Chapter Nine - Medical Factors

9.1. **Time Frame For Survival (TFFS):** The time-frame for survival is an assessment of the minimum and maximum period a missing person is likely to live. This assessment is subjective and contains numerous variables including the physical condition of the person, their age, general health, clothing, weather conditions, the ability to remain dry, and their consumption of food, water and alcohol. There are a number of medical conditions that go hand in hand with search and rescue missions. These can be loosely divided into cold weather problems and hot weather problems. We will touch briefly on both of these topics to give you, as a co-ordinator, a basic understanding and awareness.

9.2. **Survivor Stress Factors:** Two basic assumptions are to be made concerning survivors of a distress incident:

a. there are always survivors who require emergency medical care; and
b. they are under a condition of great stress and experiencing shock.

9.3. It may also be assumed that not even able-bodied, logical-thinking survivors will be able to help themselves.

9.4. Records include numerous accounts where supposedly able-bodied, logical-thinking survivors failed to accomplish extremely simple tasks in a logical order, and thus hindered, delayed or even prevented their own rescue.

9.5. This is due to shock that, following an accident, is often so great that even those of strong mind think and act illogically. All survivors will be in some degree of shock. Some may be calm and somewhat rational, some may be hysterical and in panic, while the remainder will be temporarily stunned and bewildered.

9.6. This last group will generally have passive attitude and can be easily led during the first 24 hours after the incident. As the shock wears off, most of them will develop active attitudes. Those that do not develop active attitudes will die unless rescued quickly.

9.7. Individuals who observe an emergency situation and reporting it to the SAR system should also be considered as being under stress. Many times it will be necessary for SAR personnel to specifically request essential information from an individual reporting an emergency. This situation should be expected and SAR personnel should be prepared to cope with it.

9.8. **Survival Environment Factors:** The environment in which the survivor is exposed is another factor that limits the time available to complete their rescue. In some cases, environment will be the most time critical of all. Climatic atlases are useful to evaluate probable climatic conditions in regions where few or no weather reporting facilities are available.

9.9. The relation of survival time to water temperature, air temperature, humidity and wind velocity is not a simple one. These and other factors often exist in combination to complicate the problem of estimating life expectancy of survivors. Individuals will vary in their reaction to cold and heat stresses.

9.10. Additional factors which will vary a survivor's life expectancy include the type of clothing worn, the clothing's wetness, the survivor's activity during their exposure, initial body temperature, physical conditions, thirst, exhaustion, hunger, and various psychological stresses such as isolation, loneliness and remoteness, and the all-important individual will to live.

9.11. The graphs contained in this chapter are provided to assist the SMC in determining the urgency required to remove survivors from the environment, and to assist in evaluating the practicality of terminating a search. These graphs are based upon case histories, field tests, laboratory experiments and analysis of all known data. However, the SMC must understand that some individuals will exceed the life expectancy or tolerance times indicated in these figures, and therefore should consider these figures as helpful guidelines rather than absolute controlling factors.

9.12. **Hypothermia:** Hypothermia is the abnormal lowering of internal body temperature (heat loss) and results from exposure to the chilling effects of cold air, wind or water. Death from hypothermia may occur in both land survival and water survival situations. Hypothermia is the leading cause of death for dementia suffers located deceased after being reported missing.

9.13. Internal body temperature is the critical factor in hypothermia. If the body temperature is depressed to only 35°C, most persons will survive. If the body temperature is depressed to approximately 33°C, most persons will return to useful activity. At about 32°C, the level of consciousness becomes clouded and unconsciousness occurs at 30°C. Only 30 percent would be expected to survive these temperatures. At body temperature depressions of 26°C and below, the average individual will die, and ventricular fibrillation (heart attack) will usually occur as the final event. However in some cases individuals have survived with body temperatures as low as 17°C.

9.14. **Water Hypothermia:** The body will cool when immersed in water having a temperature of less than 33°C. The warmest temperature that ocean water can be at any time of year is 29°C. Approximately one-third of the earth's oceans have water temperatures of 19°C or above. Most dams and inland waterways have water at temperatures far less than that of the ocean.

9.15. The rate of body heat loss increases as the temperature of air and water decreases. If a survivor is immersed in water, hypothermia will occur very rapidly due to the decreased insulating quality of wet clothing and the fact that water will displace the layer of still air that normally surrounds the body. Water allows a rate of heat exchange approximately twenty five times greater than that of air at the same temperature.

9.16. In water temperatures above 21°C survival time depends solely upon the fatigue factor of the individual, some individuals having survived in excess of 80 hours at these temperatures.

9.17. Between 15°C and 21°C an individual can survive up to 12 hours. At 15°C skin temperatures will decrease to near water temperature within 10 minutes of entry and shivering and discomfort is experienced immediately upon immersion. Dunking and submersion difficulties become increasingly distressful to the survivor.

9.18. From 10°C to 15°C the survivor has a reasonably good chance if rescue is completed within 6 hours. Faintness and disorientation occur at water temperatures of 10°C and below. Violent shivering and muscle cramps will be present almost from the time of entering the water and intense pain will be experienced in the hands and feet. This very painful experience will continue until numbness sets in.

9.19. All skin temperatures decrease to that of the surrounding water temperature in about 10 minutes. In the temperature range from 4°C to 10°C, only about 50 per cent of a group can be expected to survive longer than 1 hour. In water temperatures of 2°C and below the

survivor suffers a severe shock and intense pain on entering the water. This shock in some instances may be fatal owing to loss of consciousness and subsequent drowning.

9.20. Water survivors who die within 10 to 15 minutes after entry into frigid water apparently do not succumb because of reduced body temperature, but rather from the shock of rapid entry into cold water. Fifteen minutes is too short a time for the internal body temperature to fall to a fatal level, even though the outer skin temperatures are at the same temperature as the water. In addition, the temperatures of the hands and feet fall so rapidly that such immersions are frequently less painful than those in 4°C to 10°C water.

9.21. Factors that slow the loss of body heat are:

a. high body weight,

b. heavy clothing,

c. survival clothing,

d. or the use of a huddling or other protective behaviour.

Factors that make a person lose body heat faster are:

a. low body weight,

b. light clothing,

c. or exercising (such as the situation where a survivors without lifejackets must swim to stay afloat).

Specialised insulated protective clothing, such as immersion suits or wet suits, is capable of increasing survival time from 2 to 10 times the basic duration shown on the figure.

9.22. **Wind Hypothermia:** Although the body will lose heat approximately twenty-five times slower in calm air than when immersed in water, the body heat loss will be accelerated with increasing wind velocities. This is an additional factor to consider for exposed survivors.

9.23. Hypothermia can occur on land as well as at sea. A human has a much greater chance of suffering hypothermia if immersed in the sea or other waterway. The warmest sea water will get to is about 29°C, with a world wide average of 19°C. Temperature loss in water is about 25 times greater that in air of the same temperature. Therefore immersion in the sea can drop body core temperatures very quickly.

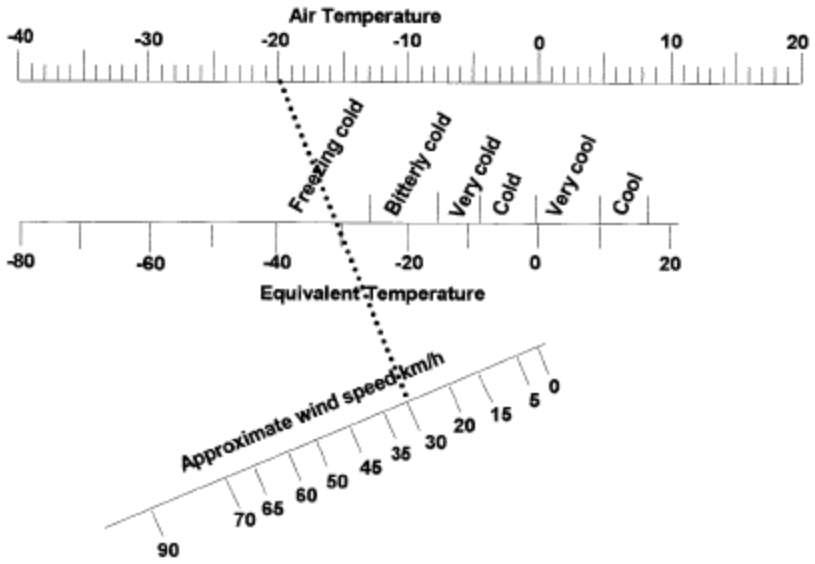
9.24. Hypothermia can happen during cold nights in desert country or anytime in the colder areas of the State. It occurs when the body's temperature falls below 35°C. It is characterised by intense shivering, followed by loss of co-ordination, confusion and irrationality. If it is not halted unconsciousness will follow and then death. This can happen in a period as short as one hour. Once the body's core temperature falls to 28°C the heart will stop. If a person is wet, ill or dehydrated it will lessen their chances of fighting off hypothermia. Symptoms are shivering, poor co-ordination, decreasing levels of consciousness, slow and irregular pulse and numbness. This is a medical emergency. To treat, remove from the cold, remove any wet clothing, move to a warm area if possible. Cover the victim with blankets and apply hot water bottles or pads. Remember that the victim has lost body heat and will not be able to warm themselves so just covering them with a blanket will not do, you have to provide a source of warmth. Warm slowly. Seek urgent medical attention. Do not allow the victim to relax as the sudden rush of cold blood from the extremities can cause the heart to stop. This has happened during previous SAR missions when the victim has been located, relaxed and has gone into cardiac arrest.

9.25. Assume that there are always survivors who require medical attention and that they are under great stress and shock until evidence suggests otherwise.

9.26. Not even able bodied, logical-thinking persons can help themselves when suffering the effects of hypothermia and stress.

9.27. Persons assessing a time frame for survival must recognise the limitations of such an assessment and not regard it as an arbitrary period for survival. The following subsections may assist in providing a guide to assist in search planning.

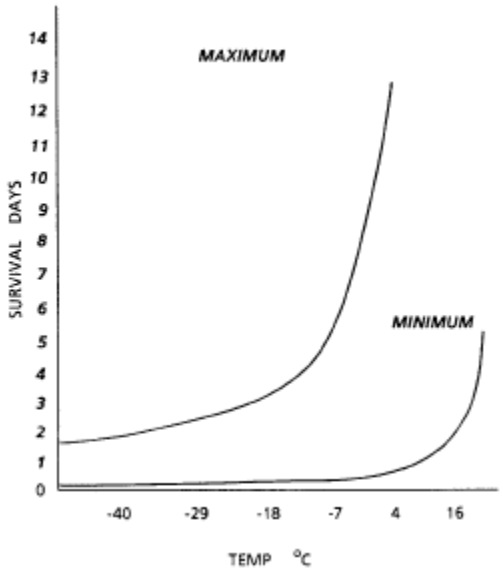
9.28. **Wind Chill:** This is the sensation of cold felt by humans as a result of wind movement. This causes people to feel colder than the actual temperature, even in low wind conditions. The wind-chill diagram below is an adaptation of the work of Steadman and Dixon where the wind speed has been converted from metres per second to kilometres per hour, rounded up or down to the nearest 5 km.



Wind Chill Table

9.29. The dotted line is an example where the air temperature is -20°C and a wind speed of approximately 30 km/h. This produces an equivalent temperature of -32°C on exposed flesh.

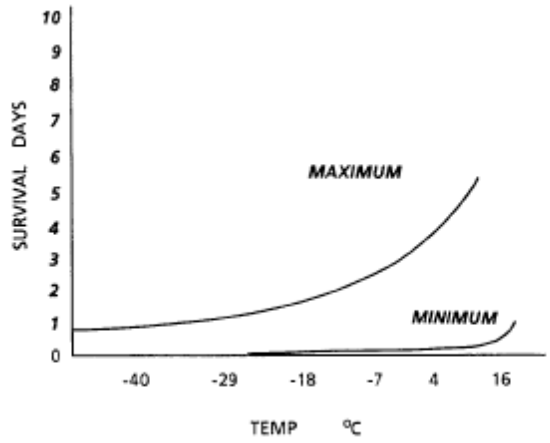
9.30. **Hypothermia:** Hypothermia is the condition experienced when the human body's core temperature **decreases** from a 'normal' 37°C to less than 35°C. Hypothermia in a field environment can result from cold water immersion, exposure to cold wet conditions, or from a variety of medical conditions. As this is a life-threatening condition, the possibility of hypothermia will influence the time-frame for survival. As environmental conditions of rain, wind and snow worsen, the opportunity for body heat loss increases. This loss can be countered by insulation with clothing, both windproof and/or rainproof. As a rough guide, a person suffering from hypothermia when the temperature is 0°C may be expected to survive from as little as four hours up to ten or more days.



Hypothermia Survivability Graph

9.31. **Hypothermia Survivability**: The above graph which describes the range of days for fatal exposure or hypothermia survivability, in days, for a given temperature. The information calculated is a guide only and is based upon a healthy 25 year old male wearing the equivalent of normal clothing, including a jacket.

9.32. **Wet-Chill Survivability**: The below graph which describes wet-chill survivability. Accidental hypothermia resulting from wet-chill is the most dangerous and commonly-fatal weather hazard. Essentially, wet-chill is the wetting of the missing person in cold and windy weather. The result is a significant decrease in that person's ability to survive.



Wet Chill Survivability Graph

9.33. **Water Immersion**: Hypothermia induced by immersion in cold water has a more rapid onset. There is no ready answer to how long a person will survive as there are many factors involved including:

(1) water temperature;
(2) duration of immersion;
(3) insulation (body fat and clothing worn);
(4) level of activity; and
(5) weather conditions (especially wind and wave action).

The following chart is a guide to the survival time of a lean person in rough water and should not be regarded as arbitrary. For this reason, searchers must treat cold water areas such as streams, lakes and dams as significant danger to the missing person(s).

Clothing Type	Time to Incapacity (Body Core Temp 34°C)	Time to Unconsciousness (Body Core Temp 30°C)	Time to Cardiac Arrest (Body Core Temp 25°C)
Light Clothing	0.4 Hrs	0.8 Hrs	1.3 Hrs
4.8 mm Wet Suit	1.6 Hrs	3.2 Hrs	4.9 Hrs
Insulated Dry Clothing	3.0 Hrs	5.7 Hrs	9.1 Hrs

Water Immersion Table Based on Steinman and Kublis (1986)

NB: The above times are not cumulative and are a guide only. An example of the variation in survival time between two persons in light clothing immersed in water at 6°C is that one could remain capacitated for 1.3 hours whilst the second could go into cardiac arrest in the same time.

9.34. **Effects of Alcohol**: The consumption of alcohol can impact upon the time-frame for survival, both in hot and cold environments. Alcohol is likely to accelerate dehydration in hot climate and may lessen the ability to retain heat in cold areas.

9.35. **Hyperthermia, Heat Stress and Dehydration:** Hyperthermia, heat stress and dehydration are dangers in hot climates, particularly in desert areas. The most severe form of heat stress is heatstroke, during which the body temperature rises due to the collapse of the temperature control mechanism of the body. If the body temperature rises above 42°C, the average person will die. Milder forms of heat stress are heat cramps and heat exhaustion. Another limiting factor both in hot climates and in survival situations at sea is dehydration. A person totally without water can die within a few hours (Western Qld 1999 4 hrs from leaving vehicle to death), although some have survived for a week or more.

9.36. The human body functions best at 38°C ± 2°C, although it will tolerate the core temperature dropping to 33°C or rising to 42°C with a good chance of full recovery. Between 32°C and 26°C body functions begin to shut down and unconsciousness usually follows. Below 26°C the average individual will perish, although there have been many cases of persons surviving. Temperatures above 43°C will prove fatal in most circumstances unless urgent medical assistance is sought. Death can occur in as short a period as four hours.

9.37. The least serious, but still potentially dangerous, of the heat related problems are muscular cramps. The exact cause is unknown but the onset of cramps can be rapid. They mostly affect the larger muscles of the body, but can occur in any of the body's muscles. Cramping is brought on by strenuous activity in warm or moderate temperature conditions and can be described as a bunching of shortening of the muscles causing what feels like a knot. To alleviate cramps place the victim in a cool, comfortable place, provide cool water but do not give salt or salt tablets as a normal diet contains adequate salt for recovery. The cramped muscles may be lightly stretched and massaged to hasten recovery. Recovery is normally swift.

9.38. **Heat exhaustion**: Is the next most serious of the heat related illnesses. It is brought on by long periods of activity in a hot environment. This not only occurs with persons in arid areas but also to fire-fighter and factory workers working in confined spaces with high temperatures. To maintain a constant body temperature in hot weather the body sweats,

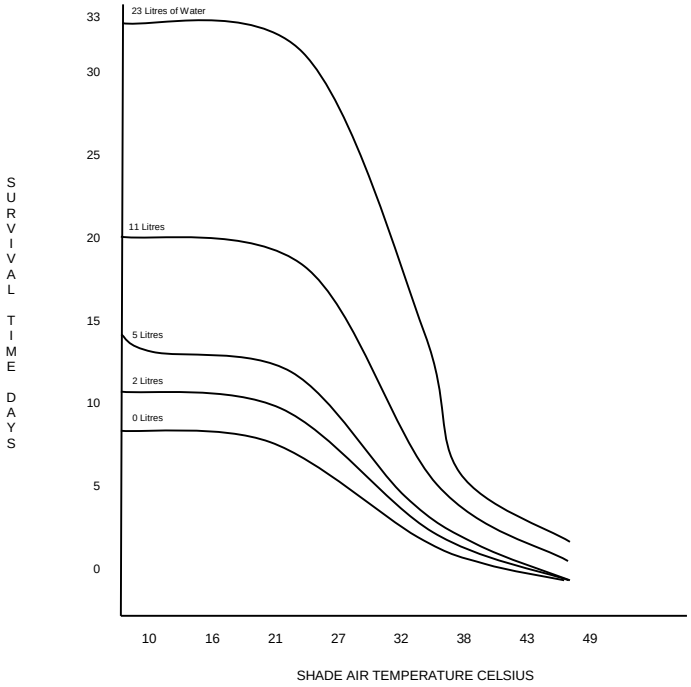
using the evaporation of body fluids from the skin to produce a cooling effect. A side effect of this is the loss of vital body fluids which in turn decreases blood volume. Blood temperature then rises resulting in an increased blood flow to the limbs to assist in cooling, reducing blood flow to the internal organs. This lack of blood can cause shock and heat exhaustion. If recognised early heat exhaustion can often be controlled and reversed. If left undetected the body's temperature will continue to rise and will result in changes in levels of consciousness. Symptoms include dizziness and weakness, exhaustion, rapid and weak pulse, nausea, headache, skin that may feel cool and moist and look pale but progressing to hot and red. First aid treatment of heat exhaustion is vital. If conscious lay the victim down in a cool and shaded area with legs slightly elevated, remove or loosen tight clothing, give water in small quantities. If vomiting or unable to drink seek urgent medical attention. If the victim is unconscious place them in the recovery position in a cool and shaded area. Check breathing, airway and circulation. Keep them cool and seek urgent medical attention.

9.39. **Heat stroke**: Is the most serious of the heat related illnesses. As the body's fluid levels become low sweating stops. As a result of this the body's core temperature continues to rise. The lack of blood to the vital organs necessitates that blood be brought from the limbs back to the core, thereby contributing to a further increase in body temperature. At this stage the body is unable to cool itself and the temperature rises rapidly. Vital organs then begin to fail; convulsions, unconsciousness and death soon result. Symptoms of heat stroke include rapid, shallow breathing, a pulse that may be strong and rapid at first but deteriorating to weak and irregular, falling in and out of consciousness, hot, dry and red skin and a high body temperature. Treatment is similar to heat exhaustion. Stop the victim from doing anything; at this stage they will have lost the ability to make rational decisions. Place them in a cool area, lying down with the legs elevated. Cool the body and given small quantities of cool water. Seek urgent medical assistance. To cool the body remove any tight or restrictive clothing and any clothing soaked with perspiration. Cover the skin with cool and wet items such as towels. Fan the body to aid in evaporation and cooling. Continue to do so until the body's temperature falls to 38°C.

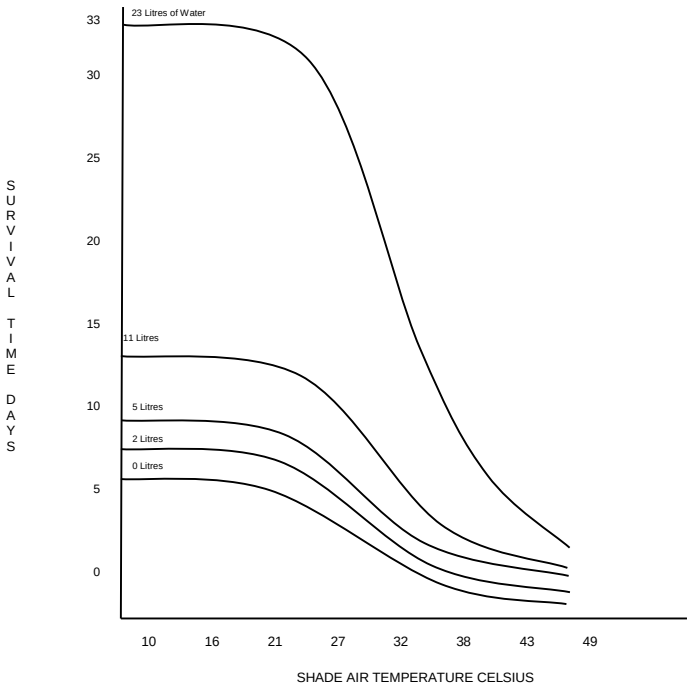
9.40. In all cases rapid assessment of the situation and prompt first aid can mean the difference between life and death. If you have any doubt about which stage a victim may be in then assume the worst and treat accordingly.

9.41. Dehydration is the excessive loss of water from the body, this leads to an imbalance in the electrolytes. As the body is composed mostly of water there needs to be equilibrium between water lost, as in sweat and urine, and water gained as in drinking and food. If more water is lost than ingested then dehydration is the result. Severe dehydration can end in death. Small amounts of water or clear fluids can assist a person suffering dehydration but ultimately medical attention needs to be sought as fluids can be replaced more efficiently intravenously. The body can only take in approximately 1.1 litres of liquid per hour via the stomach whereas intravenous fluids can be introduced at a much greater rate if necessary.

9.42. **Hyperthermia:** Hyperthermia is the condition experienced when the human body's core temperature **increases** from a 'normal' of 37°C to more than 39°C. If the missing person's core temperature exceeds 42°C, the person might be expected to die. The below graphs provide a guide to expected desert survivability but should not be regarded as arbitrary. The old survival adage of 3 minutes without air, 3 days without water and 3 weeks without food should be remembered when referring to these graphs.



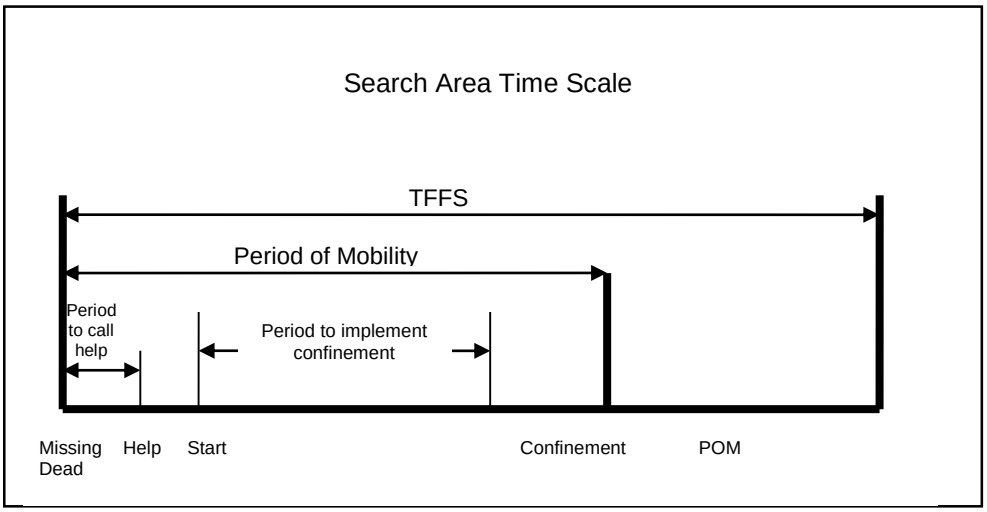
Approximate Desert Survival (Survivor Stationary)



Desert Survival (Survivor night walking)

9.43. **Dehydration:** The rate of dehydration will vary with the temperature, movement of the missing person, their medical condition and other factors. As a guide, a person missing and who has access to only 2 litres of water may be expected to survive from as little as a few hours in extremely hot climates, to as much as 20 or more days in temperate climate. It should be remembered that alcohol is not a substitute for water and may accelerate dehydration.

9.44. **Period of Mobility (POM):** The period of mobility or time to confinement since missing are used to assess the maximum distance a missing person could travel which will, in turn, dictate the size of the overall search area. An assessment of the period of mobility can be made by assuming a mobility period of 2/3 or 67% the missing person's time frame for survival.



9.45. **Search Area Time Scale:** The total search area time-scale may be plotted to give a clear picture of the situation and the time by which the missing person should be found, to ensure the greatest chance of survival.

9.46. **Example:** A person is missing in the alpine area of NSW. The wind is 40kph from the south. Air temperature is 0°C degrees and they are wearing nothing but underclothes. Using the wind chill table we can ascertain that the equivalent air temperature is going to be very cold, about -12°C. Consultation with the hypothermia graph will give an approximate period of survival of between ¼ day (6hrs) and 4 ½ days. If our missing person can find shelter and warmth he may survive to the 4 ½ day period. If he remains out in the open with limited clothing he will perish in the 6 hours. It now starts to rain, soaking our MP. Consulting the Wet Chill Survival graph we can see that there will be a distinct shortening of the TFFS. It is now between about 4 hours and 2 days, depending on what the MP is able to find by way of shelter and warmth. The POM can be as short as 2 ½ hours to just over a day. There is a definite amount of urgency required now. The desert survival charts can be read in a similar way, but be aware these are for the northern hemisphere. There are a number of recorded instances where persons have perished in the desert in as little as four hours without water.