Provision of Consultancy Services for Round 3 Reporting Obligations Including the Strategic Noise Mapping in Malta Under the Directive 2002/49/EC

Contract Ref. No.: ERA_T06/2017

Malta International Airport Noise Modelling

Final Report

Document Code: 593-14-2/3

March 2019

Acousti-Cal Consultancy

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ARHI

Report for

Environment & Resources Authority
Hexagon House
Spencer Hill
Marsa, MRS 1441
Malta

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About this report

Directive 2002/49/EC, commonly referred to as the Environmental Noise Directive (END), requires Member States to undertake strategic noise mapping within major agglomerations, in the vicinity of major road and rail transport corridors and around major airports.

Under Directive 2002/49/EC the strategic noise mapping of non-major airports with fewer than 50,000 operations per year is required only where such airports could potentially affect an agglomeration. The airports that are located within, or near to, the boundary of an agglomeration should be included within the strategic noise mapping if they produce a noise emission such that there is an exposure above 55 dB L_{den} or 50 dB L_{night} inside the agglomeration.

This report describes the Consultants approach to aircraft noise modelling for Malta International Airport, for 2016 under Round 3 of the Directive, which may affect the agglomeration in Malta, the process of noise calculations and analysis of the results.

1 Introduction

This report has been prepared by Acustica Limited, a specialist environmental noise and acoustics consultancy, in association with DARH 2 Acoustics & Architecture L.l.c. and Acousti-Cal Consultancy (the Consultants) as an added deliverable under Stage 2 of the contract "To Compile the Round 3 Strategic Noise Maps for Malta Under Directive 2002/49/EC" (Ref: ERA_T06/2017) (herein and after referred to as the "Contract").

This document has been prepared to detail the aircraft noise modelling for Malta International Airport (MIA) within the context of the Environment & Resources Authority (ERA) project "Compile the Round 3 Strategic Noise Maps for Malta Under Directive 2002/49/EC". The assessment of noise has been undertaken using the Federal Aviation Administration (FAA) Integrated Noise Model (INM) version 7.0. This document aims to give MIA and ERA an understanding of the noise modelling process including data capturing and processing, developing noise model datasets, noise calculation, QA procedures, result post-processing, result presentation and analysis of the results.

1.1 Scope of work

The END requires Member States to produce strategic noise maps for the main sources of environmental noise, i.e. major roads, major railways, major airports and agglomerations with a population of more than 100,000 persons in 2016.

The Directive is transposed separately in each Member state of the EU into local legislation. In Malta, the END is transposed by the *"Assessment and Management of Environmental Noise Regulations, 2004"*, L.N. 193 of 2004 (Regulations). The Regulations were made by the Minister for Rural Affairs and the Environment under the Environmental Protection Act, 2001 (CAP. 435), subsequently amended in 2005. Following the passing of CAP 504, *Environment and Development Planning Act*, 2010, the regulations were subsequently renumbered as Subsidiary Legislation 504.63 of 2007, *Assessment and Management of Environmental Noise Regulations*, 2004.

Responsibility for the environment now resides with the Ministry for the Environment, Sustainable Development, and Climate Change (MESDC). The Environment & Resources Authority (ERA) was established following the passing of CAP 549 *Environment* Protection Act, 2016, and the Regulations were subsequently renumbered as Subsidiary Legislation 549.37, Assessment and Management of Environment Noise Regulations of 2018. The Regulations state that the designated competent authority for the making of strategic noise maps, the publication of information on environmental noise, and the drawing up of action plans, is the Environment & Resources Authority (ERA). The Minister responsible for the environment retains the power to designate other bodies or persons as the competent authority for different provisions and different purposes of the Regulations.

Under the directive, mapping is required at 5 yearly intervals, with the first round of noise maps reported at the end of 2007, second round by the end of June 2012 and the third round to be completed by the end of June 2017 in respect of the 2016 calendar year.

Result information based upon analysis of the maps e.g. population exposure, coverage statistics and quality information are to be supplied to the European Commission (EC) within 6 months of this date using the recommended reporting templates developed by the European Environment Agency (EEA) and published on the EIONET Reportnet Reporting Obligations Database (ROD).

The assessment of noise from Malta International Airport aircraft movements has been undertaken within the context of the (ERA) project "Compile the Round 3 Strategic Noise Maps for Malta Under Directive 2002/49/EC", which operates with reference to the Regulations.

This report sets out the process by which the assessment of noise from aircraft movement has been undertaken as part of this project, and covers the approach shown in Figure 1.1.

For a complete overview of all elements of the work undertaken under the project, this report should be read in conjunction with 593-15-2 Compile R3 Noise Maps for Malta - Draft Final Report.

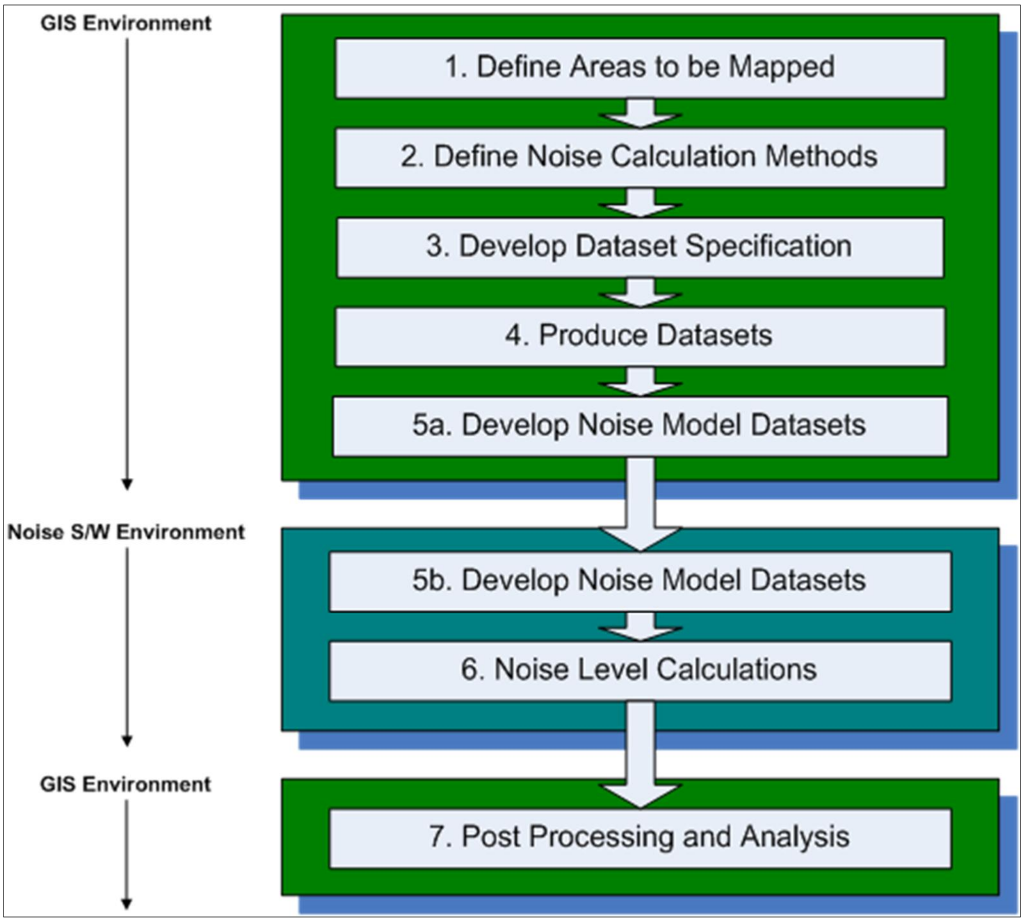

Figure 1.1: Overview of Noise Mapping Process

2 Define Area to be Mapped

2.1 Agglomeration

The Environmental Noise Directive sets out a requirement to assess the noise levels from “major airports” at any location within or outside any agglomerations. A “major airport” is defined as one with in excess of 50,000 total movements per year, an average of approximately 137 movements per 24 hours. There were nearly 44,000 aircraft movements associated with Malta International Airport (MIA) during the 2016 assessment year for the third round of strategic noise mapping, therefore MIA is not designated as a “major airport” under the Regulations, and thus does not need to be mapped as a “major airport”.

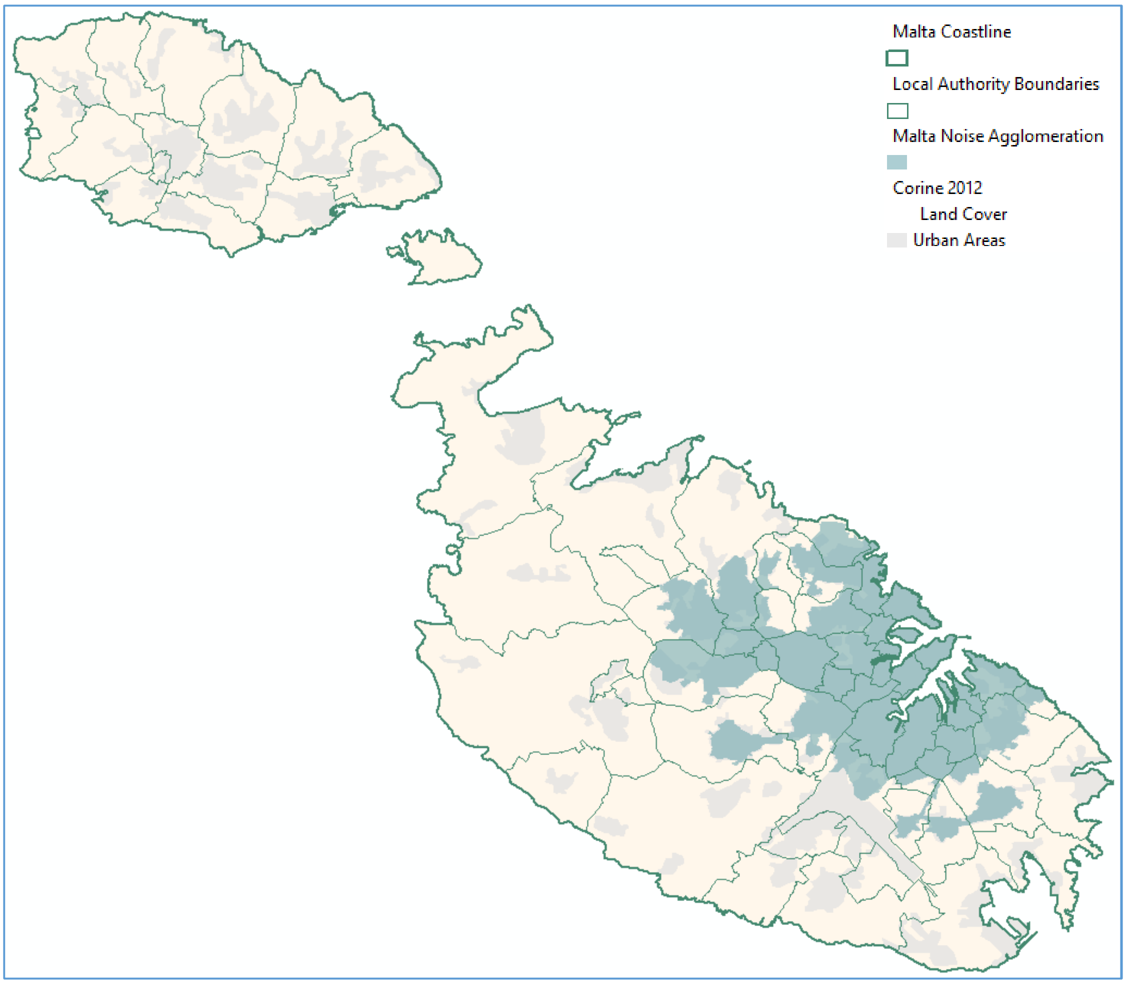

Figure 2.1: Environmental noise agglomeration definition

Under the END there is also a requirement to assess the noise levels from all airports with civil movements, whether they are designated major airports or not, for locations within agglomerations. The environmental noise agglomeration in Malta is shown in Figure 2.1.

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Malta International Airport does not fall within the agglomeration boundary; however, MIA is located just outside the boundary of the agglomeration, and aircraft flight paths on departure and arrival do overfly the agglomeration. It was therefore determined that strategic noise mapping of MIA should be undertaken as it was considered possible that the aircraft movements would affect locations inside the agglomeration boundary, and result in a noise exposure in excess of 55dB L_{den} or 50dB L_{night} at locations outside the boundary of the airfield and within the agglomeration boundary.

3 Define Noise Calculation Method

The EC recommended Interim method is:

- For AIRCRAFT NOISE: ECAC.CEAC Doc. 29 'Report on Standard Method of Computing Noise Contours Around Civil Airports', 1997. Of the different approaches to the modelling of flight paths, the segmentation technique referred to in section 7.5 of ECAC.CEAC Doc. 29 will be used.

Which should be used in accordance with the adaptations set out in:

- Commission Recommendation 2003/613/EC of 6 August 2003, which acknowledges the revision of Doc. 29 and suggests using the updated Doc. 29 after release by ECAC, provided this is "appropriate and considered necessary". ECAC Doc. 29 3rd edition was released in 2006.

The method of assessment including the recommended adaptations is referred to as ECAC Doc 29 Interim.

It should be noted that aircraft noise modelling undertaken across Europe regularly makes use of the Federal Aviation Authority (FAA) Integrated Noise Model (INM) software[1]. The FAA FAQ for INM indicates that versions of INM prior to v7.0 complied with the methodologies contained in ECAC Doc 29 2nd Edition, although without the EC recommended adaptations set out in Commission Recommendation 2003/613/EC, whilst INM v7.0 is compatible with the methodologies contained in ECAC Doc. 29 3rd edition[3].

The FAA INM software package, v6.2 and v7, has been widely used across Europe as the basis of END mapping of airports without any challenges being raised by EEA or DG Environment. It has therefore been concluded to use INM v7.0c for R3 strategic noise mapping of MIA.

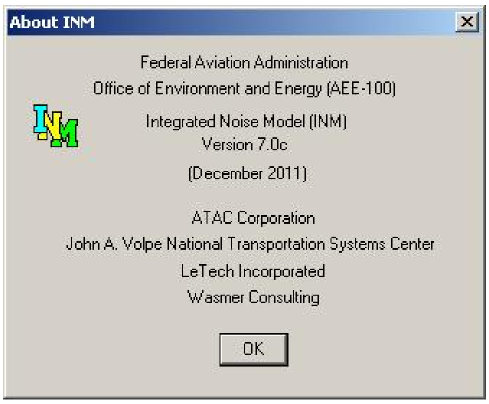


Figure 3.1: Integrated Noise Model v7.0c

[1] Available at: http://www.faa.gov/about/office_org/headquarters_offices/apl/research/models/inm_model [accessed December 2018]

4 Develop Dataset Specification

In order to be able to develop an aircraft noise source emission dataset, it was first necessary to develop a specification of requirements.

Below is set out the high-level description of the requirements for airport and aircraft data, to enable the construction of an INM assessment model. This description was used during the data capture phase to help ensure that the information being collected was compliant with the overall requirements of the project.

The data was collected through a series of meetings and discussions with the airport operator, and traffic control and the transport authority. Details of the information collected and the processing of that data are set out below in Sections 4, 5 and 6.

4.1 Aircraft Movement Data

For each aircraft the following information was required, with consideration made to any operational differences between periods day, evening and night.

- Movement Data (per aircraft)
- Arrival / Departure dates and times
  - S.O.R. (Not Stand Times)
  - Provided in local time
- Aircraft types
  - ICAO (International Civil Aviation Organization) Codes
  - Engine variant details
- Destination
  - Destination of aircraft (used as an indication of fuel load)
  - More critical for major aircraft, long haul and charter flights
  - Runway
  - Runway Direction
- Route
  - Departure Route provided per aircraft
  - Arrival Route provided per aircraft

4.2 Airport Data

For Malta International Airport the following information was required, with consideration given to any operational differences between the stipulated periods of day, evening and night.

- Runway Centre Point
  - Centre point coordinate in latitude and longitude
  - Elevation of runway centre point (m)
- Runway End Points
  - Runway end points provided in km referenced from the runway centre point.
  - Elevation of runway ends (m)
- Runway Width
  - Width (m)
- Take Off / Landing (per aircraft, destination and periods)
  - Start of roll coordinate referenced to centre point (km)
  - Approach threshold coordinate relative to runway centre point (km)
  - Glide slope (degrees)
  - Threshold Crossing Height (m)

- Average Airport Meteorological Conditions
    - Average Airport Temperature (°C)
    - Average Pressure (mm Hg)
    - Average Humidity (%)
    - Average Headwind (km/h)
- Route Definitions (aircraft, route and period dependant)
    - Radar Track Data from NTK (e.g. B&K, GEMS, Lochard)
    - Plan View Drawing derived from a statistical distribution (CSV, DXF)
- Terrain Data
    - Ground elevation data such as equal height contours (SHP, DXF)

5 Aircraft Operations

This section details the INM modelling of aircraft movements at Malta International Airport during 2016, and the sources of the data which were used to construct the model.

5.1 Movements

MIA provided aircraft movement data for the 2016 calendar year, 1st January to 31st December. The total number of movements to and from MIA during 2016 was 43,756. These movements were made up of a combination of helicopters, civil aircraft and military aircraft. In line with common practice across Europe for noise mapping of airports under the END, helicopters and military movements were not included in the noise modelling; however, helicopters are included in determining the airport's total movements. During preliminary checks, for 4 operations, supplied data fields were completely empty, so that operations were excluded from further considerations, i.e., total number of operations taken into account were 43,752.

Table 5.1 gives a breakdown of the operations reported for MIA in 2016.

Table 5.1: Summary of 2016 Movements

Assessment period	Type of movement	Number of movements	Total sum	Percentage of total number of movements	
Day	Arrival	15,230	31998	34.81%	73.13%
	Departure	16,768		38.33%	
Evening	Arrival	4,214	7362	9.63%	16.83%
	Departure	3,148		7.20%	
Night	Arrival	2,451	4392	5.60%	10.04%
	Departure	1,941		4.44%	
24h	Arrival	21,895	43752	50.04%	100%
	Departure	21,857		49.96%	

5.2 Flight Logs

Aircraft operation data was supplied by MIA and MATS. Flight logs were provided in the form of an Excel sheet with arrival operations in one sheet-tab, and the departure operations in another sheet-tab. Table 5.2 shows an example of the data supplied for each flight operation during 2016, with a total of 43,752 logged operations.

During preliminary check of flight data consistency, 42 flights didn't have information about aircraft type, but aircraft registrations were included. Using web queries on Aircraft Registration Database Lookup (http://www.airframes.org), a manual search was conducted and all the missing data about certain aircraft types was found and used to complete the table.

Table 5.2: Example of the data for flight operation

Origin Name	Origin Code	Aircraft Registration	AircraftType	AircraftType (TM Corrected)	Day	Hour	Minute
VIENNA SCHWECHAT	VIE	9HAEI	AIRBUS A320-214	AIRBUS A320-214	1.1.2016	20	12
BRUSSELS - NATIONAL	BRU	9HAEK	AIRBUS A320-214	AIRBUS A320-214	1.1.2016	22	6
PARIS - CHARLES DE GAULLE	CDG	9HAEH	AIRBUS A319-112	AIRBUS A319-112	1.1.2016	12	52
DUSSELDORF	DUS	9HAEO	AIRBUS A320-214	AIRBUS A320-214	1.1.2016	13	35
FRANKFURT	FRA	9HAEO	AIRBUS A320-214	AIRBUS A320-214	1.1.2016	22	28
….	…	…	…	…	…	…	…

Table 5.3: Example of operations with missing aircraft type

OBJECTID *	Origin Name	Origin Code	Aircraft Registration	AircraftType	AircraftType TM Corrected	ICAO Code	Day	Hour
5800	VENICE - MARCO POLO	VCE	9HFGV		EMB-500 Phenom 100	<Null>	3.5.2016.	9
10866	BARCELONA	BCN	9HFGV		EMB-500 Phenom 100	<Null>	14.7.2016.	11
20398	BORDEAUX - MERIGNAC	BOD	9HFGV		EMB-500 Phenom 100	<Null>	1.12.2016.	19
27756	<Null>	<Null>	9HFGV	<Null>	EMB-500 Phenom 100	<Null>	4.5.2016.	9
32741	<Null>	<Null>	9HFGV	<Null>	EMB-500 Phenom 100	<Null>	14.7.2016.	14
42265	<Null>	<Null>	9HFGV	<Null>	EMB-500 Phenom 100	<Null>	1.12.2016.	20
6725	KEFALLINIA - ARGOSTOLLION	EFL	9HFOM		EMB-500 Phenom 100	<Null>	17.5.2016.	13
28608	<Null>	<Null>	9HFOM	<Null>	EMB-500 Phenom 100	<Null>	17.5.2016.	16
4361	GENEVA - GENEVE COINTRIN	GVA	CSDTC		EMB-500 Phenom 100	<Null>	10.4.2016.	19
4665	NICE - COTE D' AZUR	NCE	CSDTC		EMB-500 Phenom 100	<Null>	15.4.2016.	16
13151	GENEVA - GENEVE COINTRIN	GVA	CSDTC		EMB-500 Phenom 100	<Null>	13.8.2016.	11
26305	<Null>	<Null>	CSDTC	<Null>	EMB-500 Phenom 100	<Null>	11.4.2016.	12
26617	<Null>	<Null>	CSDTC	<Null>	EMB-500 Phenom 100	<Null>	16.4.2016.	9
35025	<Null>	<Null>	CSDTC	<Null>	EMB-500 Phenom 100	<Null>	13.8.2016.	11
9588	PARIS - LE BOURGET	LBG	CSDVS		EMB-500 Phenom 100	<Null>	27.6.2016.	15
9885	PALMA MALLORCA	PMI	CSDVS		EMB-500 Phenom 100	<Null>	1.7.2016.	14
11003	ALBENGA	ALL	CSDVS		EMB-500 Phenom 100	<Null>	16.7.2016.	10
31475	<Null>	<Null>	CSDVS	<Null>	EMB-500 Phenom 100	<Null>	27.6.2016.	17
31762	<Null>	<Null>	CSDVS	<Null>	EMB-500 Phenom 100	<Null>	1.7.2016.	15
32892	<Null>	<Null>	CSDVS	<Null>	EMB-500 Phenom 100	<Null>	16.7.2016.	11
5834	CATANIA - FONTANAROSSA, SICILY	CTA	EIEXI		Boeing 717-2BL	<Null>	3.5.2016.	15
7508	CATANIA - FONTANAROSSA, SICILY	CTA	EIEXI		Boeing 717-2BL	<Null>	28.5.2016.	9
18698	CATANIA - FONTANAROSSA, SICILY	CTA	EIEXI		Boeing 717-2BL	<Null>	29.10.2016.	9
27721	<Null>	<Null>	EIEXI	<Null>	Boeing 717-2BL	<Null>	3.5.2016.	16
29396	<Null>	<Null>	EIEXI	<Null>	Boeing 717-2BL	<Null>	28.5.2016.	10
40568	<Null>	<Null>	EIEXI	<Null>	Boeing 717-2BL	<Null>	29.10.2016.	10
1201	FIGARI - SUD CORSE	FSC	FGBDR		Beech F33A Bonanza	<Null>	1.2.2016.	17
3526	PANTELLERIA	PNL	FGBDR		Beech F33A Bonanza	<Null>	27.3.2016.	16
9448	COMISO, SICILY	CIY	FGBDR		Beech F33A Bonanza	<Null>	25.6.2016.	13
12283	CANNES - MANDELIEU	CEQ	FGBDR		Beech F33A Bonanza	<Null>	2.8.2016.	16
25422	<Null>	<Null>	FGBDR	<Null>	Beech F33A Bonanza	<Null>	27.3.2016.	10
33636	<Null>	<Null>	FGBDR	<Null>	Beech F33A Bonanza	<Null>	26.7.2016.	10
40657	<Null>	<Null>	FGBDR	<Null>	Beech F33A Bonanza	<Null>	31.10.2016.	13
12853	LAUSANNE - LA BLECHERETTE	QLS	HBDJR		EXTRA EA-400/500	<Null>	9.8.2016.	14
34881	<Null>	<Null>	HBDJR	<Null>	EXTRA EA-400/500	<Null>	11.8.2016.	12
20797	BRINDISI - PAPOLA CASALE	BDS	IDROV		Cessna R172K Hawk XP	<Null>	9.12.2016.	13
42811	<Null>	<Null>	IDROV	<Null>	Cessna R172K Hawk XP	<Null>	12.12.2016.	7
20798	SALERNO - PONTECAGNANO	QSR	N197TF		AEROFAB Lake LA-250	<Null>	9.12.2016.	12
43522	<Null>	<Null>	N197TF	<Null>	AEROFAB Lake LA-250	<Null>	27.12.2016.	10
5602	TEL AVIV YAFO - BEN GURION INTERNATIONAL	TLV	OMGTA		Boeing 737-4Q8	<Null>	30.4.2016.	20
27562	<Null>	<Null>	OMGTA	<Null>	Boeing 737-4Q8	<Null>	1.5.2016.	10
20628	LONDON - STANSTED	STN	SPKPV		SAAB SF34	<Null>	5.12.2016.	23

5.3 Aircraft Modelling

In order to develop the INM model for the assessment of aircraft noise, the next step was to match each of the aircraft types within the flight logs with aircraft within the INM database.

The INM database covers most major aircraft types, but it is not exhaustive and therefore not all aircraft are modelled directly in INM. As specific data is not available within INM for all aircraft types and variants, modelling of some aircraft and variants is undertaken by substituting other similar aircraft where appropriate. Furthermore, some aircraft types, whether relatively new or rare, are not included within the INM database directly, or have a known substitute available within the model. Under these circumstances it is necessary to make assumptions in order to determine suitable substitutions for these aircraft. These substitutions may be based upon a certification data, engine type or number of seats etc.

This process leads to three main categories of aircraft to be modelled:

1. INM contains the aircraft complete with relevant data;
2. INM does not contain the aircraft, but the FAA/ATAC have identified a suitable substitution using another aircraft within the INM database; and

3. INM does not contain the aircraft, there is no officially identified substitution, and the user needs to determine a suitable substitute from within the INM database.

The impact of aircraft selection and substitutions upon the uncertainty of the noise contours depends upon the contribution of each aircraft type to the noise contours, and hence the proportion of these aircraft substitutions making up the overall movements. The overall contribution of an aircraft type is determined by the noise level for an individual aircraft combined with its number of movements. Whilst it is important to ensure that dominant aircraft types are correctly identified, or substituted with caution, there is a diminished benefit in the assignment of substitutes for aircraft types which have very little contribution to the overall noise assessment.

Required INM substitutions for aircraft types operating from and to MIA were made by assessing the aircrafts engines, size and weight and identifying appropriate aircraft which can represent these where no FAA/ATAC recommendation is available.

In order to identify unique aircraft types, it was necessary to conduct various type of corrective actions like:

- correction of misspelled aircraft types (for example “Boieing” instead of “Boeing”, “AIRBUS INDUSRTIE 319-112”),
- erasing multiple spaces between words,
- correction of “small caps” into “all caps”,
- identifying same aircraft types from different aircraft type descriptions like “BOEING 737-86J(WINGLETS)” and “BOEING B737-86J(WINGLETS)”
- identify wrong aircraft type (for example “AIRBUS A32A”) by searching correct aircraft type by aircraft registration, etc.

The XLS file flight logs were imported into GIS geodatabase, following modifications to the formatting of the dates within the XLS file using a spreadsheet editor. Other data manipulations were also performed to ensure fields were in an acceptable format.

Following data import to geodatabase, a series of data queries were developed to identify and audit the received data. The data auditing process was designed to obtain general facts and statistics regarding the flight data, validation of date formats, as well as searches for anomalies and inconsistencies. In general, the data auditing process identified the following:

- Inconsistent entries
- Incorrect, blank and mismatched entries
- Unique values (such as aircraft, destinations)
- Daily trends

Inconsistent or bad entries were resolved with the assistance of MIA, or determined by the consultants based upon previous experience on other noise mapping projects.

5.4 Aircraft Substitutions

Analysis of the supplied flight log data identified a total of 70 unique aircraft types across the 43,752 movements, as shown in Table 5.4.

As agreed during the meeting with ERA, MIA and MATS, a series of database queries were produced in order to identify the most appropriate matches between the 70 unique aircraft types within the MIA flight logs and the aircraft within the INM database. The first stage was to identify those aircraft which could be directly assigned to an entry within the INM database. The second step took the remaining unmatched aircraft from the MIA flight log and identified suitable substitutes from the INM substitution database. Where an aircraft type from the MIA flight log continued to remain unmatched the third stage was to use the following web databases to identify suitable aircraft from the INM database/INM substitutions from the details of each aircraft type:

- http://airframes.org/
- http://www.aragge.ch/
- http://www.airport-data.com/

Following completion of the three-stage procedure, the results of the analysis showed the following:

- There were 944 helicopter and military movements which were excluded from the noise modelling.
- For the rest of 42,808 movements, Transport Malta provided additional description of the aircraft types, which results with 465 unique descriptions. In order to assign correct INM aircraft type, every single unique description has been checked against:
    - INM aircraft database
    - INM substitution database
    - available web databases to find matches or suitable substitutions to existing INM aircraft or INM substitutions;
- For 188 movements a suitable match could not be found, and the general aviation type GASEPF / GASEPV was assigned (aircraft types DR40/LROBIN; KODIAC100; MICROLIGHT; MOONEY RANGER; STINSON; TECNAM; THRUSH; ROCKWELL).

Analysis of the data in Table 5.4 shows that 14 aircraft types[2] account for more than 90% of the total number of operations at MIA during 2016, as shown in Figure 5.1. For each of these 14 aircraft types it was possible to correctly assign the aircraft from the INM database.

[2] During previous round of noise mapping, 15 aircraft types accounted for more than 90% of the total number of operations

Table 5.4: List of unique INM aircraft types and number of operations at MIA during 2016

No	INM Aircraft type	Number of operations	Percentage of total	No	INM Aircraft type	Number of operations	Percentage of total	No	INM Aircraft type	Number of operations	Percentage of total
1	A320-211	13866	32,391%	26	CIT3	127	0,297%	51	LEAR45	10	0,023%
2	737800	12370	28,896%	27	DO328	116	0,271%	52	CNA182	9	0,021%
3	A319-131	4926	11,507%	28	F10062	109	0,255%	53	MD83	8	0,019%
4	A321-232	1973	4,609%	29	FAL20	79	0,185%	54	747400	7	0,016%
5	DHC6	834	1,948%	30	GV	70	0,164%	55	COMJET	6	0,014%
6	DHC8	638	1,490%	31	CNA172	67	0,157%	56	ECLIPSE500	6	0,014%
7	GASEPF	634	1,481%	32	GIV	59	0,138%	57	GIIB	4	0,009%
8	757300	630	1,472%	33	LEAR35	52	0,121%	58	IA1125	4	0,009%
9	737300	540	1,261%	34	LEAR36	52	0,121%	59	MD81	4	0,009%
10	BAE146	519	1,212%	35	767300	50	0,117%	60	MD82	4	0,009%
11	CNA55B	515	1,203%	36	LEAR60	50	0,117%	61	PA42	4	0,009%
12	737400	471	1,100%	37	LEAR55	49	0,114%	62	TU134	4	0,009%
13	777300	426	0,995%	38	CNA441	45	0,105%	63	SF340	3	0,007%
14	C12	418	0,976%	39	A310-304	40	0,093%	64	A300-622R	2	0,005%
15	737700	381	0,890%	40	COMSEP	38	0,089%	65	A300B4-203	2	0,005%
16	CNA750	329	0,769%	41	DOMIN	36	0,084%	66	ATR72	2	0,005%
17	CNA500	304	0,710%	42	LEAR25	36	0,084%	67	DC1010	2	0,005%
18	CRJ9-ER	292	0,682%	43	GASEPV	33	0,077%	68	EMB170	2	0,005%
19	CL600	257	0,600%	44	707320	19	0,044%	69	PA44	2	0,005%
20	HS748A	252	0,589%	45	737500	18	0,042%	70	PA61	2	0,005%
21	EMB145	230	0,537%	46	EMB190	18	0,042%				
22	717200	202	0,472%	47	GII	18	0,042%				
23	A340-211	194	0,453%	48	GULF1	15	0,035%				
24	BEC58P	166	0,388%	49	777200	10	0,023%				
25	A330-301	138	0,322%	50	CNA206	10	0,023%				

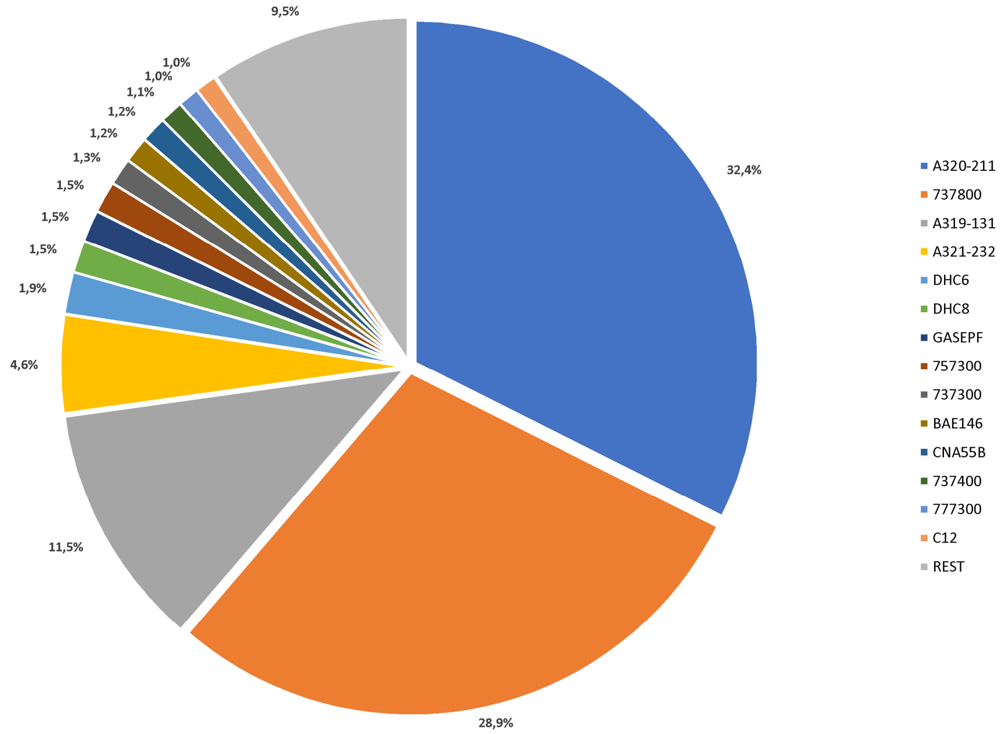


Figure 5.1: Summary of 2016 Movements

The total number of movements assigned to the default general aviation type GASEPF / GASEPV within INM, due to lack of clear information, was 0.43% of the total annual movements, and not considered to impact upon the results.

5.5 Stage Lengths and Flight Profiles

The flight profile is the rate of assent which an aircraft has upon departure. For departure movements, the INM model provides a different number of flight profiles, speeds and thrust profiles for most aircraft types. This is particularly relevant for larger aircraft which are used for charter or long-haul flights. Flight profiles are mainly determined by departure weight, which is usually determined by the length of the flight and subsequent fuel load. This is addressed by INM using Stage Lengths.

INM makes the assumption that an aircraft will take off with a full complement of passengers irrespective of the destination and stage length. As the stage length increases, the aircraft will require a much larger fuel load on departure. This results in the aircraft profile being slightly lower than when a shorter stage length is flown. Table 5.5 shows INM stage lengths verses distance.

Table 5.5: INM Stage Lengths

Stage Length	Distance (nmi)
1	0 – 500
2	501 – 1000
3	1001 – 1500
4	1501 – 2500
5	2501 – 3500
6	3501 – 4500
7	4501 – 5500
8	5501 – 6500
9	over 6500 nmi

In order to estimate stage length, destinations are often used to calculate approximate flight distances. These flight distances can then be converted into stage length using the information provided in Table 5.4.

By querying the MIA flight logs, 397 unique destinations were identified by ICAO code. A direct straight line distance was then assigned to each of the destinations and then filtered down into stage length according the classifications shown in Table 5.4. Figure 5.2 show the destinations offered by MIA for both European and International flights respectively.

Figure 5.2: Most common European and International Destinations Served by MIA

In cases where more than one origin or destination was offered by the query, the most frequent was selected and assigned to the movement. Table 5.6 shows a summary of aircraft departures from MIA against stage length.

Table 5.6: Summary of Departures against Stage Length

Stage Length	Number of Departures
1	2,444
2	4,243
3	8,177
4	1,211
5	35
6	6
7	20
8	24
9	0

5.6 Flight Routes

With the aircraft movements prepared within INM as described above, each movement was ready to be assigned to a specific flight track inbound to or outbound from the airfield. The development of the flight tracks is discussed in Section 6.

6 Airfield Definitions

This section details the INM modelling of Malta International Airport's airfield and the sources of the data which were used to construct the model.

6.1 Runways

ICAO defines a runway as a "defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft". The physical strip of tarmac or concrete on the ground may also be described as the landing strip.

Runways are named by a number between 01 and 36, which is generally one tenth of the magnetic azimuth of the runway's heading. A landing strip can normally be used in both directions, and each runway is named separately as the aircraft travels on a different heading, therefore "runway 09" in one direction is "runway 27" when used in the other direction. The two numbers differ by 18 (180°).

Landing strips are also set out in various sections. The Runway is the surface from threshold to threshold, and is the section used for take-off and landings in normal use. The thresholds effectively demark the start and end of the runway. Along the runway there will typically be other markings, with the runway name adjacent to the threshold, "09" in Figure 6.1.

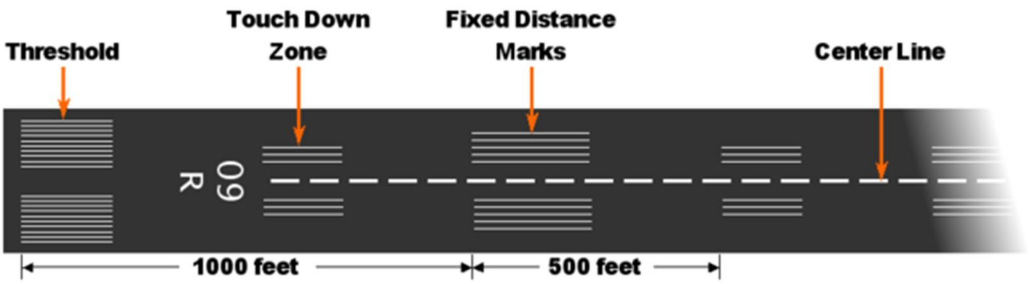


Figure 6.1: Typical runway markings

In some cases the runway may have a displaced threshold which may be used for taxiing, take-off and landing rollout, but not for touchdown. A displaced threshold is marked using which arrows as shown in Figure 6.2.

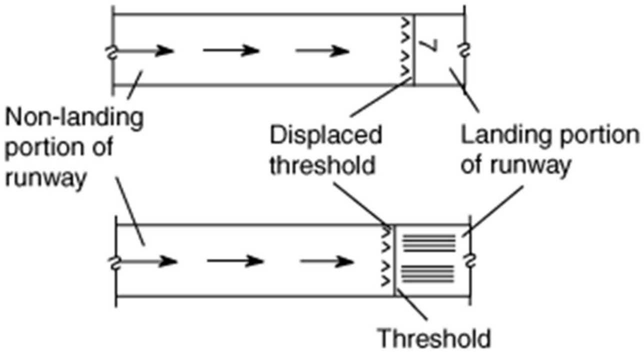


Figure 6.2: Runway with displaced threshold

A runway with a displaced threshold will often have marking similar to Figure 6.3.

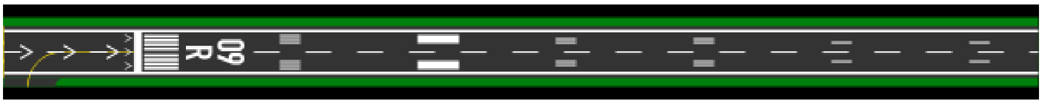


Figure 6.3: Typical runway markings including displaced threshold

6.2 Study Centre Point

The centre point for the study area was selected (X1, Y1) as the official Airport Reference Point (ARP) provided by MIA. The centre point of the study was entered into the INM model as a latitude and longitude (lat, long) in order to enable the correct assessment of corrections due to meteorological conditions.

Table 6.1: Study Centre Point Data

Lat	Long	Elevation
35°51'27.15"N	14°28'38.78"E	75m

6.3 Runways at MIA

MIA has two physical runways, the longer runway 13/31 runs roughly south-east to north-west, and the shorter runway 05/23 runs roughly south-west to north-east. The runways named “runway 05”, “runway 23”, “runway 13” and “runway 31”; referring to the bearing of the runway operations. The end points of the physical runways were defined relative to the study centre point and are presented in Table 6.2 below.

Table 6.2: Runway end points

RWY	Threshold	Lat	Long	Elevation
05/23	05	35°51'13.27"N	14°28'14.95"E	88m
	23	35°51'13.27"N	14°28'14.95"E	88m
13/31	13	35°50'42.51"N	14°29'34.07"E	75m
	31	35°50'44.83"N	14°29'31.32"E	78m

Figure 6.4 shows the aerial photograph of the airfield, and the INM model showing the centre point (marked with a cross) together with the runways 05/23 and 13/31 and corresponding end points.

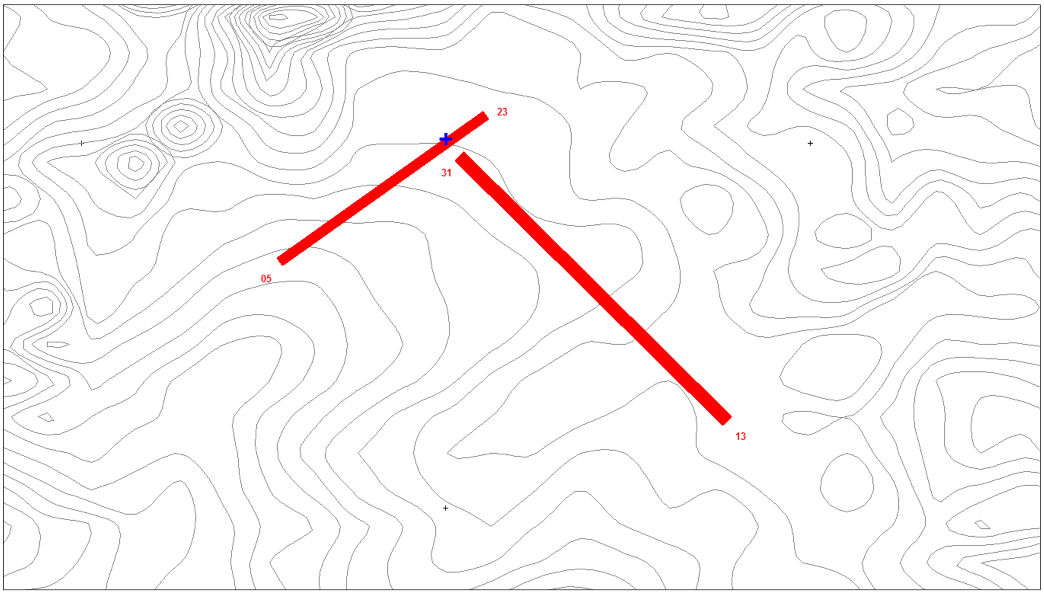


Figure 6.4: MIA aerial photograph and INM model

6.4 Runway Width

MIA provided details of the runway widths, 45m for runway 05/23 and 60m for runway13/31.

6.5 Runway Thresholds

As discussed earlier, a runway may have a displaced threshold to indicate a part of the runway which may be used for taxiing, take-off or landing rollouts, but not for landings. Within the INM modelling, the threshold indicates the location of the start of roll point for departing aircraft, and is used with the threshold crossing height to estimate the typical touchdown point of arriving aircraft. Where a displaced threshold is present at the airfield, it should be included within the INM model to ensure correct geometry is maintained.

Threshold displacements, crossing heights and glide slopes were obtained from MIA and the referenced website.

The runway thresholds were defined relative to the respective end points of the runways, as shown in Table 6.3. At MIA only runway 31 has a displaced threshold.

Table 6.3: MIA Displaced Thresholds

Location	Departures	Arrivals		
	Displaced Threshold (m)	Displaced Threshold (m)	Glide Slope (degrees)	Threshold Cross height (m)
Runway 05	0	0	3^o	20.5m
Runway 23	0	0	3^o	20.5m
Runway 13	0	0	3^o	19.6m
Runway 31	0	656ft [3]	3^o	19.6m

6.6 Start of Roll Locations

Start of roll is the location on the runway where the aircraft begins the take-off run. Distances of the start of roll with respect to the ARP were obtained from MIA (Table 6.4).

Table 6.4: MIA Start of Roll Distances

Start of roll distance referenced to centre point	
RWY end	Distance
13	1,772m
31	1,677m
05	1,188m
23	1,188m

[3] http://www.airport-data.com/world-airports/LMML-MLA/

6.7 Terrain Data

The terrain data used within INM was based upon the terrain model files used for the Round 3 strategic noise mapping of Malta, which was based upon information supplied by ERA IR Unit. This data was converted from contour lines into a 3D point ShapeFile format. It was then re-projected from the ED50 coordinate system into a Geographic projection system (Latitude/Longitude) with the Datum configured as the WGS84 projection system. The units of the projection were set as Arc degrees. This configuration is the standard projection system used within INM. The modelled terrain data covered a rectangular shaped area of 625 km^2 (25 km x 25 km) extending beyond the immediate shoreline of Malta. A triangulated elevation grid of the area was converted into GridFloat format and interpreted to a series of 3m spaced equal height contours during import into INM.

Figure 6.5 shows the triangulated elevation data for the area of interest in the WGS84 projection. Figure 6.6 shows the interpolated 3m contours in GridFloat format used within the INM model.

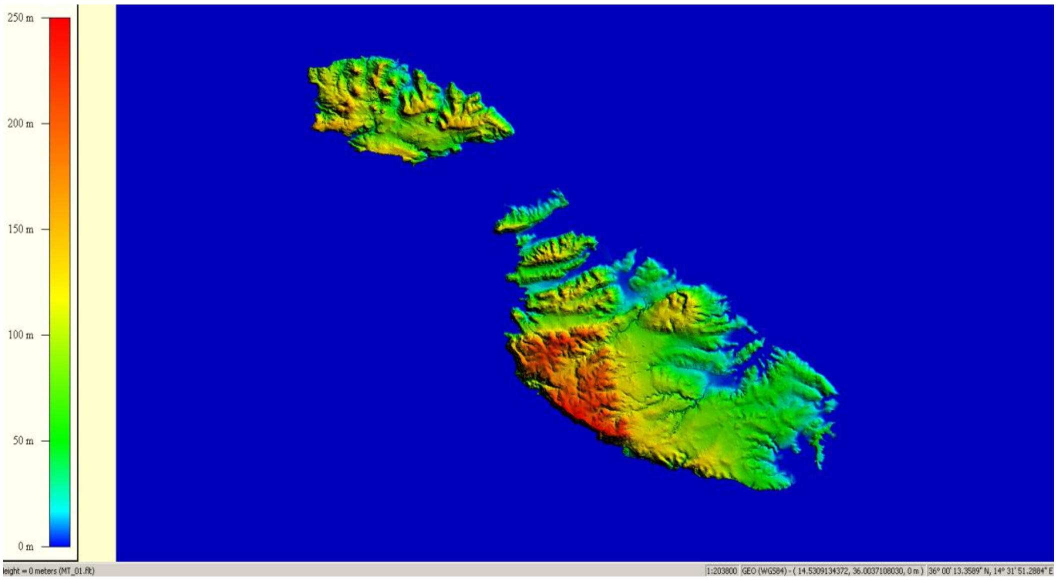


Figure 6.5: Triangular elevation grid (GridFloat); Geographic projection system (Latitude/Longitude); WGS84

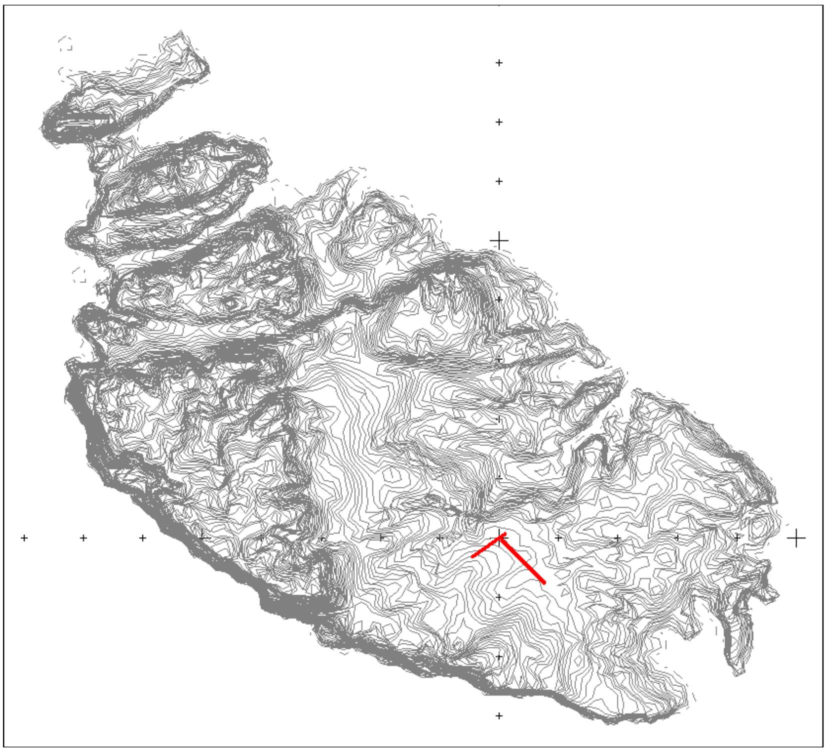


Figure 6.6: Equal height contour lines within INM based upon the imported grid

7 Routes and Dispersion

In the previous sections of this report, the process to setup the aircraft movements database was described, and the setup of the airfield model, including the runways, was discussed.

This section discusses the routes followed by the aircraft arriving and departing MIA, the dispersion of flight tracks around these modelled routes, and the assignment of aircraft onto the modelled tracks.

The section also discusses the sources of the route information, and its interpretation for the modelling within INM. The complete 2016 flight logs were supplied by MIA, and these were used to assess actual runway and route usage over the year 2016.

7.1 Routes

The noise-relevant portion of the route taken by approaching aircraft is defined on the airfield chart, and is governed by the constant gliding angle of the instrument landing system. This results in a single inbound route per runway, with little variation between individual aircraft.

The particular route taken by departing aircraft depends upon many factors including:

- Runway in use;
- Destination;
- Aircraft Type;
- Operational Characteristics; and
- Noise Abatement Tracks / Departure Rules.

MATS provided annotated airspace diagrams (e-mail dated 30th January 2018) which indicated the routes for departing aircraft from each of the four runways, and further information was obtained following a meeting with TM and MATS during January 2018. These airspace diagrams are shown in Figures 7.1, 7.3, 7.5 and 7.7.

These airspace diagrams were overlaid onto an outline of the Maltese islands in GIS, as shown on Figures 7.2, 7.4, 7.6 and 7.8.

The routes were digitised in GIS, and then imported into INM as a set of CSV files. The imported tracks were used as a guide for manually digitising the routes within INM to enable dispersion sub-tracks to be generated by INM, which cannot be directly, achieved using imported routes. The thin black line with label “ARRIVAL” represents the main arrival route, while the departure routes with corresponding labels are shown as thicker curves.

7.1.1 *Runway 05*

Figure 7.1 shows a standard departure chart for runway 05, with six designated departure routes named AGARI 2A, GOZO (GZO) 3A, OBITA 2A, GODAK 2A, LORED 2A, SUDIK 2A.

AIP
MALTA

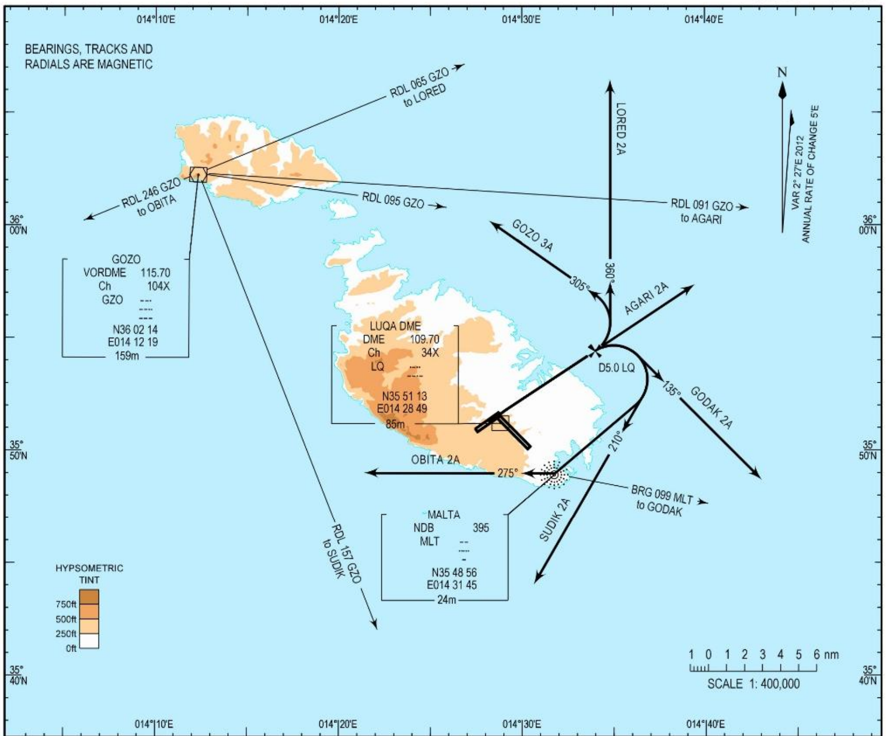
AD 2-LMML-SID05 - 1
17 AUG 2017

STANDARD DEPARTURE CHART -
INSTRUMENT (SID) - ICAO

GROUND	121.6	RADAR	128.150
TOWER	135.1	ATIS	127.4

TRANSITION ALTITUDE 5000FT

MALTA/Luqa
RWY 05
AGARI 2A GODAK 2A
GOZO (GZO) 3A LORED 2A
OBITA 2A SUDIK 2A



SID	TAKE-OFF / ROUTING	ALTITUDE RESTRICTIONS
AGARI 2A	Straight ahead, intercept GZO R091 inbound to AGARI.	Cross LQ 5.0 DME at 2500ft or above. Climb to maintain 5000ft.
GODAK 2A	Straight ahead until LQ 5.0 DME, turn right, make a track of 135°, intercept MLT BRG 099° inbound to GODAK.	
GOZO 3A	Straight ahead until LQ 5.0 DME, turn left, make a track of 305°, intercept GZO R095 inbound to GZO VOR.	
LORED 2A	Straight ahead until LQ 5.0 DME, turn left, make a track of 360°, intercept GZO R065 inbound to LORED.	
OBITA 2A	Straight ahead until LQ 5.0 DME, turn right inbound to MLT NDB, make a track of 275°, intercept GZO R246 inbound to OBITA.	
SUDIK 2A	Straight ahead until LQ 5.0 DME, turn right, make a track of 210°, intercept GZO R157 inbound to SUDIK.	

NOTES:

1. Aircraft cleared on an assigned SID shall climb to altitude 5000 ft QNH, unless otherwise instructed by ATC.
2. SIDs are an integral part of Noise Abatement Procedures (refer to AD 2.21) and should be strictly adhered to within the limits of aircraft performance.
3. Aircraft which are unable to conform to the published altitude restrictions shall inform ATC prior to departure.
4. After passing 2000 ft on assigned SID contact LUQA Radar on 128.150 MHz or as advised in ATIS reports.
5. On first contact with LUQA Radar report call-sign, assigned SID, current altitude and cleared altitude.
6. Unless otherwise instructed by ATC no speed restrictions are applicable.

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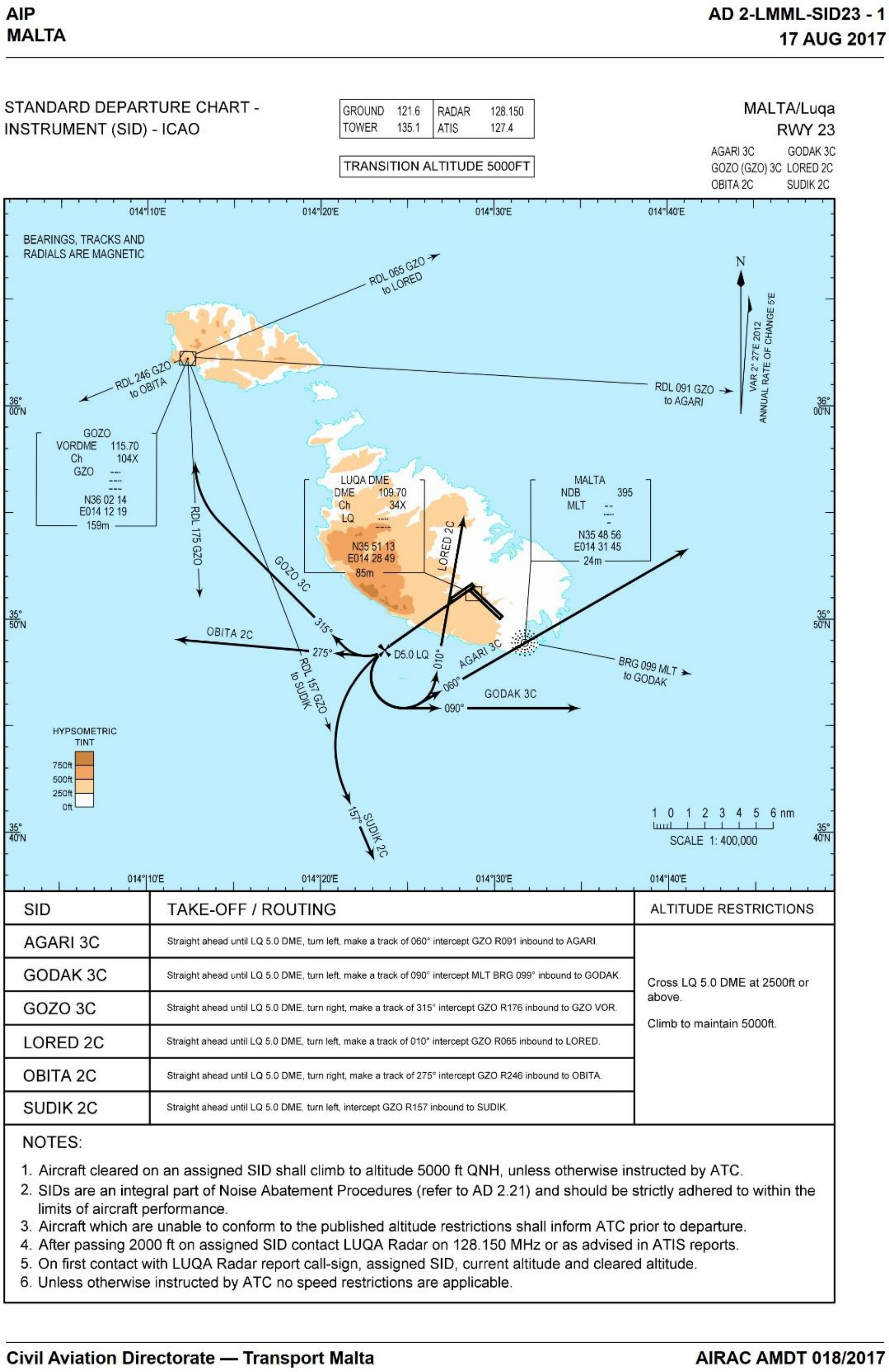
Figure 7.1: Standard departure chart for RWY 05

Figure 7.2: Digitised MIA departure and approach routes for RWY 05

7.1.2 *Runway 23*

Figure 7.3 shows a standard departure chart for runway 23, with six designated departure routes named AGARI 3C, GOZO (GZO) 3C, OBITA 2C, GODAK 3C, LORED 2C, SUDIK 2C.



AIP
MALTA

AD 2-LMML-SID23 - 1
17 AUG 2017

STANDARD DEPARTURE CHART - INSTRUMENT (SID) - ICAO

GROUND 121.6	RADAR 128.150
TOWER 135.1	ATIS 127.4

TRANSITION ALTITUDE 5000FT

MALTA/Luqa
RWY 23
AGARI 3C GODAK 3C
GOZO (GZO) 3C LORED 2C
OBITA 2C SUDIK 2C

SID	TAKE-OFF / ROUTING	ALTITUDE RESTRICTIONS
AGARI 3C	Straight ahead until LQ 5.0 DME, turn left, make a track of 060° intercept GZO R091 inbound to AGARI.	Cross LQ 5.0 DME at 2500ft or above. Climb to maintain 5000ft.
GODAK 3C	Straight ahead until LQ 5.0 DME, turn left, make a track of 090° intercept MLT BRG 099° inbound to GODAK.	
GOZO 3C	Straight ahead until LQ 5.0 DME, turn right, make a track of 315° intercept GZO R176 inbound to GZO VOR.	
LORED 2C	Straight ahead until LQ 5.0 DME, turn left, make a track of 010° intercept GZO R065 inbound to LORED.	
OBITA 2C	Straight ahead until LQ 5.0 DME, turn right, make a track of 275° intercept GZO R246 inbound to OBITA.	
SUDIK 2C	Straight ahead until LQ 5.0 DME, turn left, intercept GZO R157 inbound to SUDIK.	

NOTES:

1. Aircraft cleared on an assigned SID shall climb to altitude 5000 ft QNH, unless otherwise instructed by ATC.
2. SIDs are an integral part of Noise Abatement Procedures (refer to AD 2.21) and should be strictly adhered to within the limits of aircraft performance.
3. Aircraft which are unable to conform to the published altitude restrictions shall inform ATC prior to departure.
4. After passing 2000 ft on assigned SID contact LUQA Radar on 128.150 MHz or as advised in ATIS reports.
5. On first contact with LUQA Radar report call-sign, assigned SID, current altitude and cleared altitude.
6. Unless otherwise instructed by ATC no speed restrictions are applicable.

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AIRAC AMDT 018/2017

Figure 7.3: Standard departure chart for RWY 23

Figure 7.4: Digitised MIA departure and approach routes for RWY 23

7.1.3 *Runway 13*

Figure 7.5 shows a standard departure chart for runway 13, with six designated departure routes named AGARI 2B, GOZO (GZO) 3B, OBITA 2B, GODAK 2B, LORED 2B, SUDIK 2B.

AIP
MALTA

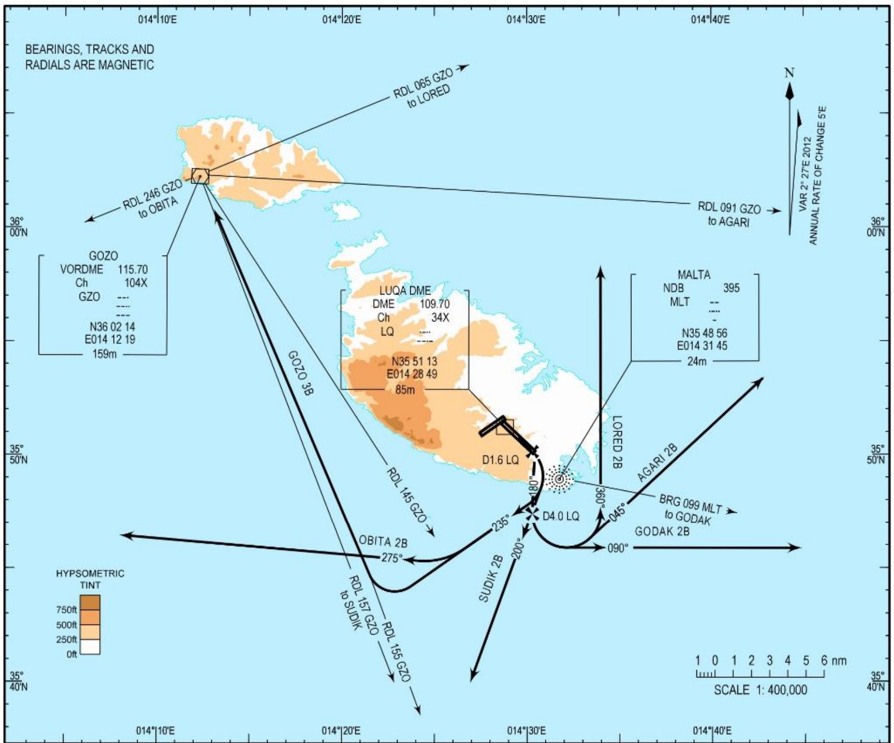
AD 2-LMML-SID13 - 1
17 AUG 2017

STANDARD DEPARTURE CHART -
INSTRUMENT (SID) - ICAO

GROUND	121.6	RADAR	128.150
TOWER	135.1	ATIS	127.4

TRANSITION ALTITUDE 5000FT

MALTA/Luqa
RWY 13
AGARI 2B GODAK 2B
GOZO (GZO) 3B LORED 2B
OBITA 2B SUDIK 2B



SID	TAKE-OFF / ROUTING	ALTITUDE RESTRICTIONS
AGARI 2B	Straight ahead until LQ 1.6 DME, turn right, make a track of 180° until LQ 4.0 DME, turn left, make a track of 045° , intercept GZO R091 inbound to AGARI.	Right turn after departure not below 500ft above DER elevation. Climb and maintain 5000ft.
GODAK 2B	Straight ahead until LQ 1.6 DME, turn right, make a track of 180° until LQ 4.0 DME, turn left, make a track of 090° , intercept MLT BRG 099° inbound to GODAK.	Right turn after departure not below 500ft above DER elevation. Climb and maintain 5000ft.
GOZO 3B	Straight ahead until LQ 1.6 DME, turn right, make a track of 235° until crossing GZO R145, turn right, intercept GZO R155 inbound to GZO VOR.	Right turn after departure not below 500ft above DER elevation. Cross GZO R145 at 2500ft or above. Climb and maintain 5000ft.
LORED 2B	Straight ahead until LQ 1.6 DME, turn right, make a track of 180° until LQ 4.0 DME, turn left, make a track of 360° , intercept GZO R065 inbound to LORED.	Right turn after departure not below 500ft above DER elevation. Climb and maintain 5000ft.
OBITA 2B	Straight ahead until LQ 1.6 DME, turn right, make a track of 235° until crossing GZO R145, turn right, make a track of 275° , intercept GZO R246 inbound to OBITA.	Right turn after departure not below 500ft above DER elevation. Cross GZO R145 at 2500ft or above. Climb and maintain 5000ft.
SUDIK 2B	Straight ahead until LQ 1.6 DME, turn right, make a track of 200°, intercept GZO R157 inbound to SUDIK.	Right turn after departure not below 500ft above DER elevation. Climb and maintain 5000ft.

NOTES:

1. Aircraft cleared on an assigned SID shall climb to altitude 5000 ft QNH, unless otherwise instructed by ATC.
2. SIDs are an integral part of Noise Abatement Procedures (refer to AD 2.21) and should be strictly adhered to within the limits of aircraft performance.
3. Aircraft which are unable to conform to the published altitude restrictions shall inform ATC prior to departure.
4. After passing 2000 ft on assigned SID contact LUQA Radar on 128.150 MHz or as advised in ATIS reports.
5. On first contact with LUQA Radar report call-sign, assigned SID, current altitude and cleared altitude.
6. Unless otherwise instructed by ATC no speed restrictions are applicable.

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Figure 7.5: Standard departure chart for RWY 13

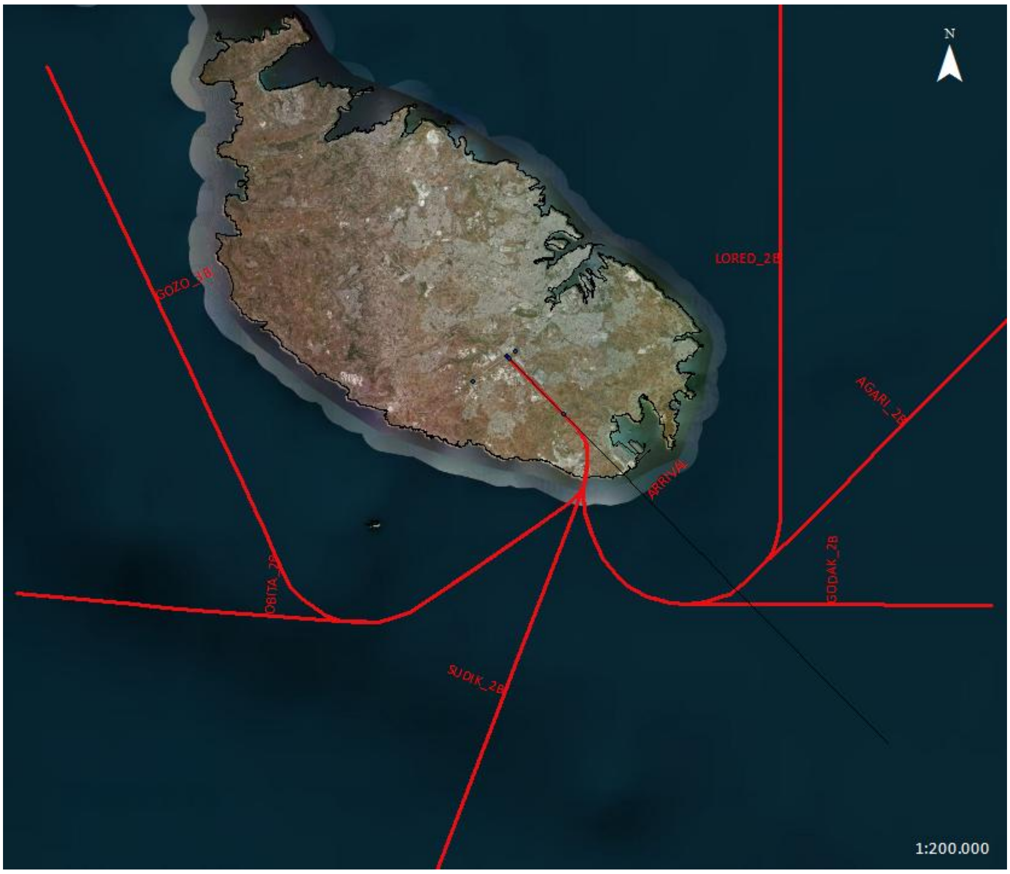


Figure 7.6: Digitised MIA departure and approach routes for RWY 13

7.1.4 *Runway 31*

Figure 7.7 shows a standard departure chart for runway 31, with six designated departure routes named AGARI 2D, GOZO (GZO) 3D, OBITA 2D, GODAK 2D, LORED 2D, SUDIK 2D.

AIP
MALTA

AD 2-LMML-SID31 - 1
17 AUG 2017

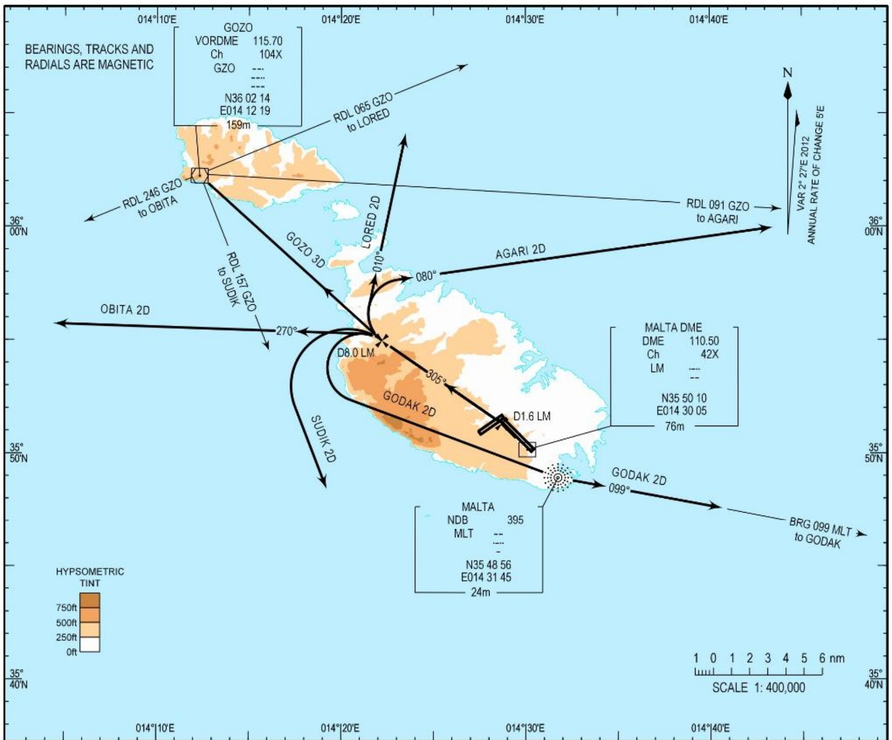
STANDARD DEPARTURE CHART -
INSTRUMENT (SID) - ICAO

GROUND	121.6	RADAR	128.150
TOWER	135.1	ATIS	127.4

TRANSITION ALTITUDE 5000FT

MALTA/Luqa
RWY 31

AGARI 2D GODAK 2D
GOZO (GZO) 3D LORED 2D
OBITA 2D SUDIK 2D



SID	TAKE-OFF / ROUTING	ALTITUDE RESTRICTIONS
AGARI 2D	Straight ahead until LM 1.6 DME, turn left, make a track of 305° until LM 8.0 DME, turn right, make a track of 080°, intercept GZO R091 inbound to AGARI.	Left turn after departure not below 500ft above DER elevation. Cross LM 8.0 DME at 2500ft or above. Climb and maintain 5000ft.
GODAK 2D	Straight ahead until LM 1.6 DME, turn left, make a track of 305° until LM 8.0 DME, turn left inbound to MLT NDB, intercept MLT BRG 099° inbound to GODAK.	
GOZO 3D	Straight ahead until LM 1.6 DME, turn left, make a track of 305° until LM 8.0 DME, turn right inbound to GZO VOR.	
LORED 2D	Straight ahead until LM 1.6 DME, turn left, make a track of 305° until LM 8.0 DME, turn right, make a track of 010° , intercept GZO R065 inbound to LORED.	
OBITA 2D	Straight ahead until LM 1.6 DME, turn left, make a track of 305° until LM 8.0 DME, turn left, make a track of 270° , intercept GZO R246 inbound to OBITA.	
SUDIK 2D	Straight ahead until LM 1.6 DME, turn left, make a track of 305° until LM 8.0 DME, turn left, intercept GZO R157 inbound to SUDIK.	

NOTES:

1. Aircraft cleared on an assigned SID shall climb to altitude 5000 ft QNH, unless otherwise instructed by ATC.
2. SIDs are an integral part of Noise Abatement Procedures (refer to AD 2.21) and should be strictly adhered to within the limits of aircraft performance.
3. Aircraft which are unable to conform to the published altitude restrictions shall inform ATC prior to departure.
4. After passing 2000 ft on assigned SID contact LUQA Radar on 128.150 MHz or as advised in ATIS reports.
5. On first contact with LUQA Radar report call-sign, assigned SID, current altitude and cleared altitude.
6. Unless otherwise instructed by ATC no speed restrictions are applicable.

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Figure 7.7: Standard departure chart for RWY 31

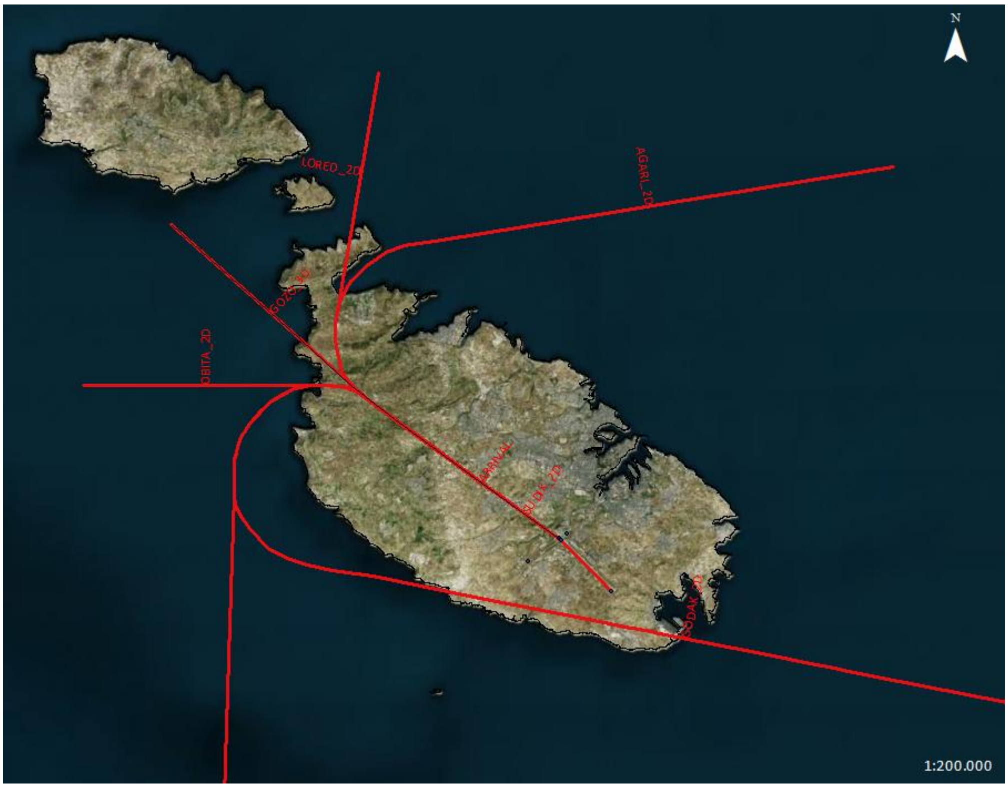


Figure 7.8: Digitised MIA departure and approach routes for RWY 31

7.2 Route Dispersions

Aircraft departing MIA follow one of the departure routes set out above, however in reality they do not all stay completely aligned to the centre of the departure route with some variation between individual flights. To take into consideration the variation between aircraft, the model does not assume that all aircraft follow the modelled routes exactly, but are dispersed onto tracks around the modelled "main" departure route.

The modelled dispersion increases the further the aircraft has travelled along the route. INM allows the modelling of dispersion according to either preconfigured or user defined dispersion patterns. In locations where noise levels are dominated by departure noise, the inclusion of dispersion has the effect of widening the noise contours.

Where detailed logs of actual flight tracks are available it is possible to use them directly to take into account the actual tracks flown. When actual tracks are not available, such as for MIA, it is normal practice to assume a distribution of the aircraft onto five flight tracks around the modelled route. The five dispersion tracks include one for the main departure route, two inner dispersion routes and two outer dispersion routes. The ICAO dispersion percentages were then adopted to distribute the aircraft across the five tracks using the following assumptions:

1. 39.0% of departures are allocated to the main departure route;
2. 24.0% of departures are allocated equally to the two inner dispersion routes and offset by a distance of 1 standard deviation; and
3. 6.5% of departures are allocated equally to the two outer dispersion routes and offset by a distance of 2 standard deviations.

As flight tracks become increasingly spread out and dispersed the further along the departure route the aircraft travel, this was also be considered in the modelling. INM models this effect by using the 'half-width' parameter. This is the distance from the main departure route to the outside sub track; therefore, twice the half-width is the actual width of the dispersed track. As actual data on the dispersion of flight tracks around the departure routes was not available for MIA, the dispersion patterns were assumed based upon the Consultants typical experience from previous projects.

Table 7.1 shows the Outer Track Displacement distance, and half widths, in both metres and nautical miles used within the INM model. It was assumed that dispersion reaches its limit at distances greater than 11km from start of roll.

Table 7.1: Assumed Dispersions on all departure routes

Distance From Start of Roll (km)	Half Width (m)	2 Standard Deviations Outer Track Displacement (m)	2 Standard Deviations Outer Track Displacement (nmi)
0.0	0	0	0.0
1.0	0	0	0.0
2.0	0	0	0.0
3.0	20	40	0.022
3.5	39	77	0.042
4.0	78	156	0.084
4.5	119	238	0.128
5.0	160	320	0.173
5.5	205	410	0.221
6.0	250	500	0.270
6.5	292	585	0.315
7.0	334	668	0.360
7.5	372	743	0.401
8.0	409	818	0.441
8.5	437	874	0.471
9.0	465	930	0.501
9.5	489	977	0.527
10.0	512	1024	0.552
10.5	533	1066	0.574
11.0 and above	554	1107	0.597

Each of the MIA departure routes within the INM model, described in Sections 7.1, was assigned the dispersion pattern set out in Table 7.1. This enabled INM to generate the four dispersion tracks around each of the departure routes.

The layout of the departure routes and dispersion tracks modelled in INM are shown in Figure 7.9.

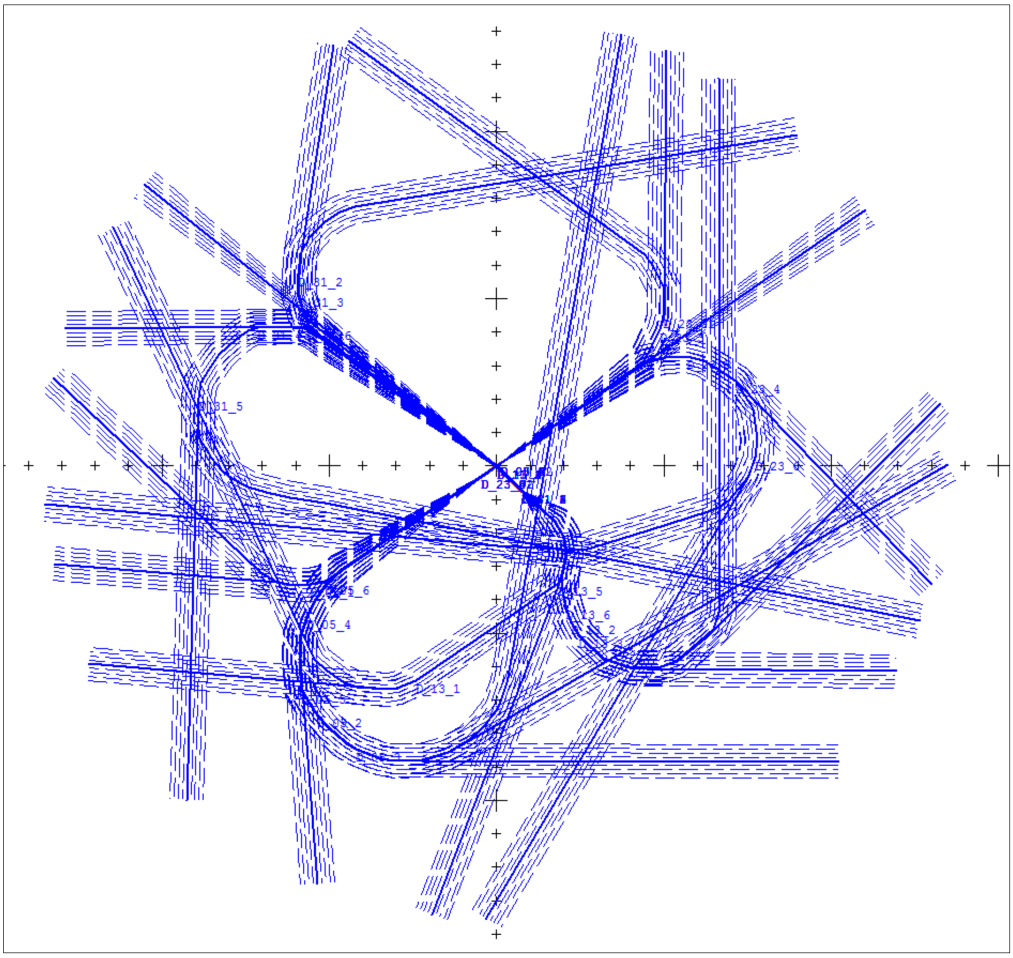


Figure 7.9: Departure routes and dispersion tracks for MIA

7.3 Runway Use

During 2nd round of noise mapping, MIA and MATS provided a detailed breakdown of the monthly arrivals and departures per runway, as set out in Table 7.2. MATS also provided estimates for the split of departing aircraft across each departure route for each runway, as set out in see Table 7.3.

Table 7.2: Analysis of the operations on MIA per runway

Month	ARRIVALS				DEPARTURES			
	RWY 13/31		RWY 05/23		RWY 13/31		RWY 05/23	
	13	31	5	23	13	31	5	23
January	278	750	1	49	377	701	0	4
February	216	716	17	118	265	756	21	37
March	498	653	13	72	643	534	12	52
April	545	779	14	86	618	750	21	16
May	535	952	26	74	612	884	20	51
June	521	1032	8	92	620	1001	1	6
July	569	1039	2	86	712	1003	0	11
August	568	1115	6	69	703	1025	0	9
September	560	1049	8	77	499	1135	0	33
October	702	833	24	55	809	769	12	11
November	763	285	5	27	828	216	7	24
December	147	837	1	53	200	831	0	0
Total	**16,925**				**16,839**			

Table 7.3: Analysis of the use of the departure routes

RWY05		RWY 23		RWY 13		RWY 31	
SID Description	**Flights (%)**	**SID Description**	**Flights (%)**	**SID Description**	**Flights (%)**	**SID Description**	**Flights (%)**
AGARI 2A	3%	AGARI 3C	3%	GOZO (GZO) 3B	90%	AGARI 2D	3%
GOZO (GZO) 3A	90%	GOZO (GZO) 3C	90%	AGARI	3%	GOZO (GZO) 3D	90%
OBITA 2A	1%	OBITA 2C	1%	LORED	3%	OBITA 2D	1%
GODAK 2A	1%	GODAK 3C	1%	OBITA	1%	GODAK 2D	1%
LORED 2A	3%	LORED 2C	3%	SUDIK	2%	LORED 2D	3%
SUDIK 2A	2%	SUDIK 2C	2%	GODAK	1%	SUDIK 2D	2%

Due to preferential runway scheme procedures which determine the distribution of traffic on all four runways, percentage wise it is unlikely to have significant variations from one year to another. Therefore, the distribution of traffic on all four runways for 2011 were used as a base line for 2016 (E-mail dated 31 October 2018).

Unfortunately, there was no dataset which could provide a link between specific aircraft operations, stage lengths and the runway used; therefore, the consultants provided three alternative processes which could be used to develop the model datasets. From these three alternatives, ERA with the assistance of the MIA and MATS selected the preferred scenario, which was then used to construct necessary datasets within INM, this approach is discussed below.

As discussed above, each runway at the airport has its own approach and departure routes. On the basis of the data received from MIA and MATS concerning the monthly use of each of the runways (Table 7.2), it was possible to produce statistical analysis about the type of operation (arrival or departure) and runway used. Results of the analysis are presented in Tables 7.4, 7.5 and 7.6.

It can be seen in Table 7.4 that runway 13-31 is the preferred runway. This runway handled approximately 96% of all movements during 2016, with the dominant use of runway 31. It can also be seen that runway 05-23 was used infrequently during 2016.

Table 7.4: Annual 24-Hour Summary of Runway Usage

Runway	Arrival	Departure	Percentage of total	Total
RWY 13	17.5%	20.4%	37.9%	96.1%
RWY 31	29.7%	28.4%	58.2%	
RWY 05	0.4%	0.3%	0.6%	3.9%
RWY 23	2.5%	0.8%	3.3%	

Table 7.5: Annual 24-Hour Summary of Arrival Operations (percentages of all arrival operations)

Runway	Arrival
RWY 13	34.9%
RWY 31	59.3%
RWY 05	0.7%
RWY 23	5.1%

Table 7.6: Annual 24-Hour Summary of Departure Operations (percentages of all departure operations)

Runway	Departure
RWY 13	40.9%
RWY 31	57.0%
RWY 05	0.6%
RWY 23	1.5%

In order to prepare the input data required by the INM software package, it was necessary to analyse flight operations data on the basis of the following approach:

a) consolidate flight data in order to produce a final dataset with verified operation type, INM aircraft type, assessment period, stage length and total number of operations per day;
b) distribute departure operations to each runway in line with Table 7.6;

c) distribute departure operations to each route in line with Table 7.3; and
d) distribute arrival operations to each runway in line with Table 7.5.

A series of database queries was designed in order to process the movements and assign them to the appropriate runways and routes. The processing of assignments to routes were undertaken on a per aircraft type, per time period basis. For example, all departure operations using runway 31, for aircraft type A320, during the daytime period, with the same stage length, were distributed across the six departure routes according to the percentages in Table 7.3.

8 Noise Level Calculations

Aircraft noise calculations were conducted using the Integrated Noise Model (INM) software, Version 7.0c from the Federal Aviation Administration (FAA), Office of Environment and Energy (AEE-100).

The INM calculation core supports assessment of various types of noise indicators (e.g. L_{day}, EPNL, $_{LA, Max}$ etc.), weighting (A-weighted, Perceived or C-weighted), and time period (day, evening, night).

In line with the requirements of the Regulation and the Directive, the assessment of aircraft movement at MIA was undertaken for the following noise indicators:

- L_{den}
- L_{night},

The noise indicator L_{den} is calculated from the noise indicators L_{day}, $L_{evening}$, L_{night}, in line with the following equation:

$$L_{den} = 10\lg\frac{1}{24}\left(12*10^{\frac{L_{day}}{10}} + 4*10^{\frac{L_{evening}+5}{10}} + 8*10^{\frac{L_{night}+10}{10}}\right)$$

As INM does not directly implement this equation, it is necessary to define multipliers and exposure factors for the three time periods; day (07:00 - 19:00), evening (19:00 - 23:00) and night (23:00 - 07:00); which produce the same overall result, as shown in Table 8.1.

Table 8.1: Summary of multipliers used for the noise indicators in order to derive L_{den}

Day period	Noise indicator			
	$L_{day} = L_{Aeq,\ 12\ hours}$	$L_{evening} = L_{Aeq,4\ hours}$	$L_{night} = L_{Aeq,\ 8\ hours}$	L_{den}
Day	1	0	0	1
Evening	0	1	0	3.16
Night	0	0	1	10
10Log(T)	46.35 dB	41.58	44.59	49.365

For example, for a 24-hour averaging time in seconds and a reference time of one second, 10log(T)=10*log(24×60×60s/1s) = 49.365 dB. Hence assessment period "day" has a total duration of 12 hours, time multiplier is calculated as 10*log(12×60×60s/1s) = 46.354 dB.

The calculation of the L_{night} and L_{den} noise indicators was conducted using the setup as shown in Figure 8.1.

The calculation of the noise levels was conducted on 100m by 100m grid points, with a precision of one decimal place for each grid cell. The calculated 100m grid results for each noise indicator were interpolated to a 10m by 10m grid using GIS.

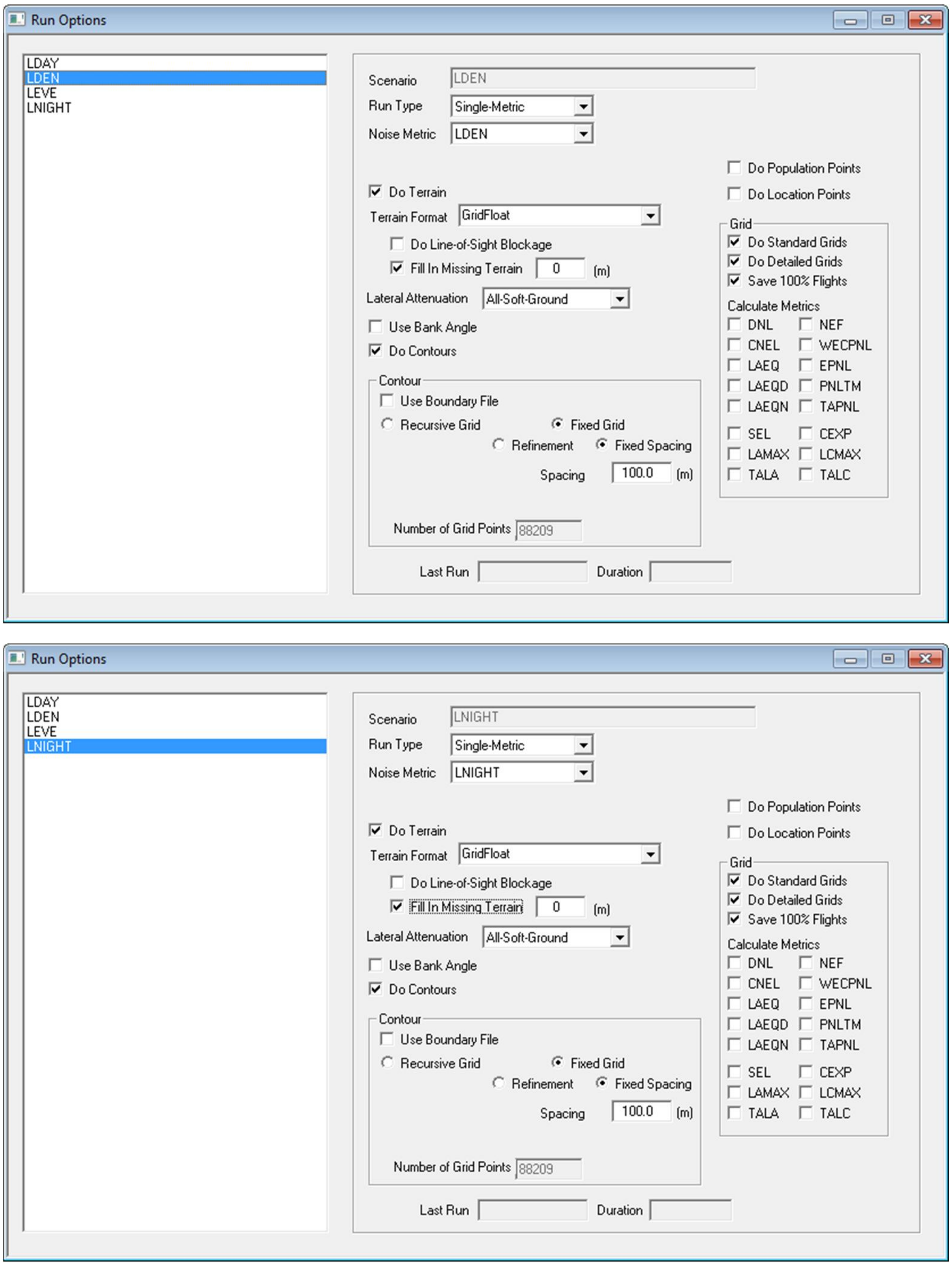


Figure 8.1: Malta International Airport calculation set up

The graphical layouts of the noise classes for the airport movements within the agglomeration, excluding helicopters, for each of the required noise indicators, are presented in Appendix A.

The graphical layouts of the noise classes for the airport movements, excluding helicopters, for each of the required noise indicators, are presented in Appendix B.

Each graphical layout covers aircraft noise levels in the range from the 55 dB to over 80 dB (L_{den}), while for the noise indicator L_{night}, the graphical layouts cover aircraft noise levels in the range from 50 dB to over 80 dB.

9 Post Processing and Analysis

Following the assessment of noise levels, it was possible to undertake secondary analysis utilising the results from the noise calculation process.

9.1 Noise Grid Processing

Noise grids were produced for MIA at 100.008 m due to limitations within the INM software. These were subsequently interpolated using the Natural Neighbour interpolation algorithm to a 10m grid and zeroed.

The output was masked to the contract area extent. Within ESRI ArcGIS Spatial Analysis the grids were reclassified to produce results for each of the following noise level bands (dB):

- L_{den} 55 – 59, 60 – 64, 65 – 69, 70 – 74, ≥75
- L_{night} 50 – 54, 55 – 59, 60 – 64, 65 – 69, ≥70

The reclassified ESRI grids were then exported as ESRI Shapefiles, projected to UTM Zone33, to enable spatial analysis with the building polygons in Malta. It is of note, that steps were employed so as to maintain the inherent precision within the original INM output. Grid cell integrity has been maintained with grid lines not generalised.

9.2 Population Analysis

The Directive requires information on the estimated total number of people (in hundreds) living in dwellings that are exposed to L_{den} higher than 55, 60, 65 and 75dB from airport movement within the agglomeration boundary.

The results of the population exposure analysis for the third round of aircraft traffic noise mapping for Malta agglomeration are set out in Table 9.1 which includes the results from the Round 2 strategic noise mapping for 2011.

Table 9.1: Number of people living within dwellings inside Malta noise agglomeration exposed to noise categories from air traffic

Noise Scenario	Noise Category	2016 Population	2011 Population
L_{den}	55-59	7,600	5,500
	60-64	500	300
	65-69	0	0
	70-74	0	0
	≥75	0	0
	Total	**8,100**	**5,800**
L_{night}	50-54	800	1,000
	55-59	0	0
	60-64	0	0
	65-69	0	0
	≥70	0	0
	Total	**800**	**1,000**

It should be noted that the 2016 population exposure assessment was undertaken based upon detailed information from Water Services, whereas the 2011 assessment was based upon Census data. The difference between the population datasets may account for some of the difference in exposure results.

In additional to the assessment of exposure of people in dwellings inside the agglomeration required under the Directive, the number of people exposed to aircraft noise outside the agglomeration has also been assessed for R3, the results are shown in Table 9.2.

Table 9.2: Number of people living within dwellings inside and outside Malta noise agglomeration exposed to noise categories from air traffic

Noise Scenario	Noise Category	2016 Population Inside Agglomeration	2016 Population Outside Agglomeration	2016 Population Total
L_{den}	55-59	7,554	1,604	9,158
	60-64	500	7	507
	65-69	0	1	1
	70-74	0	0	0
	≥75	0	0	0
	Total	**8,054**	**1,612**	**9,666**
L_{night}	50-54	789	36	825
	55-59	0	2	2
	60-64	0	0	0
	65-69	0	0	0
	≥70	0	0	0
	Total	**789**	**38**	**827**

9.3 Dwelling Analysis

The Directive requires information on the estimated total number of dwellings (in hundreds) exposed to L_{den} higher than 55, 60, 65, 70 and 75dB for airports that affect agglomerations.

The results of the analysis were disposed into a series of output files which were reviewed and summarised below.

The results of the dwellings analysis for the third round of aircraft traffic noise mapping for Malta agglomeration are set out in Table 9.3 which includes the results from the Round 2 strategic noise mapping for 2011.

It should be noted that the 2016 dwellings exposure assessment was undertaken based upon detailed information from Water Services, whereas the 2011 assessment was based upon Census data. The difference between the population datasets may account for some of the difference in exposure results.

In additional to the assessment of dwellings inside the agglomeration required under the Directive, the number of dwellings exposed to aircraft noise outside the agglomeration has also been assessed for R3, the results are shown in Table 9.4.

Table 9.3: Number of dwellings inside Malta noise agglomeration exposed to noise categories from air traffic

Noise Scenario	Noise Category	2016 Dwellings	2011 Dwellings
L_{den}	55-59	3,300	2,400
	60-64	200	100
	65-69	0	0
	70-74	0	0
	≥75	0	0
	Total	**3,500**	**2,500**
L_{night}	50-54	300	400
	55-59	0	0
	60-64	0	0
	65-69	0	0
	≥70	0	0
	Total	**0**	**0**

Table 9.4: Number of dwellings inside and outside Malta noise agglomeration exposed to noise categories from air traffic

Noise Scenario	Noise Category	2016 Dwellings Inside Agglomeration	2016 Dwellings Outside Agglomeration	2016 Dwellings Total
L_{den}	55-59	3,260	683	3,943
	60-64	205	22	227
	65-69	0	6	6
	70-74	0	0	0
	≥75	0	0	0
	Total	**3,465**	**711**	**4,176**
L_{night}	50-54	330	43	373
	55-59	0	7	7
	60-64	0	0	0
	65-69	0	0	0
	≥70	0	0	0
	Total	**330**	**50**	**380**

9.4 Area Analysis

The Directive requires information on the estimated total area (in km^2) exposed to L_{den} higher than 55, 60, 65, 70 and 75dB for major airports with more than 50,000 movements per year. This is not a mandatory requirement for MIA, however the R3 the analysis has been undertaken to help support the development of the upcoming noise action plan.

The results of the analysis were disposed into a series of output files which were reviewed and summarised below.

The results of the exposed area analysis for the third round of aircraft traffic noise mapping for Malta agglomeration are set out in Table 9.5.

Table 9.5: Area inside and outside Malta noise agglomeration exposed to noise categories from air traffic

Noise Scenario	Noise Category	2016 Area (km^2) Inside Agglomeration	2016 Area (km^2) Outside Agglomeration	2016 Area (km^2) Total
L_{den}	55-59	1.49	7.75	9.23
	60-64	0.15	3.83	3.99
	65-69	0	1.22	1.22
	70-74	0	0.44	0.44
	≥75	0	0.38	0.38
	Total	**1.64**	**13.62**	**15.26**
L_{night}	50-54	0.28	4.43	4.71
	55-59	0	1.50	1.50
	60-64	0	0.52	0.52
	65-69	0	0.21	0.21
	≥70	0	0.21	0.21
	Total	**0.28**	**6.87**	**7.15**

Appendix A – Malta International Airport Air Traffic Noise Contour Maps within agglomeration

Noise indicator L_{den}

Noise indicator L_{night}

Malta International Airport

L_{night}

Legend

Agglomeration boundary

Lnight

- < 50 dB(A)
- (50-54,99) dB(A)
- (55-59,99) dB(A)
- (60-64,99) dB(A)
- (65-69,99) dB(A)
- (70-74,99) dB(A)
- (75-79,99) dB(A)
- > 80 dB(A)

N

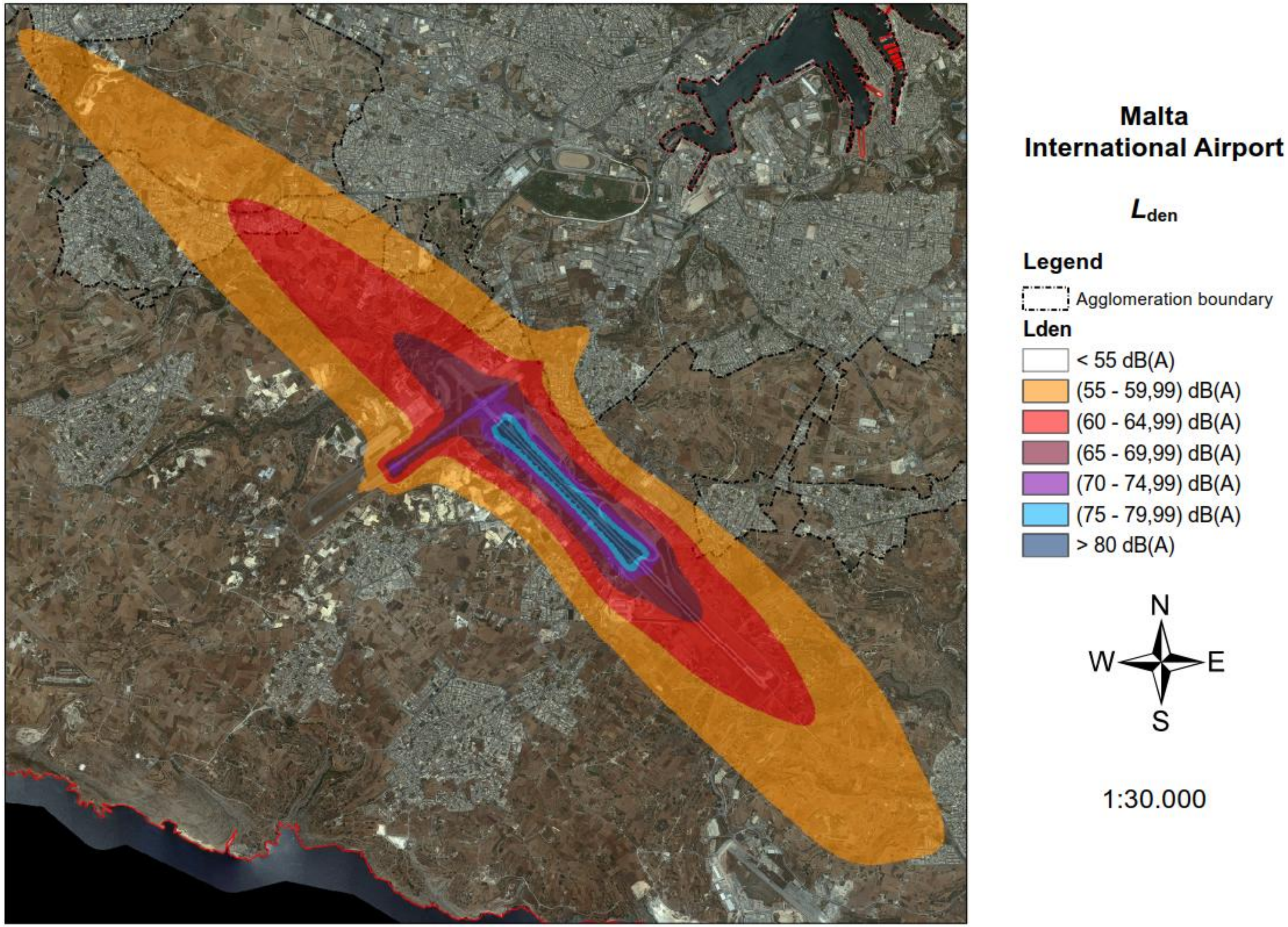
W E

S

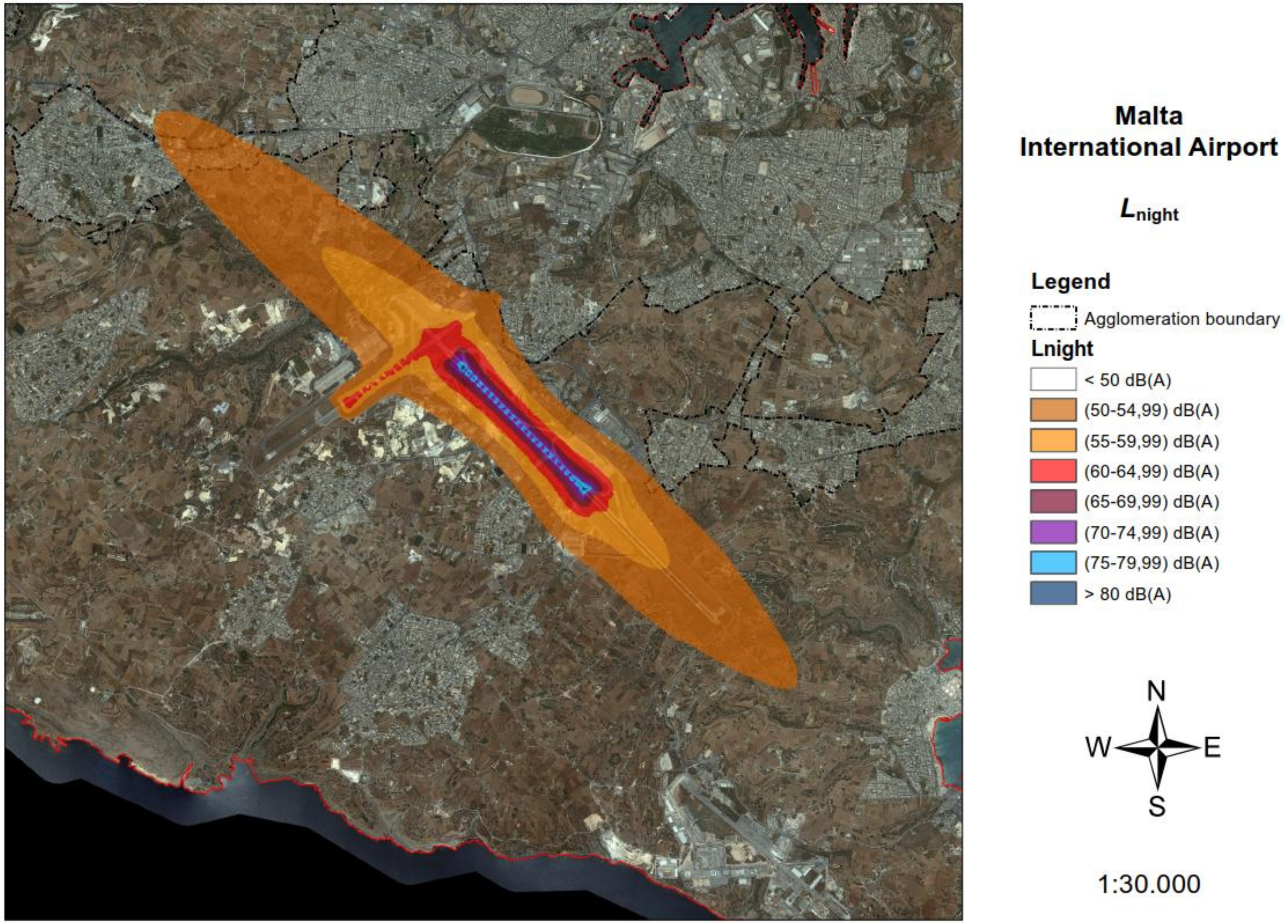
1:30.000

Appendix B – Malta International Airport Air Traffic Noise Contour Maps

Noise indicator L_{den}



Noise indicator L_{night}



Appendix E: Glossary of Acoustic and Technical Terms

Term	Definition
Agglomeration	Major Continuous Urban Area as set out within the Regulations
Attribute Data	A trait, quality, or property describing a geographical feature, e.g. vehicle flow or building height
Attributing (Data)	The linking of attribute data to spatial geometric data
Data	Data comprises information required to generate the outputs specified, and the results specified
dB	Decibel
DEM	Digital Elevation Model
DSM	Digital Surface Model
DTM	Digital Terrain Model
DVD	Digital Versatile Disk
EC	European Commission
END	Environmental Noise Directive (2002/49/EC)
ESRI	Environmental Systems Research Institute
GIS	Geographic Information System
INM	Integrated Noise Model
ISO	International Standards Organisation
Metadata	Descriptive information summarising data
NA	Not Applicable
Noise Bands	Areas lying between contours of the following noise levels (dB): L_{den} <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, ≥75 L_d <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, ≥75 L_e <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, ≥75 L_n <45, 45-49, 50 – 54, 55 – 59, 60 – 64, 65 – 69, ≥70 Notes: 1) It is recommended that class boundaries be at .00, e.g. 55 to 59 is actually 55.00 to 59.99
Noise Levels	Free-field values of L_{den}, L_d, L_e, and L_n at a height of 4m above local ground level
Noise Level - L_d - Daytime	L_d (or L_{day}) = $L_{Aeq,12h}$ (07:00 to 19:00)
Noise Level - L_e - Evening	L_e (or $L_{evening}$) = $L_{Aeq,4h}$ (19:00 to 23:00)
Noise Level - L_n - Night	L_n (or L_{night}) = $L_{Aeq,8h}$ (23:00 to 07:00)
Noise Level - L_{den} – Day/Evening/Night	A combination of L_d. L_e and L_n as follows: $L_{den} = 10\lg\frac{1}{24}\left(12*10^{\frac{L_{day}}{10}} + 4*10^{\frac{L_{evening}+5}{10}} + 8*10^{\frac{L_{night}+10}{10}}\right)$
Noise Mapping (Input) Data	Two broad categories: (1) Spatial (e.g. road centre lines, building outlines).

Term	Definition
	(2) Attribute (e.g. vehicle flow, building height – assigned to specific spatial data)
Noise Mapping Software	Computer program that calculates required noise levels based on relevant input data
Noise Model	All the input data collated and held within a computer program to enable noise levels to be calculated.
Noise Model File	The (proprietary software specific) project file(s) comprising the noise model
Output Data	The noise outputs generated by the noise model
Processing Data	Any form of manipulation, correction, adjustment factoring, correcting, or other adjustment of data to make it fit for purpose. (Includes operations sometimes referred to as 'cleaning' of data)
QA	Quality Assurance
Spatial (Input) Data	Information about the location, shape, and relationships among geographic features, for example road centre lines and buildings.
WG - AEN	Working Group – Assessment of Exposure to Noise