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Civil Aviation Regulatory Commission

Guidance material

Rescue Operations In Difficult Environments

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RESCUE OPERATIONS IN DIFFICULT ENVIRONMENTS

1. GENERAL

1.1 At airports where a significant proportion of aircraft arrivals and departures takes place over water, swampy areas or other forms of difficult terrain in the immediate vicinity of the airport and where conventional RFF vehicles may not be capable of an effective response, the airport or appropriate authority should ensure the availability of special procedures and equipment to deal with accidents which may occur in these areas. These facilities need not be located on, or be provided by, the airport if they can be made immediately available by off-airport agencies as part of the airport emergency plan. In all cases, the airport or appropriate authority must determine and specify in advance the response area for which it undertakes to provide a rescue service.

1.2 In producing its detailed plan, the airport or appropriate authority should have regard to the services and facilities already provided by the search and rescue organization in accordance with 4.2.1 of Annex 12 to Chicago Convention — *Search and Rescue,* to ensure that the separate responsibilities for an aircraft accident in the vicinity of the airport are clearly delineated. All operations, and any exercises conducted to test operational efficiency, should involve the relevant rescue coordination centre, to ensure the effective mobilization of all resources.

1.3 The objectives of each operation must be to create conditions in which survival is possible and from which the total rescue operation can succeed. This concept anticipates that the initial, rapid response attendance may have to provide a preliminary level of succour while awaiting the arrival of a larger rescue force. The first stage would have as its objective the removal of immediate hazards to survivors, their protection, including the first-aid treatment of injuries, and the use of communications equipment to identify the locations to which additional rescue forces must respond. The emphasis will be on rescue and need not include any firefighting capability.

1.3.1 If a fire situation has occurred in the impact stage of an accident, the inevitably extended response times of the first vehicles are likely to preclude effective firefighting operations. The scale of provision of rescue equipment should be related to the capacities of the larger aircraft using the airport. Typical capacities of passengers are provided in the aircraft diagrams in the websites of the various aircraft manufacturers referred to in Appendix 1.

1.4 The types of difficult terrain for which special rescue facilities may be required include:

a) the sea or other large bodies of water adjacent to the airport;
b) swamps or other similar surfaces, including the estuaries of tidal rivers;
c) mountainous areas;
d) desert areas; and
e) locations which are subject to heavy seasonal snowfalls.

1.5 The equipment to be deployed in effecting a rescue operation will vary with the environment in which the operation is to be conducted. The training required by

the personnel delegated to these duties will similarly reflect the terrain conditions. In all situations the basic equipment may include:

a) communications equipment, which may include equipment for visual signals. Ideally the use of a transmitter on the distress frequency will provide a link with air traffic control and the emergency operations centre;
b) navigation aids;
c) medical first-aid equipment;
d) life-support equipment, including life-jackets in marine situations, shelter, foil blankets and drinking water;
e) lighting equipment; and
f) lines, boat hooks, megaphones and tools, e.g. wire cutters and harness knives.

1.6 The types of vehicle available for rescue operations in difficult terrain will include:

a) helicopters;
b) hovercraft;
c) boats, of a number of types and capacities;
d) amphibious vehicles;
e) tracked vehicles; and
f) all-terrain vehicles, including those employing ground-effect to minimize wheel-loadings.

1.7 In most States the more complex forms of vehicles are already in service with military formations or other forms of security organizations, from which valuable operational performance data may be available. Some of the more obvious factors relating to each type of vehicle are discussed below.

a) *Helicopters.* The variety of helicopters now in general service offer a range of emergency options, dependent on the capacity, endurance and operational limitations of each type. The larger helicopters, with trained crews specializing in rescue operations, are most often deployed by military agencies and may be available in emergencies to civil airports. For successful liaison with helicopters, in operations on land or in the water, a communications link is essential, with control of the surface facility under the direction of a person familiar with the operational requirements of helicopters. This will reduce the hazard to the helicopter, particularly at night, from obstructions and the movement of vehicles and personnel at the accident site. Helicopters can be used to drop life rafts and other flotation devices in marine situations and other forms of life-support equipment in land-based accident situations. Where an aircraft accident has occurred in the water and a large number of survivors may be at risk, it will be essential to have personnel with life rafts or dinghies at the surface, where the survivors may require assistance to reach a safe location before final rescue can take place. It may therefore be necessary to link any helicopter rescue effort with a simultaneous surface operation. It should also be noted that the downwash from helicopters can cause serious distress to survivors in the water by creating turbulence. The use of helicopters as airborne control positions or as a source of floodlighting can beadvantageous. The cost involved in housing, operating and maintaining a continuously-available rescue helicopter may preclude its provision at an airport facility but arrangements with military or commercial organizations should secure its availability in an emergency.

b) *Hovercraft.* These offer an adaptable form of transport with operational performance, capacity and cost being related to size. The smaller hovercraft have a limited capability for clearing obstructions and when operated on water may be restricted by wave height. They also have a limited capacity for accommodating survivors but this can be offset by their ability to deliver survival equipment to an accident site. As with helicopters, the hovercraft will need a highly-trained operator and skilled maintenance personnel to maximize its operational availability and deployment. The costs of housing, operating and maintaining a hovercraft, which may need a slipway to facilitate its deployment to any tidal water surface, will be substantial.

c) *Boats.* In selecting the type of rescue boat to be operated it will first be necessary to consider the range of water surface conditions likely to be encountered, the depth of water in the response area, any subsurface hazard, such as rocks and coral reefs, and then the role to be accorded to each boat. The expertise necessary to make the appropriate choice should be available within each State, permitting a choice to be made from the wide range of options. These would include rigid-hulled seagoing craft, with considerable range and capacity and smaller, inflatable craft, with outboard motors, primarily intended for inshore operations. Some States have combined the inshore rescue and the search and rescue roles, providing vessels with advanced navigational equipment and major medical facilities. In other States, the inshore rescue facility is provided by the airport or appropriate authority using trained RFF personnel to crew inflatable craft. These craft, mounted on trailers for rapid deployment and ease of launching, carry containers holding inflatable life rafts which can be deployed at the accident site to accommodate survivors. There are also relatively small rigid-hulled craft which achieve their propulsion by means of subsurface water jets, thus eliminating the hazard of propellers to survivors in the water. These, too, can carry life rafts. The life rafts, once filled with survivors, are not easily towed but they can be marshalled and secured against drifting by the powered rescue craft, until additional support arrives. There will also be marine craft available from commercial sources and from private users but their acceptability in a rescue support role will be dependent on the speed with which they can be dispatched and the existence of communications which will permit their control. Random interventions, although desirable on humanitarian grounds, can create difficulties at the accident site.

d) *Amphibious vehicles.* These are usually wheeled vehicles, relatively small in size and primarily in use by military and security forces. Their speed on water is slow and their capacity is limited. One exception to this classification, already in use at an airport as a rescue craft, is a vehicle having its propulsion provided by two longitudinal cylinders with a raised helical section. This vehicle can operate on paved surfaces, water or mud, having a hull which provides buoyancy. Within the hull there is accommodation for rescue equipment, including life rafts, and some capacity for survivors once the life rafts have been deployed. All amphibious vehicles would require a launching ramp to facilitate their entry into water as they cannot negotiate significant obstructions. As with all vehicles, they require effective maintenance, particularly in the design features which provide buoyancy.

e) *Tracked vehicles.* These can be effective in negotiating rough ground and deep snow but all vehicles of this type have a relatively low payload to gross weight factor. They are usually slower than wheeled vehicles of similar capacities but are superior in their ability to tow sleds over snow-covered surfaces. Some tracked vehicles are in use as rescue vehicles at airports. They require skilled maintenance to preserve their availability. A tracked vehicle can serve to convey personnel and small items of equipment to the accident site on snow-covered surfaces but is unlikely to have any other significant role.

f) *Ground-effect vehicles.* The early studies of vehicles in this category, mainly in military and agricultural applications, showed that some reduction in wheel loadings could be achieved. The absence of ground-effect production vehicles suggests that the technical problems have proved difficult to resolve. The availability of alternative solutions for soft ground operations may also have contributed to the lack of progress with this form of vehicle.

2. OPERATIONAL PROCEDURES FOR ACCIDENTS IN THE WATER

2.1 Where airports are situated adjacent to large bodies of water such as rivers or lakes, or where they are located on coastlines, special provisions should be made to expedite rescue.

2.2 In such incidents the possibility of fire is appreciably reduced due to the suppression of ignition sources. In situations where fire is present, its control and extinguishment present unusual problems unless the proper equipment is available.

2.3 It can be anticipated that the impact of the aircraft into the water might rupture fuel tanks and lines. It is reasonable to assume that quantities of fuel will be found floating on the surface of the water. Boats having exhausts at the waterline may present an ignition hazard if operated where this condition is present. Wind and water currents must be taken into consideration in order to prevent floating fuel from moving into areas where it would be hazardous. Care should be taken in the use of flares, flame floats or other pyrotechnics where fuel is present on the water. As soon as possible these pockets of fuel should either be broken up or moved with large velocity nozzles or neutralized by covering them with foam or a high concentration of dry chemical powders. Calm surfaces will usually present more of a problem than choppy or rough surfaces.

2.4 Diving units should be dispatched to the scene. When available, helicopters can be used to expedite the transportation of divers to the actual area of the crash. All divers who may be called for this type of service should be highly trained in both scuba diving and underwater search and recovery techniques. In areas where there are no operating governmental or municipal underwater search and recovery teams, arrangements may be made with private diving clubs. The qualifications of the individual divers should be established by training and practical examination.

2.5 In all operations where divers are in the water, the standard diver's flag should be flown and boats operating in the area should be warned to exercise extreme caution.

2.6 Where fire is present, approach should be made after wind direction and velocity, water current and swiftness are taken into consideration. Fire may be moved away from the area by using a sweeping technique with hose streams. Foam and other extinguishing agents should be used where necessary.

2.7 It should be anticipated that victims are more apt to be found downwind or downstream. This should be taken into consideration in planning the attack.

2.8 Where the distance offshore is within range, dacron-covered, rubber-lined fire lines can be floated into position by divers or boats and used to supplement fire boats. In an emergency, rafts can be assembled by two persons exhaling into a section of 6 cm fire hose, coupling it to itself, folding and binding it with hose straps.

2.9 Where occupied sections of aircraft are found floating, great care must be exercised to not disturb their watertight integrity. Removal of the occupants should be accomplished as smoothly and quickly as possible. Any shift in weight or lapse in time may result in their sinking. Rescuers should use caution so that they are not trapped and drowned in these situations.

2.10 Where occupied sections of the aircraft are found submerged, there remains the possibility that there may be enough air trapped inside to maintain life. Entry by divers should be made at the deepest point possible.

2.11 Where only the approximate location of the crash is established upon arrival, divers should use standard underwater search patterns marking the locations of the major parts of the aircraft with marker buoys. If sufficient divers are not available, dragging operations should be conducted from surface craft. In no instance should dragging and diving operations be conducted simultaneously.

2.12 A command post should be established at the most feasible location on an adjacent shore. This should be located in a position to facilitate the in and out movement of water rescue vehicles.

3. ASSESSMENTS FOR ACCIDENTS BEYOND RUNWAY THRESHOLDS

3.1 An assessment of the approach and departure areas within 1 000 m of the runway threshold should be carried out to determine the options available for rescue, including suitable resources that should be provided. In considering the need for any specialist rescue and access routes, the following should be considered:

a) the environment, in particular the topography and composition of the surface;
b) physical hazards and associated risks that exist within the area;
c) options for access and for RFF purposes;
d) hazards, risks and control measures of the options for rescue;
e) use of external services;
f) an analysis of the advantages and disadvantages of the options;
g) policies and procedures to define and implement practices;
h) competence standards to match the above; and
i) monitoring testing and review of the capability.

3.2 Aerodrome operators and/or RFF service (RFFS) providers should ensure the development of special procedures and availability of equipment to deal with accidents or incidents that may occur in these areas. The facilities that house this equipment need not be located on, or provided by, the aerodrome, if they can be made available within reasonable time frames by off-aerodrome agencies as detailed in the Aerodrome Emergency Plan.

3.3 Where RFFS vehicles respond to accidents or incidents using the public highway, an assessment of the implications of such a response should be carried out. The following should be considered:

a) legal requirements for vehicles and drivers;
b) that suitable policies and procedures are in place;
c) competence and training requirements for drivers;
d) pre-planning of routes for suitability; and
e) monitoring and review of such responses.

3.4 Consideration also should be given to the following:

a) provide direct access to the operational runway(s);
b) designate access routes to the response area (consider debris and casualties);
c) maintenance of roads and access routes (including construction activities);
d) mitigate the possibility of any public and/or private non-emergency vehicle blocking the progress of responding emergency vehicles;
e) take into account the gross weight and maximum dimensions of the RFFS vehicle(s) expected to use these routes/roads; or any other responding vehicles;
f) that roads are capable of being traversed in expected conditions;
g) exit/access gates or frangible sections in the security fence that are constructed to allow RFFS vehicles to safely pass through with minimal delay;
h) exit/access points will need to be clearly identified. Retro-reflective tape or markers will be of assistance where the aerodrome may need to be accessible during the hours of darkness or conditions of low visibility;
i) the mitigation of impediments to RFF vehicle mobility; and
j) provide sufficient vertical clearance from overhead obstructions for the largest RFFS vehicles.

3.5 Maintaining the response capability in low visibility conditions

3.5.1 To meet the operational objective as nearly as possible in less than optimum conditions of visibility, especially during low visibility operations, suitable guidance, equipment and/or procedures for RFF services should be provided.

3.5.2 RFFS vehicles should approach any aircraft accident or incident by the quickest route commensurate with safety, although this might not necessarily be the shortest distance to the incident site. Traversing through unimproved areas can take longer than travelling a greater distance on paved surfaces, therefore a thorough knowledge by RFFS personnel of the topography of the aerodrome and its immediate vicinity for all weather conditions is paramount. The use of grid maps and careful selection of routes is essential for success in meeting the response objectives.

3.5.3 RFFS vehicles should be equipped with an airfield chart clearly showing all taxiways, runways, holding points and vehicle routes marked with their appropriate designation. The chart(s) should be accompanied by written instructions clearly detailing the action that the driver should take in the event of vehicle breakdown or if the driver should become unsure of the vehicle's position on the aerodrome.

3.5.4 Consideration should be given to the provision and use of technical equipment, e.g. surface movement radar, infrared vision systems, taxiway centreline lighting, vehicle positioning equipment and other navigation aids that could enhance RFFS response to the location of an accident or incident site in low visibility conditions.

3.5.5 Once low visibility operations have been initiated it may be necessary to restrict the operation of vehicles in the aircraft manoeuvring area. Procedures developed for ATC to assist the RFFS in case of an accident or incident should be put in place.

3.5.6 RFFS and associated external emergency response personnel should be made aware of the existence of any areas that may, from time to time, become impassable because of weather or other conditions, and of the location of obstacles both permanent and temporary.

3.5.7 Operational procedures should be developed through which air traffic control (ATC) stop or divert all aircraft and non-essential traffic that conflicts with responding RFFS vehicles. RFFS personnel should continuously monitor the minimum visibility operating conditions in order to maintain response capability under such conditions.

4. TRAINING OF PERSONNEL

4.1 The training to be undertaken by personnel appointed to specialized rescue vehicles and their associated equipment will not present significant problems. Where there are particular forms of hazard, such as the sea, mountains or desert areas, there will be individuals who have experience in operating and surviving in these environments. These experts could provide the basic instruction required by crew members, adapting as necessary to accommodate new types of equipment. The manufacturers of specialized equipment can also provide expertise. The principal aim of training will be to instil confidence in equipment of all types, to establish the operating limits of vehicles and equipment and to develop the teamwork which converts individuals into an effective crew. In this process it is essential to create team leaders who will have the absolute authority to determine when to mount a rescue operation. There may well be occasions when prudence will decree that operations in intolerable conditions would merely add to the casualties without any reasonable expectation of success.

5. INTER-AGENCY EXERCISES

5.1 While the airport or appropriate authority may initiate the call for a rescue operation and dispatch a unit from within the airport there will be supporting

forces from off-airport agencies. These may include, in appropriate circumstances, military units, medical services, mountain rescue teams, divers and civil defence contingents of various types. The coordination of these services will require the same degree of effort as is necessary in developing the airport emergency plan (see *Airport Services Manual* (Doc 9137), Part 7 — *Airport Emergency Planning*).

5.2 In particular, the need for effective communications will be paramount. Survivors of an aircraft accident, recovered from a difficult location, must be brought to one or more assembly points at which conventional ambulances and medical assistance will be waiting. Prior notification of injuries by radio can ensure that appropriate treatment is available and that specialized hospitals prepare reception facilities. Realistic simulations of incidents will contribute to inter-service liaison and identify areas in which improvements in facilities or procedures can provide a more effective service.