Expansion and development of Vágar airport (Faroe Islands)

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1. INTRODUCTION (Lukas)

1.1. About the Faroese Islands in general

Vágar Airport is located on Vágar Island, which is one of the islands contained in a subarctic island group called the Faroe Islands. They are an autonomous province of the Kingdom of Denmark. Their population is almost 49 000 inhabitants (July, 2010).

The Faroe Islands consists of 18 major islands, which lies between the Norwegian Sea and North Atlantic Ocean, approximately halfway between Great Britain and Iceland. Their closest neighbours are the Northern and Western Isles of Scotland. Its area is 1,399 square kilometres.

Islands are rugged and rocky. Coasts are mostly cliffs. The highest point is Slættaratindur, 882 meters above sea level.

The Faroe Islands generally have cool summers and mild winters, with a usually overcast sky and frequent fog and strong winds. Although at a high latitude, due to the Gulf Stream, their climate is ameliorated.

Figure 1.1 - Location of the Faroe Islands

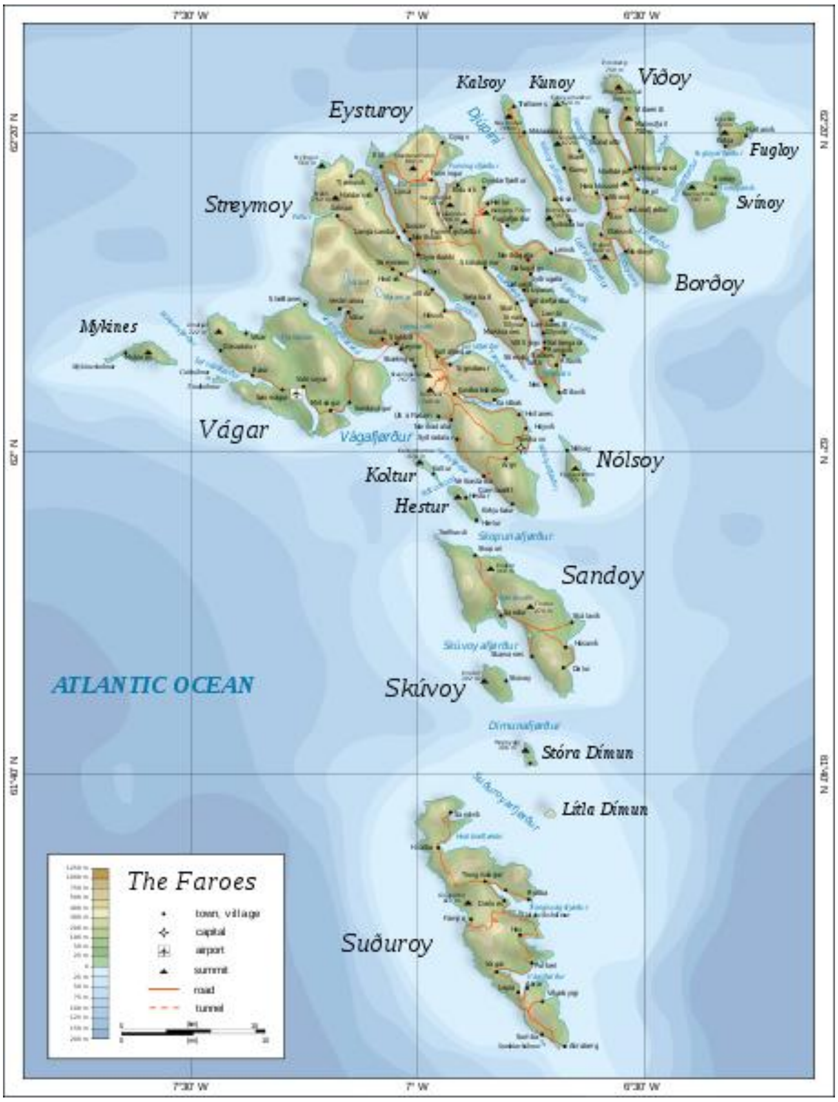

Figure 2.2 – Map of the Faroe Islands

1.2. Transportation in general

Due to the fact that islands are quite small and their terrain is rocky the transportation system was not as extensive as in other place of the world. This situation has now changed and infrastructure of the Faroe Islands has been developed extensively. Around 80% of the population is now connected by tunnels going through the mountains and by bridges between islands and causeways which link the three largest islands and three other large islands to the northeast together, while the other two large islands to the south of the main area are connected to the main area with new fast ferries.

1.3. Vágar Airport

1.3. a) Location

As was mentioned above Vágar Airport is located on Vágar Island, which is most westerly of the large islands. His area is 178 square kilometers, which makes him the third largest behind Streymoy and Eysturoy. Vágar Island is connected by Vágatunnilin (build: 2002, length: 4900 m) with Streymoy Island, where lies the capital of the Faroe Islands, Tórshavn.

1.3. b) History

Vágar airport was built during World War II by British Royal Engineers, its location was chosen mainly because it was hard to see from the surrounding waters and any potential German warship. In the early '60s the need and popular demand in the Faroes for civil aviation grew to the point of making a modernisation of the runway a necessity to facilitate passenger traffic.

1st July 1963 Vagar Airport became operational for civil aviation and the first carrier landed on the 17th July 1963. During the early years only propeller aircraft were implemented. Since 1977 jet aircraft too have serviced the routes to the airport. The Danish Civil Aviation Administration administered Vagar Airport from 1963 to the 30th of April 2007.

1.3. c) Current situation

On the 1st of May 2007, the Faroe Government took over Vagar Airport. From that same date the airport became a national government institution under the Ministry of Trade and Industry, which was responsible for the continued operation of Vagar Airport. From the 24th of July 2008, all Vagar Airport activities were transferred to the holding company Vagar Airport Ltd., which thereby became responsible for conducting all operational activities at Vagar Airport.

Vágar Airport is the only airport on the Faroe Islands used for international traffic. It is main operating base for Faroese national airline Atlantic Airways. For short period during 2006 there was also operating low cost airline FaroeJet, which bankrupted later.

2. FLIGHTS ANALYSIS (Lukas and Aitor).

2.1. Geographical characteristics.

Once the Faroe Islands have been located within the introduction, we are able to determine the distances to the nearest countries and important cities. This knowledge is relevant in order to understand the current air traffic and to forecast the future one.

The distances to some of the nearest countries and islands are the following:

- Shetland Islands, Scotland: 285 kilometres.
- Orkney Islands, Scotland: 300 kilometres.
- Mainland Scotland: 320 kilometres.
- Iceland: 600 kilometres.
- Norway: 800 kilometres.
- Denmark: 1,100 kilometres.
- Sweden: 1,200 kilometres.
- Finland: 1,600 kilometres.
- Greenland: 1,800 kilometres.

The distances to some of the nearest cities with more than 100,000 inhabitants are:

- Aberdeen, Scotland: 540 kilometres.
- Bergen, Norway: 655 kilometres.
- Glasgow, Scotland: 670 kilometres.
- Reykjavík, Iceland: 800 kilometres.
- Aalborg, Denmark: 1091 kilometres.
- Copenhagen, Denmark: 1310 kilometres.

2.2. Current situation.

2.2. a) Atlantic Airways.

Nowadays, there is only one airline operating from Vágar Airport, the national carrier of the Faroe Islands Atlantic Airways. This airline was founded on 1988 and operates seven aeroplanes on routes covering the North Atlantic. As we explained before, due to the existing short length of the runaway, only short take off and landing (STOL) aircrafts can use the airport. This is the reason why the 7-aircrafts fleet of Atlantic Airways is formed exclusively by BAe-146/RJ aeroplanes, which have a capacity for 94 seats and flight autonomy of 3-4 hours.

Fig. 2.1. Atlantic Airways aircraft: BAe-146/RJ

Furthermore, a number of domestic Faroese destinations (shown in the table below) can be reached from Vágar by the Atlantic Airways helicopter service, which also responds to all search and rescue missions around the Faroes.

1. Civil Aerodromes and Heliports — 1. Civile flyvepladser og helikopterflyvepladser

Aerodrome/Heliport name Location indicator/ **Flyveplads/helikopterflyveplads navn** Stedindikator	Type of traffic permitted/Trafiktyper tilladt (INTL = International, NTL = National)			Reference to AD Section Remarks/ Reference til AD afsnit Bemærkninger
Froðba EKFA	NTL	VFR	Schengen only	AD 3 - EKFA
Klaksvík EKKV	NTL	VFR	Schengen only	AD 3 - EKKV
Mykines EKMS	NTL	VFR	Schengen only	AD 3 - EKMS
Skúvoy EKSY	NTL	VFR	Schengen only	AD 3 - EKSY
Stóra Dímun EKSR	NTL	VFR	Schengen only	AD 3 - EKSR
Svínoy EKSO	NTL	VFR	Schengen only	AD 3 - EKSO
Tórshavn/Bodanes EKTB	NTL	VFR	Schengen only	AD 3 - EKTB
Vágar EKVG	INTL-NTL	IFR-VFR	All Traffic	AD 2 - EKVG

Table. 2.1. Faroese aerodromes and heliports.

2.2. b) Current destinations.

According to Atlantic Airways website[2], the destinations that formed their route network for 2011 are shown below. The frequency of the flights depend a lot on the season considered, being the highest air traffic during the summer period (from 1st June until 1st September). The rest of the year is considered as winter period.

- Copenhagen (Denmark): 20 weekly flights during winter, being increased until 26 during the summer period.
- Reykjavík (Iceland): Twice per week in winter, increased until 3 in summer.
- Billund (Denmark): 2 weekly flights during winter, being increased progressively until one daily flight during July and August.
- Bergen (Norway): Twice per week exclusively during the summer period.
- Aalborg (Denmark): 3 weekly flights during the summer period.
- London - Stansted (United Kingdom): 2 weekly flights during the summer.

If we make an approximation of the number of scheduled flights for 2011 and we take into account that the summer period involves 13 weeks, the resultant number is 1480. We shall bear in mind that this figure is in connection with the number of aircrafts going to Vágar Airport, which are likely to come back to their destinies on the same day, meaning a total amount of scheduled aircraft operations of around 3,000.

Nevertheless, more destinations are actually connected with the Faroe Islands, due to chart flights provided for tour operators and other companies. Some of the chart flights during the last weeks (winter period) are the following:

- Greenland: Narsarsuaq (25th March).
- Iceland: Keflavik (9th April).
- Norway: Kristiansund (5th April), Stord (7th April), Trondheim (24th May).
- Finland: Rovaniemi (1st April), Helsinki – Vantaa (10th April).
- Scotland: Inverness (22nd May).

2.2. c) Number of passengers.

The total number of arriving and departing passengers through Vágar Airport during the last five years had been around 210,000 passengers per year, although during the last two years this number has decreased due to the economical recession. The following data has been compiled from Vágar Airport website:

YEAR	Number of passengers	Number of ''Large Scale'' travel days
2010	200,000	19
2009	203,000	20
2008	222,000	29
2007	219,000	-
2006	208,000	-

Table. 2.2. Number of passenger through Vágar Airport in the last five years.

A ''large scale'' travel day is defined for Vágar Airport as more than 1,000 passengers per day, what usually takes place during the summer period, specially the month between the 15th July and the 15th August. These busy days will be relevant in order to calculate the passenger flow during the design peak hour and estimate the subsequent level of service (LOS) for the different areas within the terminal building.

2.3. Future situation.

2.3. a) Target year.

As we need to forecast the future traffic level for Vágar Airport, the first step is to define the ''target year'' for which the expanded airport is going to be designed. Bearing in mind that the expansion of an airport is an expensive work, it makes sense to consider a period of 20 years forward. Furthermore, the target year is usually taken as a round number, so we decided that our design year for Vágar Airport will be 2030.

2.3. b) Possible airlines interested on Vágar Airport.

Taking into account the nearest countries named before, we could expect that at least some of the most important airlines in these countries will be interested on connect the Faroe Islands to their route network. As we explain within the later section about runaways, the reference code will be maintained as 3C, meaning that the types of aircrafts to be used for the expanded airport shall fulfill the following requirements: aeroplane reference field length (ARFL) less than 1800 m (not included), wing span in range 24 up to but not included 36 m and outer main gear wheel span in range 6 up to but not including 9 m. Therefore, we also should take into account the fleet of each airline, in order to analyze if they have this type of aircrafts and if they would be able to operate on the future Vágar Airport. The results of the research are shown below:

- Scandinavian Airlines SAS (Norway): From a total fleet of 141 aeroplanes, they have 28 x Boeing 737-600 and 19 x Boeing 737-700
- Cimber Sterling (Denmark) – 6 x Boeing 737-700 of a 26-aircrafts fleet.
- Iceland Express (Iceland) – 2 x Boeing 737-700 of a 5-aircrafts fleet.
- EasyJet (United Kingdom) – 7 x Boeing 737-700 of 178-aircrafts fleet. (This airline decided to operate with Airbus aeroplanes, so the few Boeing 737-700 reaming will be phased out during 2011).

Objects of research were also another airlines operating in our area of interest like Norwegian Air Shuttle, Finnair, Ryanair and Icelandair. However, these airlines do not own any aircrafts which belong to category 3C, so at this time they are not expected to be served on Vágar airport.

Therefore, we can conclude that the most likely airlines to use Vágar Airport in the following years, besides Atlantic Airways, will be Scandinavian Airlines and Cimber Sterling, and based on this assumption we are going to make our airtraffic forecast.

2.3. c) Future number of aircraft operations.

In order to make the necessary traffic forecast for the target year 2030, we need to take into acoount that we are interested in determine the traffic during the design peak hour and for that, the following assumptions are going to be considered:

- We will be focus on the busiest period of the year, the commented month between the 15th of July and the 15th of August.
- Scheduled flights during the winter period would involve 80% of the aircraft operations in Vágar Airport. Therefore, we assume a future increase of chart flights around 10% due to the expected tourism growth.
- The current opening hours for Vágar Airport during the summer period are from 08:00 h to 16:00 h each day. As we will increase the traffic, it makes sense to expect a larger availability in the time schedule, for example 12 hours.

The first step is about making an estimation of the amount of weekly connections, for what we will analyze separately each of the three considered carriers.

- **Atlantic Airways:** It will be still the main airline in Vágar Airport, because its currently 43 weekly connections during summer period will be difficult to reach for the other two. Despite the expected increase of tourism for the target year 2030, we will assume that due to the incorporation of Cimber Sterling, which is mainly based in Denmark, Atlantic Airways will have just a slight growth. Therefore, we will consider a figure of 50 weekly connections for this carrier.
- **Cimber Sterling:** This danish low cost company has as main hubs the airports of Copenhagen and Billund. Furthermore, they are connected with others like Aarhus, Aalborg or Karup. Therefore, we can assume around 10 weekly connections which will be added to the existings from Atlantic Airways.
- **Scandinavian Airlines:** As we can see in the figure below, it is one of the most important carriers within the north of Europe and therefore, it would be able to establish several connections. Denmark would be already well covered by the other two airlines, but other northern countries such as Norway, Sweden or Finland would be an ideal field of work for Scandinavian Airlines. We estimated around 10 weekly connections to Norway (which is the closest country), and 3 for

the further Sweden and Finland. Besides, we need to take into account that Vágar Airport is currently connected with only one main hub in Europe (London). Therefore, for the future situation we could also expect flights from some of the other main airports: Frankfurt am Mein, Charles de Gaulle (Paris) or Schiphol (Amsterdam). Finally, and taking into account their large aircrafts fleet, we will consider 20 weekly connections with Vágar Airport.

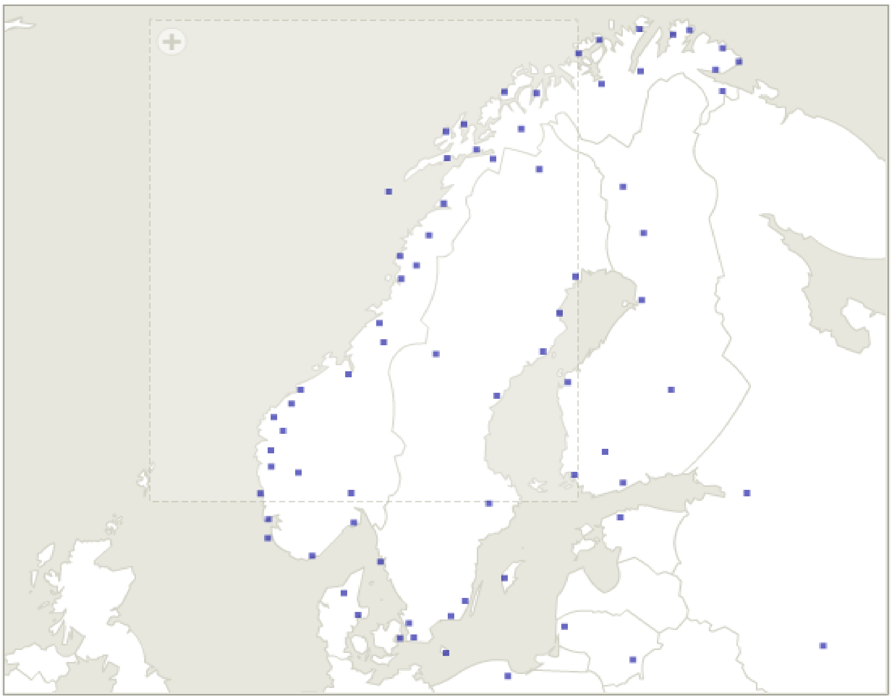

Fig. 2.2. Scandinavian Airlines destination-map for northern Europe.

Summarizing all the previous considerations, we estimate an amount of 80 weekly scheduled connections during the busiest month, what means a total of 100 if we take into account the chart flights.

The second step will be to convert this weekly figure in a daily one. For that, we should take into account that the distribution will not be uniform, concentrated mainly around the weekend. Thus, we will assume a peak amount of 25 daily connections, which could be overcome in some specific dates, but this situation will just imply some delays in departuring flights until we will reach the balance. As we explained in a previous section, each connection is likely to include two operations per day (flight from Vágar Airport to other destination and return flight, or viceversa). Thus, we will estimate a figure of 50 daily operations (either departures or arrivals).

Finally, the third and last step is about choosing the number of aircraft operations during the design peak hour. As we commented before, we assume Vágar Airport to be operative up to 12 hours (four hours more than the current situation). Therefore, the average of aircraft operations is around 4, but we should bear in mind the fact that in the daily airtraffic distribution we have two peaks. The first peak takes place usually in the morning around 08:00 and the second one in the evening around 19:00. Thus, we will assume the aircraft operations during the peak hour up to 9 (twice the daily average of the peak month), resulting that during the rest of the day we would have around 3 operations per hour, considering these two peak hours.

3. GENERAL LAYOUT (Lukas)

a. Current Runway

i. Current problems

The main problem of Vágar airport today is his short runway length. It is just 1250 m long. This is caused by its Army history. In order to improve breaking actions the runway has transverse grooves. Furthermore, emergency turn-off areas, close to each end of the runway, with broken stones have been established. Damage to aircraft using the areas may be expected.

Due to the current length of runway just short take-off and landing aircrafts (STOL) such as BAe 146 are able to take-off and land on this runway.

Figure 3.1 – BAe 146 - 200

ii. Technical data

Nearest town:	Sørvágur	1,5 km
Reference point:	62.03.51N 007.16.38V	
Category:	3C - cat 6	
Runway:	RWY 13	1.250 x 30 m asphalt grooved

	RWY 31	1.250 x 30 m asphalt grooved
Taxiway:	1, asphalt	
Apron:	Asphalt	
Local time:	Summer:	UTC +1
	Winter:	UTC
Instrument:	LLZ, DME	
Frequency:	124,85 khz	
Elevation:	280 ft.	
ICAO-stytting:	EKVG	
IATA-stytting:	FAE	

iii. Current Runway physical characteristics

Runway 13-31 code number is 3 and code letter is C. It is 30 m wide a 1250 m long. Surface of runway is asphalt (PCN 28/F/A/X/U). Runway slope is 0,62 (1,29) %. Turning areas at the ends of runway has dimensions 60 x 30 m. Dimensions of the strip are 1370 x 150 m.

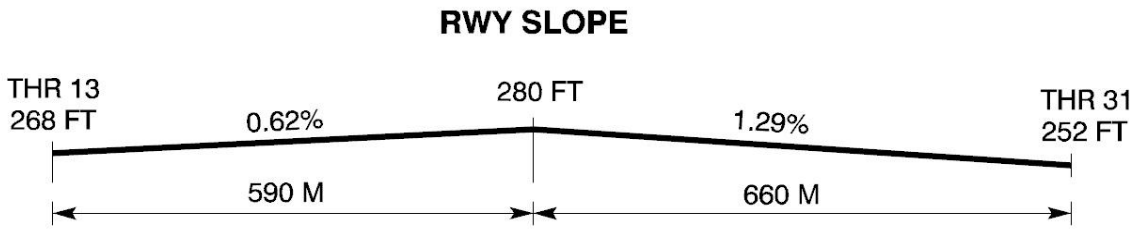

Figure 3.2 – Current runway slope

Close to RWY 13 - 31 areas with broken stones have been established. The diameters of the stones are from 20 to 100 MM. The stone layer depth range from150 MM at the runway shoulder to 450 MM at the end of each area. The areas will be worked up twice a year to maintain a porous structure. Snow clearance and de-icing will not be carried out on the areas. The areas are not marked. Previous accidents indicate that braking effect can be expected only by blocking the wheels. Damage to aircraft using the areas may be expected. Use of the areas take place solely on the operators own responsibility.

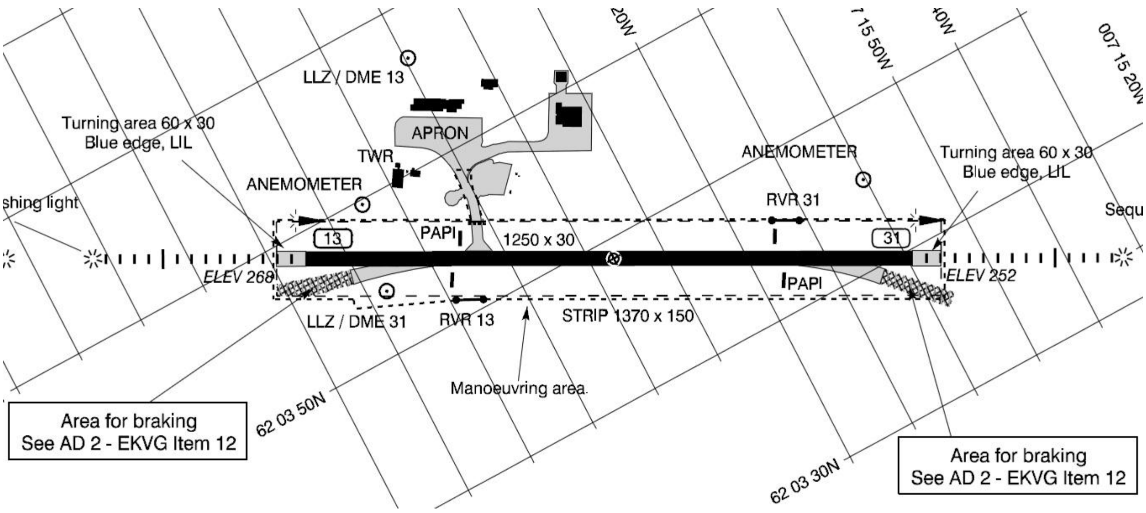

Figure 3.3 – Current layout of Vágar Airport

b. New designed runway

To attract more airline companies, provide more safety and expand airport at all it will be necessary to extend existing runway 13 – 31. Current Airport reference code of Vágar airport is 3C. Code number 3 includes airplane reference fields which length is from 1200 m up to but not including 1800 m. Due to the local space possibilities and also financial aspects it would be good to keep this code number 3, because the current width of runway is 30 m and in case of extension to 1800 m or more code number would be transferred to 4, which requires runway width 45 m. This change is not needed and it would represent just waste of money.

i. Aircraft

For designing runway and other elements consisting airport was chosen Boeing 737 – 600. The reason of this decision is that it fits to the reference code 3C and it is the most represented type of aircraft at the company that we would like to attract – Scandinavian Airlines (SAS). The SAS fleet includes nowadays 28 Boeings 737 – 600. Danish low-cost carrier Cimber Sterling, which is considered also like potential served airline, owns 6 Boeings 737 – 700 (aircraft with similar dimensions) which belong to code 3C as well.

Aircraft	Total	Orders	Passengers				Notes
			J	E	Y	Total	
Airbus A319-100	4	—	0	0	141	141	OY-KBO painted in retro livery
Airbus A321-200	8	—	0	0	198	198	
Airbus A330-300	5	—	34	35	195	264	SE-REF painted in Star Alliance livery
Airbus A340-300	7	—	46	28	171	245	A 7th A340-300 will return in 2011
Boeing 737-400	3	—	0	0	150	150	To be phased out
Boeing 737-500	9	—	0	0	120	120	To be phased out LN-BUD in hybrid livery
Boeing 737-600	28	—	0	0	123	123	
Boeing 737-700	19	—	0	0	141	141	
Boeing 737-800	18	—	0	0	150 179 186	150 179 186	LN-RRL painted in Star Alliance livery
Bombardier CRJ200	4	—	0	0	50	50	Operated by Cimber Sterling
Bombardier CRJ900 NextGen	12	—	0	0	88	88	
McDonnell Douglas MD-82	23	—	0	0	150	150	To be phased out Three painted in Star Alliance livery
McDonnell Douglas MD-87	3	0	0	0	125	125	To be phased out One painted in Star Alliance livery
Total	**141**						

Figure 3.4 – SAS fleet

Figure 3.5 – Boeing 737 - 600

ii. Runway length

Determination of the runway length is one of the most important decisions both for designing an aerodrome, but also to allow economic operation of a particular type of aircraft to specific destinations. Length of the runway also gives us limiting information about the type of aircraft that will be able to use this aerodrome and its maximal payload and range.

As the most distant flight operated from Vágar airport is considered current flight to Narsarsuaq in Greenland. This distance is 1100 NM (measured on Google Earth).

Most distanced flights:

1. Narsarsuaq, Narsarsuaq Airport (UAK), Greenland 1100 NM
2. Helsinki, Vantaa Airport (HEL), Finland 930 NM
3. Rovaniemi, Rovaniemi Airport (CPH) , Finland 900 NM
4. Copenhagen, Kastrup Airport (CPH), Denmark 750 NM
5. London, Stansted Airport (STN), Denmark 660 NM

(Note: NM = Nautical miles)

In case that it would be not possible to land on Vágar Airport, due to the bad weather conditions or in emergency cases, it is also necessary to know how far is located the nearest airport on which would be possible to relocate flight.

Nearest suitable Airports:

1. Stornoway, Stornoway Airport (SYY), Isle of Lewis (Scotland) 235 NM
2. Wick, Wick Airport (WIC), Scotland 250 NM
3. Egilsstaðir, Egilsstaðir Airport (EGS), Iceland 270 NM

(Note: All Airports listed above have asphalt runway long at least 1800 m)

While we are designing runway length we have to think also that its take-off weight will include reserve fuel, in case of closed destination airport, to fly to another the closest airport. Like another closest and suitable airport for our most distant flight was found Kangerlussuaq Airport (SFJ) on Greenland, which is one of only two civilian airports in Greenland large enough to handle large airliners. Distance between Narsarsuaq Airport (UAK) and Kangerlussuaq Airport (SFJ) is approximately 380 NM. Its runway 10-28 measures 2810m.

Due to the Payload/Range diagram for Boeing 737-600 maximal take-off weight can be 140 000 lb. This value was established for distance 1750 NM. It is including reserve for aircraft to get to closest airport from Vágar and be able to circle, while waiting for landing.

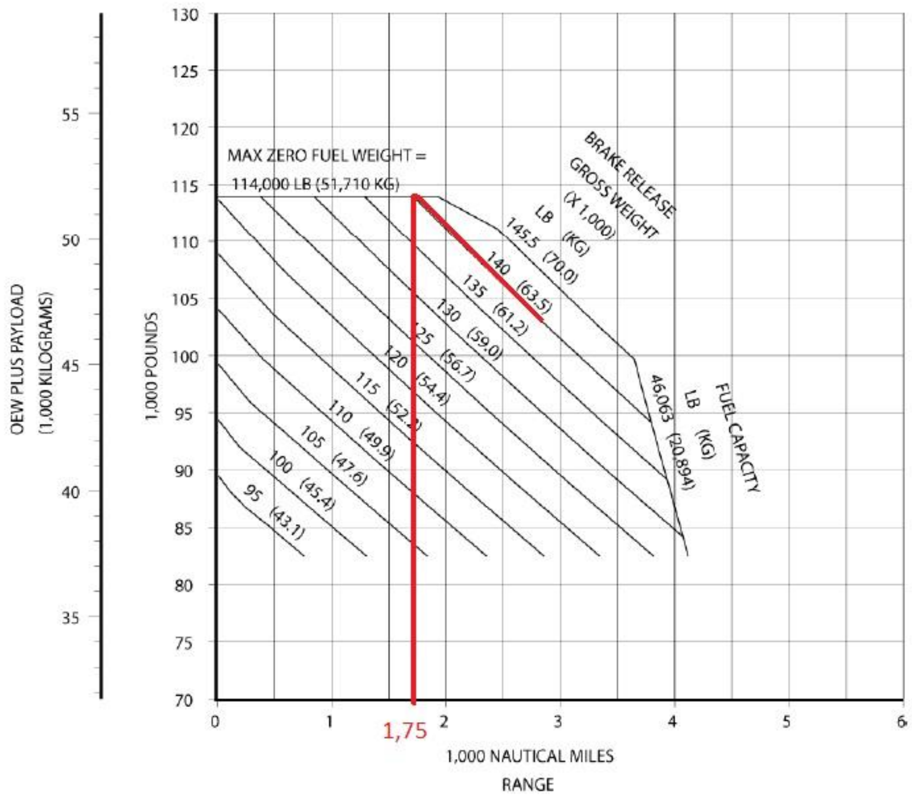

Figure 3.6 – Payload/range diagram

Take-off runway length is depended on many conditions like: temperature, direction of wind, altitude, runway gradient, using plane with winglets.

Conditions on Vágar Airport

- Temperature

  The highest average temperature during the warmest month (August) on Faroe Islands is 14 °C.

- Elevation

  Vágar Airport is located 85,344 m (280 ft.) above sea level.

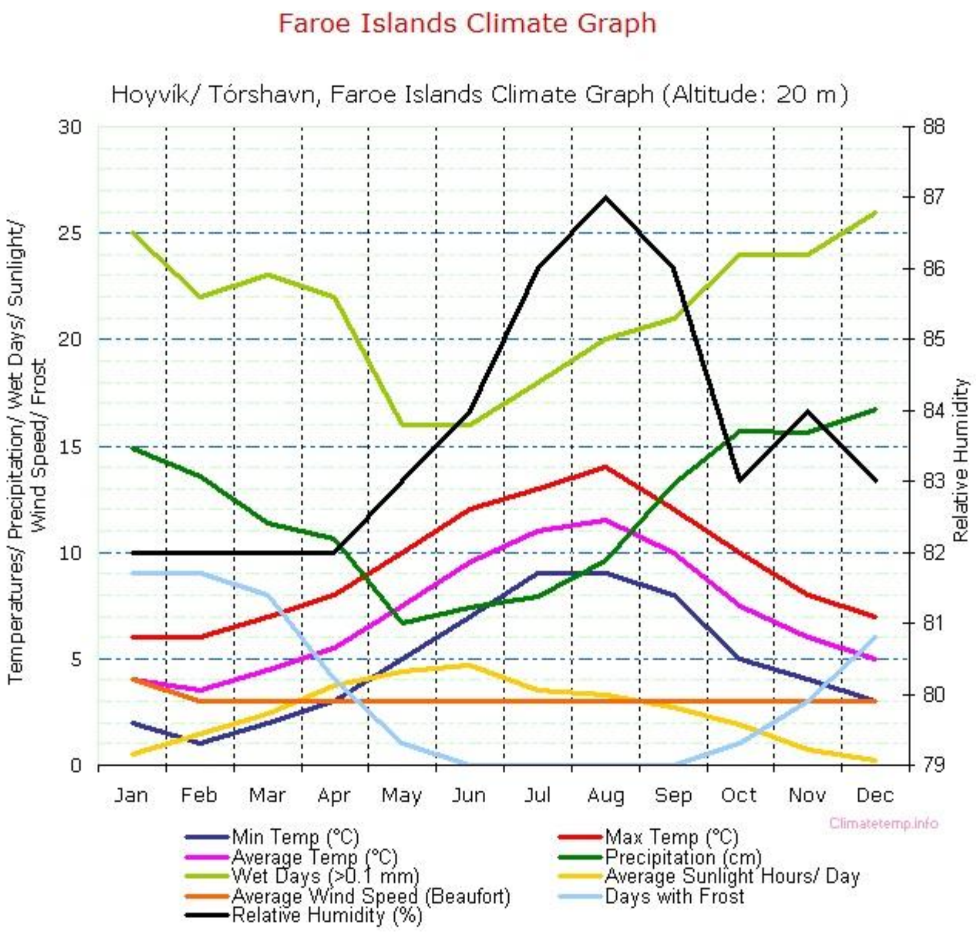

Figure 3.7 – Faroe Island climate graph

For determining the basic runway length we use these conditions:

- zero wind

- dry runway

- zero runway gradient

- temperature STD (which is 15 °C)

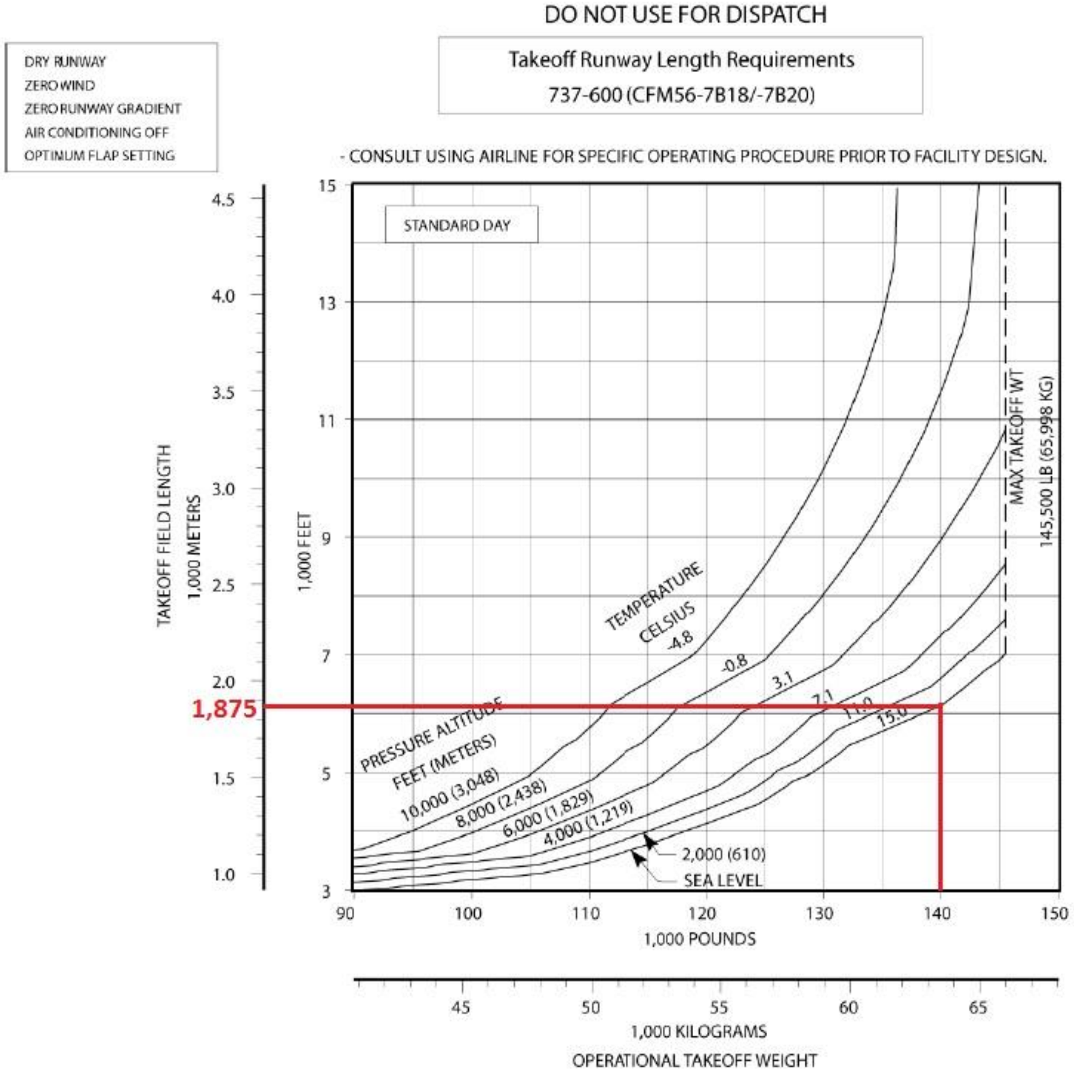

Figure 3.8 – Take–off field length graph

The graph for these conditions says that the Takeoff length should be around 1875 m. This value needs to be corrected according to real conditions.

Runway length corrections

- **Elevation**

The basic length selected for the runway should be increased at the rate 7 % per 300 m elevation.

Runway take-off length corrected for elevation:

$$\left(1875 \times \mathbf{0{,}07} \times \frac{\mathbf{85}}{\mathbf{300}}\right) + 1875 = \mathbf{1912}\ \boldsymbol{m}$$

- **Temperature**

The length of runway should be further increased at the rate 1 % for every 1 °C by which the aerodrome reference temperature exceeds the temperature in the standard atmosphere for the aerodrome elevation. This temperature in standard atmosphere is for Vágar airport 14, 45 °C , because it is 85 m above sea level.

Runway take-off length corrected for elevation and temperature:

$(1912 \times (14 - 14{,}45) \times 0{,}01) + 1912 = \mathbf{1903\ m}$

- **Slope**

Where the basic length determined by take-off requirements is 900 m or over, that length should be further increased at the rate 10 % for each 1 % of the runway slope.

Runway take-off length corrected for elevation, temperature and slope:

Taking-off from East to West:

$[(789 \times 0{,}62 \times 0{,}1) + 789] - [(535 \times 1{,}29 \times 0{,}1) + 535] - [(579 \times 0{,}8 \times 0{,}1) + 579] = \mathbf{1836\ m}$

Taking-off from West to East:

$[(475 \times 0{,}8 \times 0{,}1) + 475] + [(660 \times 1{,}29 \times 0{,}1) + 660] - [(768 \times 0{,}62 \times 0{,}1) + 768] = \mathbf{1978\ m}$

(NOTE: Expected extension for calculations was: 199 m westward and 455 m eastward)

Previous calculations show that corrected take-off length should be for the worse case (aircraft full of passengers, taking-off in upwards slope 1,29 %, with zero wind and high temperature) around **1980 m**. This situation will occur really rarely, because flights scheduled to Narsarsuaq Airport in Greenland are just few per year. Designing runway that long would be very uneconomical, because probably in 99,5 % of cases much shorter runway would be sufficient. Overwhelming majority of flights from Vágar Airport will be scheduled do closer locations. It is expected that temperature over the year will be lower that maximal average in August, aircrafts will not be always completely full and since the Faroe Islands lies in the middle of Atlantic Ocean there will be most of the time hit wind. Maximal expected take-off weight will be between 130 – 135 000 lb, which gives us basic take-off length 1650 m.

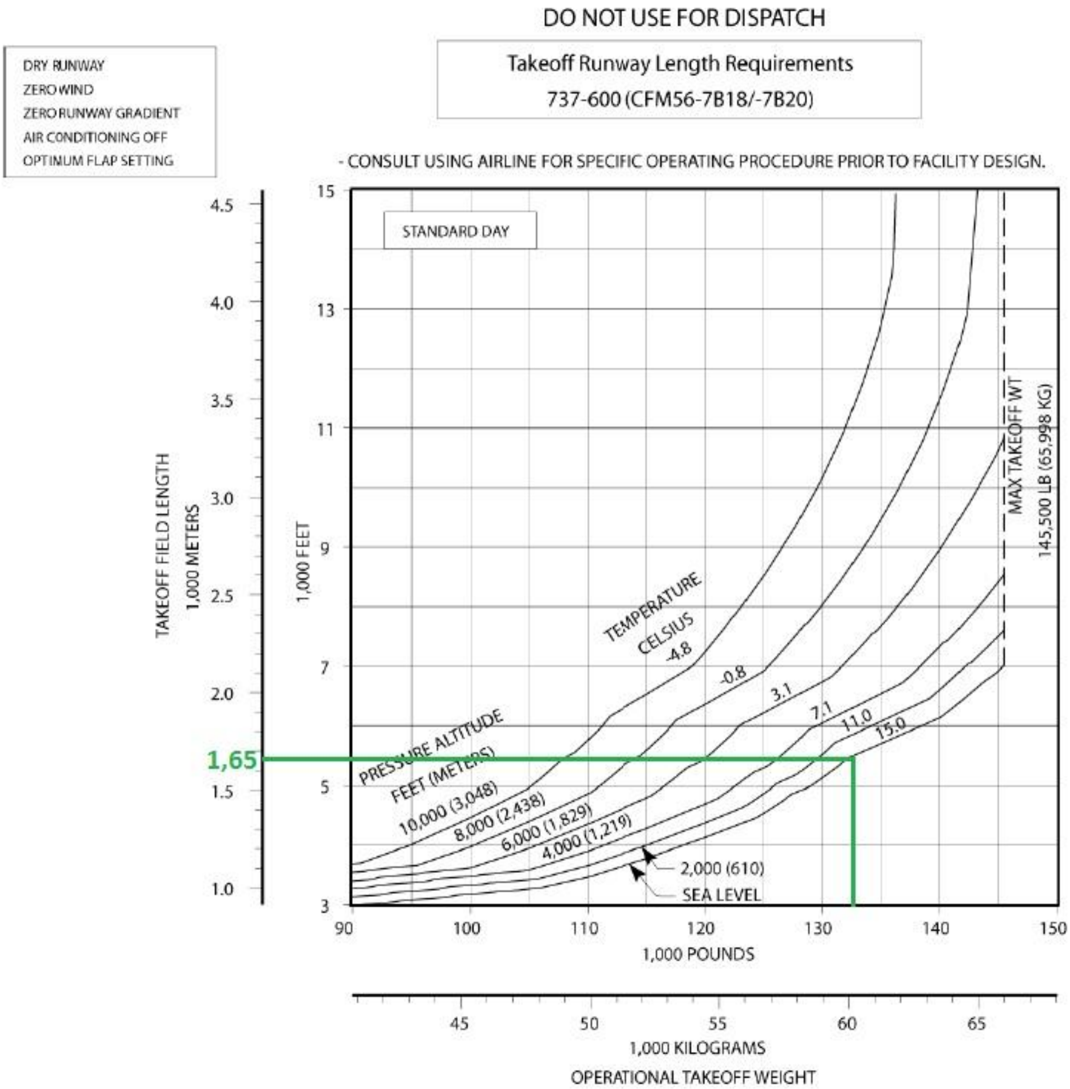

Figure 3.9 – Payload/range diagram

Runway length corrections

- **Elevation**

Runway take-off length corrected for elevation:

$$\left(1650 \times 0{,}07 \times \frac{85}{300}\right) + 1650 = \mathbf{1683\ m}$$

- **Temperature**

Runway take-off length corrected for elevation and temperature:

$$(1683 \times (14 - 14{,}45) \times 0{,}01) + 1683 = \mathbf{1676\ m}$$

- **Slope**

Runway take-off length corrected for elevation, temperature and slope:

Taking-off from East to West:

$$[(887 \times 0{,}62 \times 0{,}1) + 887] - [(660 \times 1{,}29 \times 0{,}1) + 660] - [(129 \times 0{,}8 \times 0{,}1) + 129] = \mathbf{1636}\ \boldsymbol{m}$$

Taking-off from West to East:

$$[(350 \times 0{,}8 \times 0{,}1) + 350] + [(660 \times 1{,}29 \times 0{,}1) + 660] - [(666 \times 0{,}62 \times 0{,}1) + 666] = \mathbf{1749}\ \boldsymbol{m}$$

According to previous calculations and corrections is the designed length of runway **1799 m**. This value will provide ability to operate hopefully 99,5 % of all scheduled flights. In case that bad meteorological conditions (high temperature, no wind) and other adverse conditions will occur (aircraft with maximal payload) on our most distant flight this flight will be postponed to better conditions.

Another important fact, which supports the value of the designed length, is that Vágar Airport will stay in reference code **3C** and there will be no need to extend width of runway and make other needed changes like move further taxiways.

Runway length conclusion

Current runway 13-31 will be extended for 549 m. Similar value of extension was also performed by consulting engineers who were calculating new runway length for Vágar Airport. [2]

Extension will be 350 m westward and 199 m eastward. Due to the fact that we unfortunately could not get 3D terrain map of airport and its surroundings we had to take over this information. Anyway in case we would have that 3D map, we would investigate how to extend runway according to local terrain conditions and other aspects then compare them and pick the best solution.

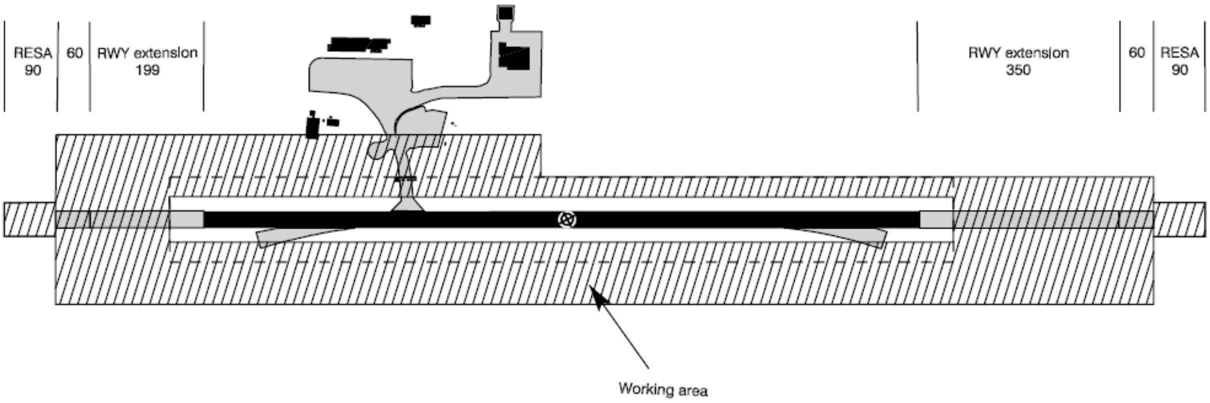

Figure 3.10 – Runway extensions

iii. Runway width

As mentioned above extension of runway will not cause transferring airport reference code, so runway width will stay 30 m, which is the value that are airports with reference code 3C provided.

iv. Runway shoulders

Runway shoulders are not designed due to the fact that they do not have to be provided for a reference code C.

v. Slopes on runway

Longitudinal slope on runway

ICAO Annex 14 says that no portion of runway should exceed longitudinal slope of 1,5% where the code number is 3 except that for first and last quarter of the length of a precision approach category II or III the longitudinal slope should not exceed 0,8 %.

Current runway follows these requirements except the first quarter from east end, which has longitudinal slope 1,29 %. Slope of new designed extension on this end will be just 0,8 % as ICAO recommends plus another 100 m of the current runway should be reconstructed with the slope 0,8 %. However this change is not designed due to the fact that ICAO just recommend this and this operation would bring extra costs. The opposite (western) end of runway which will be extended as well is designed with the same slope as the previous part of runway (0,62 %). This value follows ICAO recommendation.

Longitudinal slope changes

The transition from one slope to another should be accomplished by a curved surface with a rate of change not exceeding 0,2 % per 30 m (minimum radius of curvature of 15 000 m).

Transverse slope on runway

To promote the most rapid drainage of water the transverse slope of runway is 1,5% and it is substantially same throughout the length of a runway. Transverse slope is symmetrical on each side of runway centre line.

vi. Runway turn pads

Due to the fact that ends of extended runway are not served by taxiways or taxiway turnarounds there are provided runway turn pads.

Its width its 30 m like the width of runway and their length is 50 m. There were designed according to the space needed for 180 degrees turn for Boeing 737 – 700. Effective turning angle is 75 degrees. Nose wheel is following circle leading line of radius 13,30 m. Around the turn pads are designed shoulders, which are 5 m wide. Designing them is recommended to prevent jet blast surface erosion from the turning aeroplane and foreign object ingestion damage to the aeroplane engines.

vii. Runway strip

Runway strip provides an area clear of objects which may endanger aeroplanes. It extends laterally to a specified distance from the runway centre line, longitudinally before threshold, and beyond the runway end. For airport with reference code 3C strip should extend before the threshold and beyond the end of the runway for a distance at least 60 m and on each side of the runway centre line throughout the length of the runway for at least 150 m.

Object inside strip

Runway strip shall be free of obstacles. This rule is broken in current layout, because there is a control tower, which goes into the strip. We recommend relocate this control tower from runway strip to appropriate location which depends on the height of the tower, because it cannot also project Transitional obstacle surface.

Grading

The centre portion of a taxiway strip should provide a graded area to a distance from the centre line of the taxiway of at least 12,5 m for code letter C.

Longitudinal slopes

Along the graded portion of a strip a longitudinal slope should not exceed 1,75 % for code number 3.

Transverse slopes

Transverse slope on that portion of a strip to be graded should be adequate to prevent accumulation of water on the surface but should not exceed 2,5 % for code number 3.

viii. Runway end safety areas

A runway safety area shall be provided at each end of runway strip for code number 3. It shall extend from the end of a runway strip to a distance at least 90 m. Recommended is extension to 240 m. The width of a runway end safety area shall be at least twice that of the associated runway.

The designed runway end safety areas extend from the end of a runway strip to a distance 240 m and their width is 60 m.

ix. Clearways

On Vágar airport is established one clearway on the eastern end of runway, because there is a lake which offers this possibility. On the other end (western) establishing of clearway is not possible due to the fact that in this area is a town.

The origins of clearway are located at the end of take-off run available (TORA), which are limited by thresholds on both runway ends. Length of the clearway should not exceed half of the TORA and therefore clearway is 900 m long. It extends laterally to a distance of 75 m on each side of the extended centre line of the runway.

c. Taxiways

i. Taxiways system

Although we expect grow of air traffic on Vágar airport general changes related to taxiway system are not needed. Vágar airport belongs to and will belong to the group of aerodromes where the number of aircraft movements during the peak hour traffic is relatively small and therefore only one short taxiway connecting runway and apron is sufficient. This model is able to handle up to 12 movements during the peak hour. There are two main taxiways designed – A and B. A connects runway and apron and B turns from A to right part of apron.

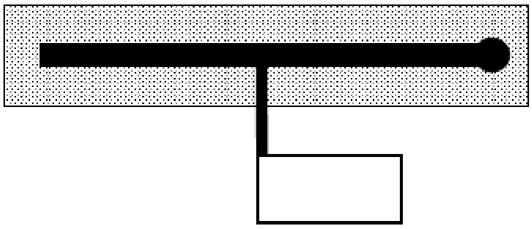

Figure 3.11 – Taxiway system (up to 12 movements during peak hour)

ii. Taxiways geometry

a. Width

Width of taxiways depends on aircraft wheel base and on code letter. Wheel base of Boeing 737-700 is 12,60 m that means that taxiways width has to be 15 m on a straight portion. The clearance distance between the outer main wheel of the aeroplane and the edge of the taxiway has to be 3 m. Current width of taxiways according to the document AIP Faroe Islands is 21 m, which means that any extension of taxiways is needed.

b. Taxiway shoulders

The main function of the taxiway shoulders is to prevent ingestion of foreign object by an aeroplane´s engines. For code letter C they have to extend symmetrically on each side of the taxiway so that overall width of the taxiway and its shoulders on straight portion is 25 m. Due to this fact it is necessary to extend taxiway shoulders 2 m on each side to reach this value.

c. Taxiway strip

Another element which belongs to taxiway is taxiway strip. Its function is similar to that of a runway strip. Taxiway strip is extended symmetrically on each side of the centre of the taxiway throughout the length of the taxiway to the distance **26 m.** Taxiways strip is free of obstacles.

d. Obstacle limitation surfaces

i. Required obstacle limitation surfaces

The following obstacle limitation surfaces needed to be established for precision approach category II:

- Inner horizontal surface
- Conical surface
- Approach surface
- Inner approach surface
- Transitional surface
- Inner transitional surface
- Balked landing surface

Note: Balked landing surface does not have to be established for Vágar airport due to the fact that it has approach and take-off climb surfaces available from both ends of runway.

ii. Obstacle limitation surfaces dimensions

All needed surface were established according to ICAO Annex 14.

APPROACH RUNWAYS

	RUNWAY CLASSIFICATION									
	Non-instrument				Non-precision approach			Precision approach category I		Precision approach category II or III
	Code number				Code number			Code number		Code number
Surface and dimensions[a]	1	2	3	4	1,2	3	4	1,2	3,4	3,4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
CONICAL										
Slope	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Height	35 m	55 m	75 m	100 m	60 m	75 m	100 m	60 m	100 m	100 m
INNER HORIZONTAL										
Height	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m
Radius	2 000 m	2 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m
INNER APPROACH										
Width	—	—	—	—	—	—	—	90 m	120 m[e]	120 m[e]
Distance from threshold	—	—	—	—	—	—	—	60 m	60 m	60 m
Length	—	—	—	—	—	—	—	900 m	900 m	900 m
Slope								2.5%	2%	2%
APPROACH										
Length of inner edge	60 m	80 m	150 m	150 m	150 m	300 m	300 m	150 m	300 m	300 m
Distance from threshold	30 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m
Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%	15%	15%
First section										
Length	1 600 m	2 500 m	3 000 m	3 000 m	2 500 m	3 000 m	3 000 m	3 000 m	3 000 m	3 000 m
Slope	5%	4%	3.33%	2.5%	3.33%	2%	2%	2.5%	2%	2%
Second section										
Length	—	—	—	—	—	3 600 m[b]	3 600 m[b]	12 000 m	3 600 m[b]	3 600 m[b]
Slope	—	—	—	—	—	2.5%	2.5%	3%	2.5%	2.5%
Horizontal section										
Length	—	—	—	—	—	8 400 m[b]	8 400 m[b]	—	8 400 m[b]	8 400 m[b]
Total length	—	—	—	—	—	15 000 m	15 000 m	15 000 m	15 000 m	15 000 m
TRANSITIONAL										
Slope	20%	20%	14.3%	14.3%	20%	14.3%	14.3%	14.3%	14.3%	14.3%
INNER TRANSITIONAL										
Slope	—	—	—	—	—	—	—	40%	33.3%	33.3%
BALKED LANDING SURFACE										
Length of inner edge	—	—	—	—	—	—	—	90 m	120 m[e]	120 m[e]
Distance from threshold	—	—	—	—	—	—	—	[c]	1 800 m[d]	1 800 m[d]
Divergence (each side)	—	—	—	—	—	—	—	10%	10%	10%
Slope	—	—	—	—	—	—	—	4%	3.33%	3.33%

a. All dimensions are measured horizontally unless specified otherwise.
b. Variable length (see 4.2.9 or 4.2.17).
c. Distance to the end of strip.
d. Or end of runway whichever is less.
e. Where the code letter is F (Column (3) of Table 1-1), the width is increased to 155 m.

Figure 3.12 – Dimensions of obstacle limitation surfaces

RUNWAYS MEANT FOR TAKE-OFF

Surface and dimensions[a] (1)	Code number 1 (2)	2 (3)	3 or 4 (4)
TAKE-OFF CLIMB			
Length of inner edge	60 m	80 m	180 m
Distance from runway end[b]	30 m	60 m	60 m
Divergence (each side)	10%	10%	12.5%
Final width	380 m	580 m	1 200 m 1 800 m[c]
Length	1 600 m	2 500 m	15 000 m
Slope	5%	4%	2%[d]

a. All dimensions are measured horizontally unless specified otherwise.
b. The take-off climb surface starts at the end of the clearway if the clearway length exceeds the specified distance.
c. 1 800 m when the intended track includes changes of heading greater than 15° for operations conducted in IMC, VMC by night.
d. See 4.2.24 and 4.2.26.

Figure 3.13 – Dimensions of obstacle limitation surfaces

iii. Obstacle limitation surfaces conclusion

Tails of the biggest aircrafts (Boeings 737) standing on apron stands are projecting transitional surface around 2,5 m. They are not located far enough to stay clear of transitional surface. This mistake was cause by establishing obstacle limitation surfaces after the whole apron layout was finished and project deadline was to close. To remove this mistake would be needed to relocate at least stands for Boeings 737 further from runway strip. One option could be creating new part of terminal not parallel with the existing one but placing angled further from the current layout. Another fact is that control tower is located already in a strip and therefore aircrafts projecting transitional surface seems much smaller problem than this.

Helicopter stands are located in appropriate distances from runway strip and therefore they do not project Transitional surface, when there are helicopters standing on.

Approach surface, Take-off climb surface, Conical surface and Inner horizontal surfaces are projected by some obstacles (mountains). Due to this fact these obstacles will need to be lighted. Operating heliport in low visibility will not be allowed.

e. Visual aids for navigation

i. Wind indicators

An aerodrome shall be equipped with at least one wind indicator. Designed wind indicator is located in runway strip. It is made from lightweight fabric. Its shape is truncated cone with dimensions: length 3,6 m, diameter of larger end 0,9 m and diameter of smaller end 0,6 m. Its colour is red and white.

ii. Markings

a. General

Runway markings are white. Taxiway markings, runway turn pad markings, aircraft stand markings are yellow. Apron safety lines are red. Service road marking is white.

b. Runway designation marking

Runway designation marking is provided at thresholds. It consists of two-digit whole number which shows one-tenth of the magnetic North. On western end of runway is placed number 13 and on eastern 31.

c. Runway centre line marking

A runway centre line marking consists of a uniformly spaced stripes and gaps. The length of a stripe is 30 m and length of a gap is 54,4 m. Its width is 0,90 m.

d. Threshold marking

The stripes of the threshold marking commence 6 m from the threshold. A runway threshold marking consist of a pattern of longitudinal stripes of a uniform dimension disposed symmetrically about the centre line of runway. For the runway of width 30 m are 8 stripes designed. Their length is 30 m. Stripes are 1,8 m wide with 1,8 m spacing between them.

e. Transverse stripe

Thresholds are marked by transverse stripe of width 1,80 m, because there are runway turn pads located before thresholds.

f. Aiming point parking

The aiming point marking consists of two conspicuous stripes and it is provided at each approach end of the runway. The distance from threshold to beginning of marking is 300 m. Length of the aiming point stripe is 50 m. Its width is 6 m and lateral spacing between inner sides of stripes is 12 m. This value does not respond with ICAO Annex 14, where the minimum stated is 18 m. It has been designed differently according to small width of runway.

g. Touchdown zone marking

The touchdown zone markings consist of 4 pairs of rectangular markings symmetrically disposed about the runway centre line. The pairs of markings are provided at longitudinal spacing of 150 m beginning from the threshold. Each stripe of each marking is 22,5 m long and 3 m wide. The lateral spacing between the inner sides of the rectangles is equal to that of the aiming point.

h. Runway side stripe marking

The runway side stripe marking is provided between the thresholds of runway and extended to the end of turn pads behind thresholds. It consists of two stripes, one placed along each edge of runway. Runway side strip has 0,9 m width.

i.Taxiway centre line marking

The taxiway centre line is a single continuous yellow line, 15 cm to in width provided on taxiways, runway turn pads, de-icing pad and apron stands. This provides a visual cue to permit taxiing along a designated path. Aircraft should be kept centred over this line during taxiing.

j.Runway turn pad marking

Runway turn pad marking is provided for continuous guidance to enable aeroplane to complete a 180-degree turn and align with the runway centre line. Runway turn pad marking is extended parallel to the runway centre line marking for 60 m beyond the point of tangency.

k. Runway holding position marking

Runway Holding Position Markings indicate where an aircraft is supposed to stop when approaching a runway. They consist of four yellow lines, two solid and two dashed, spaced six or twelve inches apart, and extending across the width of the taxiway or runway. Distance from the runway centre line to runway holding position is for precision approach category II 90 m.

l.Aircraft stand marking

Basic aircraft stop line – Pilots eye stop positions

On each of stands designed on Vágar airport are designed also Pilots eye stop positions. They indicate where should pilot stop aircraft while he is parking on a stand and therefore they need to be visible from cockpit. These stop lines are located at right angles to the alignment bar, abeam the left pilot position at the intended point of stop. Their length is minimally 6 m and width 0,3 m. Next to them are located signs saying for which aircrafts is each bar. Sign has letter of height 1 m.

Nose wheel stop positions

Theses transverse bars indicate nose wheel stop positions to the marshaller. They are provided again on all stands. On Taxi-out stands there is just one position serving for all 3 types of aircrafts. On Bridge connected stands are 2 Nose wheel stop position bars, because aircrafts need to stop differently according to the setting of Air Bridge. It consists from continuous yellow line which is extended 3 m to both sides from stand lead-in line (aircraft centre line). Its width is 0,2 m. Next to them are located signs oriented to the terminal building (marshaller) saying for which aircraft is each bar. Signs have height of 0,5 m.

Direction to parking stands

This marking assist the pilot of an approaching aircraft to identify the appropriate parking. It consists of black characters of height 2 m place on a yellow background with black borders. If the angle between centre lines of the taxiways is in range 0° - 60° the characters are oriented perpendicularly to the centre line of taxiway where the sign is pointing. If is the angle in range 61° - 90° the characters are oriented parallel to the centre line of taxiway where the sign is pointing.

Apron and taxiway edge lines

This marking is used where the edge of the full strength pavement cannot be easily discerned .Its designed like double yellow line. Each of lines and gap between them has width 0,15 m.

Stand safety line

This line depicts the area that must remain free of staff, vehicles and equipment when an aircraft is taxiing (pr being towed) into position or has started engines in preparation for departure. Once all engines have been shut down and the anti-collision lights have been switched off, vehicles may cross the line to service the aircraft. This marking is designed like red continuous line of 0,2 m width. For code C aircraft the clearance must be 4,50 m. This distance is measured from the most outer shape lines of all aircrafts that this stand is going to accommodate.

Equipment parking area

This marking is used to delineate an area within which vehicle and equipment can park freely without infringing any stand areas or taxiways, including taxiway strip surfaces. This marking is designed like white line of 0,1 m width.

No parking area and Air bridge wheel position

The area under an air bridge has to be kept free of vehicles and equipment to ensure the safe operation of the air bridge. Wheel positions are recommended for the air bridge itself, using either a circle or a square, to locate the air bridge in a safe position when not in use and to allow aircraft to enter the stand safely. This marking is designed like red line of 0,1 m width.

Underground services including fuel hydrant markings

This marking is indicative of the markings recommended for use with all underground services. The size and shape of the markings depends on the size of the service opening. Any above ground projection, such as a lift-up hydrant connection system or cover, should preferably be painted red. This marking is designed like red line of 0,1 m width.

Tractor push back line

This line marking is for a use of a tractor driver when pushing an aircraft from a stand. A transverse bar indicates the position where the aircraft (nose wheel) is to be stopped, prior to be disconnected from the tractor. To avoid confusion with markings for aircrafts it is designed like white broken line of width 0,1 m.

m. Other marking

Service road

Boundaries of service roads are marked by continuous white line 0,1 m in width.

Vehicle limit line

Used where a service road is also the limit of vehicle activity on an apron. Its designed like double white line. Each of lines and gap between them has width 0,1 m.

Taxiway and taxilane crossing

Where service roads cross a taxiway or taxilane is used this special markings. It consists of 2 broken lines which are right next to each other and their gaps are changing to the bench. Length of gap and stripe is equal – 1 m. This marking is designed like white line of 0,1 m width.

Vehicle stop lines are located at the safe distance from taxiway centre line. Their widths is 0,5 m.

iii. Signs

a. Mandatory instruction signs

Mandatory signs identify a location beyond which an aircraft taxing or vehicle shall not proceed unless authorized by the aerodrome control tower. Mandatory instruction sign consist of an inscription on a red background. They include runway designations signs and category II runway holding position signs.

Runway designations signs

They are located at taxiway/runway intersection on each side of the runway- holding position. The inscription on a runway-holding position consists of the taxiway designation and a number.

b. Information signs

Information signs include direction signs and location signs. Information signs are located on the left hand side of the taxiway. Locations sign other that location sign consist of an inscription in black on a yellow background. A location sign consist of an inscription in yellow on black background.

Perpendicular distance from defined taxiway pavement or runway pavement to the edge of near side of signs is designed like 15 m, which is in the range that ICAO Annex 14 Volume 1 offers.

4. Apron (Lukas)

a. Apron concept

Current apron concept on Vágar Airport is an open concept, which includes 4 Taxi-out (self manoeuvring) stands. Due to the fact that the growth of air traffic on Vágar airport is expected it is needed to expand also size of an apron and increase number of its apron stands.

Hybrid concept was chosen as a new apron concept. It is designed like a combination between simple and linear concept, because 3 current apron stands will be kept like Taxi-out and the fourth will be replaced with a Bridge connected (Nose-in stands) and also 2 new Bridge connected stands will be created. So in conclusion apron will consists of 3 Taxi-out stands and 3 Bridge connected stands. This layout will not require much more extra space because Bridge connected stands require less space than Taxi-out stands. On the Bridge connected stands the aeroplanes will be located directly nose inwards from the terminal building frontage and Taxi-out stands they will be parked at an angle.

b. Apron sizing

Width of an aircraft stand has to consist of wing span value of an aircraft plus clearance distance added from both sites. All aircraft stands should provide the minimum clearance 4,5 m between an aircraft using the stand and any adjacent building, aircraft on another stand and other objects.

c. Apron extension

Due to the fact that all aircraft stands will be suitable for all types of aeroplanes (Boeing 737 – 600, Boeing 737 – 700 and BAe 146 – 200) indented to operate from Vágar Airport it will be necessary to extend apron. Directions and needed lengths of extensions were determined by placing model of the aircraft with the biggest wing span onto apron drawing in dwg file (format of AutoCAD file) and simulating its movements why taxiing, parking on an apron stand and driving out. These simulations should be done in specialized software however we did not own this software and its license so it was created as best as we could – in AutoCAD. Minimum clearance distance between aircraft stand taxilane centre line and any other object, which is for code 3C - 24,5 m was met everywhere.

d. Apron stands

i. Taxi-out stands

Although that on left part of apron were located Taxi-out stands in previous layout they were adjusted to be able to accommodate the most demanding aircraft (Boeing 737 – 700). These Taxi-out stands are designed like angled nose-in stands. Angle between parked position on Stand number 1 and the edge of apron (which is almost parallel with terminal building) is 45 °. Angle between the other Taxi out stands – numbers 2 and 3 and the edge of apron is 50 °. All Taxi-out stands are designed in that way that it will be possible for the aircrafts on neighbouring stands to operate independently, because they have secured turning clearances for their entire route while they will be taxing to the stand and driving out. This clearances 4,5 m are added behind the wing tips of the wings further from turning points of aircrafts. For all Taxi out stands was used the turning angle 70°, which is the second largest possible. This value was chosen according to the space limitations. All Taxi-out stands also contain straight part between the turn parts. This straight part is 6 m long and it is important for aircrafts, because the stress in nose wheel needs to be released by straightening it up and also it is much easier for aircraft to start moving while it has nose wheel straight.

ii. Nose-in bridge connected stands

Apron stands number 4,5 and 6 are bridge connected stands where aircrafts stand nose-in and they need to be pushed back by a towing tractor to leave to stand. For determining their distance from each other and also from stand number 3 (Taxi-out stand) was used the same method like for Taxi-out stands – simulations of movements in AutoCAD. The centre lines of air bridges have distance 39 m. Requirements for minimum clearances around the shape of aircrafts are met.

All three air bridges have the same parameters. Air bridges used for our stands are produced by manufactured ThyssenKrupp Airport systems. Its type is TB 19/13.0-2. They consist from a straight fixed part attached to the terminal building. This fixed part has slope of 1,94° and it is 14,80 m long. Centre lines of aircrafts on these stands are distanced 15,00 m away from centre line of fixed parts of bridges. Following part of the air bridge is rotunda-shape joint, which has slope 0°. After this joint comes movable and expandable part of a bridge. Its length lies in the range from 13,3 m to 19,3 m and it consist of 2 tunnels. Last part of the air bridge is connection to the aircraft, which is long 2 m and it has slope 0°. For design of the air bridges for these apron stands were used Boeing 737 – 700, which has the same parameters (aircraft width, distance between aircraft floor and ground, distance between aircraft nose and nose wheel and distance between aircraft nose and front door) needed for this design as Boeing 737 – 600 and BAe 146 – 200, which is indented to use these stands as well. Distance between aircraft floor of BAe 146 - 200 and apron pavement is smaller than have Boeings (2,74 m) so it has to be possible to extend the air bridge more to a needed distance in order to keep maximal air bridge slope 4,50°. So in conclusion the air bridges for Boeings will be extended just to a distance 14,00 m and slope of air bridges will be 3,11° and for BAe 146 – 200 will be air bridges extended to a distance 19,00 m and a slope of air bridges will be 4,10°.

TWO TUNNEL BRIDGE - STEEL

MODEL	Lmax		Lmin	
TB 15/11.0-2	15.30 m	50.20'	11.30 m	37.08'
TB 17/12.0-2	17.30 m	56.76'	12.30 m	40.36'
TB 19/13.0-2	19.30 m	63.32'	13.30 m	43.64'
TB 21/14.0-2	21.30 m	69.89'	14.30 m	46.92'
TB 23/15.0-2	23.30 m	76.45'	15.30 m	50.20'
TB 25/16.0-2	25.30 m	83.00'	16.30 m	53.48'
TB 27/17.0-2	27.30 m	89.57'	17.30 m	56.76'
TB 29/18.0-2	29.30 m	96.13'	18.30 m	60.04'
TB 31/19.0-2	31.30 m	102.70'	19.30 m	63.32'
TB 33/20.0-2	33.30 m	109.26'	20.30 m	66.60'
TB 35/21.0-2	35.30 m	115.82'	21.30 m	69.89'
TB 37/22.5-2	37.30 m	122.38'	22.80 m	74.80'
TB 39/23.5-2	39.30 m	128.94'	23.80 m	78.08'
TB 41/24.5-2	41.30 m	135.51'	24.80 m	81.36'
TB 43/25.5-2	43.30 m	142.07'	25.80 m	84.64'
TB 45/26.5-2	45.30 m	148.63'	26.80 m	87.93'

PBB Code Description

TB (C) XX / XX - X
1 2 3 4

1: Telescopic Bridge (TB). (C) means glazed side walls.
2: Approximate length of the Apron Drive PBB in an extended state.
3: Approximate length of the Apron Drive PBB in a retracted state.
4: Number of tunnels.

Figure 4.1 – ThyssenKrupp air bridges

	Value (m)								
Aircraft	1	2	3	4	5	6	7	Slope (%)	X (m)
BAe 146 - 200	3,42	2,14	2,26	5,08	19	3,5	1,36	4,10	14,83
B737-600	3,76	2,74	4,09	5,03	14	3,5	0,76	3,11	10,54
B737-700	3,76	2,74	4,09	5,03	14	3,5	0,76	3,11	10,54

Table legend:

1 Aircraft width (m)
2 Distance: floor-ground (m)
3 Distance: aircraft nose-nose wheel (m)
4 Distance: aircraft nose-aircraft front door (m)
5 Bridge length (m)
6 Rotunda elevation
7 Height difference

Table 4.1 – Bridge settings for each aircraft

e. Featured services on bridge connected (nose-in) stands

i. General

We had decided to place on these new apron stands ground support system of some basic services like jet fuel, pre-conditioned air, ground power unit and portable water. All the services featured in the ground support system are pit based solutions, buried in the apron. We had chosen the CombiBox system from the manufacturer CombiBox. The boxes are made of galvanized steel and are available in different sizes. The typical airport box is 700 mm wide, 900 mm long and 1300 mm deep. It will withstand a load of 100 000 kg over a surface on the cover of 300 x 300 mm, without any damage or visual permanent set. The box can take this load either free-standing or cast into a concrete surface. All boxes are prepared for connection to drainage system. The boxes are then equipped with any of the required services.

ii. Advantages of ground support system :

- Increased safety with a clean apron

The removal of service vehicles from the apron *reduces the risk of collision* between aircraft and service vehicles. An increasingly dangerous and costly problem at today's busy, vehicle congested ramps.

- Increased capacity with shorter turnaround time

The CombiBox System allows the units to be serviced independently of each other without the need for ground service vehicles. The elimination of ground service vehicles *makes space available*. The turnaround can be shortened, and the airport will gain from increased capacity.

- Better ground service

A complete and individual service at every apron *reduces waiting times*, often a source of irritation and consequent costs. In the CombiBox system the control system enables individual registration of rendered ground services.

- Reduced costs of ground support

Increased safety, increased capacity and improved ground service will result in *substantial costs savings*. The fixed system causes in itself lower labour costs.
All CombiBox systems are delivered in accordance with Lloyd´s requirements or any other regulations where applicable.

All pits are hot dipped galvanized for 100 years of in ground service. The Combiboxes are load-tested and dimensioned to take the full weight of any ramp vehicle. Each system may be connected to a host system for collecting data and reporting operating status. The system is monitored and consumption data is collected as to provide on-line consumption reports for easy invoicing.

iii. Featured services

a. Pre-conditioned air pit (PCA)

PCA pit is located 2,60 m from aircrafts centre line on left side on bridge connected apron stands. Its located under wings of parked aircrafts. Locations PCA intakes of Boeing 737 -700 and 737-600 were found in aircrafts manual. They are located in a diameter 13 m that is possible to reach by a PCA hose coming from a pit. We were not able to find out location of PCA intake of BAe 146 – 200, but it is expected that it will be in reachable distance from a PCA pit.

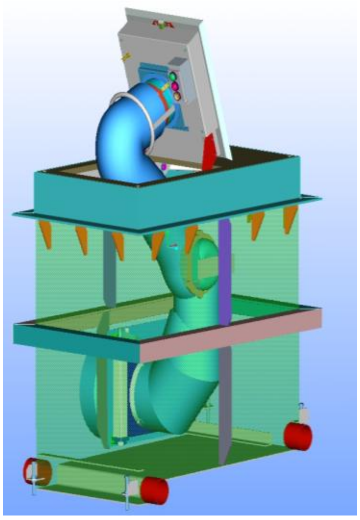

Figure 4.2 – CombiBox PCA pit

b. Ground power unit (GPU)

GPU pit is located 2,80 m from aircrafts centre line on the right side and in front the most front door of any parked aircraft on bridge connected stands. It is not located under any parked aircraft. GPU pit does not interfere with PBB or with catering vehicle servicing the aircrafts. Towing tractor of width 3 m does not have any difficulties to pass it. GPU pit is provided with a 12 m long lightweight 400 Hz cable and standard 400 Hz aircraft connector. GPU intakes of all aircrafts intended to be served on these stands are located in reachable distance. Locations GPU intakes of Boeing 737 -700 and 737-600 were found in aircrafts manual and location of GPU intake of BAe 146 – 200 was measured from model drawing in dwg (AutoCAD) file.

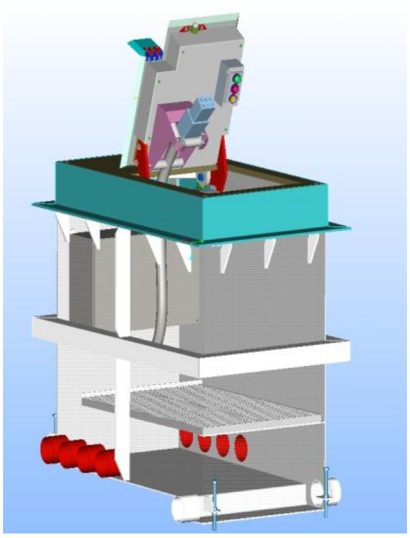

Figure 4.3 – CombiBox GPU pit

c. Fuel pit

FUEL pit is located 12,00 m from aircrafts centre line on the right side. It is not located under any parked aircraft on bridge connected stands. FUEL pit is provided with a 15 m long hose. FUEL intakes of all aircrafts intended to be served on these stands are located in reachable distance. Locations of FUEL intakes of Boeing 737 -700 and 737-600 were found in aircrafts manual and location of FUEL intake of BAe 146 – 200 was measured from model drawing in dwg (AutoCAD) file. Dimensions of FUEL pit are 1300 x 2160 x 1550 mm (W x L x H).

d. Portable WATER pit

Portable WATER pit is located 5,00 m from aircrafts centre line on the right side. It is located under wings of parked aircrafts. Portable WATER pit is provided with a 20 m long hose. WATER intakes of all aircrafts intended to be served on these stands are located in reachable distance. Locations of WATER intakes of Boeing 737 -700 and 737-600 were found in aircrafts manual and location of WATER intake of BAe 146 – 200 was measured from model drawing in dwg (AutoCAD) file.

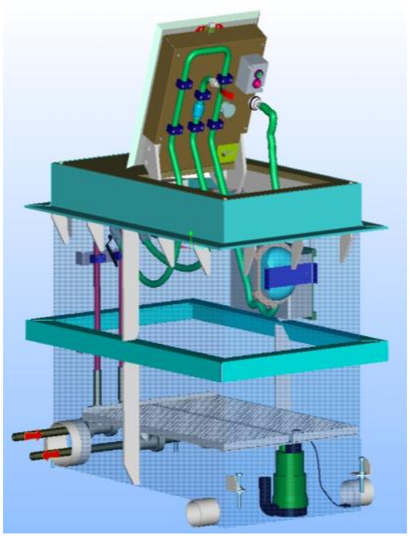

Figure 4.4 – CombiBox portable WATER pit

	PCA		GPU		FUEL		WATER	
Aircraft	**dis. from nose wh.(m)**	**dis. from aircraft CL(m)**	**dis. from nose wh.(m)**	**dis. from aircraft CL(m)**	**dis. from nose wh.(m)**	**dis. from aircraft CL(m)**	**dis. from nose wh.(m)**	**dis. from aircraft CL(m)**
BAe 146 - 200	NA	NA	3,9	1,4 (right)	12,8	9,26 (right)	10,5	0,93 (right)
B737-600	10,7	0	2,6	0,9 (right)	14,8	7,7 (right)	22,3	0,3 (right)
B737-700	12,1	0	2,6	0,9 (right)	16,2	7,7 (right)	24,7	0,3 (right)

Table 4.2 – Intakes locations

5. Heliport (Lukas)

a. Introduction

Atlantic Airways also operates a domestic service by helicopter, in many instances a vital connection to many of the islands, which otherwise can only be reached by sea. The helicopter has proved a vital tool on the islands since the 1960s, when helicopters from Danish coast guard vessels patrolling the Faroes undertook a variety of tasks, including ferrying equipment and supplies between the islands. The government hired a helicopter in 1978 for these tasks, but in the 1980s a commercial public helicopter service was launched linking each of the islands using two Bell Helicopter Textron aircraft. Initially, the helicopter service was a standalone company, SL Helicopters, but the decision to concentrate Faroese aviation into one firm led the helicopter department becoming part of Atlantic Airways in 1994. The helicopters provide a round trip 'hopper' service to each of the islands, which is also ideal for tourists looking for aerial views. The company is required to have at least one helicopter, operational and ready for search and rescue duties.

b. Destinations and flight schedule

Three days a week (Sundays, Wednesdays and Fridays) there are scheduled flights to the outer islands, and during the summer months of June, July, and August also on Mondays. On the remaining days other tasks are undertaken, such as charter trips and sling flights. Sling flights involve flying with goods which are hooked underneath the helicopter, and transported from one place to another.

The cargo types are almost unlimited: live animals (such as horses, calves, smelt), hay, concrete mix, timber, sheds, mini-diggers, fuel tanks, and even cars and tractors are among the things that can be transported in this way.

The flights visit Tórshavn and Klaksvík towns, southern islands Dímun, Froðba, Koltur, Skúvoy, and northern islands Hattarvík, Kirkja, Mykines and Svínoy.

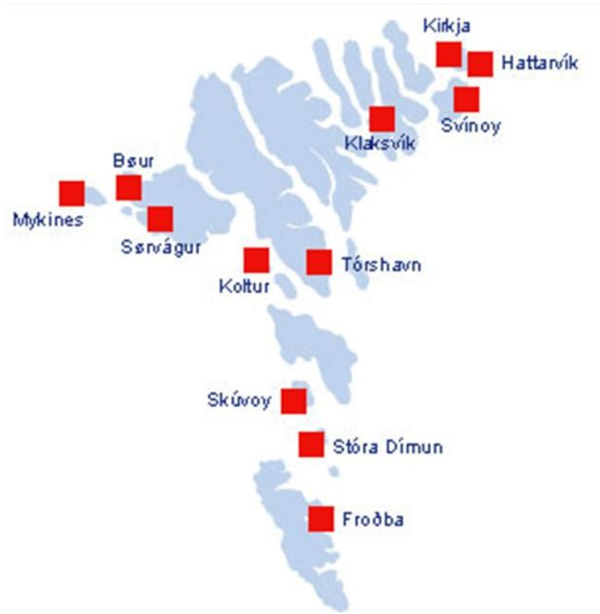

Figure 5.1 – Destinations of Atlantic Helicopters

c. Special duties

Atlantic Helicopters has a helicopter with crew on standby 24 hours a day 365 days a year for search & rescue and ambulance flights. The helicopter is a Bell 412, and is specially equipped for this purpose. Search & rescue is a public responsibility and the Ministry of Fishery has made a contract with Atlantic Helicopters to undertake this duty.

Atlantic Helicopters has also had similar Search & Rescue contracts with the oil exploration companies, which have been operating in Faroese waters over the last few years.

d. Current helicopters´ fleet

Figure 5.2 – Atlantic Helicopters fleet

e. Designed changes

According to plan drawings and sketches that we have been able to reach there is only one obvious helicopter stands located on Vágar Airport. Location of one current helicopter stand is next to main taxiway connecting runway and apron. This helicopter stand is located in runway strip and therefore its relocation is designed. Due to the fact that Atlantic Helicopters´ fleet consists of three helicopters it would be needed to provide stands for all of them.

Three new helicopter stands (H1, H2, H3) are designed. Helicopter stands H1 is located on left side of apron and stands H2 and H3 are located on right side of apron. New connecting service road is designed around the edge of apron on the right side to reach the helicopter stand H1. Passenger will be transported there by a minibus (max 15 passengers in helicopter).

f. Physical characteristics

Heliport on Vágar Airport is a surface-level heliport.

i. Final approach and take-off area (FATO)

The width of a FATO for a helicopters operating in a performance class 1 shall be not less than the greatest overall dimension (D) of the largest helicopter the FATO is intended to serve.

The greatest overall dimension (D) of all three helicopters operating on Vágar Airport has Bell 412. It is 17,13 m. In our case like a FATO will serve runway 13-31, which width is 30 m. Length of FATO was designed like 200 m.

The mean slope in any direction of a FATO shall not exceed 3 % and no portion of a FATO shall have a local slope exceeding 5 % (performance class 1). These requirements are also met.

ii. Rejected take-off areas

Due to the fact that we use runway like FATO it is also good opportunity to establish Rejected take-off areas on both sides of FATO, where is their origin located. Their width is the same as the width of FATO and their length is designed like 300 m. I would be possible to make them longer, but this value is sufficient.

iii. Safety area

FATO and associated Rejected take-off areas are surrounded by a safety area, which is not paved. Due to the fact that FATO is intended to be used by helicopters operating in instrumental meteorological conditions (IMC) safety area is extended laterally to a distance 45 m on each side of the FATO centre line and longitudinally to a distance 60 m beyond the ends of the FATO. The surface of the safety area does not exceed an upward slope of 4 % outwards from the edge of the FATO.

iv. Helicopter clearways

Helicopter clearways are provided from both approach/take-off sides. They are located beyond the end of the rejected take-off area. Their width is equal to the width of associated safety areas, which is 90 m. Helicopter clearways are 300 m long.

v. Touchdown and lift-off areas (TLOF)

There are three TLOF areas designed, which are not located within the FATO. Its main reason is that two helicopters (Bell 412 HP and Bell 420 EP) are provided with skids and therefore after they will reach FATO they will be air-taxiing to the TLOF areas which are collocated with helicopter stands.

The TLOF shall be sufficient size to contain a circle of diameter at least 0,83 D of the largest helicopter the area is intended to serve.

To have a possibility to park any of their helicopters on any of these three stands they are all designed for the helicopter with greatest overall dimension – Bell 412.

TLOF areas have circular shape. Their diameter is 14,50 m (17,13 x 0,83 = 14,22 m).

vi. Helicopter air taxiways and air taxi-routes

A helicopter air taxiway is intended to permit movement of a helicopter above the surface at a height normally associated with ground effect and at ground speed less than 37 km/h (20 kt).

The width of a helicopter taxiway shall be at least two times the largest width of undercarriage (UCW) of the helicopter that the air taxiway is intended to serve.

Helicopter which is operating on this heliport and has the largest width of UCW is Augusta Westland 139. Its UCW measures 3,17 m and therefore the minimal width of air taxiway should be 6,34 m (2 x 3,17). Designed width of air taxiway is 6,50 m. Where helicopters use taxiway for airplanes like air taxiway its width is 15 m.

A helicopter air taxiway is centred on an air taxi-route. A helicopter air taxi-route shall extend symmetrically on each side of the centre line for a distance at least equal to the largest overall width of the helicopters it is indented to serve. The largest overall width of the helicopter is the diameter of rotor of Bell 412, which is 14,02 m. The designed width of air taxi-route is 30 m (2 x 14,02 = 28,04 m). This means that air taxi-route extended 2,5 meter behind the edges of taxiway shoulders, because the overall width of taxiway with its shoulders is 25 m. Due to the fact that 25 m of air taxi-route width out of 30 m are paved it is expected that this air taxi-route will provide good ground effect.

vii. Aprons

All three helicopter stand are designed for turning also and therefore their minimal dimension cannot be less than 2 D (including 0,4 D protection zone, which extends from the edge of the helicopter stand).

Each of the designed helicopter stands plus surrounding protection areas has diameter 35 m (17,13 x 2 = 34,26 m). Width of protection area is 7 m (0,4 x 17,13 = 6,85 m).

Protection zones do not overlap. Simultaneous operations on helicopter stand H1 and Taxi-out stand 1 are not allowed, because air taxi-route overlap turning clearance of aircraft. Simultaneous operations are also not allowed on helicopter stands H2 and H3, because their air taxi-routs overlap.

The central zone of the stand shall be capable of withstanding the traffic helicopters that it is intended to serve and have a static load-bearing area of a diameter not less than 0,83 D of the largest helicopter it is intended to serve.

The designed central zone on each of helicopter stands has diameter of 14,50 m (17,13 x 0,83 = 14,22 m).

The slope in any direction on a helicopter stands does not exceed 2 %.

g. Obstacle limitation surfaces and sectors

i. Required obstacle limitation surfaces

Heliport on Vágar airport is an instrument, 3 degrees precision approach heliport. For this type of heliport need to be established following obstacle limitation surface:

- Take-off climb surface
- Approach surface
- Conical surface
- Transitional surface
-

ii. Required obstacle limitation surfaces

All needed surface were established according to ICAO Annex 14 Volume 2.

STRAIGHT TAKE-OFF

Surface and dimensions		Non-instrument (visual) Helicopter performance class 1	2	3	Instrument
TAKE-OFF CLIMB					
Width of inner edge		Width of safety area			90 m
Location of inner edge		Boundary or end of clearway			Boundary or end of clearway
First section					
Divergence	— day	10%	10%	10%	30%
	— night	15%	15%	15%	
Length	— day	a	245 m[b]	245 m[b]	2 850 m
	— night	a	245 m[b]	245 m[b]	
Outer width	— day	c	49 m[d]	49 m[d]	1 800 m
	— night	c	73.5 m[d]	73.5 m[d]	
Slope (maximum)		4.5%*	8%[b]	8%[b]	3.5%
Second section					
Divergence	— day	parallel	10%	10%	parallel
	— night	parallel	15%	15%	
Length	— day	e	a	a	1 510 m
	— night	e	a	a	
Outer width	— day	c	c	c	1 800 m
	— night	c	c	c	
Slope (maximum)		4.5%*	15%	15%	3.5%*
Third section					
Divergence		—	parallel	parallel	parallel
Length	— day	—	e	e	7 640 m
	— night	—	e	e	
Outer width	— day	—	c	c	1 800 m
	— night	—	c	c	
Slope (maximum)		—	15%	15%	2%

Figure 5.3 – Obstacle limitation surfaces dimensions

Surface and dimensions	3° approach Height above FATO 90 m (300 ft)	60 m (200 ft)	45 m (150 ft)	30 m (100 ft)
APPROACH SURFACE				
Length of inner edge	90 m	90 m	90 m	90 m
Distance from end of FATO	60 m	60 m	60 m	60 m
Divergence each side to height above FATO	25%	25%	25%	25%
Distance to height above FATO	1 745 m	1 163 m	872 m	581 m
Width at height above FATO	962 m	671 m	526 m	380 m
Divergence to parallel section	15%	15%	15%	15%
Distance to parallel section	2 793 m	3 763 m	4 246 m	4 733 m
Width of parallel section	1 800 m	1 800 m	1 800 m	1 800 m
Distance to outer edge	5 462 m	5 074 m	4 882 m	4 686 m
Width at outer edge	1 800 m	1 800 m	1 800 m	1 800 m
Slope of first section	2.5% (1:40)	2.5% (1:40)	2.5% (1:40)	2.5% (1:40)
Length of first section	3 000 m	3 000 m	3 000 m	3 000 m
Slope of second section	3% (1:33.3)	3% (1:33.3)	3% (1:33.3)	3% (1:33.3)
Length of second section	2 500 m	2 500 m	2 500 m	2 500 m
Total length of surface	10 000 m	10 000 m	10 000 m	10 000 m
CONICAL				
Slope	5%	5%	5%	5%
Height	55 m	55 m	55 m	55 m
TRANSITIONAL				
Slope	14.3%	14.3%	14.3%	14.3%
Height	45 m	45 m	45 m	45 m

Figure 5.4 – Obstacle limitation surfaces dimensions

iii. Obstacle limitation surfaces and sectors conclusion

All helicopter stands are located in appropriate distances from safety area and therefore they do not project Transitional surface, when there are helicopter standing on. The same applies on aircrafts standing on all stands. The only problem for Transitional surface again represents Control tower. As was mention before, it should be relocated.

Approach surface, Take-off climb surface and conical surface are projected by some obstacles (mountains). Due to this fact these obstacles will need to be lighted. Operating heliport in low visibility will not be allowed.

h. Visual aids for navigation

i. Wind indicators

A heliport shall be equipped with at least one wind direction indicator. Its location should indicate wind conditions over the FATO.
Helicopters will use wind indicator which is already designed for aerodrome. Its dimensions are greater than minimal required for heliport.

viii. Marking and markers

1. Heliport identification marking

A heliport identification marking is located within the FATO, near the centre of the area. It consists of a letter H in white colour. It is oriented with the cross arm of the H at right angle to the preferred final approach direction. The dimensions of the marking are : height 9 m, overall width 5,40 m and width of each part of H 1,2 m.

2. Touchdown and lift of area marking

TLOF marking is located along the perimeter of the TLOF. Its designed like continuous white line 0,3 m in width.

3. Marking for taxiways

Marking of ground taxiways respect the same rules like marking for aircrafts taxiways defined in ICAO Annex 14.

4. Air taxiway markers

Air taxiway markers should be located along the centre line of the air taxiway and spaced at interval of not more than 30 m on straight sections and 15 m on curves.
Taxiway markers do not exceed 35 cm above ground or snow level. The surface of the marker as viewed by pilot is a rectangle with the height ratio of approximately 3 to 1.

Air taxiway markers are NOT designed, due to the fact that helicopter will be air taxiing above airplane taxiway and therefore these markers cannot be placed there, because they would represent obstacles for aircrafts.

6. TERMINAL LAYOUT (Aitor)

The terminal building is usually the first and the last impression for the passenger about the country visited. Therefore, as Vágar Airport is the only one within the Faroe Islands, it is really important that the passengers will keep a good feeling of it. We want to emphasize that throughout the following report, we are focusing on the functionality of the terminal building instead of its arquitectural design.

The existing terminal is a one-storey building which is obviously not enough to fulfill the requirements for the future passenger flow. In connection with the new part of the terminal, we will need to take into account several factors which will determine its main characteristics:

- *Height:* As we commented before, there will be three air-bridge connected stands with a height of 4.0 metres at the connection with the terminal. Therefore, we will need a two storey building in the new part of the terminal, something that is not necessary in the existing building, which will be connected just with taxi-out stands.
- *Length:* It will be determine either by the the position of the third air bridge or by the location of the connection road between apron and cargo center.
- *Width:* In order to make a simple and logical extension, we will keep the width from the existing terminal building.

A simple first approach about the current terminal building (in white), the extension proposed (in green) and the three air-bridges (in pink) can be seen in the sketch below.

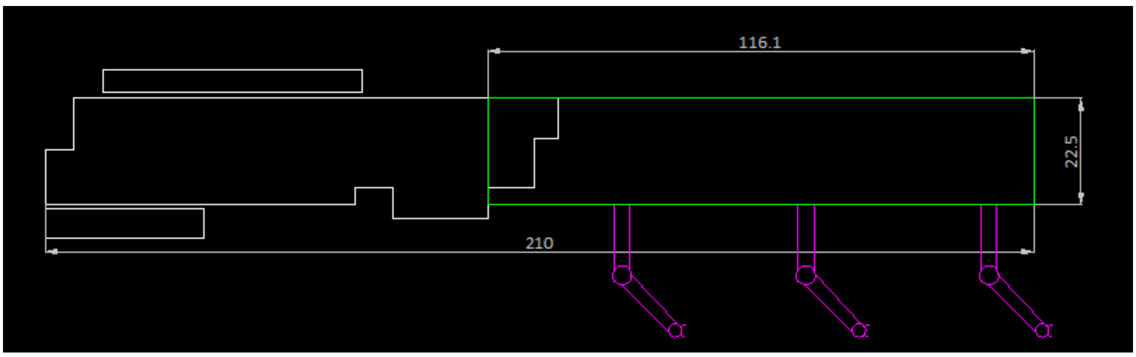

Figure 6.1. Sketch of the proposal for the extension of Vágar Airport terminal building.

In order to redevelop and expand the existing terminal buiding, a lot of preliminary tasks shall be taken into account. According to *A. Odoni and R. de Neufville (Passenger Terminal Design, 2009),* the typical design process consists of the following four steps:

- Forecasting traffic levels for peak hours.
- Specification of the Level of Service standards.
- Flow analysis and determination of server and space requirements.
- Configuration of servers and space.

The main problem of this procedure is its difficulty to take into account the variability of the passengers traffic. During the last decades, a lot of terminal buildings worldwide had failed in estimating, for the target year, the passengers' distribution within the terminal. Furthermore, we do not have neither enough information nor enough experience to make an adequate prediction, so we will base our design in the conclusions from the flight analysis made in a previous section.

6.1. Forecast of passenger flows during the design peak hour

As we explained within the section about flights analysis, we assume 9 aircraft operations (either departures or arrivals) during the design peak hour. From these operations, we assume that aproximately half of them will belong to Atlantic Airways carrier, due to the fact that they will provide 50 of the 100 weekly connections of Vágar Airport in the target year 2030. We assume that the rest of operations will be always performed by code 3C aircrafts (Boeing 737 -700 and 737-600), which belong either to Cimber Sterling or Scandinavian Airlines or charter flights.

Therefore, if we know the passenger seating capacity of each aircraft, we will be able to calculate the amount of passengers during the peak hour. These capacities can be seen in the next table:

TYPE OF AIRCRAFT	SEATING CAPACITY	
	TWO CLASS	ALL-ECONOMY
BAe-146/RJ	-	94
Boeing 737-600	108	130
Boeing 737-700	128	148

Table 6.1. Seating capacity of future aircrafts operating in Vágar Airport.

We can notice that there are variable figures depending if the airline wants or not a separation between first and tourist classes. With the carriers considered, we can suppose that the danish low cost Cimber Sterling is interested only in all-economy aircrafts, meanwhile Scandinavian Airlines is more likely to have two-class aeroplanes. But as trying to guess which type of aircraft will each carrier use is too convoluted, from our point of view makes more sense if we take the average value of 130.

Therefore, assuming four aircraft operations belonging to Atlantic Airways and five operations for the rest of airlines, we estimate a total passenger flow of 1026. On the other hand, if we assume a distribution with 5 Atlantic Airways operations, the figure that we get is 990 passengers per hour. Thus, as we are just making a suitable prediction, our design value for the passenger flow during the peak hour will be 1,000. In order to calculate the appropiate space of the different parts of the terminal, we should make an approach based on the representative busy hour, accepting that for the few hours per year with more traffic there will be unacceptable levels of crowding. For that, there are several different criteria, varying from IATA to FAA or even the different main airports. As our estimation was based on the traffic forecast for the target year and not on the current situation in Vágar Airport, we could not apply these criteria, which are also design for airports with millions of passengers per year (mppa) and not for small airports such ours.

On the other hand, as our aim will be to calculate the required areas for each activity, we need to estimate which specific passenger flow (arriving, departing or transferring) do we have during the representative busy hour. Taking into account that Vágar Airport is an origin/destination airport, we assume that there will not be any transferring flow of passengers. Therefore, we need to divide the 1,000 passenger flow during the peak hour into inbound and outbound flows, what will depend a lot in how many of the nine operations considered are arrivals and how many are departures. As in both situations we will have an odd figure, implying that one of the situations will have more than 500 passengers during the peak hour, we will assume that for the representative busy hour (not the peak hour), both arriving and departing passenger flows can be estimated as 500 per hour.

With this figure, we accept that there will be some few hours in the years close to the target year 2030, when one of the two passenger flows will be higher than the value adopted and therefore, the levels of crowding will be unacceptable during short periods of time.

6.2. Level of Service

The Level of Service (LOS) of an area or function within an airport, establishes the amount of space required per passenger in order to achieve a specific level of comfort. According to IATA Airport Development Manual, there are six different LOS:

- *Level A:* Excellent service, free flow, direct routes, no delay, excellent level of comfort.
- *Level B:* High level service, condition of stable flow, high level of comfort.
- *Level C:* Good level of service, conditions of stable flow, provides acceptable throughput, related sub-systems in balance.
- *Level D:* Adequate level of service, condition of unstable flow, delay for passengers, conditions acceptable for short periods of time.
- *Level E:* Unacceptable levels of service, conditions of unstable flow, sub-systems not in balance, represents limiting capacity of the system.
- *Level F:* System breakdown, unacceptable cogestion and delays.

For our extension of Vágar Airport the aim is to assure at least a LOS level D during the peak hour of the target year, what we assume will happen only during very short periods of time. Although the most new terminals attempt for a LOS level C, that would imply a huge surplus of space during the normal operation of the airport (winter period) and an innecesary higher budget for the project. Furthermore, the airport will be able to provide a higher LOS than level D until we will reach the passenger flow estimated for the target year 2030.

The table below shows, in a more intuitive way, these conditions referring to each LOS:

LOS	FLOWS	DELAYS	COMFORT
A	Free	None	Excellent
B	Stable	Very few	High
C	Stable	Acceptable	Good
D	Unstable	Passable	Adequate
E	Unstable	Unacceptable	Inadequate
F	System breakdown		Unacceptable

Table 6.2. Assumed Level of Service for the peak hour in the target year.

6.3. Passenger handling in the Faroe Islands

Due to the specific characteristics of Vágar Airport and the Faroe Islands, we will need to take into account some unusual circumstances which are detailed below.

The first one is that Vágar Airport is the only airport within the Faroe Islands, meaning that the only existing domestic flights are dued to the helicopter traffic between the different islands. As expectations for the future, we do not consider the construction of any new airport, because the distances between the different islands are not large and we will assume that the helicopter traffic will be able to satisfy the demand.

Nowadays Faroe Islands are not part of the European Union, but they belong to the Nordic Passport Union since 1966, which allows citizens of the Nordic countries (Denmark, Norway, Sweden, Finland and Iceland) to travel and reside in other Nordic countries without passport or residece permit. Because of that, they have an specific and almost unique regimen in connection with the Schengen Agreement.

Faroe Islands are not covered by the Schengen Area, so Schengen visas are not valid, but there are not border checks when traveling from the Faroes to any other Schengen country. The reason of that is because since 2001 and as part of the Schengen Agreement, there are not border checks between the Nordic Passport Union countries and the rest of the Schengen Area. Therefore, only travellers from non-Schengen countries (e.g. United Kingdom), are inspected in Vágar Airport.

These conditions will imply three different situations within our airport:

- *Domestic helicopter flights:* Passengers are not going to be checked and they will be able to access directly to the baggage reaclaim area avoiding controls.
- *Travellers from Schengen countries:* They will need to travel with their passport (except those from Nordic countries), but they will not be inspected.
- *Travellers from non-Schengen countries:* They will be checked and they will need passport and a special visa signed by the Ministry of Foreign Affairs of Denmark.

6.4. Determination of space requirements

The third step in the process of designing an expansion of a terminal building, once known the passenger flow and the LOS level desired, is to establish the necessary size of the different areas and make a flow analysis.

For that, we will need to bear in mind the concept of *dwell time*, which is the amount of time that people spend in an specific area. This is very important because despite the fact we will have an outgoing flow of 500 passengers per hour, they are not likely to arrive at the same time, e.g. to the check-in lobby. Therefore, if we assume a steady flow and we estimate a dwell time of half an hour, the sizing of the lobby should be done for 250 people, not for the initial 500, what would imply larger area and costs.

In order to establish the space standards per passenger in our terminal building, we will follow the IATA recommendations, which depend on the LOS level considered. These design standards can be seen in the table below, where the main functions and situations are especified.

		LOS (m2/pax)					
ACTIVITY	**SITUATION**	**A**	**B**	**C**	**D**	**E**	**F**
Check-In	Queued, with bags	1.8	1.6	1.4	1.2	1.0	Less
Waiting and circulating	Moving around freely	2.7	2.3	1.9	1.5	1.0	Less
Hold room	Queued, without bags	1.4	1.2	1.0	0.8	0.6	Less
Government inspection	Queued, without bags	1.4	1.2	1.0	0.8	0.6	Less
Baggage claim area	Moving with bags	2.0	1.8	1.6	1.4	1.2	Less

Table 6.3. IATA level of service space standards for airport passenger terminals based on the busy hour.

These are the main activities within a terminal building, but as we want to make a little more precise design, we will analyze each area in the process of outgoing and incoming passengers. For that, we will implement the previous figures with the recommendations given by *A.Kazda and R.E.Caves (Airport Design and Operation, 2007),* which gives space requirements based on experience and common practice in terminal design. The different main areas are analysed in the following pages.

- *Landside kerb:* A typical total length is 1 metre per 10 passengers during the desig peak hour, without taking into account any dwell time. Therefore, as we assumed 500 inbound and outbound passengers, that implies a lenth of 50 metres either for arrivals or for departures. As the length of our building will be longer than this distance, we will not need to provide any extra or separated kerb, assuming that the landside kerb will be long enough to be used by cars, taxis and public busses.

- *Check-in counters:* We will arrange them facing linearly to the passengers when they will enter the terminal through the departures door. The recommended distances for the different spaces given by IATA are shown in the sketch on the right, and in our case we will consider six airlines counters, which should be enough to attend the departure flights from Atlantic Airways, Scandinavian Airlines and Cimber Sterling.

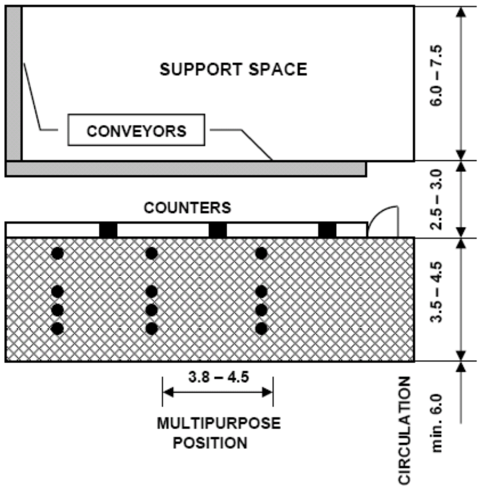

Fig 6.2. Distances surrounding a linear counter.

- *Check-in concourse:* Besides the airline counters, we need to provide some basic facilities such as airport counter information, toilets or a small cafe for the accompanying people. Furthermore, is becoming more common to use self-check-in services, which allow the passenger to avoid long queues due to the baggage-drop. Anyway, the main aim is to transfer passengers as soon as posible through the security screen and to the departure lounge, in order to avoid delays and crowding. Thus, we will consider a uniform outbound passenger flow with a dwelling time for the check-in of half an hour, meaning that the hall should be design for 250 people. In accordance to the IATA recommendation (1.2 m^2/pax), the resultant area is 300 m^2.

- *Outgoing baggage handling system:* It includes the system of belts, sorting devices, screening system and free space for transfering the baggage to the trains. The size of the baggage sorting hall depends on the bags per passenger and the type of technology used. We will assume that our airport will have a manual sorting system (few departure flights at the same time), which needs 0.425 m^2/pax (assuming an average of 1.3 bags per passenger). Therefore, we can determine that for our 500 outbound passengers, the baggage hall requirement is around 215 m^2.

- *Outbound passport control:* As we explained previously, we have three different type of borders within Vágar Airport, what will make this space distribution quite complicated. Thus, we will not go into detail locating the different desks and we will just provide the recommended space. In reference to outbound controls, it should not be necessary to wait more than 5 minutes, so this figure will be our aim for the design peak hour. Assuming again a uniform distribution, we get around 45 passengers each 5 min with a requirement of 0.8 m^2 for LOS level D. The resultant queuing area is 36 m^2, and if we take into account some basic facilities such as decks or police office, we will increase the total area up to 50 m^2.
- *Security screening:* Includes a walk-through detection device and an X-ray maschine for hand-baggage. The FAA recommends 10 to 15 m^2 per security station, which could handle up to 600 passengers per hour. But with the current strict security measures, we assume that this value is too high and therefore, we will place two security stations for our 500 outbound passengers (who are suposed to arrive at the security screen in a constant flow). Besides this security screen area, we will place free spaces on both sides in order to give the passengers some time to be ready for the screening and to recover their items after it.
- *Departure lounge:* This is the core of the landside of a passenger terminal building and we will explain it in more detail in a different section of the report.
- *Gate rooms:* Together with the departure lounge, they are the spaces where a passenger spends most of the time within an airport. These gate rooms are optional, but as we explain in a subsequent section, there are several reasons why we decided to place them in our terminal building, either in the new or in the existing part.
- *Inbound government controls:* As we explained previously, the current situation of the Faroe Islands is quite complicated and implies three different types of borders. The domestic passengers, dued exclusively to helicopter traffic, have to be separated from the international passengers. We decided that, as they will not need to show any documentation on arrival, they will be directly transferred to the baggage reclaim area. In accordance to the international passengers, all of them are going to be redirected through non return doors to the inbound control room, from where they will access afterwards to the baggage claim hall.

Again, we will not get into detail within this inbound government control area, we will just provide the recommended space. The processing time is longer than in departure, and a queuing time of 7 minutes is usually considered acceptable. The main difference between inbound and outbound processes is the characteristic of the flow. Before we considered a uniform distribution, but the inbound passengers will arrive in groups after desembarking each aircraft. Therefore, in a small period of time (from 10 to 15 minutes for the expected aircrafts) the whole amount of passengers will be at the inbound control hall. As this process time is similar to the operation intervals of our taximay system, we assume that the worst situation will be when passengers coming from 2 landed aircrafts will meet in the inbound government area. If we bear in mind the average seating capacity of 130 passengers and we assume full load aircraft, the resultant area is 208 m^2.

- *Baggage claim:* It should be located close to either the airside road for easy of transferring bags to the reclaim belt or the landside exits, in order to avoid passengers long walking distances with baggage. In the landside, the baggage reclaim hall, we will need to provide toilets, lost bag office and space for storage of bag trolleys. Besides, there are some airports which offer duty-free on arrival, and we think that is a good idea in order to increase the revenue of the airport. In total, the reclaim hall area should be around 9 m^2 per metre of claim frontage. In accordance to the airside, it is recommended to provide 3m^2 per metre of claim frontage, in order to accomodate tugs with containers, staff restroom or early bag storage.

A waiting time of 12 minutes is deemed to be acceptable, so if we take into account the same considerations as for the immigration control area (meeting of two landed flights), we will need two different baggage reclaim units. Furthermore, we need to take into account that the baggage from international and domestic passengers should also be segregated. Therefore, we will establish a small baggage reclaim hall which will be used exclusively by helicopter passengers. In this case, we assume as well that passengers from 2 helicopters can meet while waiting for the baggage.

In order to determine the total length of claim frontage, we will do it indirectly from the IATA LOS level D (1.4 m^2/pax). Considering the average seating capacity of aircrafts, we expect 260 passengers at the same time in our international baggage reclaim area, what means a total space of 364 m^2 (just as waiting area). Taking into account all the facilities commented before, we will assume that this waiting area is the 70% of the total space needed in the reclaim hall. Therefore, the largest baggage reclaim hall will have 520 m^2, with an associated belt lenght of around 58 metres (1 metre per 9 m^2). We can also calculate the airside area (3 m^2 per metre of belt), which results 175 m^2. In connection with the domestic baggage reclaim hall, as each helicoter has a capacity of 15 passengers, the necessary total area is 60 m^2. The claim frontage results 6.5 metres and the associated airside area is around 19.5 m^2.

- *Customs:* Their function is to control the traffic of goods, and therefore we will need to place two different exit doors or spaces after the baggage reclaim hall. One of them will be used for those passengers with ‘‘nothing to declare’’, is usually indicated with green signals and only randomly spot checkings are done. The second one, ‘‘goods to declare’’, is usually indicated with red color and it is connected with the customs office. Therefore, in this customs area there are space requirements for inspection tables, interwiew rooms, bonded warehouse and accomodation for staff.
- *Arrivals hall:* Should allow unimpeded exit from customs, and there are several essential facilities needed to be provided: cafés, currency exchange, tourism information office, meeting point, car rentals and ticketing for car parking and public transport. In the landside of our arrivals terminal building, we will have a clear area of 970 m^2 in order to place all the facilities and services named before.

6.5. Flow analysis

After determining the necessary space requirements for each main activity or area within our airport, the next step should be a flow analysis. That implies a simulation of the passenger flow throughout the different areas of the terminal, checking how the crowding behaves in this space and checking if our proposal works as it is suposed to. Nevertheless, we do not count with simulation programs in order to run an analysis, so we cannot check our solution, but in real life we would need that.

6.6. Configuration of Servers and Space

The final design of our terminal will therefore integrate the previous steps. We know already the inbound and outbound passenger flows, the desired level of service for the design peak hour and the different space requirements for each area in the terminal. What we are going to make now is a general distribution of these main areas in the geommetry of the new terminal building.

First of all, we need to bear in mind that the old building has only one storey and that the new part of the terminal building will be designed with two storeys, in order to be able to accomodate the desired passenger bridges. Furthermore, it is required that both flows of passengers (inbound and outbound) are physically separated, notonly for fast and fluent movement of passenger flows, but also to ensure security. The last fact that will determine the general layout of our terminal building is the direction of the traffic in the landside kerb, for which we decided that the existing building will be the entrance for the departure passengers and the new part will accomodate the arrivals terminal.

Therefore, in the existing building we will establish the landside of the departures terminal (check-in facilities), the outgoing baggage handling system (or baggage make-up) and the gate rooms connecting to the taxi-out stands.

In the new part of the terminal building we will have the main activities and areas of the airport. The second floor will accommodate passport control area, security screening, departure lounge and gate rooms connected with the passengers air bridges. In the ground or first floor, we will have both the airside (which includes immigration control area, baggage reclaim halls, baggage break-down and customs) and the landside of the arrivals terminal. Besides, we will provide an space as secure warehouse, where all the goods going up to the shops and duty-frees in the departure lounge are going to be scanned. This area can also act as a back-of-house path in order to remove food, waste or stock, without interfering with the passengers.

7. DESIGN OF THE GATE ROOMS (Aitor)

There are two main reasons why we decided to use gate rooms instead of a larger departure lounge from where the passengers could access directly to the aircrafts. The first one is dued to the taxi-out stands located in a lower level, we would have needed to place a second departure lounge and that does not make sense if these rooms (A-C) are also destinated for international passengers. The second one is that in order to reduce delays, airlines prefer to keep passengers in a closed space prior to boarding.

As we explained before in the general layout of the terminal building, we will place six gate rooms (A to F), three of them for accessing to the air-bridge connected stands and the other three for accessing to the taxi-out stands. Therefore, the first three gate rooms (A to C) will be located in the ground floor of the existing terminal building and the rest (D to F) will be located in the second floor of the new part of the terminal. Besides, taking into account the domestic helicopter passengers, it could be a good idea to provide an extra gate room for them (H), in order to wait until the bus will be ready for taking them to the respective helicopter stand.

7.1. Level of Service

In order to make a suitable design of our gate rooms, we need to bear in mind the established Level of Service (LOS) that we assumed in the general terminal layout. As we commented before, our aim will be a LOS level D for the busy hour, preventing not to fall below the LOS level E for the peak hour of the target year.

According to *A.Kazda and R.E.Caves (Airport Design and Operation, 2007),* the gate rooms should have seating for 80% of the aircraft capacity at 1.7 m^2 per seat, and standing room for the remaining possible at 1.2 m^2 /pax. Furthermore, there must also be room for the airline counter and for a queue to form for checking the boarding pass and bag recognition prior to boarding. Toilets should be provided if there is security control on entry, but as we are not sure about the procedures in Vágar Airport, we will provide them anyway.

7.2. Space requirements

In this case we are not focus on the passenger flow during the design peak hour, because each gate room will be independant from the rest and they will be attending one flight at each time. Therefore, we will need to analyze the seating capacities of the expected aircrafts intended to use Vágar Airport, which are shown in the table below:

TYPE OF AIRCRAFT	SEATING CAPACITY	
	TWO CLASS	ALL-ECONOMY
BAe-146/RJ	-	94
Boeing 737-600	108	130
Boeing 737-700	128	148

Table 7.1. Seating capacity of future aircrafts operating in Vágar Airport.

We used this table before in order to calculate the amount of passengers during the peak hour, based on the average value of 130. But in order to design these gate rooms, we need to focus on the maximum seating capacity, which is 148 for an all-economy Boeing 737-700. The reason of that is because we could have a full flight, what is likely to occur within the summer period, and if we do not size our room taking into account the higuest value, our Level of Service will decrease below the boundary adopted.

Taking into account the space recommendations commented before, the resultant area that we get is:

$$148 * 0.8 * 1.7 \text{ m}^2 + 148 * 0.2 * 1.2 \text{ m}^2 \cong \mathbf{240\ m^2}$$

But if we bear in mind that half of the expected operations will be performed by Atlantic Airways and their BAe-146/RJ (with a seating capacity of 94 passengers), this area will be definitely overdimensioned. Besides the fact that we expect this airline carrier to operate mainly in the taxi-out stands and that we do not have much available space within the existing building, we decided to design the first three gate rooms (A to C) in connection with this type of aircraft. The calculation is the following:

$$94 * 0.8 * 1.7 \text{ m}^2 + 94 * 0.2 * 1.2 \text{ m}^2 \cong \mathbf{150\ m^2}$$

In accordance to these rooms (A to C), we need to bear in mind that they will also be able to serve both types of boeings, always than the expected passenger load will not be higher than 70 % (Boeing 737-600, All-economy) or than 62 % (Boeing 737-700, All-economy). On the other hand, the gate rooms connected to the air bridges (D to F) will be able to serve each type of the aircrafts considered, with the only effect of a increasing in the level of service (LOS) for the aircrafts with smaller seating capacity,

Finally, in connection with the gate room for domestic passengers (H), we need to take into account that they will be transported by bus until the helicopter stand. Thus, the best solution is to place it in the existing building, next to the first three gate rooms. In order to make an appropiate sizing, we will assume that passengers waiting for two helicopters (seating capacities of 15 pax) can meet at the gate room. Therefore, if we apply the same space requirements as before, we get:

$$30 * 0.8 * 1.7\ m^2 + 148 * 0.2 * 1.2\ m^2 \cong \mathbf{50\ m^2}$$

7.3. Detailed design

Firstly, we will start with the design of the gate rooms in the existing building (A to C plus helicopter room H). As we explained before, inbound and outbound passengers shall be segregated by a physical barrier. Therefore, we thought that the best solution is to place an aditional door to be used exclusively by incoming passengers, thus avoiding contact either in the gate rooms or in the corridors. Besides, a non-return doors system shall be established due to security reasons. In the sketch below, we can see the main parts of the existing terminal building and the location adopted for the door used by inbound passengers coming from the taxi-out stands.

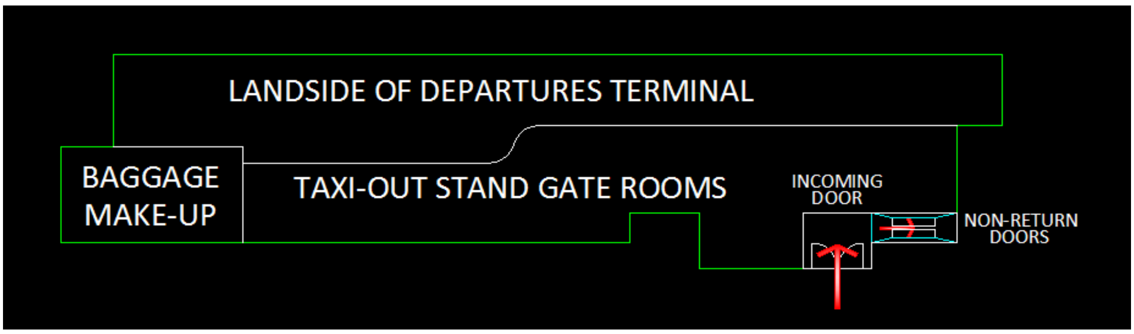

Figure 7.1. Location of the incoming and non-return doors for passengers from taxi-out stands.

If we focus now on the distribution of the remaining space, we need to take first into account that the outbound passengers are coming down from the second floor of the new building through the mechanical staircases and elevators. Thus, we will need a transitional space to redirect them to the corridor of 5.5 metres width from where they will access to their respectives gate rooms. When the corridor will only lead to the last gate room (A), its width can be reduced until 3 metres, because any queue can interfere now with the flow. The location of the four gate rooms and the direction of the passenger flow (outbound flow highlighted in green and inbound flow in red), is shown in the following sketch.

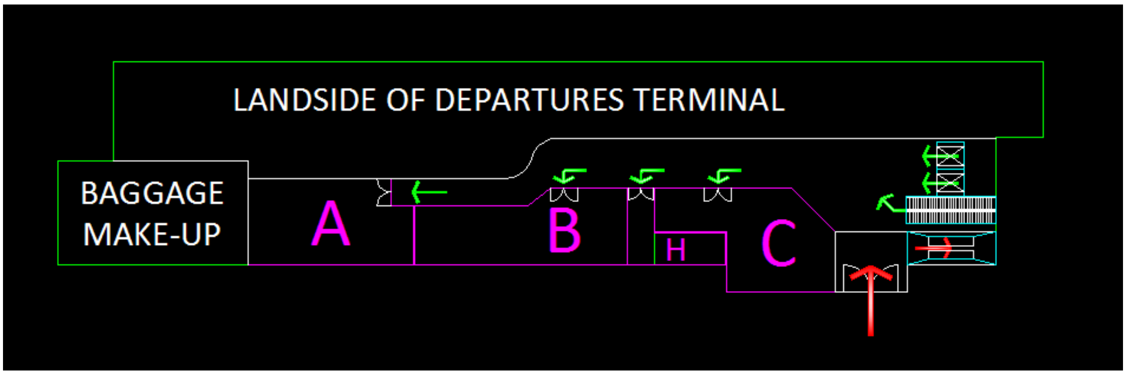

Figure 7.2. Passenger flow in the existing building and location of gate rooms A, B, C and H.

Once we fixed the position of each gate room keeping the required areas of 150 m^2 and 50 m^2 calculated before, we needed to make a more detail desig, by locating the toilets and placing the required amount of seats. The resultant distributions are shown below, where the toilets have an area of 15 m^2 for rooms A to C and 6.6 m^2 for room H

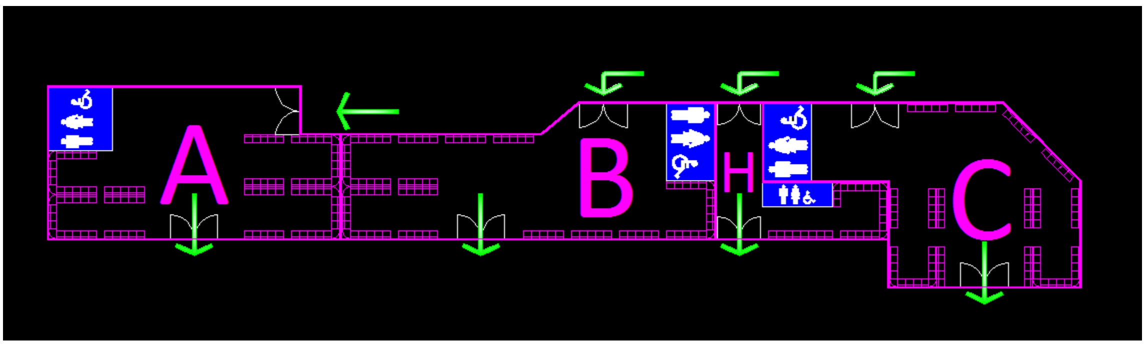

Figure 7.3. Detailed design of gate rooms A, B, C and H.

The next step is the design of the remaining gates D to F, which are located in the second floor of the new terminal building. Their design is much more complicated, because we will need to think meanwhile how are we affecting the distribution of the ground floor. The best example are the toilets, which need always a vertical continuity for the pipe services, meaning that an optimal design will place one above the other. Despite this, what causes more problems is the physical segregation between inbound and outbound passengers, meaning that within each gate room, we need to place either staircases or elevators to the lower level. But in the lower level we have the baggage reclaim hall (it should be close to the airside to facilitate transfering of bags to the belts), and passengers cannot access to this area without going before through the immigration control (Faroe Islands are a non-Schengen area). Therefore, the solution adopted is to place a corridor located in the ground floor between arrivals hall and baggage reclaim area, along which the passengers coming from the second floor can be redirected first to the inbound goverment control area. This situation is ilustrated by the sketch below, where the inbound passenger flow is indicated with red arrows.

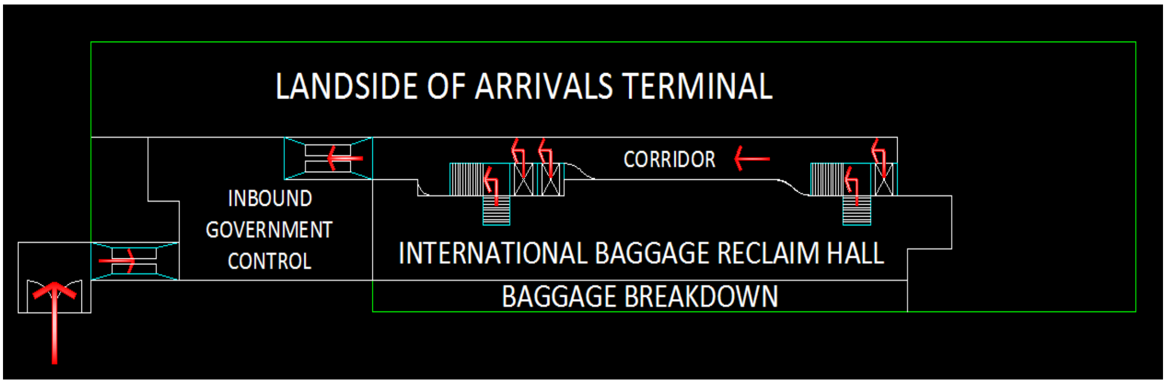

Figure 7.4. Outging international passenger flow and distribution of the international arrivals airside.

The reason why there are only two systems of staircases and elevators connecting to the three gate rooms in the second floor is because the one located in the left will be able to serve both gate rooms D and E. The second system, serving gate room F, has been located as much on the left as possible so that we will have some extra space more on the right for passengers exit and customs facilities.

Once we have solved the problem about the outgoing international passenger flow in the ground floor, we can focus on the second floor of the new terminal building and make the design for gate rooms D to F. For that we will need to bear in mind the position of toilets and system of staircase and elevators. In order to connect the latter with the exit of the passengers air bridge, we will provide a 2.5 wide corridor which will widen until accomodate the 3 meters width staircase and the necessary elevators. In connection to the staircase, we decided to use 23 steps to cover the design height of 4.0 metres (174 mm height per step). The associated depth per step for this height will be determined as 280 mm, meaning a total staircase length of 6.44 metres. In order to reduce the effect of these staircases in both the first and the second floor, we assume that with a height of 2.3 metres the passengers can circulate comfortably below the obstacle. This assumption will define the design shown in the figure on the right.

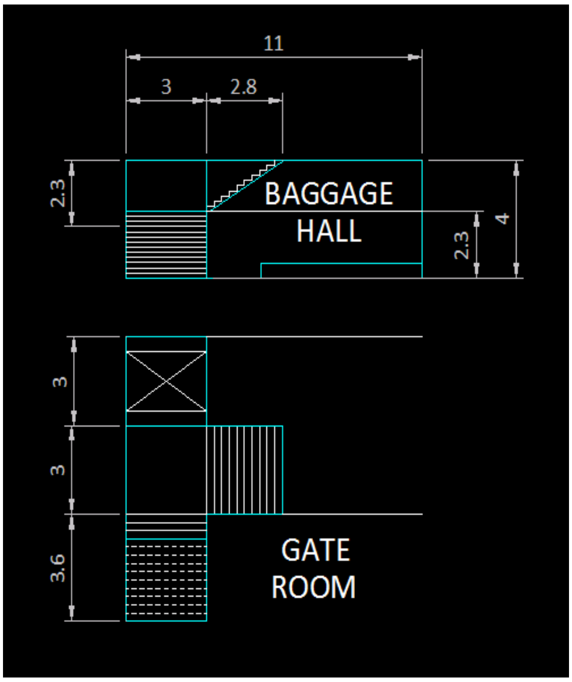

Figure 7.5. Measures of staircase an elevator.

Finally, taking into account that these three gate rooms connecting with the air bridges (D to F) should have a seating capacity of 80% of a Boeing 737-700 (all-economy), that implies around 120 seats per room. The final distributions of the necessary facilities within the different rooms can be seen in the following sketch:

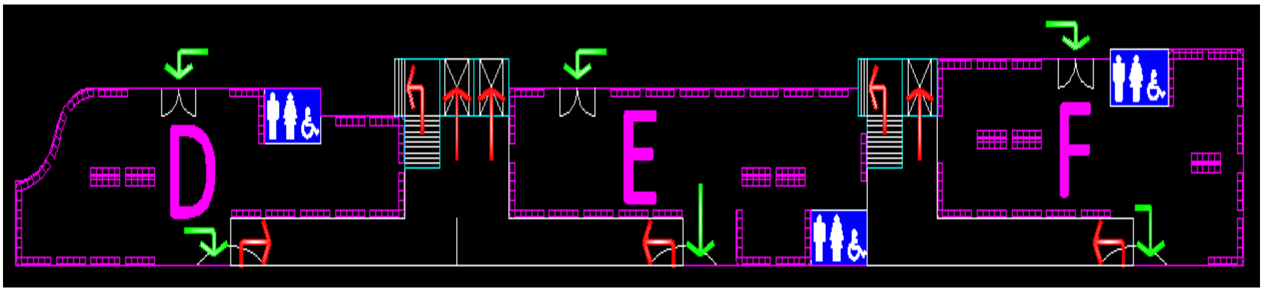

Figure 7.6. Detailed design of gate rooms D, E and F.

8. DESIGN OF THE DEPARTURE LOUNGE (Aitor)

The departure lounge of an airport is the central part of the lanside in the departures terminal building. It includes the essential activities of waiting for the flights to be called to the gate rooms: seating area, catering services, duty-frees, toilets and so on.

According to the IATA level of service chosen (LOS D), the space requirements for people waiting and moving around freely without bags is 1.5 m^2/passenger. But the main issue here will be to determine the dwell time of the outgoing passengers in our departure lounge. We commented before that for the check-in process we assumed a dwell time of half an hour. In connection with the gate rooms, passengers are also usually called there half an hour before boarding, so the remaining time between the arrival and the departure can be considered to be used in the departure lounge (the process time in the security screening is less than five minutes). As for international flights it is recommended to be present at the airport around 1h30min to 2h before departure, we will assume an average value of 1h 45mins. Therefore, the dwell time in the departure lounge can be determine as 45 mins.

As we have a figure of 500 outbound passengers during the design peak hour, we will expect to have 375 passengers at the same time in our departure lounge. Applying IATA requirements, that means a total extension of 562.5 m^2. In connection with the number of seats needed, we will follow again the recommendations given by *A.Kazda and R.E.Caves (Airport Design and Operation, 2007),* which establishes that there should be seats for 50% of the expected number of passengers unless it is likely that they will be held for a longer time (not our case). Thus, we will need around 190 seats.

The retails or duty-frees are something important for Vágar Airport, because as Faroe Islands do not belong to the Schengen Area, the revenue or profit for the airport could be quite significant. Despite their importance, these retails should be distributed so that they will not interfere with the way of the passengers to the gate rooms, but somehow they must be easily visible and accesible. Hence, it is recommended to make a floor distribution of 60% for duty-frees and 40% for catering facilities.

On the other hand, we will need a much larger space, due to the fact that the movements of goods or waste should not get in touch with the passengers, implying the necessity of a back-door way between catering services/duty-frees and the bonded warehouse located down in the ground floor.

Once all the components of our departure lounge have been justified, we will distribute them in the available area. As the sketch below shows, this free space in the second floor after placing gate rooms and security screening facilities is 770 m^2.

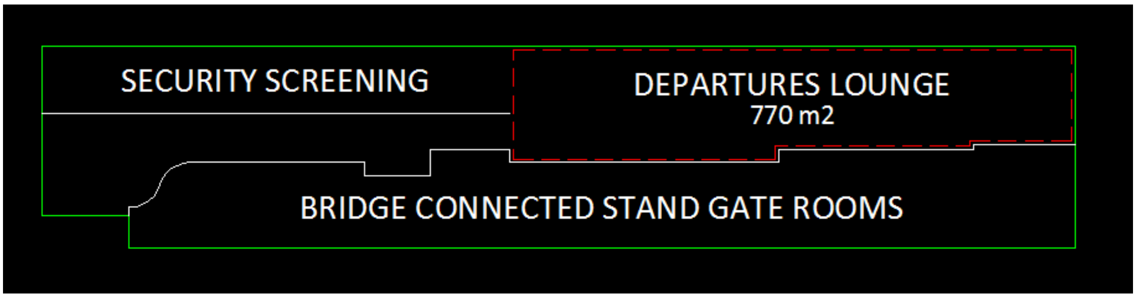

Figure 8.1. Departures lounge location and available area.

Summarizing, in this disposable area of 770 m^2 we need to provide 562.5 m^2 as space for people waiting (including 190 seats) and the rest, 207.5 m^2 will be destinated either for catering/duty-frees or for the delivery of goods. First of all, we placed the toilets taking into account how they affect the distribution of the arrivals hall in the ground floor. After that, we made an outline of the path for transporting goods and we placed the catering/duty-free facilities. The last step was about distributing the amount of seats taking into account that some of the 20% to 40% of the seating for catering might be count towards the total required airside seats. The final approach is shown in the sketch below, where the seats are distributed in order not to interfere with the way of the passengers to the gate rooms.

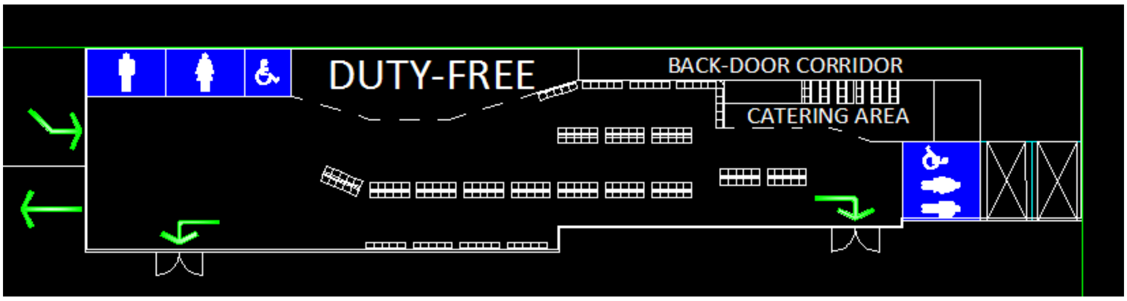

Figure 8.2. Detailed designed of the departures lounge.

9. CONCLUSION

9.1. Lukas

The most important element that I have been focused on in General part was extension of runway. Since I had not 3D map of area surrounding airport to work on possibilities of extensions I took over the information from Vágar airport web page where was introduced length of extension. This value is 549 m, so the new length of runway will be 1799 m. By using available graphs and information about Boeing airplanes and information about current runway (slope) I was able to calculate needed take-off length. This length had to be corrected by local conditions to be more representative. From calculations came up that in worst conditions (most distant flight, full aircraft, no hit wind, high temperature) the value of 1799 would be exceeded a lot. These conditions will appear very rarely and therefore I introduced new calculations where requirements to take-off were smaller and I got value which does not exceed 1799 m. I believe that my calculations are not so different to the ones that were doing specialized real engineers. The point of not exceeding value of 1799 m was to not get to code number 4 which would need more complications like extending runway width, creating runway shoulders and other financially demanding changes.

In the second part of my part of project I have been designing extension of apron to create it suitable for more apron stands. Partly by keeping the old layout of three Taxi-out stands and adding three more bridge connected stands, I found good combined apron concept, which use space available around current layout. Especially bridge connected stands will provide comfort to the passenger in bad weather conditions. All apron stands are designed to be suitable for all three types of aircrafts, which we expect that will be operating from Vágar airport. This will bring more freedom for airport schedule and organization. New designed bridge connected stands are equipped also by system of ground services. Designing these services on new apron stands seems to me like good possibility to provide more comfort and higher level of services to airlines.

Designing De-icing pad, which provides big clearance, was considered almost like a duty according to the location of the Faroe Islands.

Last part of my project was Heliport design. National helicopter transport has quite big importance on the Faroe Islands. I designed three new helicopter stands close to the apron and I also suggested removing of current one, which is located in runway strip. To transport passenger, baggage and other needed items to the helicopter was needed to design some service road. I paid attention to do not overlap important clearances and do not project obstacle limitation surfaces (especially Transitional) with locating my helicopter stands.

The purpose of this project was to perform expansion and development of Vágar airport on the Faroe Islands. I have been working with maximum of materials that I was able to reach. In conclusion I can say that I have designed needed changes of apron, heliport and general layout which will be probably be needed because extension of runway 13-31 is already under constructions. This project was one of the most interesting projects that I have been working on. Completely new thematic field than the fields I was used to work on at my home university. I learned lot of new things and also understood more solving of some problems that we have been working on in related courses (APO BS1 – Basic Airport planning and APO BS 2 Apron and Heliports).

9.2. Aitor

In the project description made in the beginning of this project, there were three main problems to solve in connection with the expansion of the terminal:

- *Which is the optimal layout of the terminal building in order to accommodate all the necessary facilities?*

We assumed as optimal layout the one that was able to separate physically both inbound and outbound passenger flows. Furthermore, we were also able to segregate the incoming international passengers from the incoming domestic passengers due to helicopter traffic, who will be redirected through a different baggage reclaim hall. Besides, we were able to locate all the necessary facilities with their respective recommended areas, what was often quite a puzzle.

On the other hand, we did not manage to make a flexible design which would allow small changes in futures extensions. The first reason for that is because we were already designing an important extension of Vágar Airport with a long lifespan, and the second one is because of the shape of the existing building. As we wanted to make an extension as uniform as possible, we kept the existing width of 22.5 metres, which gives us several problems in order to assure the passenger flow in such narrow terminal building. Anyway, for possible future extensions the building could be enlarged to the opposite side (north-west). In this case, only the baggage make-up area would need to be removed, though the planned departure lounge could be too far away from the subsequent new gate rooms.

In a general way, we are satisfied with our terminal building outline, although everything is based in a quite optimistic airtraffic forecast.

- *How shall be implemented the landside access for the new part of the terminal?*

The terrain in front of the new terminal building was already occupied by the parking for employers and bit further, by the cargo centre (which we were not likely to relocate). Therefore, as we cannot assume that the existing parking slot will be able to manage the future amount of passengers, there will be necessary to build a remote parking, but definitely not in front of the new building.

- *How shall we design either the departure lounge or the gate rooms in order to achieve the level of service established?*

Once we selected a LOS level D for the design peak hour in the target year 2030, we just needed to follow the recommendations given by IATA and other references for determining the space requirements and number of seats for these areas.

As individual conclusion, I can say that making just a first approach of a terminal building has meant facing more problems than I expected in the beginning. It also made me realized how many things should you bear in mind meanwhile designing, what in real life must be a very complicated puzzle.

I can assure that from now on, I will walk through the different terminal buildings looking around in a very obsessive way...but always keeping in mind the next quote: ☺

''The distance from the entrance into the terminal building to the airplane is inversely proportionate to how much time do you have to catch the plane''

Kauffman's airport law.

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