Flight AVI 685 EHAM-PANC

Flight planning & operations

Aviation Studies International Airlines

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Summary

Project team 2D of the dispatch centre from Aviation Studies International Airline Operational Control Centre (OCC) has the assignment to make a flight planning for a flight with a Boeing 747 from Amsterdam Schiphol Airport (EHAM) to Ted Stevens International Airport Anchorage (PANC). The flight planning should result in a Briefing Package, which consists of the operational flight plan, ATS flight plan, mass and balance of the aircraft and the weather of the airports. The operational flight plan has information for the pilot about the flight including the route and waypoints, the enroute weather. ATS flight plan has been written for the air traffic controllers and be used by search and rescue if necessary. The flight plan consists of the flight heading and the details of the aircraft, crew and cargo on board.

At EHAM there are goods ready to be shipped to the airport PANC. The goods will be flown on a Boeing 747-400 Extended Range Freighter. Among the goods are 12 horses which should be treated according the Life Animal Regulations (LAR). Also an Boeing 777 engine of 7830kg must be loaded on board. The goods are loaded into the Boeing 747 following the load sheet, which gives the weight and balance of the aircraft so that the center of gravity lies on a vantage point for the flight. The maximum weight of a fully loaded aircraft without fuel is called Maximum Zero Fuel Weight (MZFW). With the maximum fuel included the Maximum Take Off Weight (MTOW) is obtained. The Boeing has some malfunctions; inoperative brake units and engine ignitor failures. According to the Minimum Equipment List (MEL) it is possible to fly with up to 2 defective brake units but the brake force will be reduced by 10 to 15%. Also in accordance with the MEL, it is possible to fly with 4 out of 8 ignitors deactivated. Thus the aircraft satisfies all this regulations so the aircraft may depart.
The aircraft will take-off from EHAM runway 18L because of the wind angle of 160 degrees, following the Standard Instrument Departure charts (SID) the flight turns east and heading north towards his first waypoint. The flight continuing the step climb towards waypoint ANDIK up to flight level 320. By heading west from EHAM to PANC the flight will be flying on the even flight levels. Due to climbing the pilots can make the most economical use of the fuel, but the aircraft has too much weight to climb higher than FL320. In the northern hemisphere there are not many flight routes so the flight uses random routing, where in planning phase within 150nm a planned waypoint is made to fly the optimal route. En-route, the aircraft has burned fuel and is light enough to climb towards FL340 and further on the route towards FL360. For emergency situations, en-route alternates have to be within the fuel range of the planned route, these emergency situations are decompression or two engines inoperative (N-2). The en-route alternates are Stavenger Sola airport (ENZV) and Kangerlussuaq airport (BGSF). For the en-route alternates the contincency fuel is 5% of the trip fuel, but fuel policy states that this amount may be decreased to 3% of the trip fuel when an en-route alternate aerodrome is located within a circle with a radius equal to 20% of the total flight plan distance, with the centre located at 25% of the total distance from the destination aerodrome. The en-route alternate Fairbanks Int. Airport meets these requirements so we can use 3% contincency fuel. At the waypoint NENANA the descent begins with the standard approach route towards PANC. When the approach to PANC fails the flight will be diverting to the alternate Fairbanks Int. Airport (PAFA).

When the planning phase is completed and the pilots and the air traffic control submit the briefing package the operational phase starts. Flight AVI685 is successfully loaded and has departed from EHAM, where after three and a half hours flying a significant meteorological information (SIGMET) arrives at the OCC that the volcano Mt Spurr is erupting. This takes place at 21:00 UTC. The ash cloud will be right above PANC when flight AVI685 would arrive; at 01.52 UTC. Thus the flight cannot land on the destination airport. The dispatcher should pass this message to inform the flight crew and the Senior Operation Controller (SOC). The Flight Crew can be informed with the Aircraft Communications Addressing and by the Reporting System (ACARS), the ACARS printer will print the SIGMET for the pilots to read. If everyone is informed an inflight re-planning should be made. Three options are examined, namely the return to EHAM, landing at the airport alternate PAFA or divert to Vancouver International airport (CYVR). To determine what the best solution is for flight AV685 there are selection criteria established and weighting factor set. The selection criteria consist of efficiency, which depends on the delay. The more delay, the less efficient.

The costs are also included in the selection criteria. The consequences for the customer, the horses are more rested when they have a comfortable flight. And the consequences for the crew, the total amount of hours the crew has to operate in total and the remaining time they are granted affects the workload.

Conform the selection criteria the best solution is PAFA, because this alternate is on the route to Anchorage. The advantage of this is that there is enough fuel on-board to land at PAFA and fly to Anchorage without refueling the aircraft. This means that there are no extra fuel costs. Because the alternate is en-route, the delay is minimized by no deviation of the route. Flight AVI685 will arrive at PAFA at 01.22 UTC. The ash cloud of Mt Spurr is blown over PANC at 12.00 UTC so the crew had more than enough time to rest, thus the workload of the crew is low. Flight AVI685 arriving at Ted Stevens International Airport (PANC) with delay and a stopover at Fairbanks International Airport, where the flight will wait for the ash cloud to pass. Where the new cargo on PANC is already waiting, the return flight from PANC will have a delay back to Schiphol (EHAM), but will be able to arrive safely.

Content

Introduction

At January 28th 2014 a flight is planned from Schiphol (EHAM) to Ted Stevens Anchorage Airport (PANC). The flight will be carried out with a Boeing 747-400 Extended Range Freighter. At 17:30 UTC the plane should depart to Anchorage. The first task is to set up a briefing package with keeping efficiency and regulations in the occiput. The second task is to anticipate on the volcano eruption which is taking place during the flight. A solution has to be found to bring the cargo to PANC. A report is written about the briefing package and the solutions of the volcano eruption. The briefing package should be handed in at March 27th 2014 and the report at May 22th 2014.

For this assignment the Operation Control Center (OCC) of the Aviation Studies International Airline composes project group 2D. The project group consist out of 8 students of aviation studies and a project supervisor. Project group 2D is going to approach the assignment while the project supervisor monitors the progress. Every week another chairman is chosen during the 14 weeks of the project.

This report will be divided in three chapters. To make a briefing package, knowledge about preparing a flight plan is necessary. So first the general knowledge of preparing a flight will be described. To construct and plan a certain route, knowledge about the navigation and meteorological, techniques is necessary to comprehend the limitations, of the aircraft. When all relevant regulations and issues are taken into account, two different flight plans can be set up; an operational flight plan and an air traffic services flight plan. The sections of the briefing package will be explained and why they are important for the flight. **(Chapter one)**
With the knowledge of chapter one, the briefing package for the flight from EHAM to PANC can be made. Every section of the briefing package will be described for this flight. This will be underpinned with a supporting explanation or calculation. These calculations include the waypoints and the estimated time between the waypoints needed to be determined by using the wind component. Another important aspect of the flight plan is the load sheet. With this calculation the pilots know the amount of payload which can be taken on the flight. Also destination alternates need to be determined. This is needed when a problem during the flight occurs. In the planning phase a malfunction on the aircraft will become apparent. It has to be examined if the aircraft can make a take-off without any delay. **(Chapter two)**
During the flight an irregularity will occur. This could delay the flight. Next to the destination airport, a volcano becomes active, so the airport will be closed. When landed on an alternate airport, a new flight plan has to be made. To give a solution for this problem, three possibilities will be elaborated. By comparing the possibilities, the best solution for the irregularity can be given. **(Chapter three)**

The most important sources are the Flight Planning Performance Manual of the Boeing 747 and the planning charts. An attached report will contain the briefing package. The fuel calculations can be found in **(Appendix XXVI)**

1 Principles of flight planning

Some basic knowledge of flight planning is needed prior to draft a briefing package. This knowledge shall be discussed in this chapter. First of all, how arises a briefing package and what is it used for? Those questions can be answered with information about the operations control centre **(1.1)**. The operations control centre will make a flight plan. This flight plan must be efficient so the airline has the least costs and the aircraft will arrive on time **(1.2)**. Then what contains a briefing package? It turns out that all of the information that is required before, during and after the flight can be found in a briefing package. Therefore information about navigation **(1.2)**, meteorology **(1.4)**, and the aircraft that will carry out the flight **(1.5)**, fuel **(1.6)** and payload **(1.7)** is needed. The major part of that information is also needed to create a flight plan **(1.8)**. At last, there are also rules for ensuring safety and comfort of the flight which must be included into the flight planning **(1.9)**.

1.1 Operating Control Centre

The principles of the flight emerge in the operations control centre. The purpose of an operations control centre is to bring all of the divisions that have a voice in the operation of an airline under the same roof to allow a better flow of communication. The following divisions can be found in an operations control centre: dispatch operations **(1.1.1)**, load control **(1.1.2)**, meteorology **(1.1.3)**, aircraft routing **(1.1.4)**, crew scheduling, tracking and accommodations **(1.1.5)**, airport customer service **(1.1.6)**, corporate security **(1.1.7)**, maintenance centre **(1.1.8)** and emergency operations centre **(1.1.9)**. All those divisions take care of the flight. Some prepare the flights, some provide good conditions for crew and passengers and others are there to help when irregularities occur. Eventually they all ensure a safe and economically good flight.

1.1.1 Dispatch operations

Dispatch operations are concerned with the flight itself. They provide the briefing package which gives the pilot and the air traffic controllers the information needed about the flight. Dispatch operations are subdivided into dispatch **(1.1.1.a)**, navigation **(1.1.1.b)**, sector managers **(1.1.1.c)** and air traffic centre operations **(1.1.1.d)**.

1.1.1.a Dispatch

A flight dispatcher's job is to prepare the flight plan for all of the flights for an airline. Therefore they look at the weather at the origin and the destination of the flight as well as the weather at the higher altitudes. If necessary, they will adjust the standard flight route so that the aircraft will fly around hazardous weather.

A flight dispatcher also communicates with the flight crew so that he can update them about weather changes or other alterations. So a fight dispatcher monitors the flight.

1.1.1.b Navigation

Navigation monitors and updates airways. They build standard flight routes and obtain over flight permits and landing permits if necessary. Also they monitor airports which allow them to take action when they find out that a runway or an airport is closed for some time.

1.1.1.c Sector managers

Sector managers are head of an aircraft or fleet. They make sure that their aircrafts are running on time. If a problem occurs, like a damaged wing or a computer failure, they have a few options; delay, swap or cancel. Sector managers work close with a lot of other divisions because the sector manager's decision affects those other divisions too.

1.1.1.d Air traffic centre operations

The air traffic centre operations monitor and communicate to dispatchers about ground stops, ground delay programs and required and recommended re-routes. This group also monitors the competitors of the airline so that the passengers get the same quality of on time service as the passengers should have had if he or she had chosen for the competitor.

1.1.2 Load control
Load control ensures the weight and balance of an aircraft. This is one of the documents which get into the briefing package for the pilot. Hereby the pilot has the correct gross weight of the aircraft and the correct trim setting. Load control warns the dispatchers when a flight is overweight. Also load control produces the calculation of fuel-loading.

1.1.3 Meteorology
Meteorology forecasts weather like turbulence and upper air wind patterns. They also create SIGMETs for their airline's flights. Meteorology forecasts also special weathers like hurricanes and winter storms. The sector managers often make use of this information to make their decision of cancelling the flight. Meteorology itself affects the fuel calculation, route of the flight and scheduling too.

1.1.4 Aircraft routing
Aircraft routing decides which aircraft will carry out the flight. Thereby they keep an eye on where and when which aircraft must be for maintenance service.

1.1.5 Crew scheduling, tracking and accommodations
Crew scheduling decides which pilot and which stewards carry out which flight. A crew tracking is responsible for monitor the crew, especially when irregularities occur. They ensure that if a crew team misses their next flight, another crew team will take over. Crew accommodations ensure an accommodation for the crew so that when a flight is delayed the crew will have a place to stay.

1.1.6 Airport customer service
Airport customer service advocates for the passengers. This division is responsible for the passengers during delays and cancelations. They also help arrange tight connections.

1.1.7 Corporate security
Corporate security monitors the security of the whole airline. They assist the other divisions to meet the regulatory security requirements.

1.1.8 Maintenance centre
Maintenance centre monitors when an aircraft needs a maintenance service. They also provide technical assistance to the pilots in the air and the maintenance crew on the ground.

1.1.9 Emergency operations centre
Emergency operations centre springs into action when disruptive events occur such as a volcano eruption or a hurricane arises. In such cases the emergency operations centre can make decisions for all of the aircrafts of the airline.

1.2 Efficient planning
Using fuel as efficiently as possible is a high priority, thus all possible measures are taken to fly in optimal efficient conditions providing that it does not affect the flight duration drastically. The circumstances that are taken into account are the weather conditions **(1.2.1)**, as well as the optimal pressure altitude **(1.2.2)**, cruise speed and duration of the flight **(1.2.3)**, flight information regions and non-radar airspace **(1.2.4)**, Notice To Airmen (NOTAM) information **(1.2.5)**, runway conditions **(1.2.6)**, Air Operator Certificates (AOC) **(1.2.7)**, and alternate planning **(1.2.8)**.

1.2.1 Weather
It goes without saying that flying through stormy weather is not preferred. Therefore when planning the flight, the weather enroute should be investigated. Flying around the bad weather is recommended to ensure a safe and comfortable flight.
At higher altitudes in the troposphere where the winds are very strong and almost always point in the same direction. Those winds are called jet streams. When flying in the direction of a jet stream it

is recommended to fly in the jet stream when it provides the aircraft tailwind and to fly above or underneath the jet stream when it provides the aircraft headwind, or simply around it. This recommendation follows logically from shortening the flight duration. The same goes for 'common' winds.
The outside air temperature (OAT) affects the performance of the engines of the aircraft. At higher temperatures the density of the air decreases. This results in a lower mass flow of air to go through the engine which results into less weight to accelerate. Eventually less thrust is generated. So at high temperatures the engine has to work harder to create the same amount of thrust it creates at low temperatures. It is recommended to operate through low temperature areas so that the engine is more economically used.

1.2.2 Altitude

The altitude has a significant influence on the aircrafts ability to produce lift, it also affects the drag and the thrust delivered by the engines, because the air density and pressure decrease with altitude. At lower altitudes, the air density is higher causing the drag to be unnecessary high. As the density decreases with altitude, the angle of attack has to increase in order to generate enough lift, which in turn increases the drag and thus the required thrust. However, as a result of weight loss due to using fuel, the required amount of lift will decrease as well, thus allowing the aircraft to operate at greater altitudes.
The airways which are used to operate on are divided into lower and upper air routes. The major difference, regarding to planning, between those two air routes is the air density again. The upper air routes are in the upper airspace so the density is low. Therefore there are less air molecules which collide with the aircraft per second. The aircraft is certified to collide with at least the amount of air molecules which are on ground level. Therefore the aircraft can operate at higher speeds when the aircraft operates on higher altitudes. It is recommended to operate at the optimum altitude which is the highest possible altitude regarding the weight of the aircraft.

1.2.3 Cruise system

The cruise speed and the duration of the flight are inseparable. It is preferred to minimize the flight duration but then the aircraft will operate with a high cruise speed. This high cruise speed will result into high fuel consumption which is equal to high costs. Airlines usually give the pilot a Costs Index (CI) **(Equation 1.1)** which is linked to a certain cruise speed in the FMS. General airline costs covers amongst others the costs to may land on an airport, the salary of the crew and the costs the airline will get when passengers miss there transfer flight.

$$CI = \frac{Fuel\ costs}{General\ airline\ costs}$$

CI	= costs index
Fuel costs	= costs of the fuel on board at the start of the flight
General airline costs	= costs which the airline has or is going to make

Equation 1.1; Cost index

Another speed at which can be flown is the max range cruise speed. This is the cruise speed at which the aircraft can reach the maximum range. The advantage of this speed is that the fuel is used as efficient as it can be. The disadvantage of this speed is that it is a very low speed.
Since there is no indication of a preferred cost index and the max range cruise speed is a very slow speed recommended is the long range cruise speed. This is the speed at which the aircraft reaches 99% of the maximum range.

1.2.4 Flight information regions

Flight information regions (FIR's) are regions at which one air traffic company provides the flight information. Every time an aircraft enters another FIR, the aircraft will be supervised by another controller. This brings an amount of costs with it. It is recommended to fly a route with as little as possible FIR in it.

1.2.5 NOTAM

NOTAMs give critical information about the airport and its region. Thus when a part of the airspace around the airport or a runway may be temporary closed, the NOTAM describes it. The NOTAM stated also when high obstacles are moved around the airport. Basically the NOTAM will tell when something differs from normal circumstances. It is recommended to read the NOTAM prior to planning to flight so that the flight is prepared for the issues which may be come.

1.2.6 Runway condition

A runway is not always in its best condition. For example, it may be contaminated or there may be slush. A runway is contaminated when more than 25% of the runway surface area within the required length and width being used is covered by surface water more than 3.0mm or by slush or loose snow equivalent to 3.0mm of water, snow which has been compressed into a solid mass or ice including wet ice. Information about the runway is amongst others given in a runway state message **(Appendix I)** which may be provided by a METAR. The NOTAM gives also information about the runways. It is recommended to depart and arrive from a runway which is in good condition.

1.2.7 AOC

An Air Operator Certificate (AOC) is a certificate authorizing an operator to carry out specified commercial air transport operations. An AOC specifies the:

- Name and location (principal place of business) of the operator.
- Date of issue and period of validity.
- Description of the type of operations authorized.
- Type(s) of aircraft(s) authorized for use.
- Registration markings of the authorized aircraft(s) except that operators may obtain approval for a system to inform the Authority about the registration markings for aircrafts operated under its AOC.
- Authorized areas of operation.
- Special limitations/authorizations and approvals.

It is recommended to keep in mind the limitations of the AOC.

1.2.8 Alternate

An alternate must be near the destination airport. If an alternate is too close to the destination airport there is a risk that if the destination airport is closed due to weather conditions, the alternate will be too. Also when choosing a military airport as an alternate accessibility must be considered. This is, because if the aircraft only has to divert because of problems at the destination airport and not at the aircraft, it is not always allowed to land at a military airport.

1.3 Navigation

During and before a flight a pilot should be able to navigate to its destination with the principles of navigation, which must be applied to a moving aircraft **(1.3.1)**. The principles of navigation will help the pilot to find the shortest possible route and offer assistance to the pilot when the pilot needs to divert to another airport. Therefore the pilot flies through specific airspaces. The north Atlantic airspace is discussed further **(1.3.2)**. During flight the pilot uses, when navigating, multiple navigation methods **(1.3.3)**. Several maps of airports and airways are available. These maps provide a specific route around an airport or airway. The pilot uses charts of the planned route to give an overview of the departure and arrival procedures on de required airports **(1.3.4)**.

1.3.1 Principles of Navigation

The principles of navigation depend on the earth. The earth is not round and has a different shape **(1.3.1.a)**. It is possible to determine the heading of the aircraft when using the shape of the earth **(1.3.1.b)**. When the pilot knows his heading he can start to navigate around the earth using the navigation tracks **(1.3.1.c)**.

1.3.1.a The shape of the Earth

The earth is not a round sphere; usually for the shape of the earth a spheroid is used. The geographical poles are the points where the "short" axis of the spheroid reaches the surface **(Appendix IIA)**. The top of the spheroid is called the North Pole and at the bottom of the spheroid the South Pole. Seen from above the earth turns "counter clockwise" around the North Pole. The vertical axis is about 45 km shorter than the horizontal axis of the Earth.

1.3.1.b Heading

During flight a pilot uses different values for the North Pole to navigate to his destination. These values are known as:

1. True North
2. Magnetic North
3. Compass North

Ad 1. *True North*

True North (TN) is used for flight planning tracks and is defined as the direction of the tangent of the meridian in the direction of the geographic north. When planning a flight over 65 North there should be planned on True North.

Ad 2. *Magnetic North*

On different flight charts the Magnetic North (MN) is used. The magnetic North varies with time because of the change of the magnetic field of the earth. The difference between true north and magnetic north is called variation.

Ad 3. *Compass North*

The compass north will be marked on the compass of the aircraft and is not the true north; the compass can be converted to magnetic north or true north. The difference between magnetic north and Compass North is called the deviation.

1.3.1.c Earth Tracks

A position on the earth is determined with the co-ordinates across the width and length of the earth. To know more about the position on earth, like the position on the upper side or bottom side of the earth, we need to further subdivide the earth in:

1. Great Circles
2. Meridians and Longitude
3. Small Circles and Latitude

Ad 1. *Great Circle*

The earth can be divided in Great Circles (GC) and small circles **(Appendix IIB)**. A great circle centre always intersects the centre of the earth and is the largest circle on the surface of the earth. The distance of a great circle is described in degrees, 1 degree on the Great Circle is 60 minutes and these are used for distance navigation. One GC minute is equal to one Nautical Mile (NM) which is 1852 meter. The GC distance is the shortest distance between two points. Radio signals follow the GC path, which is important for scheduling of radio soundings.

Ad 2. *Meridians and Longitude*

Meridians are half GCs which are connected to each other at the two poles. The meridians are indicated in degrees, as seen from the centre of the earth, starting from a reference meridian. The reference meridian is the 0° meridian and called the Greenwich meridian **(Appendix IIA)**, named after the village near London. The position east or west of the Greenwich meridian is called the length, east or west longitude in 0-180 degrees.

Ad 3. *Small Circle and Latitude*

Besides the 180 "vertical" meridians which form together 360 GC, there is one great circle which intersects the rotation axis of the earth perpendicularly. This is the equator. The equator divides the earth into the northern- and the southern hemisphere. The other circles that intersect the axis of rotation of the earth perpendicular are all Small Circles **(Appendix IIB)**. The small circles can be identified as North or South relative to the equator. The position north or south of the equator is called the width, north or south latitude in 0-90 degrees.

1.3.2 North Atlantic airspace

In the north Atlantic airspace different kinds of airspaces exist **(Figure 1.1)**. Such as, Reduced Vertical Separation Minima (RVSM) and Northern Canadian RVSM (NDRVSM). To operate in RVSM airspace the aircraft must be RVSM approved. Before flying with a RVSM approved aircraft the operator has to be authorized and has to request clearance for RVSM operations **(1.3.2.a)**. Also tracks are made in the north Atlantic airspace. In the morning and evening North Atlantic Organized Track System (NAT OTS) provides fixed tracks indicated with a letter **(1.3.2.b)**.

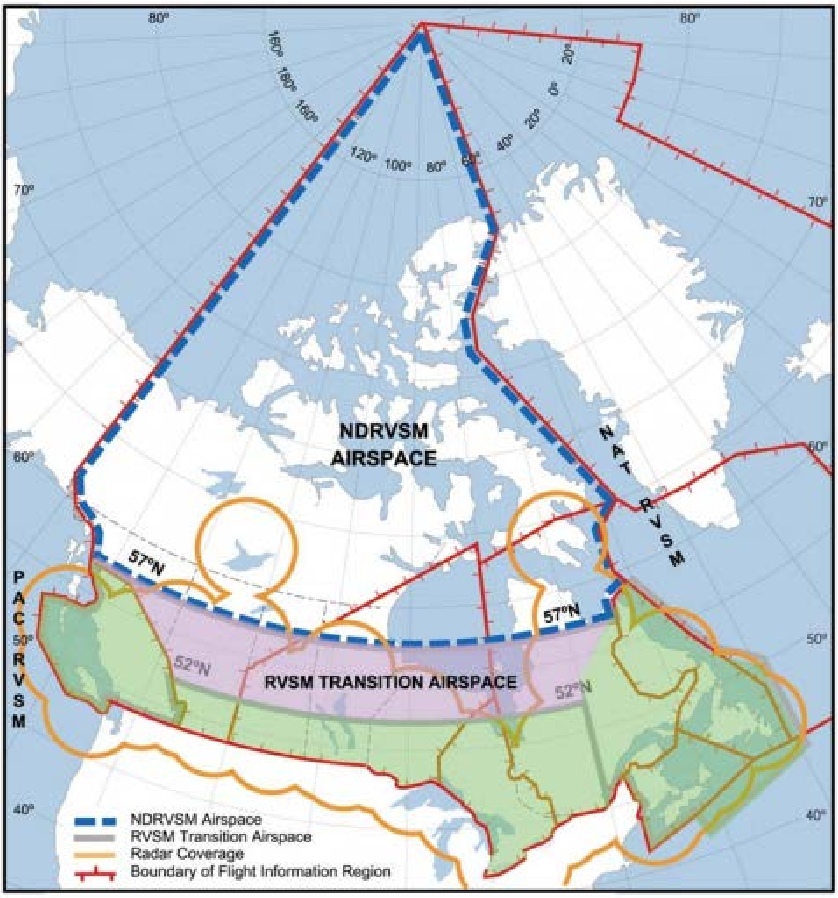

Figure 1.1; North Atlantic airspace

1.3.2.a RVSM

North Atlantic Minimum Navigation Performance Specification Airspace (NAT MNPSA) is an airspace just north of the Canary Islands (27°N) up to the North Pole, between FL285 and FL420.
RVSM airspace has been established within the confines of MNPS airspace and associated transition areas. From FL290 the altitude extends up to the RVSM altitude limit of FL410, the maximum altitude that is certificated for that type of aircraft and the limitations of altitude for example, cruise and buffet. To ensure the safe application of the separation minimum, authorization has to be requested to fly in RVSM airspace. In RVSM airspace, 1000 ft. vertical separation is applied between approved aircraft. The longitudinal separation is as follows: 10 minutes if the Mach number of the preceding aircraft is equal to or greater than that of the following aircraft. 9 minutes if the aircraft in front is M0.02 faster. 8 minutes if the aircraft in front is M0.03 faster. 7 minutes if the aircraft in front is M0.04 faster. 6 minutes if the aircraft in front is M0.05 faster. 5 minutes if the aircraft in front is M0.06 faster. If the aircraft do not report over a common point and are out of radar range the separation is 15 minutes. Lateral separation is 60 NM.

1.3.2.b NAT OTS

The NAT OTS provides fixed tracks for trans-Atlantic traffic in the morning and the evening. The traffic flows is Westbound during the day and Eastbound overnight. Each North Atlantic Organized Track is identified by a letter. The westbound tracks begin with the letter A as the most northerly track and continue vertically down with B, C, D and so on (depending on how many tracks are needed to accommodate the forecast traffic). The eastbound tracks begin with Z as the most southerly track and continue vertically upward with Y, Z, W etc. The NAT OTS operates twice during each 24 hour period. Westbound system is operational from 1130 to 1900 UTC. Eastbound system is operational from 0100 to 0800 UTC. Aircraft may fly on random routes which remain clear of the OTS or may fly on any route that joins or leaves an outer track of the OTS.

Position reports should be made at designated reporting points and at the significant points listed in the Flight Plan. If, on a NAT track report, at the points listed in the track message and at designated reporting points. The general guide is that ATC should have reports in roughly hourly intervals.
As a rule North of 70°N every 20° of longitude. South of 70° every 10° of longitude. Any changes to ETAs of 3 minutes or more should be advised to ATC. Report to ATC on reaching a new cruising level.
For flights outside the domestic ATS route network, position should be expressed in terms of latitude and longitude except when flying over named reporting points.

1.3.3 Navigation Methods

The pilot has a number of methods to navigate the aircraft to its destination. The initial aircraft, which made longer flights, navigated on compass navigation **(1.3.3.a)**. After several years, navigating developed and began to navigate using radio signals **(1.3.3.b)**. Around airports it was important to properly navigate, this happened with precision navigation **(1.3.3.c).** This is fully developed to precision approaches to the runway itself. Nowadays also navigate with help from the satellites; this is called GPS navigation **(1.3.3.d)**.

1.3.3.a Compass Navigation

Compass navigation relies on the earth's magnetic field. This magnetic field exists surrounding the earth. The magnetic field has force lines from the North Pole to the South Pole. This magnetic field can be used by the pilot to get information about the aircraft's movement and so can the pilot adjust his heading. The device which gives this information is called a compass, which provides the direction to the Magnetic North. The compass uses the magnetic force lines and works without an electrical system. The magnetic field of the earth is not constant so near a magnetic area the heading can be incorrect that is because there is variation in this fields. Because of the new navigation methods today the compass is only used as a backup device.

1.3.3.b Radio Navigation

Today the aviation uses a radio navigation system. This is used during different phases of flight, including cruise, approach and landing. Using radio beacons on the land during flight, the position of the aircraft can be determined. It is possible to follow a radio signal because the signal is constantly broadcast. A pilot can follow the beacons by tuning on to the frequency of the beacons. The position of the aircraft in relative with the beacon is displayed on the radio navigation device in the cockpit. A radio signal cannot pass through the earth's surface so a beacon which is far away of the aircraft is not always in reach.

1.3.3.c Precision Navigation

An airport works as an intersection for the airways, so around an airport the aircraft needs to be precisely navigated. During landing a precision approach system is used. An ILS system is a precision approach system and most airports use this ILS system. An ILS system consists of a localizer (at the end of the track), glide slope (next to the runway), marker beacons, and approach lighting **(Appendix IIIA)**. The ILS system transmits signals that are received by an ILS receiver in a modern aircraft. This is done with a signal in the vertical direction and a signal in the horizontal direction and these signals are called a glide slope. The ILS will navigate the aircraft in a particular track on the runway. Each category of the ILS system is categorized by the sight and the distance to which the ILS system can put the aircraft in front of the runway.

1.3.3.d Global Positioning system

Navigating through satellites is called Global Positioning System (GPS). The navigation system consists of satellites that move around the earth in permanent lanes. The signals of the satellites are received by a GPS receiver. This receiver can receive the signals and decode them. There are at least three satellites necessary to determine the position on earth. The receiver operates through measure the distance between the satellite and the receiver, taking into account the delay of the signal. The signals are converted into latitude, longitude and altitude.

1.3.4 Aeronautical Charts

When a flight is planned several charts are used. Those charts can be projected in a specific kind of ways **(1.3.4.a)**. Besides those differences there multiple kind of chart which are used during the flight planning. Starting with an aerodrome chart **(1.3.4.b)** followed by a departure chart **(1.3.4.c)** and an en-route chart **(1.3.4.d)** closing with an approach chart **(1.3.4.e)**.

1.3.4.a Chart projections

An earth chart projection is a projection of the elliptical earth on a map. There are three main projections:

1. Mercator projection
2. Lambert projection
3. Azimuthal projection

Which chart projections is used, can usually be found on the upper right corner of the chart.

Ad 1. *Mercator projection*

The Mercator projection is a cylindrical projection. This projection can be identified by the vertically meridians and the horizontally parallels. Hereby the great circle is a curve. Another characteristic of this projection is that the chart is conformal. A disadvantage of this projection is that surface deformations occur. The further a country is from the equator, the bigger it is projected. The poles are even infinitely large.

Ad 2. *Lambert projection*

A Lambert projection is a conformal conic projection. This projection can be identified by the converging meridians and the parallels which are concentric arcs. Hereby the great circle is almost straight line. The difference from a true straight line is negligible. A Lambert projection has two standard parallels. At the standard parallel the earth is conform and not deformed displayed. The rest of the chart is conforming but deformed displayed, but this deformation is not as large as the deformation on a Mercator chart.

Ad 3. *Azimuthal projection*

An Azimuthal projection is a chart projection where the projection surface is flat and touches or cut the earth. A gnomonic Azimuthal projection has a projection point in the centre of the earth. Hereby the great circle is a straight line. When the projection point is the opposite geographic pole, the projection is called polar stereographic Azimuthal projection. In this projection the parallels are perfect circles. The meridians are perpendicularly on those parallels. This chart is conforming. When the point of contact is at the opposite meridian on the equator, the projection is called equatorial stereographic Azimuthal projection. When the point of contact is just on the opposite meridian, the projection is called oblique stereographic Azimuthal projection.

1.3.4.b Aerodrome chart

An aerodrome chart is a graphical latitude and longitude correct representation of the airport including such elements as: runways, taxiways, obstacles, buildings and ground features. Aerodrome charts, display also additional information such as communications, take-off and alternate minimums and IFR departure procedures. Also there exist aerodrome charts which represent specific parts of the aerodrome to display more details of, for example, parking positions or low visibility taxiway routes.

1.3.4.c Standard Instrument Departure chart

Standard Instrument Departure charts, also called SID's, show an IFR departure route. The route starts at the runway of an aerodrome and continues via a number of markers to a designated ATS route. It is possible that there are given a couple of standard ATC instructions to go besides the chart. The legend of this chart is explained in **Appendix IVA**.

1.3.4.d En-route chart

En-route charts are offered in high and low altitudes and are used for the cruise phase. Most of the en- route charts are Lambert conformal conic projections. On this chart are amongst others aerodromes, airways, minimum altitudes and waypoints displayed. The legend of this chart is explained in **Appendix IVB**.

1.3.4.e Standard Terminal Arrival Route chart

Standard Terminal Arrival Route charts, also called STAR's, shows an IFR arrival route. The route starts at a designated ATS route and continues via a number of markers to a runway of an aerodrome. It is possible that there are given a couple of standard ATC instructions to go besides the chart. The legend of this chart is explained in **Appendix IVA**.

1.4 Metrology

As the weather can be very different in every area, meteorological reports are made for a large number of locations. These reports consist of uniform codes, which permit an efficient transmission of a large amount of information. These meteorological reports, which describe the current, forecasted and expected weather conditions, are Meteorological Aerodrome Reports **(1.4.1)**, The Terminal Aerodrome Forecasts **(1.4.2)**, the Automatic Terminal Information Services **(1.4.3)** and the Significant Meteorological Information **(1.4.4)**. To describe the wind and temperature at specific flight levels, the significant weather charts **(0)** and the upper wind and temperature charts **(1.4.6)** are used.

1.4.1 METAR

Meteorological Aerodrome Report (METAR) is the most common meteorological information source in aviation. It's a weather report on the current weather situation that routinely is prepared by the meteorological service at an airport. The weather report will be provided in METAR code to the fight crew. Weather observations in METAR code have a four-letter location indicator according to the standards of ICAO and WMO. These elements are listed in a specific sequence. The elements that can be found in the METAR are described in **Appendix VA.**

In case of a rapid change of weather condition or other critical circumstances, it is possible that the observations are updated. This is done by the Aviation Selected Special Weather Report (SPECI). SPECI is a supplement of the METAR.

1.4.2 TAF

The Terminal Aerodrome Forecast (TAF) is a forecast of the meteorological conditions at an aerodrome published in a concise statement for a certain period of time. TAFs are valid in general for a period of 24 or 30 hours a day and within an area of about five statute miles (approximately 1,609m) from the centre of an airport runway complex. The weather conditions in the TAF are coded similarly to those used in a METAR report.

A difference between a METAR and a TAF code is that the TAF does not contain QNH. Further in a TAF, the temperature and dew points are missing comparing to a METAR. But if they are given they are described at a different position then the METAR. An example of a TAF code is shown in **Appendix VB**.

1.4.3 ATIS

ATIS is short for Automatic Terminal Information Service. This is a radio service which is generally offered to departing and approaching traffic at the larger airports. ATIS consists of an automatic message that is continuously transmitted to one or more frequencies in the Very High Frequencies (VHF). It is virtually identical to the METAR. The message contains information about the current weather at the airport and operational details. The message always begins with a letter indication. The letter moves up in alphabetical order if there is a change of the data. If any significant weather condition or a runway direction is changed, the information in the ATIS will be adjusted. This is done at least every hour.

1.4.4 SIGMET

During the flight the weather is a real factor for the safety of the aircraft. To fly safe it is really useful to know which weather can be expected, in particular significant weather changes constitute a potential risk. Meteorological offices are constant occupied with the task to intercept potential hazardous en-route weather for their responsible area. This information is the significant meteorological information (SIGMET).
A SIGMET warning is mostly broadcasted on the automatic terminal information system (ATIS) or meteorological information for aircraft in flight (VOLMET). The SIGMET exists out of three different parts and starts with the Header **(1.4.4.a)** which contains basic information about the SIGMET. The first line of the SIGMET **(1.4.4.b)** continues with the valid time of the SIGMET. As last the SIGMET end with the meteorological information **(1.4.4.c)** about the weather phenomena.

1.4.4.a Header

The header **(Figure 1.2)** contains different sort of information:

1. Bulletin identification
2. Communications centre
3. Date and time
4. Possible correction of an earlier SIGMET

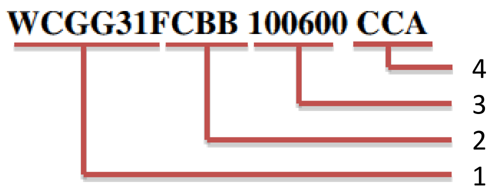

Figure 1.2; SIGMET header

Ad 1. *Bulletin identification*

The bulletin identification number starts with the data type designator **(Table 1.1)**. After the sort of the SIGMET message follows the country and territory designators. The bulletin identification will finish with the bulletin number.

Abbreviation	Definition
WC	For tropical cyclones.
WV	For volcanic ash clouds.
WS	For weather warnings other than volcanic ash clouds and tropical cyclones.

Table 1.1; type of SIGMET message

Ad 2. *Communication centre*

This part exists out of the ICAO code (four letters) from where the SIGMET message is sent. This is because the information is not going straight from the WMO to the aircraft, but with interposition of a communication centre.

Ad 3. *Date and time*

The first two numbers of this block show the date the message is sent, while the last four numbers shows the time the message is sent.

Ad 4. *Possible Correction of an earlier SIGMET*

It is always possible that there is sent a SIGMET message with wrong information. In that case there could be send a correction SIGMET. To make clear that the SIGMET contains a correction, the following codes at the end of the header CC. Where A is placed for the first correction, B for the second correction and so on.

1.4.4.b First line

The first line of the SIGMET **(Figure 1.3)** contains:

1. Location of ATS unit
2. Message identifier
3. SIGMET numbering
4. Valid period
5. Location of MWO

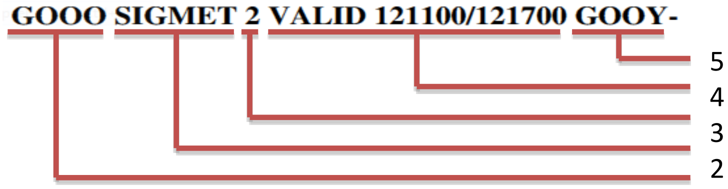

Figure 1.3; SIGMET first line

Ad 1. *Location of ATS unit*
ICAO code of the ATS unit that control the FIR or UIR for which the SIGMET is sent.

Ad 2. *Message identifier*
This part of the message only contains the word 'SIGMET' to identify that it is a SIGMET message.

Ad 3. *SIGMET numbering*
The SIGMET numbering starts counting at 0001UTC. The numbering could exist out of a maximum of three symbols.

Ad 4. *Valid period*
The period of which the SIGMET message is valid is written the same as the date and time in the header **(1.4.4.a, Ad 3)**. The start and end time of the message separated by a slash.

Ad 5. *Location of MWO*
Also the location of the issuing MWO is showed in ICAO code.

1.4.4.c Weather information

The weather information in the SIGMET consists out of seven different parts:

1. Name of the FIR/UIR
2. Weather phenomena
3. Observed or forecast
4. Location
5. Level
6. Movement or expecting movement
7. Changes in intensity

Ad 1. *Name of the FIR/UIR or CTA*
Here is the corresponding FIR/UIR or CTA region placed.

Ad 2. *Weather phenomena*
There are different shortcuts for every weather phenomena showed in **Table 1.2**.

Abbreviation	Definition
TS	Thunderstorms
TURB	Turbulence
ICE	Icing
MTW	Mountain Waves
DS	Dust storm
SS	Sand storm
RDOACT CLD	Radioactive cloud

Table 1.2; Weather phenomena abbreviations

Ad 3. *Observed or forecast*

The information of the SIGMET could be an observation (OBS), forecast (FCST) or both. Also the time when the OBS is made is given.

Ad 4. *Location*

The location of the weather phenomena could be described in different ways. The most common ways are:

- Indication of the FIR with longitudinal coordinates
- Indication of the FIR with latitudinal coordinates
- Indication of the FIR with longitudinal and latitudinal coordinates
- ICAO code
- Other international geographical features

Ad 5. *Level*

Beside the geographical coordinates also the FL of the weather phenomena needed to be described. When this information is known, it is possible to climb or decent to minimize the harassment.

Ad 6. *Movement or expecting movement*

The movement (MOV) is given in KMH or in KT with one of the eight compass direction points. When no significant movement is expected the movement is replaced for STNR.

Ad 7. *Changes in intensity*

Beside the movement or change of the phenomena location also the intensity of the weather could intensify (INTSF), weaken (WKN) or could be constant (no change, NC).

Example:

Ad 8.

`WSFR35 LFPW 021631` **`(HEADER)`**
`LFRR SIGMET 1 VALID 021700/022100 LFPW-` **`(VALID TIME)`**
`LFRR BREST FIR/UIR SEV TURB FCST WI N4945 W00300 - N5000 W00200 -`
`N5000 W00015 - N4900 W00015 - N4845 W00245 SFC/FL060 STNR NC=`**`(WEATHER INFO)`**

Ad 9.

The header tells that this SIGMET contains another weather phenomenon than volcanic clouds or a tropical cyclone. According to the third and fourth letters, FR, the corresponding country/ territory designator is France. The bulletin number is 35 and the communication centre is in Toulouse (LFPW). The SIGMET is send at 2 March at 16:31.

The ATS unit Brest (London, UK) controls the FIR/UIR for which the phenomenon is valid. This is the first SIGMET that is given since 0001UTC. The message is valid from 2 March 17:00 until 2 March 21:00 and is set up by the WMO in Toulouse.

The corresponding FIR/UIR is Brest and the forecast is severe (SEV) turbulence (TURB). The location of the turbulence is given in geographical coordinates and there is no significant movement expected (STNR) and change in intensity (NC).

Beside this standard format, there are different formats for tropical cyclones and volcanic eruptions/ash clouds. Because these are more exceptional situations and not relevant for the project they will not be described.

1.4.5 Significant Weather Charts

The significant weather (SIGWX) charts are provided by the World Area Forecast Centre (WAFC). The charts can be divided in Low level charts (<10000ft), medium/high level charts (10000ft to 40000ft) and high level charts (>25000ft). General the charts are issued every six hours, 00, 06, 12 and 18 UTC. The SIGWX charts contain the next information:

1. Jet Streams
2. Clear air turbulence
3. Tropopause levels
4. Cloud weather
5. Fronts
6. Volcanic activity

Ad 1. *Jet streams*

A jet stream is a relative narrow air current in the atmosphere which travels with a minimum speed of 80 knots, the speeds can increase to a several hundred knots. It is important to know where these jet streams are simply because they affect the performance of the aircraft. If an aircraft flies several hundreds or thousands of miles against a jet stream, the flight will take much longer and a lot more fuel will be burned. But when flying with a jet stream the ground speed will be much higher and a lot less fuel is needed for the flight. For flight planning it is the case to avoid or use the jet stream to get as much efficient as possible from the departure to the destination location. Beside the Jet streams are showed as long black arrows. Above these arrows the speed of the jet stream is given with triangles and stripes. Each triangle is a speed of 50 knots and each feather is 10 knots, the short feathers are 5 knots. Under the jet stream arrow the flight level of the jet stream is given **(Figure 1.4)**.

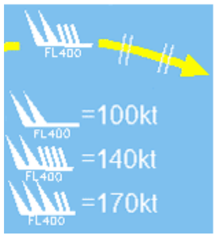

Figure 1.4; Jet stream

Ad 2. *Clear air turbulence*

Heavy turbulence can be better avoided than seek out. Turbulence in the high SIGWX chart will be showed as a dashed line; furthermore also the Flight level is indicated. The intensity of the turbulence is given with two different symbols, the left symbol is moderate turbulence and the right symbol indicates severe turbulence **(Figure 1.5)**.


Figure 1.5; Clear air turbulence intensity symbols

Ad 3. *Tropopause levels*

The tropopause levels are given in hundreds of feet placed in a squared box **(Figure 1.6)**. It is useful to know when the tropopause starts, because from this altitude it is not efficient to climb further due to the constant temperature in the tropopause.

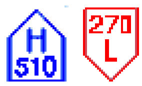

Figure 1.6; Tropopause levels

Ad 4. *Cloud weather*

In cloudy weather only turbulence and icing and visibility is measured at these heights. Not the base/top of the cloud is therefore measured, but the top of the turbulence and icing. Only moderate or severe icing or turbulence will be indicated. The areas will be showed with scalloped lines. The coverage of the area is given in a scale from 0 to 8, ISOL CB indicates a low coverage of the area, less than 1/8. OCNL CB indicates 1/8 to 4/8 coverage and FRQ CB indicates 5/8 or more coverage **(Figure 1.7)**.

Figure 1.7; Cloud weather

Ad 5. *Fronts*

The different fronts are given in the standard surface notation, a (blue) line with triangles is a cold front, a (red) line with hemispheres is a warm front, a combination of both at the one side is an occluded front and the one with both symbols but now alternating from side is a stationary front **(Figure 1.8)**.

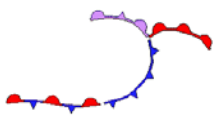
Figure 1.8 Fronts

Ad 6. *Tropical storms*

There are two symbols to indicate if it is a tropical storm or hurricane. The symbol with the open body indicates that it is a tropical storm with wind speeds of 35 to 64 knots. The solid body will indicate a tropical cyclone with wind speeds above 64 knots **(Figure 1.9)**. The location of the symbol is also the forecast condition for the concerning time.

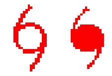

Figure 1.9; Tropical storms

Ad 7. *Volcanic activity*

Is given in with a volcanic symbol and scalloped lines with the heights of the ash cloud in hundreds of feet **(Figure 1.10)**.

Figure 1.10; Volcanic eruption

1.4.6 Upper wind and temperature chart

The upper wind and temperature chart is issued four times a day for eight different flight levels, from FL050 to FL450. The wind speed and direction is indicated by wind feathers, where the wind speed indication works exactly the same as with the significant weather charts. Beside the wind also the temperature is given. Note that the temperature that is given seems to be positive, but for example 46 means -46 degrees. When the temperature is above zero than this will be indicated with PS, so PS4 will mean 4 degrees above zero. An example can be found in **Appendix VI**.

1.5 Boeing 747-400ERF Specification and Equipment

The Boeing 747-400ERF and its performance will be described **(1.5.1)**, next the layout of the cargo room will be described **(1.5.2)**. The minimum equipment list containing the most essential items of the aircraft **(1.5.3)**. The Boeing 747-400ERF has several navigation systems **(1.5.4)**. As last the aircraft technical log will be explained **(1.5.5)**.

1.5.1 Aircraft Performance

First the specifications of the Boeing will be described **(1.5.1.a)**. Secondly the rescue and firefighting index will be explained **(1.5.1.b)**. As last, the required pavement what an airport need so a Boeing 747 can land on their runway will be explained **(1.5.1.c)**.

1.5.1.a Specifications

The flight from EHAM to PANC will be with a Boeing 747-400 Extended Range Freighter. In Table 1.3; Specifications of the Boeing 747-400 ERF the specifications of the Boeing 747-400ERF are shown.

Dimensions	
Wing Span	64.4 m
Length	70.6 m
Tail Height	19.4 m
Cabin width	6.1 m
Cargo Capacity	
Main Deck	604.48 m^3
Lower Deck	158.57 m^3
Bulk Cargo	14.72 m^3
Maximum Payload	112.760 kg
MTOW	412.775 kg
MLW	296.200 kg
MZFW	277.140 kg
Maximum Fuel Capacity	216.840 L
Maximum Range	9.200 km (4970 nm)
Cruise speed (at FL350)	0.845 M (901 km/h)
Take-Off Distance (at Sea Level)	3100 m
Landing Distance (at Sea Level)	2400 m

Table 1.3; Specifications of the Boeing 747-400 ERF

1.5.1.b Aircraft Rescue and Fire Fighting index

An airport has to comply with the aircraft rescue and firefighting index (ARFF), so a Boeing 747-400 can land on the airport. The ARFF index is based on the length of the aircraft and the average daily departures. The index is shown in **Table 1.4; Aircraft rescue and firefighting index**.

Index	Length
A	Less than 27 m
B	From 26 m to less than 38 m
C	From 38 m to less than 48 m
D	From 48 m to less than 61 m
E	More than 61 m

Table 1.4; Aircraft rescue and firefighting index

When an airport has less than five daily departures of the longest aircraft, the index for the airport is allowed to be one lower the required index. For the Boeing 747-400 an index of E is needed, unless the airport has less than five departures, index D is sufficient.

1.5.1.c Pavement Classification Number

The Pavement Classification Number (PCN) consists of five parts. The first part is the number that indicates the load-carrying capacity of the pavement. The scale starts at one and ends on 130. One means a very weak pavement and 130 a very strong pavement. The second part is the letter F or R. This indicates of the pavement is flexible (F) or rigid (R). The third part indicates the strength of the pavement. The index goes from A to D.

A = high strength
B = medium strength
C = low strength
D = very low strength

The fourth part indicates the maximum tire pressure. This index goes from W to Z.
W = no maximum pressure
X = up to 1.5MPa
Y = up to 1.0MPa
Z = up to 0.5MPa

At last the T or U is used. This indicates whether the PCN is obtained by technical evaluation (T) or by practical experience (U).
Also every aircraft has its own Aircraft Classification Number (ACN). This number depends on the pavement and strength of the runway where the aircrafts land, for the Boeing 747 it can be found in **Table 1.5**. A Boeing 747-400 cannot land on a runway where the number of the ACN is higher than the number of the PCN.

	Flexible Pavement (F)				Rigid Pavement (R)			
Strength	A	B	C	D	A	B	C	D
Boeing 747-400erf	57	63	78	100	59	69	81	92

Table 1.5; Aircraft classification number of the Boeing 747-400 ERF

1.5.2 Payload bay layout

The Boeing 747-400ERF consists of a main deck and a lower deck. On the main deck 604,5 m^3 of cargo can be stored and on the lower deck 173,3 m^3 of cargo can be stored. The dimensions of the cargo doors are added in 0. The maximum payload is 112.760 kg.
When animals are transported in the cargo area, the pressure and temperature has to be acceptable for loving. The maximum pressure on the entire aircraft including the cargo area can be 648.1 millibar.
The B747 is divided in seven temperature zones: flight deck, upper deck, crew rest, forward and aft main deck, forward and aft lower lobe cargo zone. Bleed air is used to heat the zones. Before entering the bleed air in the zones it will be cooled down. Two pack temperature controllers (PTCs) regulate the amount of bleed air with valves. The temperature on flight deck, the upper deck, crew rest zone and main deck varies between 18 to 29 degrees of Celsius. The temperature in the forward and lower lobe cargo zone can be selected with a Temperature Selector. The temperature can be selected between 4 to 29 degrees of Celsius.
Engines can only be brought into the aircraft through the side cargo door. The nose door is too small for the engines. Engines will be loaded on the main deck.

1.5.3 Minimum equipment list (MEL)

Any aircraft that operates must meet the minimum equipment list (MEL), this list contains the most important content for operations and the maintenance personnel , there is also a master minimum equipment list (MMEL) specifically designed for a particular type of aircraft. In this MMEL is set up that the operation is responsible for the new type of design and is approved by the state of design.
By giving the example of the already known malfunction of the brakes the MEL can be explained **(Figure 1.11)**. The MEL has a standard layout with every time a different malfunction described, where it says item with the given number. For this example it is 32-41-01-01.
The repair interval is divided in different repair time categories which are categorized as A, B, C and D Category A has a time interval which is given in the remarks, when the problem should be repaired. Next we got category B with an interval of three consecutive calendar days after discovery of the problem. Second last we got category C with an interval of ten consecutive calendar days after discovery of the problem. As last category D where the problem should be repaired within the time period of hundred and twenty consecutive calendar days after discovery.
Further the numbers of total installed items is given, but also the number of required items is displayed which is necessary for dispatch. Having less than this number restricts the operator for departing. With having enough installed items and meet the requirements which are described at the remarks or exceptions is authorized to depart. In that same framework are some abbreviations designated with the symbols (M), (O) and (T) these have different meanings.
“(M)” stands for maintenance. Qualified personnel may perform actions to repair the issue, where the Engineering Department is responsible for these procedures.
“(O)” stands for Operations. Authorized personnel, normally the flight crew or cabin crew perform these operations procedures which are noted in the MEL. The responsibility lies at the operator itself.
“(T)” is the technical deficiency which will be send during flight to stations along the route. The aircraft technical deficiency (aircraft registration, flight number and date). This information will be sent to OCC which are responsible for the displayed issues.

Section 2 MEL	747-400 Minimum Equipment List	ATA 32 Landing Gear

ITEM	REPAIR INTERVAL	NUMBER INSTALLED	NUMBER REQUIRED FOR DISPATCH	REMARKS OR EXCEPTIONS
Wheel Brakes				
32-41-01-01	C	16	14	(M) (O) (T) One or two brakes may be deactivated with a deactivation tool provided: a) Affected brake(s) is not leaking or damaged, b) Take-off and landing performance is calculated for two brakes deactivated, c) All reversers are operative, and d) Aircraft is not dispatched from or to a contaminated runway.

Figure 1.11; Malfunction example in the MEL

1.5.4 Navigation systems 747-400ERF

There are different navigation systems that is being used in the 747-400ERF. One of the methods is the Global Positioning System (GPS). There are several other methods that are being used this is the Inertial Reference System **1.5.4.a**. Moreover, there is the radio navigation systems which will be described in **1.5.4.b** and the weather radar in **1.5.4.c**.

1.5.4.a Inertial Reference System (IRS)

The IRS is of great importance in determining several states of the aircraft by the aid of three laser gyros and three accelerometers. Data can be obtained of position, attitude of the aircraft, true and magnetic heading, wind speed and direction, speed, accelerations and altitude.
Three modes are available for obtaining the data which are needed for navigation.

1. Full alignment
2. Fast alignment
3. IRS attitude

Ad 1. *Full alignment*

This option is only available when the aircraft is parked; it takes ten minutes to complete the alignment. The one task that has to be done is to put the present position into the Control Display Unit (CDU).

Ad 2. *Fast alignment*

This option is completed in thirty seconds but lacks information about track, ground speed and attitude errors.

Ad 3. *IRS attitude*

When alignment is lost during flight, only information about attitude can get back by moving the selector to ATT. After thirty seconds the system provides the information, the accuracy depends on the movement of the aircraft. In a straight level of flight gives the best result.

1.5.4.b Radio Navigation Systems

Radio navigation is divided into several navigation equipment, these are:

1. Automatic Direction Finding (ADF)
2. Distance Measuring Equipment (DME)
3. Instrument Landing System (ILS)
4. VOR

Ad 1. *Automatic Direction Finding (ADF)*

The signals of the ADF follow the curve of the earth. With a frequency band of 190 KHz to 1750 KHz. When putting in the radio frequency which is previously determined in the direction of the determined flight path, the pointer will point into the direction of the station.

Ad 2. *Distance Measuring Equipment (DME)*

The aircraft send out a pulse which is captured by a ground beacon which intercept this signal and send out another pulse towards the aircraft. By measuring the time it takes and with the speed of the electromagnetic pulse of 300 000 km/s the distance horizontally from the aircraft to the beacon can be calculated.

Ad 3. *Instrument Landing System (ILS)*

ILS is used of assisting the pilot to follow the correct glideslope to descend to the runway safely and precisely. ILS is active in 3 ways, first the autopilot must be turned on and either the localizer or glideslope is captured. Second the flight director is turned on, and either the localizer or the glideslope is captured, and the airplane is below 500 feet radio altitude. And third ILS is active on the ground with an airplane heading within 45 degrees of the localizer seen from the front and the ground speed is greater than 40 knots.

Ad 4. *VOR*

The VOR transmits two signals simultaneously. One signal keeps sending in all directions and the other rotates around the station. When the aircraft picks up the signals and interpret it as a radial.

1.5.4.c Weather radar

When flying through the air, you always have to do with the weather. The weather can be seen with the weather radar, it consists of two receiver-transmitter units, an antenna and a control panel. It gives a visual image of what lies ahead. Turbulence can be detected by the radar this can only be sensed if there is sufficient rainfall. Therefore clear air turbulence cannot be found on the radar.

1.5.5 Aircraft technical log

The aircraft technical log is a sheet which is needed in every flight. It is an overview about the condition of the aircraft is, information such as technical en operational data can be found. Further all other malfunctions that can be detected.

1.6 Fuel

When the flight route is decided, the amount of required fuel to cover the distance can be calculated. In order to calculate how much fuel is required, the different types of fuel **(1.6.1)**, as prescribed by EU-ops 1.255, are discussed. After which the fuel tables are examined, because these are required to calculate the necessary amount of fuel **(1.6.2)**.

1.6.1 Types Fuel

The required amount of fuel is calculated for different flight phases, starting with the fuel to taxi to the runway **(1.6.1.a)**, followed by the amount of fuel used from take-off to landing **(1.6.1.b)**. Several different types of reserve fuel are required in case of unexpected circumstances **(1.6.1.c)**. Also the captain may decide to bring extra fuel **(1.6.1.d)**.

1.6.1.a Taxi fuel

The calculation of the required amount of taxi fuel has to include the amount of fuel expected to be used prior to take-off in local aerodrome conditions, and the consumption of the Auxiliary Power Unit. The taxi fuel allowance is approximately 45kg per minute and the average APU fuel flow is 300kg/hr on the ground, as opposed to 270kg/hr at normal operating altitudes.

1.6.1.b En-route fuel

The en-route fuel consists of the amount required for the following flight operating modes. The fuel required for take-off and climb from aerodrome elevation to initial cruising altitude. The fuel flow from top of climb to top of descent, including any step climb/descent. And finally the amount of fuel from top of descent to where approach is initiated with the expected arrival procedure, with the fuel required for approach and landing.

1.6.1.c Reserve fuel

In case of unexpected circumstances during the flight, reserve fuel needs to be on board. There are four types of reserve fuel on board an aircraft:

1. Contingency fuel
2. Final reserve fuel
3. Additional fuel
4. Alternate fuel

Ad 1. *Contingency fuel*

The contingency fuel is carried on board, in case of additional en-route fuel consumption. This additional consumption can be caused by wind, ATM restrictions or routing change. Basically the minimal contingency fuel is 5 percent or more of the trip fuel, or 5 minutes holding consumption at 1500ft above the destination airport elevation, whichever amount is higher. However, the fuel policy states that this amount may be decreased to 3% of the trip fuel when an enroute alternate aerodrome is located within a circle with a radius equal to 20% of the total flight plan distance, with the centre located at 25% of the total distance from the destination aerodrome.

Ad 2. *Final reserve fuel*

The final reserve fuel is the minimum amount of fuel, which is required to fly for thirty minutes at 1500 feet above the alternate airport at the holding speed in ISA conditions. If the alternate airport is not required, this applies to the destination airport. For some regulating authorities the required sufficient fuel to hold is not thirty minutes, but forty-five minutes.

Ad 3. *Additional fuel*

To comply with specific regulatory or company requirements, the additional fuel is added. This includes ETOPS fuel, fuel required for an island or remote destination where an alternate isn't available and fuel that is required to satisfy a Minimum Equipment List (MEL) or Configuration Deviation List (CDL) performance penalty.

Ad 4. *Alternate fuel*

The amount of fuel required from the missed approach point at the destination airport until the landing at the alternate airport is called the alternate fuel. There are some scenarios this fuel is required for, such as: a missed approach at the destination, a climb to en-route altitude, cruise and descent at alternate airport, the alternate approach and the landing at the alternate airport.

1.6.1.d Extra fuel

This is the type of fuel that is added at the discretion of the captain, based on the flight experience of the captain. This type of fuel is not required.

1.6.2 Required amount of fuel

The required amount of fuel is determined using the tables and charts from the Boeing 747-400ERF Flight Planning and Performance Manual, which are displayed in **Appendix VIII**. The aircraft is expected to land with the different types of reserve fuel still on board. The entire amount of required fuel is calculated backwards from the landing to take off, because all the fuel that is used later in the flight was carried there using more fuel.
Final reserve fuel and contingency fuel are expected to still be on board when the flight has diverted to the alternate airfield. The final reserve fuel can be calculated using the holding planning table **(Appendix VIIIA)**. The contingency fuel is either 3% or 5% of the entire trip fuel. This is only a small amount of fuel which cannot be calculated precisely yet as the trip fuel is unknown. An approximate calculation is made using the long-range cruise trip fuel and time chart **(Appendix VIIIB)**. Alternate fuel is simply calculated using the long-range cruise short trip fuel and time chart **(Appendix VIIIC)**.
Fuel for descent is simply determined using the descent fuel table **(Appendix VIIID)**, since top of descent lies on an even flight level; the average value between the lower and the higher one is used.
The trip fuel is more complicated. It is not possible to fly at all optimal altitudes from the optimal altitude chart **(Appendix VIIIE)**, because airways are located at every 1000 feet. Also in international regions these airways operate in opposite directions, so it is only possible to climb 2000ft every step-climb to stay as close to the optimal altitude as possible. Now that the optimal altitude and the aircrafts weight at the top of descent are known, it is possible to calculate backwards to the top of climb with the Long Range Cruise Table in the Boeing 747-400ERF FPPM. The fuel required for the climb is determined using the En-route Climb table in the same manual.
Now that the actual trip fuel has been calculated, it is possible to determine the exact 3% or 5% contingency fuel. Finally, the taxi fuel is calculated using the average fuel flow of 45kg/minute.

1.7 Payload

A lot of information about the payload is given at the start of each flight. In the mass & balance document **(1.7.1)** is calculated how the weight is distributed and where the centre of gravity lies. The centre of gravity is a virtual point at which aircraft would balance if it were possible to suspend it at that point. Further a Notification to Captain is established **(1.7.2)**. Both of these documents can be found in the briefing package.

1.7.1 Mass & Balance

To ensure a safe flight, weight calculations are needed. By means of these calculations it is determined whether the centre of gravity (CG) lies within the CG limitations. More information about the place of the payload can be found in the check sheet. A check sheet is a loading paper which gives information about the load of the cargo and other weight **(1.7.1.a).** With the aid of a balance chart is checked whether the CG is between the limitations during the whole flight **(1.7.1.b)**. Finally a load sheet is made to give a good overview of the whole mass & balance **(1.7.1.c)**. Either the captain himself drafts a load sheet, or it is submitted to the captain for approval.

1.7.1.a Check sheet

The check sheets are used to distribute the cargo. The check sheet of the Boeing 747-400ERF is given in **Appendix IX**. In a check sheet are all of the cargo compartments of the aircraft displayed. The sheet starts with the cargo compartments of the main deck. These are subdivided in a right and left compartments. Each of these compartments has a maximum loading weight which is given beneath the relevant compartment. The right and left compartment have also a maximum combined loading weight.
Then the lower deck container and lower deck pallet locations are given. These are also splitted into a right and left location. There under the actual combined weight must be filled in and a final check must be made with regard to maximum loading weight. At the bottom of the sheet a lateral imbalance check can be made and an overview is given of the places of the cargo compartments in the aircraft.

1.7.1.b Balance chart

After the check sheet the balance chart will be used **(Appendix X)**. Hereby the position of the centre of gravity will be known. This is critical to aircraft stability. Also, can be checked with the balance

chart if the aircraft remains between the zero fuel weight, take-off weight and landing weight loading limits.
The balance chart consists of a circle with a line on it. For convenience, this line shall be called index line. On the bottom side of the circle an index scale is given. This is the dry operating weight index. Dry operating weight (DOW) is Basic Operating Weight (BOW) plus standard operating items such as standard crew and galley but without fuel. BOW is an aircraft's weight without standard operating items. This DOW index is given by the manufacture of the aircraft and is the centre of gravity position for the aircraft on its DOW. The DOW index is the index line it's starting point.
Then the line in the middle of the upper side of the circle with zero above it will be observed. Along this line, the cargo compartments are plotted. With the index line on his starting position is specified how much weight contains the first two compartments (A1 and A2). This is specified with a dot along the line right or in this case left of the compartments' names. Then the circle will be moved (in this case to the right) till the dot matches the 'zero line'. Then the weight of the cargo in compartment A is specified and so on. The last specified compartment is the compartment X. Then the index line is at his final position.
At an average altitude of the circle different kind of total masses are given. In the square on the right side of the page are the different kinds of maximum masses. For the situation above the mass of all the cargo combined with the DOW is the mass required; this is the Zero Fuel Weight. When following the round line belonging to the right mass, a cross is found with the index line. This point gives the mean average chord (MAC) value, conclude from the almost vertically lines. The MAC is the average chord length of a tapered wing. The MAC will depend on the tip and root chord **(Equation 1.2)**.

$$MAC = \frac{2}{3}\left(\frac{Cr^2+Ct*Cr+Ct^2}{Cr+Ct}\right)$$

MAC	=mean aerodynamic chord	[m]
Cr	= Chord root	[m]
Ct	= Chord tip	[m]

Equation 1.2: Mean aerodynamic chord determination

The MAC value found must be in the box two with the dashed line. This box gives the CG limitations for the aircraft's Maximum Zero Fuel Weight (MZFW).
On the 'zero line' also can be added the final reserve fuel, contingency fuel and the alternate fuel. The MAC of the Landing weight will be calculated. This value must be in box three. When adding the trip fuel, the MAC of the take-off weight is found. This value must be in box one.
Box four is given for forward take-off limits with increased after cumulative loads.

1.7.1.c Load sheet

At last the load sheet will be filled in **(Appendix XI)**. The load sheet is used to make a check if the aircraft is within his maximum load limits.
The bottom left of this sheet provides basic information such as flight number, date and aircraft registration number. To the right of this area the DOW, block fuel and operating weight are calculated. Block fuel is fuel on board when the aircraft is still at the gate. Again to the right of this area the allowable taxi weight is calculated just as the allowable traffic load.
The main part of the sheet is taken by four tables. Here is specified which compartment how much cargo contains. Also the amount of passengers must be filled in. Multiple tables are used for a transfer flight.
At the bottom of the sheet the centre of gravity position must be filled in. At the right side of the sheet the zero fuel weight, take-off weight and landing weight are calculated.

1.7.2 NOTOC

Any special load in an aircraft must be notified to the captain, referring to the notification to Captain (NOTOC). The NOTOC is divided into two parts namely: Dangerous Goods and other special load of dangerous goods by air in passenger or cargo aircraft.

Notification of a special load should be given to the pilot in command of the aircraft carrying dangerous goods. This document includes all relevant information for each dangerous goods consignment on that particular flight. It is entirely up to the captain whether he accepts the special load. NOTOC is a record of who handled the dangerous goods and who is responsible for the proper handling and storage. The loader is responsible for loading the flight and he must report that the special load is safely loaded and the pilot must sign to say that he has recognized the treatment and placement is approved.

1.8 Flight plans

All of the information discussed before can result into a flight plan. There are several flight plans. The Operational flight plan (OFP) **(1.8.1)** and the air traffic service flight plan (AFP) **(1.8.2)** will be discussed. The OFP is presented to the pilot. It will give the pilot all of the information about his flight such as route which will be flown, en route weather and information about weight distribution of the aircraft. The AFP is presented to the air traffic controllers so that they will know where the aircraft is heading to and how the aircraft will look like.

1.8.1 Operational flight plan

An OFP can be divided into several parts. An OFP starts with an ATC clearance followed by some general information about the OFP **(1.8.1.a)**. Then a summary of the flight is given **(1.8.1.b)**. Thereafter all of the information about the fuel is given **(1.8.1.c)**. Next information is given about the safety measures taken **(1.8.1.d)**. Then the information is given which will have to be imported into the flight management system (FMS). Also the check of the altimeter is given **(1.8.1.e)**. What then follows is again some space for ATC clearance and the actual route given per waypoint **(1.8.1.f)**. The OFP is closed with the information about all the different alternates **(1.8.1.g)**.

1.8.1.a General information

The general information of the OFP starts with the possible pre departure ATC clearance, not in every case this part is filled in. After the pre departure ATC clearance the dispatch briefing follows. This part contains a lot of different information; as first the dispatcher, telephone number of the dispatcher and the dispatch communication centre. MEL or CDL items that are defect are also reported followed by the weather circumstances. These weather circumstances are written with standard aviation abbreviations. Also the basic ETOPS information can be found in this part.

1.8.1.b Summary

The summary starts with the OFP number which is set up around three different numbers divided by a forward slash. The first number is the calculation number, followed by the decision point and ETOPS. A 0 will mean that there is no decision point present, or ETOPS is inapplicable. If there is placed a 1, there is a decision point present at the route, or ETOPS is applicable.
This part continues with information about the aircraft, flight and route. The most left column contains the flight number and the date the flight is taking place. One column to the right contains the type of aircraft with the aircraft identification number. Information about the different times of the flights are available in the two columns to the left. Two numbers divided by the slash give the calculated off blocks time and the airborne time, for the destination these numbers give the calculated on blocks time and touchdown time.
The calculated take-off time (CTOT) and the scheduled time of arrival (STA), close the column.
Further the general information contains the Cost index (CI), ground distance (GND DIST), air distance (AIR DIST), average wind component (AVG W/C), average ISA deviation (AVG ISA) and the fuel flow factor (F-FACTOR). The average wind component is given in knots, and starts with a T or H, which stands for tail or headwind. The average ISA deviation, in degrees of Celsius, starts with an M or P, MINUS or PLUS.

Information about the different aircraft weights can be found in the last rows of columns.

1.8.1.c Fuel

The fuel part of the OFP contains the alternate fuel, final reserve fuel, extra fuel, planned TO fuel, taxi fuel, block fuel and finally tankering fuel. A special value is the CONT with two numbers. These numbers give the standard chance that there is enough fuel on board to land at the destination airport without problems. Standard are CONT99, CONT90, CONT 5% and CONT 3%. The last two will mean that there is no data available and that 5% or 3% of the trip fuel will be used for the contingency fuel. CONT MIN is the fuel calculated with a minimum of 5 percent. In the contingency summary the static cover in minutes is given for the holding fuel. Beside this all, there are all also different reasons given by the dispatcher for the addition of extra fuel. Reasons could be bad weather or inefficient planning from the ATC. The next part contains the estimated take-off weight (TOW), take-off fuel (TOF), trip fuel (TRIP) and the trip correction/1000kg. The real values of the TOW, TOF and TRIP are filled in at the second line including the extra fuel for the holding. As last the general information of the OFP will close with the name and signature of the captain.

1.8.1.d Safety measures taken

The extended range twin engine operation (ETOPS) is set up to permit twin engine aircraft to fly long distances and have an extended range to reach the alternate destination. The first line will start with the ETOPS Entry Point, indicated with the abbreviation EEP. Directly after the EEP the ETOPS En-route Alternate (ERA) is placed. The ERA is indicated in ICAO code together with the distance from the EEP to the first ERA and the coordinates of the EEP. Then the Estimated Elapsed time (EET) when passing the EEP is placed, beside this also a Critical Fuel scenario is written. The second line consists of the ERA and the planned runway. After required (REQ) follows the validity of the ERA. As last the ETOPS minima are showed.

1.8.1.e FMS and altimeter

The FMS need to be set prior to the flight. The OFP provides data which needs to be imported into the FMS. In the OFP are the departure and the arrival airport given in ICAO code. Both with their belonging elevation. Just like the alternate airport with his elevation. Also the flight number, company route, average true track, reserve fuel, average ISA temperature deviation, average wind, cruising altitude and cost index are given. The average wind is supplied with an H for headwind or a T for tailwind.

Also an altimeter check has to be done when the reduced vertical separation minimum (RVSM) is applicable.

1.8.1.f Navigation

First of all space is left to write down the ATC clearance for the MNPS area. Then the whole route is written down as can be seen in **Figure 1.12**.

```
WAYPNT   RTE-     TRK         M      ETO  /ATO            TP TMP WIND       EFOB
   AWY   MORA          DIS   GS      ETE  /TTE      FL
--------- --------- --------- --------- --------- --------- --------
SPIM33            272                ..../....  CLB          341/002   89.7
 DCT         62        0055          0011/0011

S12W078           031                ..../....  CLB       +0 209/007   86.4
 DCT         55        0050          0007/0018
```

Figure 1.12; route notation OFP

In the navigation part waypoints can be found. Every waypoint is written in two lines. First the name of the waypoint is given in ATS format. The first and last waypoints, the airports, are given including the runway. Then the magnetic track to the next waypoint is given excluding tracks above 73 north and below 60 south. Those last tracks are true tracks because the magnetic tracks differ too much. After that space is left to fill in the estimated and actual time overhead followed by the flight level. The flight level is deflated when it is equal to the previous one. Also CLB and DSC can be given at this space. Those abbreviations stand respectively for climb and descent. Then the height of the tropopause is given into thousand feet followed by the outside air temperature and the true wind direction and speed. The line is closed by the estimated fuel on board number.

The next line gives the airway, north Atlantic track, SID or STAR which is flying on. Then the minimum off route altitude, interval distance, Mach number or cruise speed, the estimated time elapsed between waypoints and the total time elapsed since take-off are given.
ATC clearances, top of climb notes (TOC), top of descent notes (TOD), top on step notes (TOS) and bottom of descent notes (BOD) are given between the lines when necessary.
At the end of the OFP coordinates of every waypoint are given which has to be imported in to the FMS.

1.8.1.g Alternates

After the navigation part the take-off and destination alternates are given if they are applicable. The en-route alternates are given including the minimum required fuel (the EFOB). The alternates are noted just as the waypoints. Also a summary is given of the alternates with the expected runway, ground distance, planned flight level, average wind component, flying time from destination to diversion, used fuel and a short description of the route.

1.8.2 ATS Flight Plan

The ICAO ATS Flight Plan is designed to inform the Air Traffic Services (ATS) about the flight. It provides specific information about the plane, route and people on board. In case of an emergency, the ICAO ATS Flight plan provides the emergency crews with vital information about the plane, passengers on board, safety equipment and radio's on board. The flight plan uses the layout described in ICAO doc 4444. A detailed look of the ICAO Flight Plan can be found in **Appendix XII**

1.9 Regulations

A flight brings a lot of regulations that must be met and be kept in mind. Different types of navigation equipment are needed for the position of the aircraft **(1.9.1)**. Secondly the work time of the crew is limited which will be explained in **(1.9.2).** Thirdly there is a specific load regulation **(1.9.3)** which tells how load is positioned in the aircraft and how I need to be transported. Further there is the flight preparation **(1.9.4)** which is needed to prepare your flight which will be further explained. Next the Planning minima **(1.9.5),** this will limit the aircraft in any performances as weather and landing visibility. There are also regulations when an aircraft with three or more engine are flying further than 90 minutes from an en-route alternate **(1.9.6)**. And as last regulation about decompression **(1.9.7)**.

1.9.1 MNPS

For some regions aircrafts needs specific navigation equipment to enter this kinds of regions. This is required to improve accuracy, integrity and continuity. ICAO establish regulations about the required navigation performance. Five devices has to be available on the aircraft that determines automatically the position of the aircraft:

1. VOR/DME
2. LORAN-C
3. INS
4. DME/DME
5. GNSS
6. ILS

Ad 1. *VOR/DME*

With VOR the direction of a radio beacon can be determined. It tells the pilot what course he has to fly. A DME definite the distance of the aircraft to the beacon.

Ad 2. *LORAN-C*

LORAN-C consists of multiple transmitting stations. One station is the master station, and mostly three others are the secondary stations. The position can be determined by comparing the difference between time of the master station and secondary stations. The position of the transmitting stations has to be known. The accuracy is between 40 meters to 400 meters.

Ad 3. *INS*

Inertial Navigation System (INS) is a navigation system that is not using radio signals or satellites. INS measures the position by sensing the acceleration with a gyro-stabilized platform. Before take-off the position of the aircraft has to be precisely entered in the system. Normally an aircraft has three INS, so the average position can be determined.

Ad 4. *DME/DME*

With a DME the distance of a beacon to the aircraft can be determined. Using DME/DME the position is provided with a minimum of two DMEs. This results in a more accurate position.

Ad 5. *GNSS*

With multiple satellites the position of an aircraft can be highly accurate determined and gives very reliable information.

Ad 6. *ILS*

With an Instrument Landing System (ILS), the pilot can approach the runway with a high accuracy. ILS is a radio beam transmitter that provides lateral and vertical signals. An ILS consist of a localiser for the lateral direction and a glide slope for the vertical direction. In paragraph 1.3.3.c a more detailed explanation can be found.

1.9.2 Work Rest Regulations

The Netherlands has to follow the rules of EU-OPS 1.1105. The schedule of a pilot exists of three periods: off duty, duty period and flight duty period.

During off duty the flight members are relieved of all duties. They are also relieved of their duty period, also known as standby period. In the off duty period the crew can recover form there fatigue. It has been established that in the off duty period an eight hour sleep opportunity has to be available. It is the responsibility of the flight members to recover in the off duty period.

The duty period of a pilot is not allowed to exceed 60 duty hours in seven days or 190 duty hours in 28 days. The maximum flight duty period during 24 hours, is 14 hours. In duty period, the flight member has to be ready for example administrative work, flight time and training.

The maximum flight duty period is 13 hours during 24 hours. When the flight duty period start between 02.00 and 06.00 and the flight is longer than two hours, the maximum flight duty period will reduce to 11 hours. When the flight ends between 02.00 and 06.00 and is longer than two hours, the maximum duty period will reduce with one hour.

1.9.3 Specific Load Regulations

Cargo will determine how the aircraft will operate, this depends on the Central of Gravity (CG), further information can be found in mass and balance **(1.9.3.a)**.

Specific load can be divided in the transportation of dangerous goods **(1.9.3.b)** or the transportation of live animals **(1.9.3.c)**.

1.9.3.a Mass and Balance

By taking various type of cargo that will come along on the flight, these have to be strap in on specific places around the central of gravity (CG). This is of great importance in how the aircraft will operate. The specific load regulation can be found in **Appendix XIV.** There are several regulations that should be kept in mind, these are as follows: mass and balance, fuel density, accuracy of weighing equipment, centre of gravity limits, and adjustment of standard masses.

1.9.3.b Transportation of Dangerous Goods

Regulations of Dangerous goods can be found in ICAO Annex 18, Technical Instructions for the Safe of Dangerous Goods by Air. Dangerous goods are divided in nine classes: explosives, gases, flammable liquids, flammable solids, oxidizing substances, toxic and infectious substances, radioactive material, corrosive substances and as last miscellaneous dangerous substances and articles. When dangerous goods will be taken on an aircraft, it has to be satisfying multiple conditions:

- packing conditions **(Appendix XIII)**
- markings **(Appendix XIII)**

1.9.3.c Transportation of Live Animals

The International Air Transport Association (IATA) makes the Live Animal Regulations (LAR). There are a lot of rule that has to be followed by transporting horses in an aircraft. The main rules are:

- The size of the container has to be the widest point of the animal and thereby added a minimum space of 15.2 cm (6 inches).
- The lower part of the container has to be provided with material that protects the animal against kicking. The material has to be 5 cm (2 inches) in thickness.
- The material of the whole container has to be made of a non-toxic material.
- Ventilation holes have to be at least on three sides of the container and have to be a size that it cannot injure the animal.

1.9.4 Flight preparation

Before you take off to your destination, there are several regulations which must be fulfilled.
In **Appendix XV** is the JAR-OPS 1.290 included which says, what requirements the aircraft must have. Besides the requirements also an OFP will be completed before every flight.

1.9.5 Planning minima

When the route to the destination is known, it is not possible to take off without having a back-up destination also known as alternate. In **Appendix XVI** are several regulations that fall under the regulation for planning minima that will be discussed.
These are:

1. JAR-OPS 1.297 Planning minima for IFR flights
2. JAR-OPS 1.340 Meteorological Conditions
3. JAR–OPS 1.350 Fuel and oil supply

Ad 1. *The planning minima for IFR flights*

A planning minima for a take-off alternate aerodrome depends on the weather reports or forecasts or any combination thereof indicate that, during a period commencing 1 hour before and ending 1 hour after the estimated time of arrival at the aerodrome, the weather conditions will be at or above the applicable landing minima specified in accordance with JAR-OPS 1.225.

Planning minima for a destination alternate aerodrome applies if the appropriate weather reports or forecasts, or any combination thereof, indicate that, during a period commencing one hour before and ending one hour after the estimated time of arrival at the aerodrome, the weather conditions will be at or above the applicable planning minima for RVR/visibility and for a non-precision approach or a circling approach, the ceiling at or above minimum decision height (MDH).

And a second destination alternate aerodrome will be selected if the weather report for the destination and alternate are under the applicable planning minima.

The planning minima is listed in **Table 1** in **Appendix XVI**.

Ad 2. *The meteorological conditions*

The meteorological conditions could put up a limit that should be at or higher than the planning minima which will allow the pilot to continue the IFR flight.

The TAF for our alternate PAFA is:

FT 281120 2812/2918 VRB03KT **P6SM** SHSN FEW030 BKN030 OVC060=

It has a visibility of P6SM which means a visibility of more than six statue miles, means enough visibility and will have no effect on the outcome.

Ad 3. *Fuel and oil supply*

A pilot will only continue when he is satisfied with the remaining fuel that is needed to fly to the planned destination, taking into account the expected operating conditions.

1.9.6 N-2

There are regulations when two engines are inoperative, this is the normal situation minus two engines (N-2). These regulations apply for aircraft with three or more engines. Normally an aircraft has to be at an airport in 90 minutes. Therefore, in the planning phase there has to be take into account the distance of an airport. This prevents a non-achievable landing. In **Appendix XVII** JAR-OPS 1.505 En-route – Aeroplanes with three or more engines, two engines inoperative is described when an aircraft can be further away than 90 minutes form an airport. The essential point are:

- With two engine inoperative, the flight is allowed to continue with clearings of all obstacles in 5nm either side of the track, by a vertical interval of at least 2000ft, to an aerodrome.
- With two engine inoperative, the performance has to be required to land with the expected mass.
- At the moment that two engines are assumed to fail, there must be sufficient fuel to fly to the aerodrome and to hold for 15 minutes at an altitude of at least 1500ft.
- If the navigation equipment does not meet at 95% containment level, the clearings at the track has to change from 5nm to 10nm on either side.

1.9.7 Decompression

When the pressure in the cabin will decrease through a failure, the oxygen level will decrease. This happens because on a high altitude there is a low density oxygen in the air. This results in that the passengers will be without enough oxygen. For the pilots it is necessary to decent to 10.000ft or lower. On this altitude the density of the oxygen in the air is enough to survive.

In the planning phase has to be take into account that on every moment the aircraft can descent to 10.000ft in 30 minutes. If it is not possible to fly to 10.000ft in 30 minutes, because the area has high mountains, the route has to be adjust. When the aircraft is on FL100, it has fly to an en-route alternate.

2 Flight planning

Flight AVI685 will take place and be navigated according to the guidelines on the basis of Chapter 1. The relevant airports will be described in **(2.1)**. There will also be an influence of the weather **(2.2)** on this flight. The aircraft will have some malfunctions **(2.3)** before the flight departs. After departure the flight follows the planned route **(2.4)**. For the following flight the fuel **(2.5)** must be calculated for the flight. The fuel can be indicated on the mass and balance sheet **(2.6)**. Finally all the data required for the flight and pilot is defined in the briefing package **(1.7)**.

2.1 Airports

In flight planning there is a departure airport **(2.1.1)** and a destination airport **(2.1.2)**. For emergency procedures during flight and safety there are alternates **(2.1.3)** en-route and on destination.

2.1.1 EHAM

The departure is from EHAM or Schiphol Airport. The airport has six runways that all lay below sea level as seen in **Figure 2.2**. AVI685 will take off from the Aalsmeerbaan (18L - 36R). The Aalsmeerbaan is 45 meters wide and 3.400 meters long. Of the six runways the following four runways are also an option for the departure of the Boeing 747 namely: the Buitenveldertbaan (09-27), the Kaagbaan (06-24), Zwanenburgbaan (18C - 36C) and the Polderbaan (18R - 36L). The NOTAM of EHAM is attached in **Appendix XVIIIA**.

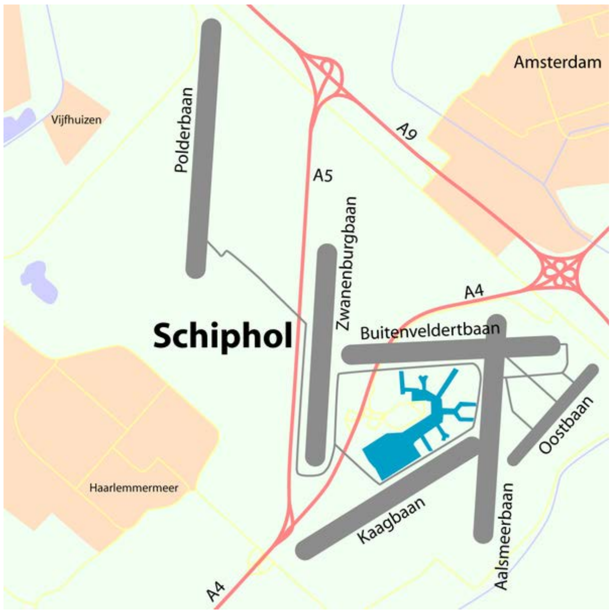

Figure 2.1; Schiphol Airport

2.1.2 PANC

PANC or Ted Stevens Anchorage International Airport is the destination airport. Seen from **Figure 2.2** PANC had three runways which are all suitable for the Boeing 747 to land: 7L/25R measuring 3,231 x 46 m, 7R/25L at 3,780 x 61 m and 15/33 at 3,531 x 46 m. The NOTAM of PANC is attached in **Appendix XVIIIB**.

2.1.3 Alternates

The alternates of the route EHAM-PANC are:

1. ENZV
2. BGSF
3. PAFA

Ad 1. *ENZV*

Stavanger Sola Airport is the en-route airport. The NOTAM of ENZV is attached in **Appendix XVIIIC**.

Ad 2. *BGSF*

Kangerslussuaq Airport is an en-route airport. The NOTAM of BGSF is attached in **Appendix XVIIID**.

Ad 3. *PAFA*

During flight when the destination airport is closed or not available there must be an alternate airport where the aircraft can land. The alternate for the flight to PANC is Fairbanks Airport or PAFA. This airport is also an en-route airport. The NOTAM of PAFA is attached in **Appendix XVIIIE**.

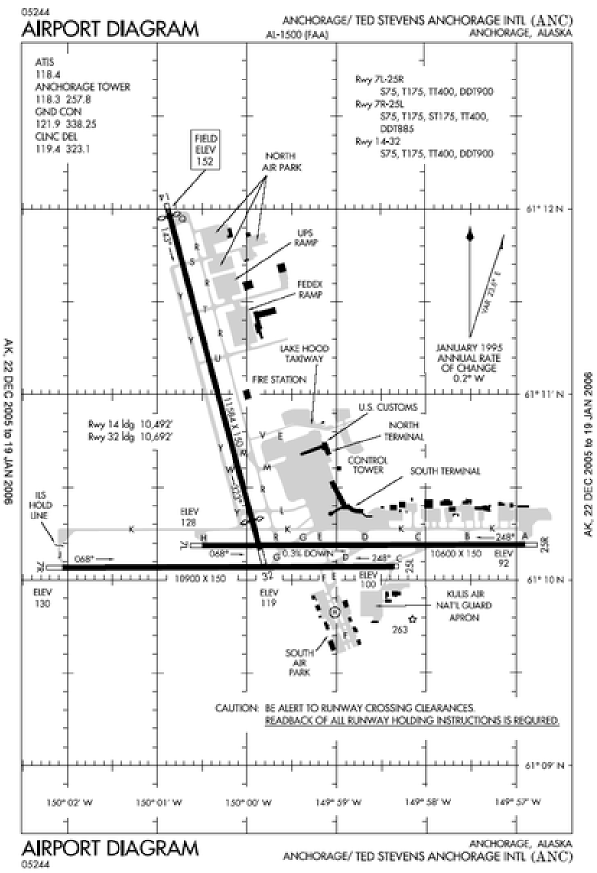

Figure 2.2; Ted Stevens Anchorage International Airport

2.2 Weather

It is critical for the efficiency and safety of the flight to consider the weather during all different flight phases, as well as on the alternate airfields. First the weather during departure from EHAM **(2.2.1)** is examined, followed by the en-route weather to determine the most efficient route **(2.2.2)** and the weather at PANC **(2.2.3)**. The weather at the alternate airfields has to be considered as well **(2.2.4).**

2.2.1 EHAM

The weather forecast for EHAM is as follows:

```
SA 281555 16014KT 9999 -RA FEW010 BKN029 BKN038 06/02 Q0994
NOSIG=
FT 281055 2812/2918 15017G27KT 9999 BKN017
TEMPO 2812/2820 7000 -RA FEW008 BKN013
PROB30 TEMPO 2813/2819 4000 RA BKN008
BECMG 2814/2817 14014KT
BECMG 2822/2901 11013KT CAVOK
BECMG 2908/2911 08016KT
PROB30 TEMPO 2908/2911 4000 BR BKN006=
```

At the planned take-off time of 17:30UTC, there is a southern wind of 14 knots with rain with visibility of 7 kilometres. From 800ft to 1000ft the clouds cover 1/8 to 2/8 of the sky, there are broken clouds at 1300ft, 2900ft and at 3800ft. There is a possibility that the visibility is temporarily decreased to 4000m.

2.2.2 Cruise

A weather chart of the northern hemisphere is shown in **Appendix XXIII.** The considerable en-route weather includes a turbulent area above Great Britain, which has been circled in red. Also a jet stream above Alaska, circled in blue, will be crossed.

2.2.3 PANC

The METAR and TAF for the destination:

```
PANC/ANC ANCHORAGE/TED STEVENS ANC INTL
SA 281453 17008KT 10SM SCT049 BKN060 OVC130 02/01 A2991=R88290395
FT 281541 2816/2918 VRB06KT P6SM SHSN SCT015 BKN020 BKN050
```

In short the weather forecast, the wind is variable, with a speed of 6 kts. There is light snowfall, and there are broken clouds at 2000ft and 5000ft. Visibility is more than 6 statute miles.

The runway state message is the last part of the METAR. For PANC is this ‘R88290395’. 88 means that it is valid for all the runways, 2 represent that the runway is wet or with water patches. The 9 stand for contamination level of 51% to 100% and 03 means the thickness in millimetre. The last two numbers represent that the breaking action is good .In these conditions the Boeing 747-400erf can land at PANC.

2.2.4 Alternate PAFA

The METAR and TAF for the alternate, airport Fairbanks.

```
PAFA/FAI FAIRBANKS INTL
SA 281453 00000KT 10SM BKN200 M02/M3 A2985=R70956594
FT 281120 2812/2918 VRB03KT P6SM SHSN FEW030 BKN030 OVC060=
```

In short, the wind is variable with a speed of 3 kts. Visibility is more than 6 statute miles. There is light snowfall. There are a few clouds at 3000ft, also broken clouds at 3000ft and overcast at 6000ft. ‘R70956594’ is the runway state message of PAFA. This is valid for runway 20R. On the run way are frozen ruts or ridges, with a contamination level of 26% to 50%. The thickness is 65 millimetre. The last two number represent the braking action, this is medium/good.

The frozen ruts or ridges do not make the runway contaminated according EASA. With a brake condition of medium/good, it is possible to land with one or two brake units inoperative.

If there is a problem at the destination airport, the route to the alternate has to comply also with the minimum weather conditions. During the flight to Fairbanks, the maximum altitude will be FL120. The weather conditions will be sufficient.

2.3 Malfunctions

Before commencing flight AVI-685, the aircraft will be prepared for flight. The aircraft has to be loaded with fuel, crew, passengers and cargo. Standard checklists have to be followed as well. When the crew works down the checklists they noticed a failure with the brake units **(2.3.1)**. A failure of this component will have consequences for the crew and for further operation of this flight. They need to check the MEL to see whether they are allowed to commence the flight with this component inoperative. During the flight there will be another malfunction with one engine **(2.3.2)**.

2.3.1 Brake Unit malfunction

While the aircraft is situated at Schiphol, the brakes are suffering a malfunction. This malfunction cannot be repaired. With a major brake failure, the aircraft will not be allowed to depart. But knowing that one or two brakes may be deactivated out of sixteen brake units **(Appendix XIX)**, departure of a B747-400 ERF is allowed with fourteen operational brake units. The repair interval for this malfunction is a category C. Which means that, items in this category (C) shall be rectified within ten consecutive calendar days following the day of discovery.

During the flight the brake malfunction has no further consequences. But during the take-off the v_1 speed will be reduced. Also during descend and landing the length of the runway, the runway condition and the weather conditions has to be taken into account. With missing two brake units, it will take longer to stop. This means that the runway length needs to be long enough in order to stop the aircraft on time, before the runway has ended. When the runway surface is wet the aircraft will need even more runway length to stop. In this case a manual performance calculation is needed, according to the MEL **(Appendix XXI)** full take-off thrust has to be used. The required runway length in WET weather conditions and with a landing weight of 296.200kg needs to be 3150m with 6kts tailwind. But because the wind is variable on Anchorage, with 6kts headwind the required runway length needs to be 2850m **(Appendix XXXII)**. But with a runway length of almost 3500m at Anchorage, which is not contaminated, this will be not a problem**.**

The V_1 in WET weather conditions with a MTOW of 412.775kg reaches 151kts. According to the MEL **(Appendix XXI)**, this V_1 needs to be corrected. Because the reversers are still operative, the new v_1 is 147kts for take-off.

2.3.2 Engine ignitor malfunction

The second malfunction is given on the EICAS; the message that is displayed is a failure of engine 2 ignitor 1. Information about this failure is given by the minimum equipment list number 74-00-01 **(Appendix XX)**. The list states that there are 8 ignitors installed where only 4 numbers are required for dispatch. This means that with the message of one ignitor is down, the aircraft will still be able to operate. Even though there are some remarks or exceptions which says that one system per engine may be inoperative but provide the nacelle anti-ice system on the associated engine operates normally, and ignition selector is positioned to ensure ignition to all engines. If these are working the aircraft is allowed for dispatch. The operations that needs to be taken to ensure all engines will be ignited is that the Auto Ignition Selector needs to be set on BOTH, this is a operational procedure (O) which is performed by the pilots.

The problem in general needs to be taken care of with a category C, which means ten calendar days after the problem discovery.

2.4 Route

The route from EHAM to PANC is chosen along waypoints, which lead the aircraft to its destination as fast as possible. The first section of the flight is the take-off **(2.4.1)** and climb of the aircraft from EHAM. The second part is the en-route flight or cruise **(2.4.2)**. And the final section contains the approach **(2.4.3)**.

2.4.1 Take-off

The take-off from EHAM will be from runway 18L, because of the wind angle of 160 degrees. Looking at the Standard Instrument Departure (SID) charts of runway 18L the route towards waypoints

PAMPUS and ANDIK is via EH024 **(Appendix XXII)**. So after take-off the flight turns east towards EH024 and then heading north towards PAMPUS and continuing the step climb towards ANDIK up to flight level 320. By climbing gradually towards FL320 the pilots can make the most economical use of the fuel.

2.4.2 En-route

The initial part of the cruise stage is along waypoints, which are located in the North Sea and the Atlantic Ocean. These waypoints are chosen to make the flight route as short as possible by planning the route as close to the great circle between EHAM and PANC as possible, but because of turbulence around Scotland the route changes from its original path to avoid this turbulence **(Appendix XXIII)**. After passing KONOM the flight will continue at FL320, until the flight reaches the random routing **(1.3.1.b)** part of the flight **(Appendix XXIV)** and start climbing towards FL340. This is because the aircraft burned fuel and is now light enough to execute a step climb towards FL340 in compliance with the optimum altitude chart **(Figure 2.3)**. The fuel usage will be more efficient because the aircrafts velocity can now increase, as has been explained in **1.2.2**.
From there the aircraft flies towards ROGSO, where it will pick up the official route again towards ROMDI. ROMDI will be passed at the maximum altitude of 36000ft, again to make the fuel consumption more efficient. Then it will continue towards ADREW, FORT YUKON and FAIRBANKS. From there it will start the approach towards PANC.

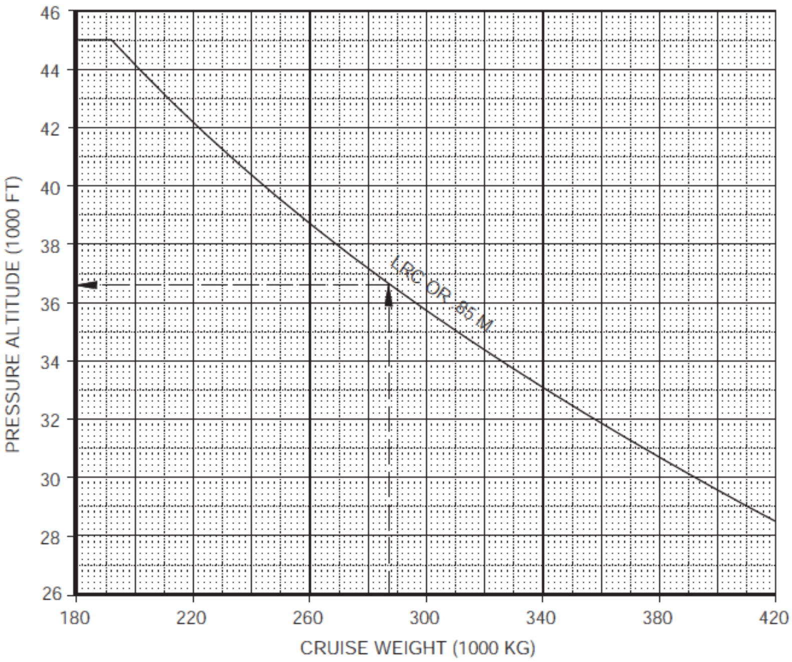

Figure 2.3; Optimum altitude

2.4.3 Approach

The flight crosses Canada and Alaska at FL360, after passing NENANA the descent begins by taking the standard approach route towards PANC **(Appendix XXV)**. After intersection the Air Traffic Controllers at PANC, the flight will be guided towards the runway. When the approach fails due to weather or other circumstances the flight will be diverted to Fairbanks Int. Airport (PAFA).

2.5 Fuel

The fuel part of the OFP **(2.5.1)** contains the different fuels and a contingency summary. In paragraph (1.6) is explained how these fuels are established. For the fuel calculations the fuel flows are necessary, these fuel flows are taken from the tables in the FPPM unless otherwise indicated. Because the difficulty of the en-route alternates, there is a supporting paragraph set up to make clear how the en-route alternates are chosen **(2.5.2)**.

2.5.1 Fuel calculations for the OFP

The calculations start by taking the distance between the waypoints and divide this by the ground speed of the aircraft, the flight time between the waypoints is calculated. Finally to get the fuel

which is needed, the time is multiplied by the fuel flow. Beside the fuel information, also some information about the destination alternate and the en-route alternates are given in the OFP, this information can be found in the large red box. Sometimes there is chosen to take extra fuel on a flight. The reasons for this extra fuel are showed at the lower side of the dashed line. **(Figure 2.4)**
The excel sheet with all the calculations can be found in **Appendix XXVI**, the excel sheet is also included on the CD, which comes with this report.

```
4.  TRIP        86886   0830              …            …
1.  CONT 3%     2606    0018              …            …
2.  ALTN        7400    0042      PAFA    …            …
3.  FINAL       4040    0030              …            …
7.  PLN TOF     101158  0953              …            …
    ALTN DIFF   …       …                 …            …
    PLN TOF     …       …                 CONT SUMMARY
    EXTRA       …       …                 CONT 3%
7.  TOF         101158  …                 ENRT ALTN    ENZV
5.  TAXI        225     …                              BGSF
6.  BLOCK       101383  …
    --------------------------------------------------------------------
         REASON EXTRA FUEL
       o ECN-ECONOMICAL          o OPN TEMPORARILY       o ATC-AIR TRAFFIC
                                                           CNTRL
       o FOB-FUEL ON BOARD       o MSC-MISCELLANEOUS     o FPC-FLIGHT PLN
                                                           CORR
       o WXX-WEATHER             o DEV-TECHNICAL      ACT.CI/CRZ USED: ...
```

Figure 2.4; Fuel

1. Contingency fuel
2. Alternate fuel
3. Final reserve fuel
4. Trip fuel
5. Plane take-off fuel
6. Taxi fuel
7. Block fuel
8. Contingency summary

Ad 1. *Contingency fuel*
The contingency fuel is in standard situation minimal 5 percent of the trip fuel, in some situations exceptions can be made. In this case, the contingency fuel can be 3 percent. This is allowed because the chosen en-route alternate falls in the radius EU OPS 1.225 is given (1.6). Theoretically there is an infinite loop between the contingency and the trip fuel, when trip fuel increased, the contingency fuel increases too. This affects the trip fuel and the loop will start again. After calculating the loop for three times the value approaches a constant. The contingency fuel for this flight will be 2606kg.

Ad 2. *Alternate fuel*
Alternate fuel is the fuel that is needed to fly from the destination airport to the destination alternate. The destination alternate is Fairbanks (PAFA). After selecting the right fuel flow from the tables in the FPPM and calculating the time, a total amount of 7400kg of fuel is needed to reach PAFA from PANC.

Ad 3. *Final reserve fuel*
The final reserve fuel is the amount of fuel required to fly a holding of 30 minutes at an altitude of 1500 feet above airport elevation. With a fuel flow of almost 8100 kg/hr at this very low altitude, 4040kg of fuel is needed to meet the regulations.

Ad 4. *Trip fuel*

For the trip fuel the wind plays a large role in the fuel consumption of an aircraft. The first step is to determine the top of climb (TOC) the step climbs and the top of decent (TOD), the tables used for the TOC and step climbs are the en-route climb tables. For the TOD the decent tables are used which also came from the FPPM. This is simply because the fuel flow is different in the climb, cruise and decent. Besides the flying altitude, the wind plays a large role in the fuel consumption of an aircraft. For each waypoint the wind speed is determined with the upper wind & temperature charts. Now the wind speed is known, the groundspeed can be calculated, which is needed for calculating the time between the waypoints. Now the altitudes with the true airspeed, the wind vectors and the fuel flow at each waypoint are known, the fuel needed for each track between the waypoints can be calculated, what will result in the Estimated Fuel On-Board (EFOB) for each waypoint. When sum all different tracks, the climb and the decent, the total trip fuel is 86886kg.

Ad 5. *Taxi fuel*

Taxi fuel is difficult to determine but an estimation could be made. The assumption is that the aircraft taxi for 20 minutes. When multiplying the time with the fuel flow of 45kg/min, this results in a taxi fuel of 900kg.

Ad 6. *Block fuel*

Block fuel is the total amount of fuel that the tanks contain before starting the engines. A summation of all fuels can be made and this will result in 101.833kg.

Ad 7. *Plane take-off fuel*

The plane take-off fuel speaks for itself, the fuel the aircraft should have on-board seconds before take-off. This fuel can be simply calculated by taking the block fuel minus the taxi fuel. The taxi fuel is indeed the only fuel that is used before take-off. 101.833-900 makes 100.933kg for the take-off fuel.

Ad 8. *Contingency summary*

This small summary shows in one glance the basic contingency information such as the percentage of the contingency fuel (3%) for which two en-route alternates are required.

2.5.2 Enroute alternates

For emergency situations en-route alternates have to be within the fuel range of the planned route. If there is no alternate airfield within range at any point of the route, more fuel has to be carried to ensure an airfield can be reached. The emergency situations that have to be accounted for are:

1. Decompression
2. Two engines inoperative

Ad 1. *Decompression*

There must be enough fuel on board to ensure that an adequate airport can be reached at an altitude of 10.000ft in case of a cabin decompression. The Decompression Diversion Planning chart **(Appendix XXVII)** is checked to ensure there is enough fuel on board. One of the critical en-route points, where the flight is far away from many adequate airfields, is at the second random routing point BARRY, but the amount of fuel on board at this point exceeds the limits of the chart. The nearest airfield Stavenger Sola (ENZV) can be reached and is set as an en-route alternate.

The most critical point where there is less fuel on board and the distance to an alternate airfield is the greatest is near the beacon ROKMA. With an estimated amount of fuel on board of 37450kg, the estimated range after decompression is 1300nm. Kangerlussuaq airport (BGSF) is roughly 1190nm away from this beacon, and is thus the second en-route alternate. As the aircraft passes ROKMA, the distance to Kangerlussuaq airport will increase but Anchorage is not yet within the range of 1300nm. Therefore Fairbanks is the third en-route alternate.

Ad 2. *Two engines inoperative*

If the distance between the planned route and an alternate airfield exceeds a flight time of 90 minutes, it is required by law to check whether there is enough fuel on board to reach an adequate airport with two engines inoperative. The range that the aircraft is able to fly with two engines inoperative can be determined using the Driftdown/Cruise Fuel and Time table, after consulting the Ground to Airmiles Conversion table for the relevant wind conditions **(Appendix XXVIII)**. At the critical point near ROKMA, the aircraft still carries enough fuel to fly roughly 1500nm, which is plenty to reach Kangerlussuaq airport. Thus, no extra fuel will be carried for these emergency situations.

2.6 Mass & Balance

It goes without saying that the aircraft will transport some load. Flight AVI-685 is a full cargo flight thus the main load will be cargo. The load that is going to be transported is specified in the notoc for this flight **(2.6.1)**. This load must be spread gradually so that none of the limitations of the aircraft are exceeded **(2.6.2)**. An extra check on those limitations is made when filling in a load sheet. Here the different kind of MAC values are also described **(2.6.3)**.

2.6.1 NOTOC flight AVI-685

A part of the NOTOC of flight AVI-685 is given as **Figure 2.6**.

SPECIAL LOAD NOTIFICATION TO CAPTAIN

FROM	FLIGHT	DATE
AMS	AVI 685	28 JAN

**** DANGEROUS GOODS****

TO	AWB NR	CL/DV COMP	UN/ID NR	SUB RSK	PCS	QTY/TI	RRR CAT	PCK GRP	DRIL IMP	CAO	POS ULD CODE
		1. MISC. DANGEROUS GOODS#AIR BAG MODULES									
ANC		9	UN 3268		1	0.62 KG		III	9L RMD		12P

Figure 2.6; Part of the NOTOC of flight AVI-685

TOTAL WEIGHT PASS+CAB. BAG	392
TOTAL WEIGHT BAGGAGE CARGO-MAIL +	100624
TOTAL TRAFFIC LOAD =	101016
CORRECTED DOW +	159190
ZERO FUEL WEIGHT =	260206
TAKE-OFF FUEL +	100933
TAKE-OFF WEIGHT =	361139
TRIP FUEL -	86887
LANDING WEIGHT =	274252

Figure 2.5; Part of the load sheet

As can be seen from the figure **(Figure 2.6)**, one piece of air bag modules with a weight of 0,62 kilograms has to be transported to PANC. These air bag modules have already been assigned a position, namely 12P. This is the indication for one of the cargo compartment of the aircraft. The whole NOTOC of flight AVI-685 is given in **Appendix XXIX**.

2.6.2 The loading of the aircraft

For this flight the total load in kilograms is given **(Figure 2.7)**. All of the cargo compartments are given at the check sheet. Also the maximum load per compartment or compartment couple is given. First the load of the NOTOC, which already have been assigned a position, is filled in on the check sheet. Now can been seen in which compartment is still space for load without overloading the aircraft.

With the aid of the balance chart can be determined whether the centre of gravity is within the maximum zero fuel-, take-off- and lading envelope. The balance chart states that if the maximum zero fuel MAC percentage is between 26 and 29, fuel will be saved. The remainder of the load will be divided over the cargo compartments so that the maximum zero fuel MAC percentage will be between 26 and 29 and so that the center of gravity is between all of the envelopes. The result is shown in **Appendix XXX**.

CARGO	77240
MAIL	750
AOG	7830
LIVE ANIMALS / HORSES	14804

Figure 2.7; Total load flight AVI-685

2.6.3 Load sheet flight AVI-685

Now the load is divided over the cargo compartments, the load sheet can be made **(Appendix XXXI)**. In the upper left corner some basic information is given such as the flight number and the aircraft registration number; which is PH-CKC.

Next to this block the reference dry operating weight given, which is 159.190 kilograms, and the dry operating index; 97.7. There is no need for a correction with regard to pantry thus the reference DOW is the corrected DOW. The sum of this DOW and the block fuel, which is calculated in **2.5**, is the operating weight.

Below this block is again the load distribution given with it destination. Also the amount of passengers is given. Since flight-685 is a cargo flight, the only passengers who will attend this flight are the attendants of the horses. On this flight there will be four attendants. At the left of the check sheet, **Figure 2.5** can be found. First the total weight of the passengers including baggage is filled in. Regulations state that one male adult has a weight of 98 kilograms including baggage thus the four attendants have a weight of 392 kilograms. The sum of the weight of the passengers and the total weight of the load gives the total traffic load. The sum of the total traffic load and the DOW gives the zero fuel weight of the aircraft. The zero fuel weight plus the take-of fuel **(2.5)** gives the take-off weight. When the trip fuel is taken of the take-off weight, the landing weight is found. At the upper right corner of the check sheet, **Figure 2.8** can be found. Here the maximum taxi weight, take-off weight, landing weight and zero fuel weight for the Boeing 747-400ERF are given. Then with all of the maximum weights the taxi weights will be calculated. Thus the calculated taxi fuel is added to the take-off weight, the calculated taxi fuel and trip fuel are added to the landing weight and the calculated block fuel is added to the maximum zero fuel weight. The allowable taxi weight is the lowest of the four numbers. The allowable taxi weight minus the operating weight gives the allowable traffic load. The allowable traffic load minus the calculated total traffic load gives the underload before last minute changes. This is the amount space in terms of cargo or passengers which is not loaded on the aircraft. At the bottom of the load sheet the different kinds of MAC values are given.

	TAXI	TAKE-OFF	LANDING	ZERO FUEL
MAXIMUM WEIGHT FOR =	414100	412800	296200	277200
FUEL +		TAXI 900	TAXI 900 TRIP 86887	BLOCK 101833
ALLOWABLE TAXI WEIGHT LOWEST OF a, b, c, d =	a.	b.	c.	d. 379033
OPERATING WT -				261023
ALLOWABLE TRAFFIC LOAD =				118010
TOTAL TRAFFIC LOAD -				101016
UNDERLOAD BEFORE LMC =				16994

Figure 2.8; Underload before LMC

2.7 Briefing Package

Now the information is gained for the route, fuel and alternates, an original and official operational flight plan **(2.7.1)** and an ATS flight plan **(0)** can be created.

2.7.1 Operational flight plan

On the 26th of January 2014 a Boeing 747-400erf will go from Schiphol (EHAM) to Ted Stevens Anchorage INTL (PANC). This flight is scheduled to leave at 17:30 local time from EHAM and will arrive at 16:52 local time at PANC, a total flight time of 08:22 hours. The ground distance is 3992nm, with an average speed of 450kts or a Mach speed of 0.85. The flight has as purpose to transport an

engine for a Boeing 777-200, 14 horses and an air bag module, which is covered by transport of dangerous goods as the regulations explain in **1.9.3.b**. Also some cargo has to be received at PANC.
The aircraft has two malfunctions: one or two brakes are deactivated and the ignition system from engine two is inoperative, but the flight can continue without delay.
The route is planned along the great circle, because the great circle is the shortest distance between two points on the earth. At Scotland the route has changed to avoid turbulence.
The en-route alternates are Stavanger Sola (ENZV), Kangerlussuaq (BGSF) and Fairbanks INTL (PAFA). Also the destination alternate is PAFA. The complete OFP can be found in the supplied briefing package.

2.7.2 ATS flight plan

The ATS flight plan is one sheet. The information on this sheet is the aircraft identification, cruising speed, flight level, all route waypoints, departure time and estimated flight time. The complete ATS flight plan can be found in the supplied briefing package.

3 OCC Failure Analyses

During the flight, OCC receives an SIGMET that the volcano Mt Spurr is erupting. This eruption has consequences for the flight AV-685 EHAM-PANC **(3.1)**. These effects and the actions have to be performed in accordance with the operating procedures **(3.2)**. After informing the crew and the Senior Operations Controller an inflight re-planning must made. There are selection criteria drafted for the possible solutions **(3.3)**. The best ranked possible solution is been named as the best solution. So diverting to the best solution must be debriefed **(3.4)** to the OCC and the Flight crew.

3.1 Flight AVI685 EHAM-PANC

The briefing package for Flight AVI685 has been finalized and published. The flight crew has accepted it. After the planning phase, the operational phase starts so flight AVI685 departs from Amsterdam. While in flight, on 21.00 UTC the OCC receives a SIGMET with an ALERT, which states that Mt Spurr **(3.1.1)** is suddenly erupting. This will have consequences for the flight **(3.1.2)**, crew and payload **(3.1.3)** so an inflight re-planning must be made.

3.1.1 Mt Spurr

The volcano Mt Spurr highlighted in **Figure 3.1** is erupting. The height of the volcano Mt Spurr is 3374 m or 11,070 ft. and the inlet is on 61.3°N / 152.25°W. Seen from **Figure 3.2** the destination airport PANC is covered by the ash cloud on the arrival time. So the dispatcher on OCC and the pilots needs to do an inflight re-planning to an alternate location where the crew and goods can be unloaded. In **Figure 3.3** is seen that the ash cloud will cover more but the volcano suddenly stops erupting, seen at 03.00 UTC. So at that time the ash cloud only getting smaller.

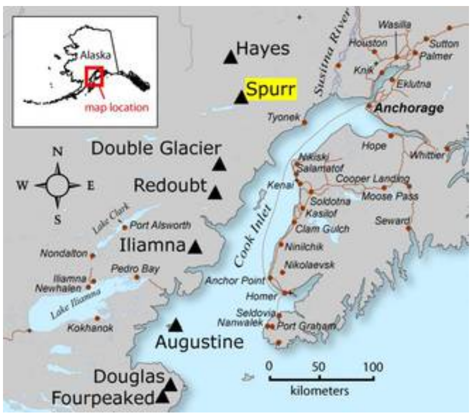

Figure 3.1; Mt Spurr

Seen that Mt Spurr has stopped erupting it can be calculated when the destination airport PANC will be available. According to the SIGMET alert message the ash clouds moves east with 20 kts. With the plume path plots can be determined that between 21:00 UTC and 00:00 UTC the ash cloud has already moved 60 nm away from the volcano and that the cloud still has to move 240 nm before aircrafts can land on PANC. When this scenario continues PANC will be operating again from 12:00 UTC.

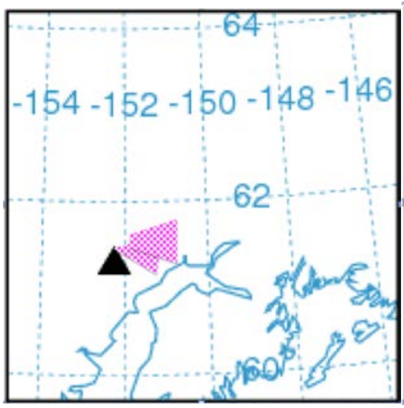

Figure 3.2; Ash Cloud 0.00 GMT

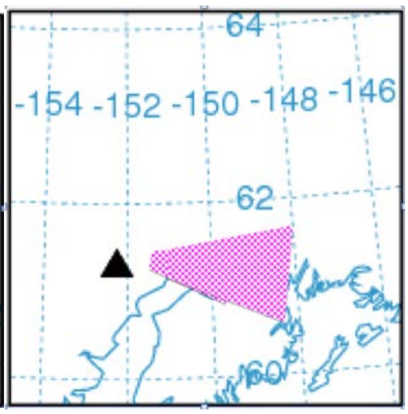

Figure 3.3; Ash Cloud 3.00 GMT

3.1.2 Flight

The flight was departing at 18.30, local time, which is 17.30 UTC. The flight duration is 8.22 hours and flight AV685 has already been 3.30 hours enroute when the Mt Spurr erupts. The expected arrival time of the flight is 01.52 UTC. On that time PANC is still covered in the ash cloud, this means that the crew and OCC has to make a choice of the flight is going to his alternate, diverting to another airport of is returning to EHAM.

3.1.3 Crew and Payload

There are some financial implications relating to the flight crew and the payload. The crew has been flying almost for 4 hours and on PANC airport there is another crew waiting for the return flight. The current crew should consider the Work Rest Regulations. Furthermore there is on PANC a payload waiting for the return flight. Because of the possible delay the current payload cannot be delivered on time and the return payload cannot depart on time from PANC the OCC needs to find a solution so the payload can arrive at their destination as quickly as possible, otherwise the financial cost of this will only increase.

3.2 Operational Procedures

When Mt Spurr erupts, the SIGMET alert is printed by the dispatcher at the Operational Control Centre (OCC). Before any course of action is taken, the dispatcher must inform the flight crew **(3.2.1)** and the Senior Operations Controller **(3.2.2)**.

3.2.1 Inform the Flight crew

To inform the flight crew of the eruption of Mt. Spurr, the dispatcher must send the SIGMET alert to the aircraft. This is done by the Aircraft Communications Addressing and Reporting System (ACARS). The ACARS data and voice modes provide automatic and manual means to transmit and receive operational, maintenance and administrative information between aircraft and a ground station. When the dispatcher reports and uploads the SIGMET alert to the aircraft, the ACARS printer will print the SIGMET for the pilots to read.

3.2.2 Inform the senior operations controller

When the dispatcher receives the SIGMET alert of the volcanic eruption, he also has to inform the Senior Operations Controller. The Senior Operations Controller is in charge of all the intercontinental flights. At the OCC, a face-to-face interaction among employees improves the ability to respond to contingencies and disruptions. So when the dispatcher receives the SIGMET alert, the Senior Operations Controller is right on the spot to look at the alert and to decide what actions to take following the volcanic eruption.

3.3 Possible Solutions

Before comparing three solutions, an explanation will be described about which selection the comparison will be based on **(3.3.1)**. The first solution is to divert to the departure airport EHAM **(3.3.2)**. The second solution is diverting to the alternate indicated in the briefing package. PAFA is the nearest located airport from the destination **(3.3.3)**. The last solution will be the diversion to Vancouver **(3.3.4)**.

3.3.1 Selection Criteria

In order to determine what the best solution is, the priorities for the solution have to be considered. A points system will be used to compare all solutions; the solution with the highest amount of points is the best solution. The solution will be chosen based on the following criteria:

1. efficiency
2. costs
3. consequences customers
4. consequences crew

Ad 1. *Efficiency*

It is the least efficient to have the aircraft divert to an airfield that lies further from Anchorage, because there is cargo at Anchorage that has to be retrieved. All extra required fuel, as well as all the extra time until the arrival at Anchorage decreases the efficiency. The lowest delay is most preferable, and will thus receive the highest amount of points. The points given for the increasing amount of hours delay is shown in **Table 3.1**; Points distribution for arrival delay.

Amount of delay	points
0 – 4 hours	5
4 – 6 hours	4
6 – 8 hours	3
8 – 10 hours	2
10 – 12 hours	1
12 or more hours	0

Table 3.1; Points distribution for arrival delay

Ad 2. *Costs*

The solution cannot be too expensive. The costs consist of all extra required fuel for a detour, as well as any required cargo handling and all the airport fees. The points given for the extra amount of money that needs to be spent is shown in **Table 3.2**.

Amount of costs (€)	points
0 – 20.000	5
20.000 – 40.000	4
40.000 – 60.000	3
60.000 – 80.000	2
80.000 – 100.000	1
>100.000	0

Table 3.2: Points distribution to expenses

Ad 3. *Consequences customers*

Every possible solution will cause a delay in the arrival of the cargo. The costumer prefers the fastest delivery. The arrival delay is already included in the efficiency, therefore this will not be included in the total points equation. The customers are paying for a good service for their horses. The points will be based on the well-being of the horses. Transportation by the road is very stressful for the horses and takes a long time. Transportation by the air is more comfortable and is faster **(Table 3.4)**.

Type of transportation	points
By air	2
By road	1

Table 3.3; Point distribution to transportation

Ad 4. *Consequences crew*

The crew has a limitation for the amount of hours they are allowed to work. It is not allowed to exceed the maximum amount of hours as specified in **1.9.2**. The total amount of hours the crew has to operate in total and the rest time they are granted affects the workload **(Table 3.4)**.

workload crew	points
Light	3
Medium	2
Heavy	1

Table 3.4: points distribution for the workload.

As some of these points are more important to consider than others, the solution will be chosen using the weighting factors shown in **Table 3.5**. As an airline, the option with the lowest financial effects has the highest priority. Efficiency has the second highest priority, as this is beneficial to the costumer and environment. The consequences for the customers have the same priority as efficiency; the service for them has to be reliable. The consequences for the crew are included since this affects the working morale, but does not have a high priority.

Factor	1	2	3
Efficiency		X	
Costs			X
Consequences customers		X	
Consequences crew	X		

Table 3.5: weighting factors

3.3.2 Divert to Amsterdam Schiphol airport

The first option after getting informed by the dispatcher about the suddenly erupting volcano is divert and return to home base EHAM **(3.3.2.a)**. This will give further consequence for the rest of the flight for amongst others delivering the freight **(3.3.2.b)**. Then a conclusion of this option can be made **(3.3.2.c)**.

3.3.2.a Schiphol Airport

EHAM is the biggest airport of The Netherlands. This is the airport where the aircraft intentionally was left from. After interpret the information about the eruption, understood is that the ash cloud will be at the destination airport at point of arrival. Therefore the airspace will be closed at PANC which means that landing is not an option. Therefore, when choosing this option, the pilots have to request ATC for a turn around to eventually land at Schiphol airport. OCC needs also to figure out whether it is possible given the amount of **fuel** on board. They need to check whether the aircraft did not pass the point of no return (PNR).

- *Fuell*

After the message that is given out three and half hour later of departure. The fuel needs to be calculated and determined with aid of a graph in the document FPPM, to see if it is possible to execute this plan. In our determined flight is the latest point Barry which is 3:24h away from EHAM. The difference between the point Barry and the point where the message is received is six minutes. the groundspeed at this point is 505kts so the distance can be calculated. This is 50.5nm.
The fuel that is needed for this distance is:

$$(2700 * 4) * \frac{50.5}{505} = 1080kg\ fuel$$

Where, 2700 is the fuel flow kilogram per hour per engine, 50.5nm the distance, and 505kts the groundspeed.

The total fuel for the outward flight is 101833-65358.3=36474.2kg fuel
36474.2+1080=37554.2kg fuel

Now the fuel needs to be determined for the homeward flight, with the aid of the graph in the document of FPPM.
Reading of, the value is about 37000kg fuel. Thus the total of 73474.2kg fuel is needed. This is far within the accepted limits.

The possibility to return to EHAM is confirmed.

3.3.2.b Consequences diverting to Schiphol Airport

PANC is closed due to volcano activity. This will lead to consequences which need to be solved.
Consequences such as:

1. coming costs in order to execute this plan,
2. the consequence for the crew this has to do with the work and;
3. rest time regulation and the consequences of for the customers.

Ad 1. *Costs*

There are different kind of costs which are displayed in **Table 3.6; Costs of Diverting to EHAM**.

Cost	Value	Extra information

Landing fee EHAM	€996.74	For aircraft weighing more than 20,000 kg, the charge is €2.41per 1,000 kg (or part thereof)
Parking fee EHAM	€677.54	€1.20 per 1,000 kilograms of weight (MTOW)
Landing fee PANC	€834.13	€2.02 per 1000 pounds
Aircraft on ground	€29,092.25,-	Nine and a half hour AOG €3,062.34 per hour
Rent horseboxes and other supplies for the horses	€1,020.78,-	€72.91,- per horse
Costs high loader	€400,-	€200,- hour/call
Rent rest room pilots	€109.37,-	Two rooms. Most are between €47.39 and €72.91 per night.
Fuel costs	€58,779.36	€0.80 per kilograms
Total costs	€91,900.17	

Table 3.6; Costs of Diverting to EHAM

Ad 2. *Consequences for the crew*

The sigmet alert message is given three and a half hour after departure, which means a total of seven hours flying to get back to EHAM (in this case the wind does not make a big of a difference). Add up the one hour and 45 minutes signing in and out duration of the pilots and the flight duty time will be eight hours and 45 minutes.

Arrival at Schiphol airport will be 17:30+9:00= 02:30 UTC the next morning (sign out, fifteen minutes, time takes place after arrival).

The flight endurance to PANC is estimated eight hours and 22 minutes with 1:45h sign in time and fifteen minutes sign out time makes ten hours and twenty-two minutes duty time necessary to reach PANC

According to the table in **Figure 3.4** the rest that is needed to be able to complete this coming flight to PANC is nine and a half hour.

Tabel bij Ops.1.1110 - 2 Verkorte rust

FDP voorafgaande aan bekorte rust	Aanmelden na bekorte rust vanaf - tot	7:30	7:45	8:00	8:15	8:30	8:45	9:00	9:15	9:30	9:45	10:00	10
00:00 - 05:59	06:00 - 13:00	7:30	8:30	9:30	10:30	11:30	12:30	13:00	13:00	13:00	13:00		
	05:00 - 06:00 13:00 - 15:00	6:30	7:30	8:30	9:30	10:30	11:30	12:00	12:00	12:00	12:00		
	15:00 - 05:00	5:30	6:30	7:30	8:30	9:30	10:30	11:00	11:00	11:00	11:00		
06:00 - 06:59	06:00 - 13:00	6:30	7:30	8:30	9:30	10:30	11:30	12:30	13:00	13:00	13:00		
	05:00 - 06:00 13:00 - 15:00	5:30	6:30	7:30	8:30	9:30	10:30	11:30	12:00	12:00	12:00		
	15:00 - 05:00	4:30	5:30	6:30	7:30	8:30	9:30	10:30	11:00	11:00	11:00		
07:00 - 07:59	06:00 - 13:00	5:30	6:30	7:30	8:30	9:30	10:30	11:30	12:30	13:00	13:00		
	05:00 - 06:00 13:00 - 15:00	4:30	5:30	6:30	7:30	8:30	9:30	10:30	11:30	12:00	12:00		
	15:00 - 05:00	3:30	4:30	5:30	6:30	7:30	8:30	9:30	10:30	11:00	11:00		
08:00 - 08:59	06:00 - 13:00	4:30	5:30	6:30	7:30	8:30	9:30	10:30	11:30	12:30	13:00		
	05:00 - 06:00 13:00 - 15:00	3:30	4:30	5:30	6:30	7:30	8:30	9:30	10:30	11:30	12:00		
	15:00 - 05:00	2:30	3:30	4:30	5:30	6:30	7:30	8:30	9:30	10:30	11:00		

Figure 3.4; Reduced rest times

The arrival time at PANC will be:
02:30 UTC arrival time at EHAM
09:30 rest time
01:45 sign in time
08:22 trip time
<u>00:15 sign out time +</u>
22:22 UTC arrival time at PANC

The time zone for Alaska is -8h so ETA at Anchorage international airport is 14:22 in the afternoon. During the rest time period the ash cloud has passed PANC, so it is possible to land after a direct flight from EHAM.

Ad 3. *Consequences for the customers*
The ash cloud disappears from the airport at 12:00UTC this means if the crew arrives at 12:37ETA which is 21:37 UTC they are able to land. Thus the horses and the GE90 engine after a delay of 21:37-1:52=19:45h. At the end the return freight will be loaded into the aircraft and returns with the crew which is sited in the Marriot hotel.

3.3.2.c Conclusion option Schiphol Airport

The option of going back to Schiphol airport is possible due to the fact that there is enough fuel. The total cost for this option is €91,900.17. The delay of the aircraft is 19:45h which is due to an eruption which is beyond the companies force majeure.

3.3.3 Divert to Fairbanks

Another option that is investigated is to divert to Fairbanks (PAFA) **(3.3.3.a)**. First the impact of the decision to divert to this airport has to be examined **(3.3.3.b)**. Afterwards this option will be evaluated **(3.3.3.c)**.

3.3.3.a Fairbanks

PAFA is a major airport which is situated in the center of Alaska and in northern direction of PANC **(Figure 3.5)**. The table below **(Table 3.7)** describes the operating information of PAFA.

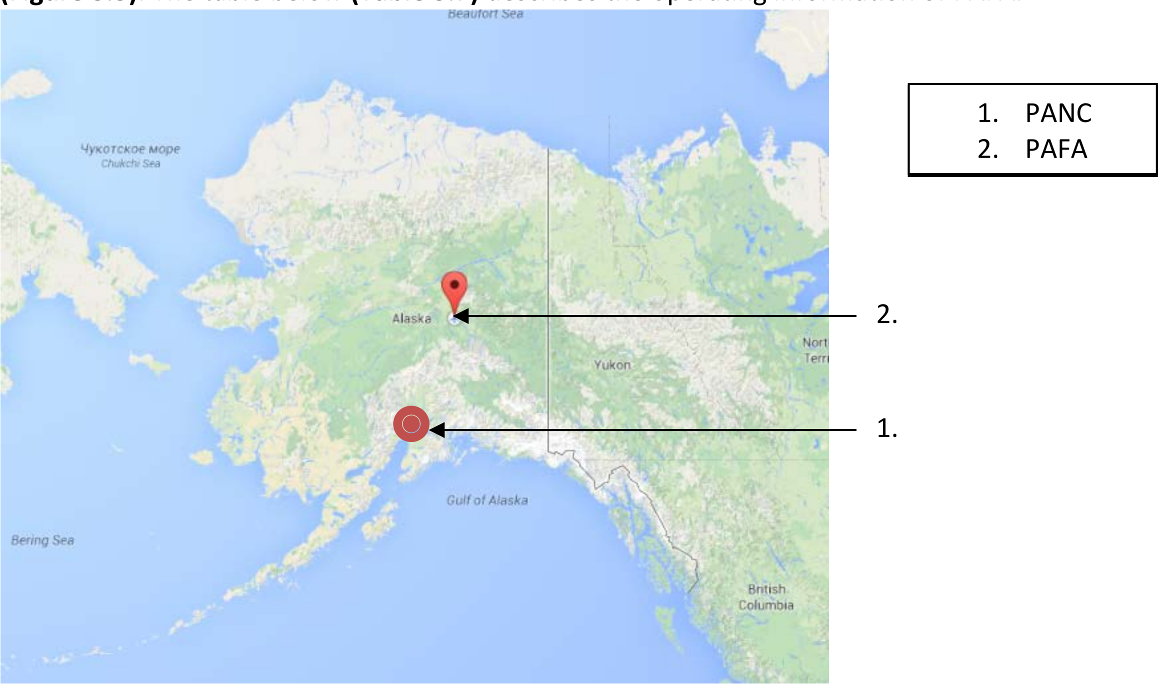

Figure 3.5; Places of PANC and PAFA

PAFA	
Opening hours	24 hours a day
Elevation	439 ft

Fire and rescue	ARFF index C
Fuel types available	100LL, JET-A1
Parking	Hangars
Airframe service	MAJOR
Powerplant Service	MAJOR
Bottled oxygen	NONE
Bulk oxygen	HIGH/LOW

Table 3.7; Operating information of PAFA

In order to fly the most efficient route to PAFA, the aircraft can maintain the planned route to PANC. It is necessary to calculate the remaining fuel onboard. When flying the current route, the aircraft will land at runway 20 R with EFOB 28607 kg. The final reserve fuel, which is the minimum fuel that has to be on board, is 4040 kg. The information about runway 20 R is given in **Table 3.8**. According to the METAR and TAF, there will be light snowfall with a wind speed of 3 kts, which varies in direction. According to the landing chart of the Boeing 747-400 ERF with a landing weight of 288909 kg and flaps 30, with one or two deactivated brakes and on a wet surface, needs a runway of 2600m **(Appendix XXXII)**. The ruts and ridges do not make the runway contaminated so there is no problem with landing on runway 20R, even with one or two brakes deactivated.

Runway 20 L	
Runway	2L/20R
Dimensions	11800 x 150 ft. / 3597 x 46 m
Instrument approach	ILS/DME
Visual slope indicator	4-light PAPI on left (3.00 degrees glide path)
Weight bearing capacity	PCN 78 /F/A/W/T

Table 3.8; Runway 20 L information

3.3.3.b Issues Fairbanks airport

Fairbanks is located only 420 kilometers to the north of Anchorage, which means a flight time of 30 minutes when flying at short trip cruise altitude. The Boeing 747-400 ERF with the GE-90 should wait at Fairbanks until the ash cloud is blown away. It is possible for the horses and the rest of the cargo to be transported on the road. However, the long distance will take approximately six and a half hours to drive. Transportation over land is difficult in Alaska due to the limited infrastructure. There is no railway in the area which connects Anchorage to Fairbanks so the only option is transporting the cargo by road. The transportation of the GE-90 by road could be a problem due to its size and weight. Narrow streets, bridges, tunnels and viaducts can slow down or even block the transportation of the GE-90. When the horse trailers start driving when the decision is made to divert to Fairbanks, the aircraft arrives three hours earlier than the trailers due to the long driving distance. The advantage of minimizing the delay is lost through the long driving distance. Waiting on Fairbanks and taking off again with the horses is a quicker solution, and doesn't require additional transportation costs.

When diverting to Fairbanks, the aircraft will land at 01:15 UTC. This means that here is slightly less than three hours left to prepare the arrival of the plane. A main deck loader is available to unload the horses immediate after the landing. Also two hotel rooms need to be arranged for the flight crew. When these primary facilities are fixed it is possible to divert to Fairbanks, the aircraft can maintain the same route until waypoint ADREW. Just before the next waypoint (Fort Yukon) the aircraft begins its final decent to Fairbanks. After the landing and a checkout of approximately 1.5 hours, the crew can rest for about 8 hours in their hotel. When using the work and rest time table the maximum flight period is 6 hours and 30 minutes which is more than enough to fly the short trip to PANC.
The flight is roughly 250 nautical miles. At 12:00 UTC the ash cloud has moved away, so the plane could depart approximately at 11:15 UTC. After the take-off the aircraft can pick up immediately the route to Anchorage. The short flight requires less than 10.000kg of fuel. No alternate fuel is required as the trip is shorter than 6 hours and Anchorage has several available runways, and the final reserve

fuel is still 4040kg. No additional fuel is required on top of the EFOB when landing on Fairbanks. An estimation of the costs is made in **Table 3.9**.

Cost	Value	Extra information
Landing fee PAFA	$2.020,3	$2.22 per 1000lbs MTOW
Parking fee PAFA	$308,56	Price for wide-body aircraft
Fee enplaned passengers PAFA	$7,88	$1.97 per enplaned passenger
Rent main deck loader PAFA	$400	Offloading and on loading estimated at $200 each.
Rent horseboxes and other supplies for the horses	$1.400,-	$100,- per horse
Rent rest room pilots	$150	
Aircraft on ground costs	$42.000	$4.200 per hour
Fuel costs	$0	EFOB on Fairbanks is plenty.
Total costs	$46.286,74	
Total costs euro's	€30.994,01	

Table 3.9; Additional costs option waiting at PAFA

3.3.3.c Conclusion option Fairbanks

Fairbanks is a good option because this alternate is on the route to Anchorage. The advantage of this is that there is enough fuel on-board to land at Fairbanks and fly to anchorage without refueling the aircraft. This means that there are no extra fuel costs and the delay is minimized. The crew has more than enough time to rest so the workload of the crew is low.

3.3.4 Divert to Vancouver International airport

The third option which can be looked at is to divert to Vancouver International airport (CYVR) **(3.3.4.a)**. However, for this option should also first be looked at the impact of the decision to divert to this airport **(3.3.4.b)**. Only then can it be determined whether this is a good option **(3.3.4.c)**.

3.3.4.a Vancouver International airport

CYVR is a major airport situated in the southeast of PANC **(Figure 6)**. It is the second largest airport of Canada. The table below **(Table 3.10)** describes the operating information of CYVR.

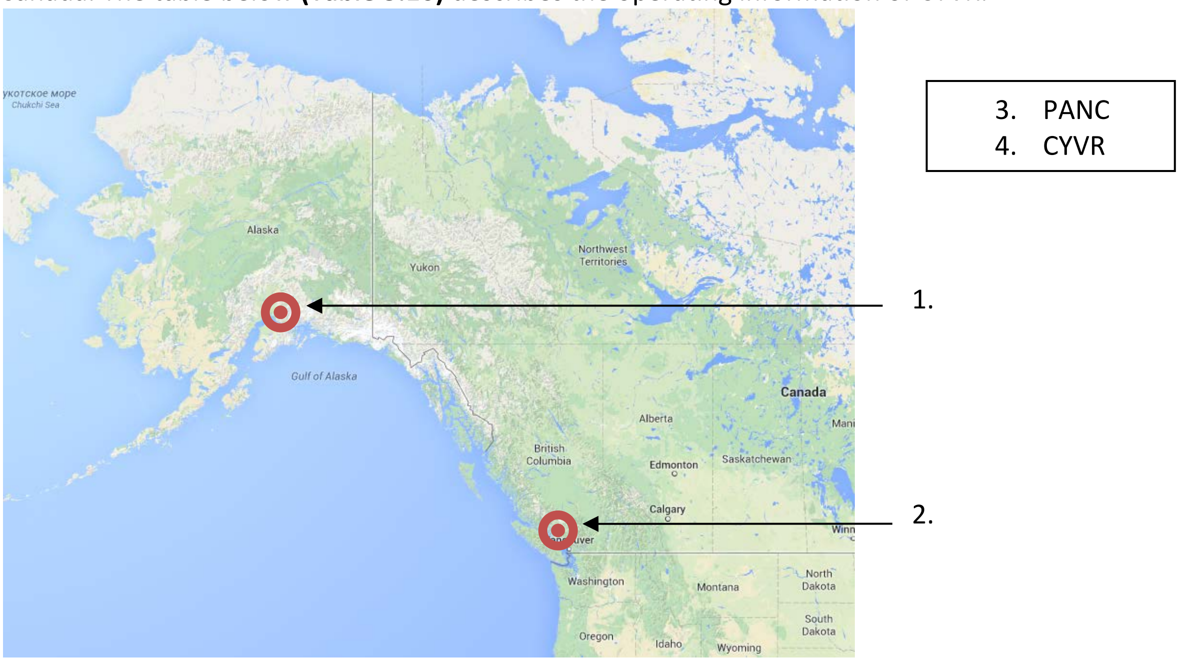

Figure 6; Places of PANC and CYVR

Opening hours	24 hours a day
Elevation	14 ft
Fire and rescue	Category 9

Fuel available	100LL (blue) JET-A, JET A-1
Airframe repair	Major
Enigne repair	Major
Bottled oxygen	Not available
Bulk oxygen	High/low
B747 freighter docks	4

Table 3.10; Operating information of CYVR

When it is decided to divert to CYVR the aircraft has to deviate immediately from the planned route in order to fly the most efficient route. The new route is given in **Appendix XXXIII**. When flying the new route the aircraft will arrive after nine hours and six minutes via STAR Keinn 7 at runway 26 R with EFOB of 11.186,3 kg. The minimum fuel on board has to be final reserve fuel which is 4040 kg. The information about runway 26 R is given in **Table 3.11.** According to the landing chart of the Boeing 747-400ERF the aircraft with a landing weight of 271.488,3 kg and flaps 30 needs a runway of 2425 meters with one or two brakes deactivated when the runway is wet. According to the TAF of CYVR the weather varies from minus shower rains to minus rains so the runway surface will indeed be wet.

Runway	**26 R (08L)**
Dimensions	9940 x 200 feet / 3030 x 61 meters
Surface	Concrete
Heading	242° magnetic
ILS	Category III

Table 3.11; Runway 26 R information

With an open airport, enough fuel on board to reach CYVR within the limits and with a runway long enough to land on with the given landing weight, divert to CYVR is an executable option.

3.3.4.b Issues Vancouver International airport

Vancouver is situated about 1156 km from Anchorage which takes an aircraft about two hours and 30 minutes to cross. It will take by car 49 hours and there is not train connection. A journey of 49 hours via road is absolutely not comfortable for the horses. Thus the only two options which are feasible are:

1. Wait till the ash cloud is blown away from PANC and then continue the flight to PANC or;
2. Arrange an internal flight so that the return crew whom are situated at PANC are brought to CYVR.

The LAR states that unloading the horses must be begin within 30 minutes after arrival. To unload the horses a high loader is needed. An 18.000kg high loader is available for hire at CYVR.

Ad 1. *Wait*

As described in **3.1** PANC will be operating again from 12:00 UTC. The aircraft arrives at CYVR at 02:35 UTC. Since a flight from CYVR to PANC will take two hours and 30 minutes, the aircraft has to wait six hours and 55 minutes to able to depart again from CYVR at 09:30 UTC.
When the flight duty period of the crew is examined, it can be seen that they have a total flight duty period of ten hours and 51 minutes for the flight from EHAM to VYCR (one and a half hour preparation time, nine hours and six minutes flight duration and fifteen minutes sign out time). This means that the crew needs a minimum reduced rest time of eight hours and 45 minutes because their local sign in time is between 15:00 and 05:00 for a two and a half hour flight exclusive preparation time and sign out time including a safety factor for amongst others head wind **(Appendix XXXIII)**. Therefore the aircraft cannot depart until 13:05 UTC. Thus the aircraft with crew, horses, engine and other freight will arrive at PANC at 15:35 UTC instead of 01:52 UTC at which the original flight would arrive.
Therefore, when choosing for this option, all of the cargo, the crew and the aircraft will at the end be in the right place but with a delay of thirteen hours and 43 minutes. Also the new crew, whom are situated at PANC, can fly the aircraft with the return freight back to EHAM. The crew of the outward

flight does have an exhausting day behind due to the only rest time the crew had; reduced rest time. It may be that this crew is assigned to a new flight scheduled from PANC. The crew will then thus delayed arrived at PANC and they will need to rest first so that this scheduled flight may be delayed too. The same goes for the return flight crew. This crew will arrive at EHAM with a delay whereby maybe the next flight scheduled for this flight is delayed too. In addition, the aircraft will use 27900 kg extra fuel because more distance is traveled.
At last there are also financial consequences. These are the additional costs which have to be made when this option is executed. In **Table 3.12** is an estimation made of these additional costs. The owners of the horses, engine and other freight have no right to claim money from the airline company because a volcano eruption is a circumstance beyond the airline company's control.

Cost	Value (Canadian dollar)	Extra information
Landing fee CYVR	$2.322,61	$5,63 per 1000 kg MTOW
Parking fee CYVR	$165,56	
Fee enplaned passengers CYVR	$8,76	$2,19 per enplaned passenger
Rent high loader CYVR	$600,-	Estimation (loading and unloading)
Rent horseboxes and other supplies for the horses	$1.400,-	$100,- per horse
Rent rest room pilots	$150	Two rooms. Most are between $65 and $100 per night.
Aircraft on ground costs	$47.880,-	Ten and a half hour AOG $4560 per hour
Extra salary pilots	$306,-	Estimated; $42,- per hour for captain, $30,- per hour for co-pilot
Fuel costs	$24.752,-	$1,19 per kg (trip fuel CYVR to PANC minus efob plus final reserve)
Total costs	$77.584,93	
Total costs euro's	€52.106,79	

Table 3.12; Additional costs option waiting at CYVR

Ad 2. *Arrange an internal flight*

Another option is to arrange an internal flight from PANC to CYVR. The return crew can arrive at CYVR with this flight. The difference with the option described above is that there is no need to take the rest time of the crew of the outward flight in account because the return crew can fly the aircraft immediately when the ash cloud is no longer around PANC. The return crew will fly the aircraft with the horses, engine, other freight and the crew of the outward flight at 09:30 UTC to PANC. There the horses, engine and other freight will be unloaded from the aircraft and the return freight will be loaded into the aircraft. Then the aircraft will be able to take off to EHAM. Hereby the return crew will be able to keep their duty time within the limits.
The horses, engine and other freight are in the end all at the right place but with a delay of ten hours and eight minutes. The crew of the return flight does have an exhausting day ahead due to the two flights the will perform from which one of the flight a long distance flight is. It may be that this crew is assigned to a new flight scheduled from EHAM. The crew will thus arrive delayed at EHAM and they will need to rest first so that this scheduled flight may be delayed too. In addition, the aircraft will use 27900 kg extra fuel because more distance is traveled.
At last there are also financial consequences. These are the additional costs which have to be made when this option is executed. In **Table 3.13** is an estimation made of these additional costs.

Cost	Value (Canadian dollar)	Extra information

Landing fee CYVR	$2.322,61	$5,63 per 1000 kg MTOW
Parking fee CYVR	$165,56	
Fee enplaned passengers CYVR	$8,76	$2,19 per enplaned passenger
Rent high loader CYVR	$600,-	Estimation (loading and unloading)
Rent horseboxes and other supplies for the horses	$1.400,-	$100,- per horse
Rent rest room pilots	$150	Two rooms. Most are between $65 and $100 per night.
Aircraft on ground costs	$31.540,-	six hours and 55 minutes AOG $4560 per hour
Extra salary pilots	$306,-	Estimated; $42,- per hour for captain, $30,- per hour for co-pilot
Fuel costs	$24.752,-	$1,19 per kg (trip fuel CYVR to PANC minus efob plus final reserve)
Cost return crew flight from PANC to CYVR	$1.000,-	$500,- per person
Total costs	$62.244,93	
Total costs euro's	€41.800,37	

Table 3.13; Additional costs arranging an internal flight to CYVR

3.3.4.c Conclusion option Vancouver International airport

When choosing to divert to Vancouver International airport two options are left. The major difference between those options is the time that the aircraft needs to stay on CYVR due to the rest time of the pilots. As can be seen both cost tables above the cheapest option is to fly the return crew with an internal flight from PANC to CYVR. Then the aircraft is able to stay three hours and 35 minutes shorter on CYVR. Thus when the return crew is flown in the delay and costs will be less than if the return crew is kept in PANC.

3.3.5 Best Option

Now that all options have been investigated, the weighting factor table from **3.3.1** can be applied to each optional solution. First the option to return to EHAM will be evaluated **(3.3.5.a)**, followed by diverting to Fairbanks **(3.3.5.b)** and finally the option to divert to Vancouver **(3.3.5.c)**. Once it has been determined which solution is the best, the recommended course of action is explained **(3.3.5.d)**.

3.3.5.a Return to EHAM

Returning to EHAM is very expensive because the total flown distance when arriving at anchorage is the greatest, and requires the most extra fuel. Combined with the long waiting time and the AOG costs, costs increase to a total of roughly €91,900.

The consequences for the costumers are good; the horses will be transported under good conditions. The time until arrival at anchorage is increased by over 14 hours, and is thus extremely inefficient.

EHAM has all the facilities required for the horses, and the consequences for the crew are optimal, since EHAM is the airport they originally departed from. With all these consequences taken into account, points can be allocated to each individual option **(Table 3.14)**.

	Score	Multiplier	Total
Costs	1	3	3
Efficiency	0	2	0
Consequences customers	2	2	4

Consequences crew	3	1	3
Overall points			10

Table 3.14: Points allocation EHAM

3.3.5.b Divert to Fairbanks

Diverting to Fairbanks is the quickest solution compared to the others. No extra fuel is required which makes it without a doubt the cheapest solution with the total costs expected to be about $46,286. The total expected time until the cargo arrives at anchorage is also the shortest, with roughly nine and a half hours delay.
The horses will also be transported by air, so the well-being will be appropriate.
The facilities are not optimal but do satisfy the requirement to offload the horses. For the crew this option is somewhat less attractive, because their rest time will be shortened. With all these points of interest taken into account the points for this option can be determined **(Table 3.15)**.

	Score	Multiplier	Total
Costs	4	3	12
Efficiency	2	2	4
Consequences customers	2	2	4
Consequences crew	2	1	2
Overall points			22

Table 3.15: Points allocation PAFA

3.3.5.c Divert to Vancouver

When the flight will divert to Vancouver (CYVR) two options can be made. As explained in **3.3.3.c** the best option is to fly over the return crew to CYVR, so that they will bring the cargo to PANC. Hereby a lot of time will be saved if the other option will be execute. Extra fuel is required, and the total expected costs are €52,106. The cargo will be on PANC with a delay of ten hours, this is not very efficient in comparing with the other solutions.
Vancouver is very far from PANC, transportation of the horses by the road is excluded. With this solution the horses will transported by air as well.
The return crew will have to fulfill two flights, one from CYVR to PANC and one from PANC to EHAM. This will be exhausting for the crew.
The total score for this solution is shown in **Table 3.16**.

	Score	Multiplier	Total
Costs	3	3	9
Efficiency	0	2	0
Consequences costumers	2	2	4
Consequences crew	1	1	1
Overall points			14

Table 3.16: Points allocation CYVR

3.3.5.d Recommended course of action

Based on the research, the Senior Operations Controller is recommended to have the flight divert to Fairbanks where the aircraft will wait for the volcanic ash cloud to pass. The remainder of the flight will be executed afterwards to deliver the cargo to Anchorage by air. This option is the most fuel and cost efficient, and all cargo will arrive at the destination with the shortest delay. Hence, this option has the preference of both the costumers and the company.

3.4 Debriefing

Flight AVI-685 from Schiphol to Anchorage has shown itself to be a flight operation filled with problems. Nevertheless the ASIA has done everything in its power to help the passengers/caretakers of the horses and cargo to reach their destination as fast, safe and comfortable as possible.

- The original flight plan shows that the duration of the flight would take only **8 hours and 22 minutes**. The ground distance is **3992nm**, with an average speed of **450kts** or a **Mach speed of 0.85**. Furthermore **101833kg** of fuel is required to complete the flight; this is including the different reserve fuels. In case of an emergency there are three **en-route alternates; Stavenger Sola (ENZV), Kangerlussuaq airport (BGSF) and Fairbanks (PAFA), which is also the destination alternate.**
- **One or two brake units suffered a malfunction** before the departure; the crew took the necessary measures to ensure a timely departure. The flight crew had to check the MEL to see whether they are allowed to commence the flight with this component inoperative. Even due to this procedure the flight didn't incurre a delay.
  During the flight a second malfunction occurs. This is given on the EICAS; the message that is displayed is a **failure of engine 2 ingitor 1.**

The first part of the flight proceeds without problems, after 3.5 hours the OCC receives an SIGMET that the volcano Mt SPurr is erupting. The destination airport PANC is covered by the ash cloud on arrival time. With only three options available, the OCC must choose the best option. The three options are: Diverting to Vancouver, Diverting to Fairbanks and Return to EHAM. The next criteria's are used to choose the best option:

- Efficiency
- Costs
- Consequences for the customers
- Consequences for the crew

When using these criteria including their weight factor, Fairbanks has the best efficiency, the lowest cost and least consequences for both customers and crew **(Table 3.17)**. Therefore project group 2D recommends the OCC to divert flight AVI-685 to Fairbanks and getting the best for all involved companies.

	Vancouver	Fairbanks	Schiphol
Costs	9	12	3
Efficiency	0	4	0
Consequences costumers	4	4	4
Consequences crew	1	2	3
Overall points	14	22	10

Table 3.17; Scores of the options (the higher the better)

Content of Appendices

Bibliography

Documents

Titel	Document name
Boeing 747-400 Flight Planning and Performance Manual	B747-400 ERF FPPM.pdf
Boeing 747-400 Minimum Equipment List	B747-400 ERF MEL.pdf
Boeing 747-400 Flight Crew Operations Manual 1	B747-400 FCOM_1.pdf
Boeing 747-400 Flight Crew Operations Manual 2	B747-400 FCOM_2.pdf
Boeing 747-400 Flight Crew Operations Manual 3	B747-400 FCOM_3.pdf
Project book period 7-8: Flight Planning & Operations	Projectboek_fligh_planning_operaterions-3.pdf
Project book period 7-8: Flight Planning & Operations Part 2	Project book flight planning 2013-2014 part 2.pdf
NDRVSM	Airspace_north_pole_canada.pdf
Publikatieblad van de Europese Gemeenschappen	CELEX-31991R3922-NL-TXT.pdf
Regeling werk- en rusttijden luchtvaart	Sc133a.pdf
Flight Safety and Volcanic Ash	Flight_safety_and_volcanic_ash.pdf
Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds	Manual on volcanic ash, radioactive material and toxic chemical clouds.pdf
Regeling werk- en rusttijden luchtvaart	Regeling werk-en rusttijden luchtvaart.pdf
Appendix II: Aircraft Technical Log – Malfunctions on Deffered Defect List (DDL)	Technical failures by group.pdf
Boeing 747-400 Normal Takeoff pattern	B747-400-Takeoff_Pattern.pdf
B747-400 Baanafstanden onder verschillende condities	B747-400 Baanafstanden onder verschillende condities.pdf
Boeing 747-400F cargo	Boeing_747-400F cargo.pdf
KLM-B747-Flight crew training	KLM-B747-Flight crew training.pdf
KLM-B747-take-off speed	KLM-B747-take-off speed.pdf
Loading figures and NOTOC	AMS-ANC Loading figures and NOTOC.pdf
Flight Planning and Fuel Management Manual	FPFMM.pdf
Fuel Policy EU-OPS 1.255	Fuel Policy EU-OPS 1.255.pdf
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Rules of the Air	ICAO rules of air annex 2.pdf
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Process report

Na vijf projecten te hebben gehad waar verschillende onderwerpen aan bod kwamen, zoals het ontwerpen van een systeem of een vliegveld, of het modificeren of analyseren van een bepaald systeem van een moderne airliner. Zijn er met dit project meerdere van deze onderwerpen gecombineerd. De opdracht van dit project was dan ook het vinden van oplossingen voor een vlucht van Amsterdam Schiphol Airport (EHAM) naar Ted Stevens Anchorage Airport (PANC), waarbij de eerste optie is om terug te vliegen naar EHAM, ten tweede uitwijken naar Fairbanks (PAFA) en als laatste de optie om uit te wijken naar Vancouver (CYVR). De vlucht wordt uitgevoerd met een Boeing 747-400ERF van de bekende fictionele Aviation Studies International Airline. Zo wordt er geacht dat ons team de beslissing maakt voor een veilig en succesvol vervolg van de vlucht als deel van het team van het Operational Control Center [OCC].

Vele aspecten kwamen hierbij kijken. Het eerste doel was om een briefing package te maken. Het heeft naar ons gevoel te lang geduurd om de briefing package te voltooien, want het bleek dat de briefing package veel eerder af moest zijn dan de hoofdstukken die geschreven moesten worden voor het volledige verslag. Doordat hoofdstuk 1 bij ons al eerder klaar was dan de briefing package, konden we aan de hand van de kennis die we op hebben gedaan in hoofdstuk 1 de briefing package beter opstellen.

Toen we eenmaal aan het verslag zijn begonnen heeft ieder zijn taak gekregen om een bepaald stuk te maken, met de deadline erbij. Doordat er bijvoorbeeld iets niet duidelijk was of nog niet helemaal af was, schoven de deadlines steeds verder op. Ook al was alles vrij duidelijk, er had sneller gehandeld en beter gecommuniceerd moeten worden. Daarnaast hadden de meesten van ons een selectie voor een van de afstudeerrichtingen, wat enkele werkzaamheden en daarmee de planning door de war gooide. Wat overigens wel goed is overgenomen door de andere projectleden.

Er mag wel gezegd worden dat de vergaderingen en dan vooral het notuleren en het voorzitterschap uitstekend zijn gedaan. De notulen waren zeer uitgebreid waar ook duidelijk in stond wat de afspraken en deadlines waren.

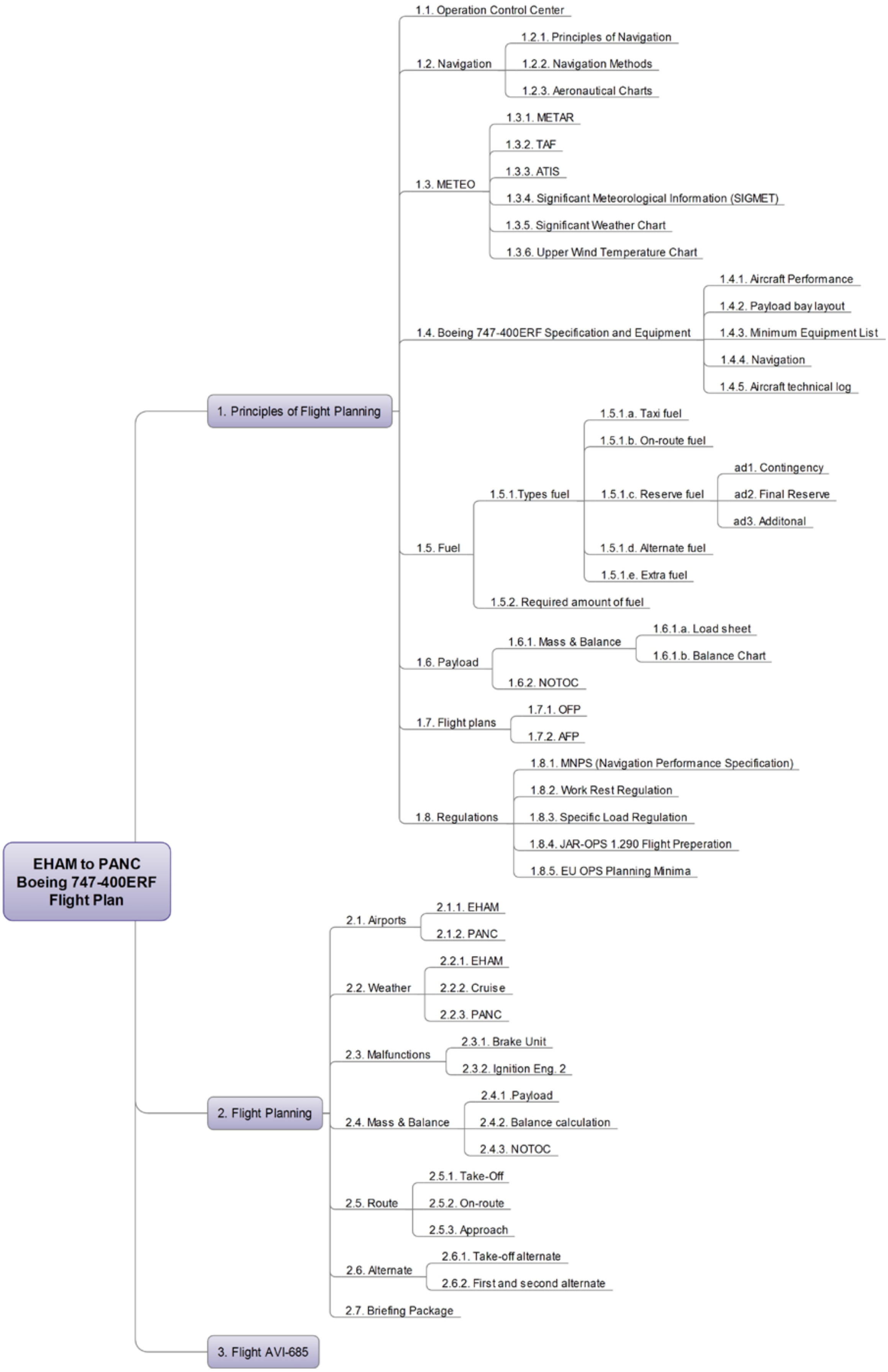
Het blijkt maar weer dat de planning en het houden aan de regels van het plan van aanpak strikter nagestreefd moeten worden.

Project Assignment

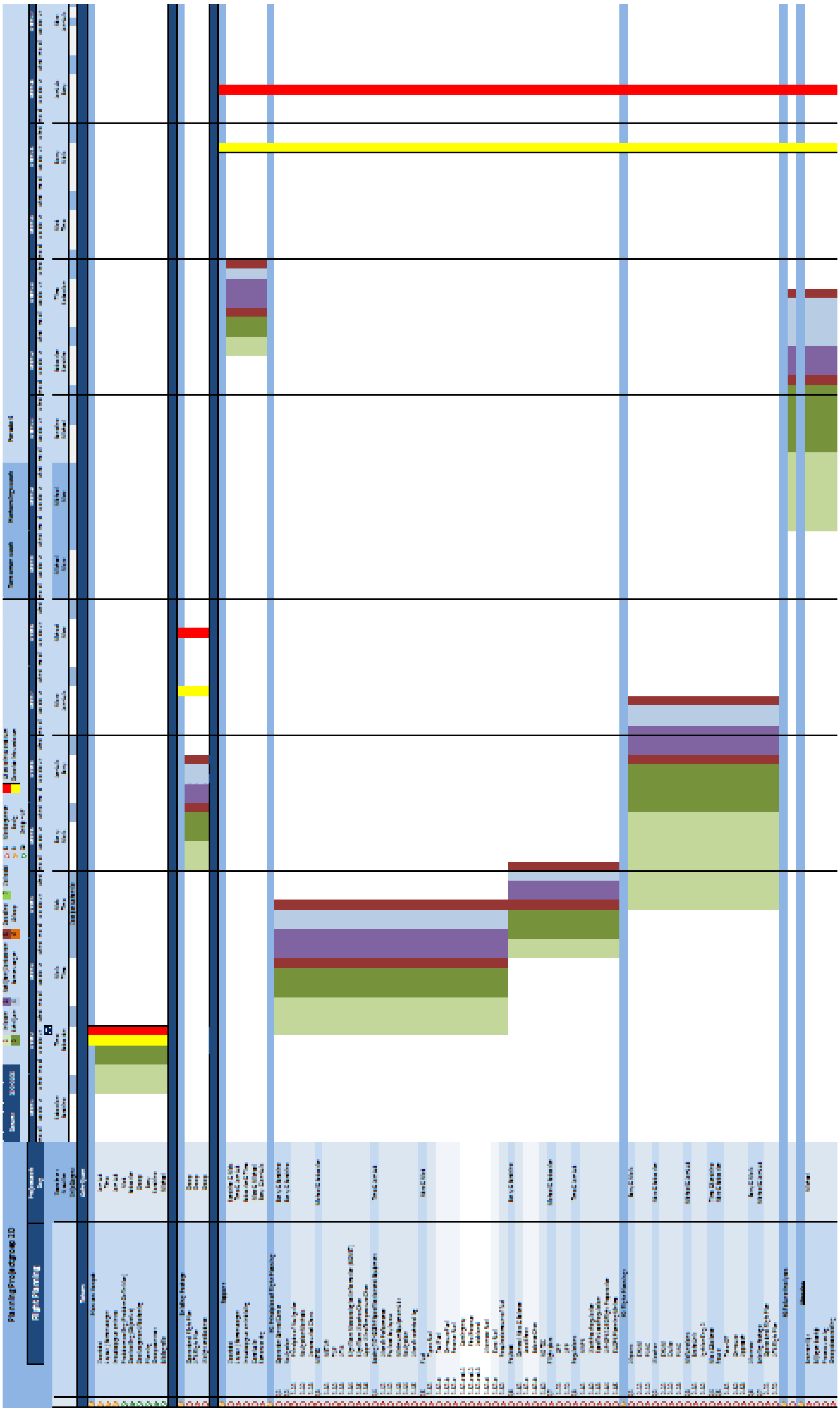
Flight Planning & Operation – Boeing 747-400ERF from Amsterdam Schiphol Airport to Anchorage.

You are a team within the dispatch department of Aviation Studies International Airline and you are tasked with the flight preparations for a flight from Amsterdam Schiphol Airport [**EHAM**] to Ted Stevens Anchorage Airport [**PANC**] with a Boeing 747-400ERF. The flight must take place at January 28th 2014 at 1730UTC because of the commercial value of the cargo.
During the flight planning phase, an Operational Flight Plan [**OFP**], including an ATS flight plan [**AFP**], shall be made according to EASA regulations. Among other things, take-off, en-route and destination alternates shall be considered. In addition to the OFP, a Mass & Balance [**M&B**] load- and trim sheet shall be made. Take into account that has been delivered with a technical complaint, which cannot be repaired. The complaint is a malfunction in a brake unit, according MEL: 32-41-01-01. Furthermore, there is a malfunction (being different for each project group) on the Aircraft Technical Log [**ATL**] which must be dealt with.
This means that Aviation Studies International Airline expects a complete briefing package from your project team, conform Part-CAT: CAT.GEN.MPA.180
During the operation of the flight, you will be confronted with a number of irregularities.
You will then act as a team of the Operation Control Center [**OCC**] and make decisions concerning the safe and successful continuation/resumption of the flight.

Pyramid Model



Planning



For a clear view is an Excel file included on the CD.

Appendices

Appendix I. Runway State Messages

Runway Designator (first and second digit) followed by a "/"
27 Runway 27 or 27L
77 Runway 27R (50 added to the designator for the 'right' runway)
88 All runways
99 Repetition of the last message received because no new information received

Runway Deposit (third digit)
0 Clear
1 Damp
2 Wet or water patches
3 Rime of Frost covered (depth normally less than 1 mm)
4 Dry snow
5 Wet snow
6 Slush
7 Ice
8 Compacted or rolled snow
9 Frozen ruts or ridges
/ Type of deposit not reported (e.g. due runway clearance in progress)

Extent of runway contamination (fourth digit)
1 10% or less
2 11% to 25%
5 26% to 50%
9 51% to 100%
/ Not reported (e.g. due runway clearance in progress)

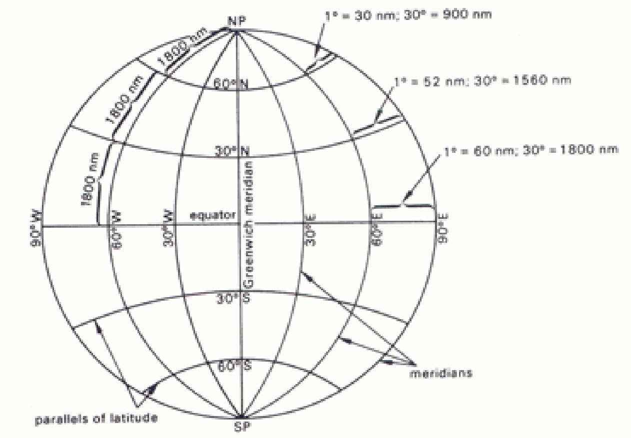
Depth of deposit (fifth and sixth digit)
00 less than 1 mm
01 1 mm etc. to 90 90 mm
91 not used
92 10 cm
93 15 cm
94 20 cm
95 25 cm
96 30 cm
97 35 cm
98 40 cm or more
99 Runway(s) non-operational due to snow, slush, ice, large drifts or runway clearance, but depth not reported
// Depth of deposit operationally not significant or not measurable
The quoted depth is the man number of readings or, if operationally significant the greatest depth measured

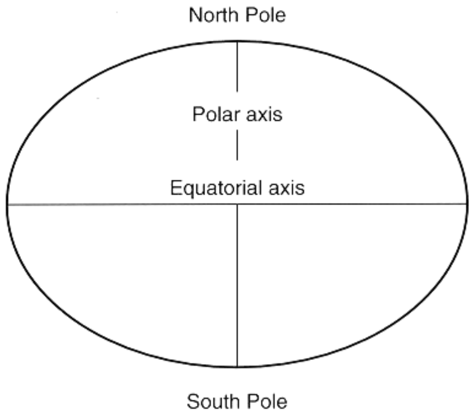
Friction co-efficient or braking action (seventh and eight digit)
28 Friction co-efficient 0.28
35 Friction co-efficient 0.35
or
91 Braking action: Poor
92 Braking action: Medium/Poor
93 Braking action: Medium
94 Braking action: Medium/Good

95 Braking action: Good
99 Figures unreliable (e.g. if equipment has been used which does not measure satisfactory in slush or loss snow)
// Braking action not reported (e.g. runway not operational, closed, etc.)
If contamination ceases to exist, the abbreviation CLRD is used

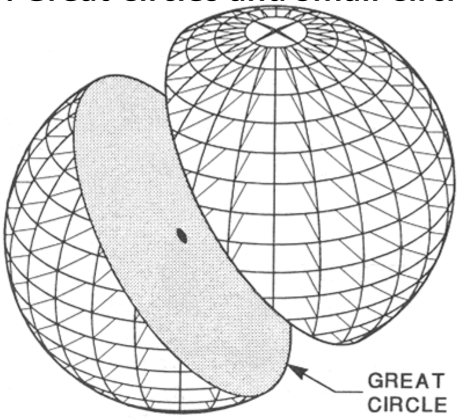
Appendix II. Navigation Tracks and Position

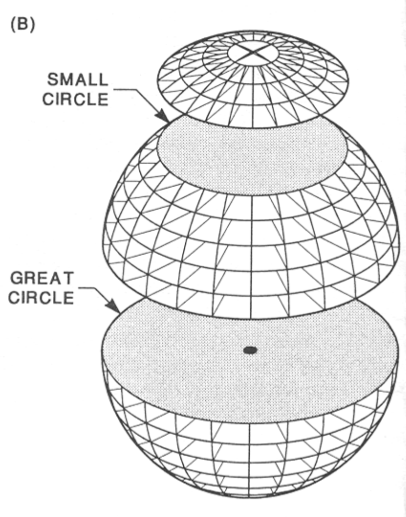
A. Earth, Longitude and Latitude





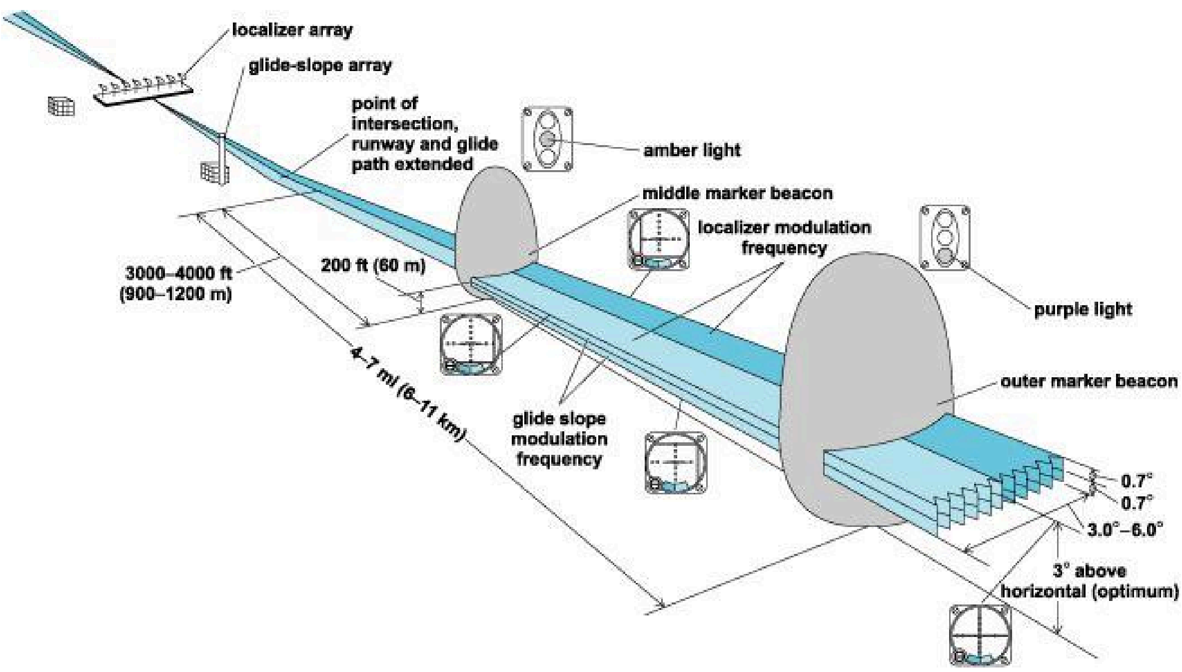
B. Great Circles and Small Circles





Appendix III. ILS System

A. Positioning ILS System

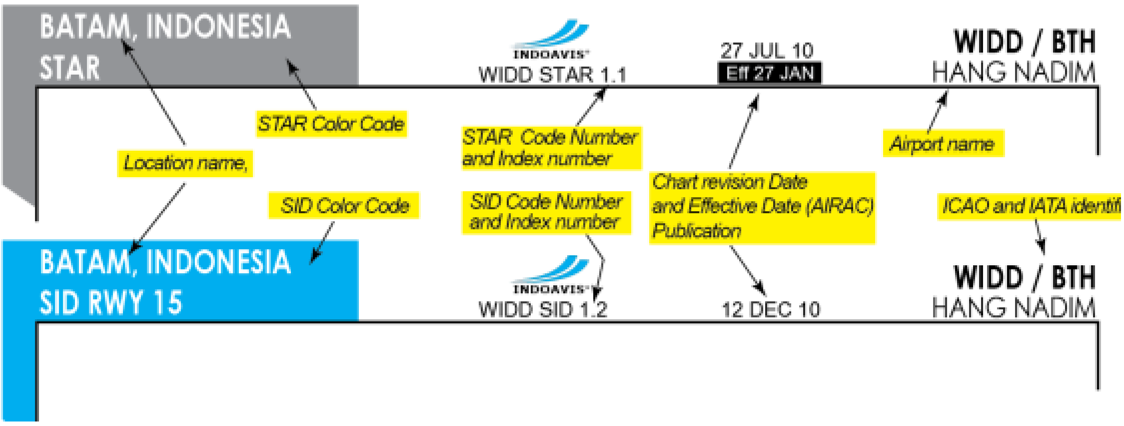


Appendix IV. Legend explanation (general)

A. SID and STAR chart legend

HEADING

OVERVIEW OF HEADING FEATURES



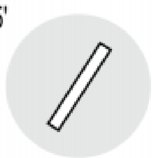
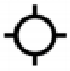
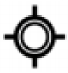
PROCEDURE TRACKS

	Departure/Arrival procedure track
	Missed approach procedure track
R055° D5 HLM	Radial line and value BR - (Bearing) R - (Radial) LR- (Lide Radial) hdg - (Heading) D - Distance
196° CARLI TWO 12000 38	Track Transition Name Minimum En-route Altitude (MEA) Segment mileage
B470 / W26 G462 11000 6000 FL245	Airways Designator Flight level
	Scale break

BEARING TRACKS

127°	Magnetic course
127°T	True course
090° hdg	Magnetic heading
R 090°	Magnetic radial

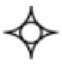
AIRPORT SYMBOLS

Halim Perdana Kusuma 85' 	Primary SID/STAR Airport Airport Name and Elevation (MSL)
	Secondary SID/STAR of Civil Airport
	Secondary SID/STAR of Military Airport
	Secondary SID/STAR of Join civil and Military Airport

ALTITUDE

4000'	At 4000'	MANDATORY	Mandatory altitude in line cross at.
4000'	At or above 4000'	MINIMUM	Minimum altitude in line cross at or above
4000'	4000' At or below	MAXIMUM	Maximum altitude in line cross at or below
4000'		RECOMMENDED	Recomended altitude

AIRSPACE FIXES

	RPC	Reporting Point (Compulsory)
	RPR	Reporting Point (On-Request)
	RNAV	RNAV Point (Compulsory)
	RNAV	RNAV Point (On-Request)
	DME	DME Distance
	MB	Mileage Breakdown
	WPT	Flyover Waypoint
	WPT	Fly-by Waypoint
D3.0 IHAL	DME info	DME value Navaid name
SPADA S05 40.7 E107 54.6	FIX POINT Info	Fixes Point Name Coordinates are shown

B. En-route chart legend

1	**Area overview**
2	**Chart name** The chart can consist of more than one map. Each map can be identified by its name. The chart name consists of a prefix, a chart number and following character. The prefix indicates the relevant area. The character indicates the covered airspace. L: low level H: high level HL: high and low level combined
3	**Map name** Map frame displayed in gray in the area overview.
4	**Map name** Map frame displayed in black in the area overview.
5	**Chart scale**
6	**Effective date:** only added if the chart becomes effective later than indicated in the revision date.
7	**Revision date** which generally is the date the customer receives the chart.
8	**Variation data**
9	**Standard parallels** (for Lambert projection only)
10	**Chart projection**
11	**Area description**

ADIZ (Air Defense Identification Zone)	
Airports The airport will be charted with city- and/or airport name, 4 letter code and longest runway in hundreds of meters and hundreds of feet in brackets. Generally only airports that are in civil use and provide at least one runway with minimum dimensions of 30m (100ft) width and 1500m (5000ft) length are shown on the chart. Airports with largest RWY ≥ 45m / 150ft width and 1500m / 5000ft length Airports with largest RWY ≥ 30m / 100ft width and 1500m / 5000ft length **Note:** As an exception to avoid congestion only airports with a minimum RWY length of 2000m (6600ft) will be charted for the territory of the United States (excluding Alaska).	

Airways/ATS routes with Maximum Authorized Altitude (MAA), airway designator with RNP value, distance in NM, Minimum Enroute Altitude (MEA), Minimum Terrain Clearance Altitude (MTCA) in red. **Maximum Authorized Altitude (MAA):** The MAA is presented on each airway/ATS route segment whenever published in the AIP (either in FL or ft) and is different from the associated airspace limitations (e.g. Lower vs. Upper airspace). **Minimum Enroute Altitude (MEA):** The MEA is presented on each airway/ATS route segment whenever it is published in the AIP (either in FL or ft) and is deviating from the associated airspace limitations (e.g. lower vs. upper airspace). The MEA is normally the lowest officially published altitude on a route segment that covers adequate NAVAID signal reception and minimum obstacle clearance (according ICAO and FAA recommendation 1000ft, in mountainous terrain 2000ft). **Multiple MAAs** applied to different airways/ATS routes on the same segment are separated by a slash. If one of those different MAAs is identical with the upper limit of associated airspace (lower respectively upper airspace) this is indicated by three dots. **Multiple MEAs** applied for different airways/ATS routes on the same segment are separated by a slash. **Multiple MEAs** Three dots indicate a MEA according limits of the associated airspace.	MAA 9500 P10⑤ 66 4000 3400
Airways/ATS routes **One-way airway/ATS route** If a route is limited to one direction a direction indicator arrow is added to the designator.	◄L851 98

Airways/ATS routes **Low/high level airways/ATS routes on combined RFCs**	W305/UW305 194
Airways/ATS routes **Different designators**	P52/W35 149
Airways/ATS routes **RNAV airway/ATS route**	UN135® 42
Airways/ATS routes **RNAV airway/ATS route with RNP value** e.g. RNP 5	UN728⑤ 66
Airways/ATS routes **VOR radial** depicted on RFCs	R244
Airways/ATS routes **Magnetic track** on an airway/ATS route segment	236°

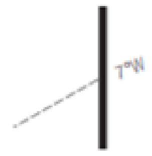
Airways/ATS routes **True track** on an airway/ATS route segment	062°T

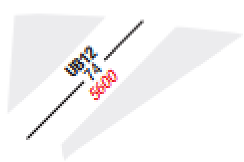
<table>
<tr>
<td>Airways/ATS routes
Airway/ATS route to be flown in even and odd FLs in indicated direction.</td>
<td>
</td>
</tr>
<tr>
<td>Airways/ATS routes
Minimum Terrain Clearance Altitude (MTCA)
The MTCA is provided for all airway/ATS route segments. MTCAs are always shown in red italic font.
The MTCA (calculated by Lido) covers exclusively terrain and obstacles relevant for air navigation with the buffers and minimum obstacle clearance (MOC) described hereunder.
Horizontal and vertical buffers
The MTCA is calculated for an area of 10NM on either side of the centerline of each airway/ATS route segment and around any NAVAID/waypoint.
The MTCA is calculated by rounding up the elevation of the highest obstruction within the safety area to the next 100ft and adding an increment of

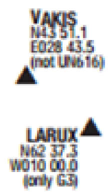
1000ft for terrain or obstructions up to 6000ft
or
2000ft for terrain or obstructions above 6000ft.
e.g. 2345ft obstacle
= 2400ft rounded up
+ 1000ft buffer
= 3400ft MTCA

Values are shown in feet.
On low level RFCs lowest indicated MTCA is 3100ft, meaning that wherever no MTCA is provided, 3000ft can be considered a safe flight altitude.
On high level RFCs lowest indicated MTCA is 10100ft, meaning that wherever no MTCA is provided 10000ft can be considered a safe flight altitude.
On combined high/low level RFCs the rules for low level RFCs apply.
Any MTCA being calculated with other than the above mentioned policies will be shown in brackets with reference to the calculation method.
In rare cases the MTCA calculated for a specific segment can be higher than the official minimum altitude.
This is due to the difference in buffer calculation and/or the definition of the safety area.</td>
<td>
</td>
</tr>
</table>

<table>
<tr>
<td>Holding Patterns: Enroute holding patterns positioned off-route are indicated on the chart by a fixed symbol. The holding fix will be shown with geographic coordinates.</td>
<td>
</td>
</tr>
<tr>
<td>Holding Patterns:
Minimum and maximum holding altitude, maximum speed and non-standard outbound time.</td>
<td>
</td>
</tr>
</table>

Isogonic lines: The interval depends on the chart scale and the distance from the magnetic pole. 1° for chart scales up to 1 inch = 100NM 2° for chart scales larger than 1 inch = 100NM 5°/10° for charts near the magnetic poles. The isogonic line values are represented outside of the chart frame.	
Magnetic compass erratic area: A line encompassing the polar area within which the magnetic compass is unreliable.	

Minimum Grid Altitude (MGA) is the lowest safe altitude to be flown off-track. The MGA is calculated by rounding up the elevation of the highest obstruction within the respective grid area to the next 100ft and adding an increment of • 1000ft for terrain or obstructions up to 6000ft or • 2000ft for terrain or obstructions above 6000ft e.g. 6445ft obstacle = 6500ft rounded up + 2000ft buffer = 8500ft MGA Shown in hundreds of feet. Lowest indicated MGA is 2000ft. This value is also provided for terrain and obstacles that would result in an MGA below 2000ft. The MGA value can be omitted over water areas. MGAs below 10000ft are shown in purple, at and above 10000ft in red.	85 104
Special Use Airspaces (SUAs) Danger (D), Restricted (R), Alert (A) and Warning (W) areas, FRZs and other SUAs are displayed with their airspace identification. Prohibited (P) areas are displayed with the airspace identification and vertical limits. For details on vertical extension (non P-areas) and activity times refer to your relevant SUA list.	
Uncontrolled airspace Controlled airspace around an airway is shown with 10NM on each side. For country specific deviations refer to CRAR pages. **Note:** A supplementary letter may indicate the type of service provided on the route. "F" indicates advisory service only, while the letter "G" indicates flight information service only. The gray overlay indicates uncontrolled airspace (ICAO class F or G).	

Waypoints Compulsory waypoint defined as non-compulsory component for airway/ATS route UP619. Waypoints associated to the airway/ATS route structure are not charted with additional conventional definitions (radial and DME values) from NAVAIDs located off-route.	
Waypoints (compulsory) Waypoint "VAKIS" not defined as component for airway/ATS route UN616. Waypoint "LARUX" defined as component for airway/ATS route G3 only.	

Appendix V. METAR and TAF

A. International METAR codes

The following is an example METAR from Burgas Airport in Burgas, Bulgaria. It was taken on 4 February 2005 at 16:00 Coordinated Universal Time (UTC).

METAR LBBG 041600Z 12003MPS 310V290 1400 R04/P1500N R22/P1500U +SN BKN022 OVC050 M04/M07 Q1020 NOSIG 9949//91=

- **METAR** indicates that the following is a standard hourly observation.
- **LBBG** is the ICAO airport code for Burgas Airport.
- **041600Z** indicates the time of the observation. It is the day of the month (the 4th) followed by the time of day (1600 Zulu time, which equals 4:00 pm Greenwich Mean Time).
- **12003MPS** indicates the wind direction is from 120° (east-southeast) at a speed of 3 MPS(5.8 KT; 6.7 mph; 11 km/h). Speed measurements can vary from knots (KT) or meters/second (MPS).
- **310V290** indicates the wind direction is varying from 310° true (northwest) to 290° true (west-northwest).
- **1400** indicates the prevailing visibility is 1,400 m (4,600 ft).
- **R04/P1500N** indicates the Runway Visual Range (RVR) along runway 04 is 1,500 m (4,900 ft) and not changing significantly.
- **R22/P1500U** indicates RVR along runway 22 is 1,500 m (4,900 ft) and rising.
- **+SN** indicates snow is falling at a heavy intensity. If any precipitation begins with a minus or plus (-/+), it's either light or heavy.
- **BKN022** indicates a broken (over half the sky) cloud layer with its base at 2,200 ft (670 m)above ground level (AGL). The lowest "BKN" or "OVC" layer specifies the cloud ceiling.
- **OVC050** indicates an unbroken cloud layer (overcast) with its base at 5,000 ft (1,500 m) above ground level.
- **M04/M07** indicates the temperature is −4 °C (25 °F) and the dewpoint is −7 °C (19 °F). An M in front of the number indicates that the temperature/dew point is below zero (0) Celsius.
- **Q1020** indicates the current altimeter setting (QNH) is 1,020 hPa (30.12 inHg).
- **NOSIG** is an example of a TREND forecast which is appended to METARs at stations while a forecaster is on watch. NOSIG means that no significant change is expected to the reported conditions within the next 2 hours.
- **9949//91** indicates the condition of the runway:
  - **99** indicates either a specific runway (e.g. 25 = Rwy 25 or 25L; adding 50 will indicate Right Runway) or all the airport's runways ("99"). Some locations will report the runway using 3 characters (e.g. 25L)
  - **4** means the runway is coated with dry snow
  - **9** means 51% to 100% of the runway is covered
  - **//** means the thickness of the coating was either not measurable or not affecting usage of the runway
  - **91** means the braking index is bad, in other words the tires have bad grip on the runway
- **CAVOK** is an abbreviation for ***C**eiling **A**nd **V**isibility **OK**ay*, indicating no cloud below 5,000 ft (1,500 m) or the highest minimum sector altitude and no cumulonimbus or towering cumulus at any level, a visibility of 10 km (6 mi) or more and no significant weather.[6]
- **=** indicates the end of the METAR

B. TAF code

This TAF example of a 30-hour TAF, released on November 5, 2008 at 1730 UTC:

```
TAF
KXYZ 051730Z 0518/0624 31008KT 3SM -SHRA BKN020
     FM052300 30006KT 5SM -SHRA OVC030
      PROB30 0604/0606 VRB20G35KT 1SM TSRA BKN015CB
     FM060600 25010KT 4SM -SHRA OVC050
      TEMPO 0608/0611 2SM -SHRA OVC030
     RMK NXT FCST BY 00Z=
```

The first line contains identification and validity times.

- **TAF** indicates that the following is a terminal area forecast.
- **KXYZ** indicates the airport to which the forecast applies (ICAO airport code).
- **051730Z** indicates that the report was issued on the 5th of the month at 1730 UTC (also known as Zulu, thus the "Z").
- **0518/0624** indicates that the report is valid from the 5th at 1800 UTC until the 6th at 2400 UTC.

The remainder of the first line contain the initial forecast conditions. Variations of the codes used for various weather conditions are many.[2]

- **31008KT** indicates that the wind will be from 310 degrees true at 8 knots.
- **3SM -SHRA BKN020** indicates that visibility will be 3 statute miles in light (-) rain (RA) showers (SH), with a broken ceiling (between 5/8 and 7/8 of the sky covered) at 2,000 feet AGL.

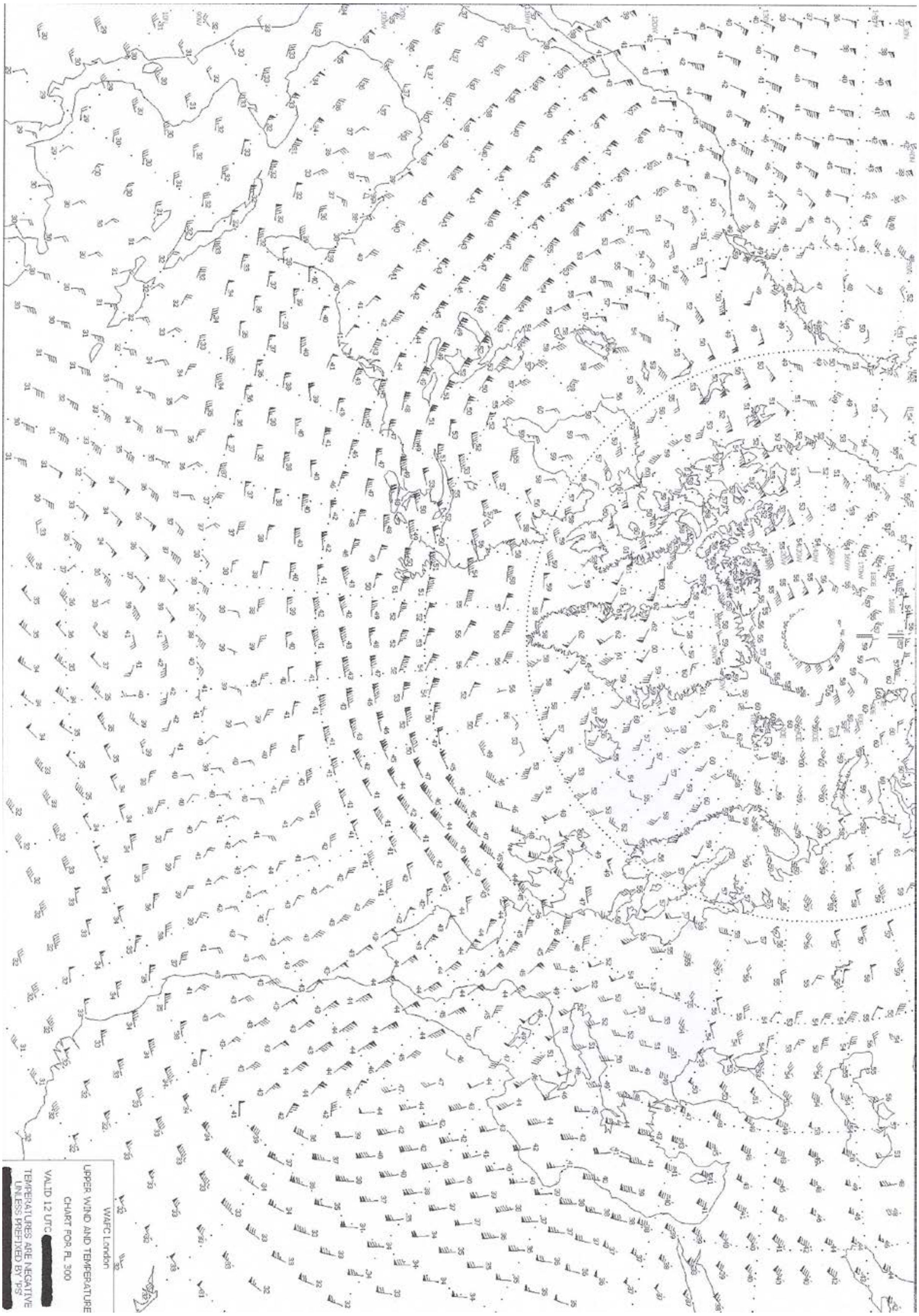
Each line beginning with **FM** indicates a rapid change in the weather over a period of less than an hour.

- **FM052300** indicates the next period lasts from (FM) the 5th at 2300 UTC to the 6th at 0600 UTC (the effective time on the next "FM" line). The remainder of the line has similar formatting to the other forecast lines.

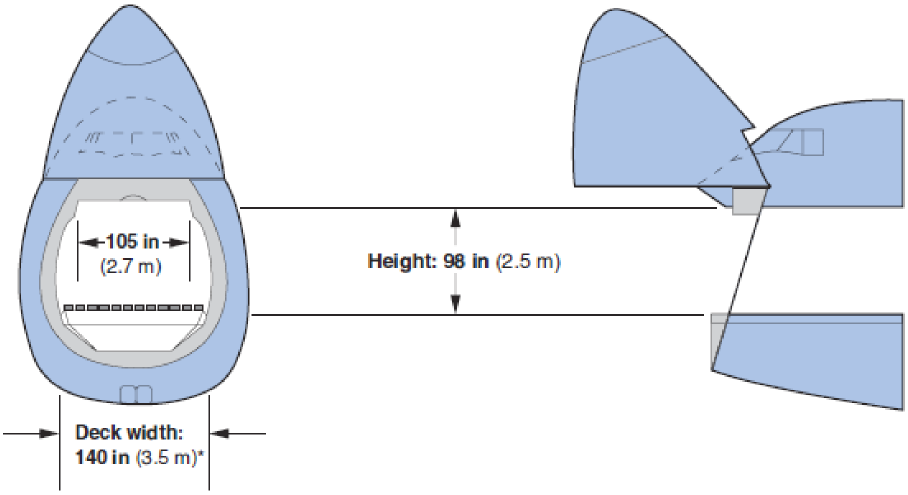
The final line is for errata, comments, and remarks.

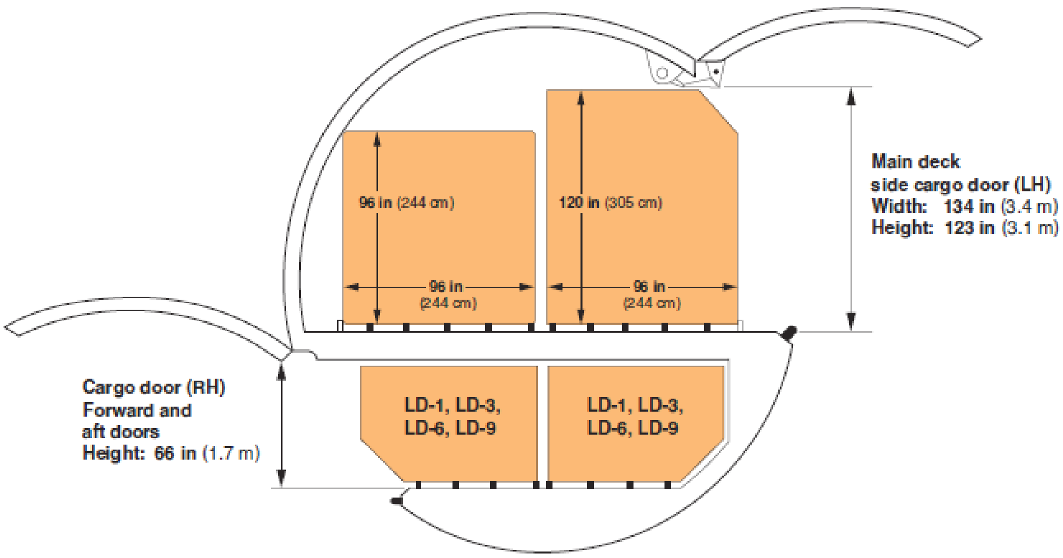
- **RMK NXT FCST BY 00Z** indicates a remark that the next forecast will be issued by 0000 UTC.

Appendix VI. **Upper wind & temperature chart**



Appendix VII. Cargo





Appendix VIII. Fuel Tables and Charts

A Holding fuel

Holding Planning

Flaps Up

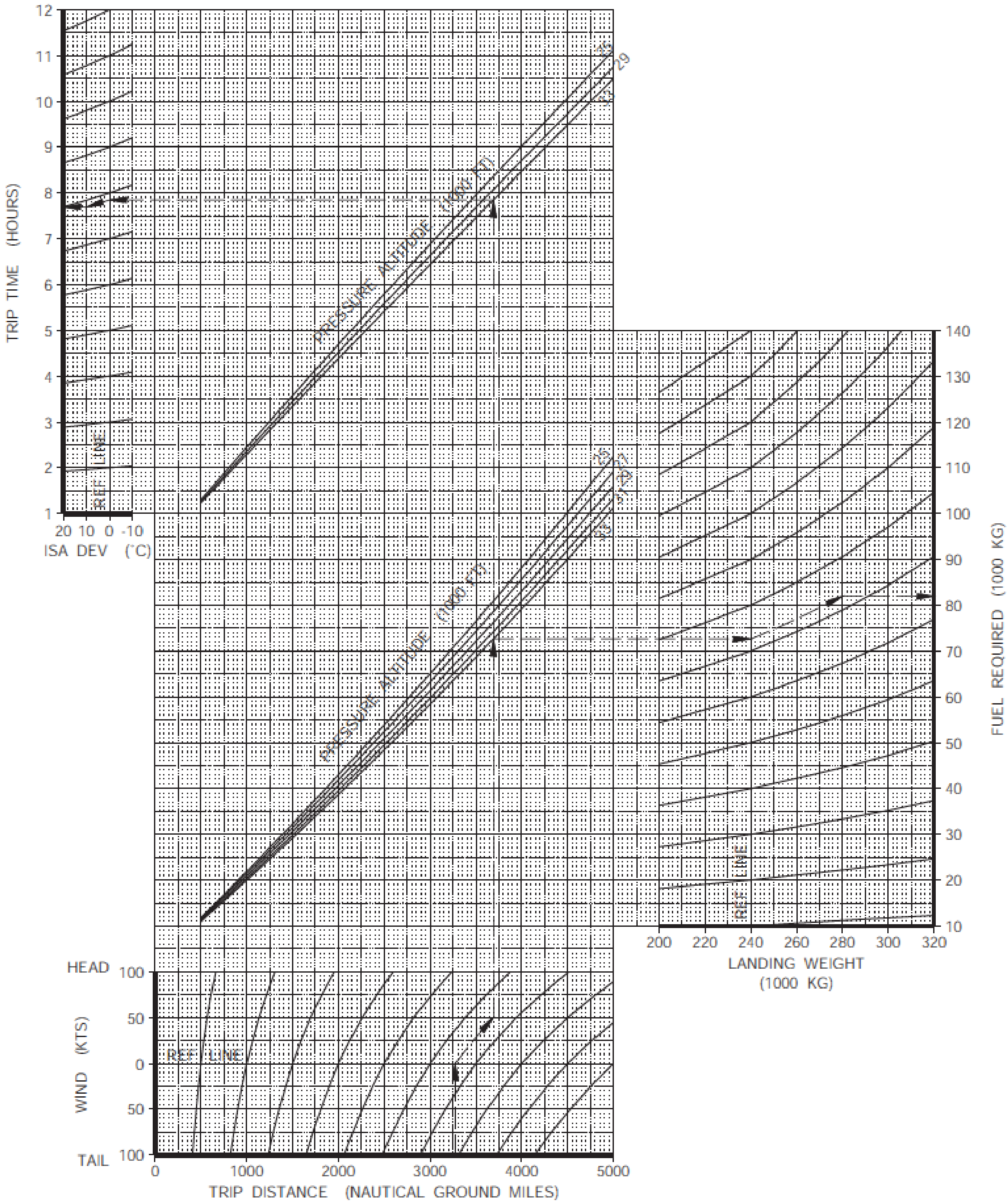
PRESSURE ALTITUDE (FT)	TOTAL FUEL FLOW (KG/HR) WEIGHT (1000 KG)											
	420	400	380	360	340	320	300	280	260	240	220	200
45000											7680	6790
40000							10810	9630	8750	7900	7060	6270
35000			13640	12410	11430	10610	9740	8920	8140	7370	6660	5980
30000	14500	13590	12620	11740	10900	10100	9320	8580	7880	7190	6550	5950
25000	13780	12910	12080	11300	10560	9820	9120	8460	7830	7220	6640	6080
20000	13340	12540	11780	11040	10350	9670	9030	8410	7820	7230	6660	6090
15000	12990	12270	11580	10910	10260	9620	8990	8370	7770	7170	6610	6060
10000	12880	12210	11550	10900	10270	9640	9040	8440	7860	7280	6730	6200
5000	12860	12210	11570	10940	10320	9710	9110	8530	7970	7410	6870	6340
1500	12950	12310	11680	11050	10430	9820	9220	8640	8080	7530	7000	6490

Flaps 1

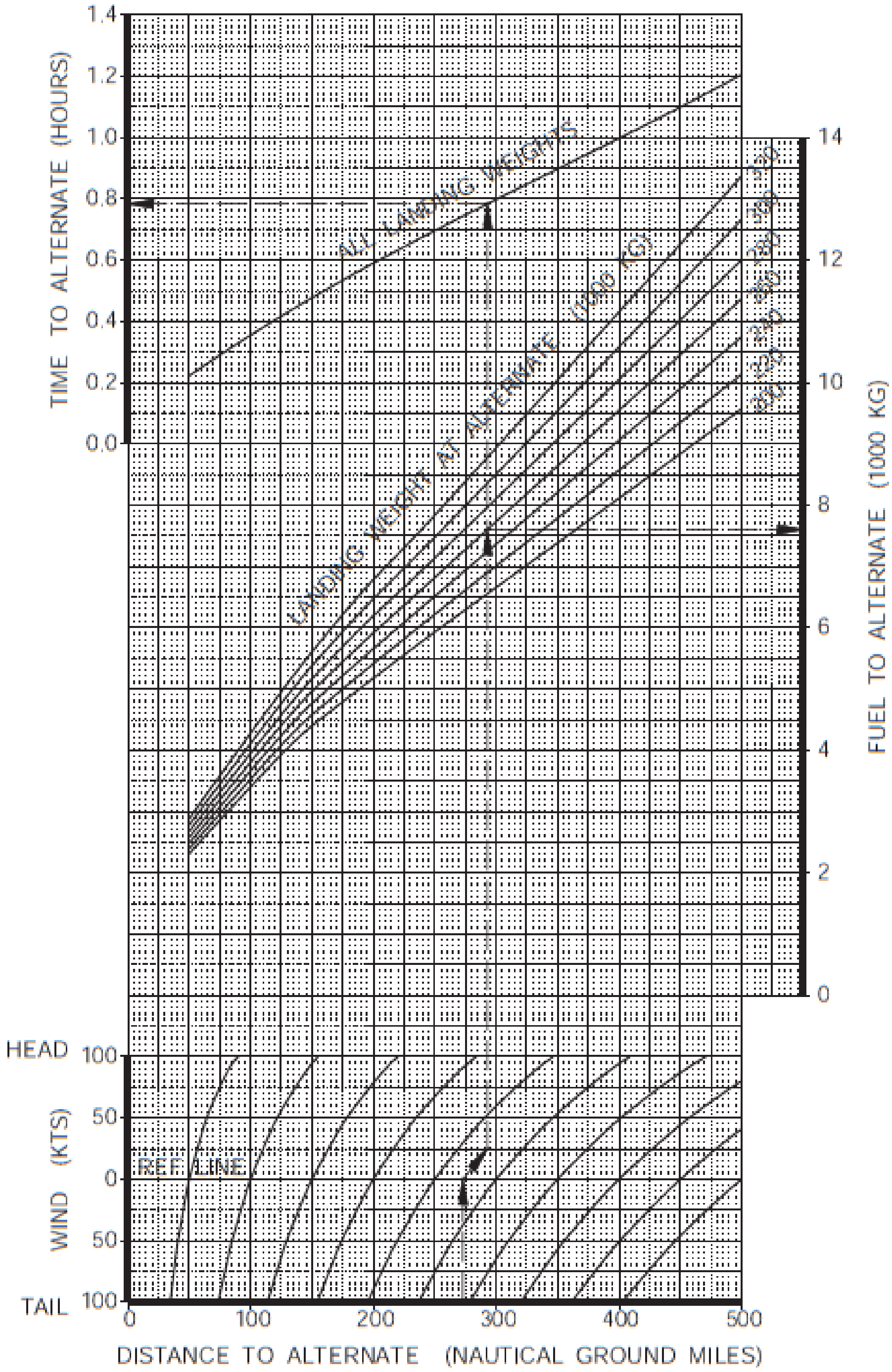
PRESSURE ALTITUDE (FT)	TOTAL FUEL FLOW (KG/HR) WEIGHT (1000 KG)											
	420	400	380	360	340	320	300	280	260	240	220	200
20000	14770	13940	13150	12370	11620	10890	10170	9470	8790	8140	7520	6900
15000	14710	13930	13170	12420	11690	10960	10240	9540	8840	8150	7490	6850
10000	14550	13800	13070	12340	11620	10910	10210	9520	8840	8180	7530	6900
5000	14460	13730	13010	12290	11590	10880	10190	9520	8860	8210	7580	6980
1500	14500	13770	13050	12340	11630	10940	10260	9590	8950	8320	7700	7110

These tables include 5% additional fuel for holding in a racetrack pattern.
Holding at flaps 1 in icing conditions is not recommended.

B Long range cruise trip fuel and time



C Long range cruise short trip fuel and time

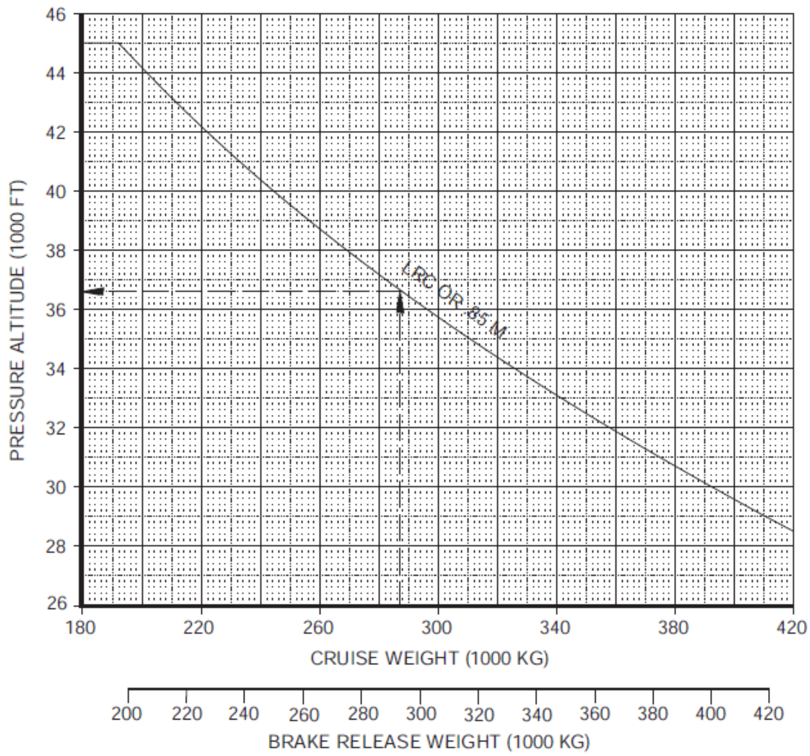


D Descent table

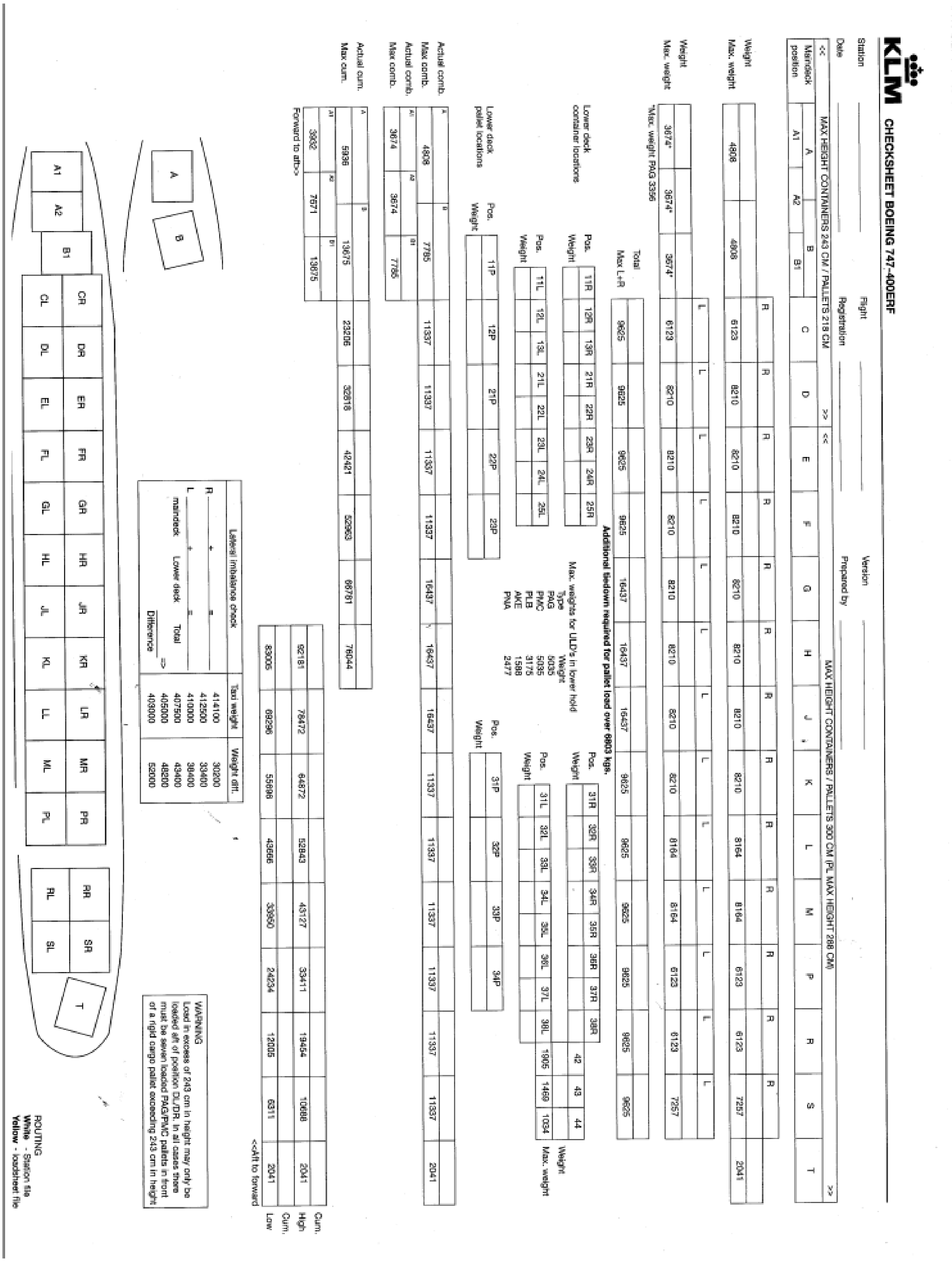
PRESSURE ALTITUDE (FT)	.84/290/250			.84/320/250			.86/340/250			.88/340/250		
	TIME (MIN)	FUEL (KG)	DISTANCE (NM)	TIME (MIN)	FUEL (KG)	DISTANCE (NM)	TIME (MIN)	FUEL (KG)	DISTANCE (NM)	TIME (MIN)	FUEL (KG)	DISTANCE (NM)
45000	28	1120	159	26	1070	152	24	1050	147	24	1040	144
43000	27	1110	155	25	1060	147	24	1040	142	24	1030	140
41000	26	1100	149	24	4050	142	23	1030	137	23	1020	135
39000	26	1090	144	24	1040	136	23	1020	132	22	1010	131
37000	25	1070	138	23	1030	131	22	1000	127	22	1000	126
35000	24	1060	133	22	1010	126	21	990	122	21	990	122
33000	23	1040	126	22	1000	120	21	980	117	21	980	117
31000	23	1020	119	21	980	116	20	960	112	20	970	113
29000	22	1000	112	20	970	110	20	950	108	20	950	109
27000	21	970	104	20	950	103	19	930	102	19	930	102
25000	19	940	97	19	920	96	18	910	95	18	910	95
23000	18	910	89	18	900	89	17	890	89	17	890	89
21000	17	880	82	17	870	82	17	860	82	17	860	82
19000	16	850	75	16	840	75	16	840	76	16	840	76
17000	15	820	68	15	810	69	15	820	70	15	820	70
15000	14	780	61	14	780	63	14	790	64	14	790	64
10000	10	650	41	10	650	41	10	650	41	10	650	41
5000	7	510	24	7	510	24	7	510	24	7	510	24
1500	4	400	12	4	400	12	4	400	12	4	400	12

Allowances for a straight in approach are included.

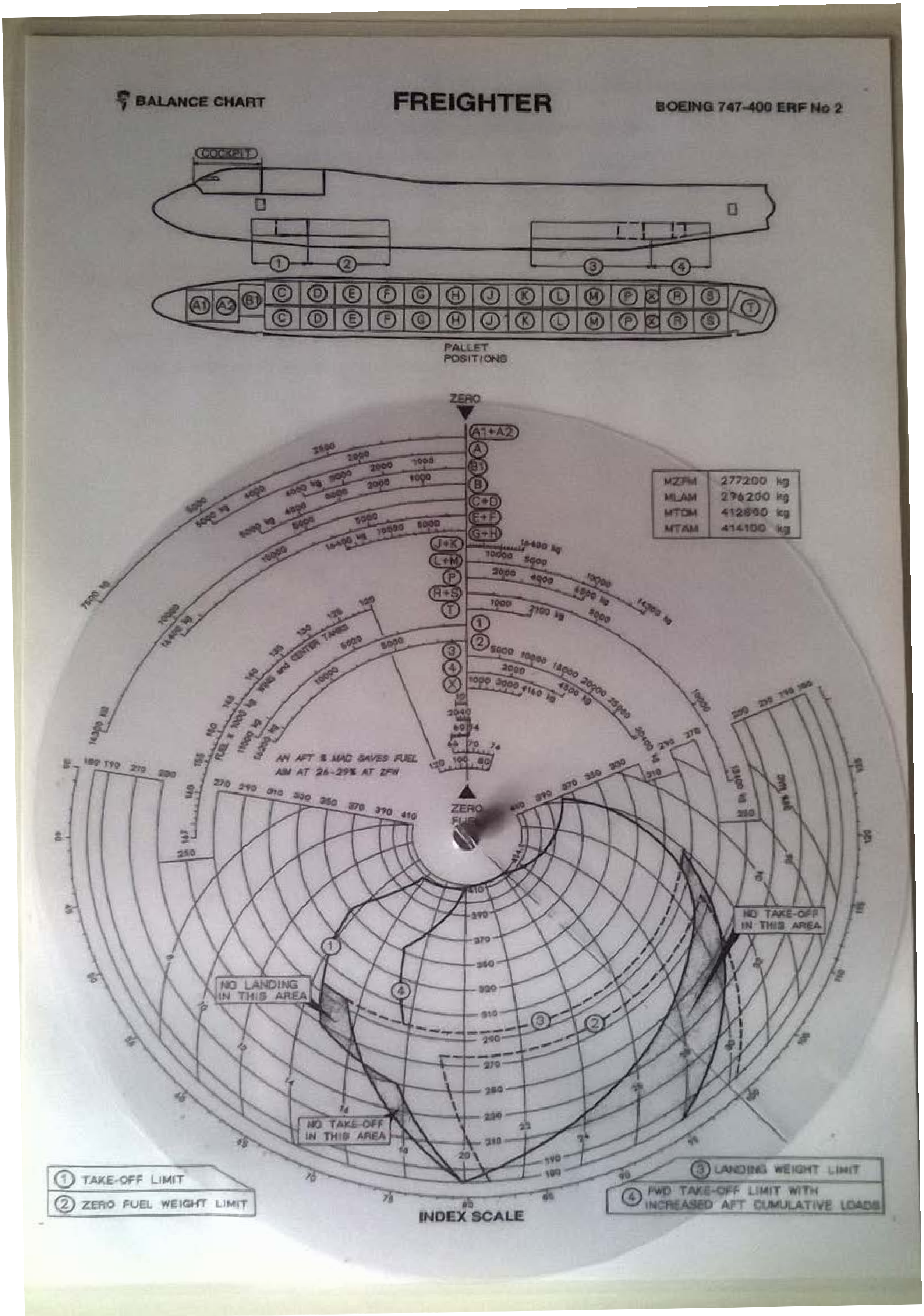
E Optimal altitude chart



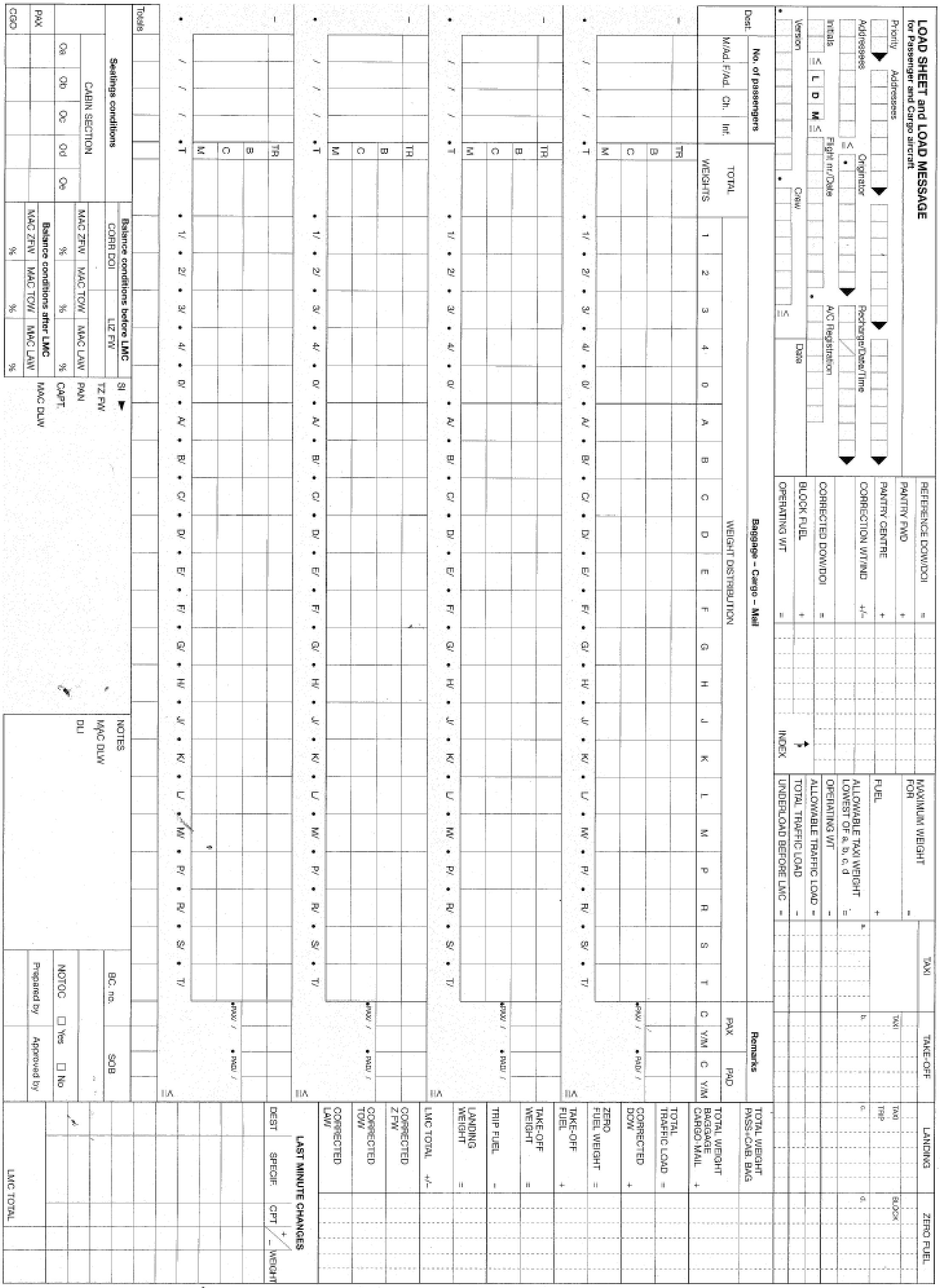
Appendix IX. **Check sheet**



Appendix X. Balance chart



Appendix XI. **Load sheet**


KLM 5656-09.97

LOAD SHEET and LOAD MESSAGE for Passenger and Cargo aircraft

Appendix XII. **ATS Flight Plan**

Form Approved: OMB NO. 2120-0026

U.S. Department of Transportation
Federal Aviation Administration

International Flight Plan

PRIORITY ADDRESSEE(S)

≪≡ FF →

≪≡

FILING TIME ORIGINATOR

→ ≪≡

SPECIFIC IDENTIFICATION OF ADDRESSEE(S) AND / OR ORIGINATOR

3 MESSAGE 7 AIRCRAFT IDENTIFICATION 8 FLIGHT RULES TYPE OF FLIGHT

≪≡ (FPL — — — ≪≡

9 NUMBER TYPE OF WAKE TURBULENCE CAT. 10 EQUIPMENT

— / — / ≪≡

13 DEPARTURE AERODROME TIME

— ≪≡

15 CRUISING SPEED LEVEL ROUTE

— →

≪≡

TOTAL EET

16 DESTINATION HR MIN ALTN AERODROME 2ND ALTN AERODROME

— → → ≪≡

18 OTHER INFORMATION

—

≪≡

19 SUPPLEMENTARY INFORMATION (NOT TO BE TRANSMITTED IN FPL MESSAGES)

HR MIN PERSONS ON BOARD EMERGENCY UHF VHF ELBA

– E/ → P/ → R/ U V E

SURVIVAL EQUIPMENT JACKETS

POLAR DESER MARITIM JUNGLE LIGHT FLUORE UHF VHF

→ S P D M J → J / L F U V

DINGHIES

NUMBER CAPACITY COVER COLOUR

→ D / → → C

AIRCRAFT COLOR AND MARKINGS

A /

REMARKS

→ N / ≪≡

PILOT-IN-COMMAND

C /)≪≡

FILED BY ACCEPTED BY ADDITIONAL INFORMATION

FAA Form 7233-4 (7-93)

(Continues on the next page)

The ATS flight plan content has nine items:

- Item 7
- Item 8
- Item 9
- Item 10
- Item 13
- Item 15
- Item 16
- Item 18
- Item 19

Ad 3. *Item 7*

This item contains the Aircraft Indication. This consists of the aircraft registration letters or the company designator followed by the flight number, which are to be used by air traffic services for radiotelephony communication and coordination. For example PHCKC

Ad 4. *Item 8*

This contains the Flight Rules and type of flight. It indicates both flight rules and type of flight. For flight rules insert one of the following letters to denote the category of flight rules:
I - IFR
V - VFR
Y - IFR first then VFR
Z - VFR first then IFR

Then insert one of the following letters to denote the Type of Flight:
S - Scheduled air service
N - Non-scheduled air service
G - General aviation
M -military
X - other than the preceding categories

Ad 5. *Item 9*

The number and type of aircraft and wake turbulence category is contained in item 9. Type of aircraft designators are stated in ICAO Doc 8643, for example a Boeing 747-400 is stated as B744. Then fill in the options for the ICAO Wake Turbulence Category:
L – Light, to indicate an aircraft type with a maximum take-off mass of 7000 kg or less
M – Medium, to indicate an aircraft type with a maximum take-off mass of less than 136000 kg, but more than 7000 kg
H – Heavy, to indicate an aircraft type with a maximum take-off mass of 136000 kg or more

Ad 6. *Item 10*

This contains the equipment list, with all the communication, navigation and surveillance equipment carried on board.

The communication (COM)/navigation (NAV) equipment, for example:
D - DME
F - ADF
G - GNSS
H - HF RTF
K - MLS
L - ILS
O – VOR
U – UHF RTF
V – VHF RTF
Z - Other equipment carried

The Surveillance (SSR) equipment, insert one or two of the following letters to describe the SSR equipment on board:
N - None
A - Transponder Mode A
C - Transponder Mode A and Mode C
E -Mode S, including aircraft identification, pressure-altitude and extended squitter (ADS-B) capability
H - Mode S, including aircraft identification, pressure-altitude and enhanced surveillance capability
I - Mode S, including aircraft identification, but no pressure-altitude capability
L -Mode S, including aircraft identification, pressure-altitude, extended squitter (ADS-B) and enhanced surveillance capability
X - Transponder – Mode S without both aircraft identification and pressure altitude transmission
P - Transponder Mode S, including pressure altitude transmission, but no aircraft identification transmission
S - Transponder Mode S, including both pressure-altitude and aircraft identification transmission.

Ad 7. *Item 13*
The Departure Aerodrome and departure time is listed in item 13. For the Departure Aerodrome use the four character ICAO location indicators, for example Amsterdam Airport Schiphol: EHAM. The departure time is indicated in hours and minutes in Co-ordinated Universal Time (UTC).

Ad 8. *Item 15*
This item contains the cruising speed, altitude or level and route of the flight. The cruising speed can be in terms of:

- **Kilometres per hour**, expressed with the letter "**K**", followed by four figures, which indicate the speed. For example K0220 (220 Km/h True Speed)
- **Knots**, expressed with the letter "N", followed by four figures, which indicate the speed. For example N0185 (185 knots True Speed)

The cruising level for the first or the whole portion of the flight can be expressed in terms of:

- **Flight Level**, expressed with the letter "F", followed by three figures, which indicate the altitude. For example F085 (Flight Level 085 or 8500ft).
- **Standard Metric Level in tens of meters**, expressed with the letter "S" followed by three figures. For example S0135 (1350 meters).
- **Altitude in hundreds of feet**, expressed with the letter "A" followed by three figures. For example A067 (6700 feet)
- **Altitude in tens of meters**, expressed with the letter "M", followed by four figures. For example M0955 (9550 meters)

For the flight route, the exact route must be described from departure until arrival, along with changes in flight level, speed and heading.

Ad 9. *Item 16*
The Destination Aerodrome, total Estimated Elapsed Time (EET) and Alternate Aerodrome(s). Like the Departure Aerodrome, the destination Aerodrome is expressed with the four-letter ICAO location indicator, like EHAM. The EET is expressed in hours and minutes of the total flight endurance, not the planned landing time. And the Alternate Aerodrome(s) are expressed, just like the Departure Aerodrome, with the four-letter ICAO location indicator.

Ad 10. *Item 18*
Item 18 consists of all other additional and important information about the flight, which can be helpful to the emergency crew in case of an emergency or failure.

Ad 11. *Item 19*

In item 19 the pilot can provide the information concerning the safety and security of the flight as well as helpful details during search and rescue missions.

Item 19 consists of 9 parts:

E/ – Fuel endurance in hours and minutes
P/ – total number of people on board
R/ – Emergency Radio: Choose UHF [U], VHF [V] or ELT [E]
D/ - Amount of Dinghies on board and the colour.
A/ - Aircraft colour and markings
N/ - Remarks
C/ - Name of the Pilot in Command

If an items are not on board or do not apply, cross out the corresponding letter.

Appendix XIII. Transportation of dangerous goods

A. Packagings

5.2 Packagings

5.2.1 Packagings used for the transport of dangerous goods in excepted quantities must be in compliance with the following:

a) there must be an inner packaging and each inner packaging must be constructed of plastic (when used for liquid dangerous goods it must have a thickness of not less than 0.2 mm), or of glass, porcelain, stoneware, earthenware or metal (see also 4;1.1.3.1) and the closure of each inner packaging must be held securely in place with wire, tape or other positive means; any receptacle having a neck with moulded screw threads must have a leak proof threaded type cap. The closure must be resistant to the contents;

b) each inner packaging must be securely packed in an intermediate packaging with cushioning material in such a way that, under normal conditions of transport, they cannot break, be punctured or leak their contents. The intermediate packaging must completely contain the contents in case of breakage or leakage, regardless of package orientation. For liquid dangerous goods, the intermediate packaging must contain sufficient absorbent material to absorb the entire contents of the inner packaging. In such cases, the absorbent material may be the cushioning material. Dangerous goods must not react dangerously with cushioning, absorbent material and packaging material or reduce the integrity or function of the materials;

c) the intermediate packaging must be securely packed in a strong, rigid outer packaging (wooden, fibreboard or other equally strong material);

d) each package type must be in compliance with the provisions in 5.3;

e) each package must be of such a size that there is adequate space to apply all necessary markings; and

f) overpacks may be used and may also contain packages of dangerous goods or goods not subject to these Instructions.

Source: Technical Instructions for the Safe of Dangerous Goods by Air, Part 3, Paragraph 5.2

B. Codes for designating types of packagings

1.2 Codes for designating types of packagings

1.2.1 Two systems of codes are used in these Instructions for designating types of packagings. The first is based on the
UN Recommendations, Chapter 6, and is applicable to packagings other than inner packagings. The second is applicable to inner packagings.

1.2.2 The code consists of:

— an Arabic numeral indicating the kind of packaging, e.g. drum, jerrican, etc., followed by
— a capital letter(s) in Latin characters indicating the nature of the material, e.g. steel, wood, etc., followed where necessary by
— an Arabic numeral indicating the category of packaging within the kind to which the packaging belongs.

1.2.3 In the case of composite packagings, two capital letters in Latin characters are used in sequence in the second position of the code. The first indicates the material of the inner receptacle and the second that of the outer packaging.

1.2.4 For combination packagings, only the code number for the outer packaging is used.

1.2.5 The following numerals must be used for the kinds of packaging:

1. *Drum*
2. *Reserved*
3. *Jerrican*
4. *Box*
5. *Bag*
6. *Composite packaging.*

1.2.6 The following capital letters must be used for the types of material:

A. Steel (all types and surface treatments)
B. Aluminium
C. Natural wood
D. Plywood
F. Reconstituted wood
G. Fibreboard
H. Plastic material
L. Textile
M. Paper, multiwall
N. Metal (other than steel or aluminium)
P. Glass, porcelain or stoneware

Source: Technical Instructions for the Safe of Dangerous Goods by Air, Part 6, Paragraph 1.2

B. General Applicability

1.1 General Applicability

1.1.3.4 Dangerous goods transported under 1.1.3.1 a), b), c) and d) may be carried on a flight made by the same aircraft before or after a flight for the purposes identified above, when it is impracticable to load or unload the dangerous goods immediately before or after the flight, subject to the following conditions:

a) the dangerous goods must be capable of withstanding the normal conditions of air transport;
b) the dangerous goods must be appropriately identified (e.g. by marking or labelling);
c) the dangerous goods may only be carried with the approval of the operator;
d) the dangerous goods must be inspected for damage or leakage prior to loading;
e) loading must be supervised by the operator;
f) the dangerous goods must be stowed and secured in the aircraft in a manner that will prevent any movement in flight which would change their orientation;
g) the pilot-in-command must be notified of the dangerous goods loaded on board the aircraft and their loading location. In the event of a crew change, this information must be passed to the next crew;
h) all personnel must be trained commensurate with their responsibilities.

Source: Technical Instructions for the Safe of Dangerous Goods by Air, Part 1, Paragraph 1.1

Appendix XIV. Mass and Balance

SUBPART J – MASS AND BALANCE
JAR-OPS 4.605 General
(See Appendix 1 to JAR-OPS 4.605)
(a) An operator shall ensure that during any phase of operation, the loading, mass and centre of gravity of the aircraft complies with the limitations specified in the Aircraft Flight Manual or equivalent document, or the Operations Manual if more restrictive.
(b) An operator must establish the mass and the centre of gravity of any aircraft by actual weighing prior to initial entry into service and thereafter at intervals of 4 years. The accumulated effects of modifications and repairs on the mass and balance must be accounted for and properly documented. Furthermore, aircraft must be reweighed if the effect of modifications on the mass and balance is not accurately known.
(c) When showing compliance with (a) above, an operator must determine the mass of the fuel load by using the actual density or, if not known, the density calculated in accordance with a method specified in the Operations Manual. (See ACJ OPS 4.605(c).)

JAR-OPS 4.607 Terminology
(a) *Dry Operating Mass*. The total mass of the aircraft prepared for a specific type of operation excluding all usable fuel and traffic load.
(b) *Maximum Take-Off Mass*. The maximum permissible total aircraft mass at take-off.
(c) *Maximum Landing Mass*. The maximum permissible total aircraft mass upon landing under normal circumstances.
(d) Traffic Load. The total mass of the passengers, task specialist personnel, carry-on specialist equipment, baggage and freight, but excluding the crew members, is termed the traffic load.

JAR-OPS 4.610 Loading, mass and balance
An operator shall describe in the Operations Manual, the mass and balance system and give an explanation of the principles involved. The methods to be employed when loading must also be detailed so that compliance with JAR-OPS 4.605 can be achieved for all the types of operation that may be undertaken.

JAR-OPS 4.615 Mass values for crew
(a) An operator shall use the following mass values to determine the dry operating mass:
(1) Actual masses including any crew baggage; or
(2) Standard masses of 85 kg for crew members including hand baggage; or
(3) Other standard masses acceptable to the Authority.
(b) On any flight where crew masses, including hand baggage, are expected to exceed the standard crew masses, an operator must determine the actual mass of crew by weighing or by adding an adequate mass increment (See ACJ OPS 4.615(b) & - 4.620(d)). The dry operating mass and the position of the centre of gravity of the aircraft must be corrected accordingly.

JAR-OPS 4.620 Mass values for persons on board other than crew
(a) If used to show compliance with JAR-OPS 4.605(a), an operator shall compute the mass of persons on board other than crew using either the actual weighed mass of each person and the actual weighed mass of baggage or the standard mass values specified in the Table below. The mass of persons on board other than crew may be established by use of a verbal statement by, or on behalf of, each person and adding to it a pre-determined constant to account for hand baggage and clothing (See ACJ OPS 4.620(a)). The procedure specifying when to select actual or standard masses and the procedure to be followed when using verbal statements must be included in the Operations Manual.
(b) If determining the actual mass by weighing, an operator must ensure that personal belongings and hand baggage are included. Such weighing must be conducted immediately prior to boarding and at an adjacent location.
(c) If determining the mass of persons on board other than crew using standard mass values, the standard mass values in the Table below must be used.

Persons on board other than crew	
Male	98 kg
Female	80 kg
Hand baggage(where applicable)	6 kg
Survival suit(where applicable)	3 kg

(d) On any flight identified as carrying a significant number of persons on board other than crew whose masses, including hand baggage, are expected to exceed the standard mass, an operator must determine the actual mass of such persons by weighing or by adding an adequate mass increment. (See ACJ OPS 4.615(b) and OPS 4.620(d)).
(e) An operator shall ensure that a commander is advised when a non-standard method has been used for determining the mass of the load.

Appendix 1 to JAR-OPS 4.605 Mass and Balance – General

(See JAR-OPS 4.605)

(a) Determination of the dry operating mass of an aircraft

(1) Weighing of an aircraft

(i) New aircraft are normally weighed at the factory and are eligible to be placed into operation without reweighing if the mass and balance records have been adjusted for alterations or modifications to the aircraft. Aircraft transferred from one JAA operator with an approved mass control programme to another JAA operator with an approved programme need not be weighed prior to use by the receiving operator unless more than 4 years have elapsed since the last weighing.

(ii) The individual mass and centre of gravity (CG) position of each aircraft shall be re-established periodically. The maximum interval between two weighings must be defined by the operator and must meet the requirements of JAR-OPS 4.605(b). In addition, the mass and the CG of each aircraft shall be re-established either by:

(A) Weighing; or

(B) Calculation, if the operator is able to provide the necessary justification to prove the validity of the method of calculation chosen, whenever the cumulative changes to the dry operating mass exceed ± 0·5% of the maximum landing mass, or for aeroplanes, whenever the cumulative change in CG position exceeds 0·5% of the mean aerodynamic chord.

(2) Weighing procedure

(i) The weighing must be accomplished either by the manufacturer or by an approved maintenance organisation.

(ii) Normal precautions must be taken consistent with good practices such as:

(A) Checking for completeness of the aircraft and equipment;

(B) Determining that fluids are properly accounted for;

(C) Ensuring that the aircraft is clean; and

(D) Ensuring that weighing is accomplished in an enclosed building.

(iii) Any equipment used for weighing must be properly calibrated, zeroed, and used in accordance with the manufacturer's instructions. Each scale must be calibrated either by the manufacturer, by a civil department of weights and measures or by an appropriately authorised organisation within 2 years or within a time period defined by the manufacturer of the weighing equipment, whichever is less. The equipment must enable the mass of the aircraft to be established accurately (See IEM to Appendix 1 to JAR-OPS 4.605, sub-paragraph (a)(2)(iii)).

(b) Special standard masses for the traffic load. In addition to standard masses for persons on board other than crew, an operator may apply to the Authority to use standard masses for other load items.

(c) Aircraft loading

(1) An operator must ensure that the loading of its aircraft is performed under the supervision of qualified personnel.

(2) An operator must ensure that the loading of the freight is consistent with the data used for the calculation of the aircraft mass and balance.

(3) An operator must comply with additional structural limits such as the floor strength, the maximum load per running metre, the maximum mass per cargo compartment, and/or the maximum seating limits.
(4) The operator must take account of in-flight changes in loading (e.g. hoist operations).
(d) Centre of gravity limits
(1) Operational CG envelope. Unless seat allocation is applied and the effects of the number of persons per seat row, of cargo in individual cargo compartments and of fuel in individual tanks is accounted for accurately in the balance calculation, operational margins must be applied to the certificated centre of gravity envelope. In determining the CG margins, possible deviations from the assumed load distribution must be considered. If free seating is applied, the operator must introduce procedures to ensure corrective action prior to take-off –if extreme longitudinal seat selection occurs. The CG margins and associated operational procedures, including assumptions with regard to occupant seating, must be acceptable to the Authority. (See ACJ to Appendix 1 to JAR-OPS 4.605, sub-paragraph (d).)
(2) In-flight centre of gravity. Further to sub-paragraph (d)(1) above, the operator must show that the procedures fully account for the worst case variation in CG travel during flight caused by movements of occupants and load and fuel consumption/transfer.

ACJ OPS 4.605(c) Fuel density

See JAR-OPS 4.605(c). 1 If the actual fuel density is not known, the operator may use the standard fuel density values specified in the Operations Manual for determining the mass of the fuel load. Such standard values should be based on current fuel density measurements for the airports or areas concerned. Typical fuel density values are:

(the SWSG suggested to maintain this ACJ, and Mr Milhan of the SWSG will draft amended text applicable to JAR-OPS 1/2/3/4. The future text will include the change below).

a.	Gasoline (piston engine fuel)	-	0.71
b.	Jet fuel Jet A1 (JP 1)	-	0.79
c.	Jet fuel Jet B (JP 4)	-	0.76
d.	Oil	-	0.88

ACJ to Appendix 1 to JAR-OPS 4.605, sub-paragraph (a)(2)(iii) Accuracy of weighing equipment

See Appendix 1 to JAR-OPS 4.605, sub-paragraph (a)(2)(iii)

1 The mass of the aircraft as used in establishing the dry operating mass and the centre of gravity must be established accurately. [Since a certain model of weighing equipment is used for initial and periodic weighing aircraft of widely different mass classes, one single accuracy criterion for weighing equipment cannot be given.] However, the weighing accuracy is considered satisfactory if the following accuracy criteria are met by the individual scales/cells of the weighing equipment used:

a.	For a scale/cell load below 2,000 kg	-	an accuracy of ± 1%;
b.	For a scale/cell load from 2,000 kg to 20,000 kg	-	an accuracy of ± 20 kg; and
c.	For a scale/cell load above 20,000 kg	-	an accuracy of ± 0.1 %.

ACJ to Appendix 1 to JAR-OPS 4.605, sub-paragraph (d) Centre of gravity limits

See Appendix 1 to JAR-OPS 4.605, sub-paragraph (d)

1 In the Certificate Limitations section of the Aircraft Flight Manual, centre of gravity (CG) limits are specified. These limits ensure that the certification stability and control criteria are met throughout the whole flight. An operator should ensure that these limits are observed by defining operational procedures or a CG envelope which compensates for deviations and errors as listed below.

1.1 Deviations of actual CG at empty or operating mass from published values due, for example, to weighing errors, unaccounted modifications and/or equipment variations.

1.2 Deviations in fuel distribution in tanks from the applicable schedule.

1.3 Deviations in the distribution of baggage and cargo in the various compartments as compared with the assumed load distribution as well as inaccuracies in the actual mass of baggage and cargo.

1.4 Deviations in actual occupant seating from the seating distribution assumed when preparing the mass and balance documentation. (See Note)

1.5 Deviations of the actual CG of cargo and occupant load within individual cargo compartments or cabin sections from the normally assumed mid position.

1.6 Deviations of the CG caused by application of the prescribed fuel usage procedure (unless already covered by the certified limits).

1.7 Deviations caused by in-flight movement of occupants and loads.

ACJ OPS 4.615(b) and OPS 4.620(d) Adjustment of standard masses

See JAR-OPS 4.615(b) and JAR-OPS 4.620(d)

When standard mass values are used, the Operations Manual should contain appropriate directives to ensure that, on aircraft where the risks of overload and/or CG errors are the greatest, commanders pay special attention to the load and its distribution and make proper adjustments.

Appendix XV. Flight Preparation

JAR–OPS 1.290 Flight preparation

(a) An operator shall ensure that an operational flight plan is completed for each intended flight.

(b) The commander shall not commence a flight unless he is satisfied that:

(1) The aeroplane is airworthy;

(2) The aeroplane is not operated contrary to the provisions of the Configuration Deviation List (CDL);

(3) The instruments and equipment required for the flight to be conducted, in accordance with Subparts K and L, are available;

(4) The instruments and equipment are in operable condition except as provided in the MEL;

(ii) **[ ] [**The operator's**]** approved ETOPS diversion time, **[**subject to any MEL restriction, up to a maximum of two hours**], [ ]** at the one-engine-inoperative cruising speed according to the AFM in still air standard conditions **[**based on the actual take-off mass**]** for aeroplanes and crews authorised for ETOPS; or

(2) Two hours flight time at a one-engine-inoperative cruising speed according to the AFM in still air standard conditions based on the actual take-off mass for three and four-engined aeroplanes; and

(3) If the AFM does not contain a one-engine-inoperative cruising speed, the speed to be used for calculation must be that which is achieved with the remaining engine(s) set at maximum continuous power.

(c) An operator must select at least one destination alternate for each IFR flight unless:

(1) Both:

(i) The duration of the planned flight from take-off to landing does not exceed 6 hours; and

(ii) Two separate runways are available **[**and useable**]** at the destination and **[**the appropriate weather reports or forecasts for the destination aerodrome, or any combination thereof, indicate that**]** for the period from one hour before until one hour after the expected time of arrival at destination, **[**the ceiling will be at least 2 000 ft or circling height + 500 ft, whichever is greater, and the visibility will be at least 5 km.**]** (see IEM OPS 1.295(c)(1)(ii)); or

(2) The destination is isolated and no adequate destination alternate exists.

(d) An operator must select two destination alternates when:

(1) The appropriate weather reports or forecasts for the destination, or any combination thereof, indicate that during a period commencing 1 hour before and ending 1 hour after the estimated time of arrival, the weather conditions will be below the applicable planning minima; or

(2) No meteorological information is available.

(e) An operator shall specify any required alternate(s) in the operational flight plan.

Appendix XVI. **Planning minima**

JAR-OPS 1.297 Planning minima for IFR flights

(a) *Planning minima for a take-off alternate aerodrome.* An operator shall only select an aerodrome as a take-off alternate aerodrome when the appropriate weather reports or forecasts or any combination thereof indicate that, during a period commencing 1 hour before and ending 1 hour after the estimated time of arrival at the aerodrome, the weather conditions will be at or above the applicable landing minima specified in accordance with JAR-OPS 1.225. The ceiling must be taken into account when the only approaches available are non-precision and/or circling approaches. Any limitation related to one engine inoperative operations must be taken into account.

(b) *Planning minima for a destination aerodrome (except isolated destination aerodromes).* An operator shall only select the destination aerodrome when :

(1) the appropriate weather reports or forecasts, or any combination thereof, indicate that, during a period commencing one hour before and ending one hour after the estimated time of arrival at the aerodrome, the weather conditions will be at or above the applicable planning minima as follows:
  (i) RVR/visibility specified in accordance with JAR-OP S 1.225; and
  (ii) For a non-precision approach or a circling approach, the ceiling at or above MDH; or

(2) Two destination alternate aerodromes are selected under JAR OPS 1.295 (d)

(c) *Planning minima for a:*
- *destination alternate aerodrome,*
- *isolated aerodrome*
- *3% ERA aerodrome,*
- *en-route alternate aerodrome required at the planning stage*

An operator shall only select an aerodrome for one of those purposes when the appropriate weather reports or forecasts, or any combination thereof, indicate that, during a period commencing 1 hour before and ending 1 hour after the estimated time of arrival at the aerodrome, the weather conditions will be at or above the planning minima in Table 1 below.

Table 1 Planning minima.– Destination alternate aerodrome, isolated destination aerodrome, 3% ERA and en-route alternate aerodrome

Type of approach	Planning Minima
Cat II and III	Cat I (Note 1)
Cat I	Non-precision (Notes 1 & 2)
Non-precision	Non-precision (Notes 1 & 2) plus 200 ft/1 000 m
Circling	Circling

Note 1 RVR.
Note 2 The ceiling must be at or above the MDH.

JAR-OPS 1.340 Meteorological Conditions

(a) On an IFR flight a commander shall only:

(1) commence take-off;

(2) continue beyond the point from which a revised flight plan applies in the event of in-flight re-planning,

when information is available indicating that the expected weather conditions***, at the expected time of arrival,*** at the destination and/or required alternate aerodrome(s) prescribed in JAR-OPS 1.295 are at or above the planning minima, prescribed in JAR-OPS 1.297.

(b) On an IFR flight, a commander shall only continue towards the planned destination aerodrome when the latest information available indicates that, at the expected time of arrival, the weather conditions at the destination, or at least one destination alternate aerodrome, are at or above the applicable aerodrome operating minima.

(c) On an IFR flight a commander shall only continue beyond:

(1) the decision point when using the ***Reduced Contingency Fuel Procedure (Appendix 1 to JAR OPS 1.255 paragraph 2 refers) or***

(2) the pre-determined point when using the pre-determined point procedure (AMC OPS 1.255, paragraph 4 refers) (Appendix 1 to JAR-OPS 1.255 paragraph 3 refers),

when information is available indicating that the expected weather conditions***, at the expected time of arrival,*** at the destination and/or required alternate aerodrome(s) prescribed in JAR-OPS 1.295 are at or above the applicable aerodrome operating minima prescribed in JAR-OPS 1.225.

(d) On a VFR flight a commander shall only commence take-off when ***the appropriate weather reports or forecasts, or any combination thereof***, current meteorological reports or a combination of current reports and forecasts indicate that the meteorological conditions along the route or that part of the route to be flown under VFR will, at the appropriate time, be such as to render compliance with these rules possible.

JAR–OPS 1.350 Fuel and oil supply

A commander shall ***only*** commence a flight ***or continue in the event of inflight re-planning when*** he is satisfied that the aeroplane carries at least the planned amount of ***usable*** fuel and oil to complete the flight safely, taking into account the expected operating conditions.

Appendix XVII. **N-2**

JAR-OPS 1.505 En-route – Aeroplanes with three or more engines, two engines inoperative

(a) An operator shall ensure that at no point along the intended track will an aeroplane having three or more engines be more than 90 minutes, at the all-engines long range cruising speed at standard temperature in still air, away from an aerodrome at which the performance requirements applicable at the expected landing mass are met unless it complies with sub-paragraphs (b) to (f) below.

(b) The two engines inoperative en-route net flight path data must permit the aeroplane to continue the flight, in the expected meteorological conditions, from the point where two engines are assumed to fail simultaneously, to an aerodrome at which it is possible to land and come to a complete stop when using the prescribed procedure for a landing with two engines inoperative. The net flight path must clear vertically, by at least 2 000 ft all terrain and obstructions along the route within 9•3 km (5 nm) on either side of the intended track. At altitudes and in meteorological conditions requiring ice protection systems to be operable, the effect of their use on the net flight path data must be taken into account. If the navigational accuracy does not meet the 95% containment level, an operator must increase the width margin given above to 18•5 km (10 nm).

(c) The two engines are assumed to fail at the most critical point of that portion of the route where the aeroplane is more than 90 minutes, at the all engines long range cruising speed at standard temperature in still air, away from an aerodrome at which the performance requirements applicable at the expected landing mass are met.

(d) The net flight path must have a positive gradient at 1500 ft above the aerodrome where the landing is assumed to be made after the failure of two engines.

(e) Fuel jettisoning is permitted to an extent consistent with reaching the aerodrome with the required fuel reserves, if a safe procedure is used.

(f) The expected mass of the aeroplane at the point where the two engines are assumed to fail must not be less than that which would include sufficient fuel to proceed to an aerodrome where the landing is assumed to be made, and to arrive there at least 1 500 ft directly over the landing area and thereafter to fly level for 15 minutes.

Appendix XVIII. Airport NOTAM

A. EHAM – Amsterdam Schiphol

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EHAM /AMS   AMSTERDAM/SCHIPHOL
------------------------------
+++++++++++++++++++++++++++++ AIRPORT ++++++++++++++++++++++++++++++
1A86/14
  2100-0500
  TWY Y CLSD.
1A85/14
  2100-0500
  TWY C CLSD.
1A72/14
  HOLDING POSITION ESTABLISHED ON TWY A17 ABEAM ACFT STAND G6 FOR
  ACFT
  WITH WINGSPAN LARGER THAN 61M, ACFT PARKING AT ACFT STANDS G4, G6
  WILL BE TOWED FROM THIS POINT, ACFT DEPARTING FROM STANDS G4, G6
  WILL BE PULLED TO THIS POINT.
1A1646/13
  MIGRATING GEESE CROSSING EHAM AREA AT 300-700FT AROUND SR AND SS.
  PILOTS ARE ADVISED TO EXERCISE EXTREME CAUTION DURING LANDING AND
  TAKE-OFF.
1A1628/13
  TWY A9C CLSD.
1A1587/13
  OBSTACLES ERECTED AT PSN 521710N0044345E, 3900M BEHIND THR RWY 24,
  ON EXTD RCL. ELEV 27FT AMSL.
  REF AIP NETHERLANDS 2.EHAM-AOC-06-24 (14 JAN 10)
1A1494/13
  CRANE ERECTED AT PSN 521818N 0044503E, 500M WEST OF TWR-C.
  HGT 210FT, ICAO MARKED AND LIGHTED.
1A1308/13
  CRANE ERECTED AT PSN 521720N 0044217E, ELEV 218FT AMSL. ICAO
  MARKED DAY/NIGHT.
1A441/13
  ACFT STANDS D2, D4 AND D8: APRON LIGHTING MASTS (FLOOD LIGHTING)
  TRIAL IN PROGRESS. LIGHTING INTENSITY IS ADJUSTABLE, WITH
  DIFFERENT
  ILLUMINATION OF THE ACFT STANDS AS A RESULT.
CC118/13 - CHART NOTAM
  AOI IAC SID SIDPT ARR/ DEP NIGHT OPERATION:
  START OF NIGHT TIME PROCEDURES CHANGED/EXTENDED (TRIAL):
  RWY RESTRICTIONS, SUPPLEMENTARY SIDS AND RNAV TR VALID DURING
  NIGHT STARTING NOW FROM 2130 ISO 2200.
+++++++++++++++++++++++++++++ SID/STAR +++++++++++++++++++++++++++++
SX4/13
  SX0004/13 AIP SUPPLEMENT
  EHAM/AMSTERDAM/SCHIPHOL
  UNTIL 07 MAR 2014 CRANE IS ERECTED NORTH-EAST OF EHAM AIRPORT.
  POSITION 522008N0045142E HEIGHT 322 FT AGL, ELEV 326 FT, ICAO DAY
  AND NIGHT MARKED.THE OBSTACLE AFFECTS THE STSNDARD INSTRUMENT

  DEPARTURES OF RWY 04 AND 09.
  THE FOLLOWING MINIMUM CLIMB GRADIENT ARE REQUIRED.
  SIDS RWY 04:
  ANDIK 2F 4.3% TO 1000FT AMSL
  ARNEM 2F 4.3% TO 1000FT AMSL
  LEKKO 1F 4.3% TO 1000FT AMSL
  LOPIK 1F 4.3% TO 1000FT AMSL
  LUNIX 1F 4.3% TO 1000FT AMSL
  SIDS RWY 09:
  BERGI 2N 4.1% TO 1000FT AMSL
  GORLO 2N 4.1% TO 1000FT AMSL
```

B. PANC – Anchorage

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===================================
DESTINATION AIRPORT - DETAILED INFO
===================================

PANC /ANC   ANCHORAGE/TED STEVENS ANC INTL
------------------------------------------
++++++++++++++++++++++++ APPROACH PROCEDURE ++++++++++++++++++++++++
1A3121/12
  B747-400, B757, AND B767, USING INERTIAL REFERENCE SYSTEM MAGVAR
  TABLES PRIOR TO 2005 EPOCH YEAR, ARE PROHIBITED FROM CONDUCTING
  ILS
  APPROACHES BELOW STANDARD CAT I WEATHER MINIMA AT ANCHORAGE
  INTERNATIONAL AIRPORT (PANC). AIRCRAFT OPERATORS MUST REVIEW THEIR
  EQUIPMENT AND PROVIDE POSITIVE CONFIRMATION TO THE CAPTAIN IF
  THEIR
  SPECIFIC AIRCRAFT MEETS THIS REQUIREMENT. ABSENT THIS REVIEW AND
  POSITIVE NOTIFICATION, ILS OPERATIONS BELOW STANDARD CAT I WEATHER
  MINIMA ARE PROHIBITED FOR THESE SERIES AIRCRAFT. THESE SERIES
  AIRCRAFT HAVE EXPERIENCED A SHIFT OF RUNWAY CENTERLINE
  PRESENTATION
  AND DEGRADED LOCALIZER TRACKING PERFORMANCE ON ILS APPROACHES. FOR
  FURTHER INFORMATION CONTACT NORTHWEST MOUNTAIN REGIONAL OPERATIONS
  CENTER AT 425-227-1389 OR 9-ANM-ROC? FAA.GOV, OR ALASKA REGIONAL
  OPERATIONS CENTER AT 907-271-5936 OR 9-AAL-DUTY-OFFICER? FAA.GOV.
+++++++++++++++++++++++++++++ AIRPORT ++++++++++++++++++++++++++++++
1A963/14 VALID: 1401280359 - 1401290359
  ALL TWYS WET
1A962/14 VALID: 1401280403 - 1401290403
  ALL RAMPS ICE
```

C. Alternate – ENZV

```
==================
ENROUTE AIRPORT(S)
==================

ENZV /SVG   STAVANGER/SOLA
--------------------------
++++++++++++++++++++++++++++++ RUNWAY ++++++++++++++++++++++++++++++
1A2736/13
  180 DEGREES TURN FOR BACKTRACK ON RWY 11/29 SHALL BE COMPLETED
  EITHER EAST OF TWY D OR AT THE CONCRETE AREA WEST OF THR 11
1A1231/13
  CHANGE MISSED APCH TEXT TO:
  CLIMB ON R-101/R-281 ZOL TO 2000FT. INFORM ATC.
  REF AIP NORWAY AD2 ENZV 5-17, VOR RWY 29, DATED 13 DEC 2012
++++++++++++++++++++++++ APPROACH PROCEDURE ++++++++++++++++++++++++
1A3626/12
  CHANGE LOC OCA (H) TO 470(463) OCA (H) INCREASED DUE BOATS CROSSING
  LOC CENTRELINE NEAR MAPT. REF AD2 ENZV 5-13 DATED 13 DEC 2012
+++++++++++++++++++++++++++++ AIRPORT ++++++++++++++++++++++++++++++
CC28/13 - CHART NOTAM
  AGC ALL RWYS:
  THE PAVED AREA IN FRONT OF ALL THRS IS AVAILABLE FOR TAKE-OFF
  AND THE LENGTH IS INCLUDED IN DECLARED DISTANCES.
```

D. Alternate – BGSF

```
BGSF /SFJ   KANGERLUSSUAQ
-------------------------
+++++++++++++++++++++++++++++ AIRPORT ++++++++++++++++++++++++++++++
CC2/14 - CHART NOTAM
  IAC ALL APCHS:
  NAVAID NAME ISF: LOC RWY 09 ISO LOC RW10
```

E. Alternate – PAFA

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DESTINATION ALTERNATE AIRPORT(S)
================================

PAED /EDF   ANCHORAGE/ELMENDORF AFB
-----------------------------------
NIL

PAFA /FAI   FAIRBANKS INTL
--------------------------
++++++++++++++++++++++++ APPROACH PROCEDURE ++++++++++++++++++++++++
1A3968/13
  RNAV (GPS) RWY 20L, ORIG-B...
     WHEN VGSI INOPERATIVE, PROCEDURE NA AT NIGHT.
     VDP NA.
1A3664/12

  EFFECTIVE 1208271840 UNTIL FURTHER NOTICE.
  B-747-400, B-757, AND B-767, USING INERTIAL REFERENCE SYSTEM
  MAGVAR
  TABLES PRIOR TO 2005 EPOCH YEAR, ARE PROHIBITED FROM CONDUCTING
  ILS
  APPROACHES BELOW STANDARD CAT I WEATHER MINIMA AT FAIRBANKS
  INTERNATIONAL AIRPORT (PAFA). AIRCRAFT OPERATORS MUST REVIEW THEIR
  EQUIPMENT AND PROVIDE POSITIVE CONFIRMATION TO THE CAPTAIN IF
  THEIR
  SPECIFIC AIRCRAFT MEETS THIS REQUIREMENT. ABSENT THIS REVIEW AND
  POSITIVE NOTIFICATION, ILS OPERATIONS BELOW STANDARD CAT I WEATHER
  MINIMA ARE PROHIBITED FOR THESE SERIES AIRCRAFT. THESE SERIES
  AIRCRAFT HAVE EXPERIENCED A SHIFT OF RUNWAY CENTERLINE
  PRESENTATION
  AND DEGRADED LOCALIZER TRACKING PERFORMANCE ON ILS APPROACHES. FOR
  FURTHER INFORMATION CONTACT NORTHWEST MOUNTAIN REGIONAL OPERATIONS
  CENTER AT 425-227-1389 OR 9-ANM-ROCFAA.GOV, OR ALASKA REGIONAL
  OPERATIONS CENTER AT 907-271-5936 OR 9-AAL-DUTY-OFFICERFAA.GOV.
```

Appendix XIX. Minimum equipment list (1)

Section 2 | 747-400 Minimum Equipment List | ATA 32
MEL | | Landing Gear

ITEM	REPAIR INTERVAL	NUMBER INSTALLED	NUMBER REQUIRED FOR DISPATCH	REMARKS OR EXCEPTIONS
Wheel Brakes 32-41-01-01	C	16	14	(M) (O) (T) One or two brakes may be deactivated with a deactivation tool provided: a) Affected brake(s) is not leaking or damaged, b) Take-off and landing performance is calculated for two brakes deactivated, c) All reversers are operative, and d) Aircraft is not dispatched from or to a contaminated runway.

Appendix XX. Minimum equipment list (2)

KLM

ATA 74 | 747-400 Minimum Equipment List | Section 2
Ignition | | MEL

ITEM	REPAIR INTERVAL	NUMBER INSTALLED	NUMBER REQUIRED FOR DISPATCH	REMARKS OR EXCEPTIONS
74-00-01 Ignition Systems	C	8	4	(O) (T) One per engine may be inoperative provided: a) Nacelle anti-ice system on the associated engine operates normally, and b) Ignition Selector is positioned to ensure ignition to all engines.

EICAS STATUS MESSAGES

ENG _ IGNITOR 1
ENG _ IGNITOR 2

OPERATIONS (O)

1. To ensure Ignition to all engines, select Auto Ignition Selector to BOTH.

Appendix XXI. **Brake Unit MEL item**

OPERATIONS (O)

Passenger/Combi Aircraft:

1. **ONE OR TWO BRAKES DEACTIVATED WITH DEACTIVATION TOOL:**

   A. When brakes are deactivated with the deactivation tool, gear retract braking remains operative. Normal gear retraction procedure may be used. Stopping distances will increase. Therefore, takeoff and landing performance must be corrected for Two Brakes Deactivated.

   B. When LINTOP performance calculation is available:

      1) On ACARS PERF page 2/2 MEL/CDL insert code: **"32-41-01A"**

      2) For landing runway length limited weight, refer to Flight Crew Operations Manual, Performance Dispatch-Landing, Landing Field Limit Weight Passenger/Combi.

   C. In case a manual performance calculation is needed:

      1) Use FULL take-off thrust.

      2) Determine the runway length/obstacle limited take-off weight from the TL table.

      3) Correct for non-standard QNH, NacelleAnti-ice and/or Packs, if applicable.

      4) Reduce this weight by the applicable tabulated weight reduction from the table below.

      5) Determine V_1 DRY or WET for this corrected runway length/obstacle limited take-off weight and reduce it by the applicable tabulated speed reduction from the table below, refer to next pages for Passenger/Combi Takeoff Speeds table.

AUTOSPOILERS Operative	Runway condition	
	DRY	WET
Weight reduction (kg)	2,000	3,000
V_1 reduction (kt)	2	4

AUTOSPOILERS Inoperative	Runway condition	
	DRY	WET
Weight reduction (kg)	9,000	10,000
V1 reduction (kt)	5	7

      6) Check reduced V_1 DRY or WET against V_{MCG}, refer to next pages for Passenger/Combi Takeoff Speeds table.

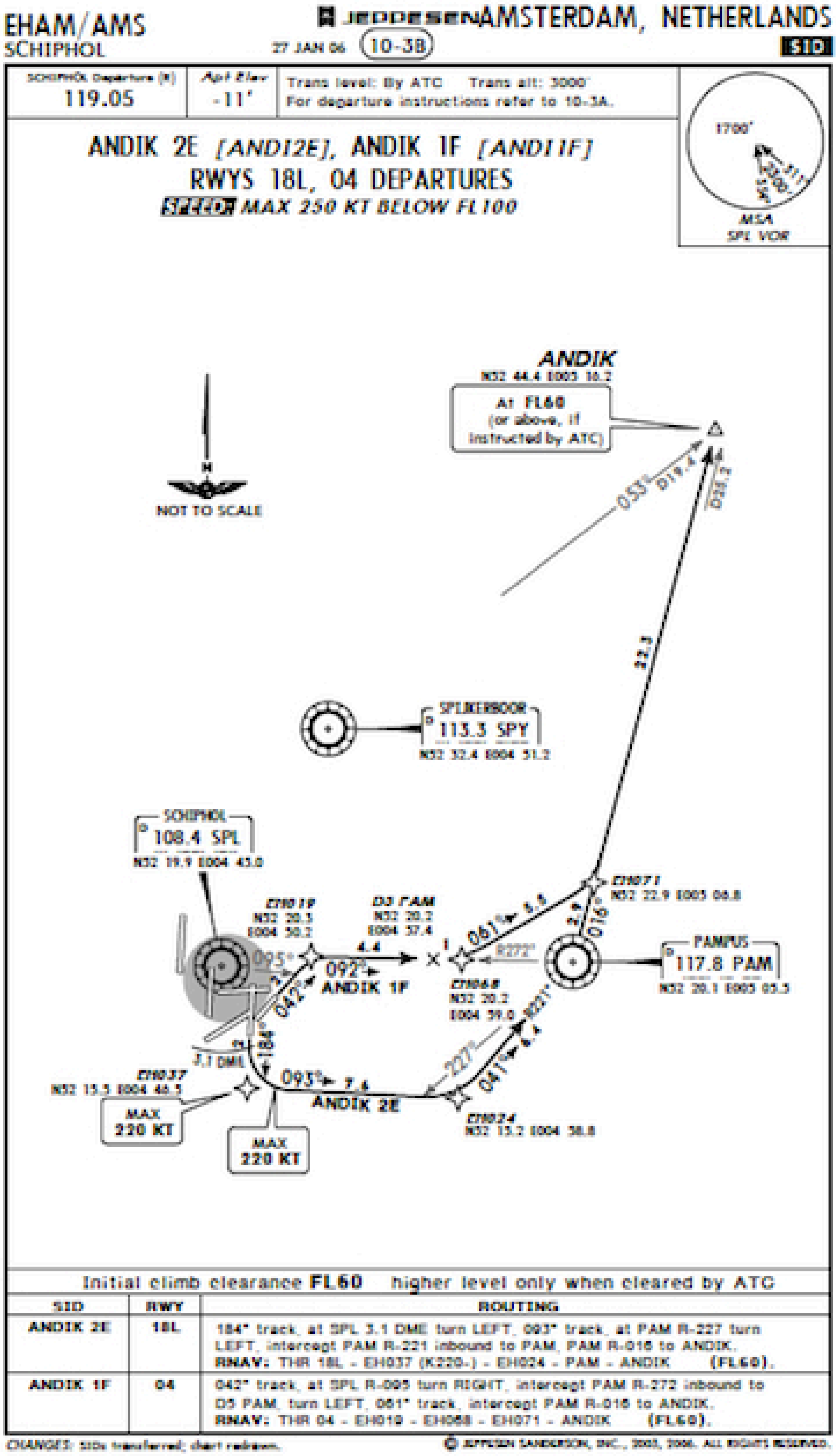
Reduced V_1 DRY or WET less than V_{MCG}	Reduced V_1 DRY or WET exceeds V_{MCG}
Take-off is permitted with V_1 increased to V_{MCG} provided that the available runway length exceeds: DRY runway - 2,000 m. WET runway - 2,400 m. The performance limited take-off weight is the lower of the corrected runway length/obstacle limited take-off weight determined above and the climb limited take-off weight (corrected for QNH, NAI, and/or PACKS, if applicable) from the TL table.	The performance limited take-off weight is the lower of the corrected runway length/obstacle limited take-off weight determined above and the climb limited take-off weight (corrected for QNH, NAI, and/or PACKS, if applicable) from the TL table. Compare the reduced V_1 DRY or WET with V_1 DRY or WET for the actual take-off weight and use the lower as operational V_1 (with V_{MCG} as a minimum).

      7) Check V_1 DRY or WET for the performance limited take-off weight against V_{MBE} for that same weight according to Passenger/Combi Brake Energy Limits chart on the next pages. The resulting V_1 DRY or WET must not be less than V_{MCG}.

      8) Enter V_1 manually on the FMS TAKEOFF REF page.

      9) For landing runway length limited weight, refer to Flight Crew Operations Manual, Performance Dispatch-Landing, Landing Field Limit Weight Passenger/Combi.

Appendix XXII. SID chart runway 18L towards ANDIK

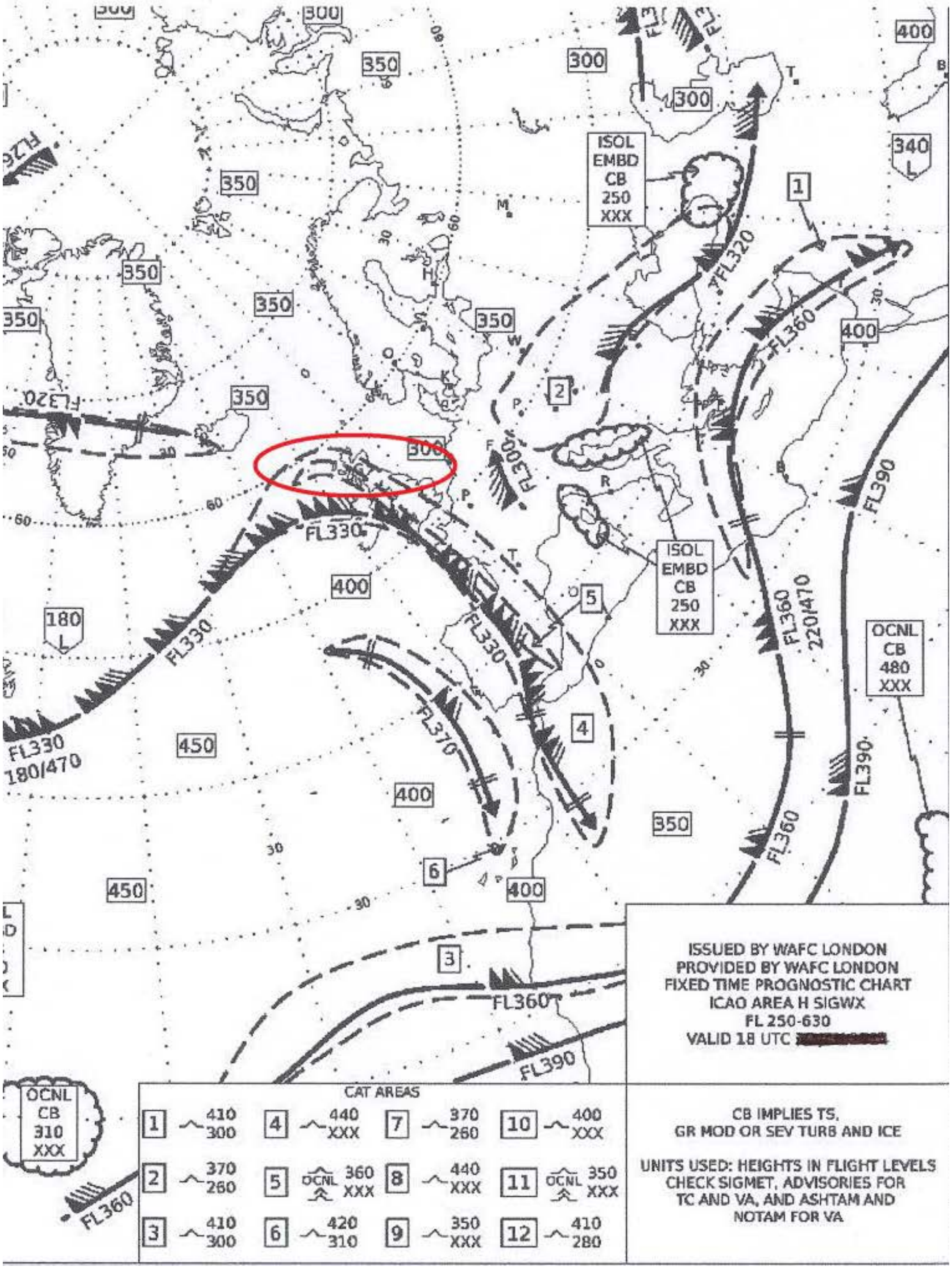


SID	RWY	ROUTING
ANDIK 2E	18L	184° track, at SPL 3.1 DME turn LEFT, 093° track, at PAM R-227 turn LEFT, intercept PAM R-221 inbound to PAM, PAM R-016 to ANDIK. **RNAV:** THR 18L - EH037 (K220-) - EH024 - PAM - ANDIK (FL60).
ANDIK 1F	04	042° track, at SPL R-095 turn RIGHT, intercept PAM R-272 inbound to D5 PAM, turn LEFT, 061° track, intercept PAM R-016 to ANDIK. **RNAV:** THR 04 - EH019 - EH068 - EH071 - ANDIK (FL60).

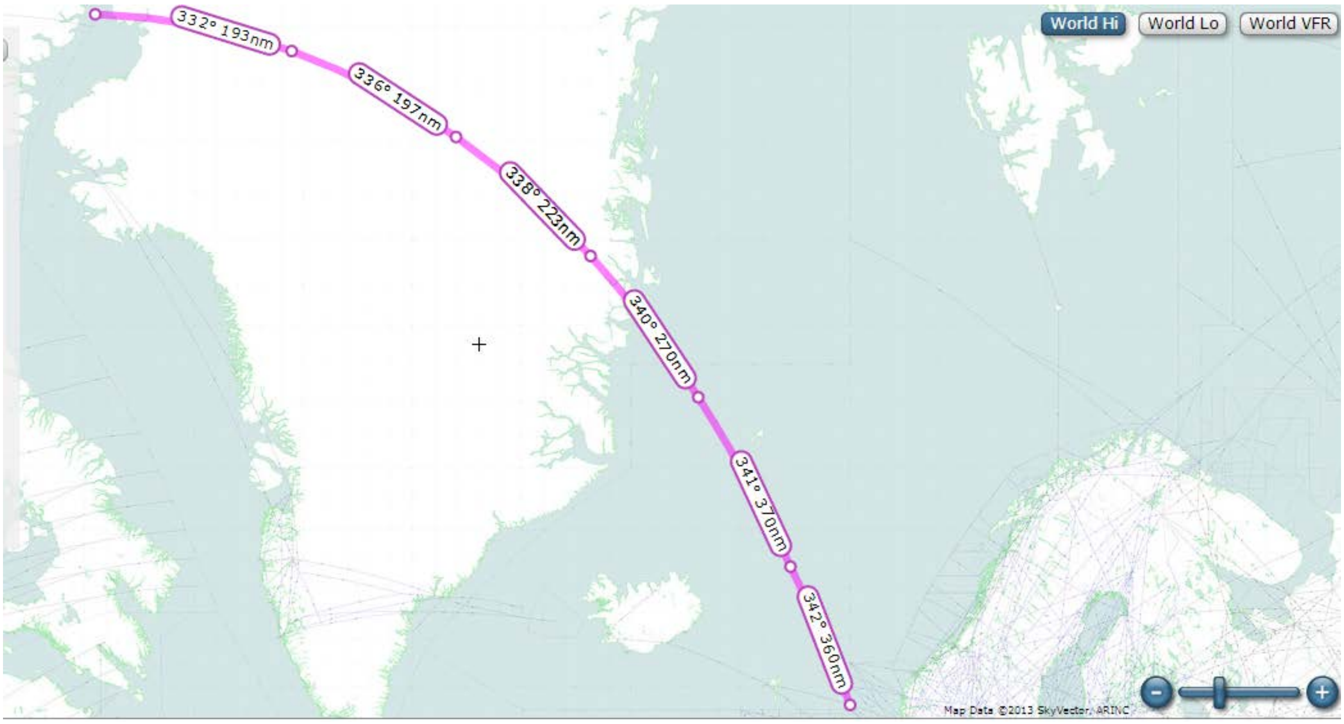
CHANGES: SIDs transferred; chart redrawn.

Appendix XXIII. **Weather above Scotland**

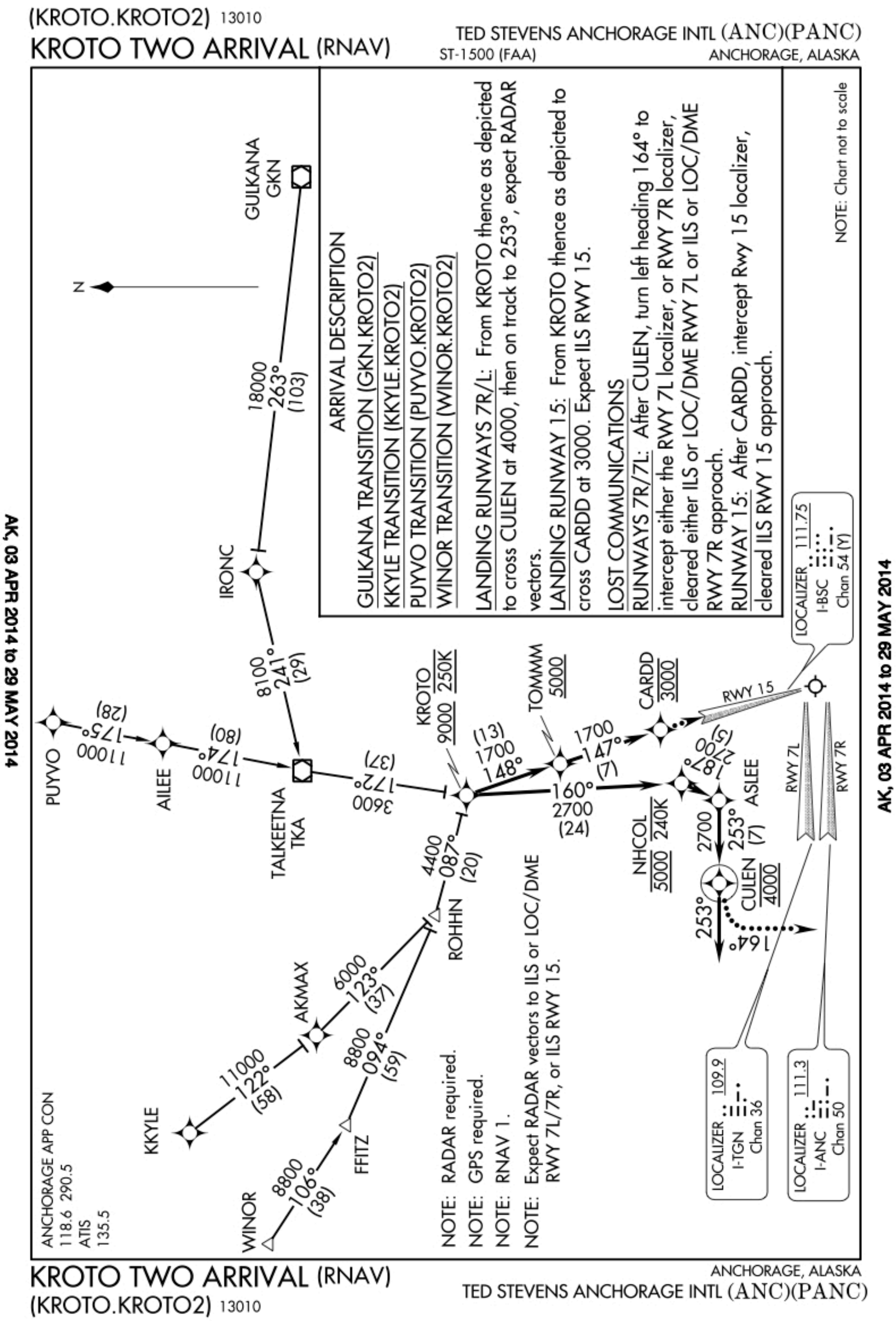
The weather that will be avoided above Scotland is market with the red circle.



Appendix XXIV. **Random Routing**



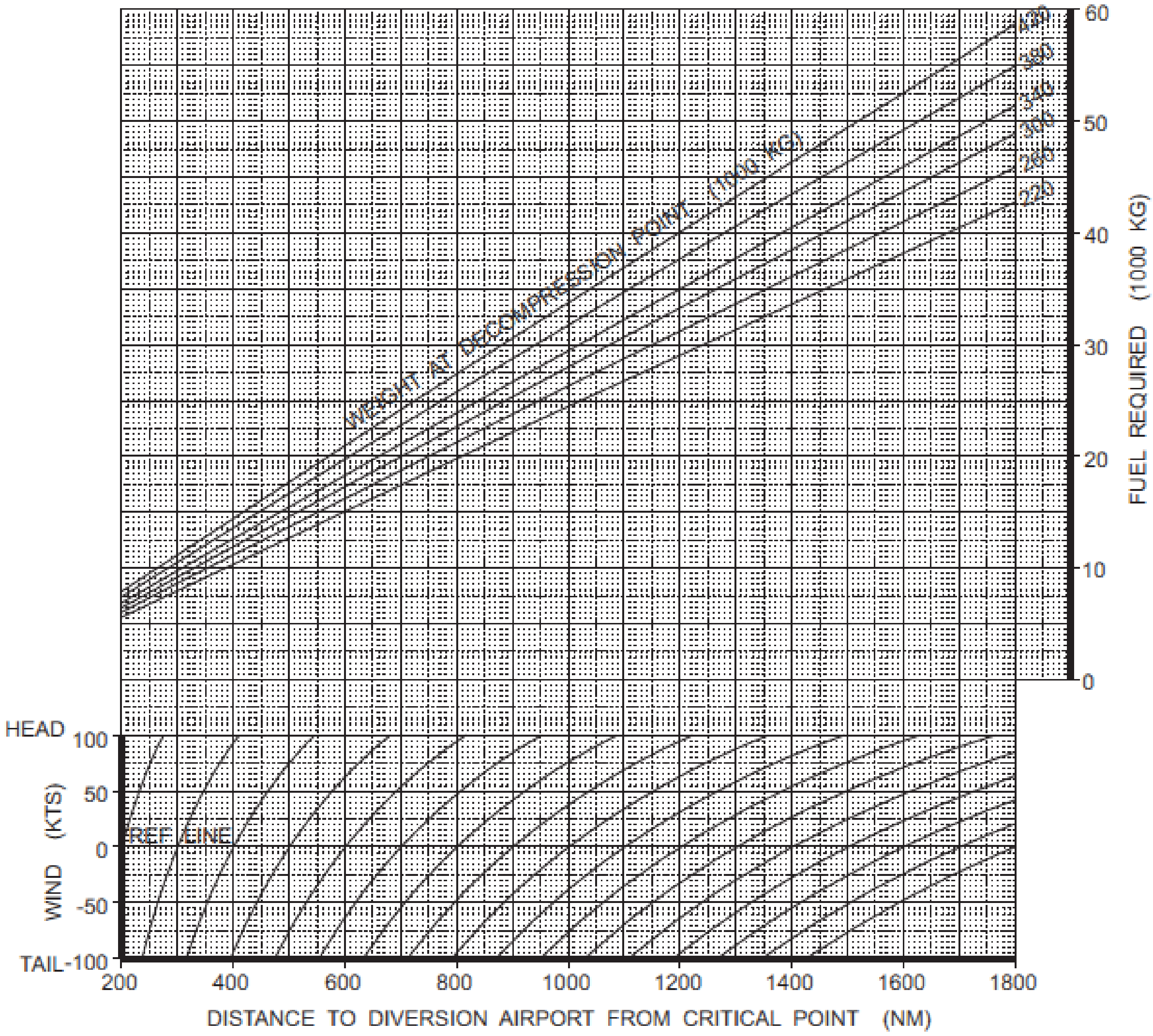
Appendix XXV. Approach route



Appendix XXVI. Fuel calculations

	Weight (kg)	EFOB	Fuel (kg)	FF (kg/hr)	FL	Distance (NM)	GS	Wind (KT)	TAS	Time (min)	
ZFW	260302		0		0	0	0				
Final Res.	264342		4040		0	0	0				
Alternate	271742		7400		0	240	0				
Contingency	274348,2		2606,2								
PANC	**274348**	**14046,2**									**SCENT PERFORMAN**
TKA-PANC	275018	**14716,1**	669,9		234	87,8	270	0	270	19,5	1030 KG
T.O.D -TKA	275378	**15076,2**	360,1		360	47,2	480	0	480	5,9	135 NM
ENN-T.O.D.	277133	**16831,2**	1755,0	2290	360	93,5	488	0	488	11,5	25 MIN
PAFA-ENN	277698	**17396,2**	565,0	2290	360	30,1	488	0	488	3,7	
FYU-PAFA	280083	**19781,1**	2384,8	2300	360	126,5	488	0	488	15,6	
ADREW-FYU	283610	**23308,3**	3527,3	2340	360	183,9	488	0	488	22,6	
RODLU-ADRE'	290780	**30478,3**	7170,0	2390	360	375	500	12	488	45,0	
ROKMA-RODL	297754	**37451,9**	6973,6	2460	360	374,9	529	40	489	42,5	
ROMDI-ROKM.	302161	**41858,5**	4406,7	2490,0	360	239,8	542	53	489	26,5	
T.O.S.C -ROMI	307550	**47248,0**	5389,5	2540,0	360	259,4	489	0	489	31,8	
B.O.S.C -T.O.S	307950	**47648,0**	400,0		340-360	14	492	0	492	1,7	
ROGSO-B.O.S	306772	**46469,5**	-1178,5	2530,0	340	-57,3	492	0	492	-7,0	
TIMO-ROGSO	310855	**50552,9**	4083,4	2580,0	340	192,3	486	-6	492	23,7	
SEBAS-TIMO	315055	**54753,5**	4200,6	2600,0	340	196,7	487	-5	492	24,2	
MARC-SEBAS	319897	**59594,7**	4841,2	2645,0	340	223,3	488	-5	493	27,5	
BARRY-MARC	325660	**65358,3**	5763,6	2700,0	340	269,5	505	12	493	32,0	
NIELS-BARRY	333797	**73494,6**	8136,3	2780,0	340	369,5	505	12	493	43,9	
T.O.S.C -NIELS	342000	**81698,0**	8203,4	2850,0	340	358,4	498	4	494	43,2	
B.O.S.C -TOS(	342450	**82148,0**	450,0		320-340	14	498	4	494	1,7	
VALDI-B.O.S.(	342175	**81873,5**	-274,5	2875,0	320	-12,0	501	4	497	-1,4	
UPATA-VALDI	346445	**86143,0**	4269,5	2900,0	320	184,4	501	4	497	22,1	
KARLI-UPATA	349266	**88964,1**	2821,1	2925,0	320	120,8	501	4	497	14,5	
NAMIK-KARLI	350140	**89838,2**	874,1	2935,0	320	37,3	501	4	497	4,5	
BUSOM-NAMIK	350831	**90528,8**	690,6	2945,0	320	26,5	452	-45	497	3,5	
GARKA-BUSC	351092	**90789,9**	261,1	2950,0	320	10	452	-45	497	1,3	
GREFI-GARKA	352373	**92070,8**	1280,9	2960,0	320	48,9	452	-45	497	6,5	
TOC -GREFI	354185	**93882,5**	1811,7	2980,0	320	68,7	452	-45	497	9,1	**LIMB PERFORMANC**
KONOM-TOC	355122	**94820,4**	937,8		277	14,5	452	-45	497	1,9	7050 KG
UNEXO-KONC	358311	**98009,0**	3188,7		133	49,3	433	-20	453	6,8	109 NM
ANDIK-UNEXC	358634	**98332,4**	323,4		118	5,0	463	10	453	0,6	19,5 MIN
EHAM-ANDIK	361235	**100932,5**	2600,1		0	40,2	240	20	220	10,1	
Taxi Fuel	362135	101832,5	900	45 kg/min						20	
Fuel	101833	**KG**			**NM**	**3992,1**			**Time**	**8,25**	
Trip	**86886,3**	**KG**									

Appendix XXVII. **Decompression diversion planning chart**



Appendix XXVIII. Two engines inoperative

Ground to Air Miles Conversion

AIR DISTANCE (NM) HEADWIND COMPONENT (KTS) 100	80	60	40	20	GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS) 20	40	60	80	100
670	627	590	556	527	500	476	454	434	416	399
1332	1249	1176	1111	1053	1000	952	909	870	834	800
1992	1869	1761	1664	1578	1500	1429	1365	1307	1253	1203
2650	2488	2345	2217	2103	2000	1907	1821	1744	1672	1606
3308	3107	2929	2771	2628	2500	2384	2277	2180	2091	2009
3970	3729	3515	3325	3154	3000	2860	2733	2616	2509	2411
4637	4354	4104	3881	3680	3500	3336	3187	3051	2926	2811
5310	4984	4695	4438	4208	4000	3812	3641	3484	3341	3208
5993	5620	5291	4998	4736	4500	4286	4092	3915	3752	3602
6687	6264	5892	5561	5266	5000	4760	4542	4343	4160	3993

Driftdown/Cruise Fuel and Time

AIR DIST (NM)	FUEL REQUIRED (1000 KG) WEIGHT AT START OF DRIFTDOWN (1000 KG) 200	220	240	260	280	300	320	340	360	380	400	TIME (HR:MIN)
500	8.7	9.4	10.1	10.8	11.4	12.2	12.9	13.7	14.3	15.2	15.8	1:16
1000	16.9	18.5	20.0	21.5	22.8	24.4	25.9	27.5	29.0	30.7	32.3	2:30
1500	24.8	27.2	29.5	31.7	33.9	36.2	38.5	40.9	43.3	45.8	48.2	3:42
2000	32.4	35.5	38.6	41.6	44.5	47.5	50.7	53.9	57.1	60.5	63.6	4:54
2500	39.7	43.6	47.3	51.1	54.7	58.5	62.4	66.5	70.4	74.6	78.5	6:06
3000	46.8	51.3	55.8	60.2	64.5	69.1	73.8	78.6	83.4	88.3	93.0	7:20
3500	53.6	58.8	63.9	69.0	74.0	79.3	84.7	90.3	95.9	101.6	107.0	8:35
4000	60.2	66.0	71.7	77.5	83.2	89.2	95.3	101.7	108.0	114.5	120.6	9:52
4500	66.6	73.0	79.3	85.7	92.1	98.7	105.6	112.7	119.7	126.9	133.8	11:13
5000	72.8	79.8	86.7	93.7	100.7	108.0	115.5	123.3	131.1	139.0	146.6	12:37

Driftdown at optimum driftdown speed and cruise at Long Range Cruise speed.

Appendix XXIX. **Notoc flight AVI-685**

SPECIAL LOAD NOTIFICATION TO CAPTAIN

FROM	FLIGHT	DATE
AMS	AVI 685	28 JAN

****** DANGEROUS GOODS******

TO	AWB NR	CL/DV COMP	UN/ID NR	SUB RSK	PCS	QTY/TI	RRR CAT	PCK GRP	DRIL IMP	CAO	POS ULD CODE
1. MISC. DANGEROUS GOODS#AIR BAG MODULES											
ANC		9	UN 3268		1	0.62 KG		III	9L RMD		12P
2. MISC. DANGEROUS GOODS#ENGINE, INTERNAL COMBUSTION, FLAMMABLE LIQUID POWERED											
ANC		9	UN 3166		6	95 KG			9L RMD		32P

****** OTHER SPECIAL LOAD ******

TO	AWB NR	CONTENTS	PCS	QTY	IMP CODE	POS ULD CODE
3.						
ANC		LIVE ANIMALS# LIVE HORSES	3	3320KG	AVI	PR
4.						
ANC		LIVE ANIMALS# LIVE HORSES	3	3084KG	AVI	PL
5.						
ANC		LIVE ANIMALS# LIVE HORSES	3	3470KG	AVI	RL
6.						
ANC		LIVE ANIMALS# LIVE HORSES	2	1890KG	AVI	SL
7.						
ANC		LIVE ANIMALS# LIVE HORSES	3	3040KG	AVI	MR
8.						
ANC		AIRCRAFT PARTS GE90-94B0 (B777-200)	1	7830KG	AOG	RSR

ITEM 2 OVERPACK USED

TEMPERATURE AND VENTILATION SETTINGS:
COMPARTMENT 1-2 : TEMP 5-10 (R.O.), VENT OFF (R.O.)
COMPARTMENT 3 : TEMP ABOVE 5 (FIXED), VENT N/A
COMPARTMENT 4 : TEMP LOW (4-10) (R.O.), VENT N/A (R.O.)
MAINDECK : TEMP 18 (R.O.), VENT HI FLOW OFF (COCKPIT)

THERE IS NO EVIDENCE THAT ANY DAMAGED OR LEAKING PACKAGES CONTAINING DANGEROUS GOODS HAVE BEEN LOADED ON THE AIRCRAFT

LOADING SUPERVISOR (NAME AND SIGNATURE)

CAPTAIN (NAME AND SIGNATURE)

Appendix XXX. Checksheet of flight AVI-685

KLM CHECKSHEET BOEING 747-400ERF

Station		Flight	AVI-685
Date	28/01 /2014	Registration	PH-CKC
Version	1	Prepared by	S. Doolhoff

<< MAX HEIGHT CONTAINERS 243 CM / PALLETS 218 CM >> << MAX HEIGHT CONTAINERS / PALLETS 300 CM (PL MAX HEIGHT 288 CM)

Maindeck position	A (A1)	A2	B (B1)	C	D	E	F	G	H	J	K	L	M	P	R	S
Weight (R)	3000		4000	725	724	2500	2500	4000	4000	4000	4000	2498	3040	3320	3915	3915
Max. weight	4808		4808	6123	8210	8210	8210	8210	8210	8210	8210	8164	8164	6123	6123	7257
Weight (L)		3000	3000	725	724	2500	2500	4000	4000	4000	4000	2498	3000	3084	3470	1890
Max. weight	3674*	3674*	3674*	6123	8210	8210	8210	8210	8210	8210	8210	8164	8164	6123	6123	7257
Total				1450	1448	5000	5000	8000	8000	8000	8000	4996	6040	6404	7385	5805
Max L+R				9625	9625	9625	9625	16437	16437	16437	9625	9625	9625	9625	9625	9625

*Max. weight PAG 3356

Additional tiedown required for pallet load over 6803 kgs.

Lower deck container locations

Pos.	11R	12R	13R	21R	22R	23R	24R	25R
Weight								
Pos.	11L	12L	13L	21L	22L	23L	24L	25L
Weight								

Pos.	31R	32R	33R	34R	35R	36R	37R	38R	42	43	44
Weight											
Pos.	31L	32L	33L	34L	35L	36L	37L	38L	1905	1469	1034
Weight											

Max. weights for ULD's in lower hold

Type	Weight
PAG	5035
PMC	5035
PLB	3175
AKE	1588
PNA	2477

Lower deck pallet locations

Pos.	11P	12P	21P	22P	23P	31P	32P	33P	34P
Weight		1				2000	95	4000	4000

	A	B	C	D	E	F	G	H	J	K	L	M	P	R	S
Actual comb.	3000	4000	1451	1448	5000	5000	8000	8000	8000	10000	5091	10040	10404	7385	5805
Max comb.	4808	7785	11337	11337	11337	11337	16437	16437	16437	11337	11337	11337	11337	11337	11337

	A1	A2	B1
Actual comb.		3000	3000
Max comb.	3674	3674	7785

	A	B	C	D	E	F	G	H
Actual cum.								
Max cum.	5936	13675	23206	32818	42421	52963	66781	76044

A1	A2	B1
3932	7671	13675

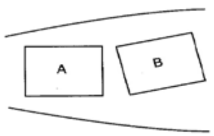
Forward to aft>>

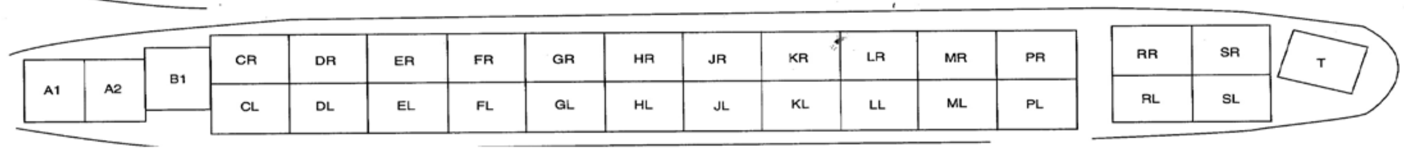
92181	78472	64872	52843	43127	33411	19454	10688
83005	69296	55696	43666	33950	24234	12005	6311

<<Aft

Lateral imbalance check	Taxi weight	Weight diff.
R ____ + ____ = ____	414100	30200
L ____ + ____ = ____	412500	33400
maindeck Lower deck Total	410000	38400
=>	407500	43400
Difference	405000	48200
	403000	52000

WARNING
Load in excess of 243 cm in height may loaded aft of position DL/DR. In all case must be seven loaded PAG/PMC pallets of a rigid cargo pallet exceeding 243 cn





ROUTING
White - St
Yellow - lo

Appendix XXXI. **Load sheet of flight AVI-685**

LOAD SHEET and LOAD MESSAGE
for Passenger and Cargo aircraft

Priority | Addressees

Addressees | Originator | Recharge/Date/Time

Initials | LDM | Flight nr./Date: AVI-685 | A/C Registration: PH-CKC

Version: 2 | Crew: 2 | Date: 28/01/2014

REFERENCE DOW/DOI	=	159190977
PANTRY FWD	+	-
PANTRY CENTRE	+	-
CORRECTION WT/IND	+/-	-
CORRECTED DOW/DOI	=	159190
BLOCK FUEL	+	101833
OPERATING WT		

MAXIMUM WEIGHT FOR		TAXI	TAKE-OFF	LANDING	ZERO FUEL
	=	414100	412800	296200	277200
FUEL	+		TAXI 900	TAXI 900 / TRIP 86887	BLOCK 101833
ALLOWABLE TAXI WEIGHT LOWEST OF a, b, c, d	=	a.	b.	c.	d. 379033
OPERATING WT	-				261023
ALLOWABLE TRAFFIC LOAD	=				118010
TOTAL TRAFFIC LOAD	-				101016
UNDERLOAD BEFORE LMC	=				

[redacted]

61023 | INDEX | UNDERLOAD BEFORE LMC | 16994

Remarks | PAX | PAD

TOTAL WEIGHT PASS+CAB. BAG	392
TOTAL WEIGHT BAGGAGE CARGO-MAIL +	100624
TOTAL TRAFFIC LOAD =	101016
CORRECTED DOW +	159190
ZERO FUEL WEIGHT =	260206

G	H	J	K	L	M	P	R	S	T	C Y/M	C Y/M
8000	8000	8000	4996	6040	6404	7385	5805	2000		PAX/	PAD/

Dest.	No. of passengers M/Ad. F/Ad. Ch. Inf.		TOTAL WEIGHTS	1	2	3	4	0	A	B	C	D	E	F
-	4	TR												
PANC		B												
		C	10095	1					6000	7000	1450	1448	5000	5000
		M												

[redacted]

ZERO FUEL WEIGHT	=	260206
TAKE-OFF FUEL	+	100933
TAKE-OFF WEIGHT	=	361139
TRIP FUEL	-	86887
LANDING WEIGHT	=	274252
LMC TOTAL	+/-	

• / / / •T • 1/ • 2/ • 3/ • 4/ • 0/ • A/ • B/ • C/ • D/ • E/ • F/ • G/ • H/ • J/ • K/ • L/ • M/ • P/ • R/ • S/ • T/

- TR B C M •PAX/ / •PAD/ /

• / / / •T • 1/ • 2/ • 3/ • 4/ • 0/ • A/ • B/ • C/ • D/ • E/ • F/ • G/ • H/ • J/ • K/ • L/ • M/ • P/ • R/ • S/ • T/

[redacted]

CORRECTED Z FW

CORRECTED TOW

CORRECTED LAW

LAST MINUTE CHANGES

DEST	SPECIF.	CPT	+/- WEIGHT

•PAX/ / •PAD/ /

• G/ • H/ • J/ • K/ • L/ • M/ • P/ • R/ • S/ • T/

• / / / •T • 1/ • 2/ • 3/ • 4/ • 0/ • A/ • B/ • C/ • D/ • E/ • F/

- TR B C M

[redacted]

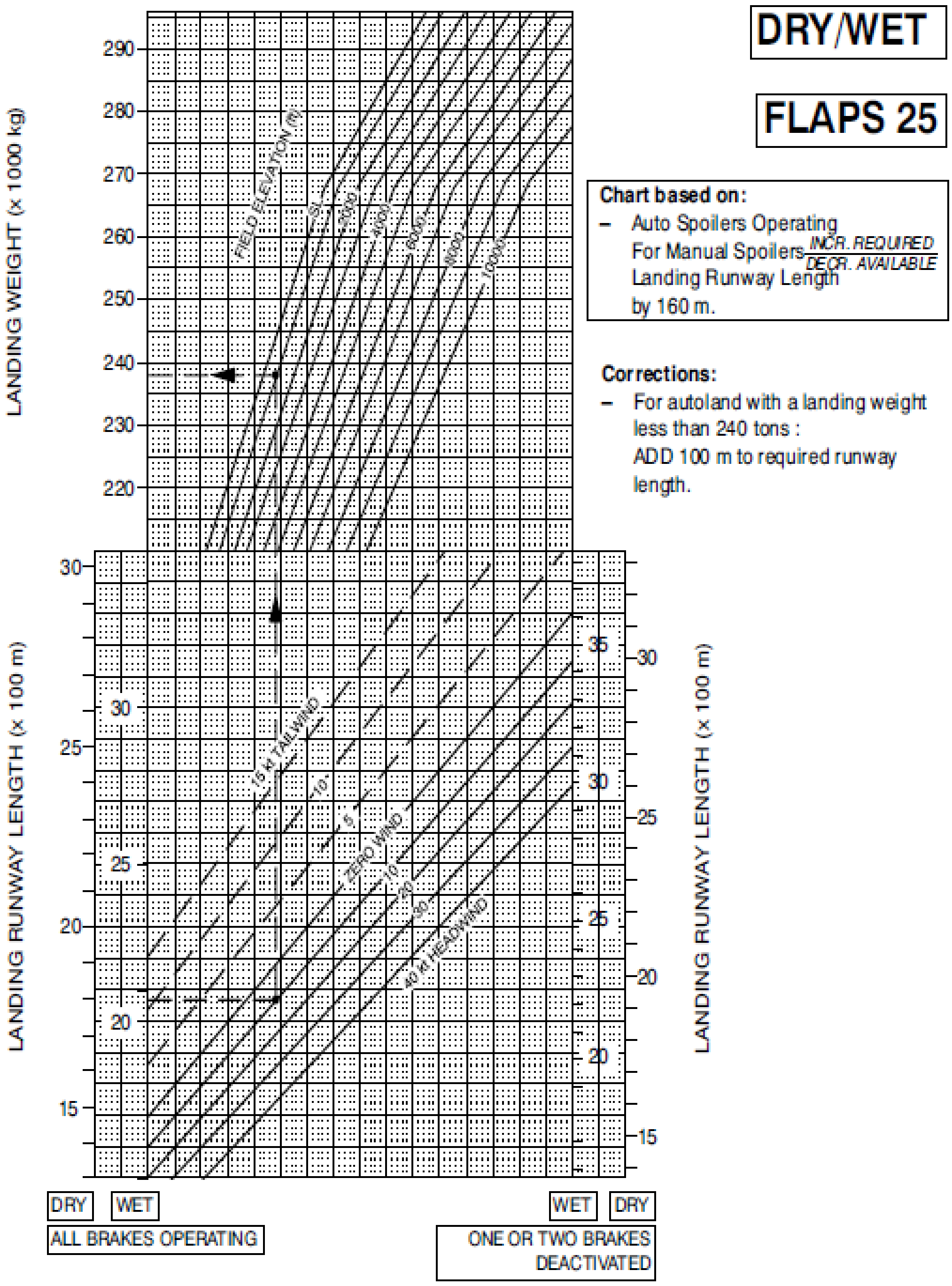
M

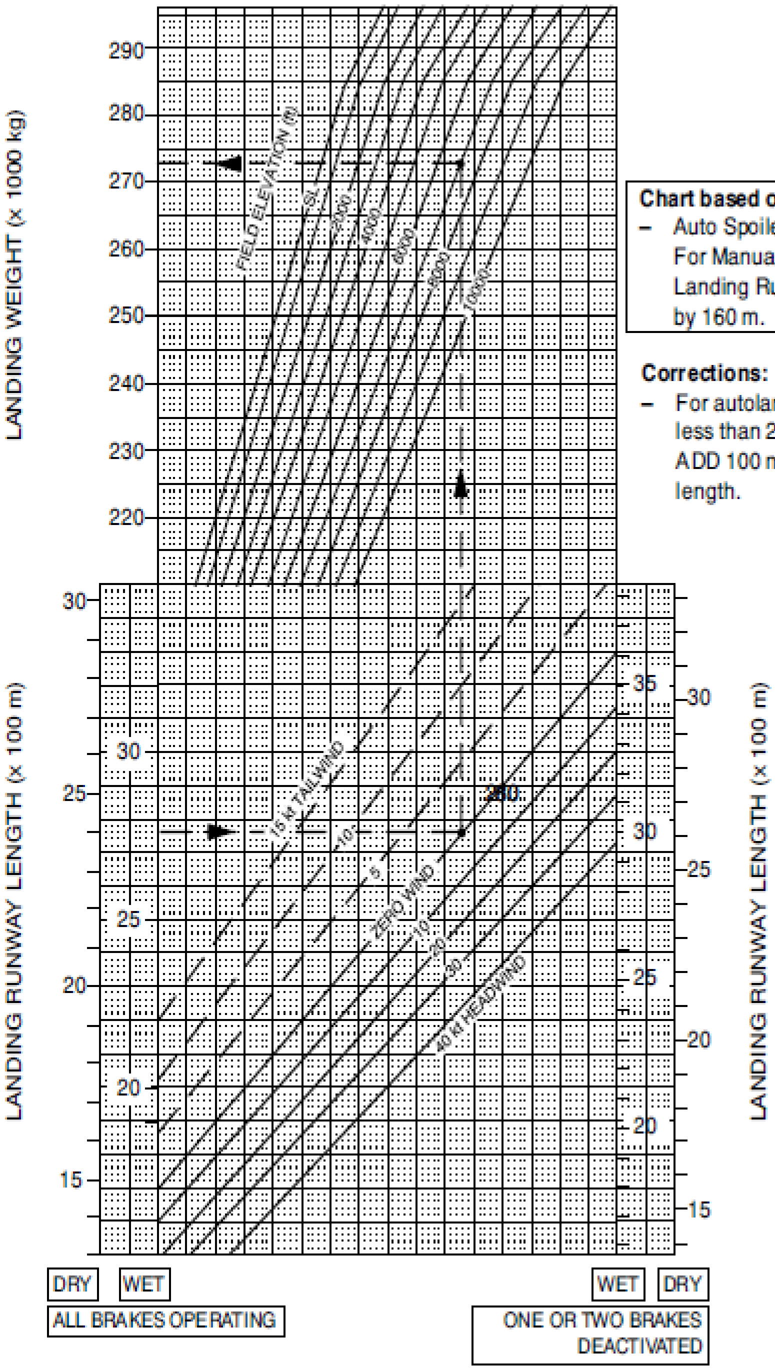
• / / / •T • 1/ • 2/ • 3/ • 4/ • 0/ • A/ • B/ • C/ • D/ • E/ • F/ • G/ • H/ • J/ • K/ • L/ • M/ • P/ • R/ • S/ • T/

Totals	4	1	10095	6000	7000	1450	1448	5000	5000	8000	8000	8000	8000	4996	6040	6404	7385	5805	2000

Seatings conditions | Balance conditions before LMC: CORR DOI, LIZ FW | SI ▶ | TZ FW | NOTES | MAC DLW | BC. no. | SOB

Appendix XXXII. **Landing Charts**





DRY/WET

FLAPS 30

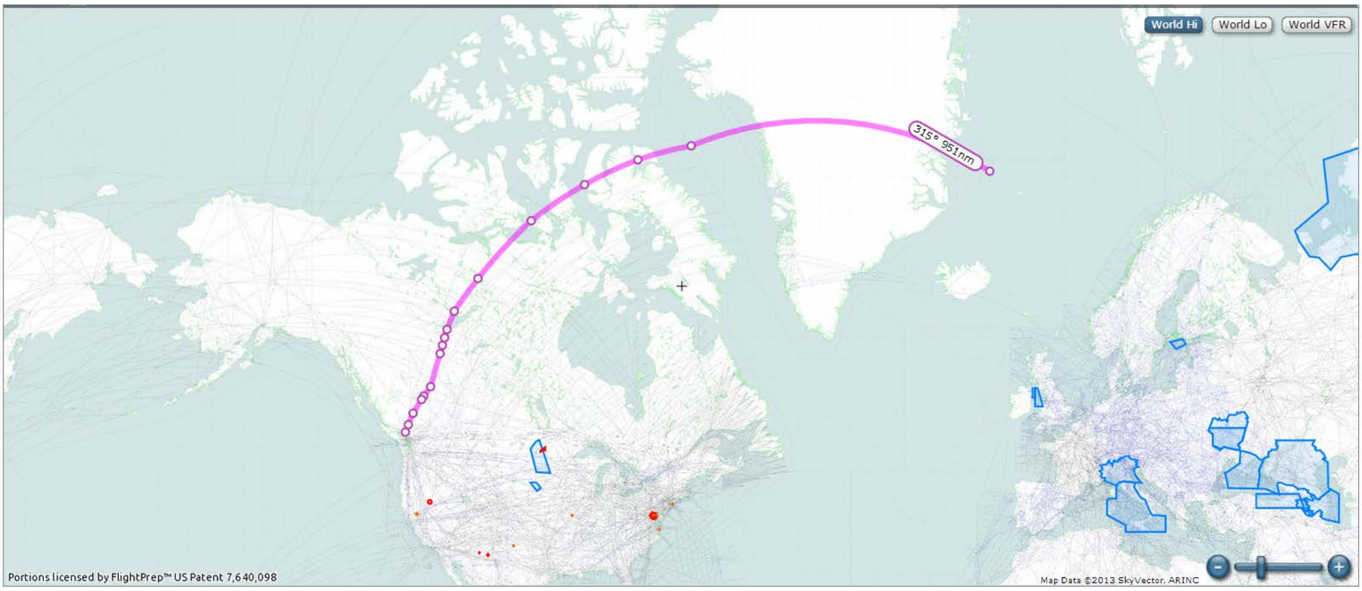
Chart based on:

– Auto Spoilers Operating
For Manual Spoilers $\frac{\text{INCR. REQUIRED}}{\text{DECR. AVAILABLE}}$ Landing Runway Length by 160 m.

Corrections:

– For autoland with a landing weight less than 240 tons :
ADD 100 m to required runway length.

Appendix XXXIII. **Divert to Vancouver International airport**



Route to Vancouver international airport

Tabel bij Ops.1.1110 - 2 Verkorte rust

FDP voorafgaande aan bekorte rust	Aanmelden na bekorte rust vanaf - tot	Maximum FDP na een verkorte rust	7:30	7:45	8:00	8:15	8:30	8:45	9:00	9:15
00:00 - 05:59	06:00 - 13:00		7:30	8:30	9:30	10:30	11:30	12:30	13:00	13:00
	05:00 - 06:00 13:00 - 15:00		6:30	7:30	8:30	9:30	10:30	11:30	12:00	12:00
	15:00 - 05:00		5:30	6:30	7:30	8:30	9:30	10:30	11:00	11:00
06:00 - 06:59	06:00 - 13:00		6:30	7:30	8:30	9:30	10:30	11:30	12:30	13:00
	05:00 - 06:00 13:00 - 15:00		5:30	6:30	7:30	8:30	9:30	10:30	11:30	12:00
	15:00 - 05:00		4:30	5:30	6:30	7:30	8:30	9:30	10:30	11:00
07:00 - 07:59	06:00 - 13:00		5:30	6:30	7:30	8:30	9:30	10:30	11:30	12:30
	05:00 - 06:00 13:00 - 15:00		4:30	5:30	6:30	7:30	8:30	9:30	10:30	11:30
	15:00 - 05:00		3:30	4:30	5:30	6:30	7:30	8:30	9:30	10:30
08:00 - 08:59	06:00 - 13:00		4:30	5:30	6:30	7:30	8:30	9:30	10:30	11:30
	05:00 - 06:00 13:00 - 15:00		3:30	4:30	5:30	6:30	7:30	8:30	9:30	10:30
	15:00 - 05:00		2:30	3:30	4:30	5:30	6:30	7:30	8:30	9:30
09:00 - 09:59	06:00 - 13:00		3:30	4:30	5:30	6:30	7:30	8:30	9:30	10:30
	05:00 - 06:00 13:00 - 15:00		2:30	3:30	4:30	5:30	6:30	7:30	8:30	9:30
	15:00 - 05:00		1:30	2:30	3:30	4:30	5:30	6:30	7:30	8:30
10:00 - 10:59	06:00 - 13:00		2:30	3:30	4:30	5:30	6:30	7:30	8:30	9:30
	05:00 - 06:00 13:00 - 15:00		1:30	2:30	3:30	4:30	5:30	6:30	7:30	8:30
	15:00 - 05:00		0:30	1:30	2:30	3:30	4:30	5:30	6:30	7:30
11:00 - 11:59	06:00 - 13:00		1:30	2:30	3:30	4:30	5:30	6:30	7:30	8:30
	05:00 - 06:00 13:00 - 15:00		0:30	1:30	2:30	3:30	4:30	5:30	6:30	7:30
	15:00 - 05:00		0:00	0:30	1:30	2:30	3:30	4:30	5:30	6:30

Minimum reduced rest time