilot's left hand in order that the cyclic control does not have to be released when the arming switch is operated. The temptation to fly with the hook armed at all times should be resisted because of the risk of accidental load release.
- 6.23.2 If a load fails to detach when the primary release is operated, the secondary system may have to be used. If it is necessary to take-off with the load and carry out another approach before using the secondary release system, it must be remembered that the load is liable to inadvertent release at any time.

6.24 **Weather and Altitude**

High temperatures, pressure altitudes and humidity can all severely reduce the performance of the helicopter. The effects of wind can vary along the route, for example an increase in performance at the lifting site may be countered by downdrafts en route or at the dropping site. The pilot should cease operations when, in his judgement, adequate performance is no longer available; when reduced visibility prevents clear sighting of obstructions or when wind conditions make helicopter control unreasonably difficult.

6.25 **Electrical Static Charges**

- 6.25.1 Because of the danger of a lightning strike, loads should not be lifted or dropped when electrical storms are known to be in the immediate area. Loading and unloading must never be attempted during a thunderstorm, as the probability of a lightning strike is fairly high.
- 6.25.2 A helicopter hovering near the ground can be regarded, for electrical purposes, as one plate of a capacitance; the ground being the other plate. In general, static electricity is most strongly induced in helicopters when the air is dry and dust laden. Any

induced charge is likely to be of lower potential when the air is moist, although rain or snow can cause the rotors to rapidly induce a static charge. Heavy charges can be induced by 'charged' air, particularly during rain caused by Cumulo-Nimbus clouds. Turbine powered helicopters may produce engine charging and should therefore always be regarded as a possible source of electric shock. The polarity and potential (voltage) of an induced charge are unpredictable and in certain conditions may be of a high value (up to 250,000 volts). The amount of electricity involved, however, is small. When the discharge takes place, the duration and amperage of the current flow will vary according to the resistance of the discharge path.

6.26 **Dissipation of Static Electricity**

- 6.26.1 Normally this does not pose a problem as contact with the ground; rig or ship allows any induced charge to be dissipated through the landing gear. Helicopter pneumatic tyres are made from electrically conducting rubber to ensure that helicopters with this type of landing gear make a good earth connection. This practice is impractical during underslung load operations and the ground handling team is responsible for the discharge of static electricity from the helicopter. For the purpose of attachment or removal of an item from the load beam of a helicopter primary or secondary hook, full static electricity discharge procedures must be carried out. This procedure also applies if for any reason the ground handling party has to contact the load before it has been lowered to the ground, or after it has been lowered to the ground and prior to carrying out the discharge procedure. For ground handlers who are required to assist with the manoeuvring of a load into position before load landing, the use of ropes (handling lines) in contact with the ground provide an additional safeguard.
- 6.26.2 Instructions on helicopter load handling procedures are to include the methods to be used by load handling teams and are to state that earthing poles must be used for all underslung load operations. Offloading or hooking up operations should only be undertaken after the helicopter has been electrically grounded. Since charging rates can be high, this earthing should be maintained throughout the operation. At high voltages, even PPE will not provide insulation against shock. In severe charging conditions initial discharging of the helicopter, or the load, by personal contact should not be attempted. It follows that all ground personnel should be safeguarded from initial contact since injury might result from being hurled bodily to the ground. Once the helicopter has been initially discharged, it is perfectly safe for personnel to maintain the earth link by manual contact with the airframe, load or slinging equipment. Earthing through the cargo itself should be avoided when explosive cargos are carried. Where this is not possible, perhaps due to automatic cargo release techniques, steps must be taken to avoid build-ups of explosive vapour mixtures. Electrically initiated explosives should be rendered "safe" and/or screened in metal containers. Provided these drills are followed carefully; there should be no danger to life, either by exploding cargo or electrical shock.
- 6.26.3 In most instances the resistivity of the human body is such that if a member of a hooking up team were to grasp a primary hook, before earthing the helicopter with the earthing pole, they may receive a severe electric shock but it is unlikely that this would be fatal, unless the individual was particularly sensitive to static. Severe muscular spasms or, under certain circumstances, local burns are possible.
- 6.26.4 Irrespective of weather conditions, or the type of helicopter concerned, it must always be assumed that a discharge arc will occur when an external load is earthed by contact with the ground. Even though there is no known instance of explosion or fire being caused by static electricity discharge this hazard may still restrict the carriage of USL by helicopters of DAC such as ammunition, live missiles (especially those electrically detonated) or highly volatile flammable liquids such as fuels or liquid oxygen. Detailed information on static charging conditions is given at Appendix B.

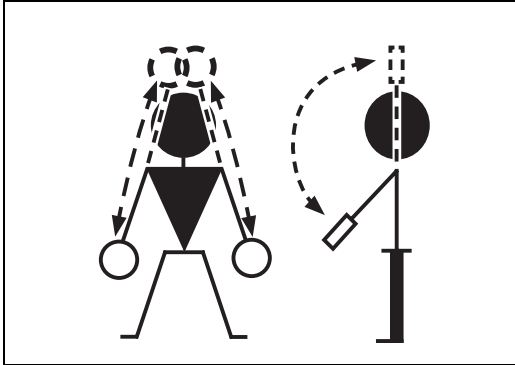
6.27 **Earthing Probes**

A simple discharger (or earthing probe) consisting of an earthing pin (a 15 cm nail is quite suitable) connected by a length of 3.5 to 5 metres of insulated wire, to a conductor, which is secured to an insulated handle of any suitable non-conducting material. The handle can be part of a broom handle, at least 85 cm in length. The conductor should be made from round and thick cross-sectioned electrically conductive material, for example, 2.5 cm diameter copper tubing. The wire cable can be of any available type, providing the resistance level of the conducting wire is low, e.g. copper or brass. The construction of this type of discharger is purposely simple so users can make similar dischargers from materials likely to be readily available.

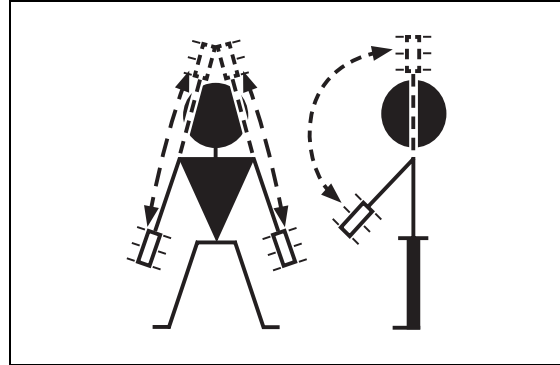
Appendix A Helicopter Marshalling Signals

Signals prescribed in Rules of the Air and Air Traffic Control Regulations, 1996, Rule 47, Table B.

In Daylight

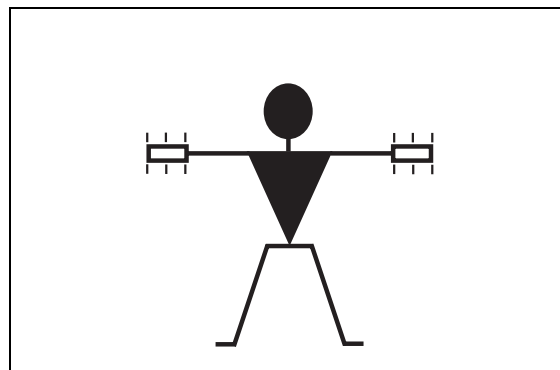
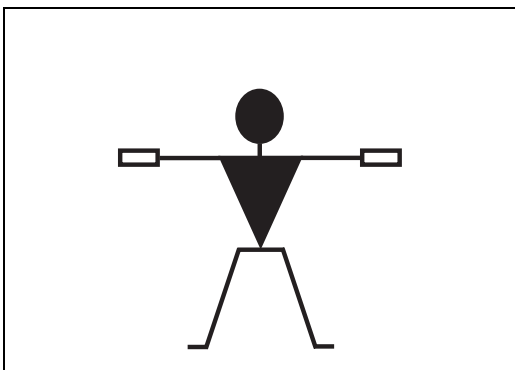


By Night



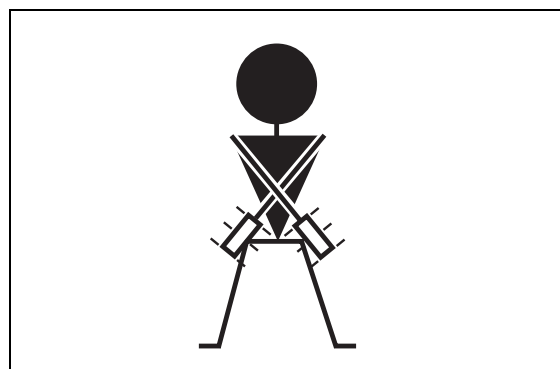
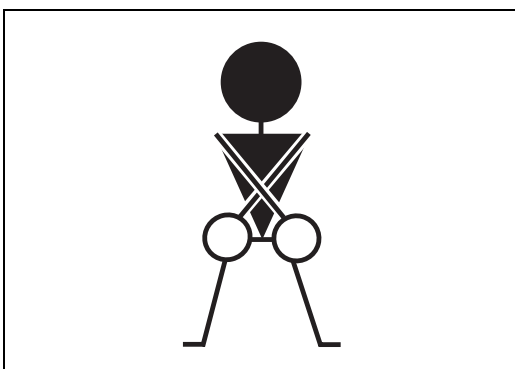
Move Ahead

Arms repeatedly moved upward and backward, beckoning onward.



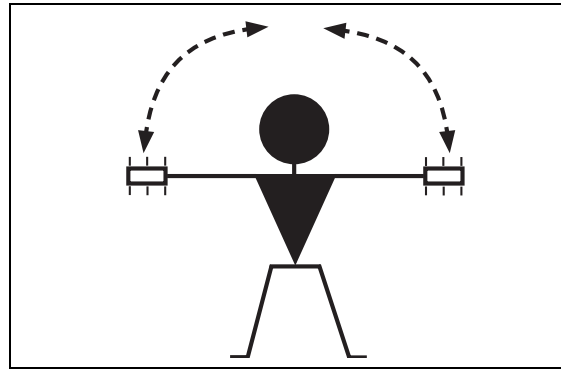
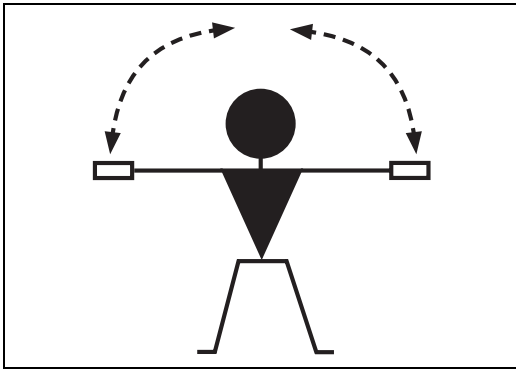
Hover

Arms placed horizontally sideways.



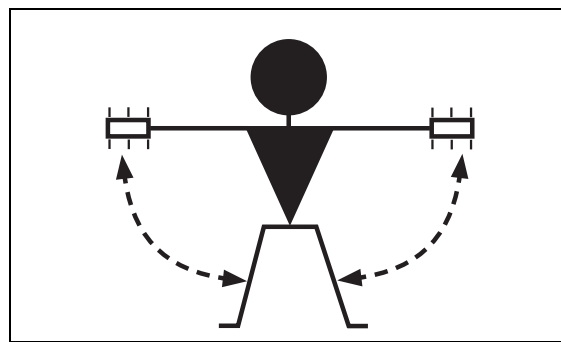
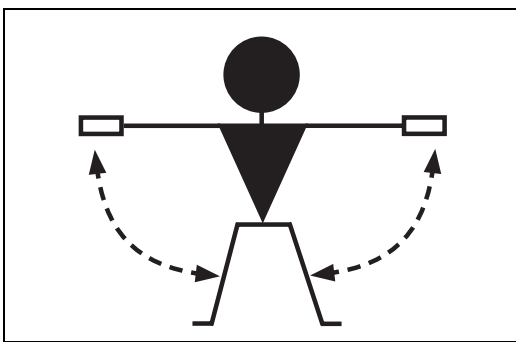
Land

Arms placed down and crossed in front of the body.



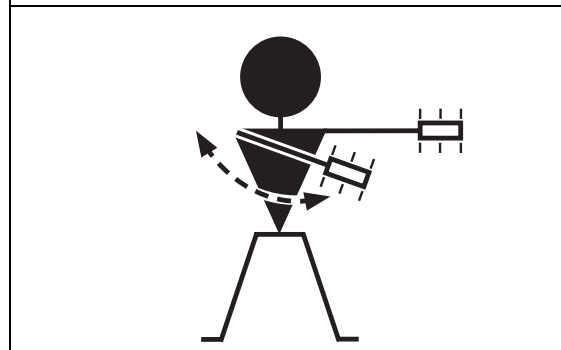
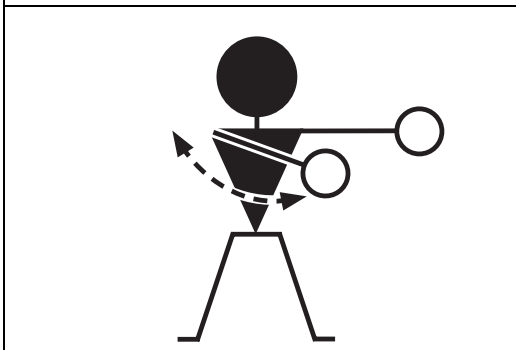
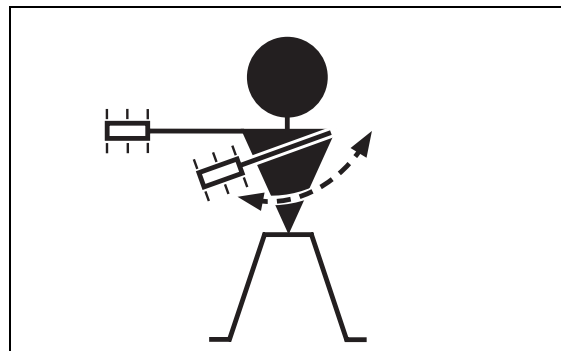
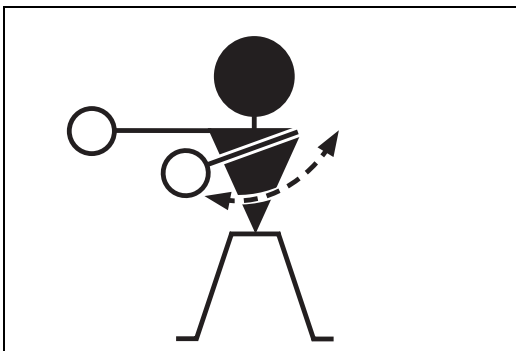
Move Upwards

Arms placed horizontally sideways with the palms up, beckoning upwards.
The speed of arm movement indicates the rate of ascent.



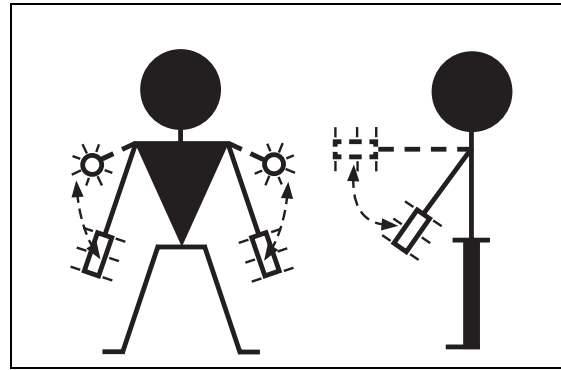
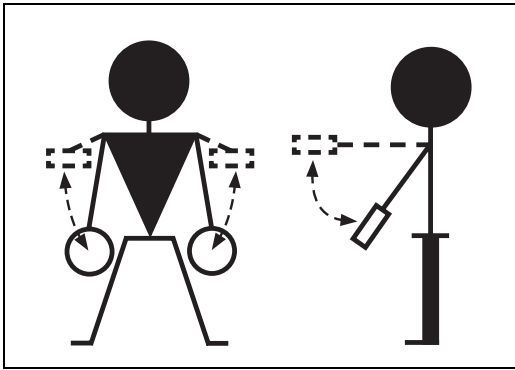
Move Downwards

Arms placed horizontally sideways with the palms towards the ground, beckoning.
The speed of arm movement indicates the rate of descent.



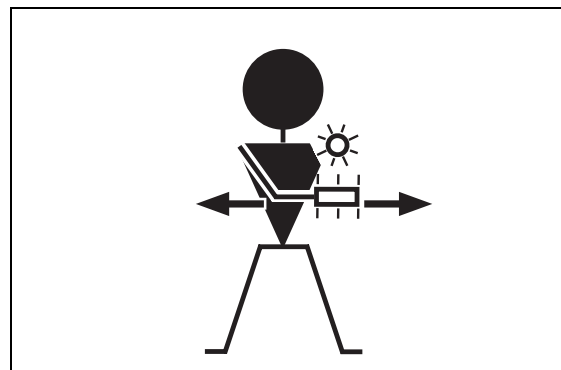
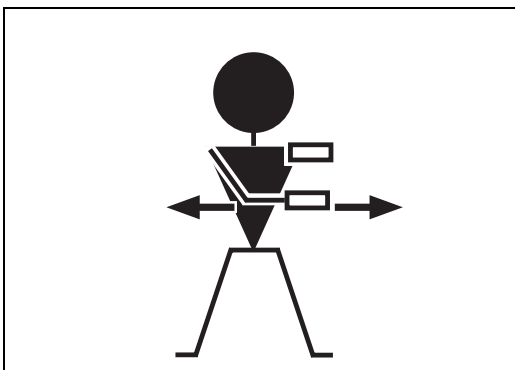
Move Horizontally

Either arm placed horizontally sideways then the other arm moved in front of the body to that side, in the direction of the movement, indicating that the helicopter should move horizontally to the left or right side, as the case may be; repeated several times.



Move Back

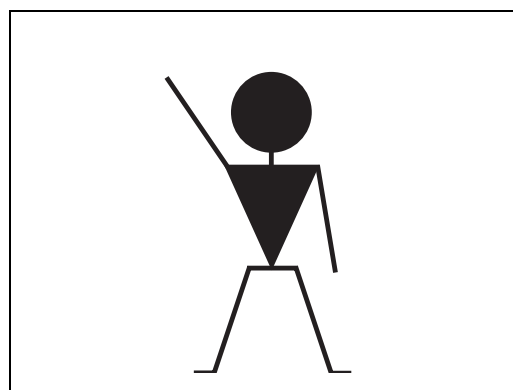
Arms placed down, the palms facing forward, then repeatedly swept up and down to shoulder level.



Release Load

Left arm extended horizontally forward, then right arm making a horizontal slicing movement below left arm.

The following signal is used by the military but is not included in Rules of the Air. Its use is recommended.



Clear To Go

Right arm fully extended, thumb up, indicating that the aircraft is clear to go.

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Appendix B Static Electricity Charging Conditions

1 Introduction

- 1.1 The following notes have been prepared by the Engineering Physics Department of the Royal Aircraft Establishment, Farnborough.
- 1.2 Work on this subject continues to be carried out and it may therefore be necessary for these notes to be revised or amended from time to time.

2 Charging Mechanisms – General

- 2.1 The generation of electrostatic charges during flight may result from either one or a combination of several different processes. The charge is stored in the capacitance of the aircraft, which for helicopters is usually in the range 300 to 1000pF, depending on size and proximity to the earth. When the aircraft first begins to charge, its voltage rises very rapidly because there is negligible current leakage into the surroundings, the conductivity of air being low. A sufficiently high voltage is eventually reached, however, to cause the field stresses in some regions of the aircraft (usually the extremities, such as blade tips) to exceed the breakdown stress for air and these regions then go into corona; the leakage current is then substantial and for a given charging current is exactly balanced by the leakage current. This equilibrium voltage can be as high as several hundred kV. Because more than one charging process may be involved it is possible for different polarities of charge to be produced simultaneously; therefore the nett charging current is the algebraic sum of all the charging currents generated at any instant.
- 2.2 The two main charging mechanisms are engine charging and precipitation charging, which will be taken to include all effects due to rain, snow, ice and dust in the atmosphere. A third effect (not strictly a charging mechanism but producing similar results) is the redistribution of charge over the aircraft surface, for example the top surface becoming negative and the underside positive, due to induction from the field of a charged cloud, but with the nett charge remaining zero. Engine charging is of course an internal effect, whilst the other two processes are the result of external influences.

3 Engine Charging

The results when the exhaust gases contain a preponderance of ions of a particular polarity, leaving the aircraft charged with the opposite polarity. The magnitude of the effect varies widely between different types of helicopter; it is negligible in some but in others can cause voltages of 30 – 50kV to be reached within 1½ - 2 minutes. The process usually imparts a positive charge to the helicopter and is largely independent of weather conditions so that it leads to a persistent static problem which exists even under conditions where all other static charging mechanisms are absent.

4 Precipitation Charging

4.1 Dust or Dry Sand Particles

Charging is due to friction between the aircraft surfaces and the airborne particles. It occurs in arid conditions when dust or sand is whipped up through the rotor disc

when the helicopter is hovering close to the ground. A positive charge is acquired by the aircraft, voltages rising to 100kV or more in a few seconds. All aircraft would be affected.

4.2 **Dry Ice Particles**

These can be encountered when a helicopter is hovering low over frozen snow, and also when flying in cloud. A negative charge is acquired, voltages rising to 100 – 200kV in a second or less. All aircraft would be affected.

4.3 **Rain or Snow**

4.3.1 Charging may be due to frictional effects as uncharged droplets impact the airframe, or each drop may have equal charges of opposite polarity at opposite ends by induction from an ambient electrical field and when the drop shatters on impact one polarity is preferentially deposited on the surface. In the latter case, for a given rain intensity the polarity and magnitude of the charging current follow those of the ambient field.

4.3.2 In practice we may distinguish two categories of rain, the first being quiet or steady rain associated with clouds having little vertical development. Here the charging currents are usually negative and small. All aircraft would be affected, and voltages could be 25 – 100kV in less than 30 seconds. One point worth noting is that aircraft exhibiting engine charging often experience reduced or even no static build-up under these conditions because the two charging currents tend to be approximately equal and of opposite polarity. The second category is shower or thunderstorm rain associated with clouds of large vertical development. This may result in very high charging currents of either polarity, producing aircraft voltages in excess of 100kV in less than one second. All aircraft would be affected.

4.4 **Induction**

This is the redistribution of charge over the airframe due to an ambient electrical field. Atmospheric fields (voltage gradients) of one polarity or the other are always present; on a cloudless day the atmospheric field near the earth is typically 100V/m. Clouds with little vertical development cause fields up to 250V/m, whilst Cb can produce fields up to 20kV/m. Regions of the aircraft having a local concentration of charge can behave in much the same way as if the whole aircraft were charged, although in fact the total nett charge is zero. For helicopter external load operations, even the "fine day" field can be significant because the potential of the helicopter will be that appropriate to its position in the field; for example, if it is hovering at 20m in a vertical field of 100V/m it will have a potential relative to earth of 2kV, which is capable of giving a slight shock to ground personnel who touch the load.

4.5 **Lightning Hazard**

There is some danger of electrostatic shock to ground crew in external load operations. If weather conditions are favourable to the formation of lightning there is also danger of a much more severe discharge due to lightning striking the helicopter and the current passing to earth through the load. The configuration is particularly prone to lightning strike because a long conducting body in an ambient field distorts the field causing a local field concentration favourable to the formation of electrical streamers which have the effect of "attracting" lightning (compare the attractive effect of tall buildings or trees). Thus external load operations can be dangerous when there is a probability of lightning.

Appendix C Air Navigation Order 2005 (ANO) References

ANO ARTICLE No.	CONTENT
43	Loading – Public Transport Aircraft and Suspended Loads
65	Towing, Picking Up and Raising of Persons and Articles
65(5)	Prohibition of Carriage of USL over Congested Areas
155	Definition of Congested Area

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