

CHAPTER 8

SAFETY CONSIDERATIONS IN HYDROMETRY

8.1 GENERAL PRACTICES

The WMO technology transfer system, the Hydrological Operational Multipurpose System (HOMS), in operation since 1981, offers a simple but effective means of disseminating a wide range of proven techniques for use by hydrologists. Particular reference is made to section A00 of the HOMS Reference Manual, which covers policy, planning and organization. This chapter, on safety considerations in hydrometry, complements preceding chapters that provide an overview of the hydrological instruments and methods of observation, by proposing safety measures needed to support the operating activities of hydrologists.

Hydrological measurements are made under an extremely wide range of conditions, many of which are potentially hazardous to the personnel making them. Knowledge of the hazards and the means by which they can be minimized are essential for hydrological personnel. A number of agencies have produced detailed and informative safety manuals. Familiarization with this material is highly recommended to hydrologists and technicians.

Each State may have its own safety standards and practices as well as laws and regulations governing safety. Additionally, at particular sites, there may be specific safety precautions which hydrological personnel would be expected to observe. Many of these are outlined in this chapter.

Each member of a hydrometric field-team has the responsibility for his or her own personal safety and that of the other team members in carrying out his or her work. Organizations have the responsibility to promote an awareness of hazards and work practices needed to minimize risks, and to provide appropriate safety equipment and training.

8.2 SAFETY AT RECORDING STATIONS

8.2.1 Access

Well-constructed footpaths, steps, ladders and the like are essential for safety on steep riverbanks. These need to be constructed for safe access in wet weather and possibly in the dark. When construction

of a station begins, the access should be completed first.

8.2.2 Platforms

High platforms and catwalks should have a non-slip surface, such as fine wire mesh fastened over timber planks. Handrails should also be fitted.

8.2.3 Wells

Some water-level recording stations have deep wells that must be entered occasionally for maintenance. Hazards exist owing to the possibility of falling and the presence of gases. All wells should have at least a simple rope, pulley and winch system installed so that a person can be rescued from the bottom of the well.

Persons descending into wells that are deep or are in any way suspected to contain gas must wear a safety harness attached to a rescue system, with one or more people in attendance at the top. A safety helmet should also be worn.

A number of gases, including carbon dioxide, methane and hydrogen sulphide, may be present in a well. They are produced from decomposing organic material and may displace air, leading to an oxygen deficiency as well as toxicity and flammability. These dangers can occur with quite low concentrations, and reaction to the gases may be quite rapid, with a person becoming unconscious after only one or two inhalations of a toxic gas.

Precautions include proper ventilation in all wells over 6 m in depth, opening wells for ventilation prior to entry, forbidding flames or smoking, use of gas monitoring equipment, and the routine use of safety harnesses and rescue equipment. All efforts should be made to exclude or remove organic matter from wells. The hazards of slipping can be minimized by having properly constructed ladders and by maintaining all equipment in good condition.

8.3 SAFETY PRECAUTIONS WHEN WORKING FROM BRIDGES

The main hazards in carrying out measurements or sampling from bridges are getting struck by passing

traffic or being tipped over the side of the bridge by undue force or weight on the suspended equipment.

8.3.1 **Traffic hazards**

Bridges with a pedestrian lane may provide a good margin of safety. In other circumstances, it is imperative to warn motorists with adequate signs and, if practical, flashing lights. Personnel should wear fluorescent or brightly coloured clothing, and portable traffic markers may be deployed to shift traffic flow away from the work area. If it is necessary to interface with traffic, arrangements should be made with the local authorities. In areas where there are FM radio stations, it is important to announce the schedules of the hydrological activities, so that the public may be made aware.

8.3.2 **Hazards from suspended equipment**

The potential leverage on equipment, such as gauging frames, indicates that they are prone to being tipped over the side of the bridge if the suspended equipment should become caught on river-borne debris or on boats passing below. Extra care should be taken against these dangers during floods.

Gauging cranes or frames need to be suitably counterbalanced or tied down. The overturning moment of vehicle-mounted cranes should be calculated and shear pins incorporated in the equipment, if necessary, to prevent capsizing. Over navigable water, the presence of all cables should be indicated by the attachment of marker flags.

8.4 **SAFETY PRECAUTIONS WHILE WADING**

8.4.1 **General**

Where it is possible to wade streams, hydrological measurements may be made more simply and directly than by other means. However, it becomes hazardous when the depth or velocity, or both, are excessive. Personnel must not be obligated to wade streams in situations where they feel unsafe. Experience and confidence are important factors, but must be tempered with sensible caution.

8.4.2 **Assessing the situation**

Personnel need to exercise caution and be experienced enough to decide whether wading should be

carried out in a particular situation. As a general guide, if the product of the depth in metres and the velocity in metres per second exceed 1.0, the stream is unlikely to be safe to wade. A person's build and attire will influence this decision. Waders have more drag than bare legs or wetsuits.

8.4.3 **Wearing of life jackets**

Correctly fastened life jackets of an appropriate size and design should generally be worn in flowing water above crotch level, where there is need to enter such water or where conditions could become hazardous.

8.4.4 **Safety lines and taglines**

When making discharge measurements, a rope or line strung across the river can be useful as a support. It can also serve as a line for measuring distance and should be securely anchored at both ends to sustain the weight and drag of a person against the flow of the river.

8.4.5 **Wading technique**

One should select a crossing with negotiable depths, velocities and bed material, plan a route diagonally downstream, and walk across with short steps, facing the opposite bank, and side-on to the current. It can be helpful to use a wading rod (without current meter) on the upstream side to probe the depth and provide support. It is preferable to brace against the current, remain calm and not hurry. If the crossing becomes too difficult, one should retreat, possibly by stepping backward until it is possible to turn around, and perhaps try an easier crossing.

8.4.6 **In case of mishap**

If one begins to be swept downstream, one should go with the current and head towards the bank, propelling oneself with the arms outstretched and pushing with the feet. If the bed is rocky, the natural reaction to put the feet down should be avoided as they may be caught between the rocks. If this occurs, a person can easily be pushed underwater by the current with fatal results.

If the water is deep and it is necessary to swim some distance, waders may need to be removed. The best way is to work them down to the hips and pull the feet out one at a time. One should avoid turning them inside out and should refrain from this operation where the water is shallow and the waders are likely to become snagged. Wader straps should be

fastened in such a manner that they can readily be undone.

It is possible to trap air in waders so that they aid buoyancy, either by wearing a belt tightly fastened around the waist or by quickly assuming a floating position on one's back with the knees drawn up.

8.5 SAFETY PRECAUTIONS WHILE WORKING FROM BOATS

8.5.1 General

Many types of boats are used for hydrological purposes, each having their own safety requirements. These must always be observed, as boating is inherently dangerous. The boat operator must be familiar with all operating and emergency procedures, and all regulations governing the intended operations. These may include testing the lights of the boat, watching the weather and equipping the boat with appropriate clothing for variable weather conditions, a radio and emergency supplies. Alcohol or drugs should never be consumed during boat operations. Craft must be in good repair, adequate for the conditions that could be encountered, and must not be overloaded.

8.5.2 Life jackets and safety equipment

Life jackets must be worn at all times in small craft. In larger craft, there must be a sufficient number of life jackets on board for all passengers and crew.

Each boat must carry a full inventory of safety equipment that is appropriate to the type of craft and the conditions that could be encountered. These items may include all or some of the following: life raft, flares, lifebelts, bailer, bilge pumps, safety harnesses and survival equipment. Suitable radio communication equipment should be installed whenever practical. Each boat must have a rope attached to the bow for mooring and handling, as well as an adequate anchor and sufficient rope for the bottom conditions and depths expected to be encountered. Auxiliary motive power and fuel should be on board if at all practical.

8.5.3 Use of taglines

Measuring lines or taglines are frequently used for measuring the distance across a river. These need to

be of an adequate size and type of material to prevent stretch and hold the necessary flags. However, the lighter the cable, the less tension is necessary in its rigging, and thus handling will be easier and safer.

Other lines may be rigged to moor the boat at the desired measurement points, and the same factors apply. Depending on the current, these may need to be rather more substantial. All lines must be flagged with sufficient large, brightly-coloured markers across navigable waters at intervals that make the line very evident to river users. Colour itself must not be relied upon, as many people are colour-blind. Where possible, boats working with such lines should be equipped with a bright flashing light. Appropriate local authorities and all likely river users should be notified of the hazards.

Such lines may not be left unattended, and on-site personnel should be equipped with wire cutters to be used, if necessary, to prevent an accident.

8.5.4 Use of dinghies

In rivers, one should row using the ferry-glide technique, heading diagonally upstream into the current. The rower is then facing in the direction of travel downstream, and steering around any obstacle can be accomplished.

Personnel should be competent at rowing, oars should be of a suitable length (approximately 1.5 times the width between rowlocks), and secure rowlocks of the closed type are recommended. Inflatable dinghies are relatively safe with their built-in buoyancy. In the event of overturning, they can be righted by threading the bow rope around one rowlock, standing on the opposite side and pulling hard on the rope to overturn it again. Aluminium dinghies are light and durable. Their lightness makes them easy to row, but prone to being blown with the wind, which may make them unsuitable for windy conditions. If they become swamped, two people can remove most of the water by depressing the stern until the bow is well out of the water and then, quickly raising the stern, it can then be bailed out by a person alongside. When partly bailed out, boarding can be accomplished over the stern with a second person holding the bow down; then the remaining water can be bailed out. Wooden and fibreglass dinghies are often too heavy for this technique, but may float higher when swamped, thus allowing the use of a bailer.

8.6 SAFETY PRECAUTIONS WHEN WORKING WITH CABLEWAYS

Before using any cableway, personnel should check the condition, looking for signs of anchorage movement, changed sag, vandalism or other damage to the cable, backstays, anchorages, cable hardware and cable car. Manned cableways normally require regular inspections and the issuance of a fitness certificate. The certificate should be current. Personnel should never board the cable car without the on-site operator.

When using cable cars, whether moving or stopped, all personnel must be instructed never to touch the cable with the hands, because of the danger of being run over by the cable car wheels. The appropriate pulling device must be used instead. The maximum design load of the cableway must not be exceeded, and wire cutters should be carried to cut the suspension wire if it becomes entangled in the river. The wire should be cut close to the reel, and personnel should hold on tightly to the cable car during the rebound.

Unmanned cableways generally have powered or manual winches on the bank, and these need ratchets and brakes that lock firmly. As with the use of all winches, long hair and loose clothing must be fastened back to avoid being caught.

All cables and wires should be installed and used with due regard for the safety of river traffic and aircraft, particularly helicopters. Where appropriate, they must be marked with suitably durable and visible markers to indicate their presence to operators and pilots.

8.7 SAFETY PRECAUTIONS WHEN HANDLING EQUIPMENT

8.7.1 Surveying

Overhead electrical wires are a hazard when using survey staves, particularly metal ones. Signs warning of this hazard should be affixed to the back of staves, at eye level.

8.7.2 Chainsaws

Operators of chainsaws should wear suitable closely fitting clothing and safety equipment, including hard hat, ear protection, eye protection and strong work boots with steel toe-caps.

The saw should be started while being held on the ground. Cutting should be carried out in a position with firm footing, clear of obstructions and other people, and with a safe exit from falling timber or rolling branches.

Kickback can occur when the chain recoils upward from striking an obstacle. It can recoil far faster than a person's reaction time and may cause the operator to lose his or her grip. Lacerated left hands are common in this situation. In order to reduce the likelihood of this occurring, operators should maintain a firm grip with a straight wrist and good footing, cut at peak revolutions, and keep the nose of the bar away from obstructions.

8.7.3 Electrical equipment

All electrical equipment used outdoors or in damp conditions must be powered from an isolating transformer or an earth-leakage current-tripping device. All electrical leads should be routed to prevent damage from abrasion and contact with water. Leads must be kept in good repair, and any frayed or damaged connections should be properly repaired.

Circuits should not be overloaded, and repairs that should be done by a qualified electrician should not be attempted.

8.7.4 Power tools

Power tools should be used for their intended purposes only and always in accordance with the manufacturer's specifications. Personnel should be properly instructed in the use of these items. The use of some air- or power-operated tools may require authorization by government agencies. Safety goggles should always be used with all cutting, grinding or drilling equipment.

8.7.5 Protective clothing and safety equipment

Personnel must be supplied with all safety and protective items required for the working conditions and equipment being used.

8.7.6 Radioactive equipment

Some items, such as soil-moisture meters and geophysical instruments, incorporate radioactive sources. These instruments will be appropriately marked and must be handled and stored with

special care in accordance with the relevant regulations. Radiation emitted by the source can be hazardous to health. The radioactive material will usually be sealed within a stainless steel pellet. As part of the equipment, this pellet will normally be surrounded by a material such as plastic, steel or lead, which absorbs radiation. It must be ensured that the source is within this absorber when the equipment is not in operation. The pellet must not be handled under any circumstance. If it needs to be moved, long-handled tongs or similar equipment must be used.

Keeping a good distance is normally adequate protection. With some sources, significant exposure only occurs closer than 10 cm. Others require considerably more than this. It is imperative that the personnel determine the type and other details of the radioactive source being used and that they acquaint themselves with the recommended procedures and instructions for that source. Where possible, employers should provide protective gear to those personnel operating equipment with radioactive devices.

All instructions, procedures and regulations must be rigorously followed, and the equipment should be handled with the utmost care at all times.

8.7.7 **Safety aspects of groundwater monitoring**

In all instances, permission must be sought from the owners of wells. Pumps and airlift equipment for sampling, testing or developing wells should be in accordance with safety procedures for those types of equipment. Safe practices around drilling rigs are essential, and manuals of drilling practice should be consulted.

Entry into large-diameter wells for sampling should be avoided because of the potential presence of gases, as described in 8.2.3. Safety harnesses should be worn when working above large-diameter wells.

8.7.8 **Dust menace**

Dust results from the inadequate cohesion of soil particles during a dry period. Dust can cause excessive wear and tear of equipment, especially on calibration marks on gauging instruments. Personnel must ensure that dust is completely removed from the packing boxes of these instruments before packing them away after use.

8.8 **SAFETY PRECAUTIONS WHEN HANDLING CHEMICALS**

All chemicals, such as those used for the preservation of water samples, cleaning fluids and tracers, must be stored and handled with care. Inhalation of vapours or direct contact with skin, eyes and clothing should be avoided. Any spills must be cleaned up immediately by dilution with large quantities of water, neutralization or mopping up of the chemical followed by disposal of the material. Gloves, aprons and suitable clean-up materials should be made available for this purpose.

No pipetting should be done orally, except when potable waters are the only substance being used. Skin that has been in contact with acids, bases or other corrosive substances should be washed immediately with plenty of water. A neutralizing solution may be applied if appropriate, to be followed by a second washing with soap. If any chemicals enter the eyes, they should be rinsed immediately with plenty of water. Rinsing around the eyes should be done as well. It may be necessary to hold the eyelids open during the washing procedure. Rinsing should continue for several minutes. All eye injuries must be treated professionally.

Precautions must be taken as water may contain a variety of toxic or bacterial hazardous substances. These may be derived from a wide range of sources, such as wastewater or effluent discharges, leachate from landfills, leakages from storage tanks, washing of agricultural spray tanks, and chemical or oil spills.

Any unusual appearance, colour, film, frothing, odours or vapours must be treated as suspicious and adequate precautions must be taken. Many toxic substances can enter the body through the skin and, in the case of vapours, through the lungs.

They can cause eye irritation, skin irritation, pruritus, rashes, nausea, stomach pain, decreased appetite, headaches, fatigue, coughing, wheezing and shortness of breath.

Precautions may include gloves, waterproof overalls, aprons, hats and eye protection. Where toxic vapours might be present, work should only be carried out in well-ventilated areas or with the use of self-contained breathing apparatus. Food should be kept away from samples and sampling locations. Personnel should always wash hands thoroughly before handling food. Smoking while sampling or near samples should be prohibited. If

flammable compounds are expected to be present, personnel should keep sparks and heat sources away, store samples in special explosion-proof refrigerators and maintain the application temperature of the chemicals.

When measuring or sampling waters with high concentrations of toxic substances, such as leachate from landfills, or with suspected radioactivity, special considerations are required and the appropriate specialist should be consulted.

8.9 SPECIAL PRECAUTIONS FOR COLD CONDITIONS

8.9.1 Hypothermia (exposure)

Hypothermia is a condition of lowered body temperature caused by exposure to cold and results in rapidly progressing mental and physical collapse. Its onset is caused by cold temperatures aggravated by wet clothes, wind, hunger and exhaustion. It often occurs in conditions where its early symptoms may not be recognized.

Early symptoms of exposure may include signs of tiredness, cold and exhaustion, lack of interest, lethargy, clumsiness and stumbling, slurred speech and irrational behaviour. These signs constitute a medical emergency and require immediate action to prevent further heat loss and to effect rewarming. The victim may not complain and possibly deny that there is a problem. Later symptoms indicating a very serious emergency include obvious distress, a cessation of shivering despite the cold, collapse and unconsciousness.

Rewarming must be started immediately when symptoms become evident. The victim's body will probably be incapable of generating sufficient warmth to accomplish this, and warmth must be applied gradually to the torso, but not to the limbs and extremities. Warming the extremities will increase blood circulation to these cooler parts of the body and reduce the temperature of the body's core still further.

The requirements for rewarming are shelter, dry clothes, insulation (such as a sleeping bag), and warmth applied to the vital organs of the body. The latter can be done through close body contact, for example, by sharing a sleeping bag. The person should not be rubbed nor should direct heat be applied. Warm, sweet drinks, but never alcohol, are helpful to a person who is conscious.

With warmth and shelter, patients often appear to recover quickly, but a resumption of cold conditions can bring on collapse. Full recovery can take up to two days.

Hypothermia can be prevented by providing adequate shelter and insulated and windproof clothing. One should avoid prolonged wet conditions and have food and shelter available, such as a tent or bivouac. Employers and contractors can also provide warm-up shelters at the workplace where workers can find refuge from the cold and drink hot beverages. Warm, sweet drinks and soups are better than coffee, as coffee increases heat loss from the body.

When work involves riding on an open vehicle or some activity that generates wind, the number of stops should be increased appropriately.

8.9.2 Frostbite

Exposure to extreme cold causes freezing of the outer parts of exposed tissues, such as toes, ears, fingers and nose. Affected parts become numb, dull white in colour and waxy in appearance. Superficial frostbite can be treated by applying a hand or another part of the body to the affected area, without rubbing. Rewarming should not be done by direct heat or rubbing, or with alcohol. More serious frostbite requires medical treatment.

Prevention involves wearing adequate foot, hand, face and ear protection, avoiding tight-fitting clothing or boots, keeping hands and feet dry, and constantly monitoring for signs of numbness. Constant movement or wriggling of toes and fingers to stimulate circulation is a short-term remedy that should be followed to reduce the effect of exposure to cold.

8.9.3 Working on ice-cold lakes and streams

Travel and work on ice should be done with great caution, keeping weight to a minimum. If one falls through ice, outstretch arms onto solid ice, kick to keep the body level, crawl forward on the stomach until hips reach the ice, then make a quick full-length roll onto the ice. Keep rolling until safe. If the ice is too thin for support, one should make one's way to shore by breaking the ice with one hand while supporting oneself with the other.

Rescuers should try to reach the victim with a pole, board or rope. Going out to the ice edge should only be done as a last resort. If it becomes

necessary, rescuers should carry a long pole or slide along in a prone position. If there is a rope available, it should be secured to an object on shore. A person who has fallen through ice must be dried and rewarmed as soon as possible to prevent hypothermia.

Considerable risk may be involved in taking measurements through ice. Drilling or breaking a hole may significantly reduce the strength of the ice. Ice in a stream is likely to be of variable thickness, and its strength cannot be estimated from its apparent thickness near the edge. Areas with rapids or flow disturbances, such as bridge piers, are likely to have thinner ice owing to the water movement. In advancing across an ice-covered stream, it is advisable to test the ice with an ice chisel every few steps. Hard ice will give a resounding ring, and soft ice will give a dull thud. A safety rope should be employed when there is any doubt, and a companion equipped with suitable rescue equipment should be on the bank.

8.9.4 Working in mountainous areas

The weather in mountainous areas can change rapidly, causing problems for the unwary or ill-equipped. The colder the climate, the greater the potential problems and the more clothing, supplies and safety equipment are required.

Personnel need to be experienced or be with someone who is, and the party's travel plans should be known to an appropriate person who could initiate assistance should this become necessary. Adequate waterproof, windproof and warm clothing should be worn and carried, as well as sufficient food and survival equipment for the weather extremes. Ensure that all persons arriving at the site by helicopter have this equipment with them even if they have been dropped off only for a short time, as cloud or other weather conditions may prevent the helicopter's return.

Venturing out on hard snow is not recommended without an ice axe, climbing rope and crampons, and knowledge of their use. It is important to be wary of avalanches, particularly just after snowfall or rain, to be aware of the various causes of unstable snow, and to seek advice from experienced persons. Whatever the snow conditions, travel on or below steep slopes should be avoided. If caught in an avalanche, one should make every effort to stay on top to avoid being buried, cover the nose and mouth to prevent suffocation and, if buried, try to make an air space in front of the face and chest.

8.9.5 Cold-water survival

Hypothermia will result very rapidly from immersion in cold water. Its onset can be delayed by remaining still and having sufficient coverage of clothing to reduce water movement against the body with its accompanying heat loss. It usually helps to keep as much of the body as possible out of the water, as the body loses heat much more quickly to water than to air of the same temperature.

It is preferable to keep the head above water and to draw the legs up in contact with the groin area to reduce heat loss. A life jacket is invaluable in assisting with this, and will also provide insulation to the core parts of the body. A number of people should huddle together, holding on to each other facing inwards with the sides of the chest pressed together to reduce heat loss. Children should be held in the centre of such a group.

Treatment involves rewarming of the vital organs of the body prior to warming the limbs and extremities, as described in 8.9.1.

8.10 SPECIAL PRECAUTIONS FOR HOT CONDITIONS

8.10.1 Heatstroke (hyperthermia)

Heatstroke is caused by exposure to high temperature that causes the body temperature to rise above 40°C. Adverse response to high heat varies among people depending on their acclimatization, level of fitness and, most importantly, body hydration. With the onset of excessive heat, the body loses heat primarily by the evaporation of water through sweating and respiration. If this loss of water is not replenished, the cooling mechanisms are inhibited and heat builds up. Symptoms include headache, chilling, nausea, rapid pulse, muscle pains, loss of coordination and, more severely, delirium and convulsions. If not treated, death follows.

Treatment involves immediate cooling by placing the victim in the shade, removing clothes and spraying with cold water while fanning vigorously. The victim is given fluids when fully conscious.

Precautions include being physically fit, moderating exercise, drinking moderate amounts

regularly and often, avoiding alcohol and caffeine, avoiding working in the hottest part of the day, wearing lightweight, light-coloured, loose-weave clothing and a wide-brimmed hat, and adding extra salt to meals. Employers can also use some of the following measures if their workplaces are very hot:

- (a) Engineering controls include using isolation, redesign or substitution to remove heat sources from work areas, air conditioning to cool the entire workplace, spot cooling for hot areas and worksites, local exhaust to remove heat from workplaces, automation of hot processes, as well as ensuring that the maintenance programme quickly fixes problems that create hot conditions such as steam leaks;
- (b) Fans can increase the airflow and reduce humidity. Improving the airflow increases the cooling effect of sweating. However, if the air temperature is at or above body temperature, fans will simply expose the body to more hot air. This increases the heat load and the risk of heat stress disorders;
- (c) Administrative and other measures for occasional hot indoor and outdoor work situations include providing regular rest breaks, providing adequate amounts of drinking water, proper salting of food, training workers to recognize and treat heat stress disorders, removing pregnant employees from hot work areas, scheduling work for cooler times of the day and providing light-coloured, lightweight and loose-fitting cotton clothing.

Note: Workers should be strongly encouraged to frequently drink small amounts of water or other cool (but not cold) fluids. One cup of fluid every 15–20 minutes can replace water lost in sweat. If workers drink only when they are thirsty, they may not get enough fluids.

8.10.2 Sunburn

Excessive exposure to the sun can cause severe sunburn, particularly to those with fair skin. It will cause severe pain, damage to the skin and possibly heatstroke. Prolonged exposure to the sun's ultraviolet rays can cause skin cancer, with fair-skinned people at the greatest risks.

Precautions include wearing protective clothing, with attention to head covering. Sunscreen lotions should be applied to the exposed skin. Exposure to the sun should be confined to short periods each day, with gradual increases to build tolerance.

8.11 TRAVEL AND TRANSPORT

8.11.1 General

Modes of travel and transport for hydrological work are many and varied in accordance with the wide range of terrain, climate and routes to be covered. Safety in terms of travel, taking into account all of the variations of these factors, is a wide topic in itself and is not confined only to hydrological work. Accordingly, it is only covered briefly here, and hydrologists are urged to seek out manuals and advice for particular local conditions and modes of travel.

8.11.2 Helicopters

On the ground, the noise, wind and urgency associated with helicopters tend to mask the dangers presented by the main and tail rotors. These have killed and maimed many people. One must not approach or leave the helicopter without the pilot's knowledge and approval, and this should be done within the pilot's field of vision. One should approach and leave the aircraft on the downslope side for maximum clearance from the main rotor. One should never walk around the tail.

Personnel should keep away from the landing pad or zone, and keep it clear of equipment. All equipment and loose articles should be kept well out of reach of the effects of rotor wash or they should be heavily weighted down. Long objects, such as survey staves, should be carried horizontally at waist level to avoid contact with rotors. The aircraft should be loaded under the supervision of the pilot, whose attention should be drawn to hazardous cargo, such as batteries and fuel.

Cableways and aerial wires are particularly hazardous to helicopter operations, and personnel should make the pilot aware of any that are known and assist in looking out for others.

8.11.3 Motor vehicles

In much hydrological work, frequent travel by motor vehicle means potential for serious accidents. Travel on remote, backcountry roads is common, and this provides additional hazards to those that can be encountered on highways.

The most common causes of accidents relate to excessive speed. This is no less true of backcountry roads, which are often narrow and winding and

Table I.8.1. Checklist for vehicle maintenance

Check outside every time the vehicle is driven to ensure that:	Tyres are not low, tread is not worn away, windshield wipers work and there is sufficient cleaning fluid in the reservoir, and there are no leaks under the vehicle. Mirrors, directional signals, headlights, tail lights and brake lights are clean and not broken.
Check inside every time the vehicle is driven to ensure that:	All doors are fully closed and locked, seat and head restraint are comfortably adjusted, and drivers and passengers are correctly belted; gauges work and accurately reflect engine conditions; the driver is mentally and physically ready to drive; mirrors, vents and windows are properly adjusted.
Check once a week	Oil level is sufficient before starting the vehicle. Washer fluid level is adequate.
Check once a month	Automatic transmission and brake fluid levels are satisfactory.
Check every six months	Windshield wiper blades, tyres and power steering fluid level are adequate.

have loose surfaces. The best drivers tend to accelerate smoothly, corner carefully and brake gently, being considerate of their vehicle, their passengers and other road users.

Keeping a vehicle in good working order helps to maintain control in adverse driving conditions. Table I.8.1 provides a checklist for vehicle maintenance.

8.12 SURVIVAL KITS AND RATIONS

Personnel in remote areas should carry emergency survival kits. The components of these kits will vary greatly depending on the climate, conditions and mode of travel, but should include long-life emergency food, water, water purification tablets or iodine, cooking and heating equipment, shelter, such as a tent or bivouac, sleeping bags, lighting, medical supplies, adequate clothing for the worst possible conditions, toiletry items and signalling equipment, such as a mirror, flares, walkie-talkies, mobile phones and two-way radio. A checklist for personal protective equipment is provided in Table I.8.2.

First-aid training should be given to all field personnel, and each person should be supplied with an adequate first-aid kit and manual. Topics to be covered should include rescue breathing, cardio-pulmonary resuscitation, unconsciousness, bleeding, fractures, shock, eye injuries, poisoning and burns.

Personnel should check their emergency preparedness planning at least once every six months. This will enable them to update their survival kits.

Table I.8.2. Checklist for personal protective equipment^a

<i>Type</i>	<i>Equipment</i>
<i>Chemical and disease protection</i>	Aprons Eye/face splash guards Gloves (vinyl and/or latex), sizes S, M, L and XL Protective suits, sizes S, M, L and XL Respirators (certification required for use)
<i>Climatic and UV protection</i>	Boots Fluids (for example, water and sports drinks) Hat, wide-brimmed Insect repellent (unscented) Rain gear Sunglasses Sunscreen Temperature-modifying clothing
<i>Flotation and reflective protection</i>	Orange flotation vest and jackets Safety harness
<i>Protection for working around heavy objects and machinery</i>	Black belt Hard hat Hearing protection Safety glasses Steel-toed safety boots Work gloves

^a Personal protective equipment must be selected based on the hazard to be encountered.
Source: Modified after USGS original (<http://water.usgs.gov/owq/FieldManual/Chap9/A9.11.html>).

8.13 OTHER HAZARDS

Field personnel should be familiar with, and always be on the lookout for, other hazards posed by their working environment. These include poisonous plants, stinging or biting insects, dangerous animals, quicksand and electrical storms. Also, bodily contact with or ingestion of some waters may pose significant health risks. In some localities, there may be possibility of attack by other people, for example, those who may be engaged in illegal activities. Employers have a responsibility to ensure that their employees are never unknowingly exposed to any such risks.

In case of remote field activities, personnel should travel with at least one local person who is familiar with most of the routes, people and the security situation. Some effort should be devoted to informing local leaders about the activities to be carried out in their area. This will increase community participation and cooperation.

References and further reading

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