Critical Appraisal of Dublin Airport Baseline Report E (Prepared by Consultant Team PM/TPS/SOM) Regarding Robustness of Terminal Capacity (and Functionality) Analysis

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1. Introduction

As part of the current study of terminal and piers development at Dublin Airport, Aer Rianta's consultant team of Project Management, TPS Consult and Skidmore, Owings & Merrill (PM/TPS/SOM) have prepared a Baseline Report (Issue E) (June, 2003) in order to analyse the capacity and functionality of the existing terminal and piers' facilities up until April 2003. In particular, the Baseline Report sets out the capacity assessment methodology and calculations, and the resulting capacity outputs, of the most significant areas and processes of the passenger terminal and piers[1].

The most important statement being put forward by the consultant team is that the existing terminal (and piers') facilities at Dublin Airport has a restricting capacity of 12 million passengers per annual (mppa) based on capacity constraints of particular areas. Therefore, based on current annual passenger movement levels, this annual capacity measure means that the existing terminal and piers are operating within a capacity deficit, providing a '*level of service*' to passengers significantly below that which is considered acceptable.

The purpose of this critical appraisal of the Baseline Report (Issue E) is to evaluate the robustness of the report in terms of passenger terminal capacity (and functionality) analysis. To undertake this, the critique is addressed under the following sections:

- Assessment of Key '*Assumptions*' and '*Parameters*';
- Evaluation of Capacity Assessment Methodology Undertaken;
- Analysis of '*De-tuning*' Methodology of Terminal Capacity; and
- Summary and Conclusions.

[1] Baseline Report (Issue F) (Date – 18/9/03) has now been prepared and issued. However, in terms of appraising the robustness of terminal capacity (and functionality) analysis, the capacity assessment methodology, calculations, and outputs are the identical for both Issue E and Issue F. Therefore, this critical appraisal report is applicable to, and identical for, both Baseline Report issues.

2. Assessment of Key '*Assumptions*' and '*Parameters*'

In assessing the key '*assumptions*' and '*parameters*' presented by the consultant team, this section is divided into the following sub-sections:

- Application of '*Assumptions*' and '*Parameters*' in Airport Capacity Assessment;
- Key '*Assumptions*' and '*Parameters*' Adopted for Terminal and Pier Capacity Assessment;
- Comparison/Evaluation of Key '*Assumptions*' and '*Parameters*'.

2.1 Application of '*Assumptions*' and '*Parameters*' in Airport Capacity Assessment

When undertaking an assessment of capacity of an airport complex, there is a need to incorporate '*assumptions*' and '*parameters*' into the calculation methodology and process. The determination and application of assumptions and parameters are of significant importance in the process, having a major impact on the determination of capacity of individual elements of the components of the airport complex, and therefore of the overall system capacity. Assumptions and parameters can be represented in various forms, such as temporal (i.e. time-based), spatial or ratio type. Examples of these include dwell times, handling/processing rates, space allowances, and factor allowances. It is essential that the most appropriate assumption/parameter is used within the various calculations in order to determine the most accurate and applicable capacity assessment.

2.2 Key '*Assumptions*' and '*Parameters*' Adopted for Terminal and Pier Capacity Assessment

In formalising the various assumptions and parameters to undertake the passenger terminal capacity calculations, the consultant team used numerous sources of information which include the following; Aer Rianta Information and Data, Parsons Brinkerhoff (PB) Study (2002), BAA Planning Guidelines, IATA Standards and Requirements, Dublin Transport Office (DTO) Survey (2001) and Market Research Bureau of Ireland (MRBI) Survey (2002)[2]. Various levels of information have been drawn from these sources to produce the capacity parameters and assumptions. The main composition of the parameters and assumptions consist of:

- peak day/hour passenger information;
- passenger/person spatial allowances;
- passenger/person dwell times;
- passenger:escort/greeter ratios;
- passenger processing times;
- number of processing units available/open (e.g. check-in desks, baggage reclaim devises, etc.);
- proportion of long-haul/short-haul passengers;
- proportion of passengers with bags;
- proportion of passengers/people present in areas/processes; and,
- aircraft passenger capacity.

[2] In addition, certain consultant team assumptions have been made where it has been deemed necessary.

As a sample, Table 2.2.1 sets out the key parameters and assumptions selected by the consultant team that are of major significance in the calculation of capacity of the principal terminal passenger areas:

Area	**Spatial Allowance**	**Dwell Time**	**Miscellaneous**
Departures Concourse (landside)	1.5m^2	30 mins (pax) 20 mins (escorts)	0.1 (Pax:Escort Ratio) 90% (proportion of people present in non-commercial areas)
Departures Concourse (airside)	2.1m^2	67 mins (long-haul pax) 45 mins (short-haul pax)	95% (proportion of people present in non-commercial areas) 5% (proportion of CIP/Business pax in lounges, not using concourse) 7.1% (proportion of long-haul pax) 92.9% (proportion of short-haul pax)
Baggage Reclaim Hall	1.0m^2	30 mins (all pax)	30% (proportion of area defined as through-routes) 2no. (number of units of wide body reclaims) 8no. (number of units of narrow body reclaims) 85% (max. proportion of flight present) 70% (proportion of pax with bags) 45 mins (av. claim device occupancy time per wide-body aircraft) 30 mins (av. claim device occupancy time per narrow-body aircraft)
Arrivals Concourse (landside)	1.5m^2	9 mins (pax) 36 mins (meeters)	0.186 (Pax:Greeter Ratio)

Table 2.2.1: **Sample of Key Parameters and Assumptions Used in Terminal Capacity Calculations – Dublin Airport (Source: Dublin Airport Baseline Report E, June, 2003)**

2.3 Comparison/Evaluation of Key '*Assumptions*' and '*Parameters*'

In general, the parameters and assumptions used by the consultant team in the calculation of passenger terminal capacity compare satisfactorily to aviation industry standards and are at a sufficient level of detail to enable detailed capacity calculations to be undertaken. However, there are shortcomings and/or issues with a number of the parameters and assumptions that are of such importance as to have a significance effect on the hourly and annual passenger capacities of the terminal areas and processes, and these are as follows:

- The parameter of space required per person within both the Departures Concourse (landside) and the Arrivals Concourse (landside) is taken as $1.5m^2$, which is stated as being based on the BAA Planning Guidelines. However, when undertaking the capacity calculation of the two concourse areas using the preferred BAA methodology as stated by the consultant team, an allowance of $2.1m^2$ is applied to Departures and $2.0m^2$ is applied to Arrivals, which both equate approximately to the BAA space allowance of 2.15 m^2 and incorporates throughroute and waiting areas. It is assumed that the stated spatial parameter of $1.5m^2$ is a typographical error. However, there is a need for consistency within the Report.
- The dwell times assumed for passenger and escorts of 30 minutes and 20 minutes, respectively, within the Departures Concourse (landside) would presumably include time spent on the Mezzanine Level, and in other commercial areas within the Departures Concourse (landside). However, when calculating the capacity of the Departures Concourse (landside) the area of the Mezzanine Level and other commercial areas have been excluded. In excluding these areas, the various dwell times should be proportionately reduced to take account of this, which will result in an increase in passenger capacity of what can be considered as the main (non-commercial) Departures Concourse (landside)[3]. Alternatively and more correctly, these areas should be included in the calculation as they do provide passenger capacity[4].
- The passenger:escort and greeter ratios' assumptions of 0.1 and 0.186, respectively, while sourced as DTO survey information (2001), would appear to be low. Higher ratios' assumptions could possibly be used based on the passenger profiles using the airport terminal.
- The assumption made by the consultant team that the proportion of people in non-commercial areas in the Departures Concourse (landside) of 90% and Departures Concourse (airside) of 95% are extremely high considering the space allocated to commercial areas. A more appropriate proportional split between non-commercial and commercial areas would be 60:40 or 50:50, respectively[5].

[3] This analysis is supported by the BAA Planning Guidelines (March, 1997). In calculating the capacity of a Departures Concourse, the BAA methodology, firstly, provides for the sub-division of the concourse area into waiting, throughroutes and concessions (i.e. retail and catering outlets), as different person spatial allowances relate, or are applicable, to the different sub-areas. Secondly, the static capacity of the non-commercial sub-areas of the Departures Concourse is calculated. Finally, the total passenger flow rate through the entire Departures Concourse is calculated – this calculation incorporates the passenger and escort dwell times in the Departures Concourse, which includes both non-commercial and commercial sub-areas (no distinction or separation is made between different sub-area dwell-times) (reference - BAA Planning Guidelines, March, 1997, pages 43-45).

[4] On analysis, the commercial areas associated with both the Departures Concourse (airside) and Arrivals Concourse (landside) have also been excluded from the calculation of the capacities of these areas.

[5] The assumption of proportion of people in non-commercial areas in the Departures Concourse (landside) of 90% made by the consultant team presumably relates only to the Departures Concourse (landside) at departures level, and excludes the Mezzanine Area. The more appropriate proportional split of 60:40 or 50:50, between non-commercial and commercial areas, respectively, would included the Mezzanine Area.

- In terms of the check-in process, the assumptions made regarding the average passenger processing times of 60 to 85 seconds per passenger, while extracted from a Dublin Airport Survey (2002), are considered to be underestimated. An average processing time of approximately 120 seconds could be more appropriate. In addition, the consultant team have applied the assumption, provided by Aer Rianta (Dublin Airport), that the proportion of check-in desks open at peak times is 67%. While this may be the actual case, it is necessary to ensure that at typical peak or typical busy periods passenger processes should be operating to the highest possible utilisation levels.
- The parameter of space required per passenger within the Baggage Reclaim Hall is stated as $1m^2$, with the BAA Planning Guidelines being the source. However, given the proportion of area defined as throughroutes within the reclaim hall, i.e. 30%, it may be that this space allowance is underestimated.
- The Baggage Reclaim Hall dwell time of 30 minutes for all passengers, whether reclaiming a bag or not, is considered excessive, particularly given the implied assumption that 30% of passengers have no bag(s) to reclaim and, therefore, will be walking straight through the area.

3. Evaluation of Capacity Assessment Methodology Undertaken

This section has been sub-divided as follows so as to evaluated the capacity assessment methodology in detail:

- Terminal Areas and Processes Selected for Capacity Assessment;
- Methods and Calculations used to Measure the Hourly Passenger Capacity of Selected Terminal Areas and Processes;
- 'Ratio Analysis' in the Conversion of Hourly Passenger Flow Rates to Annual Passenger Movements;
- Evaluation of Conversion Process and Ratio used to Determine Annual Passenger Capacity.

3.1 Terminal Areas and Processes Selected for Capacity Assessment

As part of the Baseline Report, capacity calculations have been undertaken for various existing areas and processes of the passenger terminal at Dublin Airport. These areas and processes are generally considered the most critical in the provision of sufficient handling capability based on the level of passenger demand to ensure an efficient operation based on an acceptable '*level of service*'. The terminal areas and processes selected for capacity assessment are split between departures and arrivals, and are as follows - Departures Concourse (landside), Check-In, Security, Departures Concourse (airside)[6], Passport Control (Piers' A,B and C), Baggage Reclaim Hall, Arrivals Customs, Arrivals Concourse (landside). (Note - Departure Gate Lounges in Piers' A, B and C have been assessed for capacity only in terms of the '*level of service*' provided to the passenger, as opposed to hourly or annual passenger capacity. This '*level of service*' assessment is based on the aircraft passenger capacity assumptions for the three piers.)

3.2 Methods and Calculations used to Measure the Hourly Passenger Capacity of Selected Terminal Areas and Processes

The consultant team has undertaken detailed capacity calculations for the selected areas and processes of the passenger terminal using two methodologies, namely, IATA method and BAA method. Both methods of capacity calculations are based on the application of mathematical formulae which incorporate various assumptions and parameters, as previously discussed, with both producing hourly passenger capacity outputs. The following is a brief description of the two methods:

- With the IATA method, '*Peak Hour Passengers*' (PHPs) are calculated for the selected areas and processes. To assess '*area*' PHP handling capacities the calculations generally incorporate measures of existing floor area, spatial allowance, and dwell time. Alternatively, to assess '*process*' PHP handling capacities the calculations generally contain measures of number of processing desks/positions/etc. actually provided and processing times. Other assumptions and parameters are also incorporated into the calculations.

[6] The Departures Concourse (airside) includes circulation/throughroute areas that actually form part of pier areas.

- Using the BAA method, '*Busy Hour Rates*' (BHRs) for passengers are calculated for the selected areas and processes. To assess '*area*' BHRs handling capacities, static capacities are calculated first based on existing floor areas, and these are then converted into BHRs using calculations that incorporate measures of spatial allowance, dwell time, peaking factors, and other assumptions and parameters. To assess '*process*' BHRs handling capacities the calculations contain measures of number of processing desks/positions/etc., processing times, service factors (i.e. peaking factors), and again other assumptions and parameters.

The two methods are somewhat similar in approach. However, the BAA method uses more detailed capacity calculations than the IATA method, therefore, varying capacity outputs can be produced. The various hourly passenger capacity outputs from the application of the two methodologies generally relate to the provision of an acceptable '*level of service*' to the passenger equivalent of IATA Level 'B' within the '*six-level-of-service*' framework, that is, the provision of a high level of service; condition of stable flow; providing acceptable throughput; related subsystems in balance. The consultant team state that the capacity outputs obtained from the BAA method are the most preferable, as this method is considered a more sophisticated and realistic approach. The BAA method is robust and reliable, and is widely accepted within the aviation industry.

Table 3.2.1 shows a comparison of the consultant team's assessed hourly passenger capacities of the selected areas and processes based on the IATA and BAA methods of calculation:

Area/Process		**IATA Method: Hourly Passenger Capacity – mppa (LoS B)**	**BAA Method: Hourly Passenger Capacity – mppa (LoS B)**
Departures Concourse (landside)		1,900	3,544
Check-In - Queueing Area		6,300	-
Check-In – Desk Processing	Standard	5,269	3,668
	Hand-Bag Only	831	568
Security		2,250	Position A – 1,794 Position B – 2,691
Departures Concourse (airside)		3,515	3,883
Passport Control (Immigration) Positions	Pier A	2,182	1,150
	Pier B	872	2,320
	Pier C	654	2,160
Baggage Reclaim Hall		3,535	5,006
Baggage Claim Devices		Wide-Body – 850 Narrow-Body – 2,400	-
Arrivals Customs		3,200	3,000
Arrivals Concourse (landside)		4,355	5,375

Table 3.2.1: **Comparison of Consultant Team's Assessed Hourly Passenger Capacities of Selected Areas and Processes for IATA and BAA Methods of Calculation (Source: Extracted from Dublin Airport Baseline Report E, June, 2003)**

Based on Table 3.2.1, the outputs from the two methods have considerable variations in terms of the hourly handling capacities of the selected areas and processes. This reinforces the issue that the make-up of the mathematical formulae for both methods are different, and also indicates the sensitiveness associated with the incorporation of parameters and assumptions within the formulae.

3.3 ‘Ratio Analysis’ in the Conversion of Hourly Passenger Flow Rates to Annual Passenger Movements

The application of ‘*ratio analysis*’ for the conversion of (historic) hourly passenger flow rates to annual passenger movements is a commonly used method to determine the capacity of areas and processes of an airport terminal. It allows for the analysis of the percentage that typical peak or typical busy hour passenger flow rates contribute to the annual passenger movements through a terminal for a particular year. The output of this analysis is a ‘*conversion ratio*’, and this can be used to determine passenger handling capacity. To allow for the conversion process to be undertaken, appropriate hourly passenger flow rates must be determined.

There are various methodologies used for the determination of the acceptable typical peak or typical busy hour passenger flow rates, and the calculation process and results can vary considerably. Applying the various methodologies will determine the typical peak or typical busy ‘*levels of demand*’ (for passengers). This hourly passenger demand level is then divided by the annual passenger movement rate to give the resulting ‘*conversion ratio*’. It is necessary to separate departing and arriving typical peak or typical busy hour passenger flow rates (and also to separate various departing and arriving flow rates through airside piers if there is more than one), as these generally different, and therefore, various departing and arriving ‘*conversion ratios*’ can be determined. These ratios can then be divided into the calculated hourly handling capacities of the departing and arriving areas and processes of an airport terminal to determine their annual passenger handling capacities.

3.4 Evaluation of Conversion Process and Ratio used to Determine Annual Passenger Capacity

In the Baseline Report, the consultant team analyse three ‘*conversion ratio*’ approaches, namely, Ashford and Wright (FAA) approach, IATA approach and BAA approach, with the BAA approach being deemed the most preferable. The BAA approach is based on the application of the methodology for calculating the Busy Hour Rate (BHR), which is the hourly passenger flow rate at or below which 95% of the annual passenger movements can be handled at an airport without overcrowding areas and processes and, therefore, experience an acceptable ‘*level of service*’ (IATA Level ‘B’). It is a well recognised and applied methodology. The method of calculation of the BHR is to rank the recorded hourly flows (for both departing and arriving passengers) in descending order and accumulate the total number of passengers involved until 5% of the annual total is reached. As stated in the previous paragraph, this busy hour passenger demand level is divided by the annual passenger movement rate to give the resulting ‘*conversion ratio*’. However, the consultant team do not undertake the process of calculating the BHR, and subsequent ‘*conversion ratio*’ calculation, but assume that a ratio of 0.0002, based on a study of passenger hourly capacity and annual throughput at London Heathrow Terminals, is appropriate for use at Dublin Airport in the determination of the annual handling capacities of the terminal areas and processes, whether departures or arrivals.

The application of the 0.0002 ‘*conversion ratio*’ by the consultant team as a means of determining annual handling capacities is inappropriate as typical peak or typical busy hour passenger flow rates through terminals can vary considerably between different airports. Table 3.2.2 illustrates the impact of applying the 0.0002 ‘*conversion ratio*’ to the calculated hourly handling capacities using the IATA and BAA methods, in terms of the annual passenger capacities of the selected areas and processes[7]:

Area/Process		IATA Method: Total Annual Passenger Capacity – mppa (LoS B)	BAA Method: Total Annual Passenger Capacity – mppa (LoS B)
Departures Concourse (landside)		9.50	17.72
Check-In - Queueing Area		31.50	-
Check-In – Desk Processing	Standard	26.30	18.34
	Hand-Bag Only	4.10	2.84
Security		11.25	Position A – 8.97
			Position B – 13.46
Departures Concourse (airside)		17.60	19.42
Passport Control Positions	Pier A	10.90	5.75
	Pier B	4.40	11.60
	Pier C	3.30	10.80
Baggage Reclaim Hall		17.70	25.03
Baggage Claim Devices		Wide-Body – 4.25	-
		Narrow-Body – 12.00	
Arrivals Customs		21.30	15.00
Arrivals Concourse (landside)		21.80	26.88

Table 3.2.2: **Comparison of Consultant Team's Assessed Annual Passenger Capacities of Selected Areas and Processes for IATA and BAA Methods of Calculation (Source: Extracted from Dublin Airport Baseline Report E, June, 2003)**

Similar to Table 3.2.1, the above table clearly shows that the outputs from the two methods have considerable variations in terms of the annual handling capacities of the selected areas and processes.

[7] In analysing the assessed Annual Passenger Capacities of the selected areas and processes for IATA and BAA methods of calculation, there are numerous inconsistencies/discrepancies in the Baseline Report between the capacity outputs from the application of the mathematical formulae and those put forward in the various summary tables. The assessed capacity outputs set out in Table 3.2.2 above are those determined by the mathematical formulae, as these are the primary source of information.

There is a need for much greater analysis within the Baseline Report of historic Dublin Airport passenger hourly and annual movements, both departing and arriving, to determine more realistic '*conversion ratios*'. The following tables and charts illustrate detailed analysis of hourly and annual movements, and corresponding '*conversion ratio*' calculations for Dublin Airport for the years 1997 to 2002. Table 3.4.1 and Charts' 3.4.1 and 3.4.2 relate to the departure analysis and calculations, and arrival analysis and calculations are set out in Table 3.4.2 and Charts' 3.4.3 and 3.4.4. Undertaking this level of analysis will inevitably provide a more robust basis for the determination of annual passenger movements based on hourly passenger flow rates.

1	**Hourly Passenger Movements**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
2	**Annual Departure Passengers (millions)**	5.15	5.79	6.35	6.88	7.12	7.50
3	**Annual Two-Way Passengers (millions)**	10.33	11.64	12.80	13.84	14.33	15.08
4	**Departure Busy Hour Rate (BHR)**	1,849	2,045	2,228	2,347	2,346	2,500
5	**Departure BHR '*Conversion Ratios*' (= Row4/Row3)**	0.000179	0.000176	0.000174	0.000170	0.000164	0.000166

Table 3.4.1 **Hourly Departure Busy Hour Rates and '*Conversion Ratios*' - Dublin Airport**

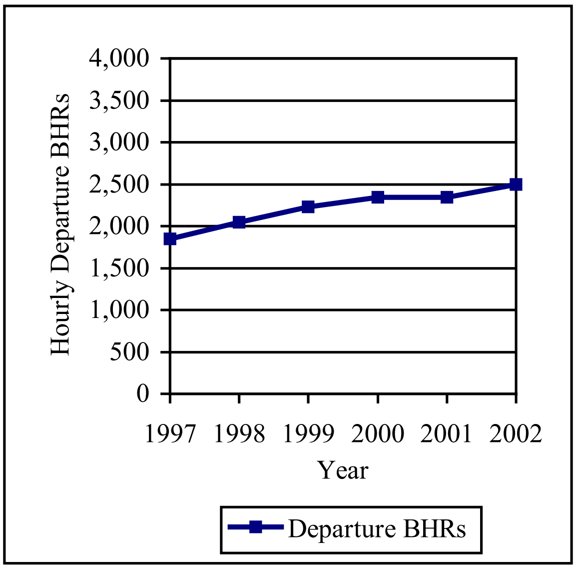

Chart 3.4.1 **Hourly Departure Busy Hour Rates - Dublin Airport**

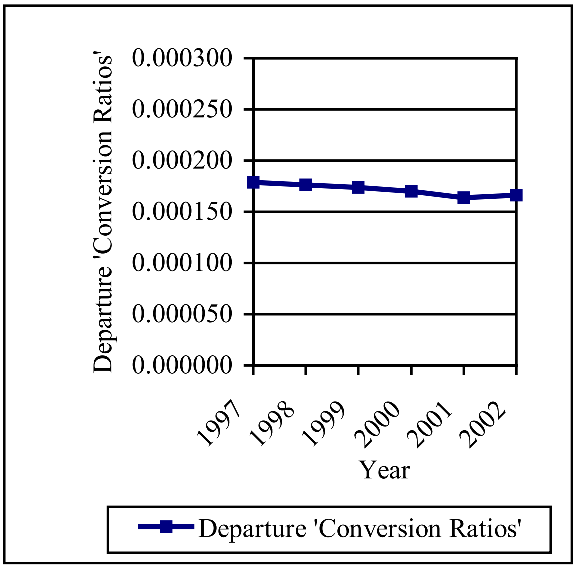

Chart 3.4.2 **Departure '*Conversion Ratios*' - Dublin Airport**

1	**Hourly Passenger Movements**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
2	**Annual Arrival Passengers (millions)**	5.09	5.73	6.31	6.81	7.08	7.46
3	**Annual Two-Way Passengers (millions)**	10.33	11.64	12.80	13.84	14.33	15.08
4	**Arrival Busy Hour Rate (BHR)**	1,645	1,801	1,961	2,058	2,120	2,177
5	**Arrival BHR '*Conversion Ratios*' (= Row4/Row3)**	0.000159	0.000155	0.000153	0.000149	0.000148	0.000144

Table 3.4.2 **Hourly Arrival Busy Hour Rates and '*Conversion Ratios*' - Dublin Airport**

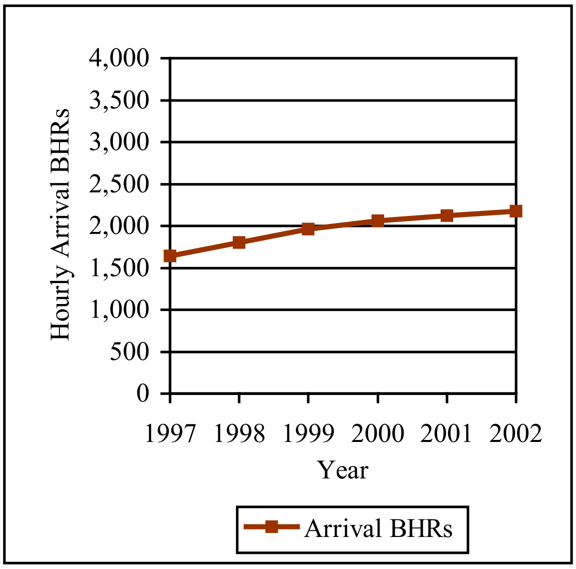

Chart 3.4.3 **Hourly Arrival Busy Hour Rates - Dublin Airport**

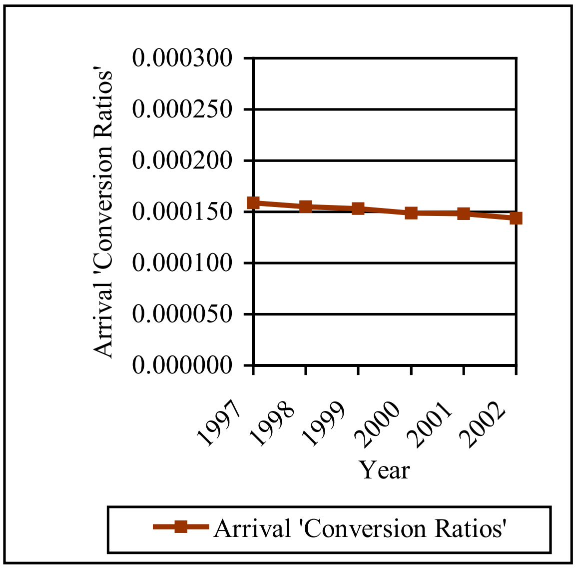

Chart 3.4.4 **Arrival '*Conversion Ratios*' - Dublin Airport**

It is evident from the above tables and charts that while both departure and arrival annual and busy hour passenger movements rates are increasing year-on-year, the related '*conversion ratios*' are decreasing. While busy hour passenger movements are increasing, they are doing so at a lesser rate than the annual passenger movements. This is as a result of more passenger passing through the airport terminal at off-peak times based on a greater increase in aircraft movements during these times. The overall impact of this is an increase from year-to-year in the annual handling capacity of the airport, without the necessity to provide additional terminal infrastructure.

Therefore, based on the above analysis and in particular the years' 2000-2002, a more appropriate set of '*conversion ratios*' for departing and arriving landside areas and processes, for example, would be in the range of 0.000164-0.000170 (departing) and 0.000144-0.000149 (arriving). In addition, an analysis is required of the forecast passenger movement rates for Dublin Airport, based on the 'Forecast 2002 Aer Rianta Report' (September, 2002) which includes the most up-to-date long-term annual passenger forecasts for the airport. Using these annual forecast rates and projecting forward corresponding '*conversion ratios*', it is possible to calculate forecast busy hour passenger flow rates. The forecast BHRs are based on the '*conversion ratios*' between the calculated BHR's and the annual passengers. These ratios may be adjusted or altered if required to represent the ratios that are forecast to apply when the terminal areas and processes are assessed to be at capacity, and when this occurs the forecast BHRs become the hourly '*Design Flow Rates*' (DFR). Therefore, the DFRs will be based on future traffic levels, and will reflect a certain degree of traffic '*peaking*'. The BHR hour of occurrence will generally vary from year to year.

The BHR methodology is at present widely used by the BAA. Undertaking the level of analysis outlined above, using this methodology, will allow for determination of when the various terminal areas and processes annual handling capacities, that may be presently providing a capacity surplus, will be reached. Alternatively, this subsequent analysis can be stated as when '*levels of demand*', in passenger terms, match '*levels of supply*', in infrastructure terms.

4. Analysis of ‘*De-tuning*’ Methodology of Terminal Capacity

The analysis of the '*De-tuning*' methodology is addresses under the following sub-sections:

- ‘*De-tuning*’ Methodology and Terminal Areas Selected for ‘*De-tuning*’;
- Level of ‘*De-tuning*’ Undertaken with Regard to Area (m^2) Reductions;
- Analysis of Impact of the ‘*De-tuning*’ Exercise;
- Evaluation of ‘*De-tuning*’ Methodology.

4.1 ‘*De-tuning*’ Methodology and Terminal Areas Selected for ‘*De-tuning*’

Having undertaken capacity calculations for various existing areas and processes of the passenger terminal at Dublin Airport, the consultant team carried out a method of '*De-tuning*' the capacity assessment outputs. The de-tuning exercise involved assessing the impact of cross-flows, pinch-points and problem areas upon the airport's terminal capacity. As stated by the consultant team, the term ‘*de-tuned*’ implies that the theoretical capacity is affected by operational and design aspects, which reduce the overall capacity.

Certain areas of the terminal have been de-tuned by removing specific amounts of space in order to take account of the reduced areas available to passengers due to varying effects. The areas de-tuned are; Departures Concourse (landside), Departures Concourse (airside), Baggage Reclaim Hall, Arrivals Concourse (landside). The main possible reason why these areas have been selected for de-tuning over the processes selected for capacity assessment, namely, Check-In, Security, Passport Control (Piers' A,B and C), and Arrivals Customs, is that these are significant areas spatially, and therefore, it may appear more achievable to reduce the areas by specific spatial amounts.

4.2 Level of '*De-tuning*' Undertaken with Regard to Area (m^2) Reductions

As stated above, de-tuning involves the removal of specific amounts of passenger/person space. Table 4.2.1 identifies the area reductions based on the de-tuning exercise:

Area	**Total Area – m^2**	**Area Reductions - m^2**	**Percentage Reductions - %**	**Revised Total Area – m^2 (based on de-tuning)**	**Comments**
Departures Concourse (landside)	3,657	1,162	31.78	2,495	Reduction in areas along face of terminal, adjacent to security areas and between check-in islands.
Departures Concourse (airside)	6,901	1,213	17.58	5,688	Reduction in areas within street and pier gate lounges.
Baggage Reclaim Hall	3,510	865	24.64	2,645	Reduction in areas along front of reclaim belts and baggage office.
Arrivals Concourse (landside)	2,964	176	5.94	2,788	Reduction in areas adjacent to revolving door and along front of car hire desks.

Table 4.2.1: **Area Reductions Based on De-tuning Exercise – Dublin Airport (Source: Part Extracted from Dublin Airport Baseline Report E, June, 2003)**

It can be seen from Table 4.2.1 that the greatest area reductions has been to the Departures Concourse (landside), with the area being reduced by approximately 32%, or almost a third. The Departures Concourse (airside) and the Baggage Reclaim Hall have been reduced in area by approximately 18% and 25%, respectively. The area reduction to the Arrivals Concourse (landside) of approximately 6% is minor in comparison to the other three.

As a supplement to the Baseline Report, the consultant team prepared a document titled 'Dublin Airport Masterplan Detuned Capacity Airside Concourse' (March, 2003). This document sets out an example of the de-tuning exercise. The Departures Concourse (airside) is defined as through-circulation spaces that are airside within the terminal and piers, and include the retail shopping street, the link corridors to the piers and the linear and rotunda circulation spaces within the piers. It does not include security check processes, gate lounges within the piers, retail/concessionaires' outlets adjoining the street, and in addition, retail/concessionaires' outlets within the pier areas, and other miscellaneous spaces. BAA capacity calculation methodology is used to calculate the capacity of the Departures Concourse (airside), firstly, for the existing layout, and secondly, for the de-tuned layout. The de-tuning exercise involved reducing the existing Departures Concourse (airside) area by specific amounts (the consultant team deducted what were considered areas unavailable to passengers for circulation), re-running the BAA capacity calculation methodology, and re-calculating the annual passenger capacity by applying the 0.0002 '*conversion ratio*' (as previously discussed). The outcome of the de-tuning exercise was to reduce the annual capacity of the Departures Concourse (airside) from 19.42mppa to 16.10mppa.

In undertaking this exercise, no consideration was given to the fact the there are different passenger utilisation rates for the three piers, and different passenger throughput (or busy hour) rates resulting from the operation of the daily schedule which generates varying peaking characteristics, and that the piers have different passenger (and airline) profiles. This point is of importance to the passenger capacity calculations both for the existing and de-tuned layouts of the Departures Concourse (airside) area.

4.3 Analysis of Impact of the '*De-tuning*' Exercise

The undertaking of the de-tuning exercise on the selected areas has resulted in a significant reduction in their passenger handling capacity, with there being a direct correlation between the levels of capacity reduction and area reduction. Table 4.3.1 sets out the annual passenger capacity reductions for the selected areas resulting from the de-tuning exercise, based on the BAA method of capacity calculation:

Area	**Total Annual Passenger Capacity – mppa**	**Revised Total Annual Passenger Capacity – mppa**
Departures Concourse (landside)	17.72	12.09
Departures Concourse (airside)	19.42	16.00
Baggage Reclaim Hall	25.03	18.85
Arrivals Concourse (landside)	26.88	25.30

Table 4.3.1: **Annual Passenger Capacity Reductions For the Selected Areas Resulting from the De-tuning Exercise – Dublin Airport (Source: Extracted from Dublin Airport Baseline Report E, June, 2003)**

4.4 Evaluation of '*De-tuning*' Methodology

The methodology of de-tuning undertaken by the consultant team is a most unusual process, and one that can be considered subjective in terms of the removal of specific amounts of space so as to make allowances for cross-flows, pinch-points and problem areas. In general, cross/opposing flows can cause capacity losses relative to one-directional flow. However, based on research by the US Transport Research Board in the preparation of the '2000 Highway Capacity Manual', it has been concluded that for a given level of pedestrian density, as counter flows increase, capacity losses decrease and total flows increase (reference - Quality of Service for Uninterrupted Pedestrian Facilities in the 2000 Highway Capacity Manual, US TRB Paper 99-0132, January, 1999).

When undertaking airport terminal capacity assessment, the normal method used to take account of the issues of cross-flows, pinch-points and problem areas is to provide sufficient spatial allowances within areas and processes, which are incorporated into the various capacity calculations. Different spatial allowances are used, firstly, to provide different '*levels of service*' within areas/processes, and secondly, to sub-divide areas/processes. The transport engineer Fruin, who pioneered the concept of pedestrians' '*levels of service*' in 1973 and has continually evolved this work up to present date, linked the application of '*levels of service*' to the design of pedestrian facilities[8]. The IATA '*six-level-of-service*' framework for passenger spatial allowances, as previously discussed, is related to Fruin's research. By applying the different spatial allowances within the framework, different '*levels of service*' are provided for typical peak or typical busy hour flow rates.

This leads on to the point that the greater the level of detail with regard to the sub-division of terminal passenger areas/processes, and the allocation of different spatial allowances to these sub-areas, then the better will be allowances made due to operational and design issues, and therefore, the more robust will be the capacity assessment process.

In addition, the division of terminal passenger areas and processes that are contiguous is a notional process, and in reality passengers/persons can move freely between these divisions. This allows for the occurrence of '*spill-over*' of passengers/persons from one sub-area to another, which is of importance when divided areas/processes within a terminal passenger area are operating at varying levels of occupancy, and the capacity of the overall departing or arriving facilities can be balanced out, and therefore, increased. A typical example of where passengers/persons 'spill-over' occurs is in the departures concourse associated with the divided areas/processes of circulation and check-in.

In conclusion, when undertaking an airport terminal passenger capacity assessment exercise, it is very unusual to, firstly, state theoretical passenger capacity, and secondly, through a process of area reduction, declare de-tuned passenger capacity. Therefore, given the impact the de-tuning methodology has had on area capacity reductions, its application within the passenger terminal capacity assessment process is considered inappropriate.

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[8] Fruin stated that the design of pedestrian facilities involves the application of traffic engineering principles combined with considerations of human convenience and the design environment. Different environments logically require the application of different qualitative as well as quantitative design standards (references - Fruin, J.J., Designing for Pedestrians: A level of Service Concept, Highway Research Board Record 355, Washington, 1973, and Fruin, J.J., Pedestrian Planning and Design, 2002). Fruin developed the relationship between the parameters of pedestrian flow (or volume), speed and space as follows: $v = S/M$, where: v = flow or volume, S = speed (this could be considered as dwell time in an area) and M = pedestrian spatial allowance.

5. Summary and Conclusions

5.1 Summary

The Baseline Report (Issue E) prepared by the consultant team is a study of the capacity and functionality of the current terminal and piers development at Dublin Airport. The study involved the undertaking of a detailed capacity analysis of selected areas and processes of the passenger terminal (which includes piers). This analysis required the formalisation of various assumptions and parameters.

The assessment of passenger capacity was carried out using the IATA and BAA methods of calculation, with the latter being put forward as the preferred method. The outputs from the two methods produced variations in the passenger handling capacities of the selected areas and processes. To enable the move from hourly to annual handling capacities, the consultant team applied a '*conversion ratio*' calculation, assuming a ratio of 0.0002.

A '*De-tuning*' exercise was undertaken which involved the removal of, or reduction in, space within certain areas in order to take account of the impact of cross-flows, pinch-points and problem areas. The result of this exercise was to reduce the assessed handling capacities of the areas, with these measures based on the BAA method of calculation.

5.2 Conclusions

To conclude this critical appraisal of the Baseline Report (Issue E), account should be taken of the following points:

- While in general the parameters and assumptions used by the consultant team satisfactorily relate to aviation industry standards, there are shortcomings and/or issues with a number of the parameters and assumptions which should be addressed as these have significant effects on the hourly and annual passenger capacities of the terminal areas and processes.
- In assessing the handling capacities of the selected areas and processes, the consultant team put forward the outputs based on the BAA method of calculation as being the current measures of capacity. The BAA method is robust and industry accepted, and therefore, its use is suitable to produce hourly passenger handling capacities.
- The process used to convert hourly to annual passenger capacities (i.e. the application of 0.0002 '*conversion ratio*') is inappropriate, and significantly more detailed passenger analysis is required to achieve more accurate and robust capacity assessments.
- The methodology of de-tuning undertaken is not a recommended exercise. It can result in subjectivity and an under-estimation of the capacity of the selected areas. The provision of appropriate passenger/person spatial allowances within the capacity calculations should take account of the impact of cross-flows, pinch-points and problem areas.