AN INTELLIGENT SYSTEM FOR THE PRE-MISSION ANALYSIS OF HELICOPTER EMERGENCY MEDICAL SERVICE OPERATIONS

by

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Submitted in fulfilment of the requirements for the degree of Doctor of Philosophy at the Sir Lawrence Wackett Centre for Aerospace Design Technology School of Aerospace, Mechanical and Manufacturing Engineering RMIT University

June 2008
Declaration

I, Simon Atyeo declare that

- except where due acknowledgement has been made, the work is that of myself alone;

- the work has not been submitted previously, in whole or in part, to qualify for any other academic award;

- the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program;

- any editorial work, paid or unpaid, carried out by a third party is acknowledged; and

- ethics procedures and guidelines have been followed.

Simon Atyeo

25 June 2008
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<td>Atlas and Database of Air Medical Services</td>
</tr>
<tr>
<td>ADM</td>
<td>Aeronautical Decision Making</td>
</tr>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>AIS</td>
<td>Aeronautical Information Service</td>
</tr>
<tr>
<td>AMPA</td>
<td>Air Medical Physician Association</td>
</tr>
<tr>
<td>AMSL</td>
<td>Above Mean Sea Level</td>
</tr>
<tr>
<td>AMT</td>
<td>Air Medical Transport</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
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<td>AusSAR</td>
<td>Australian Search and Rescue</td>
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<td>Commission on Air Medical Transport Systems</td>
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<td>Institute of Electrical and Electronics Engineers</td>
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<td>IFR</td>
<td>Instrument Flight Rules</td>
</tr>
<tr>
<td>IHT</td>
<td>Inter-Hospital Transport</td>
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<tr>
<td>IMC</td>
<td>Instrument Meteorological Conditions</td>
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<tr>
<td>IMMS</td>
<td>Intelligent Maintenance Management System</td>
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<tr>
<td>INCOSE</td>
<td>International Council on Systems Engineering</td>
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<tr>
<td>ISO</td>
<td>International Standards Organisation</td>
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<td>GIS</td>
<td>Geographical Information System</td>
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<td>MAS</td>
<td>Metropolitan Ambulance Service</td>
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<td>MEARS</td>
<td>Medical Emergency Adult Retrieval Service</td>
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<tr>
<td>Abbreviation</td>
<td>Definition</td>
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<tr>
<td>MEL</td>
<td>Minimum Equipment List</td>
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<td>MET</td>
<td>Meteorology</td>
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<td>MICA</td>
<td>Mobile Intensive Care Ambulance</td>
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<td>MGA</td>
<td>Map Grid of Australia</td>
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<td>NAEMSP</td>
<td>National Association of Emergency Medical Services Physicians</td>
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<td>NETS</td>
<td>Neonatal Emergency Transport Service</td>
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<td>NM</td>
<td>Nautical Mile(s)</td>
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<td>NOTAM</td>
<td>Notice to Airmen</td>
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<td>NTSB</td>
<td>National Transportation Safety Board</td>
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<td>NVG</td>
<td>Night Vision Goggles</td>
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<td>ODBC</td>
<td>Open Database Connectivity</td>
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<td>PC</td>
<td>Personal Computer</td>
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<td>PETS</td>
<td>Paediatric Emergency Transport Service</td>
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<td>RAV</td>
<td>Rural Ambulance Victoria</td>
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<td>RDBMS</td>
<td>Relational Database Management System</td>
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<td>RPA</td>
<td>Rotorcraft Pilot’s Associate</td>
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<tr>
<td>SAR</td>
<td>Search and Rescue</td>
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<td>SEP</td>
<td>Systems Engineering Process</td>
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<td>Sitrep</td>
<td>Situation Report</td>
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<td>SQL</td>
<td>Structured Query Language</td>
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<tr>
<td>TAWS</td>
<td>Terrain Awareness and Warning System</td>
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<tr>
<td>TOLT</td>
<td>Take-Off and Landing Time</td>
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<tr>
<td>UHAS</td>
<td>Urban Helicopter Associate System</td>
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<td>UoD</td>
<td>Universe of Discourse</td>
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<td>VBA</td>
<td>Visual Basic for Applications</td>
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<td>VFR</td>
<td>Visual Flight Rules</td>
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<td>WAC</td>
<td>World Aeronautical Chart</td>
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Executive Summary

The Helicopter Emergency Medical Service (HEMS) accident rate has driven operators from around the world to address the management of risks inherent to their operations. In-flight decision-making, pre-flight planning, failure to follow standard operating procedures, delayed remedial actions, and misinterpretation of environmental cues are all areas that need to be addressed for safe HEMS operations.

HEMS operations are complex, being a joint exercise between the flight crew, paramedics and supporting agencies. Operations occur around-the-clock, in all-weather conditions, and often with no fore-warning. In a time critical operation, where precious minutes may cost lives, operators must decide which cases warrant a HEMS response and if so, whether the conditions are safe to conduct the mission.

Intelligent systems are an emerging field offering benefits to a multitude of applications. This research forms a comprehensive investigation of the application of "intelligent systems" to the pre-mission analysis of HEMS operations. The research has resulted in the development of a prototype decision support system capable of assisting in the pre-mission analysis of HEMS operations. The prototype system is capable of supporting flight coordinators and crew in the decision-making processes prior to HEMS operations and can potentially improve emergency medical services to the community.
1. INTRODUCTION

1.1. Background

This research has been conducted in collaboration with Air Ambulance Victoria as part of Australian Research Council Linkage Project LP0347412. The aim is to develop an intelligent system to support the pre-mission analysis of helicopter emergency medical service\(^1\) (HEMS) operations.

Ambulance services are responsible for saving lives by providing pre-hospital medical care and transporting critically ill or injured patients to appropriate facilities for treatment. HEMS are the part of that service that utilises rotary wing assets for patient care and transportation.

The helicopter is recognised for its unique ability to reach remote areas, often in difficult terrain [1-7]. This capability has made it highly valuable in the recovery, resuscitation and transfer of critically ill patients to major hospitals and in the search and rescue of people at land and sea. In the early 1950's during the Korean War, helicopters were successfully used to evacuate wounded soldiers and their use was expanded during the Vietnam War with significant decreases in mortality. In 1968, based upon the military experience, the use of civilian helicopters to transport patients was suggested and civilian HEMS operations began shortly thereafter [4, 5, 8-10].

The life saving capability of the helicopter is reflected in the world-wide growth of HEMS operations [1, 2, 8, 9, 11-16]. The first dedicated Australian HEMS operation began in December 1970 servicing the Mornington Peninsula [10]. Since then, HEMS operations within Australia have grown considerably; the annual number of aeromedical transports by helicopter increasing from 1,278 patients in 1992 to 6,982 patients in 2002 [17]. HEMS now operate in all Australian states and territories except the Northern Territory.

Air Ambulance Victoria is part of the Metropolitan Ambulance Service and is responsible for aeromedical services within the state of Victoria. Air Ambulance Victoria commenced operations on 1 May 1962, with the role of supporting the Victorian Ambulance Service in the urgent and non-urgent transportation of patients over long distances. Today Air Ambulance Victoria wet leases four dedicated Beechcraft Kingair B200C aircraft and three dedicated aeromedical helicopters: one Eurocopter AS.365N3 Dauphine 2 and two Bell 412EP [18].

\(^1\) The term “helicopter emergency medical service (HEMS)” is used to describe medical helicopter operations in this thesis. Various sources also refer to them as “helicopter ambulances,” “paramedic helicopters,” “MEDEVAC,” “aerovac,” “flying intensive care units,” “emergency helicopter” and “helicopter medical transports.”
Air Ambulance Victoria’s three helicopters are based in Essendon, Latrobe Valley and Bendigo with the primary role being to provide:

- rapid transport of time critical, medical, surgical and trauma patients;
- rapid primary response of paramedical personnel and equipment to an incident or location; and
- access and/or removal of patients from remote or inaccessible locations [18].

Operational safety is a central concern in the HEMS industry; weather, night time flight, spatial disorientation from the lack of visual clues, pilot training and experience, and pressure to take the flight are all risks associated with HEMS operations [1, 8, 9, 12, 19-23]. Safely operating in this high risk environment calls for the systematic evaluation and management of the risks [19].

A recent study found that in America the risk of death for a HEMS crewmember (per hour engaged in the activity) was similar to that of rock climbers and skydivers [22, 24]. Australian HEMS operations are not immune to risk. For the period 1992-2002 the accident rate for HEMS operations in Australia was 4.38 per 100,000 flying hours, and the accident rate for HEMS operations in the state of Queensland was 25.03 per 100,000 flying hours [17].

Australian HEMS operations are perhaps further complicated by the vast distances and the predominantly hot conditions, which challenge both aircraft and crew performance [24]. Adding to this Australian HEMS are required to fulfil multiple roles, performing critical care inter-hospital transfer, land-on-scene response, hoist operations and search and rescue (SAR). In North America and Europe, there is a distinction between hoist and SAR operators and those who undertake inter-hospital transfers and land-on-scene response [24, 25].

1.2. Problem Definition

The high HEMS accident rate has prompted HEMS operators across the globe to address the management of risks inherent to their operations. In-flight decision-making, pre-flight planning, failure to follow standard operating procedures, delayed remedial actions, and misinterpretation of environmental cues are all areas that have been identified as needing to be addressed for safe HEMS operations [23].

HEMS operations are complex, being a joint exercise between the flight crew, paramedics and supporting agencies. Operations occur around-the-clock, in all-weather conditions, and often with no fore-warning. In a time critical operation, where precious minutes may cost lives, the crew must decide which cases dictate a HEMS response and if so, whether the conditions are safe to conduct the mission.

The primary goal of HEMS is to provide rapid and safe transport for critically ill or traumatised patients to an appropriate care facility. Each helicopter flight requires an initial dispatch decision with full awareness of the risk factors for the mission [26]. The decision to cancel, delay or launch must be based upon a sound and complete analysis of all available information.
This decision making process is compounded due to the disparate mission requirements, operational environment, crew capability and machine performance. Most HEMS operations are minimally planned with decisions usually being made ‘on the fly’ [27], with operators depending upon the crew and their experience to perform pre-flight planning. Given the operational environment and emotional stresses, HEMS operations are susceptible to human error which can ultimately produce accidents [21-23].

In an effort to reduce risk of HEMS operations the American Federal Aviation Administration (FAA) recommends and the Helicopter Association International (HAI) endorses the utilisation of an operational risk assessment tool to include dual decision-making for authorisation to accept or continue a HEMS mission [28]. Despite this, investigations have revealed that many HEMS operators lack a consistent, comprehensive flight dispatch procedure to assist pilots in determining the safety of a mission [19]. Subsequently the need for intelligent systems to reduce the likelihood of erroneous decisions in the pre-flight planning phase of HEMS operations has been identified [28-38].

Working in close collaboration with Air Ambulance Victoria this research aims to prototype an intelligent system for the pre-mission analysis of HEMS operations. This research will address the key problem of pre-mission analysis, by developing a system which will assist flight-coordinators and crew in the decision-making processes faced prior to HEMS operations.

1.3. **Benefits**

HEMS are hailed for their life saving ability, having been shown to improve the survival of many patients with medical and trauma emergencies [1, 3, 8, 39-48], yet the high accident rate threatens the very existence of HEMS operations [49]. This research targets an operational capability deficiency in HEMS operations, and focuses on an identified application.

Intelligent systems are an emerging field offering benefits to a multitude of applications. The research forms a comprehensive investigation of the application of "intelligent systems" to the pre-mission analysis of HEMS operations. The research has culminated in the development of a prototype intelligent system capable of assisting in the pre-mission analysis of HEMS operations. This system supports flight coordinators and crew in the decision-making processes faced prior to HEMS operations and can potentially deliver improved emergency medical services to the Australian community.

An initial dispatch decision must be made with full awareness of the risk factors for the mission. The system can likely reduce the risk of HEMS operations by assisting operators during the decision making process. The system provides a consistent, comprehensive flight dispatch procedure to assist in determining the safety of a HEMS mission. Ensuring the go/no-go decision is not based on feelings but on facts and confirming adherence to regulations, industry safety recommendations and operating procedures. It is important to ensure that HEMS resources are appropriately utilised. Studies confirm that inappropriate use increases cost and risk of injury and results in potential transport delay or unavailability of the aircraft for other requests [39]. The system assists HEMS operators in managing the utilisation of
their resources and may ultimately improve the efficiency of HEMS operations by streamlining the pre-
mission analysis and decision making processes.

The HEMS community has acknowledged globally, the need to develop systems, to address the pre-flight
planning and effectiveness of HEMS missions. The approach taken to developing the system with Air
Ambulance Victoria means that it can be easily adopted by other HEMS operators for integration into their
flight dispatch procedures.
2. LITERATURE REVIEW

2.1. *Helicopter Emergency Medical Services*

2.1.1. **Role**

The transportation of critically ill or injured patients is a challenge for ambulance services. The challenges are further compounded due to transport times, distances to medical facilities, or the transport of patients from areas that are inaccessible by road [13]. The utilisation of helicopters for the transportation of critically ill or injured patients in such instances is preferred. HEMS operations may be integrated into a country’s rescue service to provide access to high level pre-hospital care, especially in rural areas. The degree of HEMS utilisation and integration is governed by the geographic conditions and resources of each country [2, 11, 40, 44, 46, 50-57].

There are several modes of HEMS operations and business. In the United States large referral hospitals provide HEMS, with many small air taxi operators and volunteer rescue squads also providing such services [44]. In Germany HEMS are the responsibility of the states and non-profit making organisations. The German Red Cross or commercial providers are commissioned to deliver the service [51].

HEMS operations comprise of the following missions:

- **Primary response:** The transport of medical personnel and equipment direct to the scene of an accident and the rapid transport of patients to hospital;
- **Secondary response:** Direct to a designated site to meet road ambulances coming from either a hospital or incident site to facilitate rapid on-carriage of patients by helicopter to a hospital; and
- **Tertiary response:** The planned urgent and rapid transfer of critically ill patients requiring specialised care between hospitals, also known as inter-hospital transfers (IHT) [58].

U.S. and European HEMS operations are predominantly a combination of civilian HEMS and military SAR helicopters. In Australia a multi-role model is adapted that combines both disciplines in one civilian operation. This helicopter is available on a 24-hour basis for use by the ambulance service, civil aviation SAR, police, fire, and government on tasks such as HEMS, SAR, fire, and flood relief [25].

2.1.2. **Aircraft**

The helicopter offers several advantages for the transportation of critically ill or injured patients that includes the key capability if vertical takeoff and landing allowing it to directly access a hospital or accident site. Coordination with ground transportation for transport between an airport and hospital is rarely needed. Modern helicopters routinely used in HEMS operations cruise in excess of 150 mph with a range
of 250-400 miles without refuelling. These attributes offer time-savings over other forms of patient transport [2, 5, 44].

The demerits of using a helicopter for patient transport are their small size, noise and flight altitude. Cabin space is restricted compared to typical fixed-wing aeromedical transports and ground ambulances. The restricted space makes administering advanced life support difficult. Procedures such as starting intravenous lines or placing endotracheal tubes must be completed before loading the patient into the helicopter [44].

Noise is a significant problem for the transportation of patients by helicopter. Communication without headsets and intercom is challenging and listening for breath, heart, and abdominal sounds is not feasible. Changes in pressure with changing altitude is also a problem for the transportation of some patients, resulting in the need to fly at low altitudes - a problem in mountainous terrain [5, 44, 59].

HEMS operations involve more than placing a stretcher onboard a helicopter and flying the patient to a destination. The degree of treatment is governed by the mobile medical equipment available [44]. Modern rescue helicopters are equipped with advanced portable systems fitted on the aircraft according to specifications established by experienced emergency personnel [2].

HEMS aircraft usually fly "under the weather" at low altitudes using visual flight rules (VFR) which means that the pilot must maintain visual contact with the ground and horizon and not fly through clouds or in poor visibility. VFR flight exposes the HEMS crew to obstructions and terrain and in poor weather or at night, these may prove to be fatal [44]. Helicopters capable of flying using instrument flight rules (IFR) allow pilots the option of flying above and through marginal weather and landing at airports with precision or non precision electronic guidance; thus providing a higher degree of operational safety [60]. There is ongoing deliberation [12, 44, 49, 61] over using VFR helicopters versus IFR capable helicopters for HEMS operations.

Australian HEMS operations have evolved from a very limited service using Bell 47 and Bell 206 helicopters in the mid 1970s to a vastly superior service today using medium, twin engine, IFR, multi-role helicopters such as the Bell 412. The helicopters are now configured for multiple tasks with a hoist, FLIR, and searchlight [25]. Twin engine helicopters are increasingly used for HEMS operations due to safety concerns and European regulations now exclude single engine helicopters from future participation in HEMS [53].

2.1.3. Utilisation

It is essential that HEMS be appropriately utilised as they offer not only rapid transport but also high-level care at the scene and en route to definitive care at a trauma centre [55]. Efficient and cost-effective use of HEMS is a major focus of air transport research which has highlighted the need for guidelines [41, 42]. Studies confirm that inappropriate use increases cost and risk of injury and results in potential transport delay or unavailability of the aircraft for other requests [39]. A Dutch report [40] found the utilisation of
HEMS in the south-west Netherlands is far from optimal. Better dispatch protocol adherence could lead to an increase of primary dispatches by a factor of seven.

HEMS are subject to scrutiny in order to justify their utilisation, due to the increased expense of helicopter over ground transportation [14, 62]. It has been claimed that HEMS are routinely utilised to transport patients which are later determined not a medically necessity [9, 15, 63]. Further reports identify that HEMS are appropriately utilised when evaluated by the patient acuity as perceived at the time of transport [42, 62].

A significant number of requests are cancelled or aborted for various reasons and includes the following: a) bad weather; b) low freezing level; c) aircraft maintenance; d) patient not meeting medical criteria/indications; e) aircraft responding to another incident; f) terrain or obstacles; g) aircraft performance; h) inoperative equipment; i) hazardous attitude recognition; or j) other current or predicted compounding issues [39, 64]. To date aborted mission data has not been adequately investigated and evaluated in the air medical literature [39].

Powell et al. [42] assert that the development and implementation of computerised dispatch and mission statistical programs will help the ongoing assessment of appropriate HEMS usage.

2.1.4. Dispatch and Flight Coordination

The benefits of HEMS are only fully realised when the appropriate medical response services nearest the scene are immediately notified and rapidly deployed [55]. To ensure the efficient and effective allocation of resources the dispatcher should have a thorough understanding of the patient’s needs before committing a flight. The accurate assessment of a patient’s needs is challenging. The referring physician may overstate or underestimate the overall medical status of the patient to expedite transport [44].

The go/no-go decision is of global significance [65] and investigations identify the need of HEMS dispatch procedures to include a medical screening function to determine the necessity of a prospective HEMS operation [12, 13, 40, 66]. Dispatch criteria is operation dependant and there are several industry recognised sets of criteria, including the following: a) Dutch Ministry of Health [40]; b) National Association of Emergency Medical Services Physicians (NAEMSP) [13]; and c) Air Medical Physician Association (AMPA) [66].

NAEMSP [13] acknowledges there is no clearly established body of clinical literature that defines the best criteria for dispatching HEMS. A set of guidelines cannot address all clinical or operational cases in which a HEMS response is valuable. The local dispatcher’s assessment is critical, being aware of regional resources and the operational situation.

Helicopters offer expedited transport to trauma centres and deliver advanced medical personnel to the scene of injury, but many HEMS do not dispatch air medical crews until after assessment by ground personnel is received. The auto-launch method of dispatch is designed to improve the response efficiency
of HEMS as opposed to the traditional request-driven dispatch process. Auto-launch is a method of dispatching the helicopter to a scene if certain criteria are met, at the same time the ground ambulance is dispatched. It offers a method of reducing HEMS response times and improving patient outcomes, but additional research is needed to help define optimal dispatch criteria [3, 67].

In Germany, HEMS are dispatched if it is the fastest means to get a medical team to the scene, hence HEMS are not just utilised for major trauma patients. Often a ground ambulance is dispatched at the same time as the helicopter. The patient is stabilised by the helicopter’s medical crew. The ground ambulance, arrives later to takes responsibility for the patient, while the helicopter responds to a new emergency call [2, 51].

Preparation for a flight commences on initial contact from the requesting agency/person. Preliminary information is obtained and a general go/no go decision is made based on the appropriateness and feasibility of the request. If a mission is accepted, coordination of the individual flight commences [44].

Coordination of the individual flight involves aircraft selection, assembling crews and arranging necessary ground transportation. Organisations with multiple resources select the best resource, considering speed, trip length, landing requirements, anticipated weather, and cost [44].

A flight schedule is calculated, which includes the itinerary, distances and times enroute. Determining the time enroute is not simple. The average speed of a particular aircraft can be used, but this is a variable number. On shorter trips the average speed will be less than longer trips and meteorological conditions or air traffic can also impede. The dispatcher must coordinate with the pilot regarding the aircrafts range and performance limits and the need to refuel [44]. Ultimately the pilot makes the final decision based on the safety of the proposed mission as to whether the helicopter will fly or not [60].

**2.1.5. Response Time**

Death, permanent disability or long-term hospitalisation from trauma or critical illnesses can be prevented or significantly reduced through prompt medical aid. The time between injury and treatment governs the potential of recovery, making rapid response a key factor in saving lives. A long response time increases the risk of missing patients who are dependant on quick medical intervention [2, 60, 67-69].

Response time is the interval between authorities being notified and the HEMS arrival. This time interval depends on the configuration of the particular HEMS system, the dispatch procedures and the distance travelled by responding HEMS personnel [3].

Many HEMS operations claim response times of 10 minutes or less. The actual numbers are not readily available [3, 70]. One American study [70] considered request to lift-off (R/L) and dispatch to lift-off (D/L) times for a 4 week period consisting of some 197 consecutive missions in the state of Ohio. During the study period R/L and D/L averaged 10.9 ± 7.2 minutes and 6.8 ± 4.2 minutes respectively. A Norwegian study [71] reports a median response time of 20 min, but highlights an investigation into the
possible benefit of a 15 minute shorter response time, which concluded only a six percent increase in benefit.

A short response time is of less importance in remote areas, due to the flying time over the long distances, compared with densely populated areas where flying time to the scene of the accident is a few minutes [71].

2.1.6. HEMS Accidents

After a series of fatal HEMS accidents in the 1980’s, operational safety has become a central concern to the HEMS industry [1, 5, 6, 8, 9, 12, 15, 17, 19-23, 49, 53, 61, 64, 72-80]. Between 1972 and 2005, American HEMS operations have experienced 203 accidents, 83 of which were fatal. The total number of HEMS accidents and fatal accidents broken down for each year since 1980 is presented in Figure 2-1. The early and mid 1990s showed an improvement over the high accident rate of the mid 1980s, but since then there has been a steady increase in HEMS accidents, which peaked in 2003 [15, 22, 72-74].

![Figure 2-1: American HEMS Accidents 1972 to October 2005 (Source: [22, 73])](image)

Due to the increase in medical helicopter accidents during the 1980s the United States National Transportation Safety Board (NTSB) undertook a safety study of HEMS operations between 1980 and 1985, and found an accident rate of 12.34 per 100,000 flying hours, nearly twice the rate of non-scheduled air taxi helicopters. The fatal accident rate of HEMS for the same period was found to be 5.40 per 100,000 flying hours or 3.5 times greater than that of non-scheduled air taxi helicopters [8]. An investigation of German HEMS accidents for the period 1982 to 1987 reported a similar accident rate of 10.9 accidents per 100,000 flying hours and a fatal accident rate of 5.40 per 100,000 flying hours [76].

The release of the NTSB report resulted in more stringent weather minimums, enhanced pilot training programs enhanced and reduced HEMS duty time requirements [23, 77]. During the seven year period, 1987 to 1993, the estimated accident rate for hospital based HEMS was reported as 3.14 per 100,000 flight hours, which was less than the 4.28 accidents per 100,000 flight hours for all turbine-powered
helicopters during the same period. The fatal accident rate was reported as 1.68 per 100,000 flight hours; a significant improvement over the period of 1980-1985 but still 1.8 times the rate for all turbine-powered helicopters. The reduced accident rate was contributed to the emphasis placed on safety by air medical programs and the actions taken as a result of the NTSB report [77, 78].

The Air Medical Physician Association (AMPA) studied American HEMS accident rates from 1980 to 2001 and found that from 1987 there was a sharp decline, and the accident rate remained consistently below the accident rates for both American general and helicopter aviation [22]. A comparative analysis of the accident rate for American aviation operations is presented in Figure 2-2. Despite the high HEMS accident rates in the mid 1980s, for the period 1982-2001 the average for HEMS was below all helicopter operations and general aviation. During the period 1992-2001 the average, HEMS accident rate was less than 50% the rate of all helicopters and general aviation. For the period 1997-2001, the average accident rate for HEMS rose, but remained significantly lower than all helicopter and general aviation operations [22].

The AMPA also compared the fatal accident rate between American general aviation helicopter and HEMS operations. Initially, the fatality rate for HEMS was equal to or dramatically higher than all other aviation operations. From 1992 to 1997, HEMS was consistently below both general aviation and all helicopter operations in fatal accidents. Since 1998, the HEMS fatality rate has been consistently higher. [22]. The average fatal accident rate for the three periods (1982–2001, 1992-2001 and 1997-2001) for the various aviation operations is presented in Figure 2-3.
An Australian study [17] for the period 1992-2002 on HEMS accidents found an accident rate of 4.38 per 100,000 flying hours, which was higher than the American HEMS rate of 3.53 for the similar period. The fatal accident rate of Australian HEMS operations was 1.46 which was similar to that reported in America.

The reasons for HEMS crashes are varied and complex and there has been much research in the literature quantifying the cause of HEMS accidents so that appropriate steps can be taken to reduce them.

The 1988 NTSB report into HEMS safety [8] concluded the need for improvements in many areas of HEMS operations including the following: a) weather forecasting; b) operations during instrument meteorological conditions (IMC); c) personnel training requirements; d) design standards; e) crashworthiness; and f) HEMS operations management.

A survey of U.S. civilian EMS helicopter programs [61] examined both helicopter ambulance mishaps and the number of safely completed missions. The findings revealed the single most important factor was the number of flights made by the program; the accident rate for busy programs was eight times lower and the total mishap rate three times lower. Programs with the ability to fly under IFR had no mishaps during the study period.

Veillette A study of 87 American HEMS accidents between 1987 and 2000 [23] found the following as common casual factors in HEMS accidents: a) in-flight decision-making; b) pre-flight planning; c) failure to follow standard operating procedures; d) delayed remedial actions; and e) misinterpretation of environmental cues. It concluded that human error was the major cause in 76 percent of American HEMS accidents. This is similar to another investigation that reported the major cause (64%) of HEMS accidents between 1993 and 2002 as pilot error [15].

The 2002 the AMPA report on safety in air medical transport [22] notes that a disproportionate number of accidents occur during night operations, during the cruise phase of flight and on scene response missions.
Unexpected bad weather conditions and the inadvertent entry into IMC was identified as a major contributor to HEMS accidents. Accordingly the report suggests that instrument flight rules (IFR) and pilot experience enhance flight safety, and poor communication, distractions and time pressure are contributing risk factors in HEMS operations. This is supported by several other reports [1, 49, 72] which have found time pressure, distraction, workload and communication as frequent contributors to HEMS incidents and report weather as a major factor in American HEMS accidents. Collisions with objects during landing on scene and controlled flight into terrain (CFIT) has also been identified as a leading cause of HEMS accidents [53, 75, 81].

A preliminary review of HEMS accidents between 1998 and 2003 by the FAA revealed the following as the main causes: a) CFIT; b) inadvertent operation into IMC; c) pilot spatial disorientation/lack of situational awareness; d) inadequate risk assessment; and e) management deficiencies [16, 74, 79].

A NTSB special investigation [80] of 41 HEMS accidents between 2002 and 2005 identified the following recurring safety issues: a) lack of stringent requirements for HEMS operations conducted without patients on board; b) a lack of aviation flight risk evaluation programs for HEMS operations; c) a lack of consistent, comprehensive flight dispatch procedures for HEMS operations; and d) no requirement to use technologies such as terrain awareness and warning systems (TAWS) to enhance HEMS safety.

### 2.1.7 Aeronautical Decision Making

Several studies [1, 26, 44] recognise that the unique demands placed on HEMS crew members lead to fatigue, distraction, time pressure and heavy workload; all of which negatively influence good communication, thorough planning, cooperative teamwork and safe flight.

Addressing human error issues is vital to support the safety and efficiency of human-machine systems. Despite intense efforts to prevent human errors across a broad range of human activities, their number continues to be significant, and poor aeronautical decision making (ADM) and judgement plays a leading role in aviation accidents [16, 82, 83].

ADM is referred to as "the ability to search for and establish the relevance of all available information; evaluate alternative courses of action; and the motivation to choose and execute the course of action which assures safety within the time frame permitted by the situation" [26]. ADM involves one's attitudes towards risk-taking and one's ability to evaluate risks and make decisions based upon one's knowledge, skills, and experience [84].

The decision to accept, decline, continue or abort is not based on feelings but on facts, and pilots with good judgement continually assess flight status, not looking for reasons to continue but for reasons to stop [64].
A human's ability to perceive and process information is subject to a number of limitations and deficiencies, such as finite cycle time, limited working memory and cognitive biases. It is negatively impacted by environmental factors such as fatigue or stress [85].

Fatigue impairs memory, reaction time, communication and vigilance and causes cyclic reductions in alertness and performance and although the literature has not clearly linked fatigue with accidents, human error can be blamed for up to 84% of HEMS crashes [21, 26]. To limit the exposure of the HEMS operations to fatigue regulations are in place that impose mandatory shift length and off-duty rest provisions for pilots.

An American study [21] has found notable differences between on-duty work and rest patterns for pilots and medical team members. Pilots work shifts between 10 and 14 hours, with medical team members working longer shifts than pilots, with shifts exceeding 12 hours. Other research shows that the timing of trips and not necessarily the length of the duty day or the number of segments flown, appears to contribute more to the development of fatigue [23].

Stress is a normal part of life and can be beneficial in critical situations, up to a point. But pilots must ensure that daily stress plus the stresses of flying do not combine to threaten safety. Failure to effectively manage stress may lead to misjudgement, decreased performance, inattention, loss of vigilance and preoccupation [86].

Limited operational control and/or a lack of standard operating procedures have also been found to leave HEMS pilots and crew susceptible to outside influencing factors that may negatively influence their ADM [16].

### 2.1.8. Risk Management

HEMS operations are associated with risk [1]; and many observers are concerned by the mechanism that causes an experienced crew to accept the risk that kills them [64]. The Australian and New Zealand standard (AS/NZS 4360:1999) states that risk is the chance of something happening that will impact upon objectives. Risk analysis is part of any decision [87], and risks should only be accepted if they are outweighed by the potential gains [65]. Risk is measured by combining the magnitude of potential consequence and the likelihood of the same [27].

HEMS operations are inherently risky and minimally planned with decisions usually having to be made 'on the fly' [27]. Most operators and crew adopt an informal approach to risk management, doing it on the run, often using experience and ‘gut feel’ to make decisions. A changing operational environment has meant operators are now adopting risk management as a tool to streamline their strategic and operational decisions and bring some informed logic to their decision making.

Effective risk assessment and management programs need to provide a disciplined and standardized method of identifying risks, mitigating, deferring, or accepting those risks, as appropriate [16].
The FAA [79] recommends HEMS operators emphasize a safety culture within their organization by applying basic system safety attributes and risk management techniques to operations, including risk management training to flight crews so that they can make more analytical decisions about whether to launch a mission. According to the FAA the basic concepts of risk management for HEMS operations should include the following:

- The overriding concept that the pilot’s authority to decline a flight assignment is supreme, while his/her decision to accept a flight assignment is subject to review, if certain risks are identified;
  - The pilot’s decision to decline, cancel, divert, or terminate a flight overrides any decision of other parties to accept or continue a flight;
  - The pilot’s decision to accept a flight assignment may be overridden by other personnel by use of the operational control procedures and policies of the certificate holder, including the use of risk assessment and management tools and techniques;

- If the pilot has declined a flight assignment, no other parties shall continue to conduct risk assessments pertaining to that flight as their input cannot be used to override the pilot’s decision to decline the assignment;

- A risk-assessment plan is a tool used by the flight management personnel and flight crews to expand the parameters of decision making for the pilot and flight crew, and to assist in pre-flight planning and operational control of the aircraft. The company should have procedures on how to mitigate or reduce the risk to an acceptable level;

- If the pilot’s initial risk assessment results in a tentative decision to accept the flight, but significant risks have been identified, then in accordance to the company’s integrated risk assessment plan, additional operational inputs are used; and

- As potential hazards are identified in the assessment process, a collaborative group of additional persons who have the experience/knowledge to assist the flight crew in safety determinations are brought into the decision making process. Such collaboration should never result in the questioning or overruling of the pilot’s determination that the risks associated with a flight mission or operation are too numerous or high [79].

To provide HEMS organisations with appropriate risk management tools, the FAA EMS Task Force, with the assistance of the air medical community, developed Notice N8000.301 “Operational Risk Assessment Programs for Helicopter Emergency Medical Services.” This notice encourages the use of weighted risk assessment and management processes matrices but emphasises that individual HEMS operators should consider their own operational and environmental needs in developing and implementing risk assessment tools [16, 79]. Similarly, the Flight Safety Foundation Icarus Committee is developing a decision making tool called the flight operations risk assessment system (FORAS), comprising of a CFIT risk assessment matrix, which aims to assist aviation managers to determine the relative risk of an accident or incident during a flight operation [88]. In contrast Thompson [27] discourages the use of pseudo-quantitative numerical risk scores and matrices, as they are easily manipulated to obfuscate the real risk level.

Typical risk variables that the FAA suggests to incorporate into risk assessments for HEMS operations are those presented in Table 2-1.
Table 2-1: Possible risk variables included for a risk assessment for HEMS operations (Source: [79])

- **Weather (Current and Forecast);**
  - Ceiling, visibilities - departure, en route, arrival, alternate;
  - Precipitation - type(s);
  - Turbulence - existing and forecast;
  - Icing - type and forecast;
  - Winds/gust spread - wind direction, speed, gust spread;
  - Density altitude;
  - Ambient lighting;

- **Airworthiness Status of the Helicopter;**
  - Proper pre-flight;
  - Any deferred items in accordance with the Minimum Equipment List (MEL);
  - Fuel and oil serviced;
  - Security of cowling(s), doors and/or equipment;
  - VFR vs. IFR equipment capabilities;
  - Inspection status;
  - Recent maintenance actions;
  - Time remaining until next inspection, overhaul, teardown, etc.:
  - Required current maps, approach plates, NOTAMs;

- **Incorporation of Technologies to Aid in Managing Risks;**
  - Radio/radar altimeters;
  - High intensity search/landing light systems;
  - Global positioning system (GPS) moving map systems;
  - Airborne weather radar systems;
  - Night vision goggles;
  - Enhanced vision systems;
  - Autopilot/stability augmentation systems;
  - Terrain Avoidance Warning System (TAWS);
  - Adequacy of training on new technologies;

- **Pilot and Flight Crewmember Performance;**
  - Experience in make and model of helicopter, area of operations, and type of operation;
  - Rest, duty, and flight time impacts on human performance (additional duties during duty time and adequate sleep during rest period time);
  - Personal performance factors, such as personal stress (recent divorce, death, illness, or birth in family);
  - Influence of pilot’s knowledge of the patient’s status (paediatric, critical injury);
  - Communication between crew and all pertinent specialists;
  - Continuity during shift changes;
  - Currency of training;
  - Inadvertent IMC training;
  - Crew resource management;
  - Experience of crewmembers operating together as a unit;

- **Performance Margins;**
  - Weight/centre of gravity margins;
  - High density altitudes;
  - Fuel margins and range limitations;

- **Operating Environment.**
  - Terrain/obstructions;
  - Ambient lighting;
  - Natural and industrial weather factors;
  - Availability and status of airports/heliports;
  - Air traffic density;
  - Knowledge that other operators in the area have declined the flight due to:
    - Localized weather;
    - Forecast weather; and
    - Recent flight(s) experiencing marginal conditions;
  - Airspace requirements;
  - Communications and navigation facilities;
  - Availability of low-level VFR route structure;

- **Organizational Environment;**
  - Changes in required management personnel;
  - Changes in air carrier management;
  - Rapid expansion or growth;
  - New or major program changes;
  - Merger or takeover;
  - Labour management relations; and
  - Organization accidents, incidents, or occurrences.
2.2. **System Concepts**

2.2.1. **System Definition**

A system is a group of elements. The elements individually establish relationships with each other and interact with their environment both as individuals and as a collective, to form a complex or unitary whole [89, 90]. Systems are natural or man-made; comprising of the following [89]:

- **Components (Elements)**: The operating parts of a system consisting of input, process and output;
- **Attributes**: The properties of the system’s components; and
- **Relationships**: The links between components and attributes.

All system components, attributes and relationships are organised for a specific purpose. The purpose of the system as a whole is achieved through the functional relationships between the components and attributes [89].

A Systems influence is limited to a specific area. Outside this area the system has no ability to influence other systems system, this area is known as “the environment”. These limits represent a system’s boundary [90] (see Figure 2-4). In defining a system structure, Blanchard and Fabrycky [89] highlight the importance of specifying a systems boundaries and to identify the environment with which the system interacts. The system and its components, attributes, relationships and environment are presented in Figure 2-4.

![Figure 2-4: The general concept of a system](image-url)
Systems can be further classified as either ‘closed’ or ‘open’ systems, based on the interaction between the system’s elements and its environment. A closed system does not interact significantly with its environment. In contrast open systems interact with their environment, allowing information, energy and matter to cross its boundaries. A system can also be classified as either ‘static’ or ‘dynamic’. A static system is one having structure without activity, whilst a dynamic system combines structure with activity [89].

2.2.2. System Hierarchy

Systems are composed of other smaller, less complex systems know as subsystems. Thus, the components of a system are themselves systems and every system may be part of a larger system, forming a hierarchy. Subsystems are purposeful entities that contribute in varying degrees to achieving the purposes of the whole system. The designation of system, subsystem and components are relative, since the system at one level in the hierarchy is the component at another. All systems are subsystems; they only become systems when they become the focus of attention [89, 90].

The International Council on Systems Engineering (INCOSE) [91] provides a more detailed definition of the succeeding levels of the system hierarchy as presented in Figure 2-5. This hierarchy of system elements includes:

- **System**: An integrated set of elements, segments and/or subsystems to accomplish a defined objective;
- **Element or Segment**: A major product, service, or facility of the system;
- **Subsystem**: An integrated set of assemblies which performs a cleanly and clearly separated function;
- **Assembly**: An integrated set of components and/or subassemblies that comprise a defined part of a subsystem;
- **Subassembly**: An integrated set of components and/or parts that comprise a well-defined portion of an assembly;
- **Component**: Comprised of multiple parts; a clearly identified item; and
- **Part**: The lowest level of separately identifiable items.

![System Hierarchy Diagram](image-url)
2.2.3. Systems Engineering

Systems engineering is an interdisciplinary, comprehensive and structured approach for the design, creation, and operation of a successful system. Systems engineering is a life-cycle approach to the overall process of defining, developing, operating, maintaining, and ultimately replacing quality systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, and then proceeding with design synthesis and system validation while considering the complete problem [92-95]. Systems engineering involves the application of the following efforts:

- Transform an operational need into a description of system performance parameters and a preferred system configuration through the use of an iterative process of functional analysis, synthesis, optimisation, definition, design, test and evaluation;
- Incorporate related technical parameters and assured compatibility of all physical, functional and program interfaces to optimise the total system definition and design; and
- Integrate performance, producibility, reliability, maintainability, supportability and other specialties for an overall engineering effort [92].

The need for systems engineering was realised as conventional engineering specialists are generally not sufficiently experienced to ensure that all elements of the system are considered in a proper and timely manner. Whereas conventional engineering disciplines concentrate on the details of individual aspects of a system, systems engineering is concerned with the integration of all of these aspects into a coherent and effective system. Systems engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs [92-94].

The systems engineering process (SEP) is continuous, iterative and incorporates good engineering practice and common sense [91, 92]. It normally begins with an identified need and a feasibility study for the purposes of establishing a set of requirements, constraints and design criteria. Based on these, functional analysis and allocations are generated to apportion the appropriate system-level requirements down to the subsystem and lower levels of the system. System analyses are accomplished to evaluate the various alternatives that are considered feasible in meeting the identified need [92]. Basic SEP tasks include the following [91]:

- Define the systems objectives: User’s needs;
- Establish the functionality: Functional analysis;
- Establish performance requirements: Requirements analysis;
- Evolve design and operations concepts: Architecture synthesis;
- Select a baseline: Through cost/benefit trades;
- Verify the baseline meets requirements: User’s needs; and
- Iterate the process through lower level trades: Decomposition.
There are a variety of different SEP models and standards currently in use, which document in detail the implementation of the SEP [96-98]. These include the following:

- ANSI/GEIA EIA-632: Processes for Engineering a System (2003);
- EIA/IS 731.1: Systems Engineering Capability Model, Electronic Industries Alliance Interim Standard (2002);
- IEEE 1200-2005: IEE Standard for the Application and Management of the Systems Engineering Process (2005);
- ISO/IEC 15288: System Life Cycle Processes (2002); and

2.2.4. System Design and Development

Life cycle analysis is of significant importance in the design and development of systems. Its adoption throughout the design and development of a system ensures design compatibility with related physical and functional requirements and defines a definitive product configuration [89, 95]. The system life cycle is defined in seven phases as follows:

- Phase I: Requirements Development Phase.
- Phase II: Concept Development Phase.
- Phase III: Full Scale Engineering Development Phase.
- Phase IV: System Development Phase.
- Phase V: Test and Integration Phase.
- Phase VI: Operations, Support, and Modification Phase.
- Phase VII: Retirement and Replacement Phase [95].

The system design process begins with a complete understanding of the customer’s needs. It is not viable to create a product that appeals to engineers, but is of no usefulness. The customer’s needs form a set of slated requirements for a given system and the design and development process evolves through the following:

- Conceptual design: Establishment of performance parameters, operational requirements and support policies;
- Preliminary systems design: Advanced development; and
- Detail design.

This process generally begins with a visualisation of what is required and extends through the development, test, and evaluation of an engineering or prototype model of the system[92, 95].
2.3. **Information Systems**

2.3.1. **Introduction**

An information system is a set of interrelated elements or components that collect, manipulate, store and disseminate data and information to meet an objective [99]. Information systems are specially designed systems that bring data, computers, procedures and people together to manage information. These systems include computer software, firmware and hardware such as word processing systems, databases, telecommunications, computers, networks or other electronic information handling systems [99-101]

2.3.2. **Database**

A database is an organised collection of related facts and information, which have the following properties:

- Coherent collection of data with some inherent meaning.
- Customised designed, built and populated with data for preconceived applications.
- Represents some aspect of the real world, referred to as the Universe of Discourse (UoD). Changes to the UoD are reflected in the database [99, 102].

Database management systems (DBMS) are software programs that allow users to create and maintain a database. DBMS facilitate the process of defining, constructing, and manipulating databases for various applications. Defining a database involves specifying the data types, structures, and constraints on storing the data. Constructing the database is the process of storing the data itself on some storage medium that is controlled by the DBMS. Manipulating a database includes such functions as querying the database to retrieve specific data, updating the database to reflect changes in the UoD, and generating reports from the data [102].

A database system comprises of both the database and DBMS. If the database contains more than single relations and single relation schemas, then the database is commonly referred to as a relational database and the DBMS as a relational database management system (RDBMS) [102, 103].

Relational database systems allow data arranged in a tabular form to be related to data in other tables via common fields. For example, an RDBMS for company personnel might include a table of salaries and another of telephone numbers, the two tables could be related to each other by sharing an ID field that contained an ID number for each employee of the company [103]. Structured Query Language (SQL) provides an interface to relational database systems, and is the ISO and ANSI standard [104].

Standard RDBMS tools range from desktop databases like Filemaker Pro and Microsoft Access to larger complex and powerful databases like IBM DB2, Informix, Microsoft SQL Server, Oracle, and Sybase SQL Server [105].
Microsoft Access is a relational database management system which combines the relational Microsoft Jet Database Engine with a graphical user interface. It can use data stored in Access/Jet, SQL Server, Oracle, or any Open Database Connectivity (ODBC) compliant data container. Though it supports substantial object-oriented programming techniques it is not a fully object-oriented development tool. Microsoft Access is commonly used by skilled software developers and data architects to develop powerful, complex application software as well as relatively unskilled programmers and non-programmer “power users” to build more simple applications [106].

2.3.3. Spreadsheets

A spreadsheet is a specific type of database used to store and calculate information in a structured array of data cells (rows and columns). The merits of the spreadsheet lie in the cells storing numerical or alphabetical data or a formula for operating on other cells, including inbuilt powerful mathematical, statistical and financial functions. A cell can also hold references to other spreadsheets or objects (such as graphics). By defining relationships between the data in cells, a user can see the effects of certain data changes on other data in other parts of the spreadsheet. [107, 108]

The Microsoft Excel is the most popular spreadsheet application and features an intuitive interface and accomplished calculation and graphing tools. Microsoft Excel includes Visual Basic for Applications (VBA), a programming language based on Visual Basic which adds the ability to automate tasks in Excel and to provide user defined functions for use in worksheets. VBA is a powerful addition to the application which includes a fully featured integrated development environment. VBA allows the creation of forms and in-worksheet controls to communicate with the user [109].

2.3.4. Geographical Information Systems

A geographical information system (GIS) is a specific type of database system for creating and managing spatial data and associated attributes. A GIS is capable of integrating, storing, editing, analysing, sharing, and displaying geographically-referenced information. GIS commonly appear as “smart maps” which allows users to create interactive queries, analyse the spatial information, and edit data. GIS technology is commonly used for scientific investigations, resource management, asset management, environmental impact assessment development planning, cartography, and route planning [110, 111]. One such application is The Atlas and Database of Air Medical Services (ADAMS) (Figure 2.6) which was designed and developed to advance the safety of motorists along America’s roads by supporting trauma triage and transport decision-making at crash scenes that may require air medical services [112]. It enables users to view the HEMS resources in the United States on national, state and local levels [55].

ADAMS is structured as a relational database incorporated into a GIS; and provides a comprehensive, centralised source of descriptive and geographic information on HEMS that respond to trauma scenes in the United States including commercial and non profit air medical services, public services and selected military air medical units. ADAMS provides both descriptive and geographic information on each air
medical service’s corporate location, base locations, communication/dispatch centres, HEMS assets and the major hospitals which receive their trauma transports [55, 112].

ADAMS differs from traditional lists of air medical services as follows:

- It includes the street locations of all satellite bases, as well as the N-number, make and model of each helicopter;
- It is structured as a relational database, which allows data to be accessed, extracted, added to, or reassembled in many different ways without having to reorganise the original database tables; and
- The relational database has been imported into a Geographic Information System (GIS) enabling the user to view the database in a map context and link mapped objects with related text information [112].

![Atlas & Database of Air Medical Services](image)

*Figure 2-6: Atlas and database of air medical services (Source:[112])*

### 2.4. Intelligent Systems

#### 2.4.1. Introduction

Intelligent systems are computationally intensive problem solving tools and methodologies which utilise computers to present various aspects of human intelligence. The roles of intelligent systems are as follows: a) Function as intelligent assistants to augment human expertise; and b) Act as a substitute for human
expertise to save cost, time, and life. Intelligent systems have demonstrated their merit in search and optimisation, pattern recognition and matching, uncertainty management, planning and control, and adaptation [113]. Intelligent systems are reliable and not prone to human issues of fatigue. Attention is consistent; hence information or potential solutions are adequately addressed [114].

Intelligent systems such as decision support systems, expert/knowledge-based systems and associate systems assist in decision making, planning and scheduling [115-124]. Most of these systems are rule based with reasoning being a process of arriving at a conclusion based on a collection of principles [113].

Artificial intelligence involves developing techniques to allow computers to act in a manner similar to a human being. The lower end involves software that seems “a little smarter” than one would expect, where the higher end involves attempts to develop a fully conscious, intelligent, computer based entity. The lower end is continually disappearing into the general computing background, as the software and hardware evolves [125].

Various degrees of artificial intelligence are being embedded in applications and processes where information needs to be analysed for a specified output [113]. Such embedded systems are commonly referred to as “intelligent agents” and these address the screening, sifting and filtering of data, information and knowledge. It is designed to provide users the required data and analysis to save time on the routines to a fraction of the time otherwise needed to search for, copy, combine, report and distribute the data [126].

2.4.2. Operations research

The key step in the use of intelligent systems is converting and representing a process or problem into an algebraic form and then into a form understandable by an algorithm [127]. Operations research explores the fundamental properties of operations, by converting an abstract specification of a process into a set of specific, specific steps, that provide a positive and understandable conclusion to decision makers. Its application is diverse; manufacturing, transportation, construction, telecommunications, financial planning, health care, the military, and public services [125, 128].

Operations research involves observing and formulating the problem, including gathering all relevant data, to develop a mathematical model to analyse the real problem. It is then assumed that this model is a sufficiently precise that the conclusions obtained from the model are also valid for the real problem [128].

In regards to HEMS, operations research was utilised to study two different operational scenarios regarding the extension of services for a regional HEMS company based in Northern California, to analyse the operational impacts of that extension, and developing a framework suitable for the study of the ambulance helicopter assignment faced by small operators [4]. Operations research was also used to develop a mathematical model for helicopter mission planning during disaster relief operations. This involved reducing inherent decisions into two sub-problems where tactical decisions are made at the top level, and the operational routing and loading decisions are made at the base level [129].
2.4.3. Decision Support Systems

The initial concept of decision support systems (DSSs) focused on interactive computing in semi-structured decision making. The emphasis on semi-structured decision making distinguished DSSs from operations research, especially from optimisation models, which attempted to address automated decision making. Interactive use of computers was emphasised as the use of computers directly in management work was not yet demonstrated [130].

The original issues that led to the establishment of the DSS concept are now history. Computers are used extensively throughout our lives by managers and non-managers. In typical decision-oriented situations computerised data and models are commonly used for various structured, semi-structured, and unstructured tasks [130].

Since its conception, DSSs have evolved significantly; progressing from theory to advanced applications [127, 131]. The modern definition of DSSs is software products that assist users in analytical and scientific methods for decision making [127, 132]. DSSs utilise models and algorithms from disciplines such as decision analysis, mathematical programming and optimization, stochastic modelling, simulation, and logic modelling [132]. They are distinguished from classical information systems by the emphasis on real time, or interactive analysis [125].

DSS are used extensively in transportation, the military and space to assist in decision making, planning and scheduling [115, 118-120, 122, 133, 134]. Defence Research and Development Canada (DRDC) have developed SARPlan, a DSS for overland aeronautical SAR mission planning. The system aids the SAR mission coordinator in planning the search mission. It provides an optimized plan for deploying the available search effort that maximizes the probability of success [133]. Another scheduling DSS is SYNOPSE which has the ability to evaluate cargo airline flight schedules, with respect to cost, revenue and contribution to profit [120]. TurboRouter is an optimization-based DSS for vessel fleet scheduling [134].

The need for DSSs is driven by four specific limits as follows: a) cognitive limits; b) economic limits; c) time limits; and d) competitive demands [135]. The cognitive limits of humans are well understood; Humans are limited to manipulating about seven pieces of knowledge at any one time; and the stress, errors and oversights that can result from being overloaded with knowledge are just as detrimental as not having enough knowledge [136].

A DSS can be structured to provide various types of support depending upon the requirements of the user, as follows:

- **User Alert**: Alerting the user to a decision-making opportunity or challenge;
- **Problem Recognition**: Recognising problems that need to be solved as part of the decision making process;
- **Problem solving**;
- **Knowledge Processing**: Facilitating or extending the user's ability to process knowledge;
• **Perception Simulation:** Stimulating the user's perception, imagination, or creative insight; and
• **Interaction:** Coordinating or facilitating interaction among decision makers [136].

Inherent capabilities of a DSS include the following: a) handling mass data; b) extracting information; c) applying knowledge to integrate the information; d) deriving alternative courses of action; and e) assessing outcome probabilities [136].

A DSS must perceive the environment and act rationally based on reasoning [136]. In order to achieve these a DSS should comprise of the following:

• Database management capabilities with access to internal and external data, information, and knowledge.
• Modelling functions accessed by a model management system, and
• A user interface design that enable interactive queries, reporting, and graphing functions [127].

It is crucial that users maintain control over the DSS, either by focusing the system on particular reasoning goals, or by modifying the basic knowledge on which the system's judgments rely. The following attributes represent high-level characteristics common to successful intelligent decision support systems:

• **Interactivity:** The system works well with human users and other databases. Allowing them to explore the “space of possibilities” in a constraint-based way, instead of just providing the one “optimal” solution;
• **Event and Change Detection:** The system is capable of recognising and communicating important changes and events;
• **Representation Aiding:** The system represents and communicates information in a convincing, informative, and human-centred way;
• **Error Detection and Recovery:** The system has the ability to check for typical human reasoning errors. Further, the system has knowledge of its own limitations and checks for situations for which it may not be as fully capable;
• **Information Out of Data:** The system uses intelligent algorithmic techniques to manipulate data and generate information; and
• **Predictive Capabilities:** The system can predict the effect of actions on both the future environmental state and to the change in states caused by different decisions [137].

DSSs are now categorised into the following five groups based on their knowledge management and problem-processing [138]:

• **Active:** Operates in part independent of explicit direction form the user;
• **Symbiotic:** Support behaviour alteration based on the users cognitive and decision making styles;
• **Expert:** Analyses using independent knowledge fragment stored in rule form;
• **Adaptive:** Capable of making changes to itself over time to enhance its problem processing proficiency; and
• **Holistic:** Capable of holistic problem recognition and processing.
Holistic DSSs are regarded as the most advanced DSS, as they offer holistic problem recognition and processing capabilities, have the ability to operate with incomplete knowledge and are highly dynamic. Though digitally simulating holistic recognition has progressed, practical processors and truly holistic systems need to be developed [138].

To develop DSSs various off-the-shelf development tools are available, ranging from common development tools (CDT) to advanced software packages which utilise intelligent agents. The literature provides a survey of DSS development tools which is classified as follows:

- **Basic/Procedural**: Such as Visual Basic or C++ which construct a DSS from fixed procedural instructions or code;
- **Moderate**: Utilises a high-level language to use stored knowledge, procedures and rules to assemble the lower-level sub-routines and functions; and
- **Advanced**: Require limited programming from the developer, such tools utilise common flowcharting symbols to describe the process [132, 139].

Moving from basic to advanced, the development tools become easier to use but modelling flexibility is restricted. The merits of using advanced development tools is that it easier and faster to develop customised models, data, and user interfaces through the use of templates. The demerits of advanced development tools are that the predefined templates are limited and may not be able to model a particular decision problem. Use of a basic/procedural development tool provides the user the flexibility to model virtually any decision problem, but often increases the time to build the model [132, 139].

A DSS must be designed to enable decision-makers to identify what information is needed and integrate timely the acquired information effectively. The key issue for developing a DSS is to determine how to construct DSSs capable of managing these aspects of complexity for the decision-maker [140].

### 2.4.4. Expert/ Knowledge Based Systems

Expert systems address problems based on knowledge of the techniques, information, heuristics, and problem-solving processes used by human experts. These systems model the domain knowledge of a human expert and can be used in place of, or to assist, human experts in forming decisions [114, 125, 141].

Knowledge based systems are heavily orientated toward specific, narrow knowledge domains. These systems are frequently identified as rule-based systems, but can apply a variety of methodologies to represent knowledge as follows:

- **Predicate logic**: Applied on relatively small systems where the data and rules are known with certainty;
- **Semantic networks, frames, and object-oriented approaches**: Applicable where inheritance of attributes among classes is important, along with other properties;
- **Rule based approaches**: On systems where the control structure (or “inference engine”) determines the direction of the deduction; and
- **Hybrids (of all the above)**: Most frequently the case in large systems [142].
The distinction between knowledge based systems and expert systems is based upon the source of knowledge for the definition of the system. If the knowledge is from a human whose ability to solve the problem is well beyond the common ability it is referred to as an expert system; if not the system is a knowledge based system. In practice the terms expert system and knowledge based system are considered synonymous by many [114, 141, 142].

DSSs are highly flexible and interactive systems, designed to support unstructured decision making utilising decision models, databases and the decision maker’s own insights. Expert/knowledge-based systems are used by non-experts to make decisions in a particular field using analytical rules and inference.

Expert/knowledge-based systems have been applied in the diverse fields of manufacturing, finance, aerospace, transportation, telecommunications and business to address the following: a) diagnosis; b) scheduling; c) planning; d) design; e) training; and f) forecasting [114, 141-144].

Expert/knowledge-based systems are well suited to the task of scheduling and examples of such systems are pervasive throughout the literature. The United States Air National Guard uses the Intelligent Maintenance Management System (IMMS) to insure timely scheduling of helicopter maintenance. The system provides data, information, and decision-making assistance and is used on a daily basis [144]. Another scheduling support expert system is Combat Auto-Planning Advisor (CAPA). It was developed for the United States Air Force to create air battle plans and air tasking orders; a traditionally manual task performed with grease pencil and acetate boards. CAPA employs a mixture of heuristics and algorithms to address different facets of the problem. It employs a relational database which stores three types of data as follows: a) static data such as aircraft characteristics; (b) dynamic data updated at the start of each planning period; and (c) planning data which is the result of the decisions and refinements made in creating air battle plans [143].

An expert/knowledge-based system may comprise of the following components:

- **Knowledge acquisition subsystem**: The collection, transfer, and conversion of problem-solving expertise from a knowledge source to a computer program for constructing or expanding the knowledge base;

- **Knowledge base**: The knowledge necessary for understanding, formulating, and solving problems. It includes the following two basic elements: a) facts, such as the problem situation theory of the problem area; and b) special heuristics, or rules, that direct the use of knowledge to solve specific problems in a particular domain;

- **Inference engine**: A computer program that provides a methodology for reasoning about information in the knowledge base and in the “blackboard,” and for formulating conclusions;

- **Blackboard**: An area of working memory set aside for the problem description, as specified by the input data and is also used for recording intermediate results;

- **User interface**: A means by which the human operator uses and interacts with the system. Graphical user interfaces (GUI) allow the user to interact using menus and icons, command-line interfaces allow users to interact by entering commands from the keyboard; and
• **Explanation subsystem**: The ability to trace responsibility for conclusions and explain the expert system’s behaviour [114].

The development of an expert/knowledge-based system involves acquiring knowledge from experts and/or from documented sources and the subsequent construction of the knowledge base. Development also includes the construction or acquisition of an inference engine, a blackboard, an explanation facility, and any other required software, such as interfaces [114].

Commonly available expert/knowledge-based system methodologies are restricted in use, even for generic applications, for the following reasons:

- Expert/knowledge-based systems only work well in narrow domains;
- Knowledge is not always available;
- Expertise is hard to extract as knowledge transfer is subject to perceptual and judgmental biases;
- Users of expert systems have natural cognitive limits;
- No independent means of checking whether the systems conclusions are reasonable; and
- Lack of confidence by end-users [114].

Expert/knowledge-based systems are now being replaced by a diversity of intelligent systems, which are built to fulfil the following two key functions:

- The screening, sifting and filtering of a growing overflow of data, information and knowledge; and
- The support of an effective and productive use of information systems, which are tailored to the needs and personality of the user.

Such intelligent systems range from self-organizing maps to smart add-on modules to make the use of standard software more effective and productive for users [126].

### 2.4.5. Associate Systems

Associate systems are human–computer cooperative problem solving systems [145]. They are defined as intelligent decision aiding systems that provide support for human limitations in complex “system of systems” environments which challenge the cognitive capabilities of humans that are not amenable to conventional automation [146]. They are adaptive aiding systems with significant problem solving capabilities to directly share the cognitive workload of their human partners in a dynamic and flexible environment [145].

Associate systems have bounded discretion to act on your behalf but do not commit to activities without consent and know how to assist with your responsibilities. This may entail the execution of specific tasks, the collection of information, or the coordination of tasks, but only within the limits of set authority [147].

Associate systems embody these ideas of mixed initiative and bounded discretion. Mixed initiative describes the associate’s ability to act on the behalf of its human counterparts without being asked or told. Bounded discretion indicates that the associate may only act within the bounds expressly authorized by its
human counterparts. Within the bounds of its discretion, an associate system has broad knowledge based
ability to intelligently support the humans in the system. [146]

The first associate system was the Pilot’s Associate, an intelligent system designed to aid fighter pilots pilot
in real-time dynamic situations [148]. It was the Pilot’s Associate which established this set of defining
characteristics for the term associate system that continues today [146].

Associate systems have leveraged recent improvements in computers, artificial intelligence, programming
languages, algorithmic methods, terrain databases, communications technologies, sensors, flight controls,
and controls and displays [147]. Associate systems have been actively pursued in a variety of roles
including the following:

- **Rotorcraft Pilot’s Associate (RPA):** A cognitive decision aiding system for future combat helicopter
  pilots [147, 149-152];
- **Urban Helicopter Associate System (UHAS):** An associate system for aiding pilots of rotorcraft
  engaged in complex missions in urban environments [146]; and
- **Crewman’s Associate:** A decision aiding system for the U.S. Army's future main battle tank [153].
3. AIR AMBULANCE VICTORIA

3.1. Introduction

Air Ambulance Victoria commenced operations in 1962, with the role of supporting the Victorian Ambulance Service for urgent and non-urgent transportation of patients over long distances [10, 18]. The Victorian ambulance services underwent a period of rationalisation and integration which resulted in the establishment of 3 divisions in early the 1990’s [54, 154]:

- Metropolitan Ambulance Service (MAS). This is the sole pre-hospital provider for the 3.5 million people living in and around the Melbourne Metropolitan and Mornington Peninsula regions, an area of almost 10,000 square kilometres;
- Rural Ambulance Victoria (RAV). This serves the 1.3 million people living outside the metropolitan area; and
- Air Ambulance Victoria. This is responsible for aeromedical services within the state of Victoria, and operates under the control of the MAS.

The Victorian ambulance services share common training, dispatch and clinical practice protocols. The services provide a two-tiered clinical response. The first tier comprises of paramedics with basic life support skills. Mobile intensive care ambulance (MICA) paramedics provide the second tier and have a comprehensive range of skills. Dispatch to trauma is computer assisted with a mandatory MICA response for major trauma. In rural Victoria, ground based MICA paramedics provide this response in the major provincial centres; The rotary wing based MICA paramedics provide a secondary response outside the major centres [54].

The primary role of Air Ambulance Victoria is to provide the following:

- rapid transport of time critical, medical, surgical and trauma patients;
- rapid primary response of paramedical personnel and equipment to an incident or location; and
- access and/or removal of patients from remote or inaccessible locations [18].

3.2. Aircraft

3.2.1. Introduction

Air Ambulance Victoria wet leases four dedicated Beechcraft Kingair B200C aircraft and three dedicated aeromedical helicopters (one Eurocopter AS.365N3 Dauphine 2 and two Bell 412EP). The aircraft interiors are specifically designed and fitted with the latest medical equipment to treat and monitor the wide range of patients requiring aeromedical transport [18].
The Beechcraft Kingair B200C aircraft and Eurocopter AS.365N3 Dauphine 2 are based in Melbourne at Essendon Airport and a Bell 412EP is based in the Latrobe Valley and at Bendigo, to ensure the HEMS fleet can reach most of the state within one hour (Figure 3-1).

![Figure 3-1: Air Ambulance Victoria’s HEMS bases and response lines.](image)

3.2.2. Eurocopter Dauphin AS 365N3

Air Ambulance Victoria operates an IFR capable Eurocopter Dauphin 2 AS 365N (Figure 3-2A) for HEMS operations. The aircraft is contracted from the Victorian Police out of Essendon Airport, Melbourne. The crew for HEMS missions comprises of a Pilot and Observer (Victorian Police Officers), and a MICA Flight Paramedic.

The Dauphin 2 features a retractable undercarriage, a rescue hoist (76 metre, 272 kg capacity), a 30 million candlepower nitesun directional search light and a forward looking infra-red (FLIR). The helicopter is capable of transporting two stretcher patients at 145 knots with a fuel capacity of 1135 litres.

3.2.3. Bell 412EP

Air Ambulance Victoria also operates two IFR capable Bell 412EP helicopters (Figure 3-2B) for HEMS, under contract with CHC Helicopters. These operate from the Latrobe Valley Airport in Gippsland and the Bendigo Airport in Central Victoria. The crew of these helicopters comprises of a Pilot and Observer, (CHC Helicopters employees) and a MICA Flight Paramedic.
The Bell 412 features a rescue hoist (76 metre, 272 kg capacity), a 30 million candlepower nitesun directional search light, a forward looking infra-red (FLIR) and a bambi bucket capable cable hook attachment for aerial fire fighting. The helicopter is capable of transporting two stretcher or one stretcher and four sitting patients at 120 knots with a fuel capacity of 1227 litres.

Figure 3-2: Air Ambulance Victoria’s Aeromedical Fleet: (A) Eurocopter Dauphin 2 AS 365N3 “HEMS 1”; (B) Bell 412EP “HEMS 3”; and (C) Beechcraft King Air B200C (Sources [155] [156, 157])

3.2.4. Beechcraft Kingair B200C

The Beechcraft Kingair B200C (Figure 3-2C) is a twin turboprop transport aircraft fitted with the latest medical equipment to treat and monitor the wide range of patients requiring air ambulance transport. The aircraft can cruise at 250 knots with a range of over 1200 nautical miles and is pressurised to an operating altitude of 35,000 feet [158].

Air Ambulance Victoria primarily uses the aircraft for transporting patients from rural towns to the major hospitals in Melbourne. This service includes the transportation of patients to Melbourne for regular treatments such as oncology and dialysis while also facilitating acute medical conditions requiring surgery. The aircraft serves more than 86 towns within Victoria and also services southern New South Wales, northern Tasmania and some parts of South Australia [157].

3.3. Personnel

3.3.1. Mobile Intensive Care Ambulance (MICA) Paramedic

The MICA paramedic primarily provides specialist pre-hospital and inter-facility care and treatment for critically ill and injured people and attempts to stabilise or improve patient condition in preparation for and during transportation to hospital by Air Ambulance Victoria’s rotary wing air ambulances [18].

The MICA paramedic is also responsible for crewing “HEMS 1” while involved in police operations and may be tasked, as required, to work on the fixed wing air ambulance or charter aircraft transporting both routine and emergency patients [18].
3.3.2. Flight Paramedic – Fixed Wing

The Flight Paramedic – Fixed Wing primarily provides care and treatment for sick and injured people. They attempt to stabilise or improve patient condition in preparation for and during transportation to hospital by Air Ambulance Victoria’s fixed wing air ambulances [18].

The flight paramedic may be tasked to work on the rotary wing air ambulance or charter aircraft transporting both routine and emergency patients. Flight paramedics are specifically trained for their role completing a 4-week training program involving theoretical and practical aeromedical management of patients [18].

3.3.3. Flight Coordinator

The flight coordinator coordinates and dispatches the appropriate air ambulance services (fixed or rotary wing aircraft and crew) for the transfer of emergency and non-emergency patients to appropriate destinations. The flight coordinator liaises with medical retrieval teams and other ambulance communication centres to ensure effective coordination of emergency and non-emergency medical responses, and with families, hospitals, medical surgeries, airline staff and taxis to ensure well coordinated patient movements [18].

3.3.4. Flight Crew

It is the responsibility of the contractor providing the aircraft to provide a pilot and crewman to fly the aircraft and assist with the loading and unloading of patients, equipment and baggage. The terms of the contract by Air Ambulance Victoria stipulate the qualifications and experience of the pilot and crewman (Table 3-1).

The flight coordinator provides the pilot with a flight profile, which normally involves flights between two or more locations and may involve the landing of the aircraft day or night at unprepared landing sites. The pilot is responsible for all pre-flight planning and has the authority to alter the flight profile or decline the mission for the following reasons:

- The weather precluding safe operations;
- Temporary closure of the location by a responsible authority;
- Unacceptable safety risks; or
- The unsafe or unsuitable nature of the designated landing area.
Table 3-1: Air Ambulance Victoria stipulated qualifications and experience for pilot and crewman

<table>
<thead>
<tr>
<th>Pilot</th>
<th>Crewman</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Airline Transport Pilot Licence (Helicopters);</td>
<td>• Preferably 500 hours experience as crewman with 150 hours exposure to SAR and EMS;</td>
</tr>
<tr>
<td>• Command Instrument Rating for multi-engine helicopters with at least three renewals;</td>
<td>• Relevant experience with night operations acceptable to MAS</td>
</tr>
<tr>
<td>• Rescue hoist endorsement with appropriate experience;</td>
<td>• Winch endorsements greater than 12 months as per CASA Regulations,</td>
</tr>
<tr>
<td>• Low flying and sling loading endorsement with current fire bucket experience; and</td>
<td>• 80 hours experience on a road ambulance with an appropriately trained Paramedic</td>
</tr>
<tr>
<td>• At least 2,000 hours aeronautical experience, including the following</td>
<td>• Level 2 Occupational Health and Safety First Aid certification.</td>
</tr>
<tr>
<td>• 1,500 as pilot-in-command of helicopters;</td>
<td>• Completed and maintained proficiency in Air Ambulance Victoria’s three day Crewman’s course.</td>
</tr>
<tr>
<td>• 5,000 hours in multi-engine helicopters (not including in command under supervision);</td>
<td></td>
</tr>
<tr>
<td>and</td>
<td></td>
</tr>
<tr>
<td>• 100 hours at night.</td>
<td></td>
</tr>
</tbody>
</table>

3.4. Operations

Since 1998, Air Ambulance Victoria’s three aeromedical helicopters have responded to 12,536 cases transporting 9,050 patients. Cases and patient transports peaked in 2001-2003 following the introduction of the third helicopter based in Bendigo. In 2004/2005 Air Ambulance Victoria’s three aeromedical helicopters responded to 1813 cases, transporting 1380 patients. The majority of Air Ambulance Victoria’s operations are conducted by the Beechcraft Kingairs. In 2004/2005 these four fixed wing aircraft were responsible for responding to 4,208 or 69.9% cases and transporting 4,188 or 76.6% of patients [159-163].

A statistical summary of Air Ambulance Victoria aeromedical operations between 1998 and 2005 is presented in Figure 3-3 and Figure 3-4 and Appendix A.1.
Figure 3-3: Air Ambulance Victoria Responses 1998-2005 (Source [159-163]).

Figure 3-4: Air Ambulance Victoria transported patients 1998-2005 (Source [159-163]).
Air Ambulance Victoria’s operations consist of three distinct missions: a) scene response (primary); b) inter-hospital transfer (secondary); and c) the transportation of medical retrieval teams (tertiary).

Scene response involves travelling directly to the scene of an incident to stabilise the casualty and transport them to definitive care. In some instances the HEMS may be first on the scene. In this case transporting advanced life support equipment and trained personnel to the scene is the foremost aim. More often HEMS arrive after the patient has been stabilised by ground ambulance personnel.

Inter-hospital transport (IHT) is the planned rapid transfer between hospitals of patients requiring specialist care, escorted by skilled medical personnel. It may also entail transporting patients to specialist clinics or transporting patients back home after hospitalisation.

Air Ambulance Victoria is a dedicated provider of transport for medical retrieval teams such as the neonatal emergency transport service (NETS), paediatric emergency transport service (PETS) and medical emergency adult retrieval service (MEARS) [18].

Hospital-based critical care retrieval teams are a major component of trauma services in rural Australia [54, 164-167]. Medical retrieval missions differ from primary missions. It involves getting a physician or retrieval team to a severely injured patient and not to transport the patient by air. The inclusion of a physician to the team increases the range of pre-hospital therapeutic options substantially [40]. Once the patient is stabilised, transport to definitive care may involve fixed wing, rotorcraft, or road transport dictated by distance, weather, and availability [164].

In addition to the three missions, Air Ambulance Victoria is also routinely called upon by AusSAR to conduct hoist operations and assist in the search and rescue of people at land and sea.

3.5. Dispatch Process

Air Ambulance Victoria recently updated its dispatch processes to enhance accountability by establishing the Flight Coordination Centre at Essendon Airport. The Flight Coordinator based at the Centre is responsible for ensuring the appropriate response requests for helicopter and fixed wing services.

Preparation for an operation commences with the initial contact from the requesting agency or person. Preliminary data and information is obtained and a general go/no go decision is taken based on the mission viability and the availability of resources. Once a mission is accepted, coordination of the individual flight commences.

Air Ambulance Victoria’s dispatch process varies between primary and secondary cases. Primary cases adopt a helicopter response and secondary responses are either by fixed wing or helicopter (see Appendix A.2). The dispatch process for a primary and secondary response is presented in Figure 3-5 and Figure 3-6 respectively.
Air Ambulance Victoria has 32 predetermined case types for assessing a primary incident helicopter response (Appendix A.3) If the case does not match one of the predetermined case types, the Flight Coordinator has the authority to classify it as a primary response if it meets the criteria at Appendix A.4. All other cases are regarded as secondary and the dispatch criteria applies accordingly.

Coordination of an individual flight involves selecting the most appropriate aircraft, notifying and assembling paramedics and crew and arranging any ground transportation if required. The main considerations in choosing an aircraft are availability, trip length; accessibility and anticipated weather. Speed can be a critical factor, but not a necessity.

After selecting an aircraft a flight schedule is evaluated, that involves in determining the following operational parameters:

- Mission waypoints: Fixed wing aircraft involves an itinerary of airports, and for helicopters it may involve airports, helipads or unprepared landing sites on location;
- Distance between each waypoint; and
- Time enroute between each waypoint.

The flight schedule is provided to the pilot, and any clinical information is passed to the paramedics. The flight crew and flight coordinator then liaises regarding any aircraft performance limits or safety concerns. The flight coordinator will also organise with the pilot necessary refuel stops if needed. The pilot is responsible for all pre-flight planning and has the authority to alter the flight profile or decline the mission (see section 3.3.4).
Figure 3-5: Air Ambulance Victoria Helicopter Primary Dispatch Process.
4. CONCEPTUAL SYSTEM DESIGN

4.1. Introduction

The nucleus of the pre-mission analysis of HEMS operations problem is to support the user in safely and effectively utilising HEMS resources. It covers two distinct phases: resource allocation and pre-flight planning.

Resource allocation commences on initial contact from the requesting agency/person. During this phase preliminary information is obtained and a decision to accept the request is made based on the appropriateness and feasibility of the request. If a mission request is accepted, coordination of the individual flight is initiated. This involves selecting the most suitable resource (aircraft and crew), based on speed, distances, landing requirements, anticipated weather, and safety.

Following the selection of a resource for a mission request, the pre-flight planning phase commences. During this phase a flight schedule is calculated, which includes the itinerary, distances, times, expected meteorological conditions and other pertinent information. The flight coordinator then coordinates with the pilot regarding schedule, paying particular attention to the aircraft’s range and performance limits, the need to refuel, and safety. The pilot makes the final decision to accept based on the safety, thus concluding the pre-flight planning phase.

The pre-mission analysis of HEMS operations requires several data and information processing tasks to be performed in real-time in a complex dynamic environment. This stipulates a high degree of coordination between flight coordinators, pilots, paramedics and supporting agencies to achieve the various objectives in a time.

The number of decisions involved, the multi-objective nature of the issue and the uncertainty, make development and application of a single mathematical model not viable. The whole decision complex is beyond the possibility of becoming fully structured into a complete and efficiently computable model. Thus, the problem of pre-mission analysis of HEMS operations cannot only be solved by computer and the system must include interaction between planner and computer.

As the pre-mission analysis of HEMS operations cannot be solved by standard quantitative techniques or computerised systems. The ability of a DSS to bring together human judgment and computerised information in semi-structured decision situations makes it viable as an intelligent system for use in supporting the pre-mission analysis of HEMS operations.
4.2. Design Considerations

4.2.1. Decision Support Systems

A DSS is a model-based or knowledge-based system which supports decision making in semi-structured or unstructured situations. It does not replace a decision maker, but extends their decision making capabilities. When implemented appropriately, DSS have demonstrated improvement in the quality of an organisation’s decision making [132, 168].

A DSS must perceive the environment and act logically [136]. To achieve this, a DSS needs to comprise of the following:

- Database management capabilities with access to internal and external data, information, and knowledge;
- Modelling functions accessed by a model management system; and
- A user interface design that enable interactive queries, reporting, and graphing functions [127].
In a typical DSS, the problem-pertinent data and models are captured and stored as inputs in the system. The decision maker (user) then utilises the system to: a) organise the data into problem parameters; b) attach the parameters to a model; c) use the model to simulate alternatives and events; and/or d) find the best solution to the problem. Results are reported as parameter conditions (status reports), experimental forecasts, and/or recommended actions. Feedback from the user-controlled processing guides the decision maker to a problem solution, and created information and knowledge are stored as additional inputs for future or further processing [169]. This typical DSS architecture is presented in Figure 4-1.

### 4.2.2. Automation

An important consideration in the design and development of an intelligent DSS is how automation can best support human decision makers, and the degree of automation required. Levels of automation vary from fully automated, where the operator is completely removed from the decision process, to minimal levels of automation, where the automation only makes recommendations and the operator has the final say [170-173]. A number of researchers have examined and defined the various levels of control and automation, resulting is as many as ten levels [174] and as few as the five [175] described in Table 4-1.

**Table 4-1: Levels of Control and Automation (Source [175]).**

<table>
<thead>
<tr>
<th>Level of Automation</th>
<th>Human Role</th>
<th>System Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. None</td>
<td>Decide, Act</td>
<td>-</td>
</tr>
<tr>
<td>2. Decision Support</td>
<td>Decide, Act</td>
<td>Suggest</td>
</tr>
<tr>
<td>3. Consensual AI</td>
<td>Concur</td>
<td>Decide, Act</td>
</tr>
<tr>
<td>4. Monitored AI</td>
<td>Veto</td>
<td>Decide, Act</td>
</tr>
<tr>
<td>5. Full Automation</td>
<td>-</td>
<td>Decide, Act</td>
</tr>
</tbody>
</table>

In well defined tasks that require no flexibility in decision-making and possess a low probability of system failure, higher levels of automation often provide the best solution. In time critical environments with external and changing constraints such as air traffic control or military command and control operations, higher levels of automation are discouraged due to the risks, complexity of the system and the inability of the automated decision aid to be perfectly reliable [170, 171, 176, 177].

The application of automation in DSS is only effective when decisions are accurately and quickly reached based on an exact and comprehensive algorithm that considers all known constraints. The inability of automation models to account for all potential conditions or relevant factors results in brittle-decision algorithms, which potentially make erroneous or misleading proposals [171, 178].
This inability is a result of what Parasuraman et al. [174] terms the “noisiness” of the world, i.e. unplanned variations in operating conditions, unexpected or erratic behaviour of other system or human operators, system malfunctions as well as the inherent unreliability of predicting the future.

Research has also shown other disadvantages with higher levels of automation that consign the human operator to a monitoring role. This includes skill degradation, reduced situational awareness, unbalanced workload, and an over-reliance on automation [170, 171, 174, 179, 180]. To combat this, researchers assert that a human-centred approach to automation; a process which commences with the operator at the heart of the system and then incorporates automation designed to augment or assist operators in areas where they demonstrate limitations; helps prevent automation induced confusion and erroneous decisions and allows a human operator to respond with greater flexibility to uncertain and unexpected events. [170-173, 179]

Designing truly supportive technology is a challenging problem, particularly at the level of aiding the human’s cognitive processing. To illustrate, the burden associated with supervising automation as it performs an offloaded task can outweigh the benefits to improved performance; decrements can result from automation induced complacency; and a partially automated system induces more errors in cases where its knowledge is incomplete than if the user is in the loop and the system critiques the user’s performance [179].

Reducing automation levels can cause higher workloads for operators and can be seen as a sub-optimal and inefficient design approach. However, the reduction can keep operators cognitively engaged and actively involved in the decision-making process. This promotes critical function performance as well as situation awareness. Efficiency should not outweigh effectiveness as the primary consideration when designing a DSS. Automation can make a system highly efficient but ineffective, especially if the knowledge needed for a correct decision is not available in a predetermined algorithm [171, 181].

4.3. System Characterisation

A fundamental issue in providing computer based decision support is related to the issue of which operator roles and positions need assistance, why, when, and how [179]. Consultation with AAV flight coordinators, pilots and paramedics identified the primary factors considered in the pre-mission analysis for AAV operations (Table 4-2) and the following requirements for a DSS:

- Assist flight coordinators with the allocation of resources (including fixed wing);
- Assist flight coordinators with the development of a flight profile for the pilot;
- Provide pertinent information for flight profiles;
- Provide risk assessments of proposed missions;
- User friendly; and
- Operable from a conventional desktop windows based PC.
Consultation also identified that the DSS must be capable of operating in a highly dynamic and open environment which imposes variable and unpredictable demands on flight coordinators and crew. The flight coordinator and crew must be able to effectively handle the demands of new and unanticipated situations that are not addressed during system design. Thus, the pre-mission analysis decision making concept presented in Figure 4-2 was established. This concept does not restrict or hamper the operator from taking advantage of their abilities to reason, improvise, and respond. It provides the avenue to call upon the system for the support they need. It also adheres to FAA recommendations [79] that the pilot’s decision to decline, cancel, divert, or terminate a flight overrides any decision of other parties to accept or continue a flight.

The transformation of a concept to a system requires the formulation of system functions. The fundamental function of the DSS as a system is to request specific inputs from the user, for processing to produce the desired outputs. Flood and Jackson [182] characterise a system as one that functions to transform inputs to
outputs. Thus, the DSS for the pre-mission analysis of HEMS operations is conceptualised as a conventional input-process-output system (Figure 4-3).

![Architecture of a DSS for the pre-mission analysis of HEMS operations](image)

**Figure 4-3 Architecture of a DSS for the pre-mission analysis of HEMS operations**

### 4.4. System Framework

The DSS is required to provide decision support for the pre-mission analysis of HEMS operations in a timely manner, by identifying suitable resource solutions and providing a detailed flight schedule and risk assessment for a given user-specified mission request. The system is designed to provide HEMS operators with a consistent, comprehensive flight dispatch procedure to assist pilots in determining the safety of a mission.

Post review of AAV operations, a framework which augments human expertise and aids the decision-making process was developed (Figure 4-4 to Figure 4-13). The system is work-centred [183], to find, fuse, format, present information, and respond to user requests.
Figure 4-4: DSS Framework - Overview.
Figure 4-5: DSS Framework - New Request.

Figure 4-6: DSS Framework - Update Case Notes.

Figure 4-7: DSS Framework - Decline Request.

Figure 4-8: DSS Framework - Cancel Request.
Accept Mission
Record mission details as a new record in tbl_missions
End
No
Yes
Record request as accepted in tbl_requests
Display mission details for each suitable resource
Select Resource
Display detailed mission plan for selected resource
Accept Mission
Yes
Refuel Possible
No
Yes
Refuel Required
Move Next Record
No
Yes
Move to the first record of the recordset
Create a record set from the database of available resources
Display hospitals and distance from scene
Select Hospital
End of Records
Yes
End
Refuel Required
Record request as accepted in tbl_requests
Record resource as assigned in tbl_resources
Record mission details as a new record in tbl_missions
End
Yes
No
Road Transport Required = No
Determine Base, Scene & Hospital Waypoints
Refuel Possible
Yes
Perform Risk Analysis and determine category of risk
Determine Lower Safe altitudes and Azimuths between waypoints
Store Information as a new record in tbl_SelectResource
Select Hospital
IHT
Start
Load selected request from tbl_requests
Scene
Request Type
Resource Type
Fixed wing
Helicopter
Road Transport Required = No
Determine airfield closest to scene and distance (Scene response only)
Determine distances and flight times between waypoints
Determine distances and flight times between waypoints
Determine Base, Scene & Hospital Waypoints
Determine airfield closest to scene and distance (Scene response only)
Determine distances and flight times between waypoints
Record request as accepted in tbl_requests
Display detailed mission plan for selected resource
Accept Mission
Yes
Refuel Possible
No
Yes
Refuel Required
Move Next Record
No
Yes
Move to the first record of the recordset
Create a record set from the database of available resources
Display hospitals and distance from scene
Select Hospital
End of Records
Yes
End
Refuel Required
Record request as accepted in tbl_requests
Record resource as assigned in tbl_resources
Record mission details as a new record in tbl_missions
End
Yes
No
Road Transport Required = No
Determine Base, Scene & Hospital Waypoints
Refuel Possible
Yes
Perform Risk Analysis and determine category of risk
Determine Lower Safe altitudes and Azimuths between waypoints
Store Information as a new record in tbl_SelectResource
Select Hospital
IHT
Start
Load selected request from tbl_requests
Scene
Request Type
Resource Type
Fixed wing
Helicopter
Road Transport Required = No
Determine airfield closest to scene and distance (Scene response only)
Determine distances and flight times between waypoints
Determine distances and flight times between waypoints
Determine Base, Scene & Hospital Waypoints
Determine airfield closest to scene and distance (Scene response only)
Determine distances and flight times between waypoints
Record request as accepted in tbl_requests
Display detailed mission plan for selected resource
Accept Mission
Yes
Refuel Possible
No
Yes
Refuel Required
Move Next Record
No
Yes
Move to the first record of the recordset
Create a record set from the database of available resources
Display hospitals and distance from scene
Select Hospital
End of Records
Yes
End
Refuel Required
Record request as accepted in tbl_requests
Record resource as assigned in tbl_resources
Record mission details as a new record in tbl_missions
End
Yes
No
Road Transport Required = No
Determine Base, Scene & Hospital Waypoints
Refuel Possible
Yes
Perform Risk Analysis and determine category of risk
Determine Lower Safe altitudes and Azimuths between waypoints
Store Information as a new record in tbl_SelectResource
Select Hospital
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Record request as accepted in tbl_requests
Display detailed mission plan for selected resource
Accept Mission
Yes
Refuel Possible
No
Yes
Refuel Required
Move Next Record
No
Yes
Move to the first record of the recordset
Create a record set from the database of available resources
Display hospitals and distance from scene
Select Hospital
End of Records
Yes
End
Refuel Required
Record request as accepted in tbl_requests
Record resource as assigned in tbl_resources
Record mission details as a new record in tbl_missions
End
Yes
No
Road Transport Required = No
Determine Base, Scene & Hospital Waypoints
Refuel Possible
Yes
Perform Risk Analysis and determine category of risk
Determine Lower Safe altitudes and Azimuths between waypoints
Store Information as a new record in tbl_SelectResource
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Helicopter
Road Transport Required = No
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Record request as accepted in tbl_requests
Display detailed mission plan for selected resource
Accept Mission
Yes
Refuel Possible
No
Yes
Refuel Required
Move Next Record
No
Yes
Move to the first record of the recordset
Create a record set from the database of available resources
Display hospitals and distance from scene
Select Hospital
End of Records
Yes
End
Refuel Required
Record request as accepted in tbl_requests
Record resource as assigned in tbl_resources
Record mission details as a new record in tbl_missions
End
Yes
No
Road Transport Required = No
Determine Base, Scene & Hospital Waypoints
Refuel Possible
Yes
Perform Risk Analysis and determine category of risk
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Load selected request from tbl_requests
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Request Type
Resource Type
Fixed wing
Helicopter
Road Transport Required = No
Determine airfield closest to scene and distance (Scene response only)
Determine distances and flight times between waypoints
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Determine distances and flight times between waypoints
Record request as accepted in tbl_requests
Display detailed mission plan for selected resource
Accept Mission
Yes
Refuel Possible
No
Yes
Refuel Required
Move Next Record
No
Yes
Move to the first record of the recordset
Create a record set from the database of available resources
Display hospitals and distance from scene
Select Hospital
End of Records
Yes
End
Refuel Required
Record request as accepted in tbl_requests
Record resource as assigned in tbl_resources
Record mission details as a new record in tbl_missions
End
Yes
No
Road Transport Required = No
Determine Base, Scene & Hospital Waypoints
Refuel Possible
Yes
Perform Risk Analysis and determine category of risk
Perform Risk Analysis and determine category of risk
Determine Lower Safe altitudes and Azimuths between waypoints
Store Information as a new record in tbl_SelectResource
Select Hospital
IHT
Start
Load selected request from tbl_requests
Scene
Request Type
Resource Type
Fixed wing
Helicopter
Road Transport Required = No
Determine airfield closest to scene and distance (Scene response only)
Determine distances and flight times between waypoints
Determine distances and flight times between waypoints
Determine Base, Scene & Hospital Waypoints
Determine airfield closest to scene and distance (Scene response only)
Determine distances and flight times between waypoints
Record request as accepted in tbl_requests
Display detailed mission plan for selected resource
Accept Mission
Yes
Refuel Possible
No
Yes
Refuel Required
Move Next Record
No
Yes
Move to the first record of the recordset
Create a record set from the database of available resources
Display hospitals and distance from scene
Select Hospital
End of Records
Yes
End
Figure 4-9: DSS Framework - Plan Mission.
Figure 4-10: DSS Framework - Abort Mission

Start

Load selected mission from tbl_missions

Abort Mission

Yes

Record mission as aborted in tbl_missions

No

Record resource as not assigned in tbl_resources

Reactivate request

Yes

Load corresponding request from tbl_requests

Record request as not accepted in tbl_requests

End

Figure 4-11: DSS Framework - Cancel Mission

Start

Load selected mission from tbl_missions

Cancel Mission

Yes

Record mission as cancelled in tbl_missions

No

Record resource as not assigned in tbl_resources

Reactivate request

Yes

Load corresponding request from tbl_requests

Record request as not accepted in tbl_requests

End
4.5. **Design Methodology**

In the traditional systems development life cycle approach a heavy emphasis on capturing the system requirements during the early stages is adhered to. In the cases of developing decision support systems, it is difficult to establish a firm system specification up front and expect it to remain unchanged during the development process. Thus, the approach taken was to develop a prototype DSS for the pre-mission analysis of HEMS operations which will serve as a baseline for future analysis, research and development.

MS Access was chosen to prototype the DSS as it is a common desktop DBMS compatible with the VBA programming language that can be used to build graphical user interfaces, to do complex data processing and presentation. The prototype comprises of three primary components, the Database, Model Base and GUI which are described in detail in Chapters 5 to 7.
4.6. Results and Discussion

In this chapter the nucleus of the pre-mission analysis of HEMS operations problem was defined as supporting the user in safely and effectively utilising HEMS resources during the phases of resource allocation and pre-flight planning.

It was identified that the problem of pre-mission analysis of HEMS operations cannot be solved by standard quantitative techniques and a system must include interaction between planner and computer. The adoption of a DSS solution to support the pre-mission analysis of HEMS operations was necessitated by this need to bring together computerised information and human judgment.

The pre-mission analysis of HEMS operations problem was characterised and from this a DSS architecture and framework developed. Emphasis was placed on supporting the strengths and complementing the weaknesses of the operator. The developed framework provides support for the operator’s naturally preferred strategies, instead of enforcing a normative or prescriptive approach and it is work-centred, to find, fuse, format, present information, and respond to user requests.

As it is difficult to establish a firm system specification for a DSS up front and expect it to remain unchanged, the approach was taken to develop the conceptual design into a prototype DSS using Microsoft Access. The intent being that this prototype system will serve as a baseline for future research which will refine the DSS into a suitable solution for wide spread integration and application in the HEMS industry.
5. DETAILED DESIGN: DATABASE

5.1. Introduction

This chapter describes the design of the MS Access relational database required to store, manage and process the necessary information and knowledge for the system.

The terms defining the structure of a relational database is considered as a hierarchy [184]. A single database is comprises of several tables; each table containing numerous records of multiple fields, as (Figure 5-1). Database design is the process of specifying the data types, structures, and constraints on storing the data [102].

![Hierarchical structure used to structure data within a relational database.](image)

5.2. Tables

A table is a collection of data about a specific topic, such as airfields or hospitals. A separate table for each topic means that data is stored only once, for a more efficient database and fewer data-entry errors.

The name of each table must be unique in the database and each field name must be unique within a table. The naming convention used for tables includes a tag that identifies each object, i.e. tbl_Airfields for a table about Airfields. This is useful in identifying different objects in the application developing code to control the application.

Tables organise data into columns (referrer to as fields) and rows (referrer to as records). To illustrate, each field in an airfields table contains the same type of information for every airfield, such as the airfields
code. Each record in that table contains all the information about one airfield – airfields code, name, latitude, longitude, and so on.

### 5.3. Fields

The fields are defined in terms of field name, field data type, field data size and field validation rules. The special types of fields are the primary and foreign keys. A primary key is a field or combination of fields that uniquely identifies each record in a table. A foreign key refers to the primary key of another table and is used to represent a relationship between data and link two tables together.

The field data type defines whether the field is a number, a word, a date or a specialised data type. The data types and corresponding data sizes used in MS Access are given at Appendix B.1. For numeric data types, the field size enables further definition of the type of number, which in turn determines the storage size. Appendix B.2 gives the seven possible settings in the Numeric Field Size property. It is recommended that when designing a database the field size should be the smallest possible; Access runs faster with smaller field sizes [185].

### 5.4. Database Specification

#### 5.4.1. Structure

The design of a database involves specifying structure, the data types and constraints on storing the data. Analysis of the system concept (see Chapter 4) resulted in a database design with the structure and constraints presented in Figure 5-2.

This database has been designed to store the required information for understanding, formulating and solving problems (knowledge base) and the problem description and intermediate results (workspace). The tables and fields (including the data types) supporting this database structure are presented in the following sections.

#### 5.4.2. Aircraft Types Table (tbl_AircraftTypes)

The Aircraft Types table (tbl_AircraftTypes) forms part of the knowledge base and contains pertinent information relating to the aircraft. Table 5-1 specifies the fields and the type of data.
Figure 5-2: Database structure and constraints
**Table 5-1: Aircraft Types table (tbl_AircraftTypes) fields.**

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft ID</td>
<td>Text</td>
<td>Unique identifying code for the aircraft type. (Primary Key)</td>
</tr>
<tr>
<td>Make</td>
<td>Text</td>
<td>Aircraft Make and Model</td>
</tr>
<tr>
<td>Fixed/Rotary</td>
<td>Text</td>
<td>Type of aircraft, either “Fixed Wing” or “Helicopter”</td>
</tr>
<tr>
<td>Cruise Speed</td>
<td>Number (Integer)</td>
<td>Aircraft cruise speed (kts).</td>
</tr>
<tr>
<td>Range</td>
<td>Number (Integer)</td>
<td>Aircraft range without refuelling (NM)</td>
</tr>
<tr>
<td>TOLT</td>
<td>Number (Integer)</td>
<td>Take-Off and Landing Time – (min.)</td>
</tr>
<tr>
<td>Refuel Time</td>
<td>Number (Integer)</td>
<td>Time required to refuel the aircraft (min.)</td>
</tr>
<tr>
<td>IFR</td>
<td>Yes/No</td>
<td>Is the aircraft suitable for IFR operations?</td>
</tr>
<tr>
<td>NVG</td>
<td>Yes/No</td>
<td>Is the aircraft fitted with Night Vision Goggles?</td>
</tr>
</tbody>
</table>

5.4.3. **Airfields table (tbl_Airfields)**

The Airfields table (tbl_Airfields) forms part of the knowledge base and contains pertinent information about airfields and airports. Table 5-2 specifies the fields and the type of data.

**Table 5-2: Airfields table (tbl_Airfields) fields.**

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>Text</td>
<td>Unique 4 letter airfield identifier (Primary Key)</td>
</tr>
<tr>
<td>Name</td>
<td>Text</td>
<td>Name of the airfield.</td>
</tr>
<tr>
<td>Lat</td>
<td>Number (Double)</td>
<td>Latitude of the airfield (degrees, decimal).</td>
</tr>
<tr>
<td>Long</td>
<td>Number (Double)</td>
<td>Longitude of the airfield (degrees, decimal).</td>
</tr>
<tr>
<td>Altitude</td>
<td>Number (Integer)</td>
<td>Altitude of the airfield AMSL (whole ft).</td>
</tr>
<tr>
<td>Fuel</td>
<td>Yes/No</td>
<td>Are refuelling facilities available?</td>
</tr>
</tbody>
</table>
5.4.4. Case Type Table (tbl_CaseType)

The Case Type table (tbl_CaseType) forms part of the knowledge base and contains pertinent information relating to Air Ambulance Victoria’s predetermined case types. There is a referential constraint between the case type and hospital tables. Table 5-3 specifies the fields and the type of data.

Table 5-3: Case Type table (tbl_CaseType) fields.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Number</td>
<td>Number (Byte)</td>
<td>Air Ambulance Victoria predetermined case type identifier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(see Appendix A.3). (Primary Key)</td>
</tr>
<tr>
<td>Description</td>
<td>Text</td>
<td>A description of the predetermined case type</td>
</tr>
<tr>
<td>Default Hospital</td>
<td>Text</td>
<td>Name of the default hospital. (Foreign Key)</td>
</tr>
</tbody>
</table>

5.4.5. Crewman Table (tbl_Crewman)

The Crewman table (tbl_Crewman) forms part of the knowledge base and contains pertinent information relating to the crewman. Table 5-4 specifies the fields and the type of data.

Table 5-4: Crewman table (tbl_Crewman) fields.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crewman ID</td>
<td>AutoNumber (Long)</td>
<td>Unique numerical identifier for each Crewman (Primary Key)</td>
</tr>
<tr>
<td>Family Name</td>
<td>Text</td>
<td>Crewman’s family name.</td>
</tr>
<tr>
<td>Given Name</td>
<td>Text</td>
<td>Crewman’s given name</td>
</tr>
<tr>
<td>Commenced</td>
<td>Date/Time</td>
<td>Date which the Crewman commenced their current job.</td>
</tr>
</tbody>
</table>

5.4.6. Flight Coordinator Table (tbl_FlightCoord)

The Flight Coordinator table (tbl_FlightCoord) forms part of the knowledge base and contains pertinent information relating to the Flight Coordinator. Table 5-5 specifies the fields and the type of data.
5.4.7. **Helipads Table (tbl_Helipads)**

The Helipads table (tbl_Helipads) forms part of the knowledge base and contains pertinent information relating to the helipads. Table 5-6 specifies the fields and the type of data.

*Table 5-5: Flight Coordinator table (tbl_FlightCoord) fields.*

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight Coordinator</td>
<td>AutoNumber (Long)</td>
<td>Unique numerical identifier for each Flight Coordinator (Primary Key)</td>
</tr>
<tr>
<td>Family Name</td>
<td>Text</td>
<td>Flight Coordinator’s family name.</td>
</tr>
<tr>
<td>Given Name</td>
<td>Text</td>
<td>Flight Coordinator’s given name.</td>
</tr>
</tbody>
</table>

*Table 5-6: Helipads table (tbl_Helipads).*

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helipad</td>
<td>Text</td>
<td>Unique helipad name. (Primary Key)</td>
</tr>
<tr>
<td>Lat</td>
<td>Number (Double)</td>
<td>Latitude of the helipad (degrees, decimal)</td>
</tr>
<tr>
<td>Long</td>
<td>Number (Double)</td>
<td>Longitude of the helipad (degrees, decimal)</td>
</tr>
<tr>
<td>Altitude</td>
<td>Number (Integer)</td>
<td>Altitude of helipad AMSL (whole feet)</td>
</tr>
</tbody>
</table>

5.4.8. **Hospitals Table (tbl_Hospitals)**

The Hospitals table (tbl_Hospitals) forms part of the knowledge base and contains pertinent information relating to the hospitals. There is a referential constraint between the Hospital table and the Airfields and Helipads tables. Table 5-7 specifies the fields and the type of data.

*Table 5-7: Hospitals table (tbl_Helipads) fields.*

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Text</td>
<td>Name of the Hospital (Primary Key).</td>
</tr>
<tr>
<td>Airfield</td>
<td>Text</td>
<td>Unique 4 letter airfield identifier for the airfield servicing the hospital. (Foreign Key)</td>
</tr>
<tr>
<td>Helipad</td>
<td>Text</td>
<td>Name of the helipad servicing the hospital. (Foreign Key)</td>
</tr>
</tbody>
</table>
5.4.9. **Localities Table (tbl_Localities)**

The Localities table (tbl_Localities) forms part of the knowledge base and contains the latitude and longitude of a given locality. Table 5-8 specifies the fields and the type of data.

*Table 5-8: Localities table (tbl_Localities).*

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locality</td>
<td>Text</td>
<td>Unique locality name. (Primary Key)</td>
</tr>
<tr>
<td>Lat</td>
<td>Number (Double)</td>
<td>Latitude of the locality (degrees, decimal)</td>
</tr>
<tr>
<td>Long</td>
<td>Number (Double)</td>
<td>Longitude of the locality (degrees, decimal)</td>
</tr>
</tbody>
</table>

5.4.10. **Missions Table (tbl_Missions)**

The Missions table (tbl_Missions) forms part of the workspace and records pertinent information and analysis results relating to a mission. There is a referential constraint between the Missions table and the Requests, Pilot, Paramedics and Crewman tables. Table 5-9 specifies the fields and the type of data.

*Table 5-9: Missions table (tbl_Missions).*

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission ID</td>
<td>AutoNumber (Long)</td>
<td>Unique numerical identifier for each Mission (Primary Key)</td>
</tr>
<tr>
<td>Request ID</td>
<td>Number (Long)</td>
<td>The ID number of the corresponding request. (Foreign Key)</td>
</tr>
<tr>
<td>Type</td>
<td>Text</td>
<td>Type of mission, either “Primary” or “IHT”</td>
</tr>
<tr>
<td>Resource</td>
<td>Text</td>
<td>Resource assigned to the Mission (Foreign Key)</td>
</tr>
<tr>
<td>Pilot</td>
<td>Text</td>
<td>Pilot ID of the Mission Pilot (Foreign Key)</td>
</tr>
<tr>
<td>Crewman</td>
<td>Text</td>
<td>Crewman ID of the Mission Crewman (Foreign Key)</td>
</tr>
<tr>
<td>Paramedic</td>
<td>Text</td>
<td>Paramedic ID of the Mission Paramedic (Foreign Key)</td>
</tr>
<tr>
<td>Number of Waypoints</td>
<td>Text</td>
<td>Number of waypoints defining the mission.</td>
</tr>
<tr>
<td>MET/AIS</td>
<td>Memo</td>
<td>MET data relating to the mission.</td>
</tr>
<tr>
<td>NOTAM</td>
<td>Memo</td>
<td>NOTAM data relating to the mission.</td>
</tr>
<tr>
<td>Notes</td>
<td>Memo</td>
<td>Notes relating to the mission</td>
</tr>
<tr>
<td>Risk Score</td>
<td>Text</td>
<td>Risk Score of the mission.</td>
</tr>
<tr>
<td>Risk</td>
<td>Memo</td>
<td>Risk Analysis of the mission.</td>
</tr>
</tbody>
</table>
Analysis

<table>
<thead>
<tr>
<th>Field</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancelled</td>
<td>Yes/No</td>
<td>Has the mission been cancelled?</td>
</tr>
<tr>
<td>Aborted</td>
<td>Yes/No</td>
<td>Has the mission been aborted?</td>
</tr>
<tr>
<td>Complete</td>
<td>Yes/No</td>
<td>Has the mission bee completed?</td>
</tr>
</tbody>
</table>

5.4.11. NOTAMs Table (tbl_NOTAMs)

The NOTAMs table (tbl_NOTAMs) forms part of the knowledge base and is used to store the latest NOTAM information. Table 5-10 specifies the fields and the type of data.

Table 5-10: NOTAMs table (tbl_NOTAMs) fields.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>Text</td>
<td>Unique code identifying the NOTAM region. (Primary Key) In the case of an airfield this is the unique 4 letter airfield identifier (Foreign Key)</td>
</tr>
<tr>
<td>NOTAM</td>
<td>Memo</td>
<td>NOTAM as issued by Air Services Australia.</td>
</tr>
</tbody>
</table>

5.4.12. Paramedics Table (tbl_Paramedics)

The Paramedics table (tbl_Paramedics) forms part of the knowledge base and contains pertinent information relating to the paramedic. Table 5-11 specifies the fields and the type of data.

Table 5-11: Paramedics table (tbl_Paramedics) fields.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paramedic ID</td>
<td>AutoNumber (Long)</td>
<td>Unique numerical identifier for each Paramedic (Primary Key)</td>
</tr>
<tr>
<td>Family Name</td>
<td>Text</td>
<td>Paramedic’s family name.</td>
</tr>
<tr>
<td>Given Name</td>
<td>Text</td>
<td>Paramedic’s given name.</td>
</tr>
<tr>
<td>Commenced</td>
<td>Date/Time</td>
<td>Date which the Paramedic commenced their current job.</td>
</tr>
</tbody>
</table>

5.4.13. Pilot Table (tbl_Pilot)

The Pilot table (tbl_Pilot) forms part of the knowledge base and contains pertinent information relating to the pilot. Table 5-12 specifies the fields and the type of data.
5.4.14. Pilot Logbook Table (tbl_PilotLogBook)

The Pilot Logbook table (tbl_PilotLogBook) forms part of the knowledge base and contains pertinent information relating to the pilots’ experience and currency. There is a referential constraint between the PilotLog Book table and the Pilot and AircraftType tables. Table 5-13 specifies the fields and the type of data.

*Table 5-12: Pilot table (tbl_Pilot) fields.*

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot ID</td>
<td>AutoNumber (Long)</td>
<td>Unique numerical identifier for each Pilot. (Primary Key)</td>
</tr>
<tr>
<td>Family Name</td>
<td>Text</td>
<td>Pilots’s family name.</td>
</tr>
<tr>
<td>Given Name</td>
<td>Text</td>
<td>Pilots’s given name.</td>
</tr>
<tr>
<td>Commenced</td>
<td>Date/Time</td>
<td>Date which the Pilot commenced their current job.</td>
</tr>
<tr>
<td>Previous Exp</td>
<td>Number (Double)</td>
<td>Previous EMS piloting experience (Years)</td>
</tr>
</tbody>
</table>

*Table 5-13: Pilot Logbook table (tbl_PilotLogBook) fields.*

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>AutoNumber (Long)</td>
<td>Unique numerical identifier for each log book entry (Primary Key)</td>
</tr>
<tr>
<td>Pilot ID</td>
<td>Text</td>
<td>Identifying code for the pilot. (Foreign Key)</td>
</tr>
<tr>
<td>Date</td>
<td>Date/Time</td>
<td>Date of the flight.</td>
</tr>
<tr>
<td>Hours</td>
<td>Number (Double)</td>
<td>Number of hours flown.</td>
</tr>
<tr>
<td>Type</td>
<td>Text</td>
<td>Identifying code for the aircraft type. (Foreign Key)</td>
</tr>
<tr>
<td>Night Flight</td>
<td>Yes/No</td>
<td>Was the flight a night flight?</td>
</tr>
<tr>
<td>NVGs</td>
<td>Yes/No</td>
<td>Were NVGs used?</td>
</tr>
<tr>
<td>Check Ride</td>
<td>Yes/No</td>
<td>Was the flight a check ride?</td>
</tr>
</tbody>
</table>
5.4.15. Requests Table (tbl_Requests)

The Requests table (tbl_Requests) forms part of the workspace and records pertinent information relating to a request. There is a referential constraint between the Requests table and the Flight Coordinator, Case Number, and Hospital tables. Table 5-14 specifies the fields and the type of data which the table comprises.

Table 5-14: Requests table (tbl_Requests) fields.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Request ID</td>
<td>AutoNumber (Long)</td>
<td>Unique numerical identifier for each Request (Primary Key)</td>
</tr>
<tr>
<td>Date/Time Received</td>
<td>Date/Time</td>
<td>The date and time the request was recorded.</td>
</tr>
<tr>
<td>Flight Coordinator</td>
<td>Number (Integer)</td>
<td>Flight Coordinator ID of the Flight Coordinator recording the request (Foreign Key)</td>
</tr>
<tr>
<td>Mission Type</td>
<td>Text</td>
<td>Type of mission, either “Primary” or “IHT”</td>
</tr>
<tr>
<td>Case Number</td>
<td>Number (Integer)</td>
<td>Air Ambulance Victoria predetermined case type identifier (see Appendix A.3). (Foreign Key) – For Primary requests only.</td>
</tr>
<tr>
<td>Case Notes</td>
<td>Text</td>
<td>Notes relating to the request.</td>
</tr>
<tr>
<td>Prelim Hospital</td>
<td>Text</td>
<td>Name of the Hospital that the patient is likely to go to. (Foreign Key) – For Primary requests only.</td>
</tr>
<tr>
<td>IHT Requesting</td>
<td>Text</td>
<td>Name of the Hospital requesting the IHT (Foreign Key) – For IHT requests only.</td>
</tr>
<tr>
<td>IHT Destination</td>
<td>Text</td>
<td>Name of the Destination Hospital (Foreign Key) – For IHT requests only.</td>
</tr>
<tr>
<td>Scene Lat</td>
<td>Number (Double)</td>
<td>Latitude of the scene (degrees, decimal) – For Primary requests only.</td>
</tr>
<tr>
<td>Scene Long</td>
<td>Number (Double)</td>
<td>Longitude of the locality (degrees, decimal) – For Primary requests only.</td>
</tr>
<tr>
<td>Cancelled</td>
<td>Yes/No</td>
<td>Has the request been cancelled?</td>
</tr>
<tr>
<td>Declined</td>
<td>Yes/No</td>
<td>Has the request been declined?</td>
</tr>
<tr>
<td>Accepted</td>
<td>Yes/No</td>
<td>Has the request been accepted?</td>
</tr>
</tbody>
</table>
5.4.16. **Resources Table (tbl_Resources)**

The Resources table (tbl_Resources) forms part of the knowledge base and contains pertinent information relating to HEMS resources. There are referential constraints between the Resources table and the AircraftType and Airfields tables. Table 5-15 specifies the fields and the type of data.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource</td>
<td>Text</td>
<td>Unique alphanumeric identifier for each resource. (Primary Key)</td>
</tr>
<tr>
<td>AC Type</td>
<td>Text</td>
<td>Identifying code for the aircraft type. (Foreign Key)</td>
</tr>
<tr>
<td>Base</td>
<td>Text</td>
<td>Identifying code for the airfield the resource is based. (Foreign Key)</td>
</tr>
<tr>
<td>Assigned</td>
<td>Yes/No</td>
<td>Is the resource currently assigned?</td>
</tr>
<tr>
<td>Unavailable</td>
<td>Yes/No</td>
<td>Is the resource currently unavailable?</td>
</tr>
</tbody>
</table>

5.4.17. **Roster Table (tbl_Roster)**

The Roster table (tbl_Roster) forms part of the knowledge base and contains pertinent information of the roster. There are referential constraints between the Roster table and the Pilot and Crewman and Paramedics tables. Table 5-16 specifies the fields and the type of data.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>AutoNumber (Long)</td>
<td>Unique numerical identifier for each roster entry (Primary Key)</td>
</tr>
<tr>
<td>Date</td>
<td>Date/Time</td>
<td>The date for which the roster applies.</td>
</tr>
<tr>
<td>Shift</td>
<td>Number (Integer)</td>
<td>Indicates either 1st (08:00-18:00) or 2nd (18:00-08:00) shift.</td>
</tr>
<tr>
<td>Flight Coord</td>
<td>Number (Integer)</td>
<td>Identifying code for the flight coordinator on duty. (Foreign Key)</td>
</tr>
<tr>
<td>HEMS1 Pilot</td>
<td>Number (Integer)</td>
<td>Identifying code for the pilot who is on duty for HEMS1. (Foreign Key)</td>
</tr>
<tr>
<td>HEMS1</td>
<td>Number (Integer)</td>
<td>Identifying code for the crewman who is on duty for HEMS1.</td>
</tr>
</tbody>
</table>
### 5.4.18. Select Resource Table (tbl_SelectResource1)

The Select Resource table (tbl_SelectResource1) forms part of the workspace and records intermediate system results for each resource relating to a specific request. The data recorded in this table is erased prior to planning each new mission. There are referential constraints between the Select Resource table and the Resources, Requests, Airfields tables. Table 5-17 specifies the fields and the type of data.

**Table 5-17: Select Resource table (tbl_SelectResource1) fields.**

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource</td>
<td>Text</td>
<td>Unique alphanumeric identifier for each resource. (Primary and Foreign Key)</td>
</tr>
<tr>
<td>Request</td>
<td>Number (Long)</td>
<td>Numerical identifier for the request which the table data relates. (Foreign Key)</td>
</tr>
<tr>
<td>Base</td>
<td>Text</td>
<td>Identifying code for the airfield the resource is based. (Foreign Key)</td>
</tr>
<tr>
<td>Time To Scene</td>
<td>Number (Integer)</td>
<td>Estimated time (minutes) between the base and scene for primary missions and the base and requesting hospital for IHT for the proposed mission.</td>
</tr>
<tr>
<td>Field Name</td>
<td>Field Type</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Time To Hospital</td>
<td>Number (Integer)</td>
<td>Estimated time (minutes) between the scene and hospital for primary missions and the requesting and receiving hospital for IHT for the proposed mission.</td>
</tr>
<tr>
<td>Total Distance</td>
<td>Number (Integer)</td>
<td>Total distance (nautical miles) for the proposed mission.</td>
</tr>
<tr>
<td>Total Time</td>
<td>Number (Integer)</td>
<td>Estimated flying time for the proposed mission (minutes).</td>
</tr>
<tr>
<td>Transport</td>
<td>Yes/No</td>
<td>Is ground transportation required?</td>
</tr>
<tr>
<td>Refuel</td>
<td>Yes/No</td>
<td>Is a refuel stop required?</td>
</tr>
<tr>
<td>Static Risk</td>
<td>Number (Integer)</td>
<td>Quantitative rating of specific risk factors.</td>
</tr>
<tr>
<td>Refuel Waypoint</td>
<td>Number (Integer)</td>
<td>If a refuelling is required the waypoint number that refuelling is required.</td>
</tr>
<tr>
<td>Number of</td>
<td>Number (Integer)</td>
<td>The number (2-4) of unique waypoints that define the mission flight path.</td>
</tr>
<tr>
<td>Waypoints</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W1 Name</td>
<td>Text</td>
<td>The name of the first waypoint. Depending upon the type of waypoint this will either be “Scene”, a unique airfield identifying code or the unique helipad name.</td>
</tr>
<tr>
<td>W1 Type</td>
<td>Text</td>
<td>Specifies the type of first waypoint. Either “Airfield”, “Unprepared HLS” or “Prepared HLS”. In the case of an unprepared HLS this will also include in brackets the distance to the closest airfield, i.e. Unprepared HLS(2NM From YECH). If a fixed wing aircraft is responding to a scene response, then for the waypoint nearest the scene the distance to the scene is also included in brackets, i.e. Airfield (2NM From Scene).</td>
</tr>
<tr>
<td>W1 Lat</td>
<td>Number (Double)</td>
<td>The latitude in degrees (decimal) of the first waypoint.</td>
</tr>
<tr>
<td>W1 Long</td>
<td>Number (Double)</td>
<td>The longitude in degrees (decimal) of the first waypoint.</td>
</tr>
<tr>
<td>W1 Weather Report</td>
<td>Text</td>
<td>Identifying code for the closest airfield to the first waypoint for which weather observations will be sought. In the case of the waypoint being an airfield this is the identifying code of the airfield. (Foreign Key)</td>
</tr>
<tr>
<td>W1 Height</td>
<td>Number (Integer)</td>
<td>The elevation in feet of the first waypoint.</td>
</tr>
<tr>
<td>W2 Name</td>
<td>Text</td>
<td>The name of the second waypoint (see W1 Name).</td>
</tr>
<tr>
<td>W2 Type</td>
<td>Text</td>
<td>The type of the second waypoint (see W1Type).</td>
</tr>
</tbody>
</table>
Table 5-17: Select Resource table (tbl_SelectResource1) fields.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W2 Lat</td>
<td>Number (Double)</td>
<td>The latitude in degrees (decimal) of the second waypoint.</td>
</tr>
<tr>
<td>W2 Long</td>
<td>Number (Double)</td>
<td>The longitude in degrees (decimal) of the second waypoint.</td>
</tr>
<tr>
<td>W2 Weather Report</td>
<td>Text</td>
<td>Identifying code for the airfield which weather observations for the second waypoint will be sought (see W1 Weather Report). (Foreign Key)</td>
</tr>
<tr>
<td>W2 Height</td>
<td>Number (Integer)</td>
<td>The elevation in feet of the second waypoint.</td>
</tr>
<tr>
<td>W3 Name</td>
<td>Text</td>
<td>The name of the third waypoint (see W1 Name).</td>
</tr>
<tr>
<td>W3 Type</td>
<td>Text</td>
<td>The type of the third waypoint (see W1Type).</td>
</tr>
<tr>
<td>W3 Lat</td>
<td>Number (Double)</td>
<td>The latitude in degrees (decimal) of the third waypoint.</td>
</tr>
<tr>
<td>W3 Long</td>
<td>Number (Double)</td>
<td>The longitude in degrees (decimal) of the third waypoint.</td>
</tr>
<tr>
<td>W3 Weather Report</td>
<td>Text</td>
<td>Identifying code for the airfield which weather observations for the third waypoint will be sought (see W1 Weather Report). (Foreign Key)</td>
</tr>
<tr>
<td>W3 Height</td>
<td>Number (Integer)</td>
<td>The elevation in feet of the third waypoint.</td>
</tr>
<tr>
<td>W4 Name</td>
<td>Text</td>
<td>The name of the fourth waypoint (see W1 Name).</td>
</tr>
<tr>
<td>W4 Type</td>
<td>Text</td>
<td>The type of the third waypoint (see W1Type).</td>
</tr>
<tr>
<td>W4 Lat</td>
<td>Number (Double)</td>
<td>The latitude in degrees (decimal) of the fourth waypoint.</td>
</tr>
<tr>
<td>W4 Long</td>
<td>Number (Double)</td>
<td>The longitude in degrees (decimal) of the fourth waypoint.</td>
</tr>
<tr>
<td>W4 Weather Report</td>
<td>Text</td>
<td>Identifying code for the airfield which weather observations for the fourth waypoint will be sought (see W1 Weather Report). (Foreign Key)</td>
</tr>
<tr>
<td>W4 Height</td>
<td>Number (Integer)</td>
<td>The elevation in feet of the fourth waypoint.</td>
</tr>
<tr>
<td>Risk Analysis</td>
<td>Memo</td>
<td>The risk analysis of the proposed mission.</td>
</tr>
</tbody>
</table>

5.4.19. Select Hospital Table (tbl_SelHosp)

The Select Hospital table (tbl_SelHosp) forms part of the workspace and records intermediate system results pertinent to mission planning for a specific scene response request. The data recorded in this table is erased prior to planning each new scene response mission. Referential constraints exist between the Select Hospital table and the Hospitals and Requests tables. Table 5-18 specifies the fields and the type of data.
Table 5-18: Select Hospital table (tbl_SelectHosp) fields.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital</td>
<td>Text</td>
<td>Name of the Hospital (Primary Key and Foreign Key).</td>
</tr>
<tr>
<td>Distance</td>
<td>Number (Double)</td>
<td>Distance (nautical miles) of the hospital from the scene.</td>
</tr>
<tr>
<td>Request ID</td>
<td>Number (Double)</td>
<td>Numerical identifier for the request which the table data relates. (Foreign Key)</td>
</tr>
</tbody>
</table>

5.4.20. Terrain Table (tbl_Terrain)

The Terrain table (tbl_Terrain) forms part of the knowledge base and contains pertinent information relating to Australia’s key aeronautical heights. Table 5-19 specifies the fields and the type of data.

Table 5-19: Terrain table (tbl_Terrain) fields.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>AutoNumber</td>
<td>Unique numerical identifier for each key aeronautical height (Primary Key)</td>
</tr>
<tr>
<td>Lat</td>
<td>Number (Double)</td>
<td>The latitude in degrees (decimal) for the key aeronautical height.</td>
</tr>
<tr>
<td>Lon</td>
<td>Number (Double)</td>
<td>The longitude in degrees (decimal) for the key aeronautical height.</td>
</tr>
<tr>
<td>Height</td>
<td>Number (Integer)</td>
<td>The height in meters of the key aeronautical height.</td>
</tr>
</tbody>
</table>

5.4.21. Waypoints Table (tbl_Waypoints)

The Waypoints table (tbl_Waypoints) forms part of the workspace and records system results relating to the waypoints for each specific mission. There are referential constraints between the Waypoints table and the Missions and Airfields tables. Table 5-20 specifies the fields and the type of data.

Table 5-20: Waypoints table (tbl_Waypoints) fields.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>AutoNumber</td>
<td>Unique numerical identifier for each Waypoint (Primary Key)</td>
</tr>
<tr>
<td>Mission ID</td>
<td>Number (Long)</td>
<td>Numerical identifier for the Mission (Foreign Key)</td>
</tr>
<tr>
<td>Waypoint</td>
<td>Number (Integer)</td>
<td>The waypoint number (1-5). The system only allows up to 4 unique waypoints, the last waypoint is always the same as the</td>
</tr>
</tbody>
</table>
Table 5-20: Waypoints table (tbl_Waypoints) fields.

<table>
<thead>
<tr>
<th>Field</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Text</td>
<td>Waypoint Name. Depending upon the type of waypoint this will either be “Scene”, a unique airfield identifying code or the unique helipad name. This is followed by the type of waypoint, either “Airfield”, “Unprepared HLS” or “Prepared HLS”. In the case of an unprepared HLS this will also include in brackets the distance to the closest airfield, <em>i.e.</em> Unprepared HLS(2NM From YECH). If a fixed wing aircraft is responding to a scene response, then for the waypoint nearest the scene the distance to the scene is also included in brackets, <em>i.e.</em> Airfield (2NM From Scene).</td>
</tr>
<tr>
<td>Lat</td>
<td>Number (Double)</td>
<td>The latitude in degrees (decimal) of the waypoint.</td>
</tr>
<tr>
<td>Lon</td>
<td>Number (Double)</td>
<td>The longitude in degrees (decimal) of the waypoint.</td>
</tr>
<tr>
<td>Elevation</td>
<td>Number (Integer)</td>
<td>The elevation in feet of the waypoint.</td>
</tr>
<tr>
<td>Weather Code</td>
<td>Text</td>
<td>Identifying code for the closest airfield to the waypoint for which weather observations are sought. In the case of the waypoint being an airfield this is the identifying code of the airfield. (Foreign Key)</td>
</tr>
<tr>
<td>Distance to Next</td>
<td>Number (Double)</td>
<td>Distance (nautical miles) to the next waypoint.</td>
</tr>
<tr>
<td>Time to Next</td>
<td>Number (Integer)</td>
<td>Estimated time (minutes) to the next waypoint.</td>
</tr>
<tr>
<td>LSAlt to Next</td>
<td>Number (Integer)</td>
<td>Calculated lower safe altitude (feet) to the next waypoint.</td>
</tr>
<tr>
<td>Bearing to Next</td>
<td>Number (Double)</td>
<td>Azimuth (degrees) to the next waypoint.</td>
</tr>
<tr>
<td>Refuel</td>
<td>Yes/No</td>
<td>Refuel at this waypoint?</td>
</tr>
<tr>
<td>Arrive</td>
<td>Yes/No</td>
<td>Used to record resource arrival at the waypoint.</td>
</tr>
<tr>
<td>Depart</td>
<td>Yes/No</td>
<td>Used to record resource departure from the waypoint.</td>
</tr>
</tbody>
</table>

5.4.22. Weather Reports Table (tbl_WReports)

The Weather Reports table (tbl_WReports) forms part of the knowledge base and is used to store the latest meteorological information. Table 5-21 specifies the fields and the type of data which the table comprises.
Table 5-21: Weather Reports table (tbl_WReports) fields.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WCode</td>
<td>Text</td>
<td>Unique code identifying the area/location governed by the report. (Primary Key) In the case of an airfield this is the unique 4 letter airfield identifier (Foreign Key)</td>
</tr>
<tr>
<td>Report</td>
<td>Memo</td>
<td>Meteorological report as issued by Air Services Australia.</td>
</tr>
</tbody>
</table>

5.5. **Results and Discussion**

In this chapter the design of a MS Access relational database capable of storing, managing and processing the necessary information and knowledge for the prototype DSS was presented. The database is designed to store both the data required for understanding, formulating and solving the problem (knowledge base) as well as the problem description and intermediate results (workspace). For example: the Airfields table (tbl_Airfields) which stores pertinent data on airfields forms part of the knowledgebase; whereas the Requests table (tbl_Requests) which stores the data entered by the user for each HEMS request is categorised as part of the workspace.
6. DETAILED DESIGN: MODEL BASE

6.1. Introduction

A decision support system is an intelligent information system based on the functions and models contained within the model base. These are used to perform optimisation, simulation, advanced computations and analysis, which allows the decision support system to supply information and aid the user in decision making. This chapter describes the functions and models contained within the system’s model base.

6.2. Lower Safe Altitude

Primary HEMS missions are time limited for pre-flight planning, with pilots generally taking off within 10 minutes of being notified of a mission. The determination of lower safe altitude for the flight is an important part of this pre-flight planning, since HEMS can be called upon to go virtually anywhere at any time. Scene response missions very rarely occur in established flight paths and manually determining lower safe altitude by consulting World Aeronautical Charts is a time consuming process. The accurate determination of lower safe altitude becomes more important if the pilot encounters IMC and/or the pilot is unfamiliar with the area. The consequences of failing to follow or miscalculating lower safe altitude are not acceptable. Of the 107 American HEMS accidents between 1978 and 1998, Blumen [22] attributes controlled flight into terrain (CFIT) as the cause of 19 (18%) of the accidents.

To determine the lower safe altitude for a flight the geographical elevation data surrounding the flight path is required. The dataset used is the Geoscience Australia Critical Aeronautical Heights 1997 [186]. This dataset covers all of Australia, excluding external territories and comprises of approximately 13,000 records containing the highest points as for each World Aeronautical Chart (WAC) map area. The latitude, longitude and height of each record was imported into the terrain table (see section 5.4.20).

In accordance with Australian regulations [187] the obstacles and terrain considered for determining lower safe altitude must be within an area of 5NM surrounding and including the area defined by lines drawn from the departure point not less than 10.3° each side of the nominal track to a maximum of 30NM for conventional RNAV systems and 7NM for GPS, thence paralleling the track to abeam the destination and converging by a semicircle of 30NM (RNAV) or 7NM (GPS) centred on the destination. Figure 6-1 shows the area to be considered for a route being navigated with GPS from departure point, F, to destination point, T. In order to evaluate the lower safe altitude the decision support software defines this area using points P1, P2, P3, P4, P5, P6 and I for routes greater than 38.52 NM and points P1, P2, P3, P4 for routes equal to or less than 38.52 NM as per Figure 6-1.
Figure 6-1: Lower safe altitude region; (A) for routes greater than 38.52 NM and (B) for routes less than or equal to 38.52 NM.

The lower safe altitude is then determined by the following:

- Where the highest obstacle is more than 360FT above the height determined for terrain, the LSALT must be 1,000FT above the highest obstacle; or
- where the highest obstacle is less than 360FT above the terrain, or there is no charted obstacle, the LSALT must be 1,360FT above the elevation determined for terrain; except that
- where the elevation of the highest terrain or obstacle in the tolerance area is not above 500FT, the LSALT must not be less than 1,500FT.

The methodology (Figure 6-2) developed to determine the lower safe altitude between a specified departure point ($\phi_F, \lambda_F$) and destination point ($\phi_T, \lambda_T$) utilises the geospatial calculation functions (see section 6.7) and the Critical Aeronautical Heights dataset contained in the terrain table (see section 5.4.20).

The VBA code for Lower Safe Altitude determination is given at Appendix D.1.

The Geoscience Australia Critical Aeronautical Heights 1997 dataset [186] used does not differentiate between terrain and obstacles and therefore the methodology developed treats all points as terrain. Thus, if the highest point is an obstacle which is more than 360 feet above the highest terrain then the lower safe altitude determined will be conservative by 360 feet as 1,360 feet will have been added when only 1,000 feet is required.

This model is limited only to Australia by the geographical elevation dataset and with sufficient data the decision support systems ability to determine the lower safe altitude can be extended to provide global coverage.
An important part of flight planning is determining if the mission is within the range of the aircraft or if refuel stops are required. The methodology developed to determine if a refuel stop is required and if so where it is best to refuel is presented in Figure 6-3.
Figure 6-3: Refuel Methodology Flow Chart
In accordance to Air Ambulance Victoria’s operational preferences, the methodology first aims to refuel the aircraft after delivering the patient to the hospital. If this cannot be achieved, the methodology then tries to determine if the aircraft can be refuelled prior to loading the patient. As a last resort the methodology will seek to refuel the aircraft with the patient on-board. Currently, the refuel methodology only allows for one refuel stop to be scheduled. If a resource cannot complete the mission utilising only one re-fuel stop then the system will not display the resource as a viable option for the mission and it cannot be selected by the user.

As presented, the Refuel Function assumes that an aircraft’s range (and therefore specific fuel consumption) is constant. This method of utilising a conservative “constant range” is the commonly used by HEMS flight coordinators and pilots and gives satisfactory results for the purposes of pre-mission analysis.

The VBA code for the Refuel Function is given at AppendixD.2. The range of each aircraft is specified in the aircraft type table (see section 5.4.2) and distances between waypoints are calculated using the distance function (see section 6.7.4). Airfields with refuelling capabilities are specified in the airfields table (see section 5.4.3).

6.4. Closest Airfield

The system is required to routinely determine the closest airfield to any given location. The methodology developed to determine the closest airfield is presented at Figure 6-4. The VBA code for the ClosestAirfield function is given at AppendixD.3.
6.5. **Flight Time**

The time between injury and treatment governs the potential of recovery (see section 2.1.5). An important part of the flight coordinators decision making process is ensuring that the timeframe of the selected approach is appropriate to the needs of the patient (see section 3.5). The system therefore needs to be able to quickly estimate the response time of various resources.

The model to determine the flying time between points is based on the method presently used by the flight coordinators. The aircraft’s cruise speed is used and constants are added to account for both take off and landing and refuelling if required. The VBA code for the \textit{FlightTime} function is given at Appendix D.4.

The aircraft’s cruise speed, take-off and landing and refuel times are specified in the aircraft type table (see section 5.4.2) and the model calculates the distance between waypoints using the distance function (see section 6.7.4).

6.6. **Risk Assessment**

A lack of aviation flight risk evaluation programs for HEMS operations has been highlighted as a recurring safety issue in HEMS accidents (see section 2.1.6). Most operators and crew adopt an informal approach
To risk management, doing it on the run, often using experience and ‘gut feel’ to make decisions (see section 2.1.8).

To standardise risk assessment, the decision support system provides a procedure-weighted model\(^2\) for risk assessment. This risk-assessment is used by the flight coordinator to expand the parameters of decision making and to assist in pre-flight planning and operational control of the aircraft.

In accordance with FAA recommendations [79] the model is implemented within the context that the pilot’s decision to decline, cancel, divert, or terminate a flight overrides any decision of other parties to accept or continue a flight. Only the pilot’s decision to accept a flight may be overridden by the use of the operational control procedures and policies, including risk assessment and management tools (see section 2.1.8).

Developed from FAA Notice N8000.301 [79], the model utilises a checklist format risk assessment tool with numerical weighting values which trigger levels of risk. These levels can then be used to concur with the pilot’s “go” decision or alternatively used to activate operational control procedures to override the pilot’s decision to accept the flight.

The risk factors considered by the risk assessment model and their corresponding numerical weighting values are given in Table 6-1. The levels of risk are defined in Table 6-2.

---

### Table 6-1: Risk Analysis Model –Risk Factors

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFR equipped aircraft.</td>
<td>-4</td>
</tr>
<tr>
<td>Aircraft only equipped for VFR.</td>
<td>+4</td>
</tr>
<tr>
<td>Pilot’s last check ride greater than 6 months.</td>
<td>+2</td>
</tr>
<tr>
<td>Pilot has less than 6 months on current job.</td>
<td>+1</td>
</tr>
<tr>
<td>Pilot has less than 1 year in HEMS.</td>
<td>+1</td>
</tr>
<tr>
<td>Pilot has less than 200 hours in aircraft type.</td>
<td>+1</td>
</tr>
<tr>
<td>Pilot has greater than 500 hours in aircraft type.</td>
<td>-1</td>
</tr>
<tr>
<td>Pilot’s last flight in aircraft type greater than 30 days.</td>
<td>+1</td>
</tr>
</tbody>
</table>

\(^2\) The risk assessment model presented has been developed as a reference only; the author does not endorse its use. There is no “one size fits all” risk assessment tool and each HEMS operator should consider their own operational and environmental needs in developing risk assessment tools and plans.
The crewman or paramedic has less than 1 year experience. +1

Night Flight +1

Pilot’s last night flight in aircraft type greater than 30 days (night requests only). +1

Aircraft is Night Vision Goggles (NVG) equipped. (night requests only). -1

Pilot has had less than 3 NVG flights in the last 120 days. (night requests only, night vision goggle equipped only). +1

---

**Table 6-2: Risk Analysis Model – Levels of Risk**

<table>
<thead>
<tr>
<th>Total Score</th>
<th>Category of Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 4</td>
<td>Normal</td>
</tr>
<tr>
<td>5</td>
<td>High</td>
</tr>
<tr>
<td>≥ 6</td>
<td>Unacceptable</td>
</tr>
</tbody>
</table>

The risk assessment model utilises two main functions, StaticRiskScore and StaticRiskAnalysis. These functions and there support functions are described in sections 6.6.1 – 6.6.12).

### 6.6.1. StaticRiskScore Function

The StaticRiskScore function determines the mission’s category of risk in accordance with Table 6-1 and Table 6-2, for a given resource and estimated mission duration. It relies upon the functions described in sections 6.6.3 to 6.6.12. The VBA code for the StaticRiskScore function is given at Appendix OD.5.

### 6.6.2. StaticRiskAnalysis Function

The StaticRiskAnalysis function returns a string containing a summary of risk factors (see Table 6-1) contributing to the mission’s category of risk (see Table 6-2) for a given resource and estimated mission duration. An example is presented at Figure 6-5. It also relies upon the functions described in sections 6.6.3 to 6.6.12. The VBA code for the StaticRiskAnalysis function is given at Appendix D.6.
6.6.3. ChkCheckRide Function

The ChkCheckRide function queries the Pilots Logbook table (see section 5.4.14) to check if a pilot’s last check ride on a given aircraft type was greater than 6 months ago. It returns a Boolean expression of either true or false. The VBA code for the ChkCheckRide function is given at Appendix D.7.

6.6.4. ChkIFR Function

The ChkIFR function queries the Aircraft Types table (see section 5.4.2) to check if the aircraft is IFR equipped. It returns a Boolean expression of either true or false. The VBA code for the ChkIFR function is given at Appendix D.8.

6.6.5. ChkLastFlight Function

The ChkLastFlight function queries the Pilots Logbook table (see section 5.4.14) to check if a pilot’s last flight in a given aircraft type was greater than 30 days ago. It returns a Boolean expression of either true or false. The VBA code for the ChkLastFlight function is given at Appendix D.9.

6.6.6. ChkLastNightFlight Function

The ChkLastNightFlight function queries the Pilots Logbook table (see section 5.4.14) to check if a pilot’s last night flight in a given aircraft type was greater than 30 days ago. It returns a Boolean expression of either true or false. The VBA code for the ChkLastNightFlight function is given at Appendix D.10.

6.6.7. ChkMedCrew Function

The ChkMedCrew function queries the Crewman and Paramedics tables (see sections 5.4.5 and 5.4.12) to check if either the specified crewman or paramedic have less than 1 year experience. It returns a Boolean expression of either true or false. The VBA code for the ChkMedCrew function is given at Appendix D.11.
6.6.8. ChkNVG Function

The ChkNVG function queries the Aircraft Types table (see section 5.4.2) to check if the aircraft is NVG equipped. It returns a Boolean expression of either true or false. The VBA code for the ChkNVG function is given at Appendix D.12.

6.6.9. ChkNVGFlights Function

The ChkNVGFlights function queries the Pilots Logbook table (see section 5.4.14) to check if a pilot’s has had 3 or more NVG flights in the past 120 days. It returns a Boolean expression of either true or false. The VBA code for the ChkNVGFlights function is given at Appendix D.13.

6.6.10. ChkPilotCurrentJob Function

The ChkPilotCurrentJob function queries the Pilot table (see section 5.4.13) to check if a pilot’s has Pilot has less than 6 months on their current job. It returns a Boolean expression of either true or false. The VBA code for the ChkPilotCurrentJob function is given at Appendix D.14.

6.6.11. ChkPilotEMS Function

The ChkPilotEMS function queries the Pilot table (see section 5.4.13) to check if a pilot’s has Pilot has less than 1 year experience in flying HEMS operations. It returns a Boolean expression of either true or false. The VBA code for the ChkPilotEMS function is given at Appendix D.15.

6.6.12. GetHours Function

The GetHours function queries the PilotLogBook table (see section 5.4.14) and returns the number of hours for a given pilot and aircraft type. The VBA code for the GetHours function is given at Appendix D.16.

6.7. Geospatial Calculation Functions

There are several mathematical expressions to calculate accurate geodetic positions, azimuths and distances on the ellipsoid. Vincenty’s formulae may be used for lines ranging from a few centimetres to nearly 20,000 km, with millimetre accuracy. The formulae have been extensively tested for the Australian region, by comparison with results from other formulae [188].
Redfearn’s formulae may be used to convert between latitude and longitude and easting, northing and zone for a Transvers Mercator projection, such as Map Grid of Australia (MGA). These formulae are accurate to better than 1 mm in any zone of the MGA and for the purpose of definition may be regarded as exact [188].

6.7.1. Azimuth

The *Azimuth* function determines the forward azimuth in radians between two points \((\phi_1, \lambda_1)\) and \((\phi_2, \lambda_2)\) using Vincenty’s Inverse formulae (Appendix C.2). The VBA code for the *Azimuth* function is given at Appendix D.17.

6.7.2. Converting from MGA to latitude and longitude

The *GridtoGeo_lat* function uses Redfearn’s formulae (Appendix C.4) to determine the latitude of a point given its easting, northing and zone for a Transverse Mercator projection. The VBA code for the *GridtoGeo_lat* function is given at Appendix D.18.

The *GridtoGeo_lon* function uses Redfearn’s formulae (Appendix C.4) to determine the longitude of a point given its easting, northing and zone for a Transverse Mercator projection. The VBA code for the *GridtoGeo_lon* function is given at Appendix D.19.

6.7.3. Determining the latitude and longitude of a second point

The *lat_point* function uses Vincenty’s Direct formulae (Appendix C.3) to determine the latitude of a second point \((\phi_2)\) given an initial point \((\phi_1, \lambda_1)\), a forward azimuth in radians \((\alpha_{1-2})\) and a distance in nautical miles. The VBA code for the *lat_point* function is given at Appendix D.20.

The *lon_point* function uses Vincenty’s Direct formulae (Appendix C.3) to determine the longitude of a second point \((\lambda_2)\) given an initial point \((\phi_1, \lambda_1)\), a forward azimuth in radians \((\alpha_{1-2})\) and a distance in nautical miles. The VBA code for the *lon_point* function is given at Appendix D.21.

The *lat_point* and *lon_point* functions are used extensively by the lower safe altitude determination function (see section 6.2)

6.7.4. Distance

The *DistanceNM* function calculates the ellipsoidal distance in nautical miles between two points \((\phi_1, \lambda_1)\) and \((\phi_2, \lambda_2)\) using Vincenty’s Inverse formulae (Appendix C.2). The VBA code for the *DistanceNM* function is given at Appendix D.22.
6.8. Database Query Functions

Queries can be used to view, change, and analyze data in different ways. The system utilizes numerous different queries, the most common of which are programmed as functions.

6.8.1. GetAC Function

The GetAC function queries the Resources and AircraftTypes tables (sections 5.4.16 and 5.4.2) and returns the aircraft make for a given resource. The VBA code for the GetAC function is given at Appendix D.23.

6.8.2. GetAFCode Function

The GetAFCode function queries the Airfields table (see section 5.4.3) and returns the unique 4 letter airfield identifier of the airfield with the corresponding latitude and longitude. The VBA code for the GetAFCode function is given at Appendix D.24.

6.8.3. GetAirfieldAlt Function

The GetAirfieldAlt function queries the Airfields table (see section 5.4.3) and returns the altitude AMSL of the airfield with the corresponding unique 4 letter airfield identifier. The VBA code for the GetAirfieldAlt function is given at Appendix D.25.

6.8.4. GetAirfieldLat Function

The GetAirfieldLat function queries the Airfields table (see section 5.4.3) and returns the latitude of the airfield with the corresponding unique 4 letter airfield identifier. The VBA code for the GetAirfieldLat function is given at Appendix D.26.

6.8.5. GetAirfieldLon Function

The GetAirfieldLon function queries the Airfields table (see section 5.4.3) and returns the longitude of the airfield with the corresponding unique 4 letter airfield identifier. The VBA code for the GetAirfieldLon function is given at Appendix D.27.
6.8.6. GetCrewName Function

The GetCrewName function queries the Crewman table (see section 5.4.5) and returns a string containing the surname and given name of the crewman for a given Crewman ID. The VBA code for the GetCrewName function is given at Appendix D.28.

6.8.7. GetHLSAlt Function

The GetHLSAlt function queries the Helipads table (see section 5.4.7) and returns the altitude AMSL of the helipad with the corresponding unique helipad name. The VBA code for the GetHLSAlt function is given at Appendix D.29.

6.8.8. GetHLSCode Function

The GetHLSCode function queries the Helipads table (see section 5.4.7) and returns the unique name of the helipad with the corresponding latitude and longitude. The VBA code for the GetHLSCode function is given at Appendix D.30.

6.8.9. GetMET Function

The GetMET function queries the Weather Reports table (see section 0) and returns the meteorological report as issued by Air Services Australia for a given area/location (Figure 6-6). The VBA code for the GetMET function is given at Appendix D.31.

BENDIGO (YBDG)
RAIM GPS RAIM PREDUCTION 211401
YBDG
TSO-C129 (AND EQUIVALENT)
FAULT DETECTION
NO GPS RAIM FD OUTAGES FOR NPA
TSO-C146A (AND EQUIVALENT)
FAULT DETECTION
NO GPS RAIM FD OUTAGES FOR NPA
FAULT DETECTION AND EXCLUSION
04240518 TIL 04240523
GPS RAIM FDE UNAVBL FOR NPA

TAF TAF YBDG 220012Z 220214 18016G28KT 9999 SCT030 SCT050 FM11 17014KT 9999 SCT040 RMK T 18 20 17 14 Q 1021 1020 1021 1022

METAR METAR YBDG 220530Z AUTO 16013KT /// / / / / / / / / 20/09 Q1021 RMK RF00.0/000.0

Figure 6-6: Example GetMET return for Bendigo.
6.8.10. GetNOTAM Function

The *GetNOTAM* function queries the NOTAM table (see section 5.4.11) and returns any NOTAMs as issued by Air Services Australia for a given area/location (*Figure 6-7*). The VBA code for the *GetNOTAM* function is given at Appendix D.32.

![Figure 6-7: Example GetNOTAM return for Bendigo.](image)

6.8.11. GetParaName Function

The *GetParaName* function queries the Paramedics table (see section 5.4.12) and returns a string containing the surname and given name of the paramedic for a given Paramedic ID. The VBA code for the *GetParaName* function is given at Appendix D.33.

6.8.12. GetPilotName

The *GetPilotName* function queries the Pilot table (see section 5.4.3) and returns a string containing the surname and given name of the pilot for a given Pilot ID. The VBA code for the *GetPilotName* function is given at Appendix D.34.

6.8.13. GetRequestDate Function

The *GetRequestDate* function queries the Requests table (see section 5.4.15) and returns a the Date/Time a given request was received. The VBA code for the *GetRequestDate* function is given at Appendix D.35.

The *HasFuel* function queries the Airfields table (see section 5.4.3) and returns yes/no regarding the availability of fuel for a given latitude and longitude. The VBA code for the *HasFuel* function is given at Appendix D.36.

6.9. **Trigonometric Functions**

A number of the DSS functions and models require and make use of additional trigonometric functions which are not intrinsic to MS Access and VBA. These additional functions are detailed as follows:

6.9.1. **Convert Degrees to Radians**

The *ToDeg* function converts from radians to degrees and the VBA code is given at Appendix D.37.

6.9.2. **Convert Radians to Degrees**

The *ToRad* function converts from degrees to radians and the VBA code is given at Appendix D.38.

6.9.3. **Four-quadrant inverse tangent**

The *Atan2* function computes, in radians, the arctangent of the argument *y/x* within the range of $-\pi$ to $\pi$. The VBA code for the *Atan2* function is given at Appendix D.39.

6.9.4. **Inverse Cosine**

The *Acos* function computes the inverse cosine (arccosine) of the argument in radians. The VBA code for the *Acos* function is given at Appendix D.40.

6.9.5. **Inverse Sine**

The *Asin* function computes the inverse sine (arcsine) of the argument in radians. The VBA code for the *Asin* function is given at Appendix D.41.

6.9.6. **Secant**

The *Sec* function computes the secant of the argument in radians. The VBA code for the *Asin* function is given at Appendix D.42.
6.10. Miscellaneous functions

The following minor functions described below are not readily grouped elsewhere.

6.10.1. LatFormat Function

The *LatFormat* function is used to format latitude values into degrees, minutes, seconds and North/South. i.e. a latitude of -37.7283° becomes 36°43′42″ S. The VBA code for the *LatFormat* function is given at Appendix D.43.

6.10.2. LonFormat Function

The *LonFormat* function is used to format longitude values into degrees, minutes, seconds and East/West i.e. a longitude of 144.9016° becomes 144°54′06″ E. The VBA code for the *LonFormat* function is given at Appendix D.44.

6.10.3. RosterDate Function

The system is designed around a two shift roster, 0800-1800 and 1800-0800. As such the second shift extends across two days. The *RosterDate* function determines which days roster is in effect at a given time. The VBA code for the *RosterDate* function is given at Appendix D.45.

6.10.4. Shift Function

The *Shift* function determines which shift it is for a given hour of the day. The system is designed around a two shift roster, 0800-1800 and 1800-0800, or shift 1 and 2 respectively. The VBA code for the *YesNo* function is given at Appendix D.46.

6.10.5. YesNo Function

The *YesNo* function is used to format Boolean data into a string containing either “Yes” or “No” so that information can be accurately displayed and printed. The VBA code for the *YesNo* function is given at Appendix D.47.

6.11. Results and Discussion

In this chapter the design and development of a comprehensive model base tailored for the pre-mission analysis of HEMS operations was presented. The functions and models contained within this model base
were specifically considered to perform the necessary optimisation, simulation, advanced computations and analysis required to enable the prototype DSS to supply information and aid the user in the decision making process.

A major component of the model base is the risk assessment tool. This was developed to address the critical lack of aviation flight risk evaluation programs for HEMS operations. It is based on a checklist format risk assessment, with numerical weighting values which trigger levels of risk. It is expected that these levels will be used by the user to concur with the pilot’s “go” decision or alternatively to activate operational control procedures to override the pilot’s decision to accept the flight.

It is important to note that the risk factors and corresponding numerical weighting values considered by model were developed as a generic basis on which to demonstrate the prototype DSS. Each HEMS operator should consider their own operational and environmental needs in tailoring the risk assessment model.

The accuracy of the models and functions contained in the model base is dependent upon the information contained and entered into the DSS’s database. An example of this is the flight time model. This model, based on the method presently used by the flight coordinators, divides the distance by the aircraft’s cruise speed and adds aircraft specific constants to account for refuelling and take-off and landings. Thus, the database must contain accurate values for an aircraft’s cruise speed, take-off and landing time and refuelling time in order to ensure the usefulness and accuracy of the model.

Whilst there is potential scope to develop more detailed and complex models to try and improve accuracy, the benefits of such must be clear. An example of this is the refuel model which assumes that an aircraft’s range is constant and thus utilises a stored value in the DSS database. Utilising a conservative “constant range” is the method most commonly used by HEMS flight coordinators and pilots and gives satisfactory results for the purposes of pre-mission analysis.

To develop a more accurate model for an aircraft’s range, the model would need to determine the aircraft’s fuel consumption. Fuel consumption is a function of, amongst other things, true air speed, pressure altitude, temperature and weight. The problem is that these variables cannot be accurately determined, modelled, measured or predicted for the duration of a mission. Thus, the more detailed model is of no use due to the inherent and compounding error in utilising incomplete, vague and imprecise data.
7. DETAILLED DESIGN: GRAPHICAL USER INTERFACE

7.1. Introduction

The user interface is the key component of a DSS as it provides flexibility and ease of operation [168]. The GUI covers all aspects of communication between the user and the system. The GUI interacts with the database (see Chapter 5) and model base (see Chapter 6). It allows the user to enter data or modify data and run and view the results of the models and functions.

The developed GUI for the system comprises of 4 forms (screens): Workspace, New Request, Select Hospital and Select Resource. The workspace is the primary interface for the system, with the other forms being accessed when required (Figure 7-1). The details of the forms is as follows:

![Figure 7-1: GUI Layout]

7.2. Workspace Form

The ‘workspace’, which is the primary screen of the DSS is presented in Figure 7-2. On this screen the user can view requests, missions and mission progress, initiate a new request or mission, modify case or mission notes and record the status of requests and missions. The functionality provided on this form is summarised in Table 7-1 and the supporting VBA code is at Appendix E.1.
Figure 7-2: Workspace
<table>
<thead>
<tr>
<th>Item</th>
<th>Object</th>
<th>Function/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Requests List box</td>
<td>This list box displays all pending requests stored in the Requests table (see section 5.4.15) and allows the user to select a request. It does not display cancelled, declined or accepted requests.</td>
</tr>
<tr>
<td>B</td>
<td>New Request Button</td>
<td>Allows the user to register a new request by opening the ‘New Request’ form (see section 7.3).</td>
</tr>
<tr>
<td>C</td>
<td>Cancel Request Button</td>
<td>Allows the user to record that the selected request has been cancelled by the requesting authority. This is recorded in the corresponding record in the Requests table (see section 5.4.15).</td>
</tr>
<tr>
<td>D</td>
<td>Decline Request Button</td>
<td>Allows the user to record that the request has been declined. This is recorded in the corresponding record in the Requests table (see section 5.4.15).</td>
</tr>
<tr>
<td>E</td>
<td>Plan Mission Button</td>
<td>Allows the user to plan a mission for the selected request. For primary missions the button will open the ‘Select Receiving Hospital’ form (see section 7.4) and for an IHT mission the button populates the Select Resource table (see section 5.4.18) and then opens the ‘Select Resource’ form (see section 7.5).</td>
</tr>
<tr>
<td>F</td>
<td>Case Notes Text Box</td>
<td>This text box displays and allows changes to the case notes field for a selected request’s record in the Requests table (see section 5.4.15).</td>
</tr>
<tr>
<td>G</td>
<td>Missions List box</td>
<td>This list box displays all active missions from the Missions table (see section 5.4.10) and allows the user to select a mission. It does not display cancelled, aborted or completed missions.</td>
</tr>
<tr>
<td>H</td>
<td>Mission Profile Button</td>
<td>Displays a printable report detailing the mission and its flight plan. This report includes aircraft and crew data, waypoints, distances, azimuths, lower safe altitudes, a risk assessment, meteorological reports and NOTAMs. An example report is presented at Appendix F.</td>
</tr>
<tr>
<td>I</td>
<td>Mission Complete button</td>
<td>Allows the user to record that the selected mission has been completed. This is recorded in the corresponding record in the Missions table (see section 5.4.10).</td>
</tr>
<tr>
<td>J</td>
<td>Cancel Mission button</td>
<td>Allows the user to record that the selected mission has been cancelled by the requesting authority. This is recorded in the corresponding record in the Missions table (see section 5.4.10).</td>
</tr>
</tbody>
</table>
Table 7-1: Functionality of the ‘Workspace’ form

<table>
<thead>
<tr>
<th>Item</th>
<th>Object</th>
<th>Function/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>Abort Mission Button</td>
<td>Allows the user to record that the selected mission has been aborted. This is recorded in the corresponding record in the Missions table (see section 5.4.10). It also activates a message box asking the user if they wish for the missions corresponding request to remain active. Selecting ‘yes’ sets the request records accepted field to false, allowing it to be displayed again in the Requests list box.</td>
</tr>
<tr>
<td>L</td>
<td>Mission Waypoint Labels</td>
<td>Displays the waypoints of the selected mission from the corresponding records in the Waypoints table (see section 5.4.21).</td>
</tr>
<tr>
<td>M</td>
<td>Arrived Check boxes</td>
<td>Allows the user to record the aircrafts arrival against each of the displayed mission waypoints. This is recorded in the corresponding record in the Waypoints table (see section 5.4.21). Recording arrival at the final waypoint records that the selected mission has been completed. As per the ‘Mission Complete’ command button.</td>
</tr>
<tr>
<td>N</td>
<td>Departed Check boxes</td>
<td>Allows the user to record the aircrafts departure from each of the displayed mission waypoints. This is recorded in the corresponding record in the Waypoints table (see section 5.4.21).</td>
</tr>
<tr>
<td>O</td>
<td>Mission Notes Text box</td>
<td>This text box displays and allows changes to the mission notes field for a selected mission’s record in the Missions table (see section 5.4.10).</td>
</tr>
</tbody>
</table>

7.3. New Request Form

The New Request Form (Figure 7-3) allows the user to record new aeromedical request. The flight coordinator, date and time are automatically recorded and displayed in the top left. The user can choose to either record a scene/primary response or inter-hospital transfer request by selecting the corresponding option button.

A scene/primary response requires the user to select a corresponding case number for the request and enter the scene location. When a case number (see sections 3.5, 5.4.4 and Appendix A.1) is selected from the drop down box, the default receiving hospital is recorded and the brief case description from the case type table (see section 05.4.4) is automatically entered into the notes section. If either case number 30, 31 or 32 is selected the user is prompted with a dialogue box (Figure 7-4), to enter a description of the case, which is then recorded in the notes section. The user has three options when recording the scene location and these are recorded by selecting the corresponding option button. If known, the user may enter either
the latitude and longitude or the Map Grid of Australia (MGA) reference. The third option is to select the
general locality (see section 5.4.9) of the scene from the drop down box. This option should only be used
when the exact location of the scene is not known. If a locality or MGA reference is entered, the system
records only the corresponding latitude and longitude (see sections 5.4.9 and 6.7.2).

An inter-hospital request requires the user to select the requesting and destination hospitals from the
Hospitals table (see section 5.4.8) using the corresponding drop down boxes. The user is also prompted
with a dialogue box (Figure 7-4) to enter a description of the case, which is then recorded in the notes
section.

The notes section provided at the bottom of the form displays the case description and allows the user to
record any other pertinent information relating to the request. The log button records the new request as a
new record in the Requests table (see section 5.4.15). The cancel button closes the form, returns the user
to the ‘Workspace’ form (see section 7.2) and does not record a new request. The functionality provided
on this form is summarised in Table 7-2. The VBA code supporting this form is at Appendix E.2.

![Figure 7-3: New Request Form](image-url)
Figure 7-4: Case description dialogue box.

Table 7-2: Functionality of the ‘New Request’ form

<table>
<thead>
<tr>
<th>Item</th>
<th>Object</th>
<th>Function/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Received By/At Labels</td>
<td>Automatically displays and records the rostered flight coordinator (see section 5.4.17) responsible for recording the request and the date and time of the request.</td>
</tr>
<tr>
<td>B</td>
<td>Mission Type Option Buttons ( Scene Response / Interhospital Transfer)</td>
<td>Records the type of mission and activates the corresponding objects on the ‘New Request’ form required for that type of request.</td>
</tr>
<tr>
<td>C</td>
<td>Case Number Combo Box</td>
<td>Only required for scene/primary response requests. The user selects the case number (see section 3.5 and Appendix A.1) from the case type table (see section 5.4.4) that corresponds to the request. If case numbers 30, 31 or 32 are selected the user is prompted with a dialogue box (Figure 7-4), and is required to enter a case description which is then recorded in the Notes Text Box (M). For all other case numbers the corresponding case description from the Case Type table (see section 5.4.4) is recorded in the Notes Text Box (M).</td>
</tr>
<tr>
<td>D</td>
<td>Scene Location Option Buttons ( Lat Long/ Map Ref / Locality)</td>
<td>Only for scene/primary response requests. It activates the corresponding objects on the ‘New Request’ form required to enter the scene location in the selected format. The user can select to specify the scene location by either entering the latitude and longitude of the scene, the Map Grid of Australia (MGA) reference or the nearest locality from the Localities table (see section 5.4.9).</td>
</tr>
</tbody>
</table>
| E/F  | Latitude/Longitude Text Box | Only for scene/primary response requests when the user has selected to record the scene location by specifying latitude and longitude. The user the enters latitude and longitude into the corresponding fields in a decimal format, i.e. -37.7283° not
Table 7-2: Functionality of the ’New Request’ form

<table>
<thead>
<tr>
<th>Item</th>
<th>Object</th>
<th>Function/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>36°43’42” S.</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Zone Combo Box</td>
<td>Only for scene/primary response requests when the user has selected to record the scene location by MGA reference. The user selects the applicable zone (50;51;52;53;54;55;56;57) from the combo box.</td>
</tr>
<tr>
<td>H/I</td>
<td>Northing/Easting Text Box</td>
<td>Only for scene/primary response requests where the user has selected to record the scene location by MGA reference. The user enters northing and easting (in metres) into the corresponding fields.</td>
</tr>
<tr>
<td>J</td>
<td>Locality Combo Box</td>
<td>Only for scene/primary response requests when the user has selected to record the scene location by Locality. The user selects the locality from the localities table (see section 5.4.9) nearest the scene.</td>
</tr>
<tr>
<td>K/L</td>
<td>Requesting Hospital / Destination Hospital Combo Boxes</td>
<td>Only for IHT requests. The user specifies the requesting/destination hospital from the hospitals table (see section 5.4.8) using the corresponding combo box.</td>
</tr>
<tr>
<td>M</td>
<td>Notes Text Box</td>
<td>Displays the case description and allows the user to record other pertinent information relating the request.</td>
</tr>
<tr>
<td>N</td>
<td>Cancel Button</td>
<td>Closes the ‘New Request’ form and returns the user to the ‘Workspace’, without recording the request.</td>
</tr>
<tr>
<td>O</td>
<td>Log Button</td>
<td>Closes the ‘New Request’ form, and records the request as a new record in the Requests table (see section 5.4.15).</td>
</tr>
</tbody>
</table>
7.4. **Select Receiving Hospital Form**

The Select Receiving Hospital Form is presented in Figure 7-5. This form is displayed when the user selects a scene/primary request on the Workspace form and clicks the ‘Plan Mission’ button (see section 7.2). The form displays, in order of distance from the scene, each hospital from the hospitals table (see section 5.4.8) and allows the user to specify the receiving hospital for the potential scene response mission. The default hospital corresponding to the requests case number (see section 05.4.4) is initially selected. The select button records the selected hospital, populates the Select Resource table (see section 5.4.18) and opens the select resource form (see section 7.5). The VBA code supporting this form is at Appendix E.3.

### Figure 7-5: Select Receiving Hospital Form

The Select Receiving Hospital Form is presented in Figure 7-5. This form is displayed when the user selects a scene/primary request on the Workspace form and clicks the ‘Plan Mission’ button (see section 7.2). The form displays, in order of distance from the scene, each hospital from the hospitals table (see section 5.4.8) and allows the user to specify the receiving hospital for the potential scene response mission. The default hospital corresponding to the requests case number (see section 05.4.4) is initially selected. The select button records the selected hospital, populates the Select Resource table (see section 5.4.18) and opens the select resource form (see section 7.5). The VBA code supporting this form is at Appendix E.3.

### 7.5. **Select Resource Form**

The Select Resource Form is presented in Figure 7-6. This form is accessed from either the workspace or select receiving hospital forms (see sections 7.2 and 7.4) and allows the user to analyse possible responses to the request and initiate a mission by assigning a resource to the request. The VBA code supporting this form is at Appendix E.4.
Each viable resource for responding to the request is displayed at the top of the form in a list box along with the following information accessed from the Select Resource table (see section 5.4.18):

- **Base**: The airfield at which the resource is based (see section 5.4.16);
- **Time to Scene**: The flight time in minutes, between the resources base and the scene (or requesting hospital in the case of an IHT request) as determined by the flight time model (see section 6.5);
- **Time to Hospital**: The flight time in minutes, between the resources base, scene (requesting hospital for IHT requests) and the hospital (destination hospital for IHT requests) as determined by the flight time model (see section 6.5), it does not include the time spent attending to the patient at the scene (or requesting hospital);
- **Total Distance**: The total distance in nautical miles, between all of the waypoints defining the mission (see section 6.7.4).
- **Total Time**: The flight time in minutes, between all the waypoints defining the mission as determined by the flight time model (see section 6.5). It does not include the time spent attending to the patient at either the scene or hospital;
- **Road Transport Required**: Yes/No if the resource is unable to land directly at either the scene or hospital and additional ground transportation needed;
- **Refuel**: Yes/No if the resource is required to refuel in order to complete the mission; and
- **Risk**: The level of risk of the proposed resource response as determined by the risk analysis model (see section 6.6).
When the user clicks on one of the resources listed in the list box, the form displays down the left hand side the following information regarding the proposed mission’s waypoints:

- **Name:** The name of the waypoint. Depending upon the type of waypoint this will either be “Scene”, the unique airfield identifying code or the unique helipad name. The name is followed by the type of waypoint. Either “Airfield”, “Unprepared HLS” or “Prepared HLS”. In the case of an unprepared HLS this will also include (in brackets) the distance to the closest airfield. To illustrate – “Unprepared HLS (2NM From YECH)”. If a fixed wing aircraft is responding to a scene response, then for the waypoint nearest the scene the distance to the scene is also included – “Airfield (2NM From Scene)”;
- **Latitude:** The latitude in degrees, minutes, seconds of the waypoint;
- **Longitude:** The longitude in degrees, minutes, seconds of the waypoint;
- **Elevation:** The elevation AMSL in feet of the waypoint if known;
- **Refuel:** Yes/No if the resource is required to refuel at the waypoint as determined by the refuel model (see section 6.3);
- **Distance:** The distance to the next waypoint as determined by the distance function (see section 6.7.4);
- **Time:** The flight to the next waypoint as determined by the flight time model (see section 6.5);
- **Bearing:** The azimuth to the next waypoint as determined by the azimuth function (see section 6.7.1);
- **Lower Safe Altitude:** The lower safe altitude as determined by the lower safe altitude model (see section 6.2);

Meteorological reports and NOTAMs relevant to the proposed flight plan and a risk analysis (see section 6.6) of the potential mission are displayed on the right hand side of the form. These are accessed by clicking on the relevant tab.

The assign resource button initiates a mission by assigning the selected resource to the request and returns the user to the Workspace (see section 7.2). Details of the new mission and its waypoints are recorded as new records in the Missions and Waypoints tables (see sections 5.4.10 and 5.4.21) and the request’s record in the requests table is updated to reflect the accepted status (see section 5.4.15).

The cancel button, does not assign a resource to the request and returns the user to the Workspace (see section 7.2)

### 7.6. Results and Discussion

In this chapter the design and development of the GUI for the prototype DSS was presented. The GUI design was based around the flight coordinator’s naturally preferred strategy and was developed to be work-centred. Emphasis was placed on ensuring the GUI did not restrict or hamper the operator from taking advantage of their abilities to reason, improvise, and respond.

These approaches lead to the ‘workspace’ being designed as the primary screen of the DSS. From here the user can view requests, missions and mission progress, initiate a new request or mission, modify case or
mission notes and record the status of requests and missions. It is from this screen the user access the other
3 screens (‘new request’, ‘select hospital’ and ‘select resource’) as required.

The ‘new request’ screen is accessed by the user to record the details of a new aeromedical request. The
user can enter both primary scene response and IHT requests with the GUI prompting for only those
details relevant to type of request being recorded.

The ‘select hospital’ screen is accessed by the user when planning a HEMS response to a primary scene
response request and is used to select the receiving hospital for the request.

The ‘select resource’ screen is accessed by the user when planning a HEMS response to both primary
scene response and IHT requests. This component of the GUI displays the DSS’s analysis of suitable
resources and is used to initiate a mission by assigning a selected resource to a request.

It is the intent that the prototype DSS will serve as a baseline for future analysis, research and
development. Only components of the GUI required to demonstrate the DSS concept were developed.
Thus, a custom GUI to input, modify and delete data from the knowledge base was not pursued. Instead
the standard MS Access interface is used.
8. SYSTEM VALIDATION: CASE STUDY

8.1. Introduction

The nucleus of the pre-mission analysis of HEMS operations problem was defined in Chapter 4 as supporting the user in safely and effectively utilising HEMS resources during the phases of resource allocation and pre-flight planning. Subsequently, the pre-mission analysis of HEMS operations problem was characterised and a DSS architecture and framework developed.

This framework was further investigated and developed in Chapters 5, 6 and 7 which presented the design and development of the database, model base and GUI necessary to transform the conceptual design into a prototype system. This Chapter validates the prototype DSS’s ability to assist flight-coordinators and crew in the decision-making processes faced prior to HEMS operations through a case study.

8.2. Database

To validate the prototype DSS and demonstrate its general functionality, the tables within the database used to store information required for understanding, formulating and solving the pre-mission analysis problem were populated as follows:

8.2.1. Aircraft Types Table (tbl_AircraftTypes)

The Aircraft Types Table (tbl_AircraftTypes) was populated with the example data at Appendix G.1.

8.2.2. Airfields table (tbl_Airfields)

The Airfields table (tbl_Airfields) was populated with the example data at Appendix G.2.

8.2.3. Case Type Table (tbl_CaseType)

The Case Type Table (tbl_CaseType) was populated with the example data at Appendix G.3.

8.2.4. Crewman Table (tbl_Crewman)

The Crewman Table (tbl_Crewman) was populated with the example data at Appendix G.4.
8.2.5. Flight Coordinator Table (tbl_FlightCoord)

The Flight Coordinator Table (tbl_FlightCoord) was populated with the example data at Appendix G.5.

8.2.6. Helipads Table (tbl_Helipads)

The Helipads Table (tbl_Helipads) was populated with the example data at Appendix G.6.

8.2.7. Hospitals Table (tbl_Hospitals)

The Hospitals Table (tbl_Hospitals) was populated with the example data at Appendix G.7.

8.2.8. Localities Table (tbl_Localities)

The Localities Table (tbl_Localities) was populated with the example data at Appendix G.8.

8.2.9. NOTAMs Table (tbl_NOTAMs)

The NOTAMs Table (tbl_NOTAMs) was populated with example NOTAMs (Appendix G.9) extracted from the Air Services Australia’s online AIS/MET System.

8.2.10. Paramedics Table (tbl_Paramedics)

The Paramedics Table (tbl_Paramedics) was populated with the example data at Appendix G.10.

8.2.11. Pilot Table (tbl_Pilot)

The Pilot Table (tbl_Pilot) was populated with the example data at Appendix G.11.

8.2.12. Pilot Logbook Table (tbl_PilotLogBook)

The Pilot Logbook Table (tbl_PilotLogBook) was populated with the example data at Appendix G.12.

8.2.13. Resources Table (tbl_Resources)

The Resources Table (tbl_Resources) was populated with the example data at Appendix G.13.
8.2.14. Roster Table (tbl_Roster)

The Roster Table (tbl_Roster) was populated with the example data at Appendix G.14.

8.2.15. Terrain Table (tbl_Terrain)

The Terrain Table (tbl_Terrain) was populated with data from the Geoscience Australia Critical Aeronautical Heights 1997 dataset [186]. An extract is at Appendix G.15.

8.2.16. Weather Reports Table (tbl_WReports)

The Weather Reports Table (tbl_WReports) was populated with example MET reports (Appendix G.16) extracted from the Air Services Australia’s online AIS/MET System.

8.3. Case Study

A case study was used to validate the prototype DSS and demonstrate its general functionality. The case study involved utilising the prototype DSS to support the pre-mission analysis of two example aeromedical requests:

- Request #1
  - Type of Request: IHT
  - Requesting Hospital: Mildura Hospital
  - Receiving Hospital: Royal Melbourne Hospital
  - Description: 27yo Female, Expected complicated pregnancy.

- Request #2
  - Type of Request: Scene Response (Primary)
  - Location: 32.7S 145.72E
  - Case Number: 22
  - Description: Traffic accident, ped/M’cycle, bike

8.3.1. Recording the requests

Upon starting the system, the user is presented with the Workspace Form (Figure 8-1).
Clicking on the New Request button takes the user to the New Request Form which is used to record the details of the IHT request (Figure 8-2).
Clicking on the Log Button records the IHT request and returns the user to the Workspace Form where the pending IHT request is displayed at the top right of the screen (Figure 8-3).

![Figure 8-3: Workspace form showing the pending IHT request.](image)

Clicking on the New Request Button takes the user to the New Request Form which is used to record the details of the primary request (Figure 8-4).

![Figure 8-4: New request form showing user entering details for the scene response request.](image)
Clicking the Log Button records the primary request and returns the user to the Workspace Form. Both pending requests are now displayed at the top right of the screen (Figure 8-5).

![Workspace form showing pending IHT and Primary requests.](image)

**Figure 8-5: Workspace form showing pending IHT and Primary requests.**

### 8.3.2. Planning the Primary Mission

Selecting the primary request from the list and clicking the Plan Mission Button takes the user to the Select Hospital Form. This displays all hospitals in order of distance from the scene and the default hospital for the recorded case type is automatically selected (Figure 8-6).

It is at this point that the user needs to use their judgment to select the most appropriate hospital for the patient. In this case study, the user finds the Alfred Hospital is most suited to the patients needs. Clicking the Select Button records the selected hospital as the receiving hospital for the mission and displays the Select Resource Form (Figure 8-7).
Figure 8.6: Select hospital form with the default receiving hospital selected.

Figure 8.7: Select resource form showing the prototype DSS analysis for the Primary
At this point in the process the user must use their judgment and the analysis provided by the DSS to select the most appropriate resource for the mission. In this case the analysis shows that all seven resources (four fixed wing and three helicopters) are available to conduct the mission. For a fixed wing response the analysis shows that closest airfield to the scene of the accident is 21 nautical miles away. The user rules out sending a fixed wing aircraft due to the additional transport time that will be required to transport the patient by road over this distance.

This leaves the user with the three helicopter resources (HEMS1, HEMS2 and HEMS3) from which to choose. The analysis shows that the level of risk for each helicopter response is normal and the user therefore bases the decision on the estimated flight time of each helicopter.

The flight times for HEMS 1 are the shortest (31 minutes from base to scene, 32 minutes from scene to hospital and 13 minutes from hospital back to base) compared to HEMS 2 (45 minutes from base to scene, 36 minutes from scene to hospital and 115 minutes from hospital back to base) and HEMS 3 (46 minutes from base to scene, 36 minutes from scene to hospital and 116 minutes from hospital back to base). Based on this analysis the user selects HEMS 1 as the most appropriate aircraft. This is because the shorter response time will improve the potential of recovery for the patient and the shorter overall flight time will mean that HEMS 1 is back at base and available for another mission.

Selecting HEMS 1 from the list and clicking the Assign Resource Button records the mission in the DSS and takes the user to the Workspace Form (Figure 8-8).

![Figure 8-8: Workspace form showing pending IHT and planned primary mission.](image)

The Workspace Form now displays only the IHT request as pending and the Primary request is displayed as a planned mission in the lowered portion of the screen.
Selecting the primary mission and clicking the Mission Profile, displays a printable report detailing the mission and its flight plan (Appendix H.1). This report is then given by the user to the pilot and crewmen to review and incorporate into their ADM before commencing the mission.

8.3.3. Planning the IHT Mission

Selecting the IHT request and clicking the Plan Mission Button on the Workspace Form takes the user straight to the Select Resource Form which displays the prototype DSS’s analysis for the proposed mission (Figure 8-9).

![Select Resource Form](image)

**Figure 8-9: Select resource form showing the prototype DSS analysis for the IHT request.**

Once again the user must use their judgment and the analysis provided by the DSS to select the most appropriate resource for the mission. In this analysis it shows that only the four fixed wing resources are available to conduct the mission. This is due to HEMS 1 being currently assigned to the primary mission and HEMS 2 and 3 both requiring more than one refuelling stop to complete the mission. As the four fixed wing aircraft are all based at Essendon, it is of little consequence which one the user selects. Selecting

---

3 If HEMS 1 were available the user would be presented with the select resource form shown in Appendix H.3. From this the user would be required to use their judgment of the available analysis to select the most appropriate resource.
FW4 from the list and clicking the Assign Resource Button records the mission in the DSS and takes the user to the Workspace Form

The workspace form now shows no pending requests and the details of IHT mission are displayed along with the primary mission in the lowered portion of the screen (Figure 8-10).

Selecting the IHT mission and clicking the Mission Profile, displays a printable report detailing the mission and its flight plan the user can provide to the pilot and crewmen to review (Appendix H.2).

The user can also use the Workspace Form to track the progress of the missions. Selecting the primary mission and checking the departed box next to “YMEN- Base” records that HEMS 1 has departed Essendon (Figure 8-11).
8.4. Results and Discussion

The prototype DSS was successfully validated to support the pre-mission analysis of two example aeromedical requests. The case study validated the prototype DSS’s ability to assist flight-coordinators and crew in the decision-making processes faced prior to HEMS operations against the design requirements specified during conceptual design (Chapter 4). These were:

- Assist flight coordinators with the allocation of resources (including fixed wing);
- Assist flight coordinators with the development of a flight profile for the pilot;
- Provide pertinent information for flight profiles;
- Provide risk assessments of proposed missions;
- User friendly; and
- Operable from a conventional desktop windows based PC.

As discussed in Chapter 4, the intent is that the prototype DSS will serve as a baseline from which to refine the DSS concept into a suitable solution for wide spread integration and application in the HEMS industry.

Future research and testing is required to evaluate the prototype DSS to identify and document its strengths, weaknesses, and risks. These outcomes can then be used in the spiral development of an advanced and robust DSS suitable for the pre-mission analysis of HEMS operations.

As previously discussed in Chapter 6, the accuracy of the prototype DSS’s model base is dependent upon the information contained and entered into the database. For this case study an example database

Figure 8-11: Workspace form showing both planned IHT and Primary missions and tracking mission progress.
containing both factual and fictitious data was utilised. This was sufficient for the purpose of validating the prototype DSS concept. Prior to undertaking further research the obligatory factual data requires sourcing and validating.
9. RECOMMENDATIONS

The prototype DSS developed to support the pre-mission analysis of HEMS operations provides a holistic solution for further investigation on the viability of its application. The following is recommended for further investigation:

- **Database Development:** The prototype DSS’s accuracy is governed by the information contained within the database. To extend and improve the usefulness of the decision support system, a detailed and accurate database is required. The data required is not readily available and effort is required in sourcing and validating data and subsequently populating the database.

- **Spiral Development:** The approach taken by this research was to develop a prototype DSS for the pre-mission analysis of HEMS operations to serve as a baseline for future analysis, research and development. This approach was chosen as it is difficult to establish a firm system specification up front and expect it to remain unchanged when developing a DSS. Further research should evaluate the prototype DSS to identify and document its strengths, weaknesses, and risks. The DSS specification can be accordingly refined and the design, construction and testing of a second, more advanced prototype be subsequently addressed. This process could be iterated to develop a refined DSS, suitable for wide spread integration and application in the HEMS industry.

- **Systems Integration:** Information systems are evolving into digital nervous systems that tie all of an enterprise’s information into an information grid. The prototype DSS has presently been developed as a stand-alone system. Further research should investigate integrating the DSS with other enterprise and external IT systems, such as computerised dispatch and request systems, financial systems, workforce planning, patient medical records, and meteorological and aeronautical information services. Such integration will enhance the DSS and provide a level of synergy to improve the organisational efficiency and effectiveness of HEMS operators.

- **Mission Reporting:** In undertaking this research it was identified that there is a need for a system to record HEMS mission data and patient outcomes. Presently such data is usually not recorded or reported. The data collected by such a system could be analysed and used for future research into improving HEMS dispatch criteria, performance, utilisation and safety. It could also be used to expand and improve the model and knowledge base of the prototype DSS.
10. CONCLUSION

This research was conducted in collaboration with Air Ambulance Victoria as part of an Australian Research Council Linkage Project. It targeted an operational capability deficiency in HEMS operations, and focused on an identified application.

HEMS are acknowledged for their life saving ability, having enhanced the survival of many patients with medical and trauma emergencies [1, 3, 8, 39-44]. Yet, the high accident rate in HEMS operations is a significant concern to be addressed. This has prompted HEMS operators across the globe to focus on the management of risks inherent to their operations.

HEMS operations are complex, being a joint exercise between the flight crew, paramedics and supporting agencies. Operations occur around-the-clock, in all-weather conditions, and often with no fore-warning. In time critical operations, where precious minutes may cost lives, the crew must decide which cases dictate a HEMS response and if so, whether the conditions are safe to conduct the mission.

Intelligent systems are an emerging field offering benefits to a multitude of applications. The research forms a comprehensive investigation of the application of "intelligent systems" to the pre-mission analysis of HEMS operations. The research has resulted in the development of a prototype decision support system capable of assisting in the pre-mission analysis of HEMS operations. The prototype system is capable of supporting flight coordinators and crew in the decision-making processes faced prior to HEMS operations and can potentially improve emergency medical services to the Australian community.

The key outcomes of the research are as follows:

- A review of intelligent systems and their ability to aid the pre-mission analysis of HEMS operations. This concluded that the pre-mission analysis of HEMS operations cannot be solved by standard quantitative techniques or computerised systems. Thus, the ability of a DSS to bring together human judgment and computerised information in semi-structured decision situations makes it most suited to supporting the pre-mission analysis of HEMS operations.

- A pre-mission analysis decision making concept was established which does not restrict or hamper the operator from taking advantage of their abilities to reason, improvise, and respond. It enables the flight coordinator and crew to effectively handle the demands of new and unanticipated situations which are not addressed by the DSS.

- The pre-mission analysis of HEMS operations was characterised and a DSS architecture and framework developed. Emphasis was placed on supporting the strengths and complementing the weaknesses of the operator. The framework provides support for the operator’s naturally preferred
strategies, instead of enforcing a normative or prescriptive approach and it is work-centred, to find, fuse, format, present information, and respond to user requests.

- A comprehensive model base, tailored for HEMS pre-mission analysis was developed. This is capable of performing optimisation, simulation, advanced computations and analysis. Thus, allowing the prototype DSS to supply information and aid the user in decision making.

- A prototype DSS was developed. This is capable of providing support for the pre-mission analysis of HEMS operations, by identifying suitable resource solutions and providing a detailed flight schedule and risk assessment for a given user-specified mission request.

- The prototype addresses two critical safety issues identified by a NTSB special investigation into HEMS accidents. The lack of aviation flight risk evaluation programs for HEMS operations and the lack of consistent, comprehensive flight dispatch procedures for HEMS operations.

- The prototype DSS incorporates a procedure-weighted model for risk assessment, implemented in accordance with FAA recommendations. This allows the initial dispatch decision with full awareness of the risk factors. Thus, the decision to cancel, delay or launch is based upon a sound and complete analysis of all available information.

- The prototype DSS has the potential to reduce the risk of HEMS operations by assisting operators during the decision making process. The developed prototype provides a consistent, comprehensive flight dispatch procedure to assist in determining the safety of a HEMS mission. This ensures the go/no-go decision is not based on feelings but on facts and adheres to regulations, industry safety recommendations and operating procedures.

- The prototype DSS assists HEMS operators in managing the utilisation of their resources and ultimately improves the efficiency of HEMS operations by streamlining the pre-mission analysis and decision making processes. It has the potential to reduce the inappropriate use of HEMS resources, which increases cost and risk of injury and results in potential transport delay or unavailability of the aircraft for other requests.

This research merits application by operators and industry through further investigation. It addresses the key, safety critical problem of assisting flight-coordinators and crew in the decision-making processes faced prior to HEMS operations. The results of this research provide a framework to integrate decision support systems into the HEMS dispatch process to improve mission efficiency and effectiveness. The results also provide a prototype system and DSS architecture for customisation and further development to meet the needs of individual HEMS operators.
11. REFERENCES


[58] Booz Allen Hamilton (Ireland), *Feasibility Study On A Helicopter Emergency Medical Service (HEMS) For The Island Of Ireland*. 2004, Department of Health, Social Services & Public Safety (Belfast) and Department of Health & Children (Dublin): Dublin.


Federal Aviation Administration, *Introduction to Pilot Judgment*, Federal Aviation Administration.


## Appendix A: Air Ambulance Victoria

### A.1 Statistical Summary of Operations

<table>
<thead>
<tr>
<th>Year</th>
<th>Fixed Wing</th>
<th>All HEMS</th>
<th>HEMS1</th>
<th>HEMS2</th>
<th>HEMS3</th>
<th>HEMS 2</th>
<th>HEMS 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patients</td>
<td>Cases</td>
<td>Patients</td>
<td>Cases</td>
<td>Patients</td>
<td>Patients</td>
<td>Patients</td>
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<tr>
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<td>3,548</td>
<td>3,608</td>
<td>527</td>
<td>664</td>
<td>487</td>
<td>1,411</td>
<td>1,101</td>
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<td>1999/00</td>
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<td>3,701</td>
<td>433</td>
<td>608</td>
<td>443</td>
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<td>3,666</td>
<td>358</td>
<td>471</td>
<td>433</td>
<td>1,644</td>
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<td>2001/02</td>
<td>3,608</td>
<td>3,701</td>
<td>355</td>
<td>433</td>
<td>433</td>
<td>1,644</td>
<td>1,280</td>
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<td>2002/03</td>
<td>3,548</td>
<td>3,666</td>
<td>355</td>
<td>433</td>
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<td>2003/04</td>
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<td>355</td>
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<td>355</td>
<td>433</td>
<td>433</td>
<td>1,644</td>
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</table>

Total Patients: 4,649, 4,955, 5,612, 6,030, 6,191, 5,972, 5,467

Total Cases: 5,019, 5,345, 6,097, 6,754, 6,964, 6,570, 6,021
## A.2 Air Ambulance Victoria’s Resource Dispatch Criteria

<table>
<thead>
<tr>
<th>Dispatch Criteria</th>
<th>Rotary</th>
<th>Fixed Wing (MICA)</th>
<th>Fixed Wing</th>
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<tbody>
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<td><strong>Access</strong></td>
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</tr>
<tr>
<td>Winch</td>
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<td></td>
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<tr>
<td>Remote</td>
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<tr>
<td>Vehicle Access</td>
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<tr>
<td><strong>Distance &amp; Time</strong></td>
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<tr>
<td>Road Crew &gt; 5 min away</td>
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<td></td>
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<tr>
<td>Road Crew &lt; 5 min away</td>
<td>Wait on Sitrep</td>
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<tr>
<td><strong>Condition</strong></td>
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## A.3 Air Ambulance Victoria’s Predetermined Case Types

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<th>#</th>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
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<td>1</td>
<td>3D5</td>
<td>Snake bite, possible envenomation</td>
</tr>
<tr>
<td>2</td>
<td>7C1</td>
<td>Burns, difficulty breathing</td>
</tr>
<tr>
<td>3</td>
<td>7C2</td>
<td>Burns, large area (&gt;18%)</td>
</tr>
<tr>
<td>4</td>
<td>7D1</td>
<td>Burns or explosion: Multiple victims</td>
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<tr>
<td>5</td>
<td>7D2</td>
<td>Burns, severe SOB</td>
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<td>6</td>
<td>7D3</td>
<td>Burns, not alert</td>
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<td>7</td>
<td>12C1</td>
<td>Convulsions, pregnant pt</td>
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<td>8</td>
<td>12C2</td>
<td>Convulsions, trauma</td>
</tr>
<tr>
<td>9</td>
<td>14D1</td>
<td>Near drowning/diving, unconscious</td>
</tr>
<tr>
<td>10</td>
<td>14D2</td>
<td>Drowning, resp arrest or under water</td>
</tr>
<tr>
<td>11</td>
<td>14D3</td>
<td>Near Drowning/SOB not alert</td>
</tr>
<tr>
<td>12</td>
<td>14D4</td>
<td>Diving accident, possible neck injury</td>
</tr>
<tr>
<td>13</td>
<td>14D5</td>
<td>Scuba accident, possible BENDS</td>
</tr>
<tr>
<td>14</td>
<td>22D1</td>
<td>Industrial accident, multiple pts</td>
</tr>
<tr>
<td>15</td>
<td>22D2</td>
<td>Industrial accident, in machinery</td>
</tr>
<tr>
<td>16</td>
<td>22D3</td>
<td>Industrial accident, life status doubt</td>
</tr>
<tr>
<td>17</td>
<td>27D1</td>
<td>Stab/Gunshot, central wounds</td>
</tr>
<tr>
<td>18</td>
<td>27D2</td>
<td>Stab/Gunshot, multiple victims</td>
</tr>
<tr>
<td>19</td>
<td>27D3</td>
<td>Stab/Gunshot, not alert</td>
</tr>
<tr>
<td>20</td>
<td>27D4</td>
<td>Stab/Gunshot, multiple wounds</td>
</tr>
<tr>
<td>21</td>
<td>29D1</td>
<td>Traffic accident, multiple victims</td>
</tr>
<tr>
<td>22</td>
<td>29D2</td>
<td>Traffic accident, ped/M’cycle, bike</td>
</tr>
<tr>
<td>23</td>
<td>29D4</td>
<td>Traffic accident, trapped victim</td>
</tr>
<tr>
<td>24</td>
<td>29D5</td>
<td>Traffic accident, ejected victim</td>
</tr>
<tr>
<td>25</td>
<td>29D6</td>
<td>Traffic accident, not alert</td>
</tr>
<tr>
<td>26</td>
<td>29D7</td>
<td>Traffic accident, severe SOB</td>
</tr>
<tr>
<td>27</td>
<td>30D2</td>
<td>Traumatic injuries, severe SOB</td>
</tr>
<tr>
<td>28</td>
<td>30D3</td>
<td>Traumatic injuries, not alert</td>
</tr>
<tr>
<td>29</td>
<td>30D4</td>
<td>Traumatic injuries, trapped victim</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>Clinician/Road Crew</td>
</tr>
<tr>
<td>31</td>
<td></td>
<td>RAV</td>
</tr>
<tr>
<td>32</td>
<td></td>
<td>Other</td>
</tr>
</tbody>
</table>
A.4 Air Ambulance Victoria’s Primary Clinical Guidelines

Criteria

Patients who meet any of the following criteria should be regarded as having or potentially having, a clinical problem of major significance – i.e. are “TIME CRITICAL”. Modifying factors may include age <10 or >55 years or current medical condition and treatment, including pregnancy.

1. Vital Signs (Physiological Distress)

<table>
<thead>
<tr>
<th>Vital Signs</th>
<th>Adult</th>
<th>Paediatric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse</td>
<td>&lt;60 or &gt;100</td>
<td></td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td>&lt;10 or &gt;30</td>
<td></td>
</tr>
<tr>
<td>Hypotension</td>
<td>&lt;100 mmHg</td>
<td></td>
</tr>
<tr>
<td>Conscious State</td>
<td>GCS &lt;13</td>
<td>GCS &lt;15 for age 4+</td>
</tr>
</tbody>
</table>

2. Pattern of Actual Injury/Illness

a) Trauma

i) Penetrating injury:
   • Patients with penetrating injury to head, neck, chest, abdomen, pelvis, axilla or groin.

ii) Blunt injuries:
   • Patients with a significant injury to a single region, i.e. head, neck, chest, abdomen, pelvis, axilla or groin.
   • Patients with lesser injuries involving at least two or more of the body regions, i.e. head, neck, chest, abdomen, pelvis, axilla or groin.

iii) Specific injuries:
   • Suspected apparent isolated spinal injury
   • Burns>20% or involving respiratory tract
   • Serious crush injury
   • Fractures of two or more of the following: femur/tibia/humerus
   • Fractured pelvis
   • Limb amputations

Special Notes:

Major trauma patients are defined as a trauma patient with any one of the above vital signs and/or any one of the above Patterns of Actual Injury. In these cases Paramedics should manage the patient in accordance with appropriate Clinical Practice Guidelines and triage the patient in accordance with agreed trauma triage guidelines.
# Appendix B: MS Access

## B.1 MS Access Data Types

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Use For</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text</td>
<td>Text or combinations of text and numbers, such as addresses. Also numbers that do not require calculations, such as phone numbers, part numbers, or postal codes.</td>
<td>Up to 255 characters. Microsoft Access only stores the characters entered in a field; it does not store space characters for unused positions in a Text field. To control the maximum number of characters that can be entered, set the FieldSize property.</td>
</tr>
<tr>
<td>Memo</td>
<td>Lengthy text and numbers, such as notes or descriptions.</td>
<td>Up to 64,000 characters.</td>
</tr>
<tr>
<td>Number</td>
<td>Numeric data to be used for mathematical calculations, except calculations involving money (use Currency type). Set the FieldSize property to define the specific Number type.</td>
<td>1, 2, 4, or 8 bytes. 16 bytes for Replication ID (GUID) only.</td>
</tr>
<tr>
<td>Date/Time</td>
<td>Dates and times.</td>
<td>8 bytes.</td>
</tr>
<tr>
<td>Currency</td>
<td>Currency values. Use the Currency data type to prevent rounding off during calculations. Accurate to 15 digits to the left of the decimal point and 4 digits to the right.</td>
<td>8 bytes.</td>
</tr>
<tr>
<td>AutoNumber</td>
<td>Unique sequential (incrementing by 1) or random numbers automatically inserted when a record is added.</td>
<td>4 bytes. 16 bytes for Replication ID only.</td>
</tr>
<tr>
<td>Yes/No</td>
<td>Fields that will contain only one of two values, such as Yes/No, True/False, On/Off.</td>
<td>1 bit.</td>
</tr>
<tr>
<td>Hyperlink</td>
<td>Field that will store hyperlinks. A hyperlink can be a UNC path or a URL.</td>
<td>Up to 64,000 characters.</td>
</tr>
<tr>
<td>OLE Object</td>
<td>Objects (such as Microsoft Word documents, Microsoft Excel spreadsheets, pictures, sounds, or other binary data).</td>
<td>Up to 1 gigabyte (limited by disk space).</td>
</tr>
</tbody>
</table>
Appendix B
MS Access

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Use For</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Created in other programs using the OLE protocol, that can be linked to or embedded in a Microsoft Access table. You must use a bound object frame in a form or report to display the OLE object.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lookup Wizard</td>
<td>Creates a field that allows you to choose a value from another table or from a list of values using a combo box. Choosing this option in the data type list starts a wizard to define this for you.</td>
<td>The same size as the primary key field that is also the Lookup field; typically 4 bytes.</td>
</tr>
</tbody>
</table>


### B.2 MS Access Numeric Field Size Properties

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
<th>Decimal Precision</th>
<th>Storage Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte</td>
<td>Stores numbers from 0 to 255 (no fractions).</td>
<td>None</td>
<td>1 byte</td>
</tr>
<tr>
<td>Integer</td>
<td>Stores numbers from -32,768 to 32,767 (no fractions).</td>
<td>None</td>
<td>2 bytes</td>
</tr>
<tr>
<td>Long Integer</td>
<td>Stores numbers from -2,147,483,648 to 2,147,483,647 (no fractions).</td>
<td>None</td>
<td>4 bytes</td>
</tr>
<tr>
<td>Decimal</td>
<td>Stores numbers from $-10^{28}$-1 through $10^{28}$-1.</td>
<td>28</td>
<td>12 bytes</td>
</tr>
<tr>
<td>Single</td>
<td>Stores numbers from $-3.402823 	imes 10^{38}$ to $-1.401298 	imes 10^{-45}$ for negative values and from $1.401298 	imes 10^{-45}$ to $3.402823 	imes 10^{38}$ for positive values.</td>
<td>7</td>
<td>4 bytes</td>
</tr>
<tr>
<td>Double</td>
<td>Stores numbers from $-1.79769313486231 	imes 10^{108}$ to $-4.94065645841247 	imes 10^{324}$ for negative values and from $1.79769313486231 	imes 10^{108}$ to $4.94065645841247 	imes 10^{324}$ for positive values.</td>
<td>15</td>
<td>8 bytes</td>
</tr>
<tr>
<td>Replication ID</td>
<td>Globally unique identifier (GUID)</td>
<td>N/A</td>
<td>16 bytes</td>
</tr>
</tbody>
</table>

Appendix C: Geospatial Formula

The source of these formulae is:


C.1 Nomenclature

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>EXPLANATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Ellipsoid semi-major axis</td>
</tr>
<tr>
<td>b</td>
<td>Ellipsoid semi-minor axis. $b = a(1 - f)$</td>
</tr>
<tr>
<td>f</td>
<td>Flattening, the relationship between the semi-major and semi-minor axes of the ellipsoid: $f = \frac{a-b}{a}$</td>
</tr>
<tr>
<td>s</td>
<td>Ellipsoidal distance (m)</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Geodetic latitude, negative south of the equator ($\phi_1, \phi_2$ are the geodetic longitudes of points 1 and 2 respectively)</td>
</tr>
<tr>
<td>$\phi'$</td>
<td>Foot point latitude. Latitude for which the meridian distance $(m) = N'/k_0$</td>
</tr>
<tr>
<td>$\lambda$</td>
<td>Geodetic longitude, positive eastwards measured from Greenwich, positive eastwards ($\lambda_1, \lambda_2$ are the geodetic longitudes of points 1 and 2 respectively)</td>
</tr>
<tr>
<td>$\lambda_0$</td>
<td>Geodetic longitude of the central meridian</td>
</tr>
<tr>
<td>$\omega$</td>
<td>Geodetic longitude difference measured from the central meridian, positive eastwards</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Azimuth of the geodesic at the equator. (Forward 1-2, Reverse 2-1)</td>
</tr>
<tr>
<td>U</td>
<td>Reduced latitude</td>
</tr>
<tr>
<td>A, B, C, u</td>
<td>Internal variables</td>
</tr>
<tr>
<td>$e^2$</td>
<td>Eccentricity squared $(a^2 - b^2)/a^2$</td>
</tr>
<tr>
<td>$\rho$</td>
<td>Radius of curvature of the ellipsoid in the plane of the meridian</td>
</tr>
<tr>
<td>$\nu$</td>
<td>Radius of curvature of the ellipsoid in the prime vertical</td>
</tr>
<tr>
<td>$\psi$</td>
<td>Ratio of the ellipsoidal radii of curvature</td>
</tr>
<tr>
<td>E'</td>
<td>Easting, measured from a Central Meridian, positive eastwards.</td>
</tr>
</tbody>
</table>
Appendix C
Geospatial Formula

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>EXPLANATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>Easting, measured from the false origin (E’ + 500,000 metres for MGA94)</td>
</tr>
<tr>
<td>N’</td>
<td>Northing, measured from the equator, negative southwards.</td>
</tr>
<tr>
<td>N</td>
<td>Northing, measured from the false origin (N’ + 10,000,000 metres for MGA94)</td>
</tr>
<tr>
<td>m</td>
<td>Meridian distance. True distance from the equator, along the meridian, negative southwards.</td>
</tr>
<tr>
<td>G</td>
<td>Mean length on an arc of one degree of the meridian</td>
</tr>
<tr>
<td>σ</td>
<td>Meridian distance expressed as units G</td>
</tr>
<tr>
<td>k₀</td>
<td>Scale factor on the central meridian (0.9996 for MGA94)</td>
</tr>
</tbody>
</table>

C.2 Vincenty’s Inverse Formulae

**Given:** latitude and longitude of two points \((\phi_1, \lambda_1 \text{ and } \phi_2, \lambda_2)\)

**Calculate:** The ellipsoidal distance \((s)\) and forward and reverse azimuths between the points \((\alpha_{1-2}, \alpha_{2-1})\)

\[
\tan U_1 = (1-f) \tan \phi_1 \quad \text{Equation C2-1}
\]

\[
\tan U_2 = (1-f) \tan \phi_2 \quad \text{Equation C2-2}
\]

Starting with the approximation \(\lambda = \omega = \lambda_2 - \lambda_1\) iterate Equation C2-3 to Equation C2-10 until there is no significant change in \(\lambda\):

\[
\sin^2 \sigma = (\cos U_2 \sin \lambda)^2 + (\cos U_1 \sin U_2 - \sin U_1 \cos U_2 \cos \lambda)^2 \quad \text{Equation C2-3}
\]

\[
\cos \sigma = \sin U_1 \sin U_1 + \cos U_1 \cos U_2 \cos \lambda \quad \text{Equation C2-4}
\]

\[
\tan \sigma = \frac{\sin \sigma}{\cos \sigma} \quad \text{Equation C2-5}
\]

\[
\sin \alpha = \frac{\cos U_1 \cos U_2 \sin \lambda}{\sin \sigma} \quad \text{Equation C2-6}
\]

\[
\cos 2\sigma_m = \cos \sigma - \frac{2 \sin U_1 \sin U_2}{\cos^2 \alpha} \quad \text{Equation C2-7}
\]

\[
\cos 2\sigma_m = \cos \sigma - \frac{2 \sin U_1 \sin U_2}{\cos^2 \alpha} \quad \text{Equation C2-8}
\]

\[
C = \frac{f}{16} \cos^2 \alpha \left[4 + f(4 - 3 \cos^2 \alpha)\right] \quad \text{Equation C2-9}
\]

\[
\lambda = \omega + (1 - C) f \sin \alpha \left[\frac{\sigma + C \sin \sigma \cos 2\sigma_m + C \cos \sigma \left(-1 + 2 \cos^2 \sigma \right)}{\cos \sigma \cos 2\sigma_m} \right] \quad \text{Equation C2-10}
\]

Then evaluate:
Appendix C
Geospatial Formula

\[ u^2 = \cos^2 \alpha \left( \frac{a^2 - b^2}{b^2} \right) \]  
\[ A = 1 + \left( \frac{u^2}{16384} \right) \left[ 4096 + u^2 \left( -768 + u^2 \left( 320 - 175u^2 \right) \right) \right] \]  
\[ B = \left( \frac{u^2}{1024} \right) \left[ 256 + u^2 \left( -128 + u^2 \left( 74 - 47u^2 \right) \right) \right] \]  
\[ \Delta \sigma = B \sin \sigma \left\{ \cos 2\sigma_m + \frac{B}{4} \cos \sigma \left( -1 + 2 \cos^2 2\sigma_m \right) \right\} \]  
\[ \ldots \left\{ \frac{B}{6} \cos 2\sigma_m \left[ -3 + 4 \sin^2 \sigma \left( -3 + 4 \cos^2 2\sigma_m \right) \right] \right\} \]  

The ellipsoidal distance \( s \) between the two points is given by Equation C2-15, the forward azimuth \( (\alpha_{1-2}) \) by Equation C2-16 and the reverse azimuth \( (\alpha_{2-1}) \) by Equation C2-17.

\[ s = b\Delta (\sigma - \Delta \sigma) \]  
\[ \tan \alpha_{1-2} = \frac{\cos U_2 \sin \lambda}{\cos U_1 \sin U_2 - \sin U_1 \cos U_2 \cos \lambda} \]  
\[ \tan \alpha_{2-1} = \frac{\cos U_1 \sin \lambda}{-\sin U_1 \cos U_2 + \cos U_1 \sin U_2 \cos \lambda} \]

**C.3 Vincenty’s Direct Formulae**

*Given*: latitude and longitude of a point \( (\phi_1, \lambda_1) \) and the geodetic azimuth \( (\alpha_{1-2}) \) and ellipsoidal distance to a second point \( (s) \).

*Calculate*: latitude and longitude of the second point \( (\phi_2, \lambda_2) \) and the reverse azimuth \( (\alpha_{2-1}) \)

\[ \tan U_1 = (1 - f) \tan \phi_1 \]  
\[ \tan \sigma_1 = \frac{\tan U_1}{\cos \alpha_{1-2}} \]  
\[ \sin \alpha = \cos U_1 \sin \alpha_{1-2} \]  
\[ u^2 = \cos^2 \alpha \left( \frac{a^2 - b^2}{b^2} \right) \]  
\[ A = 1 + \left( \frac{u^2}{16384} \right) \left[ 4096 + u^2 \left( -768 + u^2 \left( 320 - 175u^2 \right) \right) \right] \]
\[ B = \frac{u^2}{1024} \left( 256 + u^2 \left[ -128 + u^2 \left( 74 - 47u^2 \right) \right] \right) \]

Starting with the approximation \( \sigma = s/(bA) \), iterate the following three equations until there is no significant change in \( \sigma \).

\[ 2\sigma_m = 2\sigma_1 + \sigma \]  

Equation C3-7

\[ \Delta \sigma = B \sin \sigma \left( \cos 2\sigma_m + \frac{B}{4} \cos \sigma \left[ 1 + 2 \cos^2 2\sigma_m \right] - \frac{B}{6} \cos 2\sigma_m \left[ 3 + 4 \sin^2 \sigma \right] \right) \ldots \]  

Equation C3-8

\[ \sigma = \frac{s}{bA} + \Delta \sigma \]  

Equation C3-9

Then, the latitude the second point \( (\phi_2) \) is given by Equation C3-10, the longitude of the second point \( (\lambda_2) \) by Equation C3-14 and the reverse azimuth \( (\alpha_{2-1}) \) is by Equation C3-15

\[ \tan \phi_2 = \frac{\sin U_1 \cos \sigma + \cos U_1 \sin \sigma \cos \alpha_{1-2}}{\left( \frac{1}{f} \left( 1 + f + \cos U_1 \sin \sigma - \cos U_1 \cos \sigma \cos \alpha_{1-2} \right) \right)^2} \]  

Equation C3-10

\[ \tan \lambda = \frac{\sin \sigma \sin \alpha_{1-2}}{\cos U_1 \cos \sigma - \sin U_1 \sin \sigma \cos \alpha_{1-2}} \]  

Equation C3-11

\[ C = \frac{f}{16} \cos^2 \alpha \left( 4 + f \left[ 4 - 3 \cos^2 \alpha \right] \right) \]  

Equation C3-12

\[ \omega = \lambda - (1 - C) f \sin \alpha (\sigma + C \sin \sigma \left[ \cos 2\sigma_m + C \cos \sigma \left[ 1 + 2 \cos^2 2\sigma_m \right] \right]) \]  

Equation C3-13

\[ \lambda_2 = \lambda_1 + \omega \]  

Equation C3-14

\[ \tan \alpha_{2-1} = \frac{\sin \alpha}{-\sin U_1 \sin \sigma + \cos U_1 \cos \sigma \cos \alpha_{1-2}} \]  

Equation C3-15

**C.4 Redfearn’s Formulae – Grid to Geographical**

These formulae can be used to convert between easting, northing and zone for a Transverse Mercator projection, such as the Map Grid of Australia (MGA), and latitude and longitude. Preliminary calculations are given in Equations C4-1 to C4-8.

\[ E = E - \text{False Easting} \]  

Equation C4-1

\[ N' = N - \text{False Easting} \]  

Equation C4-2
Appendix C

Geospatial Formula

Equation C4-3

\[ m = \frac{N'}{k_0} \]

Equation C4-4

\[ n = \frac{a-b}{a+b} = \frac{f}{2-f} \]

Equation C4-5

\[ G = a(1-n)(1-n^2) + \frac{225}{64} n^4 \frac{\pi}{180} \]

Equation C4-6

\[ \sigma = \frac{m \pi}{180G} \]

Equation C4-7

\[ x = \frac{E'}{k_0 v'} \]

Equation C4-8

The foot point latitude (in radians) is then calculated by C4-9.

\[ \phi = \sigma + \left( \frac{3n}{2} - \frac{27n^3}{32} \right) \sin 2\sigma + \left( \frac{21n^2}{16} - \frac{55n^4}{32} \right) \sin 4\sigma + \frac{15n^3}{96} \sin 6\sigma + \frac{1097n^4}{512} \sin 8\sigma \]

Equation C4-9

The radii of curvature for given latitude are also required in the evaluation of Redfearn’s formulae (Equations C4-10 to C4-12)

\[ \rho' = \frac{a\left(1-e^2\right)}{\left(1-e^2 \sin^2 \phi \right)^{3/2}} \]

Equation C4-10

\[ \nu' = \frac{a}{\left(1-e^2 \sin^2 \phi \right)^{1/2}} \]

Equation C4-11

\[ \psi' = \frac{\nu'}{\rho'} \]

Equation C4-12

The latitude is then given by Equations C4-13 to C4-17

\[ \phi = \phi' - \text{Term1} + \text{Term2} - \text{Term3} + \text{Term4} \]

Equation C4-13

\[ \text{Term1} = \left( \frac{t'}{K_0 \rho'} \right) \left( \frac{x E'}{2} \right) \]

Equation C4-14

\[ \text{Term2} = \left( \frac{t'}{K_0 \rho'} \right) \left( \frac{E' x^3}{24} \right) - 4\psi'^2 + 9\psi' \left( 1-t'^2 \right) + 12t'^2 \]

Equation C4-15
Appendix C

Geospatial Formula

Equation C4-16

Term3 = \left( \frac{r^3}{K_0 \rho^3} \right) \left( \frac{E x^4}{720} \right) \left[ 8 \psi^3 \left( 1 - 24 \psi^2 \right) - 128 \psi^3 \left( 21 - 71 \psi^2 \right) + \ldots + 15 \psi^2 \left( 15 - 98 \psi^2 + 15 \psi^4 \right) + 180 \psi^5 \left( 5 \psi^2 - 3 \psi^4 \right) + 360 \psi^6 \right]

Equation C4-17

Term4 = \left( \frac{r^4}{K_0 \rho^4} \right) \left( \frac{E x^7}{40320} \right) \left[ 1385 + 3633 \psi^2 + 4095 \psi^4 + 1575 \psi^6 \right]

The longitude by Equations C4-18 to C4-23

\omega = \text{Term1} - \text{Term2} + \text{Term3} - \text{Term4}

Equation C4-18

\text{Term1} = x \sec \phi

Equation C4-19

\text{Term2} = \frac{x^3}{6} \sec \phi \left( \psi^2 + 2 \psi^4 \right)

Equation C4-20

\text{Term3} = \frac{x^5}{120} \sec \phi \left( -4 \psi^3 \left( 1 - 6 \psi^2 \right) + \psi^2 \left( 9 - 68 \psi^2 \right) + 72 \psi^5 \psi^2 + 24 \psi^4 \right)

Equation C4-21

\text{Term4} = \frac{x^7}{5040} \sec \phi \left( 61 + 662 \psi^2 + 1320 \psi^4 + 720 \psi^6 \right)

Equation C4-22

\lambda = \lambda_0 + \omega

Equation C4-23
Appendix D: Model Base VBA Code

D.1 LSAlt Function

Public Function LSAlt(ByVal lat1 As Double, ByVal lon1 As Double, ByVal lat2 As Double, ByVal lon2 As Double) As Double
' THIS FUNCTION CALCULATES THE LOWER SAFE ALTITUDE IN FEET
Dim Distance As Double
Dim MaxTerrain As Double
Distance = DistanceNM(lat1, lon1, lat2, lon2)
If Distance > 38.519 Then
    MaxTerrain = Lsalt_2(lat1, lon1, lat2, lon2) 'This is in meters
Else
    MaxTerrain = Lsalt_1(lat1, lon1, lat2, lon2) 'This is in meters
End If
MaxTerrain = MaxTerrain * 3.28083 'Converts MaxTerrain into feet
If (MaxTerrain + 1360) < 1500 Then
    LSAlt = 1500
    Exit Function
Else
    LSAlt = MaxTerrain + 1360
End If
End Function

Public Function Lsalt_1(ByVal lat1 As Double, ByVal lon1 As Double, ByVal lat2 As Double, ByVal lon2 As Double) As Double
' THIS FUNCTION FINDS THE CRITICAL ALTITUDE FOR A FLIGHT PATH FROM 1 TO 2
' ONLY FOR DISTANCES < 38.519 NM IF > USE Lsalt_2
Dim p1_lat As Double
Dim p1_lon As Double
Dim p2_lat As Double
Dim p2_lon As Double
Dim p3_lat As Double
Dim p3_lon As Double
Dim p4_lat As Double
Dim p4_lon As Double
Dim tc As Double

tc = Azimuth(lat1, lon1, lat2, lon2)
p1_lat = lat_point(lat1, lon1, 5, tc + PI / 2) 'dist is 5nm
p1_lon = lon_point(lat1, lon1, 5, tc + PI / 2) 'dist is 5nm
p2_lat = lat_point(lat1, lon1, 5, tc - PI / 2) 'dist is 5nm
p2_lon = lon_point(lat1, lon1, 5, tc - PI / 2) 'dist is 5nm
p3_lat = lat_point(lat2, lon2, 12, tc + PI / 2) 'dist is 12nm
p3_lon = lon_point(lat2, lon2, 12, tc + PI / 2) 'dist is 12nm
p4_lat = lat_point(lat2, lon2, 12, tc - PI / 2) 'dist is 12nm
p4_lon = lon_point(lat2, lon2, 12, tc - PI / 2) 'dist is 12nm
Dim tc24 As Double
Dim tc21 As Double
Dim tc34 As Double
Dim tc31 As Double
tc24 = Azimuth(p2_lat, p2_lon, p4_lat, p4_lon)
tc21 = Azimuth(p2_lat, p2_lon, p1_lat, p1_lon)
tc34 = Azimuth(p3_lat, p3_lon, p4_lat, p4_lon)
tc31 = Azimuth(p3_lat, p3_lon, p1_lat, p1_lon)

Dim Maxheight As Double
Dim tc2point As Double
Dim tc3point As Double
Maxheight = 0

Dim RecordSet As New ADODB.RecordSet
Call RecordSet.Open(TerrainSQL(lat1, lon1, lat2, lon2), CurrentProject.Connection, adOpenDynamic)

RecordSet.MoveFirst
Do While Not RecordSet.EOF
    tc2point = Azimuth(p2_lat, p2_lon, RecordSet("lat") / 180 * PI, RecordSet("lon") / 180 * PI)
tc3point = Azimuth(p3_lat, p3_lon, RecordSet("lat") / 180 * PI, RecordSet("lon") / 180 * PI)
tc4point = Azimuth(p4_lat, p4_lon, RecordSet("lat") / 180 * PI, RecordSet("lon") / 180 * PI)
tc5point = Azimuth(p5_lat, p5_lon, RecordSet("lat") / 180 * PI, RecordSet("lon") / 180 * PI)

    '----------------------------------------------------------
    'CHECKS IF TERRAIN IS IN THE AREA 1234 AND IF IT IS LOGS THE HIGHEST PEAK
    'The 4 separate cases are required to determine if between ie 340 and 30 degrees
    If tc21 > tc24 And tc34 > tc31 Then
        If tc3point >= tc31 And tc3point <= tc34 And tc2point >= tc24 And tc2point <= tc21 Then
            Maxheight = RecordSet("Height (m)").Value
            Exit Do
        End If
    End If
    If tc21 < tc24 And tc34 > tc31 Then
        If (tc2point >= tc24 Or tc2point <= tc21) And (tc3point >= tc31 Or tc3point <= tc34) Then
            Maxheight = RecordSet("Height (m)").Value
            Exit Do
        End If
    End If
    If tc21 > tc24 And tc34 < tc31 Then
        If (tc2point >= tc24 And tc2point <= tc21) And (tc3point >= tc31 Or tc3point <= tc34) Then
            Maxheight = RecordSet("Height (m)").Value
            Exit Do
        End If
    End If
    If tc21 < tc24 And tc34 < tc31 Then
        If (tc2point >= tc24 Or tc2point <= tc21) And (tc3point >= tc31 Or tc3point <= tc34) Then
            Maxheight = RecordSet("Height (m)").Value
            Exit Do
        End If
    End If
    '----------------------------------------------------------

    'CHECKS IF WITHIN 5 NM OF POINT1 OR 12NM OF POINT2

    '------------------------------------------
If DistanceNM(lat1, lon1, RecordSet("lat") / 180 * PI, RecordSet("lon") / 180 * PI) <= 5 Then
    Maxheight = RecordSet("Height (m) ").Value
    Exit Do
Else
    If DistanceNM(lat2, lon2, RecordSet("lat") / 180 * PI, RecordSet("lon") / 180 * PI) <= 12 Then
        Maxheight = RecordSet("Height (m) ").Value
        Exit Do
    End If
End If
RecordSet.MoveNext
Loop
RecordSet.Close
Lsalt_1 = Maxheight
End Function

Public Function Lsalt_2(ByVal lat1 As Double, ByVal lon1 As Double, ByVal lat2 As Double, ByVal lon2 As Double) As Double
    ' THIS FUNCTION FINDS THE CRITICAL ALTITUDE FOR A FLIGHT PATH FROM 1 TO 2
    ' ONLY FOR DISTANCES > 38.519 NM IF < USE Lsalt_1
    Dim intermediate_lat As Double
    Dim intermediate_lon As Double
    Dim p1_lat As Double
    Dim p1_lon As Double
    Dim p2_lat As Double
    Dim p2_lon As Double
    Dim p3_lat As Double
    Dim p3_lon As Double
    Dim p4_lat As Double
    Dim p4_lon As Double
    Dim p5_lat As Double
    Dim p5_lon As Double
    Dim p6_lat As Double
    Dim p6_lon As Double
    Dim tc As Double
    tc = Azimuth(lat1, lon1, lat2, lon2)
    intermediate_lat = lat_point(lat1, lon1, 38.519, tc) 'dist 38.519 to get proper angle
    intermediate_lon = lon_point(lat1, lon1, 38.519, tc) 'dist 38.519 to get proper angle
    p1_lat = lat_point(lat1, lon1, 5, tc + PI / 2) 'dist is 5nm
    p1_lon = lon_point(lat1, lon1, 5, tc + PI / 2) 'dist is 5nm
    p2_lat = lat_point(lat1, lon1, 5, tc - PI / 2) 'dist is 5nm
    p2_lon = lon_point(lat1, lon1, 5, tc - PI / 2) 'dist is 5nm
    p3_lat = lat_point(intermediate_lat, intermediate_lon, 12, tc + PI / 2) 'dist is 12nm
    p3_lon = lon_point(intermediate_lat, intermediate_lon, 12, tc + PI / 2) 'dist is 12nm
    p4_lat = lat_point(intermediate_lat, intermediate_lon, 12, tc - PI / 2) 'dist is 12nm
    p4_lon = lon_point(intermediate_lat, intermediate_lon, 12, tc - PI / 2) 'dist is 12nm
    p5_lat = lat_point(lat2, lon2, 12, tc + PI / 2) 'dist is 12nm
    p5_lon = lon_point(lat2, lon2, 12, tc + PI / 2) 'dist is 12nm
    p6_lat = lat_point(lat2, lon2, 12, tc - PI / 2) 'dist is 12nm
    p6_lon = lon_point(lat2, lon2, 12, tc - PI / 2) 'dist is 12nm
Dim tc46 As Double
Dim tc43 As Double
Dim tc53 As Double
Dim tc56 As Double
Dim tc24 As Double
Dim tc21 As Double
Dim tc34 As Double
Dim tc31 As Double
Dim Maxheight As Double
Dim tc2point As Double
Dim tc3point As Double
Dim tc4point As Double
Dim tc5point As Double
Maxheight = 0 ' sets max height to 0 if no terrain is found
Dim RecordSet As New ADODB.RecordSet
Call RecordSet.Open(TerrainSQL(lat1, lon1, lat2, lon2), CurrentProject.Connection, adOpenDynamic)
RecordSet.MoveFirst
Debug.Print "Start "; Timer
Do While Not RecordSet.EOF
    tc2point = Azimuth(p2_lat, p2_lon, RecordSet("lat") / 180 * PI, RecordSet("lon") / 180 * PI)
    tc3point = Azimuth(p3_lat, p3_lon, RecordSet("lat") / 180 * PI, RecordSet("lon") / 180 * PI)
    tc4point = Azimuth(p4_lat, p4_lon, RecordSet("lat") / 180 * PI, RecordSet("lon") / 180 * PI)
    tc5point = Azimuth(p5_lat, p5_lon, RecordSet("lat") / 180 * PI, RecordSet("lon") / 180 * PI)

'------------------------------------------
'CHECKS IF TERRAIN IS IN THE AREA 1234 AND IF IT IS LOGS THE HIGHEST PEAK
' The 4 seperate cases are required to determine if between ie 340 and 30 degrees
If tc21 > tc24 And tc34 > tc31 Then
    If tc3point >= tc31 And tc3point <= tc34 And tc2point >= tc24 And tc2point <= tc21 Then
        Maxheight = RecordSet("Height (m)").Value
        Exit Do
    End If
End If
If tc21 < tc24 And tc34 > tc31 Then
    If (tc2point >= tc24 Or tc2point <= tc21) And (tc3point >= tc31 And tc3point <= tc34) Then
        Maxheight = RecordSet("Height (m)").Value
        Exit Do
    End If
End If
If tc21 > tc24 And tc34 < tc31 Then
    If (tc2point >= tc24 And tc2point <= tc21) And
        (tc3point >= tc31 Or tc3point <= tc34) Then
        Maxheight = RecordSet("Height (m)").Value
        Exit Do
    End If
End If

If tc21 < tc24 And tc34 < tc31 Then
    If (tc2point >= tc24 Or tc2point <= tc21) And
        (tc3point >= tc31 Or tc3point <= tc34) Then
        Maxheight = RecordSet("Height (m)").Value
        Exit Do
    End If
End If

' CHECKS IF WITHIN 5 NM OF POINT1 OR 12NM OF POINT2

If DistanceNM(lat1, lon1, RecordSet("lat") / 180 * PI,
    RecordSet("lon") / 180 * PI) <= 5 Then
    Maxheight = RecordSet("Height (m)").Value
    Exit Do
Else
    If DistanceNM(lat2, lon2, RecordSet("lat") / 180 * PI,
        RecordSet("lon") / 180 * PI) <= 12 Then
        Maxheight = RecordSet("Height (m)").Value
        Exit Do
    End If
End If

' CHECKS IF TERRAIN IS IN THE AREA 3456 AND IF IT IS LOGS THE HIGHEST PEAK

'The 4 separate cases are required to determine if between ie 360 and 30 degrees
If tc43 > tc46 And tc56 > tc53 Then
    If (tc4point >= tc46 And tc4point <= tc43) And
        (tc5point >= tc53 And tc5point <= tc56) Then
        Maxheight = RecordSet("Height (m)").Value
        Exit Do
    End If
End If

If tc43 < tc46 And tc56 > tc53 Then
    If (tc4point >= tc46 Or tc4point <= tc43) And
        (tc5point >= tc53 And tc5point <= tc56) Then
        Maxheight = RecordSet("Height (m)").Value
        Exit Do
    End If
End If

If tc43 > tc46 And tc56 < tc53 Then
    If (tc4point >= tc46 And tc4point <= tc43) And
        (tc5point >= tc53 Or tc5point <= tc56) Then
        Maxheight = RecordSet("Height (m)").Value
        Exit Do
    End If
End If

If tc43 < tc46 And tc56 < tc53 Then
    If (tc4point >= tc46 Or tc4point <= tc43) And
        (tc5point >= tc53 Or tc5point <= tc56) Then
        Maxheight = RecordSet("Height (m)").Value
        Exit Do
    End If
End If
Appendix D
Model Base VBA Code

Public Function TerrainSQL(ByVal lat1 As Double, ByVal lon1 As Double, ByVal lat2 As Double, ByVal lon2 As Double) As String
' THIS FUNCTION GENERATES AN SQL STATEMENT TO FIND THE TERRAIN OF INTEREST
Dim LonLower As Double
Dim LatLower As Double
Dim LonUpper As Double
Dim LatUpper As Double
Dim SQL As String
If lon1 < lon2 Then
    LonLower = ToDeg(lon1 - 0.01) '0.01 corresponds to a margin of 34.377 NM
    LonUpper = ToDeg(lon2 + 0.01)
Else
    LonLower = ToDeg(lon2 - 0.01)
    LonUpper = ToDeg(lon1 + 0.01)
End If
If lat1 < lat2 Then
    LatLower = ToDeg(lat1 - 0.01)
    LatUpper = ToDeg(lat2 + 0.01)
Else
    LatLower = ToDeg(lat2 - 0.01)
    LatUpper = ToDeg(lat1 + 0.01)
End If
SQL = "SELECT Terrain.Lat, Terrain.Lon, Terrain.[Height (m)] FROM Terrain"
SQL = SQL + " WHERE (((Terrain.Lat) >" & LatLower & ") AND ((Terrain.Lon) >"
AND ((Terrain.Lon) < " & LonUpper & ")")
SQL = SQL + " ORDER BY Terrain.[Height (m)] DESC;"
TerrainSQL = SQL
End Function

D.2 Refuel Functions

Public Function OneRefuel(ByVal lat1 As Double, lon1 As Double, lat2 As Double, lon2 As Double, Range As Double, Remaining As Double) As String
Dim SQL As String
Dim DTF As Double 'Distance To Fuel (NM)
Dim DFF As Double 'Distance From Fuel (NM)
Dim LatF As Double
Dim LonF As Double
Dim Code As String ' Airfield
Dim Min As Double
Dim Distance1 As Double
Dim Distance2 As Double
Dim MinCode As String

MinCode = "NA"
Dim rstFuel As New ADODB.RecordSet
SQL = "SELECT tbl_Airfields.Code, tbl_Airfields.Lat, tbl_Airfields.Long FROM tbl_Airfields WHERE ((tbl_Airfields.Fuel)=Yes)"
rstFuel.Open SQL, CurrentProject.Connection, adOpenDynamic
rstFuel.MoveFirst
Min = 1000000 ' Sets Min to Large Number
Do While Not rstFuel.EOF
LatF = rstFuel("Lat").Value
LonF = rstFuel("Long").Value
Code = rstFuel("Code").Value
If LatF = lat1 And LonF = lon1 Then 'Fuel at Scene/Hosp1 Then 'Do Nothing
Else

DTF = Round(DistanceNM(ToRad(lat1), ToRad(lon1), ToRad(LatF), ToRad(LonF)), 1)
DIFF = Round(DistanceNM(ToRad(lat2), ToRad(lon2), ToRad(LatF), ToRad(LonF)), 1)
Distance = DTF + DIFF
If (DIFF + Remaining) < Range Then
If Distance < Min Then
MinCode = Code
End If
End If
End If
rstFuel.MoveNext
Loop
rstFuel.Close
Set rstFuel = Nothing
OneRefuel = MinCode
End Function
Public Function TwoRefuel(ByVal lat1 As Double, lon1 As Double, lat2 As Double, lon2 As Double, Range As Double, Prior As Double, Remaining As Double) As String
Dim SQL As String
Dim DTF As Double 'Distance To Fuel (NM)
Dim DIFF As Double 'Distance From Fuel (NM)
Dim LatF As Double
Dim LonF As Double
Dim Code As String ' Airfield
Dim Min As Double
Dim Distance As Double
Dim MinCode As String
MinCode = "NA"
Dim rstFuel As New ADODB.RecordSet
SQL = "SELECT tbl_Airfields.Code, tbl_Airfields.Lat, tbl_Airfields.Long FROM tbl_Airfields WHERE ((tbl_Airfields.Fuel)=Yes)"
rstFuel.Open SQL, CurrentProject.Connection, adOpenDynamic
rstFuel.MoveFirst
Min = 1000000 ' Sets Min to Large Number
Do While Not rstFuel.EOF
LatF = rstFuel("Lat").Value
LonF = rstFuel("Long").Value
Code = rstFuel("Code").Value

If LatF = lat1 And LonF = lon1 Then 'Fuel at Location 1/Base
Then
' Do Nothing
Else

DTF = Round(DistanceNM(ToRad(lat1), ToRad(lon1), ToRad(LatF), ToRad(LonF)), 1)
DFF = Round(DistanceNM(ToRad(lat2), ToRad(lon2), ToRad(LatF), ToRad(LonF)), 1)
Distance1 = Prior + DTF
Distance2 = Remaining + DFF

If Distance1 < Range And Distance2 < Range Then
If Distance < Min Then
MinCode = Code
End If
End If
End If
rstFuel.MoveNext
Loop

rstFuel.Close
Set rstFuel = Nothing
TwoRefuel = MinCode

End Function

Public Function ThreeRefuel(ByVal lat1 As Double, lon1 As Double, lat2 As Double, lon2 As Double, Range As Double, Prior As Double) As String

Dim SQL As String
Dim DTF As Double 'Distance To Fuel (NM)
Dim DFF As Double 'Distance From Fuel (NM)
Dim LatF As Double
Dim LonF As Double
Dim Code As String ' Airfield
Dim Min As Double
Dim Distance As Double
Dim MinCode As String

MinCode = "NA"

Dim rstFuel As New ADODB.RecordSet
SQL = "SELECT tbl_Airfields.Code, tbl_Airfields.Lat, tbl_Airfields.Long FROM tbl_Airfields WHERE (((tbl_Airfields.Fuel)=Yes))"
rstFuel.Open SQL, CurrentProject.Connection, adOpenDynamic
rstFuel.MoveFirst

Min = 1000000 ' Sets Min to Large Number

Do While Not rstFuel.EOF
LatF = rstFuel("Lat").Value
LonF = rstFuel("Long").Value
Code = rstFuel("Code").Value

If LatF = lat1 And LonF = lon1 Then 'Fuel at Hospital/Waypoint
3 Then
' Do Nothing
Else

DTF = Round(DistanceNM(ToRad(lat1), ToRad(lon1), ToRad(LatF), ToRad(LonF)), 1)
DFF = Round(DistanceNM(ToRad(lat2), ToRad(lon2), ToRad(LatF), ToRad(LonF)), 1)
Distance = DTF + DFF

If (DTF + Prior) < Range And DFF < Range Then
  If Distance < Min Then
    MinCode = Code
  End If
End If

rstFuel.MoveNext
Loop
rstFuel.Close
Set rstFuel = Nothing
ThreeRefuel = MinCode
End Function

D.3 ClosestAirfield Function

Public Function ClosestAirfield(ByVal Lat As Double, ByVal Lon As Double) As String
  'Lat is Scene Lat
  'Lon is Secne Lon
  Dim Code As String 'Airfield Code
  Dim Dist As Double ' Distance between Airfield and Scene
  Dim Min As Double  'Minimum Distance between Airfield and Scene
  Dim ALat As Double 'Airfield Lat
  Dim ALon As Double 'Airfiels Lon
  Min = 100000000 ' Sets Min to very large number

  Dim rstAFs As New ADODB.RecordSet
  SQL = "SELECT tbl_Airfields.Code, tbl_Airfields.Lat, tbl_Airfields.Long FROM tbl_Airfields"
  rstAFs.Open SQL, CurrentProject.Connection, adOpenDynamic
  rstAFs.MoveFirst
  Do While Not rstAFs.EOF
    ALat = rstAFs("Lat").Value
    ALon = rstAFs("Long").Value
    Dist = Round(DistanceNM(ToRad(Lat), ToRad(Lon), ToRad(ALat), ToRad(ALon)), 1)
    If Min > Dist Then
      Code = rstAFs("Code").Value
      Min = Dist
    End If
    rstAFs.MoveNext
  Loop
  rstAFs.Close
  Set rstAFs = Nothing

  ClosestAirfield = Code
End Function

D.4 FlightTime Function

Public Function FlightTime(ByVal Resource As String, ByVal Distance As Double, ByVal Refuel As String) As Integer
Appendix D
Model Base VBA Code

Dim Speed As Double
Dim Time As Double
Dim TOLT As Double
Dim FuelTime As Double

Dim rstResources As New ADODB.RecordSet
SQL = "SELECT tbl_AircraftTypes.[Cruise Speed], tbl_AircraftTypes.TOLT, tbl_AircraftTypes.[Refuel Time] FROM tbl_AircraftTypes INNER JOIN tbl_Resources ON tbl_AircraftTypes.[Aircraft ID] = tbl_Resources.[AC Type] WHERE (((tbl_Resources.[Resource])='" & Resource & "'))"
rs
rstResources.Open SQL, CurrentProject.Connection, adOpenDynamic
Speed = rstResources("Cruise Speed").Value
TOLT = rstResources("TOLT").Value
If Refuel = "True" Then
FuelTime = rstResources("Refuel Time").Value
Else
FuelTime = 0
End If
rstResources.Close
Set rstResources = Nothing
Time = (Distance / Speed) * 60 + TOLT + FuelTime
FlightTime = Round(Time, 0)
End Function

D.5 StaticRiskScore Function

Public Function StaticRiskScore(ByVal Resource As String, ByVal Duration As Double) As String
' This function returns the static risk score
Dim PilotID As Integer
Dim CrewmanID As Integer
Dim ParamedicID As Integer
Dim Score As Integer
Dim Night As Boolean
Dim ACType As String

MissionTime = Duration / 60 ' This is the estimated mission time in hours
'Resource = "HEMS1"
Score = 0
'------ Get ACType ------
Dim RstResource As New ADODB.RecordSet
SQL = "SELECT tbl_Resources.[AC Type] FROM tbl_Resources WHERE (((tbl_Resources.[Resource])='" & Resource & "'))"
RstResource.Open SQL, CurrentProject.Connection, adOpenKeyset
RstResource.Fields.Refresh
RstResource.MoveFirst
ACType = RstResource("AC Type").Value
RstResource.Close
Set RstResource = Nothing
'------ End ------

'------ Determine if it will be a night flight ------
If Hour(Now) >= 18 Or Hour(Now) <= 7 Or (Hour(Now) + MissionTime) >= 18 Then
Night = True
End If
'------ End ------

'------ Get Crew Data ------
MyHour = Hour(Now)

Dim rstRoster As New ADODB.RecordSet
rstRoster.Open "tbl_Roster", CurrentProject.Connection, adOpenKeyset
rstRoster.Fields.Refresh
rstRoster.MoveFirst

Do While Not rstRoster.EOF
If rstRoster("Shift").Value = Shift(MyHour) And rstRoster("Date").Value = RosterDate(MyHour) Then
Select Case Resource
Case "HEMS1"
PilotID = rstRoster("HEMS1 Pilot").Value
CrewmanID = rstRoster("HEMS1 Crewman").Value
ParamedicID = rstRoster("HEMS1 Paramedic").Value
Case "HEMS2"
PilotID = rstRoster("HEMS2 Pilot").Value
CrewmanID = rstRoster("HEMS2 Crewman").Value
ParamedicID = rstRoster("HEMS2 Paramedic").Value
Case "HEMS3"
PilotID = rstRoster("HEMS3 Pilot").Value
CrewmanID = rstRoster("HEMS3 Crewman").Value
ParamedicID = rstRoster("HEMS3 Paramedic").Value
End Select
End If
rstRoster.MoveNext
Loop
rstRoster.Close
Set rstRoster = Nothing
'------ END Get Crew Data ------

'------ Checks if the Pilot has <200 hours in Aircraft Type
If GetHours(PilotID, ACType) < 200 Then
    Score = Score + 1
End If

'------ Checks if the Pilot has <500 hours in Aircraft Type
If GetHours(PilotID, ACType) > 200 Then
    Score = Score - 1
End If

'------ Checks if the Pilot has flown the Aircraft Type in the past 30 Days
If ChkLastFlight(PilotID, ACType) = False Then
    Score = Score + 1
End If

'------ Checks if the pilot has had Check Ride in the aircraft during the last 180 Days
If ChkCheckRide(PilotID, ACType) = False Then
    Score = Score + 2
End If

'------ Checks if the program is IFR or VFR
If ChkIFR(ACType) = True Then
    Score = Score - 4 'IFR
Else
    Score = Score + 1 'VFR
End If

'------ Checks if Medical Crew experince < 1 yr
If ChkMedCrew(CrewmanID, ParamedicID) = True Then
    Score = Score + 1
End If

'------ Checks if Pilot experince < 1 yr
If ChkPilotEMS(PilotID) = True Then
    Score = Score + 1
End If

'------ Checks if Pilot has been on current job < 180 days
If ChkPilotCurrentJob(PilotID) = True Then
    Score = Score + 1
End If

If Night = True Then
    '------ Checks if the Pilot has flown the Aircraft Type at Night
    in the past 30 Days
    If ChkLastNightFlight(PilotID, ACType) = False Then
        Score = Score + 1
    End If

    '------ Checks if the AC is NVG Equipped
    If ChkNVG(ACType) = True Then
        Score = Score - 1
    End If

    '------ Checks if the Pilot has <3 NVG Flights in the past 120 days
    If ChkNVGFlights(PilotID) = False Then
        Score = Score + 1
    End If
End If

If Score <= 4 Then
    StaticRiskScore = "Normal"
Else
    If Score >= 6 Then
        StaticRiskScore = "Unacceptable"
    Else
        StaticRiskScore = "High"
    End If
End If

End Function

D.6 StaticRiskAnalysis Function

Public Function StaticRiskAnalysis(ByVal Resource As String, ByVal Duration As Double) As String

    ' This function returns the static risk score

    Dim PilotID As Integer
    Dim CrewmanID As Integer
    Dim ParamedicID As Integer
    Dim Analysis As String
    Dim Night As Boolean
    Dim ACType As String
    Dim MissionTime As Double
    Dim Score As Integer

    MissionTime = Duration / 60 ' This is the estimated mission time
    Score = 0
    Analysis = "-----------------------------"
'----- Get ACType -----
Dim RstResource As New ADODB.RecordSet
SQL = "SELECT tbl_Resources.[AC Type] FROM tbl_Resources WHERE ((tbl_Resources.Resource)='" & Resource & "')"
RstResource.Open SQL, CurrentProject.Connection, adOpenKeyset
RstResource.Fields.Refresh
RstResource.MoveNext
ACType = RstResource("AC Type").Value
RstResource.Close
Set RstResource = Nothing
'----- End -----

'----- Determine if it will be a night flight -----
If Hour(Now) >= 18 Or Hour(Now) <= 7 Or (Hour(Now) + MissionTime) >= 18 Then
   Night = True
End If
'----- End -----

'----- Get Crew Data -----
MyHour = Hour(Now)

Dim rstRoster As New ADODB.RecordSet
rstRoster.Open "tbl_Roster", CurrentProject.Connection, adOpenKeyset
rstRoster.Fields.Refresh
rstRoster.MoveFirst
Do While Not rstRoster.EOF
   If rstRoster("Shift").Value = Shift(MyHour) And rstRoster("Date").Value = RosterDate(MyHour) Then
      Select Case Resource
         Case "HEMS1"
            PilotID = rstRoster("HEMS1 Pilot").Value
            CrewmanID = rstRoster("HEMS1 Crewman").Value
            ParamedicID = rstRoster("HEMS1 Paramedic").Value
         Case "HEMS2"
            PilotID = rstRoster("HEMS2 Pilot").Value
            CrewmanID = rstRoster("HEMS2 Crewman").Value
            ParamedicID = rstRoster("HEMS2 Paramedic").Value
         Case "HEMS3"
            PilotID = rstRoster("HEMS3 Pilot").Value
            CrewmanID = rstRoster("HEMS3 Crewman").Value
            ParamedicID = rstRoster("HEMS3 Paramedic").Value
      End Select
   End If
   rstRoster.MoveNext
Loop
rstRoster.Close
Set rstRoster = Nothing
'----- END Get Crew Data -----

'----- Checks if the Pilot has <200 hours in Aircraft Type
If GetHours(PilotID, ACType) < 200 Then
   Analysis = Analysis + vbCrLf + "Pilot < 200 hrs in Type +1"
   Score = Score + 1
End If

'----- Checks if the Pilot has <500 hours in Aircraft Type
If GetHours(PilotID, ACType) > 500 Then
   Analysis = Analysis + vbCrLf + "Pilot > 500 hrs in Type -1"
   Score = Score - 1
End If
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'------ Checks if the Pilot has flown the Aircraft Type in the past 30 Days
If ChkLastFlight(PilotID, ACType) = False Then
    Analysis = Analysis + vbCrLf + "Last Flight > 30 Days" +1"
    Score = Score + 1
End If

'------ Checks if the pilot has had Check Ride in the aircraft during the last 180 Days
If ChkCheckRide(PilotID, ACType) = False Then
    Analysis = Analysis + vbCrLf + "180 Days Since Check Ride" +1"
    Score = Score + 2
End If

'------ Checks if the program is IFR or VFR
If ChkIFR(ACType) = True Then
    Score = Score - 4 'IFR
    Analysis = Analysis + vbCrLf + "IFR Program" -4"
Else
    Score = Score + 1 'VFR
    Analysis = Analysis + vbCrLf + "VFR Program" +1"
End If

'------ Checks if Medical Crew experince < 1 yr
If ChkMedCrew(CrewmanID, ParamedicID) = True Then
    Score = Score + 1
    Analysis = Analysis + vbCrLf + "Crew < 1 yrs. Experience" +1"
End If

'------ Checks if Pilot experince < 1 yr
If ChkPilotEMS(PilotID) = True Then
    Score = Score + 1
    Analysis = Analysis + vbCrLf + "Pilot < 1 yr in EMS" +1"
End If

'------ Checks if Pilot has been on current job < 180 days
If ChkPilotCurrentJob(PilotID) = True Then
    Score = Score + 1
    Analysis = Analysis + vbCrLf + "< 180 days on Current Job" +1"
End If

If Night = True Then

'------ Checks if the Pilot has flown the Aircraft Type at Night in the past 30 Days
If ChkLastNightFlight(PilotID, ACType) = False Then
    Analysis = Analysis + vbCrLf + "Last Night Flight > 30 Day" +1"
End If

'------ Checks if the AC is NVG Equipped
If ChkNVG(ACType) = True Then
    Score = Score - 1
    Analysis = Analysis + vbCrLf + "NVG Equipped" -1"
Else
    Score = Score + 1
    Analysis = Analysis + vbCrLf + "< 3 NVG Flights in the past 120 Days" +1"
End If
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Analysis = Analysis + vbCrLf + "--------------------------------------
-----" + vbCrLf + "RISK SCORE: " & Score

StaticRiskAnalysis = Analysis + vbCrLf + vbCrLf + vbCrLf + "NORMAL = 4 or less" + vbCrLf + "HIGH = 5" + vbCrLf + "UNACCEPTABLE = 6 or greater"

End Function

D.7 ChkCheckRide Function

Public Function ChkCheckRide(ByVal PilotID As Integer, ByVal ACType As String) As Boolean
' Checks if the pilot has had Check Ride in the aircraft during the last 180 Days

Dim Chk As Boolean

Dim rstPilotLog As New ADODB.RecordSet
SQL = "SELECT tbl_PilotLogBook.Date FROM tbl_PilotLogBook
WHERE (((tbl_PilotLogBook.Date)>({Date()-180})) AND ((tbl_PilotLogBook.[Pilot ID])=" & PilotID & ") AND ((tbl_PilotLogBook.[Check Ride])=Yes) AND ((tbl_PilotLogBook.Type)='" & ACType & ")"
rstPilotLog.Open SQL, CurrentProject.Connection, adOpenKeyset
rstPilotLog.Fields.Refresh
If rstPilotLog.EOF = True And rstPilotLog.BOF = True Then
    Chk = False
Else
    Chk = True
End If
rstPilotLog.Close
Set rstPilotLog = Nothing
ChkCheckRide = Chk

End Function

D.8 ChkIFR Function

Public Function ChkIFR(ByVal ACType As String) As Boolean
' Checks if aircraft is IFR

Dim Chk As Boolean

Dim RstACType As New ADODB.RecordSet
SQL = "SELECT tbl_AircraftTypes.IFR FROM tbl_AircraftTypes
WHERE (((tbl_AircraftTypes.[Aircraft ID])=" & ACType & "])"
RstACType.Open SQL, CurrentProject.Connection, adOpenKeyset
RstACType.Fields.Refresh
RstACType.MoveFirst
Chk = RstACType("IFR").Value
RstACType.Close
Set RstACType = Nothing
ChkIFR = Chk

End Function
D.9 ChkLastFlight Function

Public Function ChkLastFlight(ByVal PilotID As Integer, ByVal ACType As String) As Boolean
' Checks if the pilot has flown the type in the last 30 Days
Dim Chk As Boolean

    Dim rstPilotLog As New ADODB.RecordSet
    SQL = "SELECT tbl_PilotLogBook.Date FROM tbl_PilotLogBook
    WHERE (((tbl_PilotLogBook.Date)>(Date()-30)) AND
    ((tbl_PilotLogBook.[Pilot ID])=" & PilotID & ") AND
    ((tbl_PilotLogBook.Type)='" & ACType & "'))"
    rstPilotLog.Open SQL, CurrentProject.Connection, adOpenKeyset
    rstPilotLog.Fields.Refresh
    If rstPilotLog.EOF = True And rstPilotLog.BOF = True Then
        Chk = False
    Else
        Chk = True
    End If
    rstPilotLog.Close
    Set rstPilotLog = Nothing

    ChkLastFlight = Chk
End Function

D.10 ChkLastNightFlight Function

Public Function ChkLastNightFlight(ByVal PilotID As Integer, ByVal ACType As String) As Boolean
' Checks if the pilot has flown the type at night in the last 30 Days
Dim Chk As Boolean

    Dim rstPilotLog As New ADODB.RecordSet
    SQL = "SELECT tbl_PilotLogBook.Date FROM tbl_PilotLogBook
    WHERE (((tbl_PilotLogBook.Date)>(Date()-30)) AND
    ((tbl_PilotLogBook.[Night Flight])=Yes) AND ((tbl_PilotLogBook.[Pilot ID])=" & PilotID & ") AND ((tbl_PilotLogBook.Type)='" & ACType & "'))"
    rstPilotLog.Open SQL, CurrentProject.Connection, adOpenKeyset
    rstPilotLog.Fields.Refresh
    If rstPilotLog.EOF = True And rstPilotLog.BOF = True Then
        Chk = False
    Else
        Chk = True
    End If
    rstPilotLog.Close
    Set rstPilotLog = Nothing

    ChkLastNightFlight = Chk
End Function

D.11 ChkMedCrew Function

Public Function ChkMedCrew(ByVal CrewmanID As Integer, ByVal ParamedicID As Integer) As Boolean
' Checks if either the crewman or paramedic have < 1 yrs experience
Dim Chk As Boolean

    Dim rstPilotLog As New ADODB.RecordSet
    SQL = "SELECT tbl_PilotLogBook.Date FROM tbl_PilotLogBook
    WHERE (((tbl_PilotLogBook.Date)>(Date()-30)) AND
    ((tbl_PilotLogBook.[Pilot ID])=" & CrewmanID & ") AND
    ((tbl_PilotLogBook.[Paramedic ID])=" & ParamedicID & ")")
    rstPilotLog.Open SQL, CurrentProject.Connection, adOpenKeyset
    rstPilotLog.Fields.Refresh
    If rstPilotLog.EOF = True And rstPilotLog.BOF = True Then
        Chk = False
    Else
        Chk = True
    End If
    rstPilotLog.Close
    Set rstPilotLog = Nothing

    ChkMedCrew = Chk
End Function
Dim Commenced As Date

Dim rstParamedic As New ADODB.RecordSet
SQL = "SELECT tbl_Paramedics.Commenced FROM tbl_Paramedics
WHERE (((tbl_Paramedics.[Paramedic ID])=" & ParamedicID & ")")
rstParamedic.Open SQL, CurrentProject.Connection, adOpenKeyset
rstParamedic.Fields.Refresh
rstParamedic.MoveFirst
Commenced = rstParamedic("Commenced").Value
rstParamedic.Close
Set rstParamedic = Nothing

Dim RstCrewman As New ADODB.RecordSet
SQL = "SELECT tbl_Crewman.Commenced FROM tbl_Crewman WHERE
((tbl_Crewman.[Crewman ID])=" & CrewmanID & ")")
RstCrewman.Open SQL, CurrentProject.Connection, adOpenKeyset
RstCrewman.Fields.Refresh
RstCrewman.MoveFirst
If RstCrewman("Commenced").Value > Commenced Then
    Commenced = RstCrewman("Commenced").Value
End If
RstCrewman.Close
Set RstCrewman = Nothing

If (Date - Commenced) >= 365 Then
    Chk = False
Else
    Chk = True
End If

ChkMedCrew = Chk

End Function

D.12 ChkNVG Function

Public Function ChkNVG(ByVal ACType As String) As Boolean
' Checks if aircraft is NVG Equipped
Dim Chk As Boolean
Dim RstACType As New ADODB.RecordSet
SQL = "SELECT tbl_AircraftTypes.NVG FROM tbl_AircraftTypes
WHERE (((tbl_AircraftTypes.[Aircraft ID])=" & ACType & ")")"
RstACType.Open SQL, CurrentProject.Connection, adOpenKeyset
RstACType.Fields.Refresh
RstACType.MoveFirst
Chk = RstACType("NVG").Value
RstACType.Close
Set RstACType = Nothing

ChkNVG = Chk

End Function

D.13 ChkNVGFlights Function

Public Function ChkNVGFlights(ByVal PilotID As Integer) As Boolean
' Checks if the pilot has had < 3 NVG Flights in the Last 120 Days
Dim Chk As Boolean
Dim rstPilotLog As New ADODB.RecordSet
SQL = "SELECT tbl_PilotLogBook.Date FROM tbl_PilotLogBook WHERE (((tbl_PilotLogBook.Date)>(Date() - 120)) AND ((tbl_PilotLogBook.NVGs)=Yes) AND ((tbl_PilotLogBook.[Pilot ID])=" & PilotID & "))"

rstPilotLog.Open SQL, CurrentProject.Connection, adOpenKeyset
rstPilotLog.Fields.Refresh
If rstPilotLog.EOF = True And rstPilotLog.BOF = True Then
    Chk = False
Else
    If rstPilotLog.RecordCount < 3 Then
        Chk = False
    Else
        Chk = True
    End If
End If
rstPilotLog.Close
Set rstPilotLog = Nothing

ChkNVGFlights = Chk

End Function

D.14 ChkPilotCurrentJob Function

Public Function ChkPilotCurrentJob(ByVal PilotID As Integer) As Boolean
' Checks if the pilot has < 6 months on current job

Dim Chk As Boolean
Dim Commenced As Date

Dim rstPilot As New ADODB.RecordSet
SQL = "SELECT tbl_Pilot.Commenced FROM tbl_Pilot WHERE (((tbl_Pilot.[Pilot ID])=" & PilotID & "))"
rstPilot.Open SQL, CurrentProject.Connection, adOpenKeyset
rstPilot.Fields.Refresh
rstPilot.MoveFirst
Commenced = rstPilot("Commenced").Value
rstPilot.Close
Set rstPilot = Nothing

If (Now - Commenced) < 180 Then
    Chk = True
Else
    Chk = False
End If

ChkPilotCurrentJob = Chk

End Function

D.15 ChkPilotEMS Function

Public Function ChkPilotEMS(ByVal PilotID As Integer) As Boolean
' Checks if the pilot has < 1 yr EMS experience

Dim Chk As Boolean
Dim Commenced As Date
Dim Previous As Integer

Dim rstPilot As New ADODB.RecordSet

ChkPilotEMS = Chk

End Function

**D.16 GetHours Function**

Public Function GetHours(ByVal PilotID As Integer, ByVal ACType As String) As Double

Dim Hours As Double
Dim Total As Double

Total = 0
Hours = 0

Dim rstPilotLog As New ADODB.RecordSet


GetHours = Total

End Function

**D.17 Azimuth Function**
Public Function Azimuth(ByVal lat1 As Double, ByVal lon1 As Double, ByVal lat2 As Double, ByVal lon2 As Double) As Double
    ' THIS Calculates Azimuth or forward azimuth between two points (lon & lat entered as rad)
    ' Uses Vincenty’s Inverse Formula
    --- The following allows for having the same lon
    If lon1 = lon2 And lat1 < lat2 Then
        Azimuth = 0
        Exit Function
    End If
    If lon1 = lon2 And lat1 > lat2 Then
        Azimuth = PI
        Exit Function
    End If
    ---
    Dim U1 As Double
    Dim U2 As Double
    Dim f As Double 'flatenning
    Dim A As Double 'Semi major axis
    Dim b As Double 'Semi minor axis
    Dim lambda As Double
    Dim omega As Double 'Diff longitude (w)
    Dim Test As Double
    Dim Eqn1 As Double
    Dim Eqn2 As Double
    Dim Eqn3 As Double
    Dim Eqn4 As Double
    Dim Eqn5 As Double
    Dim Eqn6 As Double
    Dim Count As Double
    Dim lambda_eqn_pt2 As Double
    omega = lon2 - lon1
    f = 0.0033528107
    U1 = Atn((1 - f) * Tan(lat1))
    U2 = Atn((1 - f) * Tan(lat2))
    lambda = omega
    Count = 0
    ' this loop is so the value of lambda converges
    Do While Count < 10
        Count = Count + 1
        Eqn1 = (Cos(U2) * Sin(lambda)) ^ 2 + (Cos(U1) * Sin(U2) - Sin(U1) * Cos(U2) * Sin(lambda)) ^ 2
        Eqn2 = Sin(U1) * Sin(U2) + Cos(U1) * Cos(U2) * Cos(lambda)
        Eqn3 = Sqr(Eqn1) / Eqn2
        If Eqn1 = 0 Then
            Eqn4 = 0
        Else
            Eqn4 = Cos(U1) * Cos(U2) * Sin(lambda) / Sqr(Eqn1)
        End If
        If Eqn1 = 0 Then
            Eqn5 = 0
        Else
            Eqn5 = Eqn4
        End If
        If Eqn5 = 0 Then
            Eqn6 = 0
        Else
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D.18 GridtoGeo_lat Function

Public Function GridtoGeo_lat(ByVal zone As Double, ByVal easting As Double, ByVal northing As Double) As Double

' Easting measured from the false origin (E' + 500,000m for MGA94)
' Northing from false origin (N' + 10,000,000m for MGA94)

Dim footpointlat As Double
Dim footpointlat_1 As Double
Dim footpointlat_2 As Double
Dim footpointlat_3 As Double
Dim footpointlat_4 As Double
Dim n As Double 'flattening
Dim G As Double ' mean length of an arc of one degree of the meridian
Dim m As Double 'central scale factor
Dim Ndash As Double ' Northing measured from the equater South neg
Dim FalseN As Double ' False Northing Origin (10,000,000m for MGA94)
Dim Edash As Double 'Easting measured from the central meridian
Dim FalseE As Double ' False Easting Origin (500,000m for MGA94)
Dim A As Double 'Semi Major axis 6,378,137.000 for GRS80 and WGS84
Dim b As Double 'Semi Minor axis
Dim sigma As Double 'Meridian distance expressed as units G
Dim k0 As Double ' Central Scale Factor on the Central Meridian (for 0.9996 for MGA94)
Dim e2 As Double ' eccentricity squared
Dim rho As Double 'radius of curvature of the ellipsoid in the plane of the meridian
Dim nu As Double 'radius of curvature of the ellipsoid in the prime vertical
Dim psi As Double ' Ratio of the ellipsoidal radii of curvature
Dim tdash As Double
Dim x As Double
Dim lat_term1 As Double
Dim lat_term2 As Double
Dim lat_term3 As Double
Dim lat_term3_2 As Double
Dim lat_term4 As Double

'------ ELLIPSOID DATA
f = 0.003352810681 ' GRS80 or Coord GDA/MGA
A = 6378137    'Semi Major axis 6,378,137.000 for GRS80 and WGS84
k0 = 0.9996 ' Central Scale Factor on the Central Meridian (for 0.9996 for MGA94)
b = A * (1 - f)
e2 = (A ^ 2 - b ^ 2) / A ^ 2

'---------------------------------
FalseN = 10000000
FalseE = 500000

Ndash = northing - FalseN
Edash = easting - FalseE
m = Ndash / k0
n = f / (2 - f)
G = A * (1 - n) * (1 - n ^ 2) * (1 + 2.25 * n ^ 2 + (225 / 64) * n ^ 4) * (PI / 180)
sigma = (m * PI) / (180 * G)

footpointlat_1 = sigma + ((3 * n / 2) - (27 * n ^ 3 / 32)) * Sin(2 * sigma)
footpointlat_2 = ((21 * n ^ 2 / 16) - (55 * n ^ 4 / 32)) * Sin(4 * sigma)
footpointlat_3 = (151 * n ^ 3 / 96) * Sin(6 * sigma)
footpointlat_4 = (1097 * n ^ 4 / 512) * Sin(8 * sigma)
footpointlat = footpointlat_1 + footpointlat_2 + footpointlat_3 + footpointlat_4

rho = A * (1 - e2) / ((1 - e2 * Sin(footpointlat) * Sin(footpointlat)) ^ (3 / 2))
nu = A / Sqr(1 - e2 * Sin(footpointlat) * Sin(footpointlat))
psi = nu / rho

x = Edash / (k0 * nu)
tdash = Tan(footpointlat)

lat_term1 = (tdash / (k0 * rho)) * (x * Edash / 2)
lat_term2 = (tdash / (k0 * rho)) * (Edash * x ^ 3 / 24) * (-4 * psi ^ 2 + 9 * psi * (1 - tdash ^ 2) + 12 * tdash ^ 2)
lat_term3_2 = (8 * psi ^ 4 * (11 - 24 * tdash ^ 2) - 12 * psi ^ 3 * (21 - 71 * tdash ^ 2) + 15 * psi ^ 2 * (15 - 98 * tdash ^ 2) + 15 * tdash ^ 4) + 180 * psi * (5 * tdash ^ 2 - 3 * tdash ^ 4 + 360 * tdash ^ 4)
lat_term3 = (tdash / (k0 * rho)) * (Edash * x ^ 5 / 720) * lat_term3_2
lat_term4 = (tdash / (k0 * rho)) * (Edash * x ^ 7 / 40320) * (I385 + 3633 * tdash ^ 2 + 4095 * tdash ^ 2 + 1575 * tdash ^ 6)

GridtoGeo_lat = ToDeg(footpointlat - lat_term1 + lat_term2 - lat_term3 + lat_term4)

End Function

**D.19 GridtoGeo_lon Function**

Public Function GridtoGeo_lon(ByVal zone As Double, ByVal easting As Double, ByVal northing As Double) As Double

' Easting measured from the false origin (E' + 500,000m for MGA94)
' Northing from false origin (N' + 10,000,000m for MGA94)

Dim footpointlat As Double
Dim footpointlat_1 As Double
Dim footpointlat_2 As Double
Dim footpointlat_3 As Double
Dim footpointlat_4 As Double
Dim n As Double
Dim f As Double 'flattening
Dim G As Double ' mean length of an arc of one degree of the meridian
Dim m As Double 'central scale factor
Dim Ndash As Double ' Northing measured from the equator South neg
Dim FalseN As Double ' False Northing Origin (10,000,000m for MGA94)
Dim Edash As Double 'Easting measured from the central meridian
Dim FalseE As Double ' False Easting Origin (500,000m for MGA94
Dim A As Double 'Semi Major axis 6,378,137.000 for GRS80 and WGS84
Dim b As Double 'Semi Minor axis
Dim k0 As Double ' Central Scale Factor on the Central Meridian (for 0.9996 for MGA94)
Dim e2 As Double ' eccentricity squared
Dim lon0 As Double 'Geodetic Longitude of the central meridian
Dim zonewidth As Double ' zone width in degrees
Dim lon0_1 As Double ' longitude of the central meridian of zone 1

Dim rho As Double 'radius of curvature of the ellipsoid in the plane of the meridian
Dim nu As Double 'radius of curvature of the ellipsoid in the prime vertical
Dim psi As Double ' Ratio of the ellipsoidal radii of curvature

Dim tdash As Double 'tan(footpointlat)
Dim x As Double
Dim lon_term1 As Double
Dim lon_term2 As Double
Dim lon_term3 As Double
Dim lon_term4 As Double

'------ ELLIPSOID DATA
f = 0.003352810681 ' GR80 or Coord GDA/MGA
A = 6378137 'Semi Major axis 6,378,137.000 for GRS80 and WGS84
k0 = 0.9996 ' Central Scale Factor on the Central Meridian (for 0.9996 for MGA94)
b = A * (1 - f)
e2 = (A ^ 2 - b ^ 2) / A ^ 2

---------------------

FalseN = 10000000
FalseE = 500000
zonewidth = 6 ' zone width in degrees
lon0_1 = -177 ' longitude of the central meridian of zone 1

Ndash = northing - FalseN
Edash = easting - FalseE
m = Ndash / k0

n = f / (2 - f)
G = A * (1 - n) * (1 - n ^ 2) * (1 + 2.25 * n ^ 2 + (225 / 64) * n ^ 4) * (PI / 180)
sigma = (m * PI) / (180 * G)

footpointlat_1 = sigma + (((3 * n / 2) - (27 * n ^ 3 / 32)) * Sin(2 * sigma)
footpointlat_2 = ((21 * n ^ 2 / 16) - (55 * n ^ 4 / 32)) * Sin(4 * sigma)
footpointlat_3 = (151 * n ^ 3 / 96) * Sin(6 * sigma)
footpointlat_4 = (1097 * n ^ 4 / 512) * Sin(8 * sigma)

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footpointlat = footpointlat_1 + footpointlat_2 + footpointlat_3 + footpointlat_4
rho = A * (1 - e2) / ((1 - e2 * Sin(footpointlat)) * Sin(footpointlat)) ^ (3 / 2))
u = A / Sqr(1 - e2 * Sin(footpointlat) * Sin(footpointlat))
psi = nu / rho
x = Edash / (k0 * nu)
tdash = Tan(footpointlat)
lon_term1 = x * Sec(footpointlat)
lon_term2 = (x ^ 3 / 6) * Sec(footpointlat) * (psi + 2 * tdash ^ 2)
lon_term3 = (x ^ 5 / 120) * Sec(footpointlat) * (-4 * psi ^ 3 * (1 - 6 * tdash ^ 2) + psi ^ 2 * (9 - 68 * tdash ^ 2) + 72 * psi * tdash ^ 2 + 24 * tash ^ 4)
lon_term4 = (x ^ 7 / 5040) * Sec(footpointlat) * (61 + 662 * tdash ^ 2 + 1320 * tdash ^ 4 + 720 * tdash ^ 6)
lon0 = ToRad((zone * zonewidth) + lon0_1 - zonewidth)
GridToGeo_lon = ToDeg(lon0 + lon_term1 - lon_term2 + lon_term3 - lon_term4)

End Function

**D.20 LatPoint Function**

Public Function lat_point(ByVal lat1 As Double, ByVal lon1 As Double, ByVal Distance As Double, ByVal Azimuth As Double) As Double
' THIS Calculates the Latitude of a point given its distance and azimuth from point 1
' lon & lat entered as rad
' distance as NM
' azimuth as rad
' Uses Vincenty's Direct Formula
Distance = Distance / 0.0005399568 'converts distance to meters
Dim U1 As Double
Dim f As Double 'flatenning
Dim A As Double 'Semi major axis
Dim b As Double 'Semi minor axis
Dim lambda As Double
Dim omega As Double 'Diff longitude (w)
Dim sigma As Double
f = 0.0033528107
A = 6378137
b = 6356752.31414091
Dim Eqn1 As Double
Dim Eqn2 As Double
Dim Eqn3 As Double
Dim Eqn4 As Double
Dim Eqn4_pt2 As Double
Dim Eqn5 As Double
Dim Eqn6 As Double
Dim Eqn7 As Double
Dim Eqn8 As Double
Dim Eqn9 As Double
U1 = Atn((1 - f) * Tan(lat1))
Eqn1 = Tan(U1) / Cos(Azimuth)
Eqn2 = Cos(U1) * Sin(Azimuth)
Eqn3 = Cos(Asin(Eqn2)) * Cos(Asin(Eqn2)) * (A \(^2 - b \, ^2\)) / b \(^2\)
Eqn4\_pt2 = (-768 + Eqn3 \* (320 - 175 \* Eqn3))
Eqn4 = 1 + (Eqn3 / 16384) \* (4096 + Eqn3 \* Eqn4\_pt2)
Eqn5 = (Eqn3 / 1024) \* (256 + Eqn3 \* (-128 + Eqn3 \* (74 - 47 \* Eqn3)))

\[\text{sigma} = \frac{\text{Distance}}{b \times \text{Eqn4}}\]

\[\text{Count} = 0\]

Do While Count < 10

\[\text{Count} = \text{Count} + 1\]
\[\text{Eqn6} = 2 \times \text{Atn(Eqn1)} + \text{sigma}\]
\[\text{Eqn7} = \text{Eqn5} \times \sin(\text{sigma}) \times (\cos(\text{Eqn6}) + (\text{Eqn5} / 4) \times (\cos(\text{sigma}) \times (-1 + 2 \times \cos(\text{Eqn6}) \times \cos(\text{Eqn6})) - (\text{Eqn5} / 6) \times \cos(\text{Eqn6}) \times (-3 + 4 \times \sin(\text{sigma}) \times \sin(\text{sigma})) \times (-3 + 4 \times \cos(\text{Eqn6}) \times \cos(\text{Eqn6}))))\]
\[\text{sigma} = \frac{\text{Distance}}{b \times \text{Eqn4}} + \text{Eqn7}\]

Loop

\[\text{Eqn8} = \sin(U1) \times \cos(\text{sigma}) + \cos(U1) \times \sin(\text{sigma}) \times \cos(\text{Azimuth})\]
\[\text{Eqn9} = \left(1 - f\right) \times (\text{Eqn2} \times 2 + (\sin(U1) \times \sin(\text{sigma}) - \cos(U1) \times \cos(\text{sigma}) \times \cos(\text{Azimuth})) \times 2) \times 0.5\]
\[\text{lat\_point} = \frac{\text{Atn(Eqn8)}}{\text{Eqn9}}\]

End Function

**D.21 LonPoint Function**

Public Function LonPoint(ByVal lat1 As Double, ByVal lon1 As Double, ByVal Distance As Double, ByVal Azimuth As Double) As Double

' THIS Calculates the Longitude of a point given its distance and
azimuth from point 1
- lon & lat entered as rad
- distance as NM
- azimuth as rad
- Uses Vincenty's Direct Formula

\[\text{Distance} = \frac{\text{Distance}}{0.0005399568}\] 'converts distance to meters

Dim U1 As Double
Dim f As Double 'flatenning
Dim A As Double 'Semi major axis
Dim b As Double 'Semi minor axis
Dim sigma As Double

\[f = 0.0033528107\]
\[A = 6378137\]
\[b = 6356752.31414091\]

Dim Eqn1 As Double
Dim Eqn2 As Double
Dim Eqn3 As Double
Dim Eqn4\_pt2 As Double
Dim Eqn4 As Double
Dim Eqn5 As Double
Dim Count As Double
Dim Eqn6 As Double
Dim Eqn7 As Double
Dim Eqn8 As Double
Dim Eqn9 As Double
Dim Eqn10 As Double
Dim Eqn10\_pt2 As Double

\[U1 = \text{Atn}\left((1 - f) \times \tan(\text{lat1})\right)\]
\[\text{Eqn1} = \tan(U1) / \cos(\text{Azimuth})\]
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Eqn2 = Cos(U1) * Sin(Azimuth)
Eqn3 = Cos(Asin(Eqn2)) * Cos(Asin(Eqn2)) * (A^2 - b^2) / b^2
Eqn4_pt2 = (-768 + Eqn3 * (320 - 175 * Eqn3))
Eqn4 = 1 + (Eqn3 / 16384) * (4096 + Eqn3 * Eqn4_pt2)
Eqn5 = (Eqn3 / 1024) * (256 + Eqn3 * (-128 + Eqn3 * (74 - 47 * Eqn3)))

sigma = Distance / (b * Eqn4)
Count = 0
Do While Count < 10
Count = Count + 1
Eqn6 = 2 * Atn(Eqn1) + sigma
Eqn7 = Eqn5 * Sin(sigma) * (Cos(Eqn6) + (Eqn5 / 4) * (Cos(sigma) * (-1 + 2 * Cos(Eqn6) * Cos(Eqn6)) - (Eqn5 / 6) * Cos(Eqn6) * (-3 + 4 * Sin(sigma) * Sin(sigma)) * (-3 + 4 * Cos(Eqn6) * Cos(Eqn6))))

sigma = Distance / (b * Eqn4) + Eqn7
Loop

Eqn8 = (Sin(sigma) * Sin(Azimuth)) / (Cos(U1) * Cos(sigma) - Sin(U1) * Sin(Azimuth))
Eqn9 = (f / 16) * Cos(Asin(Eqn2)) * Cos(Asin(Eqn2)) * (4 + f * (4 - 3 * Cos(Asin(Eqn2)) * Cos(Asin(Eqn2))))
Eqn10 = 2 * Atn(Eqn8) - (1 - Eqn9) * f * Eqn2 * (sigma + Eqn9 * Sin(sigma) * Eqn10)

lon_point = lon1 + Eqn10

End Function

D.22 DistanceNM Function

Public Function DistanceNM(ByVal lat1 As Double, ByVal lon1 As Double, ByVal lat2 As Double, ByVal lon2 As Double) As Double
' THIS Calculates the ellipsoidal distance between two points (lon & lat entered as rad)
' Uses Vincenty's Inverse Formula
Dim U1 As Double
Dim U2 As Double
Dim f As Double 'flatenning
Dim A As Double 'Semi major axis
Dim b As Double 'Semi minor axis
Dim lambda As Double
Dim omega As Double 'Diff longitude (w)
Dim Eqn1 As Double
Dim Eqn2 As Double
Dim Eqn3 As Double
Dim Eqn4 As Double
Dim Eqn5 As Double
Dim Eqn6 As Double
Dim Eqn7 As Double
Dim Eqn8 As Double
Dim Eqn8_pt2 As Double
Dim Eqn9 As Double
Dim Eqn10 As Double
Dim Eqn10_pt2 As Double
Dim Count As Double
Dim lambda_eqn_pt2 As Double

End Function
omega = lon2 - lon1
f = 0.0033528107
A = 6378137
b = 6356752.31414091

U1 = Atan((1 - f) * Tan(lat1))
U2 = Atan((1 - f) * Tan(lat2))

lambda = omega
Count = 0

' this loop is so the value of lambda converges
Do While Count < 10
  Count = Count + 1
  Eqn1 = (Cos(U2) * Sin(lambda)) ^ 2 + (Cos(U1) * Sin(U2) - Sin(U1) * Cos(U2) * Cos(lambda)) ^ 2
  Eqn2 = Sin(U1) * Sin(U2) + Cos(U1) * Cos(U2) * Cos(lambda)
  Eqn3 = Sqr(Eqn1) / Eqn2
  If Eqn1 = 0 Then
    Eqn4 = 0
  Else
    Eqn4 = Cos(U1) * Cos(U2) * Sin(lambda) / Sqr(Eqn1)
  End If
  If Cos(Asin(Eqn4)) * Cos(Asin(Eqn4)) = 0 Then
    Eqn5 = 0
  Else
    Eqn5 = Eqn2 - (2 * Sin(U1) * Sin(U2) / (Cos(Asin(Eqn4)) * Cos(Asin(Eqn4))))
  End If
  Eqn6 = (f / 16) * Cos(Asin(Eqn4)) * Cos(Asin(Eqn4)) * (4 + f * (4 - 3 * Cos(Asin(Eqn4)) * Cos(Asin(Eqn4))))
  lambda_eqn_pt2 = (Eqn5 + Eqn6 * Eqn2 * (A ^ 2 - b ^ 2) / b ^ 2)
  lambda = omega + (1 - Eqn6) * f * Eqn4 * (Atan(Eqn3) + Eqn6 * Sqr(Eqn1) * lambda_eqn_pt2)
  Loop
End If

Eqn7 = Cos(Asin(Eqn4)) * Cos(Asin(Eqn4)) * (A ^ 2 - b ^ 2) / b ^ 2
Eqn8_pt2 = (-768 + Eqn7 * (320 - 175 * Eqn7))
Eqn8 = 1 + (Eqn7 / 16384) * (4096 + Eqn7 * Eqn8_pt2)
Eqn9 = (Eqn7 / 1024) * (256 + Eqn7 * (-128 + Eqn7 * (74 - 47 * Eqn7)))
Eqn10_pt2 = Eqn5 * (3 + 4 * Eqn1) * (-1 + 4 * Eqn5 * Eqn5)
DistanceNM = (b * Eqn8 * (Atan(Eqn3) - Eqn10)) * 0.0005399568

Public Function GetAC(ByVal Resource As String) As String
    Dim SQL As String
    Dim Make As String
    Dim ID As String
    Dim RstResource As New ADODB.RecordSet

    D.23 GetAC Function
Appendix D
Model Base VBA Code

```
SQL = "SELECT tbl_Resources.[AC Type] FROM tbl_Resources WHERE
(((tbl_Resources.[Resource])='" & Resource & "'))"
RstResource.Open SQL, CurrentProject.Connection, adOpenKeyset
RstResource.Fields.Refresh
RstResource.MoveNext
ID = RstResource("AC Type").Value
RstResource.Close
Set RstResource = Nothing

Dim RstACType As New ADODB.RecordSet
SQL = "SELECT tbl_AircraftTypes.[Make] FROM tbl_AircraftTypes
WHERE (((tbl_AircraftTypes.[Aircraft ID])='" & ID & "'))"
RstACType.Open SQL, CurrentProject.Connection, adOpenKeyset
RstACType.Fields.Refresh
RstACType.MoveNext
Make = RstACType("Make").Value
RstACType.Close
Set RstACType = Nothing

GetAC = Make

End Function

D.24 GetAFCode Function

Public Function GetAFCode(ByVal Lat As Double, ByVal Lon As Double) As String
Dim Code As String
Dim rstAF As New ADODB.RecordSet
SQL = "SELECT tbl_Airfields.Code FROM tbl_Airfields WHERE
(((tbl_Airfields.Lat)=" & Lat & ") AND ((tbl_Airfields.Long)=" & Lon & "))"
rstAF.Open SQL, CurrentProject.Connection, adOpenDynamic
rstAF.MoveFirst
Code = rstAF("Code").Value
rstAF.Close
Set rstAF = Nothing

GetAFCode = Code
End Function

D.25 GetAirfieldAlt Function

Public Function GetAirfieldAlt(ByVal Code As String) As Double
Dim Alt As Double
Dim rstAF As New ADODB.RecordSet
SQL = "SELECT tbl_Airfields.Altitude FROM tbl_Airfields WHERE
(((tbl_Airfields.Code)='" & Code & "'))"
rstAF.Open SQL, CurrentProject.Connection, adOpenDynamic
Alt = rstAF("Altitude").Value
rstAF.Close
Set rstAF = Nothing

GetAirfieldAlt = Alt
End Function

D.26 GetAirfieldLat Function
```
Public Function GetAirfieldLat(ByVal Code As String) As Double
    Dim Lat As Double
    Dim rstAF As New ADODB.RecordSet
    SQL = "SELECT tbl_Airfields.Lat FROM tbl_Airfields WHERE ((tbl_Airfields.Code)=" & Code & ")"
    rstAF.Open SQL, CurrentProject.Connection, adOpenDynamic
    Lat = rstAF("Lat").Value
    rstAF.Close
    Set rstAF = Nothing
    GetAirfieldLat = Lat
End Function

**D.27 GetAirfieldLon Function**

Public Function GetAirfieldLon(ByVal Code As String) As Double
    Dim Lon As Double
    Dim rstAF As New ADODB.RecordSet
    SQL = "SELECT tbl_Airfields.Long FROM tbl_Airfields WHERE ((tbl_Airfields.Code)=" & Code & ")"
    rstAF.Open SQL, CurrentProject.Connection, adOpenDynamic
    Lon = rstAF("Long").Value
    rstAF.Close
    Set rstAF = Nothing
    GetAirfieldLon = Lon
End Function

**D.28 GetCrewName Function**

Public Function GetCrewName(ByVal CrewID As Integer) As String
    ' Retrieves the Crewmans Name
    Dim SQL As String
    Dim CrewName As String
    Dim RstCrewman As New ADODB.RecordSet
    SQL = "SELECT tbl_Crewman.[Family Name], tbl_Crewman.[Given Name] FROM tbl_Crewman WHERE (((tbl_Crewman.[Crewman ID])=" & CrewID & "))"
    RstCrewman.Open SQL, CurrentProject.Connection, adOpenKeyset
    RstCrewman.Fields.Refresh
    RstCrewman.MoveFirst
    CrewName = RstCrewman("Family Name").Value + ", " + RstCrewman("Given Name").Value
    RstCrewman.Close
    Set RstCrewman = Nothing
    GetCrewName = CrewName
End Function

**D.29 GetHLSAlt Function**

Public Function GetHLSAlt(ByVal Code As String) As Double
    Dim Alt As Double
    Dim rstHLS As New ADODB.RecordSet
    SQL = "SELECT tbl_Airfields.Lat FROM tbl_Airfields WHERE ((tbl_Airfields.Code)=" & Code & ")"
    rstHLS.Open SQL, CurrentProject.Connection, adOpenDynamic
    Alt = rstHLS("Alt").Value
    rstHLS.Close
    Set rstHLS = Nothing
    GetHLSAlt = Alt
End Function
Appendix D
Model Base VBA Code

D.30 GetHLSCode Function

Public Function GetHLSCode(ByVal Lat As Double, ByVal Lon As Double) As String
    Dim Code As String
    Dim rstHLS As New ADODB.RecordSet
    SQL = "SELECT tbl_Helipads.Helipad FROM tbl_Helipads WHERE (((tbl_Helipads.Lat)=" & Lat & ") AND (((tbl_Helipads.Long)=" & Lon & "))"  
    rstHLS.Open SQL, CurrentProject.Connection, adOpenDynamic
    rstHLS.MoveFirst
    Code = rstHLS("Helipad").Value
    rstHLS.Close
    Set rstHLS = Nothing
    GetHLSCode = Code
End Function

D.31 GetMET Function

Public Function GetMET(ByVal Code As String) As String
    Dim Report As String
    Dim rstWReports As New ADODB.RecordSet
    rstWReports.Open "tbl_WReports", CurrentProject.Connection, adOpenKeyset
    rstWReports.Fields.Refresh
    rstWReports.MoveFirst
    Do While Not rstWReports.EOF
        If rstWReports("WCode").Value = Code Then
            Report = rstWReports("Report").Value
        End If
        rstWReports.MoveNext
    Loop
    rstWReports.Close
    Set rstWReports = Nothing
    If Report <> "" Then
        GetMET = Report + vbCrLf + vbCrLf + vbCrLf + vbCrLf
    Else
        GetMET = Code + " - No AIS/MET Data Available" + vbCrLf + vbCrLf
    End If
End Function
Appendix D
Model Base VBA Code

D.32 GetNOTAM Function

Public Function GetNOTAM(ByVal Code As String) As String
    Dim NOTAM As String
    Dim rstNOTAMs As New ADODB.RecordSet
    rstNOTAMs.Open "tbl_NOTAMs", CurrentProject.Connection, adOpenKeyset
    rstNOTAMs.Fields.Refresh
    rstNOTAMs.MoveFirst

    Do While Not rstNOTAMs.EOF
        If rstNOTAMs("Code").Value = Code Then
            NOTAM = rstNOTAMs("NOTAM").Value
        End If
        rstNOTAMs.MoveNext
    Loop
    rstNOTAMs.Close
    Set rstNOTAMs = Nothing

    If NOTAM <> "" Then
        GetNOTAM = NOTAM + vbCrLf + vbCrLf + vbCrLf + vbCrLf
    Else
        GetNOTAM = Code + " - No Current NOTAMs" + vbCrLf + vbCrLf + vbCrLf
    End If
End Function

D.33 GetParaName Function

Public Function GetParaName(ByVal ParaID As Integer) As String
    ' Retrieves the Paramedics Name
    Dim SQL As String
    Dim CrewName As String
    Dim RstCrewman As New ADODB.RecordSet
    SQL = "SELECT tbl_Paramedics.[Family Name], tbl_Paramedics.[Given Name] FROM tbl_Paramedics WHERE (((tbl_Paramedics.[Paramedic ID])=" & ParaID & "))"
    RstCrewman.Open SQL, CurrentProject.Connection, adOpenKeyset
    RstCrewman.Fields.Refresh
    RstCrewman.MoveFirst
    CrewName = RstCrewman("Family Name").Value + ", " + RstCrewman("Given Name").Value
    RstCrewman.Close
    Set RstCrewman = Nothing

    GetParaName = CrewName
End Function

D.34 GetPilotName Function

Public Function GetPilotName(ByVal PilotID As Integer) As String
    ' Retrieves the Pilots Name
    Dim SQL As String
    Dim PilotName As String
    Dim RstPilots As New ADODB.RecordSet
    Dim SQL As String
    Dim PilotName As String
    Dim RstPilots As New ADODB.RecordSet
SQL = "SELECT tbl_Pilot.[Family Name], tbl_Pilot.[Given Name] FROM tbl_Pilot WHERE (((tbl_Pilot.[Pilot ID])=" & PilotID & "))"
RstPilots.Open SQL, CurrentProject.Connection, adOpenKeyset
RstPilots.Fields.Refresh
RstPilots.MoveNext
PilotName = RstPilots("Family Name").Value + ", " + RstPilots("Given Name").Value
RstPilots.Close
Set RstPilots = Nothing
GetPilotName = PilotName

End Function

**D.35 GetRequestDate Function**

Public Function GetRequestDate(ByVal ID As Integer) As Date
Dim SQL As String
Dim Recieved As Date
Dim RstRequests As New ADODB.RecordSet
SQL = "SELECT tbl_Requests.[Date/Time Recieved] FROM tbl_Requests WHERE (((tbl_Requests.[Request ID])=" & ID & "))"
RstRequests.Open SQL, CurrentProject.Connection, adOpenKeyset
RstRequests.Fields.Refresh
RstRequests.MoveNext
Recieved = RstRequests("Date/Time Recieved").Value
RstRequests.Close
Set RstRequests = Nothing
GetRequestDate = Recieved

End Function

**D.36 HasFuel Function**

Public Function HasFuel(ByVal Lat As Double, ByVal Lon As Double) As Boolean
Dim Fuel As Boolean
Dim rstFuel As New ADODB.RecordSet
SQL = "SELECT tbl_Airfields.Fuel, tbl_Airfields.Lat, tbl_Airfields.Long FROM tbl_Airfields WHERE (((tbl_Airfields.Fuel)=True) AND ((tbl_Airfields.Lat)=" & Lat & ") AND ((tbl_Airfields.Long)=" & Lon & "))"
rstFuel.Open SQL, CurrentProject.Connection, adOpenStatic
If rstFuel.RecordCount = 0 Then
Fuel = False
Else
Fuel = True
End If
rstFuel.Close
Set rstFuel = Nothing
HasFuel = Fuel

End Function

**D.37 ToDeg Function**

Public Function ToDeg(x) As Double
ToDeg = x * 180 / PI
End Function

**D.38 ToRad Function**

Public Function ToRad(x) As Double
ToRad = x / 180 * PI
End Function

**D.39 Atan2 Function**

Public Function Atan2(y, x) As Double
On Error GoTo Err_Atan2
If x > 0 Then
   Atan2 = Atn(y / x)
Else
   If x < 0 And y >= 0 Then
      Atan2 = Atn(y / x) + PI
   Else
      If x = 0 And y > 0 Then
         Atan2 = PI / 2
      Else
         If x < 0 And y < 0 Then
            Atan2 = Atn(y / x) - PI
         Else
            If x = 0 And y < 0 Then
               Atan2 = -PI / 2
            Else
               GoTo Err_Atan2
            End If
         End If
      End If
   End If
End If
Exit_Atan2:
   Exit Function
Err_Atan2:
   MsgBox Err.Description
   Exit Function
End Function

**D.40 Acos Function**

Public Function Acos(x) As Double
On Error GoTo Err_Acos
   If x >= 0 Then
      Acos = 2 * Atn(Sqr((1 - x) / (1 + x)))
   Else
      Acos = PI - 2 * Atn(Sqr((1 + x) / (1 - x)))
   End If
Exit_Acos:
   Exit Function
Err_Acos:
   MsgBox Err.Description
   Exit Function
D.41  Asin Function

Public Function Asin(x) As Double
On Error GoTo Err_Asin
    Asin = 2 * Atn(x / (1 + Sqr(1 - x * x)))
Exit_Asin:
    Exit Function
Err_Asin:
    MsgBox Err.Description
    Exit Function
End Function

D.42  Sec Function

Public Function Sec(x) As Double
On Error GoTo Err_sec
    If Cos(x) = 0 Then
        GoTo Err_sec
    Else
        Sec = 1 / Cos(x)
    End If
Exit_sec:
    Exit Function
Err_sec:
    MsgBox Err.Description
    Exit Function
End Function

D.43  LatFormat Function

Public Function LatFormat(ByVal Lat As Double) As String
    Dim LatWhole As Integer
    Dim LatMinutes As Double
    Dim LatSeconds As Double
    Dim NS As String
    If Lat >= 0 Then
        NS = "N"
    Else
        NS = "S"
        Lat = Lat * -1
    End If
    LatWhole = Int(Lat)
    LatMinutes = (Lat - LatWhole) * 60
    LatSeconds = Round((LatMinutes - Int(LatMinutes)) * 60, 0)
    LatMinutes = Int(LatMinutes)
LatFormat = "" & LatWhole & "° " & LatMinutes & "" " & LatSeconds & "' " & NS
End Function

**D.44 LonFormat Function**

Public Function LonFormat(ByVal Lon As Double) As String
Dim LonWhole As Integer
Dim LonMinutes As Double
Dim LonSeconds As Double
Dim EW As String
    If Lon >= 0 Then
        EW = "E"
    Else
        EW = "W"
        Lon = Lon - 1
    End If
    LonWhole = Int(Lon)
    LonMinutes = (Lon - LonWhole) * 60
    LonSeconds = Round((LonMinutes - Int(LonMinutes)) * 60, 0)
    LonMinutes = Int(LonMinutes)
    LonFormat = "" & LonWhole & "° " & LonMinutes & "" " & LonSeconds & "' " & EW
End Function

**D.45 RosterDate Function**

Public Function RosterDate(ByVal MyHour As Double) As Date
    If MyHour < 8 Then
        RosterDate = Date - 1
    Else
        RosterDate = Date
    End If
End Function

**D.46 Shift Function**

Public Function Shift(ByVal MyHour As Double) As Integer
    If MyHour >= 8 And MyHour < 18 Then
        Shift = 1
    Else
        Shift = 2
    End If
End Function

**D.47 YesNo Function**
Public Function YesNo(ByVal val As Integer) As String

If val = 0 Then
    YesNo = "No"
Else
    YesNo = "Yes"
End If

End Function
Appendix E: Graphical User Interface VBA Code

E.1 WorkSpace VBA Code

Option Compare Database
Dim NumberOfWaypoints As Double

Private Sub List_Primary_Click()
    List_IHT.Selected(-1) = True
End Sub

Private Sub Chk_D1_Click()
    Dim Selected As Integer
    Dim Mission As Integer
    Dim SQL As String
    Dim Resource As String
    Dim Waypoint As Integer
    Waypoint = 1
    Selected = Me.List_Missions.ListIndex
    If Selected = -1 Then
        Exit Sub
    End If
    Mission = Me.List_Missions.ItemData(Selected)
    Dim rstWaypoints As New ADODB.RecordSet
    SQL = "SELECT tbl_Waypoints.Arrive, tbl_Waypoints.Depart FROM tbl_Waypoints WHERE (((tbl_Waypoints.[Mission ID])=" & Mission & ") AND (((tbl_Waypoints.Waypoint)=" & Waypoint & "))"
    rstWaypoints.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
    rstWaypoints.MoveFirst
    rstWaypoints("Depart").Value = Chk_D1.Value
    rstWaypoints.Update
    rstWaypoints.Close
    If Me.Chk_D1.Value = True Then
    Else
    End If
    Txt_MissionNotes_AfterUpdate
End Sub

Private Sub Chk_A2_Click()
    Dim Selected As Integer
    Dim Mission As Integer
    Dim SQL As String
    Dim Resource As String
    Dim Waypoint As Integer
    Waypoint = 2
    Selected = Me.List_Missions.ListIndex
If Selected = -1 Then
    Exit Sub
End If

Mission = Me.List_Missions.ItemData(Selected)

Dim rstWaypoints As New ADODB.RecordSet
SQL = "SELECT tbl_Waypoints.Arrive, tbl_Waypoints.Depart FROM
tbl_Waypoints WHERE (((tbl_Waypoints.[Mission ID])=" & Mission & ")
AND (((tbl_Waypoints.Waypoint)=" & Waypoint & "))"
rstWaypoints.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
rstWaypoints.MoveFirst
rstWaypoints("Arrive").Value = Chk_A2.Value
rstWaypoints.Update
rstWaypoints.Close

If Me.Chk_A2.Value = True Then
    Me.Txt_MissionNotes.Value = Me.Txt_MissionNotes.Value + vbCrLf & 
    Now & ":" + vbCrLf & "Arrived " & Me.Lbl_Name2.Caption
Else
    Me.Txt_MissionNotes.Value = Me.Txt_MissionNotes.Value + vbCrLf & 
    Now & ":" + vbCrLf & "Arrived " & Me.Lbl_Name2.Caption & ": Cancelled"
End If

Txt_MissionNotes_AfterUpdate

End Sub

Private Sub Chk_D2_Click()
    Dim Selected As Integer
    Dim Mission As Integer
    Dim SQL As String
    Dim Resource As String
    Dim Waypoint As Integer

    Waypoint = 2
    Selected = Me.List_Missions.ListIndex

    If Selected = -1 Then
        Exit Sub
    End If

    Mission = Me.List_Missions.ItemData(Selected)

    Dim rstWaypoints As New ADODB.RecordSet
    SQL = "SELECT tbl_Waypoints.Arrive, tbl_Waypoints.Depart FROM
    tbl_Waypoints WHERE (((tbl_Waypoints.[Mission ID])=" & Mission & ")
AND (((tbl_Waypoints.Waypoint)=" & Waypoint & "))"
    rstWaypoints.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
    rstWaypoints.MoveFirst
    rstWaypoints("Depart").Value = Chk_D2.Value
    rstWaypoints.Update
    rstWaypoints.Close

    If Me.Chk_D2.Value = True Then
        Me.Txt_MissionNotes.Value = Me.Txt_MissionNotes.Value + vbCrLf & 
        Now & ":" + vbCrLf & "Departed " & Me.Lbl_Name2.Caption
    Else
        Me.Txt_MissionNotes.Value = Me.Txt_MissionNotes.Value + vbCrLf & 
        Now & ":" + vbCrLf & "Departed " & Me.Lbl_Name2.Caption & ": Cancelled"
    End If

    Txt_MissionNotes_AfterUpdate

End Sub
Private Sub Chk_A3_Click()
Dim Msg, Style, Title, Response
Dim Selected As Integer
Dim Mission As Integer
Dim SQL As String
Dim Resource As String
Dim Waypoint As Integer

Waypoint = 3
Selected = Me.List_Missions.ListIndex
If Selected = -1 Then
    Exit Sub
End If

Mission = Me.List_Missions.ItemData(Selected)

Dim rstWaypoints As New ADODB.RecordSet
SQL = "SELECT tbl_Waypoints.Arrive, tbl_Waypoints.Depart FROM tbl_Waypoints WHERE (((tbl_Waypoints.[Mission ID])=" & Mission & ")
AND (((tbl_Waypoints.Waypoint)=" & Waypoint & "))"
rstWaypoints.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
rstWaypoints.MoveFirst
rstWaypoints("Arrive").Value = Chk_A3.Value
rstWaypoints.Update
rstWaypoints.Close

If NumberofWaypoints = 3 And Chk_A3.Value = True Then
    Msg = "Is the mission complete?" ' Define message.
    Style = vbYesNo + vbCritical + vbDefaultButton2 ' Define buttons.
    Title = "Mission Complete" ' Define title.
    Response = MsgBox(Msg, Style, Title) ' Check if mission complete?
    If Response = vbYes Then ' User chose Yes
        Txt_MissionNotes_AfterUpdate
        Cmd_Complete_Click
    Else
        Chk_A3.Value = False
        End If
Else
    If Me.Chk_A3.Value = True Then
    Else
    End If
    Txt_MissionNotes_AfterUpdate
End If
End Sub

Private Sub Chk_D3_Click()
Dim Resource As String
Dim Waypoint As Integer
Waypoint = 3
Selected = Me.List_Missions.ListIndex
If Selected = -1 Then
    Exit Sub
End If
Mission = Me.List_Missions.ItemData(Selected)

Dim rstWaypoints As New ADODB.RecordSet
SQL = "SELECT tbl_Waypoints.Arrive, tbl_Waypoints.Depart FROM
tbl_Waypoints WHERE (((tbl_Waypoints.[Mission ID])=" & Mission & ")
AND ((tbl_Waypoints.Waypoint)=" & Waypoint & "))"
rstWaypoints.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
rstWaypoints.MoveFirst
rstWaypoints("Depart").Value = Chk_D3.Value
rstWaypoints.Update
rstWaypoints.Close
If Me.Chk_D3.Value = True Then
Else
End If
Txt_MissionNotes_AfterUpdate

End Sub
Private Sub Chk_A4_Click()
    Dim Msg, Style, Title, Response
    Dim Selected As Integer
    Dim Mission As Integer
    Dim SQL As String
    Dim Resource As String
    Dim Waypoint As Integer
    Waypoint = 4
    Selected = Me.List_Missions.ListIndex
    If Selected = -1 Then
        Exit Sub
    End If
    Mission = Me.List_Missions.ItemData(Selected)

    Dim rstWaypoints As New ADODB.RecordSet
    SQL = "SELECT tbl_Waypoints.Arrive, tbl_Waypoints.Depart FROM
tbl_Waypoints WHERE (((tbl_Waypoints.[Mission ID])=" & Mission & ")
AND ((tbl_Waypoints.Waypoint)=" & Waypoint & "))"
    rstWaypoints.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
    rstWaypoints.MoveFirst
    rstWaypoints("Arrive").Value = Chk_A4.Value
    rstWaypoints.Update
    rstWaypoints.Close
    If NumberOfWaypoints = 4 And Chk_A4.Value = True Then
        Msg = "Is the mission complete?" ' Define message.
Style = vbYesNo + vbCritical + vbDefaultButton2
Define buttons.
Title = "Mission Complete"
Define title.
Response = MsgBox(Msg, Style, Title)
Check if mission complete?
  If Response = vbYes Then ' User chose Yes
    Txt_MissionNotes_AfterUpdate
    Cmd_Complete_Click
  End If
Else
  If Me.Chk_A4.Value = True Then
  Else
  End If
End If

End Sub

Private Sub Chk_D4_Click()
  Dim Selected As Integer
  Dim Mission As Integer
  Dim SQL As String
  Dim Resource As String
  Dim Waypoint As Integer

  Waypoint = 4
  Selected = Me.List_Missions.ListIndex
  If Selected = -1 Then
    Exit Sub
  End If
  Mission = Me.List_Missions.ItemData(Selected)

  Dim rstWaypoints As New ADODB.RecordSet
  SQL = "SELECT tbl_Waypoints.Arrive, tbl_Waypoints.Depart FROM tbl_Waypoints WHERE (((tbl_Waypoints.[Mission ID])=" & Mission & ")
  AND (((tbl_Waypoints.Waypoint)=" & Waypoint & ")
  rstWaypoints.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
  rstWaypoints.MoveFirst
  rstWaypoints("Depart").Value = Chk_D4.Value
  rstWaypoints.Update
  rstWaypoints.Close

  If Me.Chk_D4.Value = True Then
  Else
  End If

  Txt_MissionNotes_AfterUpdate
Private Sub Chk_A5_Click()
Dim Msg, Style, Title, Response
Dim Selected As Integer
Dim Mission As Integer
Dim SQL As String
Dim Resource As String
Dim Waypoint As Integer
Waypoint = 5
Selected = Me.List_Missions.ListIndex
If Selected = -1 Then
    Exit Sub
End If
Mission = Me.List_Missions.ItemData(Selected)
Dim rstWaypoints As New ADODB.RecordSet
rstWaypoints.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
rstWaypoints.MoveFirst
rstWaypoints("Arrive").Value = Chk_A5.Value
rstWaypoints.Update
rstWaypoints.Close
If NumberOfWaypoints = 5 And Chk_A5.Value = True Then
    Msg = "Is the mission complete?"  ' Define message.
    Style = vbYesNo + vbCritical + vbDefaultButton2  ' Define buttons.
    Title = "Mission Complete"  ' Define title.
    Response = MsgBox(Msg, Style, Title)  ' Check if mission complete?
    If Response = vbYes Then  ' User chose Yes
        Me.Txt_MissionNotes.AfterUpdate
        Cmd_Complete_Click
    Else
        Chk_A5.Value = False
    End If
End If
End Sub

Private Sub Cmd_Abort_Click()
Dim Selected As Integer
Dim Mission As Integer
Dim SQL As String
Dim Resource As String
Dim RID As Integer
Selected = Me.List_Missions.ListIndex
If Selected = -1 Then
Exit Sub
End If

Mission = Me.List_Missions.ItemData(Selected)

Dim rstMission As New ADODB.RecordSet
SQL = "SELECT tbl_Missions.[Canceled], tbl_Missions.[Resource], tbl_Missions.[Request ID] FROM tbl_Missions WHERE (((tbl_Missions.[Mission ID]) = " & Mission & "))"
rstMission.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
rstMission.MoveFirst
rstMission("Canceled").Value = 1
Resource = rstMission("Resource").Value
RID = rstMission("Request ID").Value
rstMission.Update
rstMission.Close

Dim rstResources As New ADODB.RecordSet
SQL = "SELECT tbl_Resources.Assigned FROM tbl_Resources WHERE (((tbl_Resources.Resource) = " & Resource & "))"
rstResources.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
rstResources("Assigned") = False
rstResources.Update
rstResources.Close

Select Case MsgBox("Do you wish to keep the request pending?", vbYesNo, "Cancel Request")
    Case vbYes
        Dim RstRequests As New ADODB.RecordSet
        SQL = "SELECT tbl_Requests.Accepted FROM tbl_Requests WHERE (((tbl_Requests.[Request ID]) = " & RID & "))"
        RstRequests.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
        RstRequests("Accepted") = False
        RstRequests.Update
        RstRequests.Close
    Case vbNo
End Select
DoCmd.Close acForm, "Frm_WorkSpace"
DoCmd.OpenForm "Frm_WorkSpace", acNormal
End Sub

Private Sub Cmd_CancelMission_Click()
Dim Selected As Integer
Dim Mission As Integer
Dim SQL As String
Dim Resource As String
Dim RID As Integer

Selected = Me.List_Missions.ListIndex
If Selected = -1 Then
    Exit Sub
End If

Mission = Me.List_Missions.ItemData(Selected)

Dim rstMission As New ADODB.RecordSet
SQL = "SELECT tbl_Missions.[Canceled], tbl_Missions.[Resource], tbl_Missions.[Request ID] FROM tbl_Missions WHERE (((tbl_Missions.[Mission ID]) = " & Mission & "))"
rstMission.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
rstMission.MoveFirst
rstMission("Canceled").Value = 1
Resource = rstMission("Resource").Value
RID = rstMission("Request ID").Value
rstMission.Update
rstMission.Close

Dim rstResources As New ADODB.Recordset
SQL = "SELECT tbl_Resources.Assigned FROM tbl_Resources WHERE ((tbl_Resources.Resource)=" & Resource & ")"
rstResources.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
rstResources("Assigned") = False
rstResources.Update
rstResources.Close

Select Case MsgBox("Do you wish to keep the request pending?", vbYesNo, "Cancel Request")
Case vbYes
    Dim RstRequests As New ADODB.Recordset
    SQL = "SELECT tbl_Requests.Accepted FROM tbl_Requests WHERE (((tbl_Requests.[Request ID])=" & RID & ")"
    RstRequests.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
    RstRequests("Accepted") = False
    RstRequests.Update
    RstRequests.Close
Case vbNo
End Select

DoCmd.Close acForm, "Frm_WorkSpace"
DoCmd.OpenForm "Frm_WorkSpace", acNormal

End Sub

Private Sub Cmd_CancelRequest_Click()
    Dim iIdx As Integer
    Dim sItem As Integer
    iIdx = Me.List_Requests.ListIndex
    If iIdx = -1 Then Exit Sub
    sItem = Me.List_Requests.ItemData(iIdx)

    Dim RstRequests As New ADODB.Recordset
    SQL = "SELECT tbl_Requests.Cancelled FROM tbl_Requests WHERE (((tbl_Requests.[Request ID])=" & sItem & ")"
    RstRequests.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
    RstRequests("Cancelled") = True
    RstRequests.Update
    RstRequests.Close

    DoCmd.Close acForm, "Frm_WorkSpace"
    DoCmd.OpenForm "Frm_WorkSpace", acNormal

End Sub

Private Sub Cmd_Complete_Click()
    Dim Selected As Integer
    Dim Mission As Integer
    Dim SQL As String
    Dim Resource As String
Selected = Me.List_Missions.ListIndex
If Selected = -1 Then
    Exit Sub
End If

Mission = Me.List_Missions.ItemData(Selected)

Txt_MissionNotes_AfterUpdate

Dim rstMission As New ADODB.RecordSet
SQL = "SELECT tbl_Missions.[Complete], tbl_Missions.[Resource] FROM tbl_Missions WHERE (((tbl_Missions.[Mission ID])) =" & Mission & ")"
   rstMission.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
   rstMission.MoveNext
   rstMission("Complete").Value = 1
   Resource = rstMission("Resource").Value
   rstMission.Update
   rstMission.Close

Dim rstResources As New ADODB.RecordSet
SQL = "SELECT tbl_Resources.Assigned FROM tbl_Resources WHERE (((tbl_Resources.[Resource])=' & Resource & ")")"
   rstResources.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
   rstResources("Assigned") = False
   rstResources.Update
   rstResources.Close

DoCmd.Close acForm, "Frm_WorkSpace"
DoCmd.OpenForm "Frm_WorkSpace", acNormal
End Sub

Private Sub Cmd_DeclineRequest_Click()
   Dim iIdx As Integer
   Dim sItem As Integer

   iIdx = Me.List_Requests.ListIndex
   If iIdx = -1 Then
      Exit Sub
   End If

   sItem = Me.List_Requests.ItemData(iIdx)

   Dim RstRequests As New ADODB.RecordSet
   SQL = "SELECT tbl_Requests.Declined FROM tbl_Requests WHERE (((tbl_Requests.[Request ID])=' & sItem & ")")"
   RstRequests.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
   RstRequests("Declined") = True
   RstRequests.Update
   RstRequests.Close

   DoCmd.Close acForm, "Frm_WorkSpace"
   DoCmd.OpenForm "Frm_WorkSpace", acNormal
End Sub

Private Sub Cmd_New_Click()
   DoCmd.OpenForm "Frm_NewRequest"
   DoCmd.Close acForm, "Form2"
Private Sub cmd_Profile_Click()
    Dim Selected As Integer
    Dim Mission As Integer

    Selected = Me.List_Missions.ListIndex

    If Selected = -1 Then
        Exit Sub
    End If

    Mission = Me.List_Missions.ItemData(Selected)

End Sub

Private Sub Command_PlanMission_Click()
    Dim iIdx As Integer
    Dim sItem As Integer
    Dim MissionType As String
    Dim SceneLat As Double
    Dim SceneLong As Double
    Dim PrelimHosp As String
    Dim SQL As String

    iIdx = Me.List_Requests.ListIndex
    sItem = Me.List_Requests.ItemData(iIdx)

    Dim Connection As New ADODB.Connection
    Dim Catalog As New ADOX.Catalog
    Dim RstRequests As New ADODB.RecordSet

    SQL = "SELECT tbl_Requests.[Mission Type], tbl_Requests.[Prelim Hospital], tbl_requests.[Accepted] FROM tbl_Requests WHERE (((tbl_Requests.[Request ID])=" & sItem & ")"

    RstRequests.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
    MissionType = RstRequests("Mission Type")
    If MissionType = "Primary" Then
        PrelimHosp = RstRequests("Prelim Hospital")
    End If
    RstRequests.Close

    If MissionType = "Primary" Then
        'Create Hospital List with Distance
        SQL = "SELECT tbl_Requests.[Scene Lat], tbl_Requests.[Scene Long] FROM tbl_Requests WHERE (((tbl_Requests.[Request ID])=" & sItem & ")"

        RstRequests.Open SQL, CurrentProject.Connection, adOpenDynamic
        SceneLat = RstRequests("Scene Lat") 'Gets Scene Lat
        SceneLong = RstRequests("Scene Long") 'Gets Scene Long
        RstRequests.Close
        Set RstRequests = Nothing
Set Catalog = Nothing
Set Connection = Nothing

DoCmd.RunSQL ("DELETE FROM tbl_SelHosp") 'Clears the SelectHospital Table

Dim RstHospitals As New ADODB.RecordSet
SQL = "SELECT tbl_Hospitals.Name, tbl_Helipads.Lat, tbl_Helipads.Long FROM tbl_Helipads INNER JOIN tbl_Hospitals ON tbl_Helipads.Helipad=tbl_Hospitals.Helipad"
RstHospitals.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
RstHospitals.MoveFirst

Dim rstSelectHosp As New ADODB.RecordSet
Do While Not RstHospitals.EOF
    'Connection.Open ProviderStr
    'Set Catalog.ActiveConnection = Connection
    rstSelectHosp.Open "tbl_SelHosp",
    CurrentProject.Connection, adOpenDynamic, adLockOptimistic
    rstSelectHosp.Fields.Refresh
    rstSelectHosp.AddNew
    rstSelectHosp("Hospital") = RstHospitals("Name").Value
    rstSelectHosp("Distance") = Round(DistanceNM(ToRad(SceneLat), ToRad(SceneLong), ToRad(RstHospitals("Lat").Value), ToRad(RstHospitals("Long").Value)), 1)
    rstSelectHosp("Request ID") = sItem
    rstSelectHosp.Update
    rstSelectHosp.Fields.Refresh
    rstSelectHosp.Close
    'Set selectHosp = Nothing
    'Set Catalog = Nothing
    'Connection.Close
    'Set Connection = Nothing

RstHospitals.MoveNext
Loop
RstHospitals.Close
Set RstHospitals = Nothing
Set Catalog = Nothing
Set Connection = Nothing
DoCmd.Close acForm, "Form2"
DoCmd.OpenForm "Frm_SelectHosp"

Else ' Mission is IHST and Construct Select Resource Table

DoCmd.RunSQL ("DELETE FROM tbl_SelectResource1") 'Clears The Select Resource Table

Dim rstResources As New ADODB.RecordSet ' A query containing Resource info : Resource, Type, Base Location (Lat&Lon), cruise speed and TOLT
SQL = "SELECT tbl_Resources.Resource, tbl_Resources.Base, tbl_Airfields.Lat, tbl_Airfields.Long, tbl_AircraftTypes.[Cruise Speed], tbl_AircraftTypes.Range, tbl_AircraftTypes.TOLT, tbl_AircraftTypes.[Refuel Time], tbl_Resources.Assigned, tbl_Resources.Unavailable, tbl_Resources.[AC Type],"
Appendix E
Graphical User Interface VBA Code

```
tbl_AircraftTypes.[Fixed/Rotary] FROM tbl_Airfields INNER JOIN
tbl_AircraftTypes.[Aircraft ID] = tbl_Resources.[AC Type]]) ON
tbl_Airfields.Code = tbl_Resources.Base"  
rstResources.Open SQL, CurrentProject.Connection,
adOpenDynamic, adLockOptimistic
rstResources.MoveFirst

Dim rstSelectResource1 As New ADODB.RecordSet
Dim IHT1 As String      'Requesting IHT Hospital
Dim IHT2 As String      'Recieving IHT Hospital
Dim Transport As Boolean ' Ground Transport Required?
Dim RType As String     'Resource Type FW/Helicopter
Dim BLat As Double      'Base Latitude
Dim Blon As Double      'Base Longitude
Dim H1Lat As Double     'Requesting IHT Hospital Latitude
Dim H1Lon As Double     'Requesting IHT Hospital Longitude
Dim H2Lat As Double     'Recieving IHT Hospital Latitude
Dim H2Lon As Double     'Recieving IHT Hospital Longitude
Dim Base As String      'Resource Base
Dim RFLat As Double     'Refuel Lat
Dim RFLon As Double     'Refuel Lon
Dim D1 As Double        'Distance to Scene
Dim D2 As Double        'Distance to Hospital
Dim D3 As Double        'Distance to Base
Dim Range As Double     'Resource Range Nm
Dim T1 As Double        'Time To Scene
Dim T2 As Double        'Time to Hospital
Dim T3 As Double        'Time To Base
Dim CruiseSpeed As Double   'Resource Cruise Speed Kts
Dim TOLT As Double      'Take Off and Landing Time (min)
Dim DTotal As Double    'Total Distance
Dim TTotal As Integer   'Total Time
Dim RefuelCode As String      'Code of Airfield to Refuel

Dim TRefuel As Double   'Time To Refuel Resource
Dim Refuel As Boolean   'Refuel Required Yes/No
Dim RefuelLeg As Integer 'Refuel Leg 1/2/3/99
Dim RefuelWaypoint As Integer
Dim SceneAirfield As String 'Airfield closest to scene, FW will land here Heli use for Scene weather
Dim SADistance As Integer 'Distance between Scene and closest Airfield
Dim Assigned As Boolean ' Is Resource already assigned
Dim Unavailable As Boolean ' Is Resource unavailable
Dim FuelAtH1 As Boolean
Dim FuelAtH2 As Boolean
Dim NumberOfWaypoints As Integer
Dim H1No As Boolean
Dim H2No As Boolean
Dim Resource As String
Dim PilotID As Integer
Dim DateTime
Dim MyHour
Dim ACType As String

H2No = False
H1No = False

Do While Not rstResources.EOF 'Creates tbl_SELECTResource1 for user to select resource from
  Resource = rstResources("Resource").Value
  RType = rstResources("Fixed/Rotary").Value 'Assigns Resource Type
```
BLat = rstResources("Lat").Value  'Assigns Base Lat
Blon = rstResources("Long").Value  'Assigns Base Lon
Base = rstResources("Base").Value  'Assigns Base Name
Range = rstResources("Range").Value
TOLT = rstResources("TOLT").Value
CruiseSpeed = rstResources("Cruise Speed").Value
TRefuel = rstResources("Refuel Time").Value
Unavailable = rstResources("Unavailable").Value
Assigned = rstResources("Assigned").Value
ACType = rstResources("AC Type").Value

'Dim rstRequests As New ADODB.RecordSet 'Look Up
Request Table to Get Requesting and Recieving Hospitals
SQL = "SELECT tbl_Requests.[IHT Requesting],
tbl_Requests.[IHT Destination] FROM tbl_Requests WHERE
((tbl_Requests.[Request ID])=" & sItem & ")"
RstRequests.Open SQL, CurrentProject.Connection,
adOpenDynamic
IHT1 = RstRequests("IHT Requesting").Value
IHT2 = RstRequests("IHT Destination").Value
RstRequests.Close

Dim rstHospLoc As New ADODB.RecordSet 'Gets Requesting
Hospital Airfield/HLS Location depending upon Resource type
SQL = "SELECT tbl_Hospitals.Name,
tbl_Airfields.Lat, tbl_Airfields.Long, tbl_Helipads.Lat,
tbl_Helipads.Long FROM tbl_Helipads INNER JOIN (tbl_Airfields INNER
JOIN tbl_Hospitals ON tbl_Airfields.Code = tbl_Hospitals.Airfield) ON
tbl_Helipads.Helipad = tbl_Hospitals.Helipad
WHERE(((tbl_Hospitals.Name)=" & IHT1 & ")"
rstHospLoc.Open SQL, CurrentProject.Connection,
adOpenDynamic
If RType = "Helicopter" Then
  Transport = 0
  H1Lat = rstHospLoc("tbl_Helipads.Lat")
  H1Lon = rstHospLoc("tbl_Helipads.Long")
Else
  Transport = 1
  H1Lat = rstHospLoc("tbl_Airfields.Lat")
  H1Lon = rstHospLoc("tbl_Airfields.Long")
End If
rstHospLoc.Close

SQL = "SELECT tbl_Hospitals.Name,
tbl_Airfields.Lat, tbl_Airfields.Long, tbl_Helipads.Lat,
tbl_Helipads.Long FROM tbl_Helipads INNER JOIN (tbl_Airfields INNER
JOIN tbl_Hospitals ON tbl_Airfields.Code = tbl_Hospitals.Airfield) ON
tbl_Helipads.Helipad = tbl_Hospitals.Helipad
WHERE(((tbl_Hospitals.Name)=" & IHT2 & ")"
rstHospLoc.Open SQL, CurrentProject.Connection,
adOpenDynamic
If RType = "Helicopter" Then
  H2Lat = rstHospLoc("tbl_Helipads.Lat")
  H2Lon = rstHospLoc("tbl_Helipads.Long")
Else
  H2Lat = rstHospLoc("tbl_Airfields.Lat")
  H2Lon = rstHospLoc("tbl_Airfields.Long")
End If
rstHospLoc.Close

D1 = Round(DistanceNM(ToRad(BLat), ToRad(Blon),
ToRad(H1Lat), ToRad(H1Lon)), 1)
T1 = Round(TOLT + (D1 / CruiseSpeed) * 60, 0)
D2 = Round(DistanceNM(ToRad(H1Lat), ToRad(H1Lon),
ToRad(H2Lat), ToRad(H2Lon)), 1)
T2 = Round(TOLT + (D2 / CruiseSpeed) * 60, 0)
D3 = Round(DistanceNM(ToRad(H2Lat), ToRad(H2Lon), ToRad(BLat), ToRad(Blon)), 1)
T3 = Round(TOLT + (D3 / CruiseSpeed) * 60, 0)
DTotal = D1 + D2 + D3
TTotal = T1 + T2 + T3

NumberofWaypoints = 4

If H1Lat = BLat And H1Lon = Blon Then 'Base and H1 are the same
    NumberofWaypoints = 3
    D1 = 0
    T1 = 0
    DTotal = D1 + D2 + D3
    TTotal = T1 + T2 + T3
    H1No = True
End If

If H2Lat = BLat And H2Lon = Blon Then 'Base and H2 are the same
    NumberofWaypoints = 3
    D3 = 0
    T3 = 0
    DTotal = D1 + D2 + D3
    TTotal = T1 + T2 + T3
    H2No = True
End If

RefuelCode = "NA"
Refuel = 0
RefuelLeg = 0
RefuelWaypoint = 0

If DTotal > Range Then 'Need To Refuel
    Refuel = 1
    FuelAtH1 = HasFuel(H1Lat, H1Lon) 'Determines if fuel is at H1
    FuelAtH2 = HasFuel(H2Lat, H2Lon) 'Determines if fuel is at H2
    If FuelAtH2 = True And D3 < Range And H2No = False Then 'Check if fuel available at waypoint 3
        RefuelCode = GetAFCode(H2Lat, H2Lon)
        RefuelLeg = 99
        RefuelWaypoint = NumberofWaypoints - 1
        T3 = T3 + TRefuel
    End If
    If FuelAtH1 = True And D2 + D3 < Range And H1No = False And RefuelCode = "NA" Then 'Check if fuel available at either waypoint 2
        RefuelCode = GetAFCode(H1Lat, H1Lon)
        RefuelWaypoint = 2
        RefuelLeg = 99
        T2 = T2 + Refuel
    End If
    If NumberofWaypoints = 3 And RefuelCode = "NA" Then 'Refuel between Hospitals
        RefuelCode = OneRefuel(H1Lat, H1Lon, H2Lat, H2Lon, Range, D2) ' Returns code of Airfield with fuel, or NA if no airfield available
        If RefuelCode <> "NA" Then
            RFLat = GetAirfieldLat(RefuelCode)
            RFLon = GetAirfieldLon(RefuelCode)
            NumberofWaypoints = 4
            If H2No = True Then
                ...
RefuelWaypoint = 2
RefuelLeg = 1
D1 = Round(DistanceNM(ToRad(H1Lat),
ToRad(H1Lon), ToRad(RFLat), ToRad(RFLon)) + DistanceNM(ToRad(RFLat),
ToRad(RFLon), ToRad(BLat), ToRad(Blon)), 1)
T1 = Round((TOLT * 2) + ((D3 / CruiseSpeed) * 60) + TRefuel, 0)
Else
    RefuelLeg = 2
    RefuelWaypoint = 3
    D2 = Round(DistanceNM(ToRad(H1Lat),
ToRad(H1Lon), ToRad(RFLat), ToRad(RFLon)) + DistanceNM(ToRad(RFLat),
ToRad(RFLon), ToRad(BLat), ToRad(Blon)), 1)
    T2 = Round((TOLT * 2) + ((D3 / CruiseSpeed) * 60) + TRefuel, 0)
End If

DTotal = D1 + D2 + D3
TTotal = T1 + T2 + T3
End If
End If

If D1 + D2 < Range And D3 <> 0 And RefuelCode = "NA" Then 'Refuel in leg 3
    RefuelCode = ThreeRefuel(H2Lat, H2Lon, BLat,
    Blon, Range, D1 + D2) ' Returns code of Airfield with fuel, or NA if no airfield available
If RefuelCode <> "NA" Then
    RefuelLeg = 3
    NumberOfWaypoints = 5
    RefuelWaypoint = 4
    RFLat = GetAirfieldLat(RefuelCode)
    RFLon = GetAirfieldLon(RefuelCode)
    D3 = Round(DistanceNM(ToRad(H2Lat),
    ToRad(H2Lon), ToRad(RFLat), ToRad(RFLon)) + DistanceNM(ToRad(RFLat),
    ToRad(RFLon), ToRad(BLat), ToRad(Blon)), 1)
    T3 = Round((TOLT * 2) + ((D3 / CruiseSpeed) * 60) + TRefuel, 0)
    DTotal = D1 + D2 + D3
    TTotal = T1 + T2 + T3
End If
End If

If D2 + D3 < Range And D1 <> 0 And RefuelCode = "NA" Then 'Need to Refuel in Leg 1
    RefuelCode = OneRefuel(BLat, Blon, H1Lat,
    H1Lon, Range, D2 + D3) ' Returns code of Airfield with fuel, or NA if no airfield available
If RefuelCode <> "NA" Then
    RefuelLeg = 1
    RefuelWaypoint = 2
    NumberOfWaypoints = 5
    RFLat = GetAirfieldLat(RefuelCode)
    RFLon = GetAirfieldLon(RefuelCode)
    D1 = Round(DistanceNM(ToRad(BLat),
    ToRad(BLon), ToRad(RFLat), ToRad(RFLon)) + DistanceNM(ToRad(RFLat),
    ToRad(RFLon), ToRad(H1Lat), ToRad(H1Lon)), 1)
    T1 = Round((TOLT * 2) + ((D3 / CruiseSpeed) * 60) + TRefuel, 0)
    DTotal = D1 + D2 + D3
    TTotal = T1 + T2 + T3
End If
End If

If RefuelCode = "NA" Then 'Need to Refuel in Leg 2 between hospitals
    RefuelCode = TwoRefuel(H1Lat, H1Lon, H2Lat,
    H2Lon, Range, D1, D2)
If RefuelCode <> "NA" Then
  RefuelLeg = 2
  NumberofWaypoints = 5
  RefuelWaypoint = 3
  RFLat = GetAirfieldLat(RefuelCode)
  RFLon = GetAirfieldLon(RefuelCode)
  D2 = Round(DistanceNM(ToRad(H1Lat),
  ToRad(RFLat), ToRad(RFLon)), 1)
  T2 = Round((TOLT * 2) + ((D3 / CruiseSpeed) * 60) + TRefuel, 0)
  DTotal = D1 + D2 + D3
tonal Time) = TTotal + IHTTime
  RefuelWaypoint
  NumberofWaypoints
  W1 Name") = GetAFCode(BLat, Blon)
  W1 Type") = "Base"
  W1 Lat") = Blat
  W1 Lon") = Blon
  W1 Weather Report") = ClosestAirfield(BLat, Blon)
  W1 Height") = GetAirfieldAlt(GetAFCode(BLat, Blon))
  Request") = sItem
  If RType = "Helicopter" Then
    StaticRiskScore( Resource, (TTotal + IHTTime) )
    StaticRiskAnalysis( Resource, (TTotal + IHTTime) )
  Else
    StaticRiskScore( Resource, (TTotal + O) = "N/A"
    StaticRiskAnalysis( Resource, (TTotal + O) = "N/A for fixed wing aircraft"
End If

If RefuelCode = "NA" Or RefuelLeg = 99 Then
  If NumberofWaypoints = 3 Then
    If H2No = True Then
rstSelectResource1("W2 Name") = GetAFCode(H1Lat, H1Lon)
"Airfield"

rstSelectResource1("W2 Type") = GetAirfieldAlt(GetAFCode(H1Lat, H1Lon))

rstSelectResource1("W2 Height") = GetAirfieldAlt(GetAFCode(H1Lat, H1Lon))

rstSelectResource1("W2 Lat") = H1Lat

rstSelectResource1("W2 Lon") = H1Lon

rstSelectResource1("W2 Weather Report") = ClosestAirfield(H1Lat, H1Lon)

Else

rstSelectResource1("W2 Name") = GetAFCode(H2Lat, H2Lon)
"Airfield"

rstSelectResource1("W2 Type") = GetAirfieldAlt(GetAFCode(H2Lat, H2Lon))

rstSelectResource1("W2 Height") = GetAirfieldAlt(GetAFCode(H2Lat, H2Lon))

rstSelectResource1("W2 Lat") = H2Lat

rstSelectResource1("W2 Lon") = H2Lon

rstSelectResource1("W2 Weather Report") = ClosestAirfield(H2Lat, H2Lon)

End If

Else

If RType = "Fixed Wing" Then

rstSelectResource1("W2 Name") = GetAFCode(H1Lat, H1Lon)
"Airfield"

rstSelectResource1("W2 Type") = GetAirfieldAlt(GetAFCode(H1Lat, H1Lon))

rstSelectResource1("W3 Name") = GetAFCode(H2Lat, H2Lon)
"Airfield"

rstSelectResource1("W3 Type") = GetAirfieldAlt(GetAFCode(H2Lat, H2Lon))

Else

rstSelectResource1("W2 Name") = GetHLSCode(H1Lat, H1Lon)
"Prepared HLS"

rstSelectResource1("W2 Type") = GetHLSAlt(GetHLSCode(H1Lat, H1Lon))

rstSelectResource1("W3 Name") = GetHLSCode(H2Lat, H2Lon)
"Prepared HLS"

rstSelectResource1("W3 Type") = GetHLSAlt(GetHLSCode(H2Lat, H2Lon))

End If

Else

If RefuelLeg = 1 Then

rstSelectResource1("W2 Name") = GetAFCode(RFLat, RFLon)
"Airfield"

rstSelectResource1("W2 Type") = GetAirfieldAlt(GetAFCode(RFLat, RFLon))

rstSelectResource1("W2 Lat") = RFLat

rstSelectResource1("W2 Lon") = RFLon

rstSelectResource1("W2 Weather Report") = ClosestAirfield(RFLat, RFLon)

Else

rstSelectResource1("W2 Name") = GetAFCode(H1Lat, H1Lon)
"Airfield"

rstSelectResource1("W2 Type") = GetAirfieldAlt(GetAFCode(H1Lat, H1Lon))

rstSelectResource1("W3 Name") = GetAFCode(H2Lat, H2Lon)
"Airfield"

rstSelectResource1("W3 Type") = GetAirfieldAlt(GetAFCode(H2Lat, H2Lon))

End If

End If
rstSelectResource1("W2 Weather Report") = RefuelCode
rstSelectResource1("W2 Height") = GetAirfieldAlt(GetAFCode(RFLat, RFLon))
If RType = "Fixed Wing" Then
    rstSelectResource1("W3 Name") = GetAFCode(H1Lat, H1Lon)
    rstSelectResource1("W3 Type") = "Airfield"
    rstSelectResource1("W3 Height") = GetAirfieldAlt(GetAFCode(H1Lat, H1Lon))
Else
    rstSelectResource1("W3 Name") = GetHLSCode(H1Lat, H1Lon)
    rstSelectResource1("W3 Type") = "Prepared HLS"
    rstSelectResource1("W3 Height") = GetHLSAlt(GetHLSCode(H1Lat, H1Lon))
End If
    If NumberOfWaypoints = 5 Then
    If RType = "Fixed Wing" Then
        rstSelectResource1("W4 Name") = GetAFCode(H2Lat, H2Lon)
        rstSelectResource1("W4 Type") = "Airfield"
        rstSelectResource1("W4 Height") = GetAirfieldAlt(GetAFCode(H2Lat, H2Lon))
        Else
            rstSelectResource1("W4 Name") = GetHLSCode(H2Lat, H2Lon)
            rstSelectResource1("W4 Type") = "Prepared HLS"
            rstSelectResource1("W4 Height") = GetHLSAlt(GetHLSCode(H2Lat, H2Lon))
        End If
        End If
    End If
End If
End If
If RefuelLeg = 2 Then
    rstSelectResource1("W3 Name") = GetAFCode(RFLat, RFLon)
    rstSelectResource1("W3 Type") = "Airfield"
    rstSelectResource1("W3 Lat") = RFLat
    rstSelectResource1("W3 Lon") = RFLon
    rstSelectResource1("W3 Weather Report") = RefuelCode
    rstSelectResource1("W3 Height") = GetAirfieldAlt(GetAFCode(RFLat, RFLon))
    If NumberOfWaypoints = 5 Then
        If RType = "Fixed Wing" Then
            rstSelectResource1("W2 Name") = GetAFCode(H1Lat, H1Lon)
            rstSelectResource1("W2 Type") = "Airfield"
            rstSelectResource1("W2 Height") = GetAirfieldAlt(GetAFCode(H1Lat, H1Lon))
            rstSelectResource1("W4 Name") = GetAFCode(H2Lat, H2Lon)
            rstSelectResource1("W4 Type") = "Airfield"
        End If
    End If
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GetAirfieldAlt(GetAFCode(H2Lat, H2Lon))

Else

GetHLSCode(H1Lat, H1Lon)

"Prepared HLS"

GetHLSCode(H2Lat, H2Lon)

"Prepared HLS"

GetHLSCode(H1Lat, H1Lon)

GetHLSCode(H2Lat, H2Lon)

Else

GetAFCode(H2Lat, H2Lon)

"Airfield"

GetAirfieldAlt(GetAFCode(H2Lat, H2Lon))

Else

GetHLSCode(H1Lat, H1Lon)

"Prepared HLS"

GetHLSCode(H1Lat, H1Lon)

GetHLSCode(H2Lat, H2Lon)

Else

GetAFCode(H1Lat, H2Lon)

GetAFCode(H2Lat, H2Lon)

Else

GetHLSCode(H1Lat, H1Lon)

HLS"

GetHLSCode(H1Lat, H1Lon)

Else

GetHLSCode(H2Lat, H2Lon)

Else

GetAFCode(H1Lat, H2Lon)

GetAFCode(H2Lat, H2Lon)

Else

GetHLSCode(H1Lat, H1Lon)

HLS"

GetHLSCode(H1Lat, H1Lon)
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```
rstSelectResource1("W3 Name") = GetHLSCode(H2Lat, H2Lon)
rstSelectResource1("W3 Type") = "Prepared HLS"
rstSelectResource1("W3 Height") = GetHLSAlt(GetHLSCode(H2Lat, H2Lon))
End If
rstSelectResource1("W2 Lat") = H1Lat
rstSelectResource1("W2 Lon") = H2Lon
rstSelectResource1("W2 Weather Report") = ClosestAirfield(H1Lat, H1Lon)
rstSelectResource1("W3 Lat") = H2Lat
rstSelectResource1("W3 Lon") = H2Lon
rstSelectResource1("W3 Weather Report") = ClosestAirfield(H2Lat, H2Lon)
rstSelectResource1("W4 Name") = GetAFCode(RFLat, RFLon)
rstSelectResource1("W4 Type") = "Airfield"
rstSelectResource1("W4 Lat") = RFLat
rstSelectResource1("W4 Lon") = RFLon
rstSelectResource1("W4 Weather Report") = RefuelCode
rstSelectResource1("W4 Height") = GetAirfieldAlt(GetAFCode(RFLat, RFLon))
End If
rstSelectResource1.Update
rstSelectResource1.Fields.Refresh
rstSelectResource1.Close
Set rstSelectResource1 = Nothing
End If
rstResources.MoveNext
Loop
rstResources.Close
DoCmd.Close acForm, "Form2"
DoCmd.OpenForm "Frm_SelectResource"
End If
End Sub

Private Sub Form_Open(Cancel As Integer)
    Lbl_Name1.Caption = ""
    Lbl_Name2.Caption = ""
    Lbl_Name3.Caption = ""
    Lbl_Name4.Caption = ""
    Lbl_Name5.Caption = ""
End Sub

Private Sub List_Missions_Click()
    Dim SelMission As Integer
    Dim Mission As Integer
    Dim SQL As String
    Dim D1 As Boolean
    Dim A2 As Boolean
    Dim D2 As Boolean
    Dim A3 As Boolean
    Dim D3 As Boolean
    Dim A4 As Boolean
    Dim D4 As Boolean
    Dim A5 As Boolean
    Dim i As Integer
```
SelMission = Me.List_Missions.ListIndex
Mission = Me.List_Missions.ItemData(SelMission)

Dim rstMission As New ADODB.RecordSet
SQL = "SELECT tbl_Missions.[Number of Waypoints],
tbl_Missions.notes, tbl_Waypoints.Waypoint, tbl_Waypoints.Name,
tbl_Waypoints.Arrive, tbl_Waypoints.Depart FROM tbl_Missions INNER
JOIN tbl_Waypoints ON tbl_Missions.[Mission ID] =
tbl_Waypoints.[Mission ID] WHERE (((tbl_Missions.[Mission ID]) =" &
Mission & ")"
rstMission.Open SQL, CurrentProject.Connection, adOpenStatic
rstMission.MoveFirst
NumberofWaypoints = rstMission("Number of Waypoints")
Txt_MissionNotes.Value = rstMission("notes").Value

Select Case NumberofWaypoints
Case 3
  Chk_A5.Enabled = False
  Chk_A5.Value = False
  Chk_D4.Enabled = False
  Chk_D4.Value = False
  Chk_A4.Enabled = False
  Chk_A4.Value = False
  Chk_D3.Enabled = False
Case 4
  Chk_A5.Enabled = False
  Chk_A5.Value = False
  Chk_D4.Enabled = False
  Chk_D4.Value = False
  Chk_A4.Enabled = True
  Chk_A4.Value = False
  Chk_D3.Enabled = True
Case 5
  Chk_A5.Enabled = True
  Chk_A5.Value = False
  Chk_D4.Enabled = True
  Chk_D4.Value = False
  Chk_A4.Enabled = True
  Chk_A4.Value = False
  Chk_D3.Enabled = True
End Select
i = 1
Do While i < NumberofWaypoints + 1
  Select Case i
  Case 1
    Lbl_Name1.Caption = rstMission("Name").Value
    Chk_D1 = rstMission("Depart").Value
  Case 2
    Lbl_Name2.Caption = rstMission("Name").Value
    Chk_D2 = rstMission("Depart").Value
    Chk_A2 = rstMission("Arrive").Value
  Case 3
    Lbl_Name3.Caption = rstMission("Name").Value
    Chk_D3 = rstMission("Depart").Value
    Chk_A3 = rstMission("Arrive").Value
  Case 4
    Lbl_Name4.Caption = rstMission("Name").Value
    Chk_D4 = rstMission("Depart").Value
    Chk_A4 = rstMission("Arrive").Value
  Case 5
    Lbl_Name5.Caption = rstMission("Name").Value
    Chk_A5 = rstMission("Arrive").Value
  End Select
  rstMission.MoveNext
i = i + 1
Loop
rstMission.Close
End Sub

Private Sub List_Requests_Click()
Dim iIdx As Integer
Dim sItem As Integer
Dim CaseNotes As String
iIdx = Me.List_Requests.ListIndex
If iIdx = -1 Then
    Exit Sub
End If
sItem = Me.List_Requests.ItemData(iIdx)
Dim RstRequests As New ADODB.RecordSet
SQL = "SELECT tbl_Requests.[Case Notes] FROM tbl_Requests WHERE (((tbl_Requests.[Request ID])=" & sItem & ")"
RstRequests.Open SQL, CurrentProject.Connection, adOpenStatic
CaseNotes = RstRequests("Case Notes")
RstRequests.Close
txt_CaseNotes.Value = CaseNotes
End Sub

Private Sub txt_CaseNotes_AfterUpdate()
Dim iIdx As Integer
Dim sItem As Integer
Dim CaseNotes As String
iIdx = Me.List_Requests.ListIndex
If iIdx = -1 Then
    Exit Sub
End If
sItem = Me.List_Requests.ItemData(iIdx)
Dim RstRequests As New ADODB.RecordSet
SQL = "SELECT tbl_Requests.[Case Notes] FROM tbl_Requests WHERE (((tbl_Requests.[Request ID])=" & sItem & ")"
RstRequests.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
RstRequests("Case Notes") = txt_CaseNotes.Value
RstRequests.Update
RstRequests.Close
End Sub

Private Sub Txt_MissionNotes_AfterUpdate()
Dim Selected As Integer
Dim Mission As Integer
Dim SQL As String
Selected = Me.List_Missions.ListIndex
If Selected = -1 Then
    Exit Sub
End If

Mission = Me.List_Missions.ItemData(Selected)

Dim rstMission As New ADODB.RecordSet
SQL = "SELECT tbl_Missions.[notes] FROM tbl_Missions WHERE 
((tbl_Missions.[Mission ID]) =" & Mission & ")"
rstMission.Open SQL, CurrentProject.Connection, adOpenDynamic, 
adLockOptimistic
rstMission.MoveFirst
rstMission("notes").Value = Txt_MissionNotes.Value
rstMission.Update
rstMission.Close

End Sub
### E.2 New Request VBA Code

```vba
Option Compare Database
Dim FlightCoordinatorID As Integer
Dim DateTime As Date
Dim CaseDescription As String

Private Sub Cmd_Cancel_Click()
    DoCmd.Close
End Sub

Private Sub Cmd_Log_Click()

    Dim SceneLat As Double
    Dim SceneLong As Double

    If Frame_SceneLocation.Value = 2 Then
        SceneLong = GridtoGeo_lon(Combo_Zone.Value, Text_East.Value, Text_North.Value)
        SceneLat = GridtoGeo_lat(Combo_Zone.Value, Text_East.Value, Text_North.Value)
    End If

    Dim RstRequests As New ADODB.RecordSet
    RstRequests.Open "tbl_Requests", CurrentProject.Connection, adOpenDynamic, adLockOptimistic
    RstRequests.Fields.Refresh
    RstRequests.AddNew
    RstRequests("Flight Coordinator") = FlightCoordinatorID  ' Records Flight Coordinator
    RstRequests("Date/Time Received") = DateTime            ' Records Date and Time
    RstRequests("Case Notes") = Text_Notes.Value            ' Records Case Notes

    If Frame_MissionType.Value = 1 Then                     ' Scene Response Mission Requested
        RstRequests("Case Number") = Combo_CaseNumber.Value ' Records Scene Response Case Number
        RstRequests("Mission Type") = "Primary"               ' Records Primary Mission Type
        RstRequests("Preliminary Receiving Hospital") = Combo_RecievingHosp.Value  'Records Preliminary Reciving Hospital

        If Frame_SceneLocation.Value = 1 Then                  ' Scene Location Specified As Lat/Long
            RstRequests("Scene Long") = Text_Lon.Value       ' Records Lat/Long
            RstRequests("Scene Lat") = Text_Lat.Value       ' Records Lat/Long
        End If

        If Frame_SceneLocation.Value = 2 Then                  ' Scene Location Specified As Map Ref
            RstRequests("Scene Long") = GridtoGeo_lon(Combo_Zone.Value, Text_East.Value, Text_North.Value)  'Converts Map Ref to Lat/Lon and Records
            RstRequests("Scene Lat") = GridtoGeo_lat(Combo_Zone.Value, Text_East.Value, Text_North.Value)  'Converts Map Ref to Lat/Lon and Records
        End If
    End If
```

If Frame_SceneLocation.Value = 3 Then ' Scene Location Specified As Locality
    Dim RstLocalities As New ADODB.RecordSet
    RstLocalities.Open "tbl_Localities", CurrentProject.Connection, adOpenKeyset 'Opens the Locality Recordset
    RstLocalities.Fields.Refresh
    RstLocalities.MoveFirst
    Do While Not RstLocalities.EOF 'Loop Finds Lat and Long of corresponding Locality
        If RstLocalities("Name").Value = Combo_Locality.Value Then
            RstRequests("Scene Long") = RstLocalities("Long").Value
            RstRequests("Scene Lat") = RstLocalities("Lat").Value
        End If
        RstLocalities.MoveNext
    Loop
    RstLocalities.Close 'Closes Recordset
    Set RstLocalities = Nothing
    Else 'IHT Mission Requested
        RstRequests("IHT Requesting") = Combo_RHosp.Value 'Records IHT Requesting Hospital
        RstRequests("IHT Destination") = Combo_DHosp.Value 'Records IHT Destination Hospital
        RstRequests("Mission Type") = "IHT" ' Records IHT Mission Type
    End If
    RstRequests.Update
    RstRequests.Close
    Set RstRequests = Nothing
End Sub

Private Sub Combo_CaseNumber_AfterUpdate()
    If Combo_CaseNumber.Value < 30 Then
        Dim RstCaseType As New ADODB.RecordSet
        RstCaseType.Open "tbl_CaseType", CurrentProject.Connection, adOpenKeyset
        RstCaseType.Fields.Refresh
        RstCaseType.MoveFirst
        Do While Not RstCaseType.EOF
            If RstCaseType("Case Number").Value = Combo_CaseNumber.Value Then
                CaseDescription = RstCaseType("Case Description").Value
                Combo_RecievingHosp = RstCaseType("Default Hospital").Value
            End If
            RstCaseType.MoveNext
        Loop
        RstCaseType.Close
        Set RstCaseType = Nothing
    Else
        CaseDescription = InputBox("Enter Case Description")
End If

CaseNotes = CaseDescription
Text_Notes.Value = CaseNotes

End Sub

Private Sub Form_Open(Cancel As Integer)

Dim MyHour
Dim FCName As String

Combo_RHosp.Enabled = False 'Sets Default data entry to Scene Response
Combo_DHosp.Enabled = False 'Sets Default data entry to Scene Response
Combo_CaseNumber.Enabled = True 'Sets Default data entry to Scene Response
Frame_SceneLocation.Enabled = True 'Sets Default data entry to Scene Response
Frame_SceneLocation.Value = 1 'Sets Default data Entry to Scene Response Lat Long
Combo_Locality.Enabled = False 'Sets data Entry to Lat Long
Combo_Zone.Enabled = False 'Sets data Entry to Lat Long
Text_North.Enabled = False 'Sets data Entry to Lat Long
Text_East.Enabled = False 'Sets data Entry to Lat Long
Text_Lat.Enabled = True 'Sets data Entry to Lat Long
Text_Lon.Enabled = True 'Sets data Entry to Lat Long

DateTime = Now
MyHour = Hour(Now)

Dim rstRoster As New ADODB.RecordSet
rstRoster.Open "tbl_Roster", CurrentProject.Connection, adOpenKeyset
rstRoster.Fields.Refresh
rstRoster.MoveFirst
Do While Not rstRoster.EOF
If rstRoster("Shift").Value = Shift(MyHour) And rstRoster("Date").Value = RosterDate(MyHour) Then
FlightCoordinatorID = rstRoster("Flight Coordinator").Value
End If
rstRoster.MoveNext
Loop
rstRoster.Close
Set rstRoster = Nothing

Dim RstFC As New ADODB.RecordSet
RstFC.Open "tbl_FlightCoord", CurrentProject.Connection, adOpenKeyset
RstFC.Fields.Refresh
RstFC.MoveFirst
Do While Not RstFC.EOF
If RstFC("Flight Coordinator ID").Value = FlightCoordinatorID Then
FCName = RstFC("Given Name").Value + " " + RstFC("Family Name").Value
End If
rstFC.MoveNext
Loop

End If
RstFC.MoveNext
Loop
RstFC.Close
Set RstFC = Nothing
Lbl_RecievedBy.Caption = FCName
Lbl_RecievedAt.Caption = DateTime
End Sub

Private Sub Frame_MissionType_AfterUpdate()
If Frame_MissionType = 2 Then
    Combo_RHosp.Enabled = True 'Sets data entry to IHT
    Combo_DHosp.Enabled = True 'Sets data entry to IHT
    Combo_CaseNumber.Enabled = False 'Sets data entry to IHT
    Frame_SceneLocation.Enabled = False 'Disables Scene Location Data Entry
    Combo_Locality.Enabled = False 'Disables Scene Location Data Entry
    Text_North.Enabled = False 'Disables Scene Location Data Entry
    Text_East.Enabled = False 'Disables Scene Location Data Entry
    Text_Lat.Enabled = False 'Disables Scene Location Data Entry
    Text_Lon.Enabled = False 'Disables Scene Location Data Entry
    Combo_Zone.Enabled = False 'Disables Scene Location Data Entry
    CaseDescription = InputBox("Enter Case Description") 'Prompts For Case Description
    Text_Notes.Value = CaseDescription 'Displays Case Description in Notes
    Combo_RecievingHosp.Enabled = False 'Sets data to IHT
Else
    Combo_RHosp.Enabled = False 'Sets data entry to Scene Response
    Combo_DHosp.Enabled = False 'Sets data entry to Scene Response
    Combo_CaseNumber.Enabled = True 'Sets data entry to Scene Response
    Frame_SceneLocation.Enabled = True 'Sets data entry to Scene Response
    Frame_SceneLocation.Value = 1 'Sets data Entry to Scene Response Lat Long
    Combo_Locality.Enabled = False 'Sets data Entry to Lat Long
    Text_North.Enabled = False 'Sets data Entry to Lat Long
    Text_East.Enabled = False 'Sets data Entry to Lat Long
    Text_Lat.Enabled = True 'Sets data Entry to Lat Long
    Text_Lon.Enabled = True 'Sets data Entry to Lat Long
    Combo_RecievingHosp.Enabled = True 'Sets data to Scene Response
End If
End Sub
Private Sub Frame_SceneLocation_AfterUpdate()

If Frame_SceneLocation = 3 Then
    Combo_Locality.Enabled = True           ' Enables Localility Entry
Else
    Combo_Locality.Enabled = False          ' Disables Localility Entry
End If

If Frame_SceneLocation = 2 Then
    Combo_Zone.Enabled = True               ' Enables Zone Entry
    Text_North.Enabled = True               ' Enables Northing location entry
    Text_East.Enabled = True                ' Enables Easting Location entry
Else
    Combo_Zone.Enabled = False              ' Disables Zone Entry
    Text_North.Enabled = False              ' Disables Location entry
    Text_East.Enabled = False               ' Disables Location entry
End If

If Frame_SceneLocation = 1 Then
    Text_Lat.Enabled = True                 ' Enables Lat location entry
    Text_Lon.Enabled = True                 ' Enables Lon Location entry
Else
    Text_Lat.Enabled = False                ' Disables Lat entry
    Text_Lon.Enabled = False                ' Disables Lon entry
End If

End Sub
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Graphical User Interface VBA Code

E.3 Select Hospital VBA Code

Option Compare Database
'Const DatabasePath = "C:\Documents and Settings\simon atyeo\My Documents\Thesis\tables.mdb"
'Const ProviderStr = "Provider=Microsoft.Jet.OLEDB.4.0;Data Source=" + DatabasePath
Dim ID As Integer
Dim SQL As String
Dim Connection As New ADODB.Connection
Dim Catalog As New ADOX.Catalog
Private Sub Cmd_Select_Click()
    Dim Idx As Integer
    Dim hospital As String
    Dim RType As String 'defines resource type
    Dim MID As Integer
    Dim SLat As Double 'Scene Lat
    Dim SLon As Double 'Scene Lon
    Dim HLat As Double 'Hospital Lat
    Dim HLon As Double 'Hospital Lon
    Dim BLat As Double 'Base Lat
    Dim Blon As Double 'Base Lon
    Dim Base As String 'Resource Base
    Dim RFLat As Double 'Refuel Lat
    Dim RFLon As Double 'Refuel Lon
    Dim D1 As Double 'Distance to Scene
    Dim D2 As Double 'Distance to Hospital
    Dim D3 As Double 'Distance to Base
    Dim Range As Double 'Resource Range Nm
    Dim T1 As Double 'Time To Scene
    Dim T2 As Double 'Time to Hospital
    Dim T3 As Double 'Time To Base
    Dim CruiseSpeed As Double 'Resource Cruise Speed Kts
    Dim TOLT As Double 'Take Off and Landing Time (min)
    Dim Transport As Boolean
    Dim DTotal As Double 'Total Distance
    Dim TTotal As Integer 'Total Time
    Dim RefuelCode As String 'Code of Airfield to Refuel At
    Dim TRefuel As Double 'Time to Refuel Resource
    Dim Refuel As Boolean 'Refuel Required Yes/No
    Dim RefuelLeg As Integer 'Refuel Leg 1/2/3/9
    Dim RefuelWaypoint As Integer
    Dim SceneAirfield As String 'Airfield closest to scene, FW will land here Heli use for Scene weather
    Dim SADistance As Integer 'Distance between Scene and closest Airfield
    Dim ALat As Double 'Lat of Airfield Closest To Scene
    Dim ALon As Double 'Lon Airfield Closest To Scene
    Dim Assigned As Boolean
    Dim Unavailable As Boolean
    Dim FuelAt2 As Boolean
    Dim FuelAt3 As Boolean
    Dim NumberofWaypoints As Integer

    'Assign Selected Hospital to Mission Table
    Idx = Me.List_Hospitals.ListIndex
    hospital = Me.List_Hospitals.ItemData(Idx)
    DoCmd.RunSQL ("DELETE FROM tbl_SelectResource1") 'Clears The Select Resource Table
Dim rstResources As New ADODB.RecordSet ' A query containing Resource info: Resource, Type, Base Location (Lat&Lon), cruise speed and TOLT
SQL = "SELECT tbl_Resources.Resource, tbl_Resources.Base, tbl_Airfields.Lat, tbl_Airfields.Long, tbl_AircraftTypes.[Cruise Speed], tbl_AircraftTypes.Range, tbl_AircraftTypes.TOLT, tbl_AircraftTypes.[Refuel Time], tbl_Resources.Assigned, tbl_Resources.Unavailable, tbl_Resources.[AC Type], tbl_AircraftTypes.[Fixed/Rotary] FROM tbl_Airfields INNER JOIN (tbl_AircraftTypes INNER JOIN tbl_Resources ON tbl_AircraftTypes.[Aircraft ID] = tbl_Resources.[AC Type]) ON tbl_AircraftTypes.[Aircraft ID] = tbl_Resources.Base"
rstResources.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
rstResources.MoveFirst

Dim rstSelectResource1 As New ADODB.RecordSet 'Creates tbl_SelectResource1 for user to select resource from
Do While Not rstResources.EOF
  Resource = rstResources("Resource").Value  
  RType = rstResources("Fixed/Rotary").Value  'Assigns Resource Type
  BLat = rstResources("Lat").Value    'Assigns Base Lat
  Blon = rstResources("Long").Value   'Assigns Base Lon
  Base = rstResources("Base").Value   'Assigns Base Name
  Range = rstResources("Range").Value
  TOLT = rstResources("TOLT").Value
  CruiseSpeed = rstResources("Cruise Speed").Value
  TRefuel = rstResources("Refuel Time").Value
  Unavailable = rstResources("Unavailable").Value
  Assigned = rstResources("Assigned").Value
  ACType = rstResources("AC Type").Value

  Dim RstRequests As New ADODB.RecordSet 'Look Up Request Table to Get Scene Location
  SQL = "SELECT tbl_Requests.[Scene Lat], tbl_Requests.[Scene Long] FROM tbl_Requests WHERE (((tbl_Requests.[Request ID]) = " & ID & "))"
  RstRequests.Open SQL, CurrentProject.Connection, adOpenDynamic
  SLat = RstRequests("Scene Lat").Value
  SLon = RstRequests("Scene Long").Value
  RstRequests.Close

  '-------- determine Airfiled Closest to Scene and distance from scene
  SceneAirfield = ClosestAirfield(SLat, SLon)
  ALat = GetAirfieldLat(SceneAirfield)
  ALon = GetAirfieldLon(SceneAirfield)
  SADistance = Round(DistanceNM(ToRad(ALat), ToRad(ALon), ToRad(SLat), ToRad(SLon)), 1)

  Transport = 0
  If RType = "Fixed Wing" Then 'If resource is FW then
    assign Scene Waypoint as Airfield closest to Scene
    SLat = ALat
    SLon = ALon
    Transport = 1
  End If

Dim RstRequests As New ADODB.RecordSet 'Look Up Request Table to Get Scene Location
SQL = "SELECT tbl_Requests.[Scene Lat], tbl_Requests.[Scene Long] FROM tbl_Requests WHERE (((tbl_Requests.[Request ID]) = " & ID & "))"
RstRequests.Open SQL, CurrentProject.Connection, adOpenDynamic
SLat = RstRequests("Scene Lat").Value
SLon = RstRequests("Scene Long").Value
RstRequests.Close

'-------- determine Airfiled Closest to Scene and distance from scene
SceneAirfield = ClosestAirfield(SLat, SLon)
ALat = GetAirfieldLat(SceneAirfield)
ALon = GetAirfieldLon(SceneAirfield)
SADistance = Round(DistanceNM(ToRad(ALat), ToRad(ALon), ToRad(SLat), ToRad(SLon)), 1)

Transport = 0
If RType = "Fixed Wing" Then 'If resource is FW then
  assign Scene Waypoint as Airfield closest to Scene
  SLat = ALat
  SLon = ALon
  Transport = 1
End If
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Dim rstHospLoc As New ADODB.RecordSet 'Gets Hospital Airfield/HLS Location depending upon Resource type
rstHospLoc.Open SQL, CurrentProject.Connection, adOpenDynamic
If RType = "Helicopter" Then
   HLat = rstHospLoc("tbl_Helipads.Lat")
   HLon = rstHospLoc("tbl_Helipads.Long")
Else
   HLat = rstHospLoc("tbl_Airfields.Lat")
   HLon = rstHospLoc("tbl_Airfields.Long")
End If
rstHospLoc.Close

D1 = Round(DistanceNM(ToRad(BLat), ToRad(Blon), ToRad(SLat), ToRad(SLon)), 1)
T1 = Round(TOLT + (D1 / CruiseSpeed) * 60, 0)
D2 = Round(DistanceNM(ToRad(SLat), ToRad(SLon), ToRad(HLat), ToRad(HLon)), 1)
T2 = Round(TOLT + (D2 / CruiseSpeed) * 60, 0)
D3 = Round(DistanceNM(ToRad(HLat), ToRad(HLon), ToRad(BLat), ToRad(Blon)), 1)
T3 = Round(TOLT + (D3 / CruiseSpeed) * 60, 0)
DTotal = D1 + D2 + D3
TTotal = T1 + T2 + T3

NumberofWaypoints = 4

If HLat = BLat And HLon = Blon Then
   NumberofWaypoints = 3
   D3 = 0
   T3 = 0
   DTotal = D1 + D2 + D3
   TTotal = T1 + T2 + T3
End If

RefuelCode = "NA"
Refuel = 0
RefuelLeg = 0
RefuelWaypoint = 0

If DTotal > Range Then 'Need To Refuel
   Refuel = 1

   FuelAt2 = HasFuel(SLat, SLon)
   FuelAt3 = HasFuel(HLat, HLon)

   If FuelAt3 = True And D3 < Range And NumberofWaypoints = 4 Then 'Check if fuel available at waypoint 3
      RefuelCode = GetAFCode(HLat, HLon)
      RefuelLeg = 99
      RefuelWaypoint = 3
      T3 = T3 + TRefuel
   End If

   If FuelAt2 = True And D2 + D3 < Range And RefuelCode = "NA" Then 'Check if fuel available at waypoint 2
      RefuelCode = GetAFCode(SLat, SLon)
      RefuelWaypoint = 2
      RefuelLeg = 99
      T2 = T2 + Refuel
   End If
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If D1 + D2 < Range And RefuelCode = "NA" Then
    'Refuel in leg 3
    RefuelCode = ThreeRefuel(HLat, HLon, Blat, Blon, Range, D1 + D2) ' Returns code of Airfield with fuel, or NA if no airfield available
    If RefuelCode <> "NA" Then
        RefuelLeg = 3
        RefuelWaypoint = 4
        NumberOfWaypoints = NumberOfWaypoints + 1
        RFLat = GetAirfieldLat(RefuelCode)
        RFLon = GetAirfieldLon(RefuelCode)
        D3 = Round(DistanceNM(ToRad(HLat), ToRad(RFLat), ToRad(RFLon)), 1)
        ToRad(HLon), ToRad(RFLat), ToRad(RFLon)) + DistanceNM(ToRad(RFLat), CruiseSpeed) * 60) + TRefuel, 0)
        DTotal = D1 + D2 + D3
        TTotal = T1 + T2 + T3
    End If
End If

If D2 + D3 < Range And RefuelCode = "NA" Then
    'Need to Refuel in Leg 1
    RefuelCode = OneRefuel(BLat, Blon, SLat, SLon, Range, D2 + D3) ' Returns code of Airfield with fuel, or NA if no airfield available
    If RefuelCode <> "NA" Then
        RefuelLeg = 1
        RefuelWaypoint = 2
        NumberOfWaypoints = NumberOfWaypoints + 1
        RFLat = GetAirfieldLat(RefuelCode)
        RFLon = GetAirfieldLon(RefuelCode)
        D1 = Round(DistanceNM(ToRad(BLat), ToRad(RFLat), ToRad(RFLon)), 1)
        DistanceNM(ToRad(RFLat), ToRad(RFLon), ToRad(SLat), ToRad(SLon)) + DistanceNM(ToRad(RFLat), CruiseSpeed) * 60) + TRefuel, 0)
        DTotal = D1 + D2 + D3
        TTotal = T1 + T2 + T3
    End If
End If

If RefuelCode = "NA" Then 'Need to Refuel in Leg 2 between scene and hospital
    RefuelCode = TwoRefuel(SLat, SLon, HLat, HLon, Range, D1, D2)
    If RefuelCode <> "NA" Then
        RefuelLeg = 2
        RefuelWaypoint = 3
        NumberOfWaypoints = NumberOfWaypoints + 1
        RFLat = GetAirfieldLat(RefuelCode)
        RFLon = GetAirfieldLon(RefuelCode)
        D2 = Round(DistanceNM(ToRad(SLon), ToRad(RFLat), ToRad(RFLon)), 1)
        DistanceNM(ToRad(RFLat), ToRad(RFLon), ToRad(HLat), ToRad(HLon)), 1)
        T2 = Round((TOLT * 2) + ((D3 / CruiseSpeed) * 60) + TRefuel, 0)
        DTotal = D1 + D2 + D3
        TTotal = T1 + T2 + T3
    End If
End If

If RefuelCode = "NA" Then 'Cannot find necessary place to refuel, resource will not be considered.
    RefuelCode = "NO"
End If
If RefuelCode <> "NO" And Assigned = False And Unavailable = False Then
    rstSelectResource1.Open "tbl_SelectResource1", CurrentProject.Connection, adOpenDynamic, adLockOptimistic
    rstSelectResource1.Fields.Refresh
    rstSelectResource1.AddNew
    rstSelectResource1("Request") = ID
    rstSelectResource1("Resource") = Resource
    rstSelectResource1("Base") = Base
    rstSelectResource1("Transport") = Transport
    rstSelectResource1("Time To Scene") = T1
    rstSelectResource1("Time To Hospital") = T2
    rstSelectResource1("Total Distance") = DTotal
    rstSelectResource1("Total Time") = TTotal + SceneTime
    rstSelectResource1("Refuel") = Refuel
    rstSelectResource1("Refuel Waypoint") = RefuelWaypoint
    rstSelectResource1("Number of Waypoints") = NumberofWaypoints
    rstSelectResource1("W1 Name") = GetAFCode(BLat, Blon)
    rstSelectResource1("W1 Type") = "Base"
    rstSelectResource1("W1 Lat") = BLat
    rstSelectResource1("W1 Lon") = Blon
    rstSelectResource1("W1 Weather Report") = ClosestAirfield(BLat, Blon)
    rstSelectResource1("W1 Height") = GetAirfieldAlt(GetAFCode(BLat, Blon))
    If RType = "Helicopter" Then
        rstSelectResource1("Static Risk") = StaticRiskScore(Resource, (TTotal + SceneTime))
        rstSelectResource1("Risk Analysis") = StaticRiskAnalysis(Resource, (TTotal + SceneTime))
    Else
        rstSelectResource1("Static Risk") = "N/A"
        rstSelectResource1("Risk Analysis") = "N/A for fixed wing aircraft"
    End If
    If RefuelCode = "NA" Or RefuelLeg = 99 Then
        If RType = "Fixed Wing" Then
            rstSelectResource1("W2 Name") = GetAFCode(SLat, SLon)
            rstSelectResource1("W2 Type") = "Airfield"
            rstSelectResource1("W2 Height") = GetAirfieldAlt(GetAFCode(SLat, SLon))
            rstSelectResource1("W3 Name") = GetAFCode(HLat, HLon)
            rstSelectResource1("W3 Type") = "Airfield"
            rstSelectResource1("W3 Height") = GetAirfieldAlt(GetAFCode(HLat, HLon))
        Else
            rstSelectResource1("W2 Name") = "Scene"
            rstSelectResource1("W2 Type") = "Unprepared HLS"
            rstSelectResource1("W2 Height") = GetHLSCode(HLat, HLon)
            rstSelectResource1("W3 Name") = "Unknown"
            rstSelectResource1("W3 Type") = "Prepared HLS"
        End If
    End If
rstSelectResource1("W3 Height") = GetHLSAlt(GetHLSCode(HLat, HLon))
End If

ClosestAirfield(SLat, SLon)
rstSelectResource1("W3 Lat") = HLat
rstSelectResource1("W3 Lon") = HLon
rstSelectResource1("W3 Weather Report") = ClosestAirfield(HLat, HLon)
End If

If RefuelLeg = 1 Then
If RType = "Fixed Wing" Then
rstSelectResource1("W3 Name") = GetAFCode(SLat, SLon)
rstSelectResource1("W3 Type") = "Airfield (" & SADistance & "NM From Scene)"
rstSelectResource1("W3 Height") = GetAirfieldAlt(GetAFCode(SLat, SLon))
rstSelectResource1("W4 Name") = GetAFCode(HLat, HLon)
rstSelectResource1("W4 Type") = "Airfield"
rstSelectResource1("W4 Height") = GetAirfieldAlt(GetAFCode(HLat, HLon))
Else
rstSelectResource1("W3 Name") = "Scene"
rstSelectResource1("W3 Type") = "Unprepared HLS (" & SADistance & "NM From " & SceneAirfield & ")"
rstSelectResource1("W3 Height") = "Unknown"
End If
GetHLSCode(HLat, HLon)
rstSelectResource1("W4 Type") = "Prepared HLS"
End If

GetHLSAlt(GetHLSCode(HLat, HLon))
End If

ClosestAirfield(RFLat, RFLon)
rstSelectResource1("W2 Name") = GetAFCode(RFLat, RFLon)
rstSelectResource1("W2 Type") = "Airfield"
rstSelectResource1("W2 Lat") = RFLat
rstSelectResource1("W2 Lon") = RFLon
rstSelectResource1("W2 Weather Report") = RefuelCode
GetAirfieldAlt(GetAFCode(RFLat, RFLon))
rstSelectResource1("W3 Lat") = SLat
rstSelectResource1("W3 Lon") = SLon
rstSelectResource1("W3 Weather Report") = ClosestAirfield(SLat, SLon)

ClosestAirfield(HLat, HLon)
End If

If RefuelLeg = 2 Then
If RType = "Fixed Wing" Then
rstSelectResource1("W2 Name") = GetAFCode(SLat, SLon)
rstSelectResource1("W2 Type") = "Airfield (" & SADistance & "NM From Scene)"
rstSelectResource1("W2 Height") = GetAirfieldAlt(GetAFCode(SLat, SLon))

GetHLSCode(HLat, HLon)
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rstSelectResource1("W4 Name") = GetAFCode(HLat, HLon)
rstSelectResource1("W4 Type") = "Airfield"
rstSelectResource1("W4 Height") = GetAirfieldAlt(GetAFCode(HLat, HLon))
Else
rstSelectResource1("W2 Name") = "Scene"
rstSelectResource1("W2 Type") = "Unprepared HLS(" & SADistance & " NM From " & SceneAirfield & ")"
rstSelectResource1("W2 Height") = "Unknown"
GetHLSCode(HLat, HLon)
rstSelectResource1("W4 Name") = GetHLSCode(HLat, HLon)
rstSelectResource1("W4 Type") = "Prepared HLS"
rstSelectResource1("W4 Height") = GetHLSAlt(GetHLSCode(HLat, HLon))
End If
rstSelectResource1("W2 Lat") = SLat
rstSelectResource1("W2 Lon") = SLon
rstSelectResource1("W2 Weather Report") = ClosestAirfield(SLat, SLon)
rstSelectResource1("W3 Name") = GetAFCode(RFLat, RFLon)
rstSelectResource1("W3 Type") = "Airfield"
rstSelectResource1("W3 Lat") = RFLat
rstSelectResource1("W3 Lon") = RFLon
rstSelectResource1("W3 Weather Report") = RefuelCode
GetAirfieldAlt(GetAFCode(RFLat, RFLon))
rstSelectResource1("W4 Lat") = HLat
rstSelectResource1("W4 Lon") = HLon
rstSelectResource1("W4 Weather Report") = ClosestAirfield(HLat, HLon)
End If

If RefuelLeg = 3 Then
If RType = "Fixed Wing" Then
rstSelectResource1("W2 Name") = GetAFCode(SLat, SLon)
rstSelectResource1("W2 Type") = "Airfield"
(" & SADistance & " NM From Scene)"
rstSelectResource1("W2 Height") = GetAirfieldAlt(GetAFCode(SLat, SLon))
rstSelectResource1("W3 Name") = GetAFCode(HLat, HLon)
rstSelectResource1("W3 Type") = "Airfield"
rstSelectResource1("W3 Height") = GetAirfieldAlt(GetAFCode(HLat, HLon))
Else
rstSelectResource1("W2 Name") = "Scene"
rstSelectResource1("W2 Type") = "Unprepared HLS(" & SADistance & " NM From " & SceneAirfield & ")"
rstSelectResource1("W2 Height") = "Unknown"
GetHLSCode(HLat, HLon)
rstSelectResource1("W3 Name") = GetHLSCode(HLat, HLon)
rstSelectResource1("W3 Type") = "Prepared HLS"
rstSelectResource1("W3 Height") = GetHLSAlt(GetHLSCode(HLat, HLon))
End If
rstSelectResource1("W2 Lat") = SLat
rstSelectResource1("W2 Lon") = SLon
rstSelectResource1("W2 Weather Report") = ClosestAirfield(SLat, SLon)
rstSelectResource1("W3 Lat") = HLat
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rstSelectResource1("W3 Lon") = HLon
rstSelectResource1("W3 Weather Report") = ClosestAirfield(HLat, HLon)

GetAFCode(RFLat, RFLon)

rstSelectResource1("W4 Name") = GetAFCode(RFLat, RFLon)
rstSelectResource1("W4 Type") = "Airfield"
rstSelectResource1("W4 Lat") = RFLat
rstSelectResource1("W4 Lon") = RFLon
rstSelectResource1("W4 Weather Report") = RefuelCode
rstSelectResource1("W4 Height") = GetAirfieldAlt(GetAFCode(RFLat, RFLon))

End If
rstSelectResource1.Update
rstSelectResource1.Fields.Refresh
rstSelectResource1.Close
Set rstSelectResource1 = Nothing
End If
rstResources.MoveNext
Loop
doCmd.Close
DoCmd.OpenForm "Frm_SelectResource"
End Sub

Private Sub Form_Open(Cancel As Integer)
Dim PrelimHosp As String
Dim rstSelectHosp As New ADODB.RecordSet
SQL = "SELECT tbl_SelHosp.[Request ID] FROM tbl_SelHosp"
rstSelectHosp.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
rstSelectHosp.MoveFirst
ID = rstSelectHosp("Request ID").Value
rstSelectHosp.Close

Dim RstRequests As New ADODB.RecordSet
SQL = "SELECT tbl_Requests.[Prelim Hospital] FROM tbl_Requests WHERE (((tbl_Requests.[Request ID])=" & ID & "))"
RstRequests.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
PrelimHosp = RstRequests("Prelim Hospital")
RstRequests.Close

listcount = Me.List_Hospitals.listcount
counter = 0
Do While counter <= listcount
  If Me.List_Hospitals.ItemData(counter) = PrelimHosp Then
    List_Hospitals.Selected(counter) = True
    Exit Do
  Else
    counter = counter + 1
  End If
Loop
List_Hospitals.Locked = False

End Sub

E.4 Select Resource VBA Code
Option Compare Database
'------------------
Dim Idx As Integer
Dim Resource As String
Dim Name1 As String
Dim Name2 As String
Dim Name3 As String
Dim Name4 As String
Dim Name5 As String
Dim Height1 As String
Dim Height2 As String
Dim Height3 As String
Dim Height4 As String
Dim Height5 As String
Dim lat1 As Double
Dim lat2 As Double
Dim Lat3 As Double
Dim Lat4 As Double
Dim Lat5 As Double
Dim lon1 As Double
Dim lon2 As Double
Dim Lon3 As Double
Dim Lon4 As Double
Dim Lon5 As Double
Dim Dist1 As Double
Dim Dist2 As Double
Dim Dist3 As Double
Dim Dist4 As Double
Dim Time1 As Integer
Dim Time2 As Integer
Dim Time3 As Integer
Dim Time4 As Integer
Dim LSAlt1 As Integer
Dim LSAlt2 As Integer
Dim LSAlt3 As Integer
Dim LSAlt4 As Integer
Dim Bearing1 As Double
Dim Bearing2 As Double
Dim Bearing3 As Double
Dim Bearing4 As Double
Dim MET As String
Dim NOTAM As String
Dim WeatherCode1 As String
Dim WeatherCode2 As String
Dim WeatherCode3 As String
Dim WeatherCode4 As String
Dim WeatherCode5 As String
Dim NumWaypoints As Integer
Dim RiskAnalysis As String

Private Sub cmd_Assign_Click()

' Dim Idx As Integer
' Dim Request As Integer
' Dim Resource As String
' Dim MissionType As String
' Dim Pilot As String
' Dim Crewman As String
' Dim Paramedic As String
' Dim NumberofWaypoints As Integer
' Dim MissionID As Integer
' Dim CaseNotes As String
' Dim TTotal As Integer

Idx = Me.List_Resources.ListIndex
If Idx = -1 Then
    Exit Sub
End If
Dim rstSelResource As New ADODB.RecordSet
SQL = "SELECT tbl_SelectResource1.Request, tbl_SelectResource1.[Number of Waypoints], tbl_SelectResource1.[Total Time] FROM tbl_SelectResource1 WHERE (((tbl_SelectResource1.Resource)=' & Resource & '))"
rstSelResource.Open SQL, CurrentProject.Connection, adOpenDynamic
NumberofWaypoints = rstSelResource("Number of Waypoints")
Request = rstSelResource("Request")
TTotal = rstSelResource("Total Time")
rstSelResource.Close

Dim RstRequests As New ADODB.RecordSet
SQL = "SELECT tbl_Requests.[Mission Type], tbl_Requests.Accepted , tbl_Requests.[Case Notes] FROM tbl_Requests WHERE (((tbl_Requests.[Request ID])=' & Request & '))"
RstRequests.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
MissionType = RstRequests("Mission Type")
RstRequests("Accepted") = True
CaseNotes = RstRequests("Case Notes").Value
RstRequests.Update
RstRequests.Close

Dim rstResources As New ADODB.RecordSet
SQL = "SELECT tbl_Resources.Assigned FROM tbl_Resources WHERE (((tbl_Resources.Resource)=' & Resource & '))"
rstResources.Open SQL, CurrentProject.Connection, adOpenDynamic, adLockOptimistic
rstResources("Assigned") = True
rstResources.Update
rstResources.Close

'------------------ This Section of Code Gets HEMS Crew Details ------------------'
Dim MyHour As Double
Dim MyDate As Double
Dim MyShift As Integer
Dim CrewmanID As Integer
Dim ParamedicID As Integer
Dim PilotID As Integer
MyHour = Hour(Now)
MyShift = Shift(MyHour)
MyDate = RosterDate(MyHour)

Dim rstRoster As New ADODB.RecordSet
SQL = "SELECT tbl_Roster.[HEMS1 Pilot], tbl_Roster.[HEMS1 Crewman], tbl_Roster.[HEMS1 Paramedic], tbl_Roster.[HEMS2 Pilot], tbl_Roster.[HEMS2 Crewman], tbl_Roster.[HEMS2 Paramedic], tbl_Roster.[HEMS3 Pilot], tbl_Roster.[HEMS3 Crewman], tbl_Roster.[HEMS3 Paramedic] FROM tbl_Roster WHERE (((tbl_Roster.Date)=" & MyDate & ") AND (((tbl_Roster.Shift)=" & MyShift & '))"
rstRoster.Open SQL, CurrentProject.Connection, adOpenStatic
Select Case Resource
Case "HEMS1"
PilotID = rstRoster("HEMS1 Pilot").Value
CrewmanID = rstRoster("HEMS1 Crewman").Value
ParamedicID = rstRoster("HEMS1 Paramedic").Value
Case "HEMS2"
PilotID = rstRoster("HEMS2 Pilot").Value
CrewmanID = rstRoster("HEMS2 Crewman").Value
ParamedicID = rstRoster("HEMS2 Paramedic").Value
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Case "HEMS3"
    PilotID = rstRoster("HEMS3 Pilot").Value
    CrewmanID = rstRoster("HEMS3 Crewman").Value
    ParamedicID = rstRoster("HEMS3 Paramedic").Value
End Select

Case Else
    PilotID = 0
    CrewmanID = 0
    ParamedicID = 0
End Select

rstRoster.Close
'---------------------------------------------------------------------
Dim rstMissions As New ADODB.RecordSet
rstMissions.Open "tbl_Missions", CurrentProject.Connection, adOpenDynamic, adLockOptimistic
rstMissions.Fields.Refresh
rstMissions.AddNew
rstMissions("Request ID") = Request
rstMissions("Type") = MissionType
rstMissions("Resource") = Resource
rstMissions("MET/AIS") = MET
rstMissions("NOTAM") = NOTAM
rstMissions("notes") = CaseNotes
rstMissions("Number Of Waypoints") = NumberofWaypoints
If Resource = "HEMS1" Or Resource = "HEMS2" Or Resource = "HEMS3" Then
    rstMissions("Pilot") = PilotID                  'ONLY FOR HELICOPTERS
    rstMissions("Crewman") = CrewmanID              'ONLY FOR HELICOPTERS
    rstMissions("Paramedic") = ParamedicID          'ONLY FOR HELICOPTERS
    rstMissions("Risk Score") = StaticRiskScore(Resource, (TTotal + SceneTime))       'ONLY FOR HELICOPTERS
    rstMissions("Risk Analysis") = StaticRiskAnalysis(Resource, (TTotal + SceneTime))     'ONLY FOR HELICOPTERS
Else
    rstMissions("Risk Score") = "N/A"
    rstMissions("Risk Analysis") = "Not Available for Fixed Wing Aircraft"
End If

MissionID = rstMissions("Mission ID")
rstMissions.Update
rstMissions.Close
Set rstMissions = Nothing

Dim rstWaypoints As New ADODB.RecordSet
Dim Count As Integer
Dim WaypointName As String
Dim WaypointElevation As String
Dim Refuel As Boolean
Dim Distance As String
Dim Bearing As String
Dim LSAlt As String
Dim Time As String
Dim Lat As Double
Dim Lon As Double
Dim Weather As String

Count = 1
Do While Count < NumberofWaypoints + 1

Select Case Count
  Case 1
    WaypointName = Name1
    Lat = lat1
    Lon = lon1
    WaypointElevation = Height1
    Distance = Dist1
    Bearing = Bearing1
    LSAlt = LSAlt1
    'T1 = Round(TOLT + (Dist1 / CruiseSpeed) * 60, 0)
    Refuel = False
    Time = FlightTime(Resource, Dist1, Refuel)
    Weather = WeatherCode1
  Case 2
    WaypointName = Name2
    Lat = lat2
    Lon = lon2
    WaypointElevation = Height2
    Distance = Dist2
    Bearing = Bearing2
    LSAlt = LSAlt2
    Refuel = Chk_Refuel2.Value
    Time = FlightTime(Resource, Dist2, Refuel)
    Weather = WeatherCode2
  Case 3
    WaypointName = Name3
    Lat = Lat3
    Lon = Lon3
    WaypointElevation = Height3
    Distance = Dist3
    Bearing = Bearing3
    LSAlt = LSAlt3
    Refuel = Chk_Refuel3.Value
    Time = FlightTime(Resource, Dist3, Refuel)
    Weather = WeatherCode3
  Case 4
    WaypointName = Name4
    Lat = Lat4
    Lon = Lon4
    WaypointElevation = Height4
    Distance = Dist4
    Bearing = Bearing4
    LSAlt = LSAlt4
    Refuel = Chk_Refuel4.Value
    Time = FlightTime(Resource, Dist4, Refuel)
    Weather = WeatherCode4
  Case 5
    WaypointName = Name5
    Lat = Lat5
    Lon = Lon5
    WaypointElevation = Height5
    Distance = 0
    Bearing = 0
    LSAlt = 0
    Time = 0
    Refuel = False
    Weather = WeatherCode5
End Select

rstWaypoints.Open "tbl_Waypoints", CurrentProject.Connection, adOpenDynamic, adLockOptimistic
rstWaypoints.Fields.Refresh
rstWaypoints.AddNew
rstWaypoints("Mission ID") = MissionID
rstWaypoints("Waypoint") = Count
rstWaypoints("Name") = WaypointName
rstWaypoints("Elevation") = WaypointElevation
rstWaypoints("Lat") = Lat
rstWaypoints("Lon") = Lon
rstWaypoints("Refuel") = Refuel
rstWaypoints("LSAlt To Next") = LSAlt
rstWaypoints("Time To Next") = Time
rstWaypoints("Distance to Next") = Distance
rstWaypoints("Bearing To Next") = Bearing
rstWaypoints("Weather Code") = Weather
rstWaypoints.Update
rstWaypoints.Close
Set rstWaypoints = Nothing

Count = Count + 1

Loop

DoCmd.RunSQL("DELETE FROM tbl_SelectResource1") 'Clears The Select Resource Table
DoCmd.RunSQL("DELETE FROM tbl_SelHosp") 'Clears the SelectHospital Table
DoCmd.Close acForm, "Frm_SelectResource"
DoCmd.Close acForm, "Frm_WorkSpace"
DoCmd.OpenForm "Frm_WorkSpace"

End Sub

Private Sub Command13_Click()

DoCmd.RunSQL("DELETE FROM tbl_SelectResource1") 'Clears The Select Resource Table
DoCmd.RunSQL("DELETE FROM tbl_SelHosp") 'Clears the SelectHospital Table
DoCmd.Close acForm, "Frm_SelectResource"
DoCmd.OpenForm "Frm_WorkSpace"

End Sub

Private Sub List_Resources_Click()

Dim Idx As Integer
Dim Resource As String

Idx = Me.List_Resources.ListIndex
Resource = Me.List_Resources.ItemData(Idx) 'Gets selected Resource

Dim RefuelWaypoint As Integer
Dim RefuelPlace As String
Dim RefuelTime2 As String
Dim RefuelTime3 As String
Dim RefuelTime4 As String

' Resets Refuel Check Boxes
Chk_Refuel2.Locked = False
Chk_Refuel3.Locked = False
Chk_Refuel4.Locked = False
Chk_Refuel2.Value = False
Chk_Refuel3.Value = False
Chk_Refuel4.Value = False
Chk_Refuel2.Locked = True
Chk_Refuel3.Locked = True

"
Chk_Refuel4.Locked = True

Dim rstSelResource As New ADODB.RecordSet
SQL = "SELECT tbl_SelectResource1.[Refuel Waypoint], tbl_SelectResource1.[Number of Waypoints], tbl_SelectResource1.[W1 Name], tbl_SelectResource1.[W1 Type], tbl_SelectResource1.[W1 Lat], tbl_SelectResource1.[W1 Lon], tbl_SelectResource1.[W1 Weather Report], tbl_SelectResource1.[W1 Height], tbl_SelectResource1.[W2 Name], tbl_SelectResource1.[W2 Type], tbl_SelectResource1.[W2 Lat], tbl_SelectResource1.[W2 Lon], tbl_SelectResource1.[W2 Weather Report], tbl_SelectResource1.[W2 Height], tbl_SelectResource1.[W3 Name], tbl_SelectResource1.[W3 Lat], tbl_SelectResource1.[W3 Lon], tbl_SelectResource1.[W3 Weather Report], tbl_SelectResource1.[W3 Height], tbl_SelectResource1.[W4 Name], tbl_SelectResource1.[W4 Type], tbl_SelectResource1.[W4 Lat], tbl_SelectResource1.[W4 Lon], tbl_SelectResource1.[W4 Weather Report], tbl_SelectResource1.[W4 Height], tbl_SelectResource1.[Risk Analysis] FROM tbl_SelectResource1 WHERE (((tbl_SelectResource1.Resource) = " & Resource & ")"
rstSelResource.Open SQL, CurrentProject.Connection, adOpenDynami
c
RiskAnalysis = rstSelResource("Risk Analysis")
NumWaypoints = rstSelResource("Number of Waypoints").Value
Name1 = rstSelResource("W1 Name").Value + " - " + rstSelResource("W1 Type").Value
Name2 = rstSelResource("W2 Name").Value + " - " + rstSelResource("W2 Type").Value
Height1 = rstSelResource("W1 Height")
Height2 = rstSelResource("W2 Height")
lat1 = rstSelResource("W1 Lat").Value
lat2 = rstSelResource("W2 Lat").Value
lon1 = rstSelResource("W1 Lon").Value
lon2 = rstSelResource("W2 Lon").Value
Bearing1 = Round(ToDeg(Azimuth(lat1, lon1, lat2, lon2)), 3)
LSAlt1 = LSAlt(ToRad(lat1), ToRad(lon1), ToRad(lat2), ToRad(lon2))
Dist1 = Round(DistanceNM(ToRad(lat1), ToRad(lon1), ToRad(lat2), ToRad(lon2)), 1)
WeatherCode1 = rstSelResource("W1 Weather Report").Value
If NumWaypoints = 5 Then
Lon3 = rstSelResource("W3 Lon").Value
Lat3 = rstSelResource("W3 Lat").Value
Height3 = rstSelResource("W3 Height")
Name3 = rstSelResource("W3 Name").Value + " - " + rstSelResource("W3 Type").Value
Bearing2 = Round(ToDeg(Azimuth(lat2, lon2, Lat3, Lon3)), 3)
LSAlt2 = LSAlt(ToRad(lat2), ToRad(lon2), ToRad(Lat3), ToRad(Lon3))
Dist2 = Round(DistanceNM(ToRad(lat2), ToRad(lon2), ToRad(Lat3), ToRad(Lon3)), 1)
Name4 = rstSelResource("W4 Name").Value + " - " + rstSelResource("W4 Type").Value
Height4 = rstSelResource("W4 Height")
Lat4 = rstSelResource("W4 Lat").Value
Lon4 = rstSelResource("W4 Lon").Value
Bearing3 = Round(ToDeg(Azimuth(Lat3, Lon3, Lat4, Lon4)), 3)
LSAlt3 = LSAlt(ToRad(Lat3), ToRad(Lon3), ToRad(Lat4),
ToRad(Lon4))
Name5 = Name1
Height5 = Height1
Lon5 = lon1
Lat5 = lat1
Bearing4 = Round(ToDeg(Azimuth(Lat4, Lon4, Lat5, Lon5)), 3)
LSAlt4 = LSAlt(ToRad(Lat4), ToRad(Lon4), ToRad(Lat5),
ToRad(Lon5))
Dist3 = Round(DistanceNM(ToRad(Lat3), ToRad(Lon3),
ToRad(Lat4), ToRad(Lon4)), 1)
Dist4 = Round(DistanceNM(ToRad(Lat4), ToRad(Lon4),
ToRad(Lat5), ToRad(Lon5)), 1)
Lbl_Lat4.Caption = LatFormat(Lat4)
Lbl_Lat5.Caption = LatFormat(Lat5)
Lbl_Lon4.Caption = LonFormat(Lon4)
Lbl_Lon5.Caption = LonFormat(Lon5)
WeatherCode5 = WeatherCode1
End If

If NumWaypoints = 4 Then
  Lon3 = rstSelResource("W3 Lon").Value
  Lat3 = rstSelResource("W3 Lat").Value
  Height3 = rstSelResource("W3 Height")
  Name3 = rstSelResource("W3 Name").Value + " - " +
rstSelResource("W3 Type").Value
  Bearing2 = Round(ToDeg(Azimuth(lat2, lon2, Lat3, Lon3)), 3)
  LSAlt2 = LSAlt(ToRad(lat2), ToRad(lon2), ToRad(Lat3),
  ToRad(Lon3))
  Dist2 = Round(DistanceNM(ToRad(lat2), ToRad(lon2),
  ToRad(Lat3), ToRad(Lon3)), 1)
  Name4 = Name1
  Height4 = Height1
  Lon4 = lon1
  Lat4 = lat1
  Bearing3 = Round(ToDeg(Azimuth(Lat3, Lon3, Lat4, Lon4)), 3)
  LSAlt3 = LSAlt(ToRad(Lat3), ToRad(Lon3), ToRad(Lat4),
  ToRad(Lon4))
  Dist3 = Round(DistanceNM(ToRad(Lat3), ToRad(Lon3),
  ToRad(Lat4), ToRad(Lon4)), 1)
  Lbl_Lat4.Caption = LatFormat(Lat4)
  Lbl_Lon4.Caption = LonFormat(Lon4)
  WeatherCode4 = WeatherCode1
End If

If NumWaypoints = 3 Then
  Lon3 = lon1
  Lat3 = lat1
  Height3 = Height1
  Name3 = Name1
  WeatherCode3 = WeatherCode1
  Bearing2 = Round(ToDeg(Azimuth(lat2, lon2, Lat3, Lon3)), 3)
  LSAlt2 = LSAlt(ToRad(lat2), ToRad(lon2), ToRad(Lat3),
  ToRad(Lon3))
  Dist2 = Round(DistanceNM(ToRad(lat2), ToRad(lon2),
  ToRad(Lat3), ToRad(Lon3)), 1)
  RefuelWaypoint = rstSelResource("Refuel Waypoint").Value
  If RefuelWaypoint = 2 Then
    RefuelPlace = rstSelResource("W2 Name").Value
    Chk_Refuel2.Locked = False
End If

End If
Chk_Refuel2.Value = True
Chk_Refuel2.Locked = True
End If

If RefuelWaypoint = 3 Then
    RefuelPlace = rstSelResource("W3 Name").Value
    Chk_Refuel3.Locked = False
    Chk_Refuel3.Value = True
    Chk_Refuel3.Locked = True
End If

If RefuelWaypoint = 4 Then
    RefuelPlace = rstSelResource("W4 Name").Value
    Chk_Refuel4.Locked = False
    Chk_Refuel4.Value = True
    Chk_Refuel4.Locked = True
End If

rstSelResource.Close
Set rstSelResource = Nothing

Lbl_Name1.Caption = Name1
Lbl_Name2.Caption = Name2
Lbl_Name3.Caption = Name3
Lbl_Name4.Caption = Name4
Lbl_Name5.Caption = Name5

Lbl_Height1.Caption = Height1
Lbl_Height2.Caption = Height2
Lbl_Height3.Caption = Height3
Lbl_Height4.Caption = Height4
Lbl_Height5.Caption = Height5

Lbl_Lat1.Caption = LatFormat(lat1)
Lbl_Lat2.Caption = LatFormat(lat2)
Lbl_Lat3.Caption = LatFormat(Lat3)

Lbl_Lon1.Caption = LonFormat(lon1)
Lbl_Lon2.Caption = LonFormat(lon2)
Lbl_Lon3.Caption = LonFormat(Lon3)

Lbl_Dist1.Caption = Dist1
Lbl_Dist2.Caption = Dist2
Lbl_Dist3.Caption = Dist3
Lbl_Dist4.Caption = Dist4

RefuelTime2 = "False"
RefuelTime3 = "False"
RefuelTime4 = "False"

If RefuelWaypoint = 2 Then
    RefuelTime2 = "True"
End If

If RefuelWaypoint = 3 Then
    RefuelTime3 = "True"
End If

If RefuelWaypoint = 4 Then
    RefuelTime4 = "True"
End If

Lbl_Time1.Caption = FlightTime(Resource, Dist1, False)
Appendix E
Graphical User Interface VBA Code

Lbl_Time2.Caption = FlightTime(Resource, Dist2, RefuelTime2)

Lbl_Bearing1.Caption = Bearing1
Lbl_Bearing2.Caption = Bearing2
Lbl_Bearing3.Caption = Bearing3
Lbl_Bearing4.Caption = Bearing4

Lbl_LSAAlt1.Caption = LSAlt1
Lbl_LSAAlt2.Caption = LSAlt2
Lbl_LSAAlt3.Caption = LSAlt3
Lbl_LSAAlt4.Caption = LSAlt4

MET = GetMET("Area30") + GetMET(WeatherCode1)
NOTAM = GetNOTAM(WeatherCode1)

If WeatherCode2 <> WeatherCode1 Then
    MET = MET + GetMET(WeatherCode2)
    NOTAM = NOTAM + GetNOTAM(WeatherCode2)
End If

If WeatherCode3 <> WeatherCode1 And WeatherCode3 <> WeatherCode2 And NumWaypoints >= 4 Then
    MET = MET + GetMET(WeatherCode3)
    NOTAM = NOTAM + GetNOTAM(WeatherCode3)
End If

    MET = MET + GetMET(WeatherCode4)
    NOTAM = NOTAM + GetNOTAM(WeatherCode4)
End If

txt_MET.Value = MET
txt_NOTAM.Value = NOTAM
txt_Risk.Value = RiskAnalysis

If NumWaypoints = 3 Then
    lbl_Name5.Visible = False
    Lbl_Height5.Visible = False
    Lbl_Lon5.Visible = False
    Lbl_Lat5.Visible = False
    Lbl_Name4.Visible = False
    Lbl_Height4.Visible = False
    Lbl_Lon4.Visible = False
    Lbl_Lat4.Visible = False
    Lbl_Time4.Visible = False
    Lbl_Dist4.Visible = False
    Lbl_Bearing4.Visible = False
    Lbl_LSAAlt4.Visible = False
    Lbl_Time3.Visible = False
    Lbl_Dist3.Visible = False
    Lbl_Bearing3.Visible = False
    Lbl_LSAAlt3.Visible = False
End If

If NumWaypoints = 4 Then
    lbl_Name5.Visible = False
    Lbl_Height5.Visible = False
    Lbl_Lon5.Visible = False
    Lbl_Lat5.Visible = False
    Lbl_Name4.Visible = True
    Lbl_Height4.Visible = True
    Lbl_Lon4.Visible = True
    Lbl_Lat4.Visible = True
    Lbl_Time4.Visible = False
End If
Lbl_Dist4.Visible = False
Lbl_Bearing4.Visible = False
Lbl_LSAlt4.Visible = False
Lbl_Time3.Visible = True
Lbl_Dist3.Visible = True
Lbl_Bearing3.Visible = True
Lbl_LSAlt3.Visible = True
End If

If NumWaypoints = 5 Then
  Lbl_Name4.Visible = True
  Lbl_Height4.Visible = True
  Lbl_Lon4.Visible = True
  Lbl_Lat4.Visible = True
  Lbl_Time4.Visible = True
  Lbl_Dist4.Visible = True
  Lbl_Bearing4.Visible = True
  Lbl_LSAlt4.Visible = True
  Lbl_Name5.Visible = True
  Lbl_Height5.Visible = True
  Lbl_Lon5.Visible = True
  Lbl_Lat5.Visible = True
  Lbl_LSAlt5.Visible = True
  Lbl_Time3.Visible = True
  Lbl_Dist3.Visible = True
  Lbl_Bearing3.Visible = True
  Lbl_LSAlt3.Visible = True
End If

End Sub
## Mission Profile

**Mission**

<table>
<thead>
<tr>
<th>Mission ID: 132</th>
<th>Request ID: 54</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type:</td>
<td>Primary</td>
</tr>
<tr>
<td>Reviewed:</td>
<td>8/01/2008 09:59:06</td>
</tr>
</tbody>
</table>

**Aircraft**

<table>
<thead>
<tr>
<th>NEHS2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell 412EF</td>
</tr>
</tbody>
</table>

**Crew**

<table>
<thead>
<tr>
<th>Pilot:</th>
<th>Two, Pilot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crewman:</td>
<td>Two, Crewman</td>
</tr>
<tr>
<td>Paramedic:</td>
<td>Two, Paramedic</td>
</tr>
</tbody>
</table>

**Notes**

Near drowning/30B not alert

## Flight Plan

1. **YLTV - Base**

<table>
<thead>
<tr>
<th>Latitude (deg):</th>
<th>-38.2067</th>
<th>Elevation (ft):</th>
<th>591</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitude (deg):</td>
<td>146.4700</td>
<td>Weather Report:</td>
<td>YLTV</td>
</tr>
<tr>
<td>Refuel:</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance To Next (NM):</td>
<td>136</td>
<td>LSAlt To Next (ft):</td>
<td>3620</td>
</tr>
<tr>
<td>Time To Next (min):</td>
<td>78</td>
<td>Azimuth To Next (deg):</td>
<td>189</td>
</tr>
</tbody>
</table>

2. **Scene - Unprepared HLS(28NM From YOLA)**

<table>
<thead>
<tr>
<th>Latitude (deg):</th>
<th>-38.7500</th>
<th>Elevation (ft):</th>
<th>UNKNOWN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitude (deg):</td>
<td>143.6667</td>
<td>Weather Report:</td>
<td>YOLA</td>
</tr>
<tr>
<td>Refuel:</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance To Next (NM):</td>
<td>62</td>
<td>LSAlt To Next (ft):</td>
<td>3620</td>
</tr>
<tr>
<td>Time To Next (min):</td>
<td>81</td>
<td>Azimuth To Next (deg):</td>
<td>81.7</td>
</tr>
</tbody>
</table>

3. **Affected Hospital Helipad - Prepared HLS**

<table>
<thead>
<tr>
<th>Latitude (deg):</th>
<th>-37.8472</th>
<th>Elevation (ft):</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitude (deg):</td>
<td>144.9847</td>
<td>Weather Report:</td>
<td>YHER</td>
</tr>
<tr>
<td>Refuel:</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance To Next (NM):</td>
<td>74</td>
<td>LSAlt To Next (ft):</td>
<td>4306</td>
</tr>
<tr>
<td>Time To Next (min):</td>
<td>47</td>
<td>Azimuth To Next (deg):</td>
<td>118</td>
</tr>
</tbody>
</table>

---

*Monday, 14 January 2008*
Appendix F
Example Mission Profile Report

---

### YLTV - Base

<table>
<thead>
<tr>
<th>Latitude (deg):</th>
<th>Elevation (ft):</th>
</tr>
</thead>
<tbody>
<tr>
<td>-38.2047</td>
<td>591</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Longitude (deg):</th>
<th>Weather Report:</th>
</tr>
</thead>
<tbody>
<tr>
<td>144.4700</td>
<td>YLTV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Refuel:</th>
<th>Distance To Next (NM):</th>
<th>LSalt To Next (ft):</th>
<th>Time To Next (min):</th>
<th>Azimuth To Next (deg):</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>0</td>
<td>0</td>
<td>70</td>
<td>0</td>
</tr>
</tbody>
</table>

---

### Risk Analysis

- **Risk Score: High**

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot &lt; 200 hrs in Type</td>
<td>+1</td>
</tr>
<tr>
<td>Last Flight &gt; 30 Days</td>
<td>+1</td>
</tr>
<tr>
<td>180 Days Since Check Ride</td>
<td>+2</td>
</tr>
<tr>
<td>VFR Program</td>
<td>+1</td>
</tr>
</tbody>
</table>

**RISK SCORE:** 5

- **NORMAL** = 4 or less
- **HIGH** = 5
- **UNACCEPTABLE** = 6 or greater

---

### MET/AFS

**ARRA: 139**

<table>
<thead>
<tr>
<th>AFSR</th>
<th>ANBMD</th>
<th>AREA</th>
<th>FORWARD</th>
<th>220400 TO 221700 AREAS 30/32</th>
</tr>
</thead>
</table>

AND OVERVIEW:
- ISOLATED THERMOTOPES SE OF FLYR/YLTV/UECM, CONTRACTING SLOWLY
  - F/B/R/CS, ISOLATED SHOWERS S OF YLTV/UECM, MOST IRRAD SE OF YLTV/UECM.
- LOW CLOUD PATCHES W/SHRA/THUNDERSTORMS.
- LOW CLOUD/OBSTACLE Patches Lmk 08/8 of YLTV After C15.
- ISOLATED FOG SOUTHWEST LND AFTER L12. SMKE DITCHES HE LDW.

**WIND:**

<table>
<thead>
<tr>
<th>2000</th>
<th>5000</th>
<th>7000</th>
<th>10000</th>
<th>14000</th>
<th>16000</th>
</tr>
</thead>
<tbody>
<tr>
<td>170/18</td>
<td>170/16</td>
<td>170/16</td>
<td>170/16</td>
<td>190/18</td>
<td>200/20</td>
</tr>
</tbody>
</table>

AND CLOUD:

CISL EB 3000/20000 AS DER TO IN OVERVIEW. SNW ST 0800/0800 AS DER LOW
CLOUD IN OVERVIEW. SNW C/CS 3000/10000. TODDING CB S OF DOWSE
AFTER L12. TOSS LOWERING TO 4000 FROM THE N. CU TO GS TO 14000 WITH
SHRA W/SHRA IN THE BR. BRN AC/AS ABOVE 10000 & OF 14000 YLT 112.

**WEATHER:**

- TURB, SMOKE, SRBA, DX, PZ.

**VISIBILITY:**

- 3000 FT, 2000 TURB/SHRA/OZ, 8000 SRBA.

**FREEzing LEVEL:**

- 11500 IN THE FAR NW DECREASING TO 8000 IN THE SE.

**Icing:**

- NOD IN AC/AS, LARGE CV TOGS.

**Cumulonimbus:**

- NOD IN CV/AC. ISOL NOD BELOW 7000 FT LEX OF RANGES.

**And Critical Location:**

- Heights Above MSL
  - EILMERE GMD 5950 - SRBA DOT ST 2900 BEN CJ 5800
  - MDL 2900 ON BEN ST 1200 - CLOUD OR GROUND
  - INTER 0410 4500 SRBA BEN ST 1600

**For Further Information:**

- 03 5649 4580

---

Monday, 14 January 2008

Page 2 of 3
NOTAM

YLV - No Current NOTAMs

YULA - No Current NOTAMs

ESSENDON (VEXD)
AD
NORTHERN RUNWAY RESLOCATED
173M TO THE SOUTH WEST
FROM 11 01200 TO PERM
AD
NORTHERN RUNWAY RESLOCATED
131M TO THE ERM
FROM 11 01200 TO PERM
AD
RWY 36 FIXED DISTANCE AND TOUCH DOWN ZONE MARKINGS DEEPENED
8NM TO THE NORTH
FROM 11 170900 TO PERM
DOC
C0014/07 REVIEW C0018/07
TRUDGER NOTAM - AIR SUP H3/07 ESSENDON AIRPORT LIGHTING UPGRADE
SUBMITTED COPY 05/07/07 BEST EVIDENCE MATERIAL
WWW.AIRTRAFFICAUSTRALIA.COM/NOTAM/NOTAM.DOC
FROM 01 180000 TO 09 010400 007
AD
C0126/07 REVIEW C0128/07
AT-VASIS RWY 17 STAGE 1, 8 AND 6 NOT AVAIL
SUB LOT FAILS
FROM 08 212200 TO 08 180000 007
AD
C0127/07
AT-VASIS RWY 28 STAGE 1, 8 AND 6 NOT AVAIL
SUB LOT FAILS
FROM 08 212200 TO 08 180000 007
AD
C0181/07 REVIEW C0147/07
NEW TCR PLCD ESTABLISHED
IN LINE WITH FIP MARA, A RWY 09/24 TO RWY 36
CONSEQUENTLY DELIGHT THE USE OF RWY 09/24 TO ACCESS THE RWY 36 TF
ABANDONED DELIGHT LOCAL TRAFFIC OPERATIONS NOT ADV
FROM 09 000347 TO PERM
AD
C0176/07 REVIEW C0180/07
TANGO OCEAN FENCE LIT AND MARKED
INFRINGING TWR BASE BY 8NM TO THE WEST.
REDUCED TO 2NM EN FL
FROM 04 160526 TO 07 160529 007
AD
C0179/07
RWY 17/35 END NOT AVAIL ONE WIP
RWY 17 THE DEEP 1 Certification by a RAD, OBSTRUCTION MEN AND
EQUIPMENT EXPERIENCE MAY OCCUR IN PLACE OF TOWS RWY 17
RWY 17 AT-VASIS 8000 AVAIL
TWO CHARLIE, ECHO, JULIETT AND TANGO NOT AVAIL
TWO POWERED ROBOTS DEPLOYED BY YELLOW CONES.
RWY 17 TWAQ 618 TWAQ 669(2.96) A3DA 628 LDA 243
RWY 25 TWAQ 553 TWAQ 613(3.39) A3DA 553 LDA 553
SUFFICEARY TOGA
RWY 17 403(1.6) 523(1.9) 589(2.2) 658(2.5)
RWY 25 463(2.2) 583(2.5) 574(3.3)
SEP METHOD OF WORKS PLAN ESSENDON 07/1 STAGE 4
FROM 04 092900 TO 04 240009
DAILY 24/01/07
AD
C0180/07
NORTHERN ROAD VEH TANGO, DELTA, ECHO AND TANGO WED N OF TAY
CHARLIE NOT AVAIL ONE WIP
TANGO TAY INDICATED BY YELLOW CONES

Monday, 14 January 2008
TAXI VIA ARC INSTRUCTION
REFER METHOD OR WORKING PLAN 97/01 STAGE 4
FROM 04 000100 TO 04 270000
DAILY 2100/0800
EXC WED
### Appendix G: System Validation Database

#### G.1 `tbl_AircraftTypes` Example Data

<table>
<thead>
<tr>
<th>Aircraft ID</th>
<th>Make</th>
<th>Fixed/Rotor y</th>
<th>Cruise Speed</th>
<th>Range</th>
<th>TOL T</th>
<th>Refuel Time</th>
<th>IFR</th>
<th>NVG</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS365N3</td>
<td>Eurocopter AS.365N3 Dauphine 2</td>
<td>Helicopter</td>
<td>145</td>
<td>350</td>
<td>10</td>
<td>10</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>B200C</td>
<td>Beechcraft Kingair B200C</td>
<td>Fixed Wing</td>
<td>250</td>
<td>500</td>
<td>20</td>
<td>20</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>B412EP</td>
<td>Bell 412EP</td>
<td>Helicopter</td>
<td>120</td>
<td>300</td>
<td>10</td>
<td>10</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

#### G.2 `tbl_Airfields` Example Data

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Lat</th>
<th>Long</th>
<th>Altitude</th>
<th>Fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>YARA</td>
<td>Ararat (VIC)</td>
<td>-37.31</td>
<td>142.9833333333333</td>
<td>3307</td>
<td>No</td>
</tr>
<tr>
<td>YARM</td>
<td>Armidale (NSW)</td>
<td>-30.5283333333333</td>
<td>151.6166666666667</td>
<td>11667</td>
<td>No</td>
</tr>
<tr>
<td>YBBT</td>
<td>Boort (VIC)</td>
<td>-36.1366666666667</td>
<td>143.7266666666667</td>
<td>965</td>
<td>No</td>
</tr>
<tr>
<td>YBDG</td>
<td>Bendigo (VIC)</td>
<td>-36.74</td>
<td>144.33</td>
<td>2313</td>
<td>Yes</td>
</tr>
<tr>
<td>YBHI</td>
<td>Broken Hill (NSW)</td>
<td>-32.0016666666667</td>
<td>141.4716666666667</td>
<td>3143</td>
<td>No</td>
</tr>
<tr>
<td>YBIR</td>
<td>Birchip (VIC)</td>
<td>-36</td>
<td>142.9166666666667</td>
<td>1115</td>
<td>No</td>
</tr>
<tr>
<td>YBKE</td>
<td>Bourke (NSW)</td>
<td>-30.0383333333333</td>
<td>145.9516666666667</td>
<td>1155</td>
<td>No</td>
</tr>
<tr>
<td>YBLA</td>
<td>Benalla (VIC)</td>
<td>-36.5516666666667</td>
<td>146.0066666666667</td>
<td>1867</td>
<td>No</td>
</tr>
<tr>
<td>YBLT</td>
<td>Ballarat (VIC)</td>
<td>-37.5116666666667</td>
<td>143.7916666666667</td>
<td>4701</td>
<td>Yes</td>
</tr>
<tr>
<td>YBNA</td>
<td>Ballina/Byron Gateway (NSW)</td>
<td>-28.8333333333333</td>
<td>153.5616666666667</td>
<td>23</td>
<td>No</td>
</tr>
<tr>
<td>YBNS</td>
<td>Bairnsdale (VIC)</td>
<td>-37.8883333333333</td>
<td>147.5683333333333</td>
<td>541</td>
<td>No</td>
</tr>
<tr>
<td>YBOR</td>
<td>Bordertown (SA)</td>
<td>-36.265</td>
<td>140.7116666666667</td>
<td>869</td>
<td>No</td>
</tr>
<tr>
<td>YBRK</td>
<td>Rockhampton (QLD)</td>
<td>-23.3816666666667</td>
<td>150.475</td>
<td>112</td>
<td>No</td>
</tr>
<tr>
<td>YBRN</td>
<td>Balranald (NSW)</td>
<td>-34.6233333333333</td>
<td>143.5783333333333</td>
<td>689</td>
<td>No</td>
</tr>
<tr>
<td>YBRS</td>
<td>Barwon Heads (VIC)</td>
<td>-38.2583333333333</td>
<td>144.4333333333333</td>
<td>164</td>
<td>No</td>
</tr>
<tr>
<td>YBSS</td>
<td>Bacchus Marsh (VIC)</td>
<td>-37.7333333333333</td>
<td>144.4216666666667</td>
<td>1706</td>
<td>No</td>
</tr>
<tr>
<td>YBTH</td>
<td>Bathurst (NSW)</td>
<td>-33.41</td>
<td>149.6516666666667</td>
<td>7989</td>
<td>No</td>
</tr>
<tr>
<td>YCBA</td>
<td>Cobar (NSW)</td>
<td>-31.5383333333333</td>
<td>145.7933333333333</td>
<td>2375</td>
<td>No</td>
</tr>
<tr>
<td>YCBB</td>
<td>Coonabarabran (NSW)</td>
<td>-31.3333333333333</td>
<td>149.2666666666667</td>
<td>6946</td>
<td>No</td>
</tr>
<tr>
<td>YCBG</td>
<td>Hobart/Cambridge (TAS)</td>
<td>-42.8266666666667</td>
<td>147.475</td>
<td>220</td>
<td>No</td>
</tr>
<tr>
<td>YCBP</td>
<td>Coober Pedy (SA)</td>
<td>-29.04</td>
<td>134.7216666666667</td>
<td>2428</td>
<td>No</td>
</tr>
<tr>
<td>YCDE</td>
<td>Cobden (VIC)</td>
<td>-38.3266666666667</td>
<td>143.0566666666667</td>
<td>1509</td>
<td>No</td>
</tr>
<tr>
<td>YCDU</td>
<td>Ceduna (SA)</td>
<td>-32.13</td>
<td>133.71</td>
<td>253</td>
<td>No</td>
</tr>
<tr>
<td>YCNK</td>
<td>Cessnock (NSW)</td>
<td>-32.7883333333333</td>
<td>151.3416666666667</td>
<td>692</td>
<td>No</td>
</tr>
<tr>
<td>YCOM</td>
<td>Cooma/Snowy Mountains (NSW)</td>
<td>-36.2966666666667</td>
<td>147.9733333333333</td>
<td>10190</td>
<td>No</td>
</tr>
</tbody>
</table>
## Appendix H

### Case Study Results

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Lat</th>
<th>Long</th>
<th>Altitude</th>
<th>Fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>YCOR</td>
<td>Corowa (NSW)</td>
<td>-35.99</td>
<td>146.351666666667</td>
<td>1539</td>
<td>No</td>
</tr>
<tr>
<td>YCRG</td>
<td>Corryong (VIC)</td>
<td>-36.183333333333</td>
<td>147.888333333333</td>
<td>3159</td>
<td>No</td>
</tr>
<tr>
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## G.3 tbl_CaseType Example Data

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</tr>
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<td>2</td>
<td>Burns, difficulty breathing</td>
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</tr>
<tr>
<td>3</td>
<td>Burns, large area (&gt;18%)</td>
<td>Alfred Hospital</td>
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<tr>
<td>4</td>
<td>Burns or explosion: Multiple victims</td>
<td>Alfred Hospital</td>
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<td>5</td>
<td>Burns, severe SOB</td>
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<tr>
<td>6</td>
<td>Burns, not alert</td>
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<tr>
<td>7</td>
<td>Convulsions, pregnant pt</td>
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<tr>
<td>8</td>
<td>Convulsions, trauma</td>
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</tr>
<tr>
<td>9</td>
<td>Near drowning/diving, unconscious</td>
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</tr>
<tr>
<td>10</td>
<td>Drowning, resp arrest or under water</td>
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</tr>
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<td>Diving accident, possible neck injury</td>
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<td>13</td>
<td>Scuba accident, possible BENDS</td>
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<td>16</td>
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<td>23</td>
<td>Traffic accident, trapped victim</td>
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</tr>
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<td>24</td>
<td>Traffic accident, ejected victim</td>
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<td>26</td>
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<td>27</td>
<td>Traumatic injuries, severe SOB</td>
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<td>28</td>
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<td>29</td>
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<td>30</td>
<td>Clinician/Road Crew</td>
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<td>31</td>
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## Appendix H

### Case Study Results

#### G.4 tbl_Crewman Example Data

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<td>ALBURY (YMAY) AD C0067/07 REVIEW C0057/07 EAST-WEST CONNECTING TWY BTN TWY DELTA AND TWY BRAVO NOT AVBL DUE WIP FROM 04 200521 TO 04 270730 EST</td>
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<td>MARYBOROUGH (VIC) (YMBU) AD C0003/06 REVIEW C0002/06 RWY 24 AND RWY</td>
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## Appendix H

### Case Study Results

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### YMCO

MALLACOOTA (YMCO) AD C0016/07 RWY 07/25 AND RWY 18/36 GRADIENT/STODA CHANGES RWY TODA 07 941(3.17) 25 941(5.92) 18 1088(5.29) 36 1088(3.49) AMEND NOTE 2 TO READ: CAUTION: FENCE 15.6FT ABV AND 70M W OF RWS END IS NOT TAKEN INTO ACCOUNT IN DETERMINING TODA GRAD AND STODA. STODA: RWY 07 839(1.6) 871(1.9) 903(2.2) 921(2.5) RWY 25 907(5.0) RWY 18 942(3.3) 1078(5.0) RWY 36 964(2.2) 1006(2.5) 1079(3.3) FROM 03 220625 TO PERM.

### YMEN

ESSENDON (YMEN) AD C0360/06 NORTHERN HELIPAD RELOCATED 175M TO THE SOUTH WEST FROM 11 012100 TO PERM AD C0361/06 NORTHERN WINDSOCK RELOCATED 131M TO THE SSW FROM 11 012100 TO PERM AD C0383/06 RWY 35 FIXED DISTANCE AND TOUCH DOWN ZONE MARKINGS DISP 33M TO THE NORTH FROM 11 170900 TO PERM DOC C0014/07 REVIEW C0013/07 TRIGGER NOTAM - AIP SUP H3/07 ESSENDON AIRPORT LIGHTING UPGRADE AVBL FM AVFAX CODE 81540 AND AIRSERVICE WEBSITE WWW.AIRSERVICESAUSTRALIA.COM/PUBLICATIONS/AIP.SUP FROM 01 150004 TO 08 310400 EST AD C0126/07 REVIEW C0125/07 AT VASIS RWY 17 STAGE 4, 5 AND 6 NOT AVBL DUE LGT FAULT FROM 03 221914 TO 05 150600 EST AD C0127/07 AT VASIS RWY 08 STAGE 4, 5 AND 6 NOT AVBL DUE LGT FAULT FROM 03 211116 TO 05 150600 EST AD C0151/07 REVIEW C0147/07 NEW TWTY KILO ESTABLISHED IN LINE WITH TWTY PAPA S RWY 08/26 TO THR RWY 35 CONSEQUENTLY REGULAR USE OF RWY 08/26 TO ACCESS THR RWY 35 IS ABANDONED DELETE LOCAL TRAFFIC REGULATION NOTE 1B FROM 03 300147 TO PERM AD C0173/07 REVIEW C0048/07 TEMPO OBST FENCE LIT AND MARKED INFRINGING TWTY HOTEL BY 5M TO THE WEST. WID REDUCED TO 21M FM CL FROM 04 160526 TO 07 160500 EST AD C0179/07 RWY 17/35 890M N END NOT AVBL DUE WIP. RWY 17 THR DISP 1160M AND MARKED BY VEE BARS. OBSTRUCTION MEN AND EQUIPMENT 10FT AGL ON RCL 703M FM START OF TORA RWY 35. RWY 17 AT-VASIS NOT AVBL. TWTY CHARLIE, ECHO, JULIETT AND TANGO NOT AVBL TWTY NOVEMBER THROUGH WORKS INDICATED BY YELLOW CONES. RWY 17 TORA 613 TODA 663(2.56) ASDA 613 LDA 343 RWY 35 TORA 553 TODA 613(4.33) ASDA 553 LDA 553 SUPPLEMENTARY TODA RWY 17 405(1.6) 502(1.9) 580(2.2) 658(2.5) RWY 35 453(2.2) 503(2.5) 574(3.3) REF METHOD OF WORKS PLAN ESSENDON 07/1 STAGE 4 FROM 04 222130 TO 04 240800 DAILY 2130/0800 AD C0180/07 NORTHERN RUNUP BAYS TANGO, DELTA, ECHO AND TWTY ROMEO N OF TWTY CHARLIE NOT AVBL DUE WIP TEMPO TXY INDICATED BY YELLOW CONES TAXI VIA ATC INSTRUCTION REFER METHOD OR WORKING PLAN 07/01 STAGE 4 FROM 04 222130 TO 04 270800 DAILY 2130/0800 EXC WED.

### YMEC

EAST SALE (YMES) AD C0384/06 REVIEW C0380/06 T-VASIS NOT AVBL SYSTEM REMOVED FROM 11 302255 TO PERM AD C0386/06 PADI RWY 09/27 COMMISSIONED RWY 09 BOTH SIDES 3 DEG 51FT RWY 27 BOTH SIDES 3 DEG 51FT DESIGN; B737-700 FROM 11 302313 TO PERM ATS C0034/07 REVIEW C0373/06 AIRBORNE RADAR APCH AVBL TO FA18 ACFT ONLY FROM 02 140237 TO 05 140200 EST ATS C0089/07 ATS OPR HR MON-THU 2245-0700 FRI 2245-0315 OPR HR MAY VARY CK PRIOR TO PLANNING FROM 04 222245 TO 04 270315

### YMIA

MILDURA (YMIA) NAV C0004/07 NDB 'MIA' FREQ 272 NOT AVBL DUE MAINT RADIATING INTERMITTENTLY ON TEST, DO NOT USE, FALSE INDICATIONS POSSIBLE FROM 04 302230 TO 05 010430 NAV C0005/07 VOR/DME 'MIA' FREQ 113.7/84X NOT AVBL DUE MAINTENANCE. RADIATING INTERMITTENTLY ON TEST WITH NIL IDENT, DO NOT USE, FALSE INDICATIONS POSSIBLE FROM 05 032230 TO 05 040430 NAV C0006/07 VOR/DME 'MIA' FREQ 113.7/84X NOT AVBL DUE MAINT RADIATING INTERMITTENTLY ON TEST WITH NIL IDENT, DO NOT USE, FALSE INDICATIONS POSSIBLE FROM 05 022230 TO 05 030330

### YMML

MELBOURNE (YMML) DOC C0082/07 BAY DELTA 5 SAFEGATE DOCK SYSTEM
Appendix H
Case Study Results

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|      | INSTALLED FROM 02 200554 TO PERM PROC C0084/07 AMD AIP DAP EAST SID RWYS SOUTH(RNAV) DATED 15 MAR 2007 ON DIAGRAM, AMD WPT NAME DARYL TO DARLY AT S37 44.2 E144 37.8 FROM 02 202218 TO PERM AD C0178/07 ILS RWY 27 IDENTIFIED IMW FREQ 109.3MHZ TCH 50FT LLZ IMW S37 39 36.17 E144 48 36.35 GP IMW S37 39 38.45 E144 50 40.27 FROM 04 040500 TO PERM PROC C0201/07 REVIEW C0144/07 TRIGGER NOTAM-SECOND REVISION SUP H47/06 INTRODUCTION OF DUAL CL OPS TAXI LANE GOLF AVBL FM AVFAX CODE 81538 AND AIRSERVICES WEBSITE WWW.AIRSERVICESAUSTRALIA.COM/PUBLICATIONS/AIP.ASP A SEPARATE NOTAM WILL BE ISSUED ACTIVATING THE PROCEDURE. FROM 04 121608 TO 08 291600 ATS C0224/07 REVIEW C0210/07 WITH EFFECT FROM 0704302000 ALL DOMESTIC FIXED WING AIRCRAFT OPERATING INTO YMML ARE REQUIRED TO ADVISE FLIGHT DETAILS AND OBTAIN A CTMS PROGRAMMED TIME OF LANDING (PTL). DOMESTIC FLIGHTS WILL BE ALLOCATED LANDING TIMES BASED ON THE AVAILABLE CAPACITY OF THE AIRPORT. NOTIFICATION OF THESE FLIGHT DETAILS IS ADDITIONAL TO ALL EXISTING NOTIFICATION REQUIREMENTS. PILOTS OF SCHEDULED AIRCRAFT WILL BE ADVISED OF THE LATEST OPERATING TIME THROUGH THEIR COMPANY. NON-SCHEDULED FLIGHTS MUST PROVIDE DETAILS BY TELEPHONE TO MELBOURNE ATC ON 03 9235 7337 PRIOR TO THE PROPOSED OPERATION. ANY CHANGES TO ALLOCATED TIMES MUST BE NOTIFIED PRIOR TO DEPARTURE. FAILURE TO ADVISE OR UPDATE FLIGHT DETAILS MAY RESULT IN EXTENSIVE AIRBORNE HOLDING OR NO AIRWAYS CLEARANCE BEING ISSUED. PROGRAMMED TIMES OF LANDING WILL BE AVAILABLE BETWEEN 0800 AND 1200UTC THE EVENING BEFORE THE PROPOSED DAY OF OPERATION, OR AFTER 2030 UTC ON THE DAY OF OPERATION. DOMESTIC FLIGHTS ALLOCATED A PROGRAMMED TIME OF LANDING ARE REQUIRED TO COMPLY WITH THIS TIME OF LANDING. DEPARTURE TIMES SHOULD BE ADJUSTED TO MEET THE TIME OF LANDING, BASED ON NORMAL OR SPECIFIED CLIMB, CRUISE, AND DESCENT PROCEDURES. COMPLIANCE WILL BE TRACKED BY AIRSERVICES AUSTRALIA. FROM 04 182227 TO 05 102230 DAILY 2000/2230 YMMM MELBOURNE FIR (YMMM) 7300 DOC C4425/06 REVIEW C4424/06 AMD AIP CHART VTC MELBOURNE AND VNC 1 EFFECTIVE 23 NOV 06 INSERT TYABB CTAF 128.0 FROM 11 160405 TO PERM DOC C0820/07 REVIEW C3673/06 TRIGGER NOTAM FM 0611221600 AMD DESIGNATED AIRSPACE HANDBOOK DATED 23 NOVEMBER 2006 AIR ROUTES-20 1. AMEND ATS ROUTE G578-INSERT WPT BRISO CHANGE WPT MELBO TO NON COMPSULORY REPORT 3 ONALA/WPT S15 11.2 E117 01.7 162/162 198 2 BRISO/WPT S16 58.6 E117 34.1 162/162 111 1500/1500 3 MELBO/WPT S17 58.2 E117 52.3 162/162 62 1500/1500 2. AMEND ATS ROUTE R592-CHANGE WPT METUM TO COMPULSORY REPORT FROM 02 210611 TO PERM DOC C0999/07 REVIEW C0982/07 AMEND DESIGNATED AIRSPACE HANDBOOK DATED 23 NOVEMBER 2006 PRD SECTION 13 YBBB/R595 WILLIAMTOWN HOURS OF ACTIVITY - DELETE 'H24' INSERT 'NOTAM' FROM 03 041400 TO 11 221400 NAV C1093/07 OMEGA TWR OBST LGT (WOODSIDE) NOT AVBL PSN S38 28.8 E146 56.2 (WI D392) SFC TO 1518FT AMSL FROM 03 062215 TO 06 070600 EST NAV C1117/07 REVIEW C0106/07 OBST LGT NOT AVBL PSN S34 22.8 E142 10.8 (APRX BRG 143 MAG 10NM FM MILDURA AD ARP) SFC TO 710FT AMSL FROM 03 080311 TO 06 290300 EST ATS C1187/07 REVIEW C5016/06 AUTOMATIC DEPENDENT SURVEILLANCE BROADCAST SER (ADS-B) AVBL TO AUTHORISED ACFT OPR WI LINE OF SIGHT OF THE FOLLOWING LOCATIONS: BUNDABERG BOURKE ESPERANCE LONGREACH WOOMERA HIGH ALTITUDE COVERAGE DETAILS AVBL FM WWW.AIRSERVICESAUSTRALIA.COM/ADSB/COVERAGE FROM 03 120304 TO 06 120200 EST DOC C1253/07 REVIEW C0110/07 AMD AIP VTC MELBOURNE AS FOLLOWS REPLACE SPOT HEIGHT OF 1035 (VCY MELBOURNE CITY CBD) WITH 985 FROM 03 152151 TO PERM ATS C1351/07 REVIEW C1321/07 LONG RANGE TFC SEQUENCING FOR FLTS ARR SYDNEY AIRPORT BTN 2000UTC AND 2100UTC LONG RANGE TFC SEQUENCING MAYBE CONDUCTED FOR FLTS ARR
## Appendix H

### Case Study Results

<table>
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</tr>
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<tr>
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<td>SYDNEY AIRPORT BTN 2000UTC AND 2100UTC. FLOW INSTRUCTIONS MAYBE ISSUED TO THESE ACFT UP TO 1000NM FM DESTINATION. THERE WILL BE NO CHANGE TO EXISTING PRIORITIES. TIMES ISSUED MAYBE SUBJECT TO CHANGE FOR OPR REASONS. FROM 03 241800 TO 11 012100 DAILY 1800/2100 DOC C1506/07 TRIGGER NOTAM - SUP H22/06 NEW ATS ROUTES Z91, Z92 AND WAYPOINTS - WOOMERA RESTRICTED AREAS AVBL FM AVFAX CODE 81565 AND AIRSERVICES WEBSITE <a href="http://WWW.AIRSERVICESAUSTRALIA.COM/PUBLICATIONS/AIP.ASP">WWW.AIRSERVICESAUSTRALIA.COM/PUBLICATIONS/AIP.ASP</a> FROM 03 300138 TO 06 010000 EST PROC C1562/07 REVIEW C0102/07 GNSS CAPABLE IFR OPERATIONS MUST CONTINUE TO NOMINATE ALL AVAILABLE NAV AIDS IN FLT NOTIFICATION. TO FACILITATE TFC FLOW WITHIN CONTROLLED AIRSPACE, PILOTS OF VOR OR ADF EQUIPPED ACFT CLEARED VIA A ROUTE DEFINED BY VOR OR NDB FAC MUST REMAIN ON THE RADIAL OR BEARING APPLICABLE TO THAT ROUTE AND AID. ATC MUST BE ADVISED IF THE ADF OR VOR TRACK KEEPING TOLERANCE CANNOT BE MAINTAINED. FROM 04 020459 TO 07 100400 EST SPA C1729/07 INCREASED AVIATION ACT BASED ON WANGARATTA AD UP TO 35 MICRO LIGHT ACFT OPR WI AREA BOUNDED BY WANGARATTA / POREPUNKAH / MOUNT BEAUTY / BRIGHT / BENALLA AND YARRAWONGA IN CLASS G AIRSPACE. CTC PERSON DAVID JACKA 0409 866996 SFC TO 10000FT AMSL FROM 04 272100 TO 04 290800 DAILY 2100/0800 NAV C1796/07 A/G FAC FIS FLIGHTWATCH 128.55 (MILDURA AREA) NOT AVBL FROM 05 020100 TO 05 020600 COM C1796/07 A/G FAC FIS FLIGHTWATCH 128.55 (MILDURA AREA) NOT AVBL FROM 04 130232 TO 04 270300 EST COM C1796/07 A/G FAC FIS FLIGHTWATCH 128.55 (MILDURA AREA) NOT AVBL FROM 04 130232 TO 06 010000 EST PROC C1751/07 OBST LGT ON TV MAST APRX 7NM SE MILLICENT NOT AVBL LOC S37 36 E140 29 SFC TO 332FT AMSL FROM 04 130424 TO 06 130600 EST AD C0012/07 REVIEW C0009/07 PORTION OF WESTERN GRASS AREAS NOT AVBL DUE MAINT MARKED BY CONES FROM 03 290159 TO 04 300000 EST AD C0027/07 AMD DAP WEST GPS ARR DATED 31 AUG 2006. AMD 10NM MSA TO 2000FT, AMD 25NM MSA AND MISSED APCH CLIMP ALT TO 2400FT. AMD SECTOR A 2300FT AND 1900FT STEP DOWN ALT TO 2400FT AND 2000FT RESPECTIVELY. FROM 03 020402 TO 04 020419 TO PERM PROC C0028/07 AMD DAP WEST RWY 18 VOR DATED 31 AUG 2006. AMD 10NM MSA TO 2000FT, AMD 25NM MSA, MISSED APCH CLIMP ALT, PROC COMMENCEMENT ALT AND HOLDING ALT TO 2400FT. FROM 03 020402 TO 04 020419 TO PERM PROC C0029/07 AMD DAP WEST RWY 18 VOR DATED 31 AUG 2006. AMD 10NM MSA TO 2000FT, AMD 25NM MSA, MISSED APCH CLIMP ALT, PROC COMMENCEMENT ALT AND HOLDING ALT TO 2400FT. FROM 03 020402 TO 04 020419 TO PERM PROC C0027/07 AMD DAP WEST GPS ARR DATED 31 AUG 2006. AMD 10NM MSA TO 2000FT, AMD 25NM MSA AND MISSED APCH CLIMP ALT TO 2400FT. AMD SECTOR A 2300FT AND 1900FT STEP DOWN ALT TO 2400FT AND 2000FT RESPECTIVELY. FROM 03 020402 TO 04 020419 TO PERM PROC C0028/07 AMD DAP WEST RWY 18 VOR DATED 31 AUG 2006. AMD 10NM MSA TO 2000FT, AMD 25NM MSA, MISSED APCH CLIMP ALT, PROC COMMENCEMENT ALT AND HOLDING ALT TO 2400FT. FROM 03 020402 TO 04 020419 TO PERM PROC C0029/07 AMD DAP WEST RWY 18 VOR DATED 31 AUG 2006. AMD 10NM MSA TO 2000FT, AMD 25NM MSA, MISSED APCH CLIMP ALT, PROC COMMENCEMENT ALT AND HOLDING ALT</td>
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### Case Study Results

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| YNHL | NHILL (YNHL) AD C0031/06 REVIEW C0030/06 RWY 18/36 AMD DECLARED DIST RWY TORA TODA ASDA LDA 18 948 1008(2.39) 948 948 36 948 1162(2.89) 948 948 1162 25(2.2) FROM 03 020422 TO PERM |

| YORB | ORBOST (YORB) AD C0001/07 RWY 07/25 GRADIENT AND STODA CHANGES RWY TODA 25 1200(4.15) STODA: RWY 07 887(1.6) 1067(1.9) 1187(2.2) 1196(2.5) RWY 25 814(2.2) 925(2.5) 1105(3.3) FROM 03 020427 TO PERM |

| YPOD | PORTLAND (YPOD) AD C0018/07 PAPI RWY 08 NOT AVBL FROM 04 200852 TO 04 240600 EST |

| YREN | RENMARK (YREN) NAV C0006/07 NDB 'REN' FREQ 200 NOT AVBL DUE MAINTENANCE. RADIATING INTERMITTENTLY, DO NOT USE, FALSE INDICATIONS POSSIBLE. FROM 04 300200 TO 04 300600 |

| YSHT | SHEPPARTON (YSHT) SPA C0002/07 TETHERED BALLOON ACTIVITY IS POSSIBLE WI 1NM RAD OF PSN S36 19.6 E145 25.3 (BRG 001 MAG 6.3NM FM ARP) FOR FUTHER DETAILS CONTACT ALEX BEECH TEL 0412 249 263 SFC TO 1000FT AGL FROM 02 282100 TO 07 310800 HJ |

| YSWG | WAGGA WAGGA (YSWG) AD C0099/06 REVIEW C0097/06 RWY 05/23 DECLARED DIST AND GRADIENT CHANGES RWY TODA 05 1828(1.91) 23 1828(1.62) FROM 12 040449 TO PERM AD C0022/07 AT-VASIS RWY 05/23 DECOMMISSIONED AMEND ERSA 15-MAR-2007 FROM 03 232024 TO PERM AD C0023/07 SINGLE SIDED (LEFT SIDE) PAPI RWY 05/23 INSTL AND COMMISSIONED RWY 05 PAPI 3.0 DEG 51FT PAL + AFRU 118.2 RWY 23 PAPI 3.0 DEG 51FT PAL + AFRU 118.2 AMEND ERSA 15-MAR-2007 FROM 03 232039 TO PERM AD C0024/07 REVIEW C0002/07 OBSTR CRANE 1000M NORTH OF ARP SFC TO 190FT AGL FROM 03 292243 TO 06 290800 EST HJ AD C0025/07 INCREASED RAAF PC9 AND CT4 ACFT OPR WI 100NM RAD WAGGA INCLUDING LLN EXER BLW 500FT AGL. ACFT BASED AT WAGGA AD. SFC TO FL170 FROM 04 222300 TO 04 270300 DAILY HJ |

| YWGT | WANGARATTA (YWGT) AD C0010/07 INCREASED AVIATION ACT BASED ON WANGARATTA AD TO 35 MICRO LIGHT ACFT OPR WI AREA BOUNDED BY WANGARATTA / POREPUNKAH / MOUNT BEAUTY / BRIGHT / BENALLA AND YARRAWONGA IN CLASS G AIRSPACE CTC PERSON DAVID JACKA 0409 866996 SFC TO 10000FT AMSL FROM 04 272100 TO 04 290800 DAILY 2100/0800 |

| YWSL | WEST SALE (YWSL) AD C0008/07 REVIEW C0005/07 EAST SALE CTAF AND WEST SALE CTAF TEMPO AD FREQ RESPONSE UNIT (AFRU) INSTALLED USING FREQ 118.3MHZ. AFRU LOCATED AT EAST SALE AD. RELIABLE COVERAGE IS NOT AVBL BELOW 500FT AGL IN THE VICINITY OF WEST SALE AD FROM 02 260256 TO 05 280200 EST |

### G.10 tbl_Paramedics Example Data

#### tbl_Paramedics

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## Appendix H
### Case Study Results

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4 This is an extract only of the example data contained within tbl_Terrain. The complete example data used was extracted from the Geoscience Australia Critical Aeronautical Heights 1997 dataset and consists of 12455 records (277 pages).
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### Appendix H

#### Case Study Results

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## Appendix H

### Case Study Results

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<td>MOUNT GAMBIER (YMTG) RAIM GPS RAIM PREDICTION 211401 YMTG TSO-C129 (AND EQUIVALENT) FAULT DETECTION NO GPS RAIM FD OUTAGES FOR NPA TSO-C146A (AND EQUIVALENT) FAULT DETECTION NO GPS RAIM FD OUTAGES FOR NPA FAULT DETECTION AND EXCLUSION 04211722 TIL 04211731 04221718 TIL 04221727 04231714 TIL 04231723 GPS RAIM FDE UNAVBL FOR NPA METAR YMTG 220530Z 18016KT 9999 SHOWERS IN VICINITY FEW025 BKN040 18/11 Q1025 RMK RF00.0/000.2 TAF TAF YMTG 220458Z 220618 16015KT 9999 LIGHT SHOWERS OF RAIN FEW025 BKN035 INTER 0612 5000 SHOWERS OF RAIN SCT015 BKN025 INTER 1218 5000 SHOWERS OF RAIN BKN010 RMK T 16 13 12 11 Q 1025 1026 1026 1026 TAF AMD YMTG 220201Z 220212 19015KT 9999 LIGHT SHOWERS OF RAIN FEW025 BKN040 INTER 0212 5000 SHOWERS OF RAIN SCT015 BKN025 RMK T 17 16 13 12 Q 1026 1025 1026 1026</td>
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<tr>
<td>YNRC</td>
<td>NARACOORTE (YNRC) RAIM GPS RAIM PREDICTION 211401 YNRC TSO-C129 (AND EQUIVALENT) FAULT DETECTION NO GPS RAIM FD OUTAGES FOR NPA TSO-C146A (AND EQUIVALENT) FAULT DETECTION NO GPS RAIM FD OUTAGES FOR NPA FAULT DETECTION AND EXCLUSION 04211717 TIL 04211726 04221714 TIL 04221725 04231711 TIL 04231721 GPS RAIM FDE UNAVBL FOR NPA METAR YNRC 220046Z 220214 17014KT 9999 FEW025 RMK T 18 20 16 14 Q 1025 1024 1025 1027 METAR METAR YNRC 220530Z AUTO 16015KT /// /// /// 20/09 Q1024 RMK RF00.0/000.0</td>
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<td>YORB</td>
<td>ORBOST (YORB) RAIM GPS RAIM PREDICTION 211401 YORB TSO-C129 (AND EQUIVALENT) FAULT DETECTION 04220116 TIL 04220121 04240107 TIL 04240112 GPS RAIM FD UNAVBL FOR NPA TSO-C146A (AND EQUIVALENT) FAULT DETECTION NO GPS RAIM FD OUTAGES FOR NPA FAULT DETECTION AND EXCLUSION 04220431 TIL 04220438 04220526 TIL 04220540 04230427 TIL 04230434 04230522 TIL 04230536 04240423 TIL 04240430 04240518 TIL 04240531 GPS RAIM FDE UNAVBL FOR NPA</td>
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<tr>
<td>YPOD</td>
<td>PORTLAND (YPOD) RAIM GPS RAIM PREDICTION 211401 YPOD TSO-C129 (AND EQUIVALENT) FAULT DETECTION NO GPS RAIM FD OUTAGES FOR NPA TSO-C146A (AND EQUIVALENT) FAULT DETECTION NO GPS RAIM FD OUTAGES FOR NPA FAULT DETECTION AND EXCLUSION 04211726 TIL 04211731 04220439 TIL 04220444 04221721 TIL 04221727 04230435 TIL 04230440 04231717 TIL 04231723 04240431 TIL 04240436 GPS RAIM FDE UNAVBL FOR NPA TAF TAF YP0D</td>
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</table>
| YREN  | **Appendix H** Case Study Results                                                                                                                   
|       | 220023Z 220214 16016KT 9999 SCT020 BKN035 INTER 0214 5000 SHOWERS OF RAIN BKN012 RMK T 17 18 16 14 Q 1025 1025 1026 1027 METAR METAR YPOD 220530Z AUTO 16012KT / / / / / / 16/10 Q1025 RMK RF00.0/000.2  
|       | RENMARK (YREN) RAIM GPS RAIM PREDICTION 211401 YREN TSO-C129 (AND EQUIVALENT) FAULT DETECTION AND EXCLUSION 04220151 TIL 04220156 04230147 TIL 04230152 GPS RAIM FDE UNAVBL FOR NPA METAR METAR YREN 220500Z AUTO 1602ZK / / / / / / 21/04 Q1022 RMK RF00.0/000.0 TAF TAF YREN 220023Z 220214 16012KT 9999 FEW040 RMK T 19 22 20 16 Q 1024 1022 1022 1023  
|       | **YSHT** SHEPPARTON (YSHT) RAIM GPS RAIM PREDICTION 211401 YSHT TSO-C129 (AND EQUIVALENT) FAULT DETECTION AND EXCLUSION 04220151 TIL 04220156 04230147 TIL 04230152 GPS RAIM FDE UNAVBL FOR NPA METAR METAR YSHT 220023Z 220214 16012KT 9999 FEW040 RMK T 19 22 20 16 Q 1024 1022 1022 1023  
|       | **YSWG** WAGGA WAGGA (YSWG) RAIM GPS RAIM PREDICTION 211401 YSWG TSO-C129 (AND EQUIVALENT) FAULT DETECTION AND EXCLUSION 04220151 TIL 04220156 04230147 TIL 04230152 GPS RAIM FDE UNAVBL FOR NPA METAR METAR YSWG 220023Z 220214 16012KT 9999 FEW040 RMK T 19 22 20 16 Q 1024 1022 1022 1023  
|       | **YSWH** SWAN HILL (YSWH) RAIM GPS RAIM PREDICTION 211401 YSWH TSO-C129 (AND EQUIVALENT) FAULT DETECTION AND EXCLUSION 04220151 TIL 04220156 04230147 TIL 04230152 GPS RAIM FDE UNAVBL FOR NPA METAR METAR YSWH 220023Z 220214 16012KT 9999 FEW040 RMK T 19 22 20 16 Q 1024 1022 1022 1023  
|       | **YSWL** STAWELL (YSWL) METAR METAR YSWL 220023Z AUTO 17012KT / / / / / / 17/10 Q1022 RMK RF00.0/000.0  
|       | **YWBL** WARRNAMBOOL (YWBL) RAIM GPS RAIM PREDICTION 211401 YWBL TSO-C129 (AND EQUIVALENT) FAULT DETECTION AND EXCLUSION 04220151 TIL 04220156 04230147 TIL 04230152 GPS RAIM FDE UNAVBL FOR NPA METAR METAR YWBL 220023Z AUTO 17012KT / / / / / / 17/10 Q1024 RMK RF00.0/000.0  
|       | **YWGT** WANGARATTA (YWGT) RAIM GPS RAIM PREDICTION 211401 YWGT TSO-C129 (AND EQUIVALENT) FAULT DETECTION AND EXCLUSION 04220151 TIL 04220156 04230147 TIL 04230152 GPS RAIM FDE UNAVBL FOR NPA METAR METAR YWGT 220023Z AUTO 17012KT / / / / / / 17/10 Q1024 RMK RF00.0/000.0  

TAF TAF YWGT 220015Z 220211 18008KT 9999 SCT040 RMK T 19 21 18 14 Q 1019 1018 1019 1020  

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## Appendix H: Case Study Results

### H.1 Primary Mission – Mission Profile Report

<table>
<thead>
<tr>
<th>WCod e</th>
<th>Report</th>
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<tbody>
<tr>
<td>YWSL</td>
<td>WEST SALE (YWSL) RAIM GPS RAIM PREDICTION 211401 YWSL TSO-C129 (AND EQUIVALENT) FAULT DETECTION 04220114 TIL 04220121 04230110 TIL 04230117 04240106 TIL 04240112 GPS RAIM FD UNAVBL FOR NPA TSO-C146A (AND EQUIVALENT) FAULT DETECTION NO GPS RAIM FD OUTAGES FOR NPA FAULT DETECTION AND EXCLUSION 04220433 TIL 04220438 04220527 TIL 04220538 04230429 TIL 04230434 04230523 TIL 04230534 04240425 TIL 04240430 04240519 TIL 04240531 GPS RAIM FDE UNAVBL FOR NPA TAF TAF AMD YWSL 220039Z 220214 17012KT 9999 LIGHT SHOWERS OF RAIN SCT020 BKN040 FM12 18005KT 9999 LIGHT SHOWERS OF RAIN BKN012 BKN030 INTER 0210 5000 SHOWERS OF RAIN BKN012 TEMPO 1014 3000 SHOWERS OF RAIN DRIZZLE BKN008 RMK T 18 20 16 13 Q 1021 1022 1023</td>
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<tr>
<td>YYWG</td>
<td>YARRAWONGA (YYWG) RAIM GPS RAIM PREDICTION 211401 YYWG TSO-C129 (AND EQUIVALENT) FAULT DETECTION NO GPS RAIM FD OUTAGES FOR NPA TSO-C146A (AND EQUIVALENT) FAULT DETECTION NO GPS RAIM FD OUTAGES FOR NPA FAULT DETECTION AND EXCLUSION 04220526 TIL 04220535 04230522 TIL 04230531 04240518 TIL 04240527 GPS RAIM FDE UNAVBL FOR NPA METAR YYWG 220530Z AUTO 17012KT /// /// /// /// 22/08 Q1018 RMK RF00.0/000.0</td>
</tr>
</tbody>
</table>
## Mission Profile

### Mission
- **Mission ID:** 133  
- **Request ID:** 58  
- **Type:** Primary  
- **Received:** 14/04/2008 13:34:36

### Aircraft
- **HEMS1**  
  - Eurocopter AS.365N3 Dauphine 2

### Crew
- **Pilot:** Three, Pilot  
- **Crewman:** Three, Crewman  
- **Paramedic:** Three, Paramedic

### Notes
- Traffic accident, ped/M’cycle, bike

### Flight Plan

1. **YMEN - Base**
   - Latitude (deg): -37.7200  
   - Longitude (deg): 144.9017  
   - Elevation (ft): 925  
   - Weather Report: YMEN  
   - Refuel: No  
   - Distance To Next (NM): 50  
   - LSA1t To Next (ft): 4428  
   - Time To Next (min): 31  
   - Azimuth To Next (deg): 32.4

2. **Scene - Unprepared HLS (21NM From YMFD)**
   - Longitude (deg): 145.7200  
   - Elevation (ft): Unknown  
   - Weather Report: YMFD  
   - Refuel: No  
   - Distance To Next (NM): 52  
   - LSA1t To Next (ft): 4729  
   - Time To Next (min): 32  
   - Azimuth To Next (deg): 234

3. **Alfred Hospital Helipad - Prepared HLS**
   - Latitude (deg): -37.6472  
   - Longitude (deg): 144.9847  
   - Elevation (ft): 0  
   - Weather Report: YMEN  
   - Refuel: No  
   - Distance To Next (NM): 8  
   - LSA1t To Next (ft): 2252  
   - Time To Next (min): 13  
   - Azimuth To Next (deg): 323
Appendix H
Case Study Results

4 YMEN - Base

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<thead>
<tr>
<th>Latitude (deg):</th>
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<th>Elevation (ft):</th>
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<td>144.9017</td>
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<td>YMEN</td>
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<td>Refuel:</td>
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<td>Distance To Next (NM):</td>
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<td>Time To Next (min):</td>
<td>31</td>
<td>Azimuth To Next (deg):</td>
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</tr>
</tbody>
</table>

Risk Analysis

Risk Score: Normal

- Pilot < 200 hrs in Type +1
- Last Flight > 30 Days +1
- 100 Days Since Check Ride +2
- IFR Program -4

RISK SCORE: 0

NORMAL = 4 or less
HIGH = 5
UNACCEPTABLE = 6 or greater

MET/AIS

AREA30 (30)
AREA 220400 TO 221700 AREAS 30/32

AND OVERVIEW:
ISOLOD THUNDERSTORMS SE OF FLIRI/LYIT/YOMC, CONTRACTING SLOWLY E/WARDS. ISOLATED SHOWERS S OF YGSR/KLA/YNRC, MORE WIDESPREAD NE OF YFLI/LYIT/YORC. LOW CLOUD PATCHES WITH SHOWERS/THUNDERSTORMS. LOW CLOUD/DRIZZLE PATCHES LAND ON/S OF DIVIDE AFTER 09Z. ISOLATED FOG SOUTHERN LAND AFTER 11Z. SMOKE PATCHES NE LAND.

WIND:
2000 5000 7000 10000 14000 18500

AND CLOUD:
ISOLOD CB 3000/3000 AS PER TS IN OVERVIEW. BKN ST 0900/3000 AS PER LOW CLOUD IN OVERVIEW. BKN CU/SC 3000/10000, TENDING SCT N OF DIVIDE AFTER 11Z, TOPS LOWERING TO 6000 FT FROM THE N. CU TOPS TO 14000 WITH SHOWERS IN THE SE. BKN AC/AS ABOVE 10000 E OF 1400Z TILL 11Z.

WEATHER:
TSRA, SMOKE, HSHA, DZ, FG.

VISIBILITY:
05000 FG, 20000 TSRA/SMOKE/DZ, 50000 HSHA.

FREEZING LEVEL:
11500 IN THE FAR NH DECREASING TO 8000 IN THE SE.

ICING:
MOD IN AC/AS, LARGE CU TOPS.

TURBULENCE:
MOD IN CU/AC. ISOLOD MOD BELOW 7000FT LEE OF RANGES.

AND CRITICAL LOCATION: HEIGHTS ABOVE MSL
KILMORE GAP: 9999 - HSHA SCT ST 3000 BKN CU 3500
FM10 2000 DZ BKN ST 1200 CLOUD ON GROUND
INTER 0810 6000 HSHA BKN ST 1500

FOR FURTHER INFORMATION PHONE 03 9669 4850

Monday, 14 April 2008
Appendix H
Case Study Results

AQNH
AREA QNH 04/07
AREA 30/32: SW OF YMBR/CAMS 1024,
REST 1021

ESSENDON (YMEN)

RAIM GPS RAIN PREDICTION 211421
YMEN
TDO-C12B (AND EQUIVALENT)
FAULT DETECTION
NO GPS RAIN FD OUTFALLS FOR NPA
TDO-C144B (AND EQUIVALENT)
FAULT DETECTION
NO GPS RAIN FD OUTFALLS FOR NPA
FAULT DETECTION AND EXCLUSION
042206527 TIL 042206529
042206533 TIL 042206541
042206513 TIL 042206525
GPS RAIN FD UNRELV FOR NPA

METAR
METAR YMEM 220530Z AUTO 19012KT // // // // 19/13 Q1022 RMK
RF00.0/000.2

TAF
TAF AND YMEM 220530Z 220618 18012KT 9999 LIGHT SHADOWS OF RAIN SCT025
BKN040 FM01 1800 SHADOWS OF RAIN BKN010 BKN010 TEMP 1118 3000 DRIZZLE BKN005 RMK T 18 16 15
14 Q 1022 1023 1024 1024
TAF AND YMEM 220618Z 220618 18012KT 9999 LIGHT SHADOWS OF RAIN BKN015
BKN030 FM01 180125 KT 9999 LIGHT SHADOWS OF RAIN SCT025 SCT035 FM11
1800 SHADOWS OF RAIN BKN012 BKN015 INTER 0010 4000 SHADOWS OF RAIN BKN010 TEMP 1022 3000 DRIZZLE BKN005 RMK T 16 16 16 Q 1022
1022 1022 1022

ATIS
ATIS YMEM H 220456
Rwy: 17
Wind: 170/12, G 20 KT3
VIS: 67 1000
Cpt: FVM120, SCT035
+ Tmp: 18
+ Qnh: 1022

YMF - No ATIS/MET Data Available

NOTAM

ESSENDON (YMEN)
AD
NORTHERN HELIPAD RELOCATED
17NM TO THE SOUTH WEST
FROM 11 012100 TO 0500
C0360/06

AD
NORTHERN WINDSOCK RELOCATED
13NM TO THE SSW
FROM 11 012100 TO 0500
C0361/06

AD
RHY 35 FIXED DISTANCE AND TOUCH DOWN ZONE MARKINGS DISPLACED
3NM TO THE NORTH
FROM 11 170500 TO 0500
C0393/06

DOC
TRIGGER NOTAM - AIF SUP B3/07 ESSENDON AIRPORT LIGHTING UPGRADE
AVBL FM AFX10 CODE 01540 AND AIRSERVICE WEBSITE
WWW.AIRSERVICEAUSTRALIA.COM/Publications/AIF.SUP
FROM 01 150004 TO 05 310000 EST
C0014/07 REVIEW C0023/07

AD
AZ-VATS RHY 17 STAGE 4, 5 AND 6 NOT AVBL
DUE TO FAULT
FROM 03 211514 TO 05 150600 EST
C0125/07

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Appendix H
Case Study Results

AD
AT-VASIS RWY 08 STAGE 4, 5 AND 6 NOT AVBL
DUE LGT FAULT
FROM 03 211316 TO 05 150000 EST

AD
NEW TWH KYLO ESTABLISHED
IN LINE WITH TWH DAERA S RWY 08/26 TO THR RWY 35
CONSEQUENTLY REGULAR USE OF RWY 08/26 TO ACCESS THR RWY 35 IS
ABANDONED DELETE LOCAL TRAFFIC REGULATION NOTE 1B
FROM 03 300147 TO PERM

AD
TEMPO OBST FENCE LIT AND MARKED
INFRINGING TWH HOTEL BY SM TO THE WEST,
WID REDUCED TO 21M FM CL
FROM 04 160526 TO 07 140500 EST

AD
RWY 17/35 890M N END NOT AVBL DUE WIP,
RWY 17 THR DISP 1160M AND MARKED BY VEE BARS, OBSTRUCTION MEN AND
EQUIPMENT 10FT AGL ON BCL 700M FM START OF TORA RWY 35,
RWY 17 AT-VASIS NOT AVBL
TWH CHARLIE, ECHO, JULIETT AND TANGO NOT AVBL
TWH NOVEMBER THROUGH WORKS INDICATED BY YELLOW CONES.
RWY 17 TORA 613 TODA 663(2.56) ASDA 613 LDA 343
RWY 35 TORA 553 TODA 613(4.33) ASDA 553 LDA 592
SUPPLEMENTARY TODA
RWY 17 405(1.6) 502(1.5) 580(2.2) 658(2.5)
RWY 35 453(2.2) 503(2.5) 574(3.33)
REF METHOD OF WORKS PLAN ESSENDON 07/1 STAGE 4
FROM 04 222130 TO 04 240300
DAILY 2130/0900

AD
NORTHERN RUNUP BAYS TANGO, DELTA, ECHO AND TWH ROMEO N OF TWH
CHARLIE NOT AVBL DUE WIP
TEMPO TWH INDICATED BY YELLOW CONES
TAXI VIA ATC INSTRUCTIONS
SUPER METHOD OF WORKING PLAN 07/01 STAGE 4
FROM 04 222130 TO 04 270000
DAILY 2130/0900

EXC WED

YMFD - No Current NOTAMs
H.2 IHT – Mission Profile Report

Mission Profile

Mission

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<td>Received:</td>
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Aircraft

| FW4 |
| Beechcraft Kingair B200C |

Crew

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<tr>
<td>Paramedic:</td>
<td>N/A, Fixed Wing</td>
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</tbody>
</table>

Notes

27yo Female
Expected complicated pregnancy

Flight Plan

1 YMEN - Base

| Latitude (deg):   | -37.7283 | Elevation (ft): | 925 |
| Longitude (deg):  | 144.9017 | Weather Report: | YMEN |
| Refuel:           | No       |
| Distance To Next (NM): | 250       | LSAlt To Next (ft): | 4677 |
| Time To Next (min): | 80       | Azimuth To Next (deg): | 314 |

2 YMIA - Airfield

| Latitude (deg):   | -34.2300 | Elevation (ft): | 548 |
| Longitude (deg):  | 142.0850 | Weather Report: | YMIA |
| Refuel:           | Yes      |
| Distance To Next (NM): | 250       | LSAlt To Next (ft): | 4677 |
| Time To Next (min): | 100       | Azimuth To Next (deg): | 49.2 |

3 YMEN - Base

| Latitude (deg):   | -37.7283 | Elevation (ft): | 925 |
| Longitude (deg):  | 144.9017 | Weather Report: | YMEN |
| Refuel:           | No       |
| Distance To Next (NM): | 246       | LSAlt To Next (ft): | 4677 |
| Time To Next (min): | 79       | Azimuth To Next (deg): | 51 |

Risk Analysis

Risk Score: N/A
Not Available for Fixed Wing Aircraft

MET/AIS

Monday, 14 April 2008
Appendix H
Case Study Results

AREA30 (30)

ARFOR ANNEX AREA FORECAST 220000 TO 221700 AREAS 30/32

AND OVERVIEW:
ISOLATED THUNDERSTORMS SE OF FLKI/YLTV/YOON, CONTRACTING SLOWLY
E’WARDS. ISOLATED SHOWERS S OF VCGR/ELD/YNKC, MORE WIDESPREAD SE OF
YELV/YLTV/VCGR. LOW CLOUD/PATCHES WITH SHOWERS/THUNDERSTORMS. LOW
CLOUD/DRIZZLE Patches LND CN/S OF DIVIDE AFTER 09Z. ISOLATED FOG
SOUTHERN LAND AFTER 11Z. SMOKE PATCHES NE LAN.

WIND
2000 5000 7000 10000 14000 18500

AND CLOUD:
ISOL CB 3000/28000 AS PER TE IN OVERVIEW. BKN ST 0800/3000 AS PER LOW
CLOUD IN OVERVIEW. BKN/SC 3000/10000, TENDING SCT N OF DIVIDE
AFTER 11Z. TOPS LOWERING TO 6000 FROM THE V. CU TOPS TO 14000 WITH
SHOWERS IN THE SE. BKN AC/AS ABOVE 10000 E OF 1400E TILL 11Z.

WEATHER:
TSRA, SMOKE, SHR, DZ, FG.

VISIBILITY:
0500M FG, 2000M TSRA/SMOKE/DZ, 5000M SHR.

FROZEN LEVEL:
11500 IN THE FAR NW DECREASING TO 8000 IN THE SE.

ICING:
MOD IN AC/AS, LARGE CU TOPS.

TURBULENCE:
MOD IN CU/AC. ISOL MOD BELOW 7000FT LEE OF RANGES.

AND CRITICAL LOCATION:
HIGHEST HEIGHTS ABOVE MSL
KILMORE GAP: 9995 -SHRA SCT ST 2000 BKN CU 3500
FM10 2000 DZ BKN ST 1200 CLOUD ON GROUND
INTER 0610 4000 BKN ST 1500

FOR FURTHER INFORMATION PHONE 03 9669 4850

AOHN AREA QNH 04/07
AREA 30/32: NW OF YREM/CAMUS 1024,
REST 1021

ESSENDON (YHEN)

RAINF GFS RAIN PREDICTION 211401

YREM
T30-1229 (AND EQUIVALENT)
FAULT DETECTION
NO GFS RAIN FD OUTAGES FOR NFA
T30-1240A (AND EQUIVALENT)
FAULT DETECTION
NO GFS RAIN FD OUTAGES FOR NFA
FAULT DETECTION AND EXCLUSION
04200527 TIL 04220533
04200529 TIL 04220535
04200519 TIL 04220525
GFS RAIN FD UNAVAIL FOR NFA

METAR METAR YREM 220530Z AUTO 19012KT /----/ /----/ 19/13 Q1022 RMK
RF00.0/000.2

TAF TAF AMD YREM 220502Z 220518Z 18012KT 9999 LIGHT SHOWERS OF RAIN SCT020
BKN040 FM14 18000KT 9999 LIGHT DRIZZLE BKN010 BKN030 INTER 0611 4000
SHOWERS OF RAIN BKN010 TEMPO 1110 3000 DRIZZLE BKN005 RMK T 16 16 12
14 Q 1022 1022 1024 1024

TAF AMD YREM 2132502 220015Z 18012KT 9999 LIGHT SHOWERS OF RAIN BKN015
BKN030 FM01 18015KT 9999 LIGHT SHOWERS OF RAIN SCT025 SCT035 PH11
18000KT 9999 LIGHT DRIZZLE BKN012 BKN025 INTER 0610 4000 SHOWERS OF
RAIN BKN010 TEMPO 1012 3000 DRIZZLE BKN005 RMK T 15 15 15 16 Q 1022
1022 1022 1022

ATIS ATIS YREM H 220456

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Appendix H
Case Study Results

RWY: 17
WIND: 170/12, G 20 KTS
VIS: 10M
CLD: FEW020, SCT035
+ TMP: 18
+ QNH: 1022

MILDURA (YMIA)
RAIN GPS RAIN PREDICTION 211401
YMIA
TSO-C129 (AND EQUIVALENT)
FAULT DETECTION
NO GPS RAIN FD OUTAGES FOR MFRA
TSO-C146A (AND EQUIVALENT)
FAULT DETECTION
NO GPS RAIN FD OUTAGES FOR MFRA
FAULT DETECTION AND EXCLUSION
04230151 TIL 04230146
04230147 TIL 04230152
04240143 TIL 04240146
GPS RAIN FD USEFUL FOR MFRA
METAR METAR YMIA 230858Z 180952T CAVOK 21/06 Q1021 RMK RF00.0/000.0
TAF TAF YMIA 220511Z 220618 17012KT 5989 SCT040 RMK T 21 10 14 12 Q 1021
1022 1023 1023
TAF YMIA 221355Z 220012 17012KT 5989 FEW040 RMK T 15 18 21 19 Q 1024
1023 1021 1022

NOTAM

ESSENDON (YMEM)
AD C0360/06
NORTHERN HELIPAD RELOCATED
175M TO THE SOUTH WEST
FROM 11 012000 TO PERM

AD C0361/06
NORTHERN WINDSOCK RELOCATED
130M TO THE SSW
FROM 11 012000 TO PERM

AD C0363/06
RWY 35 FIXED DISTANCE AND TOUCH DOWN ZONE MARKINGS DISF
13M TO THE NORTH
FROM 11 170500 TO PERM

DOC C0014/07 REVIEW C0015/07
TRIGGER NOTAM - AIP SUP 83/07 ESSENDON AIRPORT LIGHTING UPGRADE
AVBL PN AVFAX CODE 815490 AND AIRSERVICE WEBSITE
WWW.AIRSERVICEAUSTRALIA.COM/PUBLICATIONS/AIP.SUP
FROM 01 050004 TO 05 510450 EST
AD C0126/07 REVIEW C0125/07
AT-VASIS RWY 17 STAGE 4, 5 AND 6 NOT AVBL
DUE LST FAULT
FROM 03 211514 TO 05 150600 EST

AD C0127/07
AT-VASIS RWY 08 STAGE 4, 5 AND 6 NOT AVBL
DUE LST FAULT
FROM 03 211514 TO 05 150600 EST

AD C0151/07 REVIEW C0147/07
NEW TMY KILO ESTABLISHED
IN LINE WITH TMY PAPA S RWY 08/26 TO THR RWY 35
CONSEQUENTLY REGULAR USE OF RWY 08/26 TO ACCESS THR RWY 35 IS
ABANDONED DELTA LOCAL TRAFFIC REGULATION NOTE 1B
FROM 03 300147 TO PERM

AD C0173/07 REVIEW C0046/07
TEMP OBST FENCE LIT AND MARKED

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INFRINGING TVY HOTEL BY 5M TO THE WEST.
WID REDUCED TO 11M FM CL
FROM 04 160336 TO 07 160500 EST

AD  C0179/07
Rwy 17/35 900M N END NOT AVBL DUE WIP.
Rwy 17 THR DISPL 1160M AND MARKED BY VEE BARS. OBSTRUCTION MHN AND
EQUIPMENT 10FT AGL ON RCL 703M FM START OF TORA Rwy 35.
Rwy 17 AT-VASIS NOT AVBL.
TVY CHARLIE, ECHO, JULIETT AND TANGO NOT AVBL.
TVY NOVEMBER THROUGH WORKS INDICATED BY YELLOW CONES.

Rwy 17 TORA 613 TQDA 663(2.56) ASRA 613 LDA 343
Rwy 35 TORA 553 TQDA 613(4.33) ASRA 553 LDA 553

SUPPLEMENTARY TOQA
Rwy 17 495(1.6) 502(1.9) 550(2.2) 650(2.5)
Rwy 35 453(2.2) 503(2.5) 674(3.33)

REF METHOD OF WORKS PLAN ESSENDON 07/1 STAGE 4
FROM 04 222130 TO 04 240000
DAILY 2130/0800

AD  C0180/07
NORTHERN RUNUP BAYS TANGO, DELTA, ECHO AND TVY ROMEO N OF TVY
CHARLIE NOT AVBL DUE WIP.
TEMP TVY INDICATED BY YELLOW CONES.
TAXI VIA ATC INSTRUCTION
REFER METHOD OF WORKING PLAN 07/01 STAGE 4
FROM 04 222130 TO 04 270800
DAILY 2130/0800

EXC WEED

MILDURA (YMA)
NAV  C0604/07
NDB 'MIA' FREQ 272 NOT AVBL DUE MAINT.
RADIATING INTERMITTENLY ON TEST, DO NOT USE, FALSE INDICATIONS
POSSIBLE
FROM 04 002230 TO 05 010430

NAV  C0605/07
VOR/DME 'MIA' FREQ 113.7/84K NOT AVBL DUE MAINT.
RADIATING INTERMITTENLY ON TEST WITH NIL IDENT, DO NOT USE, FALSE
INDICATIONS POSSIBLE
FROM 05 032230 TO 05 040430

NAV  C0606/07
VOR/DME 'MIA' FREQ 113.7/84K NOT AVBL DUE MAINT.
RADIATING INTERMITTENLY ON TEST WITH NIL IDENT, DO NOT USE, FALSE
INDICATIONS POSSIBLE
FROM 05 022230 TO 05 030330
## Appendix H
### Case Study Results

#### H.3 Alternative IHT Select Resource Form

![IHT Select Resource Form](image)

<table>
<thead>
<tr>
<th>Resource Base</th>
<th>Time to Scene (Min)</th>
<th>Time to Hospital (Min)</th>
<th>Total Distance (Km)</th>
<th>Total Time (Min)</th>
<th>Road Transport Prepared</th>
<th>Refuel</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crew Base</td>
<td>80</td>
<td>100</td>
<td>80</td>
<td>180</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td>Facilities</td>
<td>80</td>
<td>100</td>
<td>80</td>
<td>180</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td>Patient</td>
<td>80</td>
<td>100</td>
<td>80</td>
<td>180</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**NAME: YMBH - Base**
- LAT: 37° 43' 42.5" S
- LON: 144° 51' 16" E
- Elevation (m): 925
- Distance (Km): 105.7
- Time (min): 74
- Airnav (F-1): 222,884
- LSAR (F-1): 4677

**NAME: YMBH - Airfield**
- LAT: 37° 43' 42.5" S
- LON: 144° 51' 16" E
- Time (min): 74
- Airnav (F-1): 222,884
- LSAR (F-1): 4677

**NAME: Mildura Hospital Hospital - Prepared H.S.**
- LAT: 34° 11' 34.5" S
- LON: 147° 1' 17" E
- Elevation (m): 0
- Distance (Km): 246
- Time (min): 112
- Airnav (F-1): 59,977
- LSAR (F-1): 4677

**NAME: Royal Melbourne Hospital Hospital - Prepared H.S.**
- LAT: 30° 51' 57.5" S
- LON: 144° 50' 45" E
- Elevation (m): 0
- Distance (Km): 4.6
- Time (min): 12
- Airnav (F-1): 137,766
- LSAR (F-1): 2520

**NAME: YMBH - Base**
- LAT: 37° 43' 42.5" S
- LON: 144° 51' 16" E
- Elevation (m): 925

---

**AERIAL (OK)**
- **AERIAL AREA FORECAST:** 22/0000 TO 22/1700 AREAS 210/22
- **AERIAL VIEW:**
  - ISOLATED THUNDERSTORMS SE OF FLINDERS/VIOINT, CONTRACTING SLOWLY EASTWARDS. ISOLATED SHOWERS S OF YAMBALA, PINDI, WINDING SE OF YAMBALA/VIOINT. LOW CLOUD PATCHES WITH SHOWERS/THUNDERSTORMS. LOW CLOUDS/DJF/88X48 PATTERN AND NORTHERN ONSET OF OVERCAST AFTER 0000. ISOLATED FOG SOUTHERN LAND AFTER 11Z. SHOWERS PATCHES NE LAND.
  - **WIND:**
    - 2000 5000 2000 10000 10000 10000
    - 17000 17000 17000 17000 17000 17000 17000
  - **CLOUD:**
    - ISOL CIRROPHV 00000 AS PER TS ON OVERVIEW. BN 060000000 AS PER LOW CLOUD IN OVERVIEW. BN CLOU 200000000 W/T CLOUD SCATTER IN DSPT AFTER 11Z. TOPS LOADING TO 6000 FROM THE W. CU TOPS TO 15000 WITH SHOWERS IN THE SE. BN CLOU AHEAD 10000 E OF 144° E TO 11Z.
  - **WEATHER:**
    - TEMPS, SMOKE, SHRA, OZ, RG.
  - **VISIBILITY:**
    - 80000000 200000000 0000 0000
  - **FREEZING LEVEL:**
    - 10000 IN THE FAR NW DECREASING TO 8000 IN THE SE.
  - **ICING:**
    - PISO IN AGARS, LARGE X TOPS.
  - **TURBULENCE:**
    - MOD steady.

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